90TH ANNUAL MEETING
EMBASSY SUITES, MONTEREY BAY
SEASIDE, CALIFORNIA

General Information

Registration and Information
Welcome! Registration packets will be available at the registration table for those members who have pre-registered. Those who have not pre-registered but wish to attend the meeting can pay for membership and registration (with an added $30 late fee) at the registration table. Unfortunately, banquet tickets cannot be sold at the meeting because the hotel requires final counts of attendees well in advance. The Attitude Adjustment Hour (AAH) is included in the registration price, so you will only need to show your badge for admittance. WSN t-shirts and other paraphernalia can be purchased or picked up at the WSN Student Committee table.

A partial list of restaurants near the Embassy Suites can be found at the end of the program.

Special Event Information
On Thursday, November 12, there will be a student workshop entitled “Postdocs: what are they, how do you get them, and what can they do for you?” held in Laguna Grande AB. Immediately following will be the student mixer, held at Hopkins Marine Station located at 120 Oceanview Blvd., Pacific Grove, CA. On Friday, November 13, the WSN poster session will begin at 630 PM in the Laguna Grande EFG ballroom and the Attitude Adjustment Hour (AAH) will begin at 8 PM in the Laguna Grande ballroom. The Presidential Banquet will be held on Saturday, November 14 at 7:30 PM in the Laguna Grande ballroom, immediately followed by the Auction for the Student Travel Fund at ~ 9:30 PM.
SPECIAL EVENTS

Thursday, November 12

1800 – 2000  WSN Student Workshop (Laguna Grande AB)
2030 – 2400  WSN Student Mixer (Hopkins Marine Station)

Friday, November 13

1830 – 2030  WSN Poster Session (Laguna Grande EFG)
2000 – 2300  AAH: Attitude Adjustment Hour (Laguna Grande)

Saturday, November 14

1815 – 1900  WSN Annual Business Meeting (Seaside Ballroom)
1930 – 2130  WSN Presidential Banquet (Laguna Grande)
2130 – 2330  WSN Auction (Laguna Grande)

PROGRAM OF EVENTS

* Indicates person presenting
† Indicates eligibility for Best Student Paper or Best Student Poster Award

THURSDAY, NOVEMBER 12, 2009

1600 – 2000  Registration

1800  WSN student workshop: “Postdocs: what are they, how do you get them, and what can they do for you?”  (Laguna Grande AB)

Speakers to include:
Katie Arkema, The Natural Capital Project, Stanford University
Rebecca Martone, University of British Columbia
Jameal Samhouri, NOAA Fisheries - NMFS, Northwest Fisheries Science Center

2030  WSN Student Mixer - Hopkins Marine Station
120 Oceanview Blvd., Pacific Grove, CA
Open to all graduate and undergraduate students; no ticket required.
See the student desk for directions.
FRIDAY, NOVEMBER 13, 2009

STUDENT SYMPOSIUM

LAGUNA GRANDE ABCD

DARWIN AND THE SEA

0830  INTRODUCTION AND ANNOUNCEMENTS (Jenn Sunday)

0835  Grosberg, RK  UC Davis  DARWIN & THE SEA: THE MAKING OF AN EVOLUTIONIST

0930  Bernardi, G  UC Santa Cruz  DARWIN'S FISHES: SPECIATION IN THE GALAPAGOS ISLANDS

1000  BREAK

1030  Palumbi, SR  Stanford University  HOW MUCH LOCAL ADAPTATION IS THERE IN THE SEA? IMPLICATIONS FOR POPULATION BIOLOGY, EVOLUTION AND CLIMATE CHANGE

1100  Baskett, M  UC Davis  THE IMPLICATIONS OF HUMAN-DRIVEN EVOLUTION FOR MARINE MANAGEMENT

1130  SYNTHESIS, QUESTIONS AND DISCUSSION

1145  LUNCH
FRIDAY, NOVEMBER 13, 2009

SESSION 1       INVERTEBRATE BIOLOGY       LAGUNA GRANDE A

Chair: D. Zacherl

1300  †Colvin, MA*, and BT Hentschel San Diego State University SEASONAL VARIABILITY IN GROWTH RATES AND TRACE METAL CONCENTRATIONS OF POLYDORA CORNUTA IN THE TIJUANA ESTUARY ARE RELATED TO RAIN EVENTS

1315  †Matson, PG1, Steffen, BT2, and RM Allen3 1-UC Santa Barbara 2-UC Berkeley 3-University of Queensland, St. Lucia LINKING LARVAL BEHAVIOR AND ALGAL SETTLEMENT PREFERENCE IN CYPHONAUTES LARVAE OF MEMBRANIPORA MEMBRANACEA

1330  †Jones AM1*, and Lohse DP2 1-Division of Science and Environmental Policy (SEP), California State University, Monterey Bay 2-Department of Biology, University of California, Santa Cruz A REGIONAL COMPARISON OF MYTILUS CALIFORNIANUS GROWTH RATES ALONG THE CENTRAL COAST OF CALIFORNIA

1345  †Kelly, JA*, and SF Craig Humboldt State University GEOGRAPHIC VARIATION IN SPOTTING PATTERN IN THE NUDIBRANCH DIAULULA SANDIEGENSIS

1400  †Burns, J*, Rozet, NK, Gregg, TM, and M Takabayashi University of Hawaii at Hilo SKELETAL GROWTH ANOMALIES AFFLICTING MONTIPORA CAPITATA CORALS: AN ANALYSIS OF SKELETAL MORPHOLOGY AND DISEASE PREVALENCE.

1415  Dimond, J*, Bingham, B, Muller-Parker, G, and K Wuesthoff Shannon Point Marine Center, Western Washington University SEASONAL STABILITY OF ANTHOPLEURA ELEGANTISSERTIMA SYMBIOTIC ALGAL POPULATIONS

1430  †Wolf, M* University of Oregon, Oregon Institute of Marine Biology PARASITE PENTHOUSE: SITE SPECIFICITY OF AN ENDOPARASITIC COPEPOD WITHIN ITS NUDIBRANCH HOST

1445  †Frohbieter, DW* Alaska Pacific University HABITAT SELECTION AND MOVEMENT OF THE GIANT PACIFIC OCTOPUS, ENTEROCTOPUS DOFLEINI

1500 BREAK
FRIDAY, NOVEMBER 13, 2009

SESSION 2   DISPERSAL AND RECRUITMENT I  LAGUNA GRANDE A

Chair: R. Wilson

1530 **Borges, R**\(^1\), **Serrão, EA**\(^1\), and **EJ Gonçalves**\(^2\) 1-CCMAR, Centre Marine Sciences. Algarve University, Portugal 2-Eco-Ethology Research Unit, ISPA, Portugal  DIFFERENT MECHANISMS FOR DIFFERENT SPECIES – SMALL SCALE DIFFERENCES IN THE OCCURRENCE AND DISTRIBUTION OF TEMPERATE REEF FISH LARVAE

1545 †**Krug, JM**\(^1\), and **MA Steele** CSU Northridge A TEST FOR SPATIALLY CORRELATED RECRUITMENT AND THE EFFECTS OF PREDATORS AND HABITAT ON RECRUITMENT AND MORTALITY OF A TEMPERATE REEF FISH

1600 †**Trbovich, SM**\(^1\), and **RR Wilson, Jr.** CSU Long Beach GENETIC EVIDENCE FOR PERIODIC COASTAL-DERIVED RECRUITMENT ACROSS OFFSHORE THERMAL AND CURRENT BARRIERS IN KELP BASS (PARALABRAX CLATHRATUS), A TEMPERATE ROCKY REEF FISH

1615 †**Pinsky, ML**\(^1\), and **SR Palumbi** Stanford University GENETIC SCALES OF LARVAL DISPERSAL IN FISH: ARE THEY COMPATIBLE WITH SELF-RECRUITMENT?

1630 †**Haupt, AJ**\(^1\), **Micheli, F**, and **SR Palumbi** Hopkins Marine Station, Stanford University DISPERAL AT A SNAIL’S PACE: STRONG GENETIC STRUCTURE IN THE FISHERIES GASTROPOD MEGASTRAEA UNDOSA.

1645 †**Maliska, ME** University of Washington, Friday Harbor Labs SETTLEMENT CUES AND THEIR POTENTIAL EFFECT ON DISPERSAL IN TWO SIBLING SPECIES OF ROCKY INTERTIDAL GASTROPODS, LITTORINA PLENA AND LITTORINA SCUTULATA

1700 †**Le Corre, N**\(^1\), **Johnson, LE**\(^1\), and **F Guichard**\(^2\) 1 - Université Laval 2 - McGill University DEMOGRAPHIC COUPLING: THE LINK BETWEEN ADULTS AND RECRUITS ACROSS THE YEARS IN THE ST. LAWRENCE ESTUARY.

1715 **Strathmann, RR** Friday Harbor Labs, University of Washington PLASTICITY IN HATCHING FROM A NUDIBRANCH EGG RIBBON AND ITS EFFECT ON DURATION AS A PRECOMPETENT SWIMMING LARVA

1730 †**Nickols, KJ**\(^1\), **Gaylord, B**\(^2\), and **J Largier**\(^3\) 1-Bodega Marine Laboratory, UC Davis 2-Bodega Marine Laboratory and Department of Evolution and Ecology, UC Davis, 3-Bodega Marine Laboratory and Department of Environmental Science and Policy, UC Davis  THE COASTAL BOUNDARY LAYER: NEARSHORE VELOCITY ATTENUATION AS ANOTHER CONTRIBUTOR TO PASSIVE PHYSICAL RETENTION OF MARINE LARVAL ORGANISMS.

1745 †**Fredell, AW**\(^1\), **Martin, KL**\(^2\), and **DZ Zacherl**\(^1\) 1 - CSU Fullerton 2 - Pepperdine University OUT OF THE SAND AND INTO THE SURF: CAN WE DETERMINE SELF-RECRUITMENT IN THE CALIFORNIA GRUNION, LEURESTHES TENUIS.
Chair: R. Martone

1300 Peña, TS*, Gonzalez, LI, and TH Keitt University of Texas at Austin CONSEQUENCES OF SMALL WORLD CONNECTIONS AND ALLEE EFFECTS ON THE PERSISTENCE OF MARINE PROTECTED AREAS

1315 †Llaban, AS*, and PJ Krug CSU Los Angeles REPRODUCTIVE INTERFERENCE AND ALLEE EFFECTS AT A SHIFTING RANGE BOUNDARY

1330 †Cavanaugh, KC1*, Siegel, DA1, Kinlan, BP2, and DC Reed2 1-Institute for Computational Earth System Science, UC Santa Barbara 2 Marine Science Institute, UC Santa Barbara SCALING LOCAL MEASUREMENTS OF GIANT KELP CANOPY COVER AND BIOMASS TO REGIONAL ESTIMATES USING SATELLITE OBSERVATIONS

1345 Kitting, CL1*, Loomis, T2, Loomis, S2, and S Cassell3 1-CSU East Bay and Undersea Voyager Project. 2-Undersea Voyager Project, South Lake Tahoe 3-Undersea Voyager Project UNUSUAL COLONIAL PROTISTS AND OTHER ALGAL DISTRIBUTIONS IN DEEP FALLEN LEAF LAKE, WITHOUT INVASIVE INVERTEBRATES AND PLANTS, NEAR LAKE TAHOE, CALIFORNIA.

1400 †Kiriakopolos, SL*, and KE Boyer San Francisco State University, Romberg Tiburon Center THE ROLE OF HERBIVORY BY BRANTA CANADENSIS (CANADA GEESE) IN THE ANNUAL LIFE CYCLE OF A SAN FRANCISCO BAY ZOSTERA MARINA (EELGRASS) POPULATION

1415 Coyer JA1*, Hoarau, G2, van Schaik, J1, Luijckx, P3, and JL Olsen1 1-University of Groningen, The Netherlands 2-Bodo University College, Norway 3-University of Basel, Switzerland MTDNA AND MICROSATELLITE ANALYSIS OF THE INTERTIDAL ALGA FUCUS DISTICHUS REVEAL MULTIPLE COLONIZATIONS OF THE NORTH ATLANTIC FROM THE NORTH PACIFIC AND TWO GLACIAL REFUGIA

1430 Martone, RG1*, Micheli, F1, Dunbar, RB2, and EB Roark3 1-Hopkins Marine Station, Stanford University 2-School of Earth Sciences, Stanford University 3-College of Geosciences, Texas A & M SPATIO-TEMPORAL VARIATION IN GROWTH OF MEGASTRAEA UNDOSA: CONTEXT-DEPENDENT EFFECTS OF TEMPERATURE

1445 Brannin, MT*, Fingerut, JT, and MK O'Donnell Saint Joseph's University HOW DOES FLOW RATE AND SIZE AFFECT LARVAL GROWTH RATES? A STUDY ON THE BLACK FLY SIMULIUM TRIBULATUM

1500 BREAK
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SESSION 4  INTERTIDAL ECOLOGY I  LAGUNA GRANDE C

Chair: B. Allen

1530  Tepler, SK*, and MW Denny  Hopkins Marine Station, Stanford University  WHY DOES CHLOROSTOMA FUNEBRALIS HAVE A BLACK SHELL?

1545  †Jensen, MM*, and MW Denny  Hopkins Marine Station, Stanford University  IMPINGEMENT: THE NEGLLECTED INTERTIDAL HYDRODYNAMIC FORCE

1600  †Kordas, RL*, and CD Harley  University of British Columbia  EXPERIMENTAL WARMING REDUCES INVERTEBRATE DENSITY AND OVERALL SPECIES RICHNESS ON ROCKY SHORES

1615  †Levine, MR*  Western Washington University  MICROHABITAT AFFECTS THE DISTRIBUTION OF TWO ALGAL SYMBIONTS HOSTED BY THE INTERTIDAL SEA ANEMONE ANTHOPLEURA XANTHOGRAMMICA

1630  †Emery, M*, and BL Bingham  Western Washington University  FACTORS THAT INFLUENCE BODY TEMPERATURE OF THE COMMON SEA ANEMONE, ANTHOPLEURA ELEGANTISSIMA, DURING AERIAL EXPOSURE

1645  †Romero, R†  Moss Landing Marine Laboratories  RECRUITMENT STRATEGIES OF THE EPHEMERAL, OPPORTUNISTIC MACROALGAE ULVA AND PORPHYRA IN CENTRAL CALIFORNIA

1700  Shaughnessy, FJ*  Humboldt State University  COMMUNITY DYNAMICS AND CLIMATE CHANGE AT A ROCKY INTERTIDAL SITE IN HUMBOLDT BAY, CA: 11 YEARS OF PHYCOLOGY STUDENT DATA

1715  †Smith, KA*  University of South Carolina  DIEL PARTITIONING OF SURGE AND SUBMERGENCE INFLUENCES INTERTIDAL BARNACLE SPECIES DISTRIBUTION PATTERNS

1730  †Takagi KK1*, Cherdasukjai P2, Mimura I1, Yano Y1, Adulyanukosol K2, and Tsuchiya M1  1-University of the Ryukyus 2-Phuket Marine Biological Center  SOLDIER CRAB (DOTILLA MYCTIROIDES) DISTRIBUTION, FOOD RESOURCES AND SUBSEQUENT ROLE IN ORGANIC MATTER FATE IN AO TANG KHEN, PHUKET, THAILAND

1745  †Waltz, GT1*, Kimura, S2, Steinbeck, JR2, and DE Wendt†  1-Center for Coastal Marine Sciences, California Polytechnic State University, San Luis Obispo 2-Tenera Environmental, Inc., San Luis Obispo, CA. BARE SPACE OR BOUNTIFUL BIOTA: AN ANALYSIS OF HUMAN DISTURBANCE ON OUR ROCKY SHORELINES
FRIDAY, NOVEMBER 13, 2009

SESSION 5  EVOLUTIONARY BIOLOGY I  SEASIDE BALLROOM

Chair:  R. Hechinger

1300  †Miklasz, KA*, and MW Denny  Hopkins Marine Station  HOW TO GET A BIGGER HOUSE WITHOUT GOING UNDERWATER: A CASE STUDY IN UNICELLULAR ALGAE

1315  †Combosch, DJ*, and SV Vollmer  Marine Science Center, Northeastern University POPULATION GENETICS OF AN ECOSYSTEM-ENGINEER – POCILLOPORA DAMICORNIS (CNIDARIA, SCLERACTINIA) IN THE TROPICAL EASTERN PACIFIC

1330  †Trathen, DY*, and PJ Krug  CSU Los Angeles COMPARATIVE PHYLOGEOGRAPHY OF CARIBBEAN SEA SLUGS WITH LONG-LIVED VS. SHORT-LIVED LARVAE

1345  †Wells, E.H.*, and E.D. Grosholz  UC Davis SHARED EVOLUTIONARY HISTORY AND THREE WHELKS’ ABILITY TO ADAPT TO NOVEL PREY

1400  Hechinger, RF*  Marine Science Institute, UCSB THE PROBABILITY OF DEATH AFFECTS ADAPTIVE ALLOCATION TO GROWTH AND REPRODUCTION: FIELD EVIDENCE FROM A GUILD OF BODY SNATCHERS

1415  †Pespeni, MH*, Oliver, TA, and SR Palumbi  Hopkins Marine Station, Stanford University THE PURPLE SEA URCHIN GENOME SUGGESTS LOCAL ADAPTATION ALONG A LATITUDINAL GRADIENT DESPITE HIGH GENE FLOW

1430  Leonard, JL1*, Pearse, JS1, Backelaju, T2, and K Breugelman2 1-Long Marine Laboratory, UCSC 2-Royal Belgian Institute of Natural Sciences. Brussels A PUZZLING CLADE OF BANANA SLUGS (ARIOLIMAX (MEADARION); STYLOMMATOPHORA)

1445  †Aguirre, JD*, Blows, MW, and DJ Marshall  University of Queensland EGGS CHOOSE THE SPERM THAT PRODUCE THE BEST QUALITY OFFSPRING

1500  BREAK
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SESSION 6 BEHAVIORAL ECOLOGY SEASIDE BALLROOM

Chair: D. Goley

1530  †Burris, ZP*  Oregon Institute of Marine Biology MATING BEHAVIOR OF THE SEA SPIDER ACHELIA SIMPLISSIMA

1545  Scheel, D  Alaska Pacific University SPECIALIZATION IN THE DIET OF A GENERALIST PREDATOR, ENTEROCTOPUS DOFLEINI

1600  Lee, RK*  Alaska Pacific University GIANT PACIFIC OCTOPUS (ENTEROCTOPUS DOFLEINI) INTERACTION WITH SHRIMP POTS IN PRINCE WILLIAM SOUND

1615  DeSalles, PA1*, Papastamatiou, YP2, Micheli, F1, and DJ McCauley1 1-Hopkins Marine Station, Stanford University 2-Hawaii Institute of Marine Biology, University of Hawaii at Manoa MOVEMENT PATTERNS AND HABITAT PREFERENCE OF THE GIANT MANTA RAY, MANTA BIOSTRIS, AT A REMOTE PACIFIC ATOLL

1630  Andrew, KS., Williams, GD., and PS. Levin NOAA Fisheries, NWFSC, Seattle, WA DAILY, SEASONAL, AND YEARLY PATTERNS OF MOVEMENT FOR SIXGILL SHARKS HEXANCHUS GRISEUS IN PUGET SOUNDS.....AND BEYOND.

1645  †Espinoza, M*, Farrugia, TJ, and CG Lowe CSU Long Beach INFLUENCE OF WATER TEMPERATURE ON SITE FIDELITY, MOVEMENTS AND HABITAT USE OF THE GRAY SMOOTH-HOUND SHARK (MUSTELUS CALIFORNICUS) IN A NEWLY RESTORED ESTUARINE HABITAT

1700  Goley, PD,1*, Jenkinson, R 2, Hudson, C1, Fuller, A1, Hacker, G1, Niemeyer, M3, Mallo, A4, Deutsch, S5, Toropova, C6, Bigham, K1, Rushton, A1, Teeple, N1, Eberle, J1, Giordano, S1, Lui, A1, Korcheck, K1, McGrane, M1, Warner, S1, Rushton, A1, and E Xanders1 1-Humboldt State University 2-San Diego State University 3-NOAA 4-University of Auckland 5-Texas A and M 6-Nature Conservancy THE TEMPORAL AND SPATIAL DISTRIBUTION OF GRAY WHALES ESCHRICHTIUS ROBUSTUS IN NORTHERN CALIFORNIA

1715  †Grason, EW*, and BG Miner Western Washington University NON-CONSUMPTIVE EFFECTS IN A MARINE FOOD CHAIN WITH BOTH NATIVE AND INVASIVE SPECIES.

1730  †Schroeder, SL*  Oregon Institute of Marine Biology, University of Oregon  THE GRASS IS GREENER: LOTTIA GIGANTEA HOME RANGE FORMATION BASED ON VARIABLE ALGAL DENSITY

1745  †Horwith, MJ*  University of Washington ABOVE- AND BELOWGROUND COMPETITIONS BETWEEN SHOOTS CONTROL MORPHOLOGY AND PROPAGATION IN A CLONAL MARINE ANGIOSPERM (ZOSTERA MARINA)
FRIDAY, NOVEMBER 13, 2009

SESSION 7  COMMUNITY ECOLOGY I  LAGUNA GRANDE D

Chair: B. Erisman

1300  **Erisman, BE**, Paredes, G, Hastings, PA, and O Aburto-Oropeza  *Scripps Institution of Oceanography*  SPATIAL PATTERNS, SPECIES COMPOSITION, AND TROPHIC STRUCTURE OF MARINE FISHERIES FROM NORTHWEST MEXICO WITH IMPLICATIONS FOR ECOSYSTEM-BASED MANAGEMENT

1315  †Parravicini, V*, Micheli, F, Peirano, A, Roghi, F, Salvati, E, Morri, C, and C.N. Bianchi 1-DipTeRis, University of Genoa 2-Hopkins Marine Station, Stanford University 3-ENEA, Marine Environment Research Centre, Santa Teresa, Italy. 4-ISPRRA, Istituto Superiore per la Protezione e la Ricerca Ambientale, Italy. ASSESSING DECADAL-SCALE CHANGE IN BENTHIC COMMUNITY STRUCTURE: AN EXAMPLE FROM A NW MEDITERRANEAN CORALLIGENOUS COMMUNITY

1330  †Jacobson, LM*, and PJ Edmunds  *CSU Northridge*  LONG-TERM CHANGES IN BIOLOGICAL QUALITY OF SEAWATER ON A SHALLOW CARIBBEAN REEF

1345  †Cameron, CM*, and PJ Edmunds  *CSU Northridge*  THE EFFECTS OF DIFFERENT TYPES OF SIMULATED FISH PREDATION ON THE GROWTH AND RECOVERY OF SMALL CORALS

1400  †Dale, JJ1*, and KN Holland 1-University of Hawaii 2-Hawaii Institute of Marine Biology  FEEDING ECOLOGY AND HABITAT USE OF BROWN STINGRAYS (*Dasyatis lata*) IN HAWAI‘I INFERRED FROM STOMACH CONTENT AND STABLE ISOTOPE ANALYSIS

1415  Tolimieri, N** NOAA Fisheries, Northwest Fisheries Science Center  PATTERNS IN TAXONOMIC DISTINCTNESS OF WEST COAST GROUNDFOXES IN RELATION TO DEPTH AND LATITUDE

1430  **Johnson DW**, and RW Lamb  *Oregon State University*  COMMUNITY-WIDE EFFECTS OF A LARGE MARINE RESERVE: EVIDENCE OF A TROPHIC CASCADE IN A DIVERSE ASSEMBLAGE OF REEF FISHES?

1445  Ridlon, A.D.*, Weiskel, H.W., and E.D. Grosholz  Department of Environmental Science and Policy, UC Davis  NATIVE SNAIL DISPROPORTIONATELY VULNERABLE TO PREDATION BY INVASIVE PREDATOR

1500  BREAK
FRIDAY, NOVEMBER 13, 2009

SESSION 8  COMMUNITY ECOLOGY II  LAGUNA GRANDE D

Chair: N. Tolimieri

1530  Long, JD.1*, Mitchell, JL.2, Giddens, H.3, and EE Sotka3 1 - San Diego State University 2 - Northeastern University 3 - College of Charleston LOCAL CONSUMERS INDUCE RESISTANCE IN SOUTHERN, BUT NOT NORTHERN, SPARTINA POPULATIONS

1545  Chang, AL.1*, Brown, CW1, Crooks, JA.2, and GM Ruiz1 1 - Smithsonian Environmental Research Center 2 - Tijuana River NERR STORMS AND DROUGHTS: COMMUNITY CONSEQUENCES OF ALTERED ESTUARINE HYDROLOGICAL CYCLES

1600  †Edwards, KF.1*, and JJ Stachowicz UC Davis SPATIALLY VARIABLE SETTLEMENT CAN PROMOTE COEXISTENCE IN BENTHIC COMMUNITIES

1615  Lee, S.C.1*, and J.F. Bruno2 1 - Hopkins Marine Station, Stanford University 2 - University of North Carolina at Chapel Hill EFFECTS OF PROPAGULE SUPPLY AND RESOURCE AVAILABILITY ON ASSEMBLY AND ECOSYSTEM PROPERTIES IN MULTITROPHIC MARINE COMMUNITIES

1630  †Watson, JR1*, Siegel, DA1, Raimondi, P2, Hays, C3, Mitarai, S4, Dong, C5, and JC McWilliams5 1 - UC Santa Barbara 2 - UC Santa Cruz 3 - UC Merced 4 - Okinawa Institute of Science and Technology 5 – UCLA COMMUNITIES CONNECTED BY CURRENTS: A STUDY OF NEARSHORE MARINE SPECIES IN THE SOUTHERN CALIFORNIA BIGHT

1645  Munguia, P1*, Ojanguren, AF, Evans, A, Rickman, L, Gemmell, B, Cook, C, and K Duskak The University of Texas at Austin A REVIEW OF POSITIVE INTERACTIONS IN MARINE COMMUNITIES

1700  Dufault, AM1*, Marshal, K, and IC Kaplan NOAA Northwest Fisheries Science Center, Conservation Biology Division. Current affiliation: CSU Northridge A META-ANALYSIS OF DIETS AND TROPHIC OVERLAP WITHIN THE CALIFORNIA CURRENT

1715  Douglass, JG* Smithsonian Marine Station at Fort Pierce DO MARINE RESERVES AFFECT SEAGRASS COMMUNITIES? OBSERVATIONS AND EXPERIMENTS FROM FLORIDA

1730  Farlin, JF1*, Lewis, LS2, Anderson, TW1, and CT Lai1 1 - San Diego State University 2 - Scripps Institution of Oceanography STABLE ISOTOPE ANALYSIS OF AMPHIPODS IN AN EELGRASS FOOD WEB

1745  Novak, M1* UC Santa Cruz LINEAR RESPONSES FROM NONLINEAR INTERACTIONS: WHY LINEAR MEASURES OF SPECIES INTERACTION STRENGTHS DO AND DO NOT SUFICE
## FRIDAY, NOVEMBER 13, 2009

### SESSION 9  
**APPLIED ECOLOGY I**  
**LAGUNA GRANDE C**

**Chair:** J. Lindholm

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<td>1300</td>
<td><strong>RETURN TO OBSERVATIONAL ECOLOGY</strong></td>
<td>Sagarin, RD*, and A Pauchard Institute of the Environment, University of Arizona A</td>
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<td>1315</td>
<td><strong>POPULATION GENETICS AND THE ENDANGERED SPECIES ACT</strong></td>
<td>Kelly, RP* UC Berkeley</td>
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<td>1330</td>
<td><strong>ASSESSING ECOLOGICAL EFFECTS OF AREA-BASED MANAGEMENT POLICIES ON NORTHERN ABALONE IN HAIDA GWAIJ, BRITISH COLUMBIA</strong></td>
<td>Lee, LC*, and AK Salomon Simon Fraser University School of Resource and Environmental Management</td>
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<td>1345</td>
<td><strong>OVERVIEW OF THE BIOLOGICAL SAMPLING USED TO ASSESS THE CENTRAL CALIFORNIA COAST MARINE PROTECTED AREAS - WITH EMPHASIS ON ROCKY INTERTIDAL HABITATS.</strong></td>
<td>Ammann, KN*, Bell, CA, George, MK, and PT Raimondi UC Santa Cruz AN</td>
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<td>1400</td>
<td><strong>OLYMPIA OYSTER (OSTREA LURIDA) RECRUITMENT, GROWTH, AND SURVIVAL ALONG PHYSICAL AND BIOLOGICAL GRADIENTS IN A CENTRAL CALIFORNIA ESTUARY</strong></td>
<td>Deck, AK*, and ED Grosholz Bodega Marine Lab, UC Davis</td>
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<td>1415</td>
<td><strong>RECOVERY TRAJECTORIES IN SEAFLOOR COMMUNITIES IMPACTED BY TRAWLING ALONG THE CENTRAL COAST OF CALIFORNIA. (OR TRAWLING: GONE TODAY, HERE TOMORROW?)</strong></td>
<td>Lindholm, J1*, Gleason, M2, Kline, D1, and C Parrish-Kuhn1 1 - Institute for Applied Marine Ecology at CSU Monterey Bay 2 - The Nature Conservancy</td>
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<td>1430</td>
<td><strong>PROCESS-BASED MODELS FOR MAPPING AND VALUING ECOSYSTEM SERVICES PROVIDED BY COASTS AND OCEANS</strong></td>
<td>Arkema, KK*, Guerry, A, Ruckelshaus, M, and M Pinsky Woods Institute for the Environment, Stanford University</td>
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<td>1445</td>
<td><strong>EVIDENCE FOR MICROBE-DRIVEN JANZEN-CONNELL EFFECTS IN A TROPICAL CORAL</strong></td>
<td>†Marhaver, KL1*, Vermeij, MJA2, and SA Sandin1 1 - Scripps Institution of Oceanography 2 - University of Amsterdam, The Netherlands, and Carmabi Foundation, Curacao, Netherlands Antilles</td>
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FRIDAY, NOVEMBER 13, 2009

SESSION 10 INVASIVE SPECIES LAGUNA GRANDE B

Chair: S. Lonhart

1530 **Lonhart, SI**, and **C Zabin** 1 - NOAA, Monterey Bay National Marine Sanctuary 2 - Smithsonian Environmental Research Center and UC Davis COMING TO A HARBOR NEAR YOU: THE INVASIVE ASIAN KELP *UNDARIA PINNATIFIDA*

1545 †**Collins, CA**, †**Flores, VR**, †**Mackie, JA**, †**Craig, SF**, and †**M Nelson** 1 – UC Santa Cruz 2 - CSU Humboldt 3 - CSU San Jose POPULATION VARIATION AND EFFECTS OF COPPER IN *WATERSIPORA SUBTORQUATA*

1600 †**Dowell, LN**, and †**A Lauer** CSU Bakersfield DIVERSITY OF EPIBIOTIC MICROORGANISMS ASSOCIATED WITH INVASIVE MARINE BRYOZOAN SPECIES FROM NORTHERN CALIFORNIA (MONTEREY BAY AND ELKHORN SLOUGH)

1615 †**Gonzales, VA**, and †**B Tsukimura** CSU Fresno POPULATION DECLINE OF THE CHINESE MITTEN CRAB, *ERIOCHEIR SINENSIS*, IN SAN FRANCISCO BAY

1630 †**Preisler, RK**, and †**K Wasson** 1 - UC Santa Cruz, 2 - Elkhorn Slough Estuarine Research Reserve BIOGEOGRAPHIC VARIATION IN ABUNDANCE, HABITAT USE, AND BEHAVIOR OF THE EUROPEAN GREEN CRAB, *CARCINUS MAENAS*

1645 †**Selden, RL**, †**Cahill, AE**, †**Crim, RN**, and †**S Crickenberger** 1 - UC Santa Barbara 2 - State University of New York Stony Brook 3 - University of British Columbia 4 - Clemson University DISPERSAL LIMITATION AND POST-SETTLEMENT SURVIVAL OF AN INTRODUCED ASCIDIAN (*BOTRYLLOIDES VIOLACEUS*) IN SAN JUAN ISLANDS, WA

1700 †**Smith, NS**, and †**JB Shurin** University of British Columbia CONSEQUENCES OF COASTAL HABITAT MODIFICATION FOR MARINE FISH INVASION

1715 †**Sorte, CJB**, and †**JJ Stachowicz** 1 - Bodega Marine Lab, UC Davis 2 – UC Davis PRIORITY EFFECTS AND INVASIVE DOMINANCE IN A MARINE FOULING COMMUNITY

1730 †**Stewart, JS**, and †**WF Gilly** Hopkins Marine Station of Stanford University, Pacific Grove SEASONAL ABUNDANCE OF HUMBOLDT SQUID IN MONTEREY BAY IN RELATION TO UPWELLING

1745 **Zabin, CJ**, **Davidson, I**, **Brown, CW**, **Chang, AL**, **Ashton, GV**, **Ruiz, GM**, and **M. Sytsma** 1 - Smithsonian Environmental Research Center, Tiburon CA 2 - Aquatic Bioinvasion Research & Policy Institute, Portland State University 3 - UC Davis 4 - Smithsonian Environmental Research Center, MD HULL FOULING AND MOVEMENT PATTERNS OF RECREATIONAL VESSELS IN SAN FRANCISCO BAY AND ENVIRONS
FRIDAY, NOVEMBER 13, 2009

1830-2030  WSN POSTER SESSION  LAGUNA GRANDE EFG

2000-2300  WSN ATTITUDE ADJUSTMENT HOUR  LAGUNA GRANDE

The AAH will be held in part of the Laguna Grande Ballroom of the Embassy Suites, where you can enjoy food and beverages with your colleagues and see posters in the neighboring Laguna Grande rooms. Tickets are required.
PRESIDENTIAL SYMPOSIUM

PREDICTING THE EFFECTS OF CLIMATE VARIATION ON MARINE ORGANISMS, COMMUNITIES, AND ECOSYSTEMS

0800  INTRODUCTION (Robert Carpenter)

0815  **Feely, R** Pacific Marine Environmental Laboratory OCEAN ACIDIFICATION OF THE NORTHEASTERN PACIFIC COASTAL WATERS

0845  **Hofmann, GE** UC Santa Barbara IF YOU CAN'T RUN AND YOU CAN'T HIDE: PHYSIOLOGICAL MECHANISMS TO TOLERATE A RAPIDLY CHANGING ENVIRONMENT

0915  **Sanford, E** Bodega Marine Laboratory, University of California Davis PREDICTING THE EFFECTS OF CLIMATE CHANGE ON MARINE POPULATIONS AND COMMUNITIES: CHALLENGES AND OPPORTUNITIES

0945  BREAK

1015  **Klinger, T** University of Washington HOW WILL CLIMATE CHANGE IMPACT MARINE ECOSYSTEM FUNCTION?

1045  PANEL DISCUSSION

1115  WSN LIFETIME ACHIEVEMENT AWARD (Greg Cailliet)

1130  INTRODUCTION OF THE NATURALIST OF THE YEAR (by Robert Carpenter)

1135  WSN NATURALIST OF THE YEAR (Jenn Caselle)

1200  LUNCH
SATURDAY, NOVEMBER 14, 2009

SESSION 11    POPULATION BIOLOGY II    SEASIDE BALLROOM

Chair: A. Cheroske

1300 †Gordon, D*, P Krug CSU Los Angeles ENVIRONMENTAL EFFECTS ON LARVAL DEVELOPMENT OF THE SEA SLUG ALDERIA WILLOWI

1315 Miller, EF*, Pondella, DJ, Beck, DS, and KT Herbinson MBC Applied Environmental Sciences HISTORIC POPULATION TRENDS OF CALIFORNIA SCIAENIDS (FAMILY SCIAENIDAE): IMPLICATIONS OF OCEANOGRAPHIC FORCING, CLIMATE CHANGE, AND FISHING

1330 Freiwald, J* UC Santa Cruz DENSITY-DEPENDENT HOME RANGE SIZE IN A TEMPERATE REEF FISH, KELP GREENLING (HEXAGRAMMOS DECAGRAMMUS)

1345 †McCully, KM*, and DC Potts UC Santa Cruz STATUS AND DYNAMICS OF THE BLACK-LIPPED PEARL OYSTER, PINCTADA MARGARITIFERA, AT MIDWAY ATOLL, NORTHWESTERN HAWAIIAN ISLANDS

1400 Putnam, HM*, Stat, M, Pochon, X, and RD Gates University of Hawaii at Manoa CHARACTERIZING SYMBIODINIUM DIVERSITY AND HOST SPECIFICITY IN THE CORALS OF MOOREA, FRENCH POLYNESIA

1415 †Puritz, JB*, and RJ Toonen Hawaii Institute of Marine Biology, University of Hawaii LIMITED DISPERSAL DESPITE HIGH DISPERSAL POTENTIAL: THE FINE SCALE POPULATION STRUCTURE OF PATIRIA MINIATA IN THE SOUTHERN CALIFORNIA BIGHT

1430 †Cooper, EE* Oregon Institute of Marine Biology EFFECTS OF PREDATION ON POPULATION STRUCTURE OF CHLOROSTOMA (TEGULA) FUNEBRALIS, AN INTERTIDAL GASTROPOD

1445 †Lord, JP* Oregon Institute of Marine Biology NOTES ON THE DISTRIBUTION, LARVAL DEVELOPMENT AND EARLY LIFE STAGES OF THE GUMBOOT CHITON, CRYPTOCHITON STELLERI

1500 BREAK
SATURDAY, NOVEMBER 14, 2009

SESSION 12  FISHERIES ECOLOGY I  LAGUNA GRANDE C

Chair: K. Anthony

1530 †Rogers, BL*, Lowe, CG, and E Fernandez-Juricic CSU Long Beach HOW POP-EYE FROM BAROTRAUMA AFFECTS VISION IN ROCKFISH (SEBASTES SPP.)

1545 †Young, MA†, Iampietro, PJ‡, Kvitk, RG², and CD Garza³ 1 - Seafloor Mapping Lab, CSUMB and UC Santa Cruz 2 - Seafloor Mapping Lab, CSUMB 3 – CSU Monterey Bay MULTIVARIATE BATHYMETRY-DERIVED LANDSCAPE ECOLOGY MODEL ACCURATELY PREDICTS ROCKFISH DISTRIBUTION IN CORDELL BANK NATIONAL MARINE SANCTUARY, CA, USA

1600 †Lotterhos, KE* Florida State University CONTRIBUTION OF PRE- AND POST-SETTLEMENT PROCESSES TO RECRUITMENT DYNAMICS OF BLACK ROCKFISH, SEBASTES MELANOPS

1615 †Al-Humaidhi, AW* University of Maine AN ASSESSMENT OF SPATIAL DYNAMICS OF STOCK STRUCTURE FOR THREE GULF OF MAINE GROUNDFISH SPECIES

1630 †Gherard, KE* CSU Northridge AGE, GROWTH, AND BATCH FECUNDITY OF THE GULF CORVINA, Cynoscion Othonopterus, FROM THE NORTHERN GULF OF CALIFORNIA, MEXICO

1645 Zgliczynski, BJ*, Sandin, SA², Williams, ID³, Schroeder, RE³, Nadon, MO³, and BL Richards³ 1 - NOAA Pacific Islands Fisheries Science Center (PIFSC), Coral Reef Ecosystem Division (CRED) Hawaii, and Center for Marine Biodiversity and Conservation, Scripps 2 - Center for Marine Biodiversity and Conservation, Scripps 3 - NOAA-Joint Institute for Marine and Atmospheric Research and PIFSC, CRED, Honolulu CORAL REEF FISH ASSEMBLAGES ACROSS THE PACIFIC

1700 Donovan, MK*, and RE Schroeder Joint Institute for Marine and Atmospheric Research, University of Hawaii, NOAA, Pacific Islands Fisheries Science Center, Coral Reef Ecosystem Division COMPARISON OF REEF FISH ASSEMBLAGE STRUCTURE ACROSS AN EXPLOITATION GRADIENT IN AMERICAN SAMOA

1715 White, C, and C Costello UC Santa Barbara MATCHING SPATIAL PROPERTY RIGHTS FISHERIES WITH SCALES OF FISH DISPERSAL

1730 Marinovic, BB¹, and S Bargu² 1 - UC Santa Cruz 2 - Louisiana State University DIFFERENCES IN MALE/FEMALE RELATIVE ABUNDANCE AND SIZE IN DAYTIME SURFACE SWARMS FOR TWO SPECIES OF MONTEREY BAY KRILL

1745 †Ettner, EE, Burchfield, JD, and BB Marinovic UC Santa Cruz COMPARISON OF KRILL SIZE STRUCTURE COLLECTED CONCURRENTLY USING MIDWATER ROPE TRAWLS AND STANDARD BONGO NETS.
SATURDAY, NOVEMBER 14, 2009

SESSION 13  SPECIES-HABITAT ASSOCIATION  LAGUNA GRANDE B

Chair: D. Eernisse

1300  †Cerda, JA\textsuperscript{1*}, Sorte, CJ \textsuperscript{2}, and SL Williams\textsuperscript{1} 1 - UC Santa Cruz 2 - Bodega Marine Laboratory, UC Davis ASSOCIATIONS BETWEEN NATIVE AND INVASIVE CAPRELLA AND BUGULA: EPIFAUNA-SUBSTRATUM INTERACTIONS

1315  †Kelly, MK \textsuperscript{1*}, Lindholm, J\textsuperscript{1}, Knight, A\textsuperscript{1}, Kline, D\textsuperscript{1}, and J deMarignac\textsuperscript{2} 1 - Institute for Applied Marine Ecology (IfAME), CSU Monterey Bay 2 - SIMoN Program, Monterey Bay National Marine Sanctuary DISTRIBUTION OF THE BLACKEYE GOBY, RHINOLOGOBIOPS NICHOLSI, AROUND TEMPERATE REEFS ALONG THE CENTRAL COAST OF CALIFORNIA

1330  Eernisse, DJ\textsuperscript{1*}, and A Draeger\textsuperscript{2} 1 - Cal State Fullerton 2 - No Affiliation NEW CHITONS (MOLLUSCA: POLYPLACOPHORA) FROM SEAMOUNTS OFF SOUTHERN CALIFORNIA

1345  Bell, CA\textsuperscript{*}, Ammann, KN, George, MK, and PT Raimondi UC Santa Cruz ASSESSING THE AMOUNT OF SUITABLE HABITAT AND THE POPULATION SIZE OF BLACK ABALONE (HALIOTIS CRACHERODII) FROM HALF MOON BAY TO POINT CONCEPTION

1400  Reinhard, LJ\textsuperscript{1*}, Ammann, KN\textsuperscript{2}, Tinker, MT\textsuperscript{3}, and PT Raimondi\textsuperscript{2} 1 - UC Davis 2 – UC Santa Cruz 3 - USGS/UCSC EFFECTS OF SEA OTTERS ON LOCAL DISTRIBUTION AND DENSITY OF BLACK ABALONE

1415  †Mach, ME\textsuperscript{1*}, and CD Levings\textsuperscript{2} 1 - University of British Columbia 2 - Department of Fisheries and Oceans Canada IDENTIFYING THE DETERMINANTS OF NATIVE AND INVASIVE SPECIES COMPOSITION IN CANADIAN EELGRASS BEDS AT A REGIONAL AND NATIONAL SCALE

1430  Stewart, H.L\textsuperscript{*}, and K. Britton-Simmons Friday Harbor Labs STREAMLINING BEHAVIOR OF THE RED URCHIN STRONGYLOCENTROTUS FRANCISCANUS IN RESPONSE TO FLOW

1445  †Perlman, BM\textsuperscript{4} Moss Landing Marine Laboratories SWIMMING PERFORMANCE, AS INDICATED BY U_{CRIT} AND C-START ESCAPE RESPONSES, IN SURFPERCHES (EMBIOTOCIDAE)

1500  BREAK
1530 Miller, LP¹, Denny, MW², and CDG. Harley³ 1 - Northeastern University 2 - Hopkins Marine Station, Stanford University 3 - University of British Columbia PREDICTING THE FREQUENCY OF LETHAL AND SUBLETHAL STRESS EVENTS FOR A DOMINANT COMPETITOR FOR SPACE IN THE MID-INTERIDAL ZONE OF CALIFORNIA

1545 †Gosnell, JS², and SD Gaines UC Santa Barbara THE IMPACT OF SEA STAR DENSITY ON MARINE SNAILS VIA NON-CONSUMPTIVE EFFECTS

1600 Yamane, L¹, Gilman, SE², and B Helmuth¹ 1 - University of South Carolina 2 - Claremont Colleges HEATED RESPONSES: FEEDING AND GROWTH RATES OF AN INTERTIDAL SNAIL AS A FUNCTION OF BODY TEMPERATURE

1615 †Leroux, C⁰, and LE Johnson Université Laval PERFORMANCE ACROSS ENVIRONMENTAL GRADIENTS: SOURCE MICROHABITATS INFLUENCE LIFE HISTORY TRAITS IN THE MARINE SNAIL LITTORINA SAXATILIS UNDER COMMON CONDITIONS.

1630 Schultz, ST¹, Goddard, JHR.²*, Gosliner, TM³, Mason, DE⁴, Pence, WE⁴, McDonald, GR⁵, Pearse, VB⁵, and JS Pearse⁶ 1 - University of Zadar, Croatia 2 - Marine Science Institute, UCSB 3 - California Academy of Sciences 4 - California High School 5 - California Academy of Sciences GOING WITH THE FLOW: NUDIBRANCH GASTROPODS TRACK LARGE-SCALE FLUCTUATIONS IN CLIMATE

1645 †Hart, A⁰ University of Washington LITTORINE SNAIL DENSITY REGULATES THE RELATIVE IMPORTANCE OF DIRECT AND INDIRECT EFFECTS ON AN INTERTIDAL ROCKWEED

1700 Carrington, E¹*, Rivera, G², Snow, H¹, Craig, C¹, O'Donnell, M.J.¹, and S Gilman³ 1 - UW Friday Harbor Labs 2 - Univ. of Virgin Islands 3 - Claremont Colleges TIDAL RHYTHMS IN THE FORAGING ACTIVITY OF WHELK NUCELLA OSTRINA

1715 †Traiger, SB¹*, Gravem, SA², and SG Morgan² 1 - UCSC 2 - UCD, Bodega Marine Laboratory CHLOROSTOMA (TEGULA) FUNEBRALIS SIZE REFUGE AND ESCAPE RESPONSE FROM LEPTASTERIAS HEXACTIS

1730 †Gravem, SA¹*, Traiger, S², and SG Morgan¹ 1 - Bodega Marine Lab, UC Davis 2 - UC Santa Cruz DOES PREDATOR AVOIDANCE INITIATE TROPHIC CASCADES IN TIDE POOL COMMUNITIES?

1745 Bingham, BL, Dimond, J, and G Muller-Parker Western Washington University HOW DOES SYMBIONT COMPLEMENT AFFECT REPRODUCTION IN THE INTERTIDAL ANEMONE, ANTHOPLEURA ELEGANTISSIMA?
SATURDAY, NOVEMBER 14, 2009

SESSION 15 COMMUNITY ECOLOGY III LAGUNA GRANDE D

Chair: S. Hamilton

1300 †Bowles, C*, and E Grosholz Bodega Marine Lab, University of California Davis
RESILIENCE IN TWO ALTERNATE SOFT-SEDIMENT COMMUNITIES DEPENDS ON COMMUNITY SIZE AND DISTURBANCE TYPE

1315 Ferrier, GA*, Zimmer, CA, and RK Zimmer UCLA CHEMICAL COMMUNICATION, KEYSTONE MOLECULES, AND SIGNALS THAT STRUCTURE NATURAL COMMUNITIES

1330 Harley, CDG* University of British Columbia RANGE LIMITS IN SPACE AND RANGE CONTRACTIONS IN TIME ARE DETERMINED BY THE COMBINATION OF THERMAL STRESS AND PREDATION

1345 Stachowicz, JJ†, Best, RJ1, Bracken, MES2, and M Graham3 1 - UC Davis 2 - Northeastern University 3 - Moss Landing Marine Labs COMPLEMENTARITY IN MARINE BIODIVERSITY MANIPULATIONS: RECONCILING DIVERGENT EVIDENCE FROM FIELD AND MESOCOSM EXPERIMENTS

1400 †Rogers, TL*, and JK Elliott University of Puget Sound COMPETITION BETWEEN PISASTER OCHRACEUS AND EVASTERIAS TROSCHELII IN PUGET SOUND

1415 †Seaborn, TJ* University of Washington, Friday Harbor Labs LIMPETS AND THEIR ALGAL EPIBIONTS: COSTS AND BENEFITS OF HOSTING ACROSIPHONIA SPP AND ULVA LACTUCA ON YOUR BACK

1430 †Aquilino, KM*, and JJ Stachowicz UC Davis INTERACTIVE EFFECTS OF SEAWEED DIVERSITY AND HERBIVORY ON COMMUNITY RECOVERY FROM DISTURBANCE IN THE ROCKY INTERTIDAL ZONE

1445 Britton-Simmons, KH*, Rhoades, AL, and MN Dethier University of Washington HERBIVORE WASTES IN LABORATORY FEEDING TRIALS: ARE WE USING THE WRONG CONTROL?

1500 BREAK
1530 Behrens, MD*, Lansverk, AL, and BT Monson Pacific Lutheran University
TEMPERATURE AND DIET EFFECTS ON THE GROWTH OF XIPHISTER MUCOSUS: IMPLICATIONS FOR DIVERSITY GRADIENTS IN HERBIVOROUS FISHES

1545 Ferry-Graham, LA1*, Dean, M2, and D Huber3 1 - Moss Landing Marine Laboratories 2 - UC Irvine 3 - University of Tampa HARD PREY PROCESSING IN CHIMAEROID FISHES

1600 †Bell, TW*, Honderlero, D, Drumm, D, Wilson, K, and WC Oechel San Diego State University COMPARATIVE CARBON FLUX IN MARINE AND TERRESTRIAL SUBTROPICAL ECOSYSTEMS IN LòPEZ MATEOS, BAJA CALIFORNIA SUR, MEXICO

1615 †Colvard, NB*, and PJ Edmunds CSU Northridge THE INFLUENCE OF REFLECTED LIGHT FROM THE BENTHOS ON CORAL PHYSIOLOGY


1645 †Zerebecki, RA1*, and CJB Sorte2 1 - Northeastern University 2 - Bodega Marine Lab, UC Davis ARE INVASIVE SPECIES MORE TEMPERATURE TOLERANT THAN NATIVES? A MARINE FOULING COMMUNITY CASE STUDY

1700 †Hettinger, A1*, Sanford, E1, Gaylord, BP1, Hill, TM2, Russell, AD2, Forsch, M1, Page, HN3, and K Sato1 1 - Department of Evolution and Ecology, Bodega Marine Laboratory, UC Davis 2 - Department of Geology, Bodega Marine Laboratory, UC Davis, 3 - Department of Geology, UC Davis, 4 - Kalamazoo College, Kalamazoo, Michigan 5 - University of North Carolina, Wilmington OCEAN ACIDIFICATION EFFECTS PERSIST THROUGH THE LARVAL AND JUVENILE PHASES OF THE OLYMPIA OYSTER (OSTREA LURIDA)

1715 Kost, LE*, Logan, CA, and GN Somero Hopkins Marine Station of Stanford University TEMPORAL PATTERNING OF METABOLIC ENZYME ACTIVITIES IN GILL AND ADDUCTOR MUSCLE OF MYTILONA CALIFORNIANUS

1730 Tepolt, CK*, and SR Palumbi Stanford University THE PHYSIOLOGY OF INVASION: THERMAL TOLERANCE OF CARCINUS MAENAS IN CALIFORNIA

1745 Kelly, MW*, Sanford, E, and RK Grosberg University of California, Davis RANGE LIMITS, CLIMATE CHANGE AND ADAPTIVE POTENTIAL: GEOGRAPHIC VARIATION IN THERMAL TOLERANCE IN THE COPEPOD TIGRIOPUS CALIFORNICUS
SATURDAY, NOVEMBER 14, 2009

SESSION 17

LAGUNA GRANDE C

CONSERVATION AND RESTORATION ECOLOGY

Chair: C. Whitcraft

1300 †Crowther, DA*, and BN Tissot Washington State University, BALANCING CONSERVATION AND NEARSHORE FISHERIES: A COMPARATIVE SPATIAL ANALYSIS OF TWO MPA SITES IN OREGON

1315 Hall, NC*, Nakamura, R1, Starr, RM2, and DE Wendt1 1 - California Polytechnic State University, San Luis Obispo 2 - UC Sea Grant Extension Program, Moss Landing MERGING TWO DATA SETS COLLECTED BY HOOK AND LINE FISHING IN ORDER TO ESTABLISH A LONGER BASELINE FOR A CENTRAL CALIFORNIA MARINE PROTECTED AREA.

1330 †Farrugia, TJ* CSU Long Beach HABITAT RESTORATION THROUGH THE EYES OF A FISH: HOW ARE SHOVELNOSE GUITARFISH (RHINOBATOS PRODUCTUS) UTILIZING A NEWLY RESTORED SOUTHERN CALIFORNIA ESTUARY?

1345 Levin, PS* NOAA Fisheries THE DEMISE OF ROCKFISH SEBASTES SPP. IN PUGET SOUND: ARE THEY WORTHY OF FEDERAL PROTECTION UNDER THE ENDANGERED SPECIES ACT?

1400 †Koeppel, JA*, Craig, SF, Koeppel, RD*, and E Thomson Humboldt State University PREDATION BY EASTERN OYSTER DRILLS (UROSALPINX CINEREA) ON NATIVE OYSTERS (OSTREA LURIDA) IN HUMBOLDT BAY

1415 Grupe, BM1*, Briscoe, CH1, Cape, M1, Hartmann, A1, Hoyt, K1, Kay, I2, Knight, C1, Latham, E1, Navarro, MO1, Roeland, K1, Tumer-Tomaszewicz, C1, Warner, N1, Wilkens, EC1, and LA Levin1 1 - Scripps Institution of Oceanography 2 - Natural Reserve System, UC San Diego SEA LEVEL RISE IN A SOUTHERN CALIFORNIA SALT MARSH: PREDICTING CONSEQUENCES AND IDENTIFYING SOLUTIONS USING A MULTI-DISCIPLINARY FRAMEWORK

1430 Smith, JR1*, Whitaker, SG2, and SN Murray1 1 - CSU Fullerton 2 - CSU Fullerton and National Park Service, Channel Islands National Park EXPERIMENTAL RE-ESTABLISHMENT OF THE ROCKWEED, SILVETIA COMPRESSA, ON URBAN SOUTHERN CALIFORNIA SHORES

1445 †Turner, KR*, and KP Sebens Friday Harbor Laboratories, University of Washington PREDATOR EFFECTS ON BENTHIC COMMUNITIES IN THE SAN JUAN ISLANDS, WA

1500 BREAK
**SESSION 18**  
**SEASIDE BALLROOM**  
**DISPERSAL AND RECRUITMENT II**  
Chair: J. Caselle

1530  
Lundquist, CJ, Hailes, SF, Hunt, HL, Pilditch, CA, and JE Hewitt  
1 - NIWA (National Institute of Water & Atmospheric Research Ltd.), New Zealand  
2 - University of New Brunswick  
3 - University of Waikato, New Zealand  
SPATIAL VARIABILITY IN DISPERSAL OF JUVENILE BIVALVES IN A NEW ZEALAND ESTUARY

1545  
†Ross, PM, Pilditch, CA, Hogg, ID, and CJ Lundquist  
1 - University of Waikato, New Zealand  
2 - NIWA (National Institute of Water & Atmospheric Research Ltd.), New Zealand  
LIMITED DISPERSAL OR NATURAL SELECTION? POPULATION GENETIC STRUCTURE IN A NEW ZEALAND BIVALVE

1600  
†Cover, W.A, and DC Potts  
UC Santa Cruz  
UNEXPECTED PATTERNS OF CORAL RECRUITMENT AT DEGRADED SITES WITH BENTHIC CYANOBACTERIAL BLOOMS ON MIDWAY ATOLL

1615  
Barshis DJ, Sokta, EE, Sivasundar, A, Menge, BA, Barth, J, and SR Palumbi  
1 - Hopkins Marine Station of Stanford University  
2 - College of Charleston  
3 - Eawag: Swiss Federal Institute of Aquatic Science and Technology  
4 - Oregon State University  
COASTAL UPWELLING MAY DRIVE SWEEPSTAKES RECRUITMENT IN THE ACORN BARNACLE BALANAS GLANDULA

1630  
White, JW, Fisher, J, and SG Morgan  
UC Davis - Bodega Marine Lab  
IMPROVING FIELD ESTIMATES OF PELAGIC LARVAL MORTALITY BY ACCOUNTING FOR SPATIAL PATCHINESS

1645  
†Burgess, SC, and DJ Marshall  
University of Queensland, Australia  
COSTS OF DISPERSAL, HABITAT SELECTION, AND THE SPATIAL SCALES OF REALIZED CONNECTIVITY.

1700  
Morgan, SG, Fisher, JL, and AJ Mace  
1 - Bodega Marine Laboratory, UC Davis  
2 - California Ocean Science Trust  
BEHAVIORAL-PHYSICAL PROCESSES REGULATING LARVAL RECRUITMENT IN UPWELLING REGIONS

1715  
Miller, SH, and SG Morgan  
Bodega Marine Lab, UC Davis  
USING TRACE-ELEMENT SIGNATURES IN SOFT TISSUES TO DETERMINE POPULATION CONNECTIVITY AND THE NATAL ORIGINS OF NEW RECRUITS

1730  
Kinlan, BP, and SE Koch  
1 - UC Santa Barbara  
2 - UCLA  
A NOVEL STATISTICAL METHOD TO PINPOINT LARVAL ORIGINS AND ESTIMATE RANGE-WIDE CONNECTIVITY IN OPEN COAST MARINE POPULATIONS

1745  
Koch, SE, Kinlan, BP, Warner, RR, and DC Zacherl  
1 - UCLA  
2 - UC Santa Barbara  
3 - CSU Fullerton  
BUILDING EMPIRICAL ESTIMATES OF LARVAL DISPERSAL AND POPULATION CONNECTIVITY IN A KELP FOREST SPECIES
SATURDAY, NOVEMBER 14, 2009

SESSION 19 EVOLUTIONARY BIOLOGY II LAGUNA GRANDE A

Chair: S. Dudgeon

1300 †terHorst, CP* Florida State University INDIRECT ECOLOGICAL EFFECTS CHANGE AN EVOLUTIONARY TRAJECTORY

1315 †Knope, ML*, Scales, J, and J Pienaar Stanford University ADAPTIVE SHIFTS IN SCALE NUMBER AND BODY SIZE ASSOCIATED WITH HABITAT TYPE IN MARINE SCULPINS

1330 Dudgeon, SR1*, Ryan, CA1, Cameron, BB2, and RK Grosberg2 1 - CSU Northridge 2 - UC Davis HERITABILITY OF COLONY FORM IN THE HYDROZOA, HYDRACTINIA SYMBIOLONGICARPUS

1345 †Ryan, CA*, and SR Dudgeon CSU Northridge INTRA-SPECIFIC COMPETITION AS AN AGENT OF MORPHOLOGICAL SELECTION

1400 †Sunday, JM1*, Crim, R2, Harley, CD2, and MW Hart1 1 - SFU 2 – UBC POTENTIAL TO ADAPT? HERITABILITY OF LARVAL GROWTH IN AN ACIDIFIED OCEAN

1415 Ladner, JT1*, van Oppen, M2, and SR Palumbi1 1 - Hopkins Marine Station, Stanford University 2 - Australian Institute of Marine Science IDENTIFYING CRYPTIC POPULATIONS: A MULTI-LOCUS GENETIC TEST OF CORAL MORPHOSPECIES

1430 †Tice, KA* University of Hawai‘i CAN AFLP-BASED GENOME SCANS DETECT A SELECTION SIGNATURE IN BROADLY DISPERSING ORGANISMS? THE CASE OF SHELL POLYMORPHISM IN THE PERIWINKLE ECHINOLITTORINA HAWAIENSIS

1445 Oliver, TA1*, Garfield, DA2, Manier, MK3, Wray, GA2, and SR Palumbi1 1 - Hopkins Marine Station, Stanford University 2 - Duke University 3 - Syracuse University WHOLE-GENOME POSITIVE SELECTION IN SHALLOW AND DEEP-SEA URCHINS

1500 BREAK
SATURDAY, NOVEMBER 14, 2009

SESSION 20 COMMUNITY ECOLOGY IV LAGUNA GRANDE D

Chair: S. Sandin

1530 **Shinen, JL**, and **SA Navarrete** Estación Costera de Investigaciones Marinas, Pontificia Universidad Católica de Chile COEXISTENCE AND INTERTIDAL ZONATION OF CHTHAMALID BARNACLES ALONG CENTRAL CHILE: INTERFERENCE COMPETITION OR A LOTTERY FOR SPACE?

1545 †**Needles, LA**, **Cadotte, MW**, **Wendt, DE**, and **SD Gaines** 1 - UC Santa Barbara 2 - University of Toronto - Scarborough 3 - California Polytechnic State University San Luis Obispo SCALE DEPENDENT CONTROLS OF COMMUNITY INVASION AND FORMATION IN MARINE FOULING COMMUNITIES

1600 **Nelson, ML**, and **SF Craig** Humboldt State University THE EFFECTS OF GROWTH MORPHOLOGY ON EARLY SUCCESSION IN A TEMPERATE MARINE FOULING COMMUNITY

1615 **Segui, LM**, and **KA Hovel** San Diego State University INTERACTIVE EFFECTS OF URCHIN DENSITY AND REFUGE AVAILABILITY ON URCHIN MORTALITY IN A MARINE RESERVE

1630 **Byrnes, JE**, **Cardinale, BJ**, and **DC Reed** UC Santa Barbara THE CONSEQUENCES OF ALGAL SPECIES RICHNESS FOR RESISTANCE TO URCHIN GRAZING

1645 **Janousek, CN** UC Davis MICROBIAL DIVERSITY EFFECTS ON VARIATION IN PLANT PRODUCTIVITY WITHIN SIMPLE PATHOSYSTEMS

1700 **Miller, RJ** Marine Science Institute, UCSB PARTITIONING OF PRIMARY PRODUCTION AMONG GIANT KELP (MACROCYSTIS PYRIFERA), UNDERSTORY MACROALGAE AND PHYTOPLANKTON ON A TEMPERATE REEF

1715 †**Stier, AC**, **Geange, SW**, and **KM Hanson** 1 - University of Florida 2 - Victoria University of Wellington 3 - Scripps Institution of Oceanography SPATIOTEMPORAL VARIATION IN PREDATION PRESSURE STRUCTURES REEF FISH COMMUNITIES

1730 †**White, JSS.** University of Florida INDIRECT EFFECTS OF A MARINE ECOSYSTEM ENGINEER ALTER CORAL DISTRIBUTION

SATURDAY, NOVEMBER 14, 2009

1815  WSN Annual Business Meeting  SEASIDE BALLROOM

Please attend this discussion of society business, including the election of officers, finances of the society, and other issues.

1930  Presidential Banquet  LAGUNA GRANDE

Please come enjoy an evening of fun, food, and wine with your fellow WSN members. Features an address by President Robert Carpenter. To attend the banquet and the Presidential Address, tickets are required.

2130  WSN Auction for student travel  LAGUNA GRANDE

After the banquet, please stay for the annual auction as we try to raise as much money as possible for the student travel fund. All members may attend the auction without attending the banquet.

SUNDAY, NOVEMBER 15, 2009

PLENARY ADDRESS  LAGUNA GRANDE

DR. JAMES ESTES, US GEOLOGICAL SURVEY

0800  INTRODUCTION by local chair Mike Graham

0805  Estes, J US Geological Survey THE TROPHIC DOWNGRADEING OF PLANET EARTH

0900  BREAK
SUNDAY, NOVEMBER 15, 2009

SESSION 21  APPLIED ECOLOGY II  LAGUNA GRANDE C

Chair: B. Tissot

1000  Wormald, CL*, Bailey, DM, Allen, LG, and MA Steele  CSU Northridge  COMPARISON OF BIOMASS PRODUCTION OF TEMPERATE REEF FISHES IN A SOUTHERN CALIFORNIA MARINE PROTECTED AREA AND ADJACENT FISHED AREAS

1015  Steele, MA1*, Wang, D1, Schroeter, SC2, and DC Reed2 1 – CSU Northridge 2 - UC Santa Barbara  A TEST FOR EQUIVALENCE OF REPRODUCTION OF TEMPERATE REEF FISHES ON ARTIFICIAL VERSUS NATURAL REEFS

1030  Tissot, BN*, and TC Stevenson  Washington State University  ECOLOGICAL EFFECTS OF TRADE IN ORNAMENTAL CORAL REEF SPECIES

1045  Samhouri, JF1*, Kaplan, I1, Ainsworth, C1, Arkema, KK2, and PS Levin1 1 - NOAA Fisheries, Northwest Fisheries Science Center 2 - Woods Institute for the Environment, Stanford University  USING MARINE FOOD WEB MODELS TO IDENTIFY TRADE-OFFS INHERENT TO ECOSYSTEM-BASED MANAGEMENT

1050  †Tanner, CA1*, Gambi, MC2, and LA Levin1 1 - Scripps Institution of Oceanography 2 - Stazione Ecologia del Benthos, Italy  AN OCEAN ACIDIFICATION MODEL SYSTEM: URCHIN LARVAL RESPONSES TO REDUCED PH AT SHALLOW-WATER CO2 VENTS

1100  Salomon, AK1*, Buhle, E2, Shears, N3, Katz, S4, and S Gaines5 1 - Simon Fraser University 2 - National Marine Fisheries Service 3 - University of Auckland 4 - Channel Islands National Marine Sanctuary 5 - Marine Science Institute, UCSB  CASCADING EFFECTS OF PREDATOR DEPLETION CAN ALTER KEY ECOLOGICAL PROCESSES AND THE RESILIENCE OF A KELP FOREST ECOSYSTEM

1130  Teck, SJ1*, Halpern, BS2, Kappel, CV2, Micheli, F3, Selkoe, KA4, Crain, CM5, Martone, R3, Shearer, C6, Arvai, J7, Fischhoff, B8, Murray, G9, Neslo, R10, and R Cooke11 1 - Dept of Ecology, Evolution, Marine Biology, UC Santa Barbara 2 - National Center for Ecological Analysis and Synthesis 3 - Hopkins Marine Station, Stanford U. 4 - Hawai‘i Institute of Marine Biology, University of Hawai‘i; National Center for Ecological Analysis and Synthesis 5 - Center for Ocean Health, Ecology and Evolutionary Biology, UC Santa Cruz 6 - Department of Sociology, UC Santa Barbara 7 - Environmental Science and Policy Program, Michigan State University 8 - Department of Social and Decision Sciences, Carnegie Mellon University 9 - Institute for Coastal Research, Vancouver Island University 10 - Delft University of Technology, The Netherlands 11 - Delft University of Technology, The Netherlands; Resources for the Future, Washington, D.C.  USING EXPERT JUDGMENT TO ESTIMATE MARINE ECOSYSTEM VULNERABILITY IN THE CALIFORNIA CURRENT

11:45  Breen, RT*  Gulf of the Farallones National Marine Sanctuary Advisory Council  A STAKEHOLDERS PERSPECTIVE ON THE NORTH CENTRAL COAST PROCESS THAT ESTABLISHED MPA'S THROUGH CALIFORNIA'S MARINE LIFE PROTECTION ACT
SUNDAY, NOVEMBER 15, 2009

SESSION 22 PLANT/ALGAL BIOLOGY LAGUNA GRANDE B

Chair: D. Steller

1300 †Muth, AM* Moss Landing Marine Labs SUBSTRATE RUGOSITY AFFECTS KELP ZOOSPORE AGGREGATION AND FERTILIZATION SUCCESS

1315 †Demes, KW†, and MH Graham‡ 1 - University of British Columbia 2 - Moss Landing Marine Laboratories STORAGE AND ABIOTIC REGULATION OF INVESTMENT IN SEXUAL VS. VEGETATIVE REPRODUCTION IN THE CLONAL KELP, LAMINARIA SINCLAIRII (LAMINARIALES, PHAEOPHYCEAE)

1330 Steller, DL*, Foster, MS, and R Riosmena-Rodriguez Moss Landing Marine Laboratories LONG-TERM VARIATION OF BIOGENIC RHODOLITH BEDS AND RECOVERY FROM MAJOR DISTURBANCE EVENT

1345 †Bohnhoff, JC†, and KA Miklas‡ 1 - Stanford University 2 - Hopkins Marine Station TIDAL EFFECTS ON SPORE RELEASE IN TWO ARTICULATED CORALLINE ALGAE

1400 Lindstrom, SC* University of British Columbia ADDITIONAL CRYPTIC DIVERSITY SUGGESTS A PACIFIC ORIGIN OF THE RED ALGAL FAMILY PALMARIAECEAE

1415 †Mach, KJ*, Staaf, AV, Tepler, SK., Bohnhoff, JC, and MW Denny Hopkins Marine Station of Stanford University FAILURE BY FATIGUE IN THE RED MACROALGA MAZZAELLA

1430 Molina, ME†, Glibert, PM‡, Alexander, JA‡, and J Li‡ 1 - Humboldt State University 2 - University of Maryland Center for Environmental Science THE EFFECT OF DIFFERENT N:P RATIOS AND LIGHT LEVELS ON THE GROWTH RATE OF AND , TWO HARMFUL DINOFLAGELLATES

1445 †Okamoto, DK†, and GL Eckert‡ 1 - UC Santa Barbara 2 - University of Alaska Fairbanks, School of Fisheries and Ocean Sciences PATTERNS OF KELP COLONIZATION ON ARTIFICIAL AND NATURAL REEFS IN A SOUTHEAST ALASKAN GLACIAL FJORD
SUNDAY, NOVEMBER 15, 2009

SESSION 23  INTERTIDAL ECOLOGY III  SEASIDE BALLROOM

Chair: C. Garza

1000 Craig, CA1*, Gilman, SE2, O'Donnell, MJ1, and E Carrington1 1 - Friday Harbor Laboratories, University of Washington 2 - Claremont Colleges WIRED: CHARACTERIZING FIELD TEMPERATURES OF THREE INTERACTING INTERTIDAL SPECIES

1015 Denny, MW*, Hunt, LJH, Miller, LP, and CDG Harley Hopkins Marine Stationn, Stanford University HOW BAD CAN IT GET? PREDICTING EXTREME EVENTS IN ECOLOGY

1030 Dwyer, TR*, and GC Trussell Marine Science Center, Northeastern University PREDATOR RISK CUES AND PREY PHYSICAL STATE IN AN INTERTIDAL FOOD WEB

1045 †Escobar, JB*, and SA Navarrete Estación Costera de Investigaciones Marinas, Pontificia Universidad Católica de Chile THE ROLE OF FISH HERBIVORY IN CONTROLLING THE DISTRIBUTION OF THE DOMINANT CORTICATED ALGA MAZZAELLA LAMINARIODES: IS THERE PREDICTABLE VARIATION ACROSS SEA-SCAPES?

1100 Fan, TY*, and YT Cheng National Museum of Marine Biology and Aquarium, Checheng, Taiwan TEMPORAL AND SPATIAL VARIATION OF CORAL RECRUITMENT IN SOUTHERN TAIWAN

1115 †Foster, NL* UC Santa Barbara PRESERVED SPECIMENS EXPOSE THE GHOSTS OF PARASITES PAST: POTENTIAL USES AND LIMITATIONS

1130 Garza, CD* CSU Monterey Bay SCALE DEPENDENCE IN THE DISTRIBUTION AND INTENSITY OF SPECIES BOUNDARIES IN INTERTIDAL COMMUNITIES

1145 Ruesink, JL University of Washington RESILIENCE OF INTERTIDAL EELGRASS (ZOSTERA MARINA) TO DIFFERENT TYPES AND MAGNITUDES OF DISTURBANCE
SUNDAY, NOVEMBER 15, 2009

SESSION 24  FISHERIES ECOLOGY II  SEASIDE BALLROOM

Chair: M. Steele

1300  †Frechette, DM*, Osterback, AM, Bond, MH, Hayes, SA, Moore, JW, Shaffer SA, and JT Harvey Moss Landing Marine Laboratories HOW MANY NEEDLES IN THE HAYSTACK? APPLICATION OF MARK-RECAPTURE METHODS TO ESTIMATE AVIAN PREDATION ON JUVENILE SALMONIDS IN CENTRAL CALIFORNIA

1315  Allen, LG1*, and BE Erisman2 1 - Southern California Marine Institute; CSU Northridge 2 - Scripps Institution of Oceanography THE EXISTENCE, IMPORTANCE, AND CONTRIBUTION OF FISH SPawning AGGREGATIONS TO THE ECOSYSTEMS AND FISHERIES OF THE TEMPERATE WATERS OFF SOUTHERN CALIFORNIA

1330  †Rossetto M1*, De Leo GA1, and Micheli F2 1 - Dipartimento di Scienze Ambientali, Università degli Studi di Parma 2 - Hopkins Marine Station, Stanford University ACCOUNTING FOR PLASTICITY IN MODELING INDIVIDUAL GROWTH OF ABALONE

1345  Rogers-Bennett, L* Bodega Marine Lab and California Department Fish and Game ABALONE AS ECOSYSTEM INDICATORS: ARE "BAD" YEARS "GOOD" FOR ABALONE?

1400  Rassweiler, A*, Costello, CJ, and DA Siegel UC Santa Barbara THE VALUE OF SPATIAL INFORMATION IN MPA NETWORK DESIGN

1415  †Stevenson, TC1*, Tissot, BN1, and J Dierking2 1 - Washington State University Vancouver 2 - University of Hawaii INCREASED PRODUCTIVITY IN WEST HAWAII’S AQUARIUM FISHERY: THE CONTRIBUTION OF FLEET DYNAMICS VS. MARINE PROTECTED AREAS

1430  Rasmussen, DE1, Nakamura, R1, Starr, RM2, and Wendt DE1 1 - California Polytechnic State University San Luis Obispo 2 - Moss Landing Marine Laboratories COMPARISONS OF BAITING AND TRAPPING PROTOCOLS INSIDE AND OUTSIDE OF MARINE PROTECTED AREAS ALONG CALIFORNIA’S CENTRAL COAST

1445  †Knuckey, JD* Moss Landing Marine Laboratories ETMOPTERUS SP. NOV. A NEW SPECIES OF LANTERNSHARK (SQUALIFORMES: ETMOPTERIDAE) FROM TAIWANESE WATERS
Chair: K. Sebens

1000 †Whalen, MA*, and JE Duffy Virginia Institute of Marine Science, The College of William & Mary THE FIRST RIGOROUS FIELD TEST OF MESOGRAZER IMPACTS IN SEAGRASS BEDS: SAYING GOODBYE TO CAGE ARTIFACTS

1015 O'Connor, MI* NCEAS WARMING STRENGTHENS CONSUMER CONTROL ACCORDING TO GENERAL THEORY

1030 †Hart, SP*, and DJ Marshall University of Queensland SPATIAL ARRANGEMENT AFFECTS POPULATION DYNAMICS AND COMPETITION INDEPENDENT OF COMMUNITY COMPOSITION

1045 McCollum, BA*, and KP Sebens University of Washington COMMUNITY STRUCTURE AND DYNAMICS IN ROCKY SUBTIDAL MARINE PRESERVES, SAN JUAN ISLANDS, WASHINGTON

1100 †Elahi, R*, and KP Sebens University of Washington MOBILE GRAZERS REPLACE THE SPACE SESSILE PLAYERS ERASE: INTERPRETING THE IMPORTANCE OF DIVERSITY IN A TROPHIC CONTEXT

1115 †Pirtle, JL*, and GL Eckert University of Alaska Fairbanks, School of Fisheries and Ocean Sciences UNRAVELING PATTERNS OF NEARSHORE SUBTIDAL COMMUNITY STRUCTURE AND ENVIRONMENTAL VARIABILITY IN THE SOUTHEAST ALASKA ARCHIPELAGO

1130 †Karr, KA* UC Santa Cruz ECOLOGICAL CONSEQUENCES OF HABITAT VARIABILITY: A LOOK AT YOUNG-OF-YEAR ROCKFISH (SEBASTES SPP.) AND PREY COMMUNITY DYNAMICS IN THE CANOPY OF KELP FORESTS

1145 Kroeker, KJ†*, Gambi, MC², and F Micheli¹ 1 - Hopkins Marine Station, Stanford University 2 - Stazione Ecologia del Benthos, Ischia, Italy SHIFTS IN COMMUNITY STRUCTURE OF SMALL MOBILE INVERTEBRATES TO OCEAN ACIDIFICATION
Chair:  J. Elliott

1300  †Dee, LE*, Witman, JD, and ML Brandt Brown University  REFUGIA AND TOP-DOWN CONTROL OF THE PENCIL URCHIN EUCIDARIS GALAPAGENSIS IN THE GALÁPAGOS MARINE RESERVE

1315  †Foley, MM* UC Santa Cruz  THE IMPORTANCE OF LAND-SEA CONNECTIVITY IN THE GIANT KELP FORESTS OF BIG SUR, CALIFORNIA

1330  †Rhoades, OK*, Witman, JD, and M Brandt Brown University  TROPICAL FROSTBITE: THE IMPACT OF LA Niña BLEACHING ON FINGER CORAL-ASSOCIATED FAUNA

1345  Schmitt, RJ*, Holbrook, SJ, Brooks, AJ, and MK Johnson UC Santa Barbara  STRUCTURE - FUNCTION FEEDBACKS CRITICAL TO RESILIENCE OF PACIFIC STAGHORN CORAL

1400  Levin, LA¹, Wheeler, SG²*, Mendoza, GF¹, Thurber, A¹, Lee, R¹, and T Washington¹ 1 - Scripps Institute of Oceanography 2 - San Diego State University  COLONIZATION PATTERNS OFFER A WINDOW INTO METACOMMUNITY STRUCTURE OF SEEPS IN THE NE PACIFIC OCEAN

1415  Elliott, JK*, and TL Rogers University of Puget Sound  THE EFFECT OF GULL PREDATION ON SEA STAR SIZE, COLOR, AND HABITAT USE IN PUGET SOUND

1430  Rogers, A¹*, Paddock, MJ², and K Lorenzen¹ 1 - Imperial College London 2 - Simon Fraser University  UNDERSTANDING DIFFERENTIAL RECOVERY RATES OF DIADEMA ANTILLARUM IN THE CARIBBEAN

1445  Paddock, MJ¹*, Rogers, A², Lorenzen, K², and IM Côté³ 1 - Santa Barbara City College 2 - Imperial College London 3 - Simon Fraser University  POPULATION DYNAMICS OF FISH PREDATORS AND COMPETITORS OF A ONCE-ABUNDANT TROPICAL URCHIN, DIADEMA ANTILLARUM, OVER LARGE SPATIAL AND TEMPORAL SCALES
SUNDAY, NOVEMBER 15, 2009

SESSION 27        PHYSIOLOGICAL ECOLOGY II        LAGUNA GRANDE B

Chair: W. Dowd

1000 †Lockwood, BL*, Sanders, JG, and GN Somero Hopkins Marine Station, Stanford University DIFFERENCES IN TRANSCRIPTOMIC RESPONSES TO HEAT-STRESS IN NATIVE AND INVASIVE BLUE MUSSELS (GENUS MYTILUS): MOLECULAR CORRELATES OF INVASIVE SUCCESS.

1015 †Logan, CA*, Kost, LE, Mattioli, K, Logan, P*, and GN Somero Stanford University FROM BAJA CALIFORNIA TO TATOOSH ISLAND: THERMAL PHYSIOLOGY OF THE RIBBED MUSSEL, MYTILUS CALIFORNIANUS

1030 †Monaco, CJ¹*, Brokordt, K², and CF Gaymer² 1 - Department of Biological Sciences, University of South Carolina 2 - Departamento de Biología Marina, Centro de Estudios Avanzado en Zonas Áridas (CEAZA), Universidad Católica del Norte LATITUDINAL THERMAL GRADIENT EFFECT OVER THE COST OF LIVING ON THE INTERTIDAL PORCELAIN CRAB PETROLISTHES GRANULOSUS

1045 †Shimer, EL*, and PJ Krug CSU Los Angeles SURVIVAL AT THE EDGE: ECOPHYSIOLOGY AND RANGE LIMITS OF THE ESTUARINE SEA SLUG ALDERIA

1100 Smith, LM*, Vasquez, MC, and SR Dudgeon CSU Northridge HYDRODYNAMIC REGULATION OF COLONY FORM IN HYDROZOANS

1115 Dowd, WW¹*, Cech, JJ Jr.², and D Kültz³ 1 - Stanford University, Hopkins Marine Station 2 - UC Davis, Department of Wildlife, Fish and Conservation Biology 3 - UC Davis, Department of Animal Science ECOPHYSIOLOGICAL LESSONS FROM COMPARATIVE PROTEOMICS STUDIES IN SHARKS

1130 †Brander, SM*, and GN Cherr UC Davis, Bodega Marine Lab ENDOCRINE DISRUPTION IN A CALIFORNIA ESTUARY: LINKING INDIVIDUAL-LEVEL EFFECTS TO POPULATION-LEVEL CONSEQUENCES

11:45 Hirst, MB*, Hagen, KD, and SC Dawson UC Davis INTERACTIONS IN THE BOVINE RUMEN
SUNDAY, NOVEMBER 15, 2009

SESSION 28  POPULATION BIOLOGY III  LAGUNA GRANDE C
Chair: B. Pernet

1300  Shelton, AO*  Center for Stock Assessment Research, UCSC ECOLOGICAL AND EVOLUTIONARY DRIVERS OF FEMALE-BIASED SEX RATIOS: TWO SEX MODELS OF PERENNIAL SEAGRASSES

1315  †Garchow, MN*, and P Krug  CSU Los Angeles POPULATION DYNAMICS AT A SHIFTING RANGE BOUNDARY BETWEEN SISTER SPECIES OF ESTUARINE SEA SLUG: ROLE OF THE PHYSICAL ENVIRONMENT VERSUS LARVAL SUPPLY

1330  †Staaf, DJ*  Hopkins Marine Station of Stanford University SQUID KIDS IN HOT WATER: OMMASTREPHID PARALARVAE IN THE EASTERN TROPICAL PACIFIC WARM POOL

1345  †Blaine, JB*, Tissot, BN1, Starr, RM2, and MM Yoklavich3  1 - Washington State University 2 - Moss Landing Marine Lab 3 - NOAA Fisheries, Santa Cruz DEEP-POPULATION DISTRIBUTION OF TWO COMMERCIAL SPECIES OF SEA CUCUMBER, PARASTICHOPUS CALIFORNICUS AND PARASTICHOPUS LEUKOTHELE IN CENTRAL CALIFORNIA

1400  †Sanders, JG1*, and SR Palumbi2  1 - Department of Organismic and Evolutionary Biology, Harvard University 2 - Hopkins Marine Station, Stanford University CLOSELY RELATED SYMBIODINIUM STRAINS SHOW STRONG BIOGEOGRAPHIC STRUCTURING IN THE INTERTIDAL ANEMONE ANTHOPLEURA ELEGANTISSIMA

1415  Cockrell, ML1*, and CJB Sorte2  1 - Northeastern University 2 - University of California, Davis STAGE-STRUCTURED POPULATION MODELING AS A TOOL FOR PREDICTING RESPONSES OF THE INVASIVE TUNICATE BOTRYLLOIDES VIOLACEUS TO CLIMATE CHANGE


1445  Lorda, J*, Hechinger, RF, and KD Lafferty  Department of Ecology, Evolution, and Marine Biology, UCSB WHAT CONTROLS THE POPULATION OF THE NEW ZEALAND MUD SNAIL, POTAMOPYRGUS ANTIPODARUM, IN ITS NATIVE RANGE?
ABSTRACTS

STUDENT SYMPOSIUM: DARWIN AND THE SEA

THE IMPLICATIONS OF HUMAN-DRIVEN EVOLUTION FOR MARINE MANAGEMENT
Baskett, M UC Davis
Humans are shifting the selection pressure acting on marine organisms by altering how survival and/or reproductive success depends on heritable traits. For large-scale human impacts that dominate ecological processes, this shift can drive evolutionary change that is rapid and substantial enough to affect management decisions. In marine systems, such human impacts include exploitation, habitat degradation, invasive species, and climate change. In this talk I will discuss examples of human-driven evolution in marine systems and their management implications. In all of these cases, biases in human impacts with respect to specific traits determine whether rapid evolutionary change might occur, and trait-based variation is critical to the adaptive capacity in response to human-driven changes. Therefore, a challenge to management is to account for variation in traits that interact with anthropogenic activities to influence population dynamics, and a challenge to marine ecology is to expand our understanding of these dynamics.

DARWIN'S FISHES: SPECIATION IN THE GALAPAGOS ISLANDS
Bernardi, G UC Santa Cruz
Island populations have played a pivotal role in the elucidation of allopatric speciation, with the much heralded Galapagos finches as the most notable example. The study of the origin of species is currently experiencing renewed interest with theoretical and empirical advances, yet while much attention has been devoted to terrestrial and freshwater systems, comparatively little is known about speciation in marine environments. In particular, scientists have not capitalized on the potentially important island systems. In this study we worked in the Galapagos islands and surrounding areas where we examined the relationship between population structure, a precursor to speciation, in species of reef fishes that exhibit three types of distributions: endemic, insular, and Panamic. Using a combination of classic population structure and coalescent approaches, we assessed the degree of genetic population structure in the three groups of fish species. In addition, we evaluated the level of inter-island genetic diversity in endemic species, to determine if Galapagos fishes, like their terrestrial counterparts, could be used as a model for allopatric speciation in the sea.

THE YOUNG DARWIN & THE SEA: THE MAKING OF AN EVOLUTIONIST
Grosberg, R Center for Population Biology, UC Davis
Darwin’s affair with the sea began while he was a 17-year old medical student at Edinburgh, where he often ditched class and collected along the shore of the Firth of Forth with “Professor” Robert Grant. Grant was former physician who gave it up to become an eminent marine biologist, invertebrate zoologist, and ardent (but somewhat misguided) evolutionist who undoubtedly precipitated Darwin’s quitting medical school. At 22, Darwin found himself on his first (and last) voyage. Unimaginably seasick for his five long years on the Beagle, Darwin never got on a ship again. But his experiences with the sea profoundly influenced his development as an evolutionary biologist. While working with Grant, he recognized that conservative features of early developmental stages often reflected phylogeny. While on the Beagle, and especially after reading Lyell, he proposed a theory for the formation of coral atolls that required developing testable predictions based on unobserved historical processes, a methodological breakthrough. And after he returned to the comfort of Down House, he used his growing obsession with barnacles as the foundation for extending the domain of historical sciences into predictions based on his rapidly developing ideas concerning natural and sexual selection. And then there’s the bryozoan tree...

DARWIN’S OCEAN: RAPID EVOLUTION CAUSED BY HUMAN-INDUCED ENVIRONMENTAL CHANGES
Palumbi, SR Stanford University, Hopkins Marine Lab
Evolution of populations within species is driven by natural selection, genetic drift and mutation pressure. Favoring rapid evolution are big population sizes, short generation times, and strong natural selection. Human change of the biosphere results in strong selection pressure because ecosystem properties have been so seriously altered. For species with big population sizes and short generation times, such as many fisheries species, rapid evolution is often the result. Recent evidence from marine genetics points to more cases of natural selection working on genetic variation, with the result that local adaptation may be more common in the oceans than currently thought. In the face of oncoming climate shifts, understanding rapid evolution is more important than ever. Understanding which species may evolve quickly enough in the face of rapid environmental change and which will be left behind is a critical evolutionary question in marine biology and across the whole biosphere.
OCEAN ACIDIFICATION OF THE NORTHEASTERN PACIFIC COASTAL WATERS
Feely, R Pacific Marine Environmental Laboratory
Carbon dioxide (CO$_2$) is one of the most important “green-house” gases in the atmosphere affecting the radiative heat balance of the earth. As a direct result of the industrial and agricultural activities of humans over the past two centuries, atmospheric CO$_2$ concentrations have increased by about 100 ppm. The atmospheric concentration of CO$_2$ is now higher than experienced on Earth for at least the last 800,000 years, and is expected to continue to rise, leading to significant temperature increases in the atmosphere and oceans by the end of this century. The global oceans are the largest natural long-term reservoir for this excess heat and CO$_2$, absorbing approximately 85% of the heat and 30% of the anthropogenic carbon released into the atmosphere since the beginning of the industrial era. Recent studies have demonstrated that both the temperature increases and the increased concentrations of CO$_2$ in the oceans are causing significant changes in marine ecosystems. Many marine organisms are already affected by these anthropogenic stresses, including impacts due to ocean acidification. Recent studies have provided new findings that organisms growing in estuaries or in coastal upwelling zones such as those living near river mouths or along the continental shelf of west coast of the North America from Canada to Mexico may already be experiencing significant biological impacts resulting from the combined effects of freshwater input, coastal upwelling and ocean acidification. Dr. Feely will discuss the present and future implications of increased CO$_2$ levels on the health of our ocean ecosystems and related ocean-based economies.

IF YOU CAN'T RUN AND YOU CAN'T HIDE: PHYSIOLOGICAL MECHANISMS TO TOLERATE A RAPIDLY CHANGING ENVIRONMENT
Hofmann, GE UC Santa Barbara.
Given the rapid rate of environmental change that is predicted for the world’s oceans, existing physiological plasticity of contemporary organisms may be critical to species’ response to climate change. Although evolutionary rescue via processes such as local adaptation and rapid evolution may be possible, many species will rely heavily on their current tolerance windows, especially those that involve multiple stressors (e.g., temperature change and acidification occurring together). Additionally, environmental stressors may affect a species in different ways – for example, by driving that organism outside a thermal tolerance window, by altering the costs of metabolic processes under the new conditions, or by changing patterns of development and reproduction. In this presentation, I will cover how understanding physiological plasticity and physiological mechanism is an important part of the larger strategy in predicting the biological consequences of environmental change in marine ecosystems.

HOW WILL CLIMATE CHANGE IMPACT MARINE ECOSYSTEM FUNCTION?
Klinger, T University of Washington.
Climate change is likely to influence ecosystem function through direct and indirect effects that cause changes in functional diversity and in the rates of key ecological processes. Despite potential losses of populations or species, ecosystem function can be maintained across a range of conditions as long as key processes such as primary production and trophic relationships are preserved. Substantial changes in ecosystem function are likely to follow from the accumulation of smaller changes that in combination influence key processes, resulting in non-linear dynamics that produce rapid shifts in the state of a system. Although current predictive capacity is low, insight into the potential effects of climate change on marine ecosystem function can be derived from inspection of regime shifts in marine and aquatic systems. Management of diverse human activities across a range of scales can help to maintain marine ecosystem function and the services provided.

PREDICTING THE EFFECTS OF CLIMATE CHANGE ON MARINE POPULATIONS AND COMMUNITIES: CHALLENGES AND OPPORTUNITIES
Sanford, E Bodega Marine Laboratory, UC Davis
As the rate of climate change accelerates, ecologists are increasingly engaged in forecasting how changes in ocean temperature, pH, and other parameters will alter the abundance and distribution of marine organisms. "Climate envelope" models have emerged as a promising approach to predict how the distribution of species will shift in response to a changing physical environment. These models typically define a species' niche by correlating its current
distribution with present-day conditions. These niche parameters are then combined with scenarios of future climate change to forecast range expansions and contractions. In this talk, I will suggest that the accuracy of climate envelope models is currently hampered by a lack of information in a number of areas including: (1) the factors that set range boundaries, (2) genetic variation among populations in tolerance traits (local adaptation), (3) the scope for future evolutionary change, and (4) the potential effects of species interactions. I'll present some current work that is seeking to address some of these gaps. I'll also highlight a growing need for mechanistic, interdisciplinary studies that combine experimental ecology, evolutionary biology, physiology, population genetics, ecomechanics, remote sensing, modeling, and other approaches to address population and community-level responses to changing ocean conditions.

PLENARY ADDRESS

THE TROPHIC DOWNGRADING OF PLANET EARTH
Estes, J UC Santa Cruz
A widely recognized by poorly understood effect of the rise of humans has been the decline of most large vertebrates. Our failure to appreciate the consequences of this global trophic downgrading has two root causes—a deeply held view of the primacy, if not an essential ubiquity, in the bottom control of nature; and the virtual impossibility of providing definitive experimental evidence for the ecological roles of large, mobile species. In February 2008, John Terborgh (Duke University) and I organized a workshop at the White Oak Plantation to explore the importance of top down forcing and trophic cascades across global ecosystems. My talk, which previews a forthcoming book, provides an overview of our findings and some of their unlikely implications for future human welfare.
**CONTRIBUTED PAPER ABSTRACTS**

† **EGGS CHOOSE THE SPERM THAT PRODUCE THE BEST QUALITY OFFSPRING**
Aguirre, J.D.*, Blows, M.W., and D.J. Marshall  University of Queensland, School of Biological Sciences, Queensland, Australia

In sexual selection, females can choose to mate with either males of higher genetic quality, or more genetically compatible males. Choice for both male quality and male compatibility increase female reproductive success by increasing the genetic quality of her offspring. Studies on broadcast spawning species have shown that species recognition happens at the level of gametes – eggs can recognize sperm of the same species, and it appears that this gamete-level choice also occurs within species. Some male x female combinations of gametes result in higher fertilization success than others, but whether this reflects male quality effects or genetic compatibility remains unknown. Here, we examined the consequences of female choice on offspring quality, and thus female reproductive success in the broadcast spawning ascidian Ciona intestinalis. Using a quantitative genetics, half-sib breeding design we found that male genetic quality effects were either weak or non-significant, whereas male compatibility effects were strong and persistent. Moreover, we find there is a positive relationship between male x female compatibility at fertilization and post-fertilization offspring performance. Overall, our results suggest that gametes that are more compatible at fertilization will result in higher performing offspring, and provide evidence that mate-choice can occur in the ancestral reproductive strategy of broadcast spawning.

† **AN ASSESSMENT OF SPATIAL DYNAMICS OF STOCK STRUCTURE FOR THREE GULF OF MAINE GROUNDFISH SPECIES**
Al-Humaidhi, A.W.* University of Maine, School of Marine Sciences

The Gulf of Maine Atlantic cod (Gadus morhua), haddock (Melanogrammus aeglefinus) and white hake (Urophycis tenuis) stocks have declined and show few signs of recovery, despite efforts by the Northeast Fisheries Management Council to reduce fishing mortality since the 1990s. One hypothesis explaining the lack of recovery is that there is an inconsistency of spatial scales in fisheries management relative to the underlying ecological boundaries. Managing stocks consistent with the ecological scale of the fishery may have an important impact on the recoverability of the stocks. The objective of this study is to evaluate this hypothesis. We will evaluate spatial variation in the stock structure of these groundfish species -- in the inshore waters of the Gulf of Maine, using an eight-year data set (2000-2008) from the Maine Department of Marine Resources inshore trawl survey. The biological parameters we examine include size at sexual maturity, size structure, sex ratio, and condition factors (weight to length ratios) in each of the study areas across the Gulf of Maine. Temporally consistent spatial variation of biological parameters between study areas for these species may suggest that management needs to adjust to appropriately accommodate the spatial variation in stock structure.

**THE EXISTENCE, IMPORTANCE, AND CONTRIBUTION OF FISH SPAWNING AGGREGATIONS TO THE ECOSYSTEMS AND FISHERIES OF THE TEMPERATE WATERS OFF SOUTHERN CALIFORNIA**
Allen, L.G.†, and B.E. Erisman*† 1 - Southern California Marine Institute; CSU Northridge 2 - Scripps Institution of Oceanography, UC San Diego

Fish spawning aggregations (FSAs), the large and temporary gatherings of fishes for the sole purpose of reproduction, represent one of the most incredible biological phenomena of the marine realm. Spawning aggregations are important biological events crucial to the life history of many reef fishes. They are also very important to commercial and sport fisheries worldwide, because they often involve species of high market value and high-quality meat. We know that tropical FSAs are declining and disappearing worldwide due to overfishing and poor management. However, little attention has been paid to the existence, importance, or contribution of FSAs to the ecosystems and fisheries of temperate zones. This is unfortunate, because this same phenomenon occurs in the vicinity of kelp forests, rocky reefs, and sand flats of temperate zones. The fisheries which target aggregating species in these ecosystems face many of the same conservation and management challenges and require many of the same management strategies that have been identified for tropical species. Moreover, such information is very important to the direction in which fisheries management in California is headed (i.e., ecosystem-based management). The purpose of this talk is to: 1) review some important biological and fishery characteristics of four reef associated fishes (white seabass, barred sand bass, kelp bass, and giant sea bass) that form spawning aggregations off southern California, 2) discuss the interaction between fishing, spawning and the effects of overfishing aggregations, and 3) propose options for management of aggregations based on the success of a recent policy.
AN OVERVIEW OF THE BIOLOGICAL SAMPLING USED TO ASSESS THE CENTRAL CALIFORNIA COAST MARINE PROTECTED AREAS - WITH EMPHASIS ON ROCKY INTERTIDAL HABITATS.

Ammann, K.N.*, Bell, C.A., George, M.K., and P.T. Raimondi UC Santa Cruz

In 2007 a network of 29 MPAs was established along the central coast of California reaching from Pigeon Point south to Point Conception. Four main sampling schemes are providing the biological data for the MPAs. These include: 1. the Collaborative Fisheries Research Program that assesses areas based on fishing surveys, 2. deep rocky reef sampling, 3. subtidal kelp forest surveys and 4. intertidal rocky reef surveys. In order for the MPAs to effectively protect habitats and preserve ecosystem biodiversity several goals have to be met. These goals include creating a baseline of marine resources, assessing the performance of the MPAs and providing adaptive management of the MPA network. Given the number and spatial extent of MPAs the characterization and assessment should rely on existing monitoring programs when available and appropriate to increase cost effectiveness and broaden the interest beyond just the MPAs. Intertidal habitats are arguably the most sensitive areas to land-based and human activities. Current intertidal MPA work in the central coast is based on an existing long-term monitoring program MARINe (Multi-Agency Rocky Intertidal Network). This program has established site surveys that characterize community assemblages and provide long-term assessments of the rocky shores. Coordination with existing sampling provides an extremely efficient way to ensure that biological sampling meets well-developed monitoring standards and that data are compatible along the entire west coast of North America.

DAILY, SEASONAL, AND YEARLY PATTERNS OF MOVEMENT FOR SIXGILL SHARKS HEXANCHUS GRISIEUS IN PUGET SOUND.....AND BEYOND.

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The patterns of movement for apex predators will determine their impact on local communities and their susceptibility to natural or anthropogenic perturbations to their environment. Sixgill sharks Hexanchus griseus are the largest resident fish in Puget Sound and are known to feed upon a wide variety of prey in other parts of the world. We have been studying their patterns of movement for four years to address their potential role in the Puget Sound ecosystem and their potential susceptibility to fishing pressure. On a daily basis, sub-adult sixgill sharks generally have limited movement (<5 km). Many sharks occupy core areas during the winter, while their ranges expand in the summer. Sub-adult sharks have begun to leave Puget Sound after 2.5 years of residency since tagging. Larger sharks are the least detected and have been detected outside Puget Sound for up to 2 years and then return. These patterns of movement and stable isotope analyses suggest that Puget Sound is a region where mature individuals come to give birth and juveniles remain in the nearshore waters for some period before leaving Puget Sound for the outer coast.

† INTERACTIVE EFFECTS OF SEAWEED DIVERSITY AND HERBIVORY ON COMMUNITY RECOVERY FROM DISTURBANCE IN THE ROCKY INTERTIDAL ZONE

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Theory and experiments suggest that herbivores may mediate the effect of primary producer diversity on community productivity and resilience from disturbance. However, most experimental studies examine effects of herbivores on cleared substrate without regard to the diversity or composition of the surrounding community. The surrounding community could affect recovery directly by altering propagule supply or indirectly by altering ambient herbivore density or modifying local abiotic conditions. To determine the interactive effect of herbivory and surrounding algal diversity on the recovery of a rocky intertidal community, we conducted a 1.5 yr (and continuing) field experiment assessing algal recruitment and succession in small cleared patches. We nested two herbivore treatments, ambient and reduced abundances, within 1.5 m diameter monocultures and polycultures of four common algal species. Recovery of perennial algae was fastest in patches cleared within polycultures, but only when exposed to herbivores. The increased recovery rate of patches containing herbivores is likely due to the consumption of ephemeral algal species that compete for space with perennial species, but the reasons for the “diversity effect” are more complex. In polycultures, desiccation rates are lower, herbivore composition is altered, and propagule supply may be higher compared to monocultures, all of which could contribute the observed effect of diversity. We discuss the evidence for these different mechanisms and the implications for feedbacks between herbivore and algal communities.

PROCESS-BASED MODELS FOR MAPPING AND VALUING ECOSYSTEM SERVICES PROVIDED BY COASTS AND OCEANS

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Many important ecosystem services are provided by coastal and ocean environments. However, a growing variety and intensity of human activities, coupled with impacts of climate change, threaten the sustained delivery of these services. Moreover, the processes and ecosystems that humans rely on are often poorly understood, scarcely monitored, and only appreciated after they are lost. The Natural Capital Project, an innovative partnership among Stanford University, The
Nature Conservancy and World Wildlife Fund, has embarked on a 2-year program to develop a suite of spatially-explicit ecosystem service models called Marine InVEST (Integrated Valuation of Ecosystem Services and Trade-offs) and to apply them in a temperate ecosystem to inform on-the-ground decision-making. Marine InVEST maps and values a variety of services, including food from fisheries and aquaculture, recreation and coastal protection. During this presentation we will focus on key attributes and results of the coastal protection models. Much of the previous work on wave attenuation by mangroves, corals, marshes and seagrasses is not sufficient for predicting under what conditions biogenic habitat may prevent coastal erosion and inundation, nor for valuing this service. We present a process-based model consisting of (1) a biophysical step where the supply of the service varies with habitat heterogeneity and fluctuations in key forcing variables, (2) a use step where demand for the service is quantified, and (3) an economic step for valuation in monetary terms. Our model is sufficiently general to be transferable for use with diverse habitats, policy issues, and data limitations.

COASTAL UPWELLING MAY DRIVE SWEEPSTAKES RECRUITMENT IN THE ACORN BARNACLE BALANUS GLANDULA
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Sweepstakes recruitment and chaotic genetic patchiness are phenomena common to many marine populations; yet the specific forces responsible for such patterns are a topic of much debate. We tested for spatial and temporal annual changes in population structure in the rocky-intertidal barnacle Balanus glandula from a contiguous stretch of the Oregon coastline in the northeast Pacific Ocean. Analysis of the cytochrome oxidase I (COI) mitochondrial locus found high haplotype diversity, with a total of 884 unique haplotypes out of 3132 individuals (28.2%). A previous estimate of a Ne / N ratio of approximately 5 X 10e-3 indicates the potential for tremendous temporal genetic variation among cohorts. Although little genetic variation was observed between locations, small but significant variation was found between year classes (FST = 0.00082 p-value=0.01698 +/- 0.00061). Average pairwise FST comparisons for a given year class were significantly correlated with the cumulative windstress (a seasonal estimate of upwelling strength) for that particular settlement year (p < 0.01). Lower pairwise FST values corresponded to years with greater upwelling strength, suggesting that strong upwelling may have a homogenizing effect on the pelagic larval pool. We hypothesize that inter-annual variability in coastal upwelling could be a driving force behind a sweepstakes pattern of chaotic genetic patchiness, even in a highly abundant, well-dispersed species such as B. glandula.

TEMPERATURE AND DIET EFFECTS ON THE GROWTH OF XIPHISTER MUCOSUS: IMPLICATIONS FOR DIVERSITY GRADIENTS IN HERBIVOROUS FISHES
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There has been much recent attention paid to the latitudinal diversity gradient in marine herbivorous fishes and the potential mechanisms driving this pattern. However, there has been no consensus on the strength of this pattern or which potential mechanisms are most important. A thermal constraint on digestion has garnered some initial support, but this potential mechanism has been questioned by others. To test the potential validity of a thermal constraint on digestion, we reared individuals of a cold-temperate herbivore, the rock prickleback (Xiphister mucosus), at two temperatures (6° and 16° C) and fed them diets of differing quality (herbivorous and omnivorous). We measured growth as the change in mass and length over 8 weeks. If such a constraint exists, we would predict higher growth on an omnivorous diet than an herbivorous diet at cold temperatures, but that this difference should be reduced at higher temperatures. In this species, the effect of diet quality on growth was dependent on temperature, with higher growth on an omnivorous diet only at high temperatures. Additionally, digestive morphology was affected by temperature, but not diet quality. Relative gut length was higher at low temperatures than high temperatures. These results contradict some previous findings. Here, we discuss the potential reasons for these contradictions and the implications to our understanding of the mechanisms driving diversity patterns in marine herbivorous fishes.

ASSESSING THE AMOUNT OF SUITABLE HABITAT AND THE POPULATION SIZE OF BLACK ABALONE (HALIOTIS CRACHERODII)FROM HALF MOON BAY TO POINT CONCEPTION
Bell, C.A.1*, Ammann, K.N., George, M.K., and P.T. Raimondi UC Santa Cruz

Black abalone (Haliotis cracherodii) have experienced mass mortalities along the coast of California since the mid-1980s and are now protected under the USA Endangered Species Act. Mortality is due to poaching and a fatal wasting disease called “withering syndrome”. Working with MARIne (Multi-Agency Rocky Intertidal Network) and PISCO (Partnership for Interdisciplinary Studies of Coastal Oceans) monitoring groups we have documented their decline along the California coast. We currently sample abalone populations at 27 sites from Point Conception to Halfmoon Bay. The last extant large and healthy populations exist in the Monterey Bay National Marine Sanctuary- their area of
A total of 864 morphological and habitat characteristics were recorded, including color morph, substrate type, slope, and complexity. Lobos, Pt. Sur, and Big Creek), individual sea cucumbers of these species were identified and sized. Additionally, we used a gradient of sample areas away from an area of known suitable habitat (a current sampling site – was the center of the gradient) and found that suitable habitat is not spatially clustered. We also found strong correlation between the quality of habitat and the density of abalone. Our data can be applied to further studies that will aim to estimate the entire population and aid in the recovery of black abalone.

† COMPARATIVE CARBON FLUX IN MARINE AND TERRESTRIAL SUBTROPICAL ECOSYSTEMS IN LÓPEZ MATEOS, BAJA CALIFORNIA SUR, MEXICO
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The impact of global climate change on the net primary productivity of natural ecosystems and agriculture in semi-arid regions has the potential to significantly impact carbon balance, climate and food production due to the considerable water stress and high temperatures of these systems. Despite the importance of understanding carbon exchange dynamics in semi-arid regions, carbon flux in these biomes is significantly understudied. The objective of this study is to quantify and compare net ecosystem carbon exchange among four distinct ecosystems: lagoon, mangrove, desert and agricultural field; all under similar microclimates in a semi-arid region of Baja California Sur, using tower-based eddy covariance techniques and pCO2 measurements. All eddy covariance data were collected from a single transportable tower during consecutive 14-24 hour periods from April 1- April 5, 2009. Eddy covariance data showed the lagoon, mangrove and agricultural sites were all net carbon sinks, displaying mean hourly fluxes of -84.9 mgC m², -121.1 mgC m², and -413.1 mgC m², respectively. Measurements of pCO2 in the lagoon displayed a mean hourly carbon flux rate of 5.2 mgC m², showing a slight CO2 source. The desert ecosystem was a net carbon source, displaying a mean hourly flux of 0.16 mgC m². Photosynthetically active radiation and surface soil temperature were found to be significant meteorological variables in relation to the carbon exchange rates for each of these ecosystems except the lagoon, which displayed a negative relationship with tidal flow.

HOW DOES SYMBIONT COMPLEMENT AFFECT REPRODUCTION IN THE INTERTIDAL ANEMONE, ANTHOPLEURA ELEGANTISSIMA?
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The intertidal sea anemone Anthopleura elegantissima may host two distinct algal symbionts: green chlorophytes (zoochlorellae) or brown dinophytes (zooxanthellae). Within a single habitat, individual A. elegantissima may be found hosting either symbiont alone, hosting a mixture of both symbionts, or hosting very few or no symbionts (aposymbiotic). An important question in symbiosis is how the host benefits from its symbionts. Reproductive condition was hypothesized to be positively correlated with the presence of symbionts, with zooxanthellae predicted to provide a stronger positive relationship with host gonad development than zoochlorellae. A field population of A. elegantissima was sampled in July 2009 in the San Juan Islands, WA. Qualitative indices of gonad development and quantitative measurements of gonad size failed to reveal differences in gonad development between anemones with zooxanthellae or zoochlorellae. However, there were large differences in reproductive development of symbiotic and aposymbiotic individuals. Anemones with symbionts had large, well developed gonads while those without symbionts had little to no reproductive tissue. Our results indicate that, for A. elegantissima, hosting symbionts may dramatically increase sexual reproduction. Finer scale sampling is necessary to determine whether more subtle differences occur in reproduction of A. elegantissima hosting zooxanthellae or zoochlorellae.

† DEEP-POPULATION DISTRIBUTION OF TWO COMMERCIAL SPECIES OF SEA CUCUMBER, PARASTICHOPUS CALIFORNICUS AND PARASTICHOPUS LEUKOTHELE IN CENTRAL CALIFORNIA
Blaine, J.B.*, Tissot, B.N.†, Starr, R.M.‡, and M.M. Yoklavich§ 1 - Washington State University 2 - Moss Landing Marine Lab 3 - NOAA Fisheries, Santa Cruz
Sea cucumbers are fished around the world. Along the west coast of the U.S., Parastichopus californicus is the primary species targeted in both a trawl and SCUBA dive fishery, and Parastichopus leukothele is also likely collected in trawls. As most fishery stock assessments target shallow populations of sea cucumbers, the deeper populations often go unmonitored. The purpose of this study is to identify the spatial distribution and dynamics of the deeper (>30m) populations of P. californicus and P. leukothele in central CA. Using the Delta submersible dive footage from the 2007 central CA marine protected area baseline surveys in five primary locations (Soquel Canyon, Portuguese Ledge, Pt. Lobos, Pt. Sur, and Big Creek), individual sea cucumbers of these species were identified and sized. Additional morphological and habitat characteristics were recorded, including color morph, substrate type, slope, and complexity. A total of 864 P. californicus and 482 P. leukothele were identified on transects, ranging in size from 10-45cm and 5-
35cm, respectively. Preliminary analysis shows that \textit{P. californicus} populations in the northernmost sites (Soquel and Portuguese Ledge) are significantly larger than those in the other three sites. Further analyses to be conducted include examining population density, depth distribution, spatial arrangement, and habitat characterization. Results from this study will provide a fishery-independent analysis of understudied deep sea cucumber populations that may be helpful in the management of these two species.

† TIDAL EFFECTS ON SPORE RELEASE IN TWO ARTICULATED CORALLINE ALGAE
Bohnhoff, J. C. 1*, and K. A. Miklasz 2 1 - Stanford University 2 - Hopkins Marine Station
At Hopkins Marine Station in Monterey, California, coralline algae thrive in the rocky intertidal zone. In their intertidal habitat they are subjected to significant environmental fluctuations as the tide draws in and out. The daily changes in temperature, light quality, and desiccation that corallines experience greatly influence many aspects of their life cycle. This study focuses on how these factors may affect coralline algal reproduction in particular, since algal spores are especially vulnerable to environmental fluctuations. One would expect intertidal algae to time spore release in response to these environmental fluctuations, in one of two ways: 1) algae directly control spore release in response to immediate environmental conditions, or 2) algae release according to an internal clock calibrated to the tidal cycle. To test the direct response hypothesis, two articulated coralline algae (\textit{Corallina vancouveriensis} and \textit{Calliarthus tuberculatum}) were monitored for spore release under controlled laboratory conditions of varying temperature, light, and desiccation. To test the internal clock hypothesis, \textit{Corallina} was isolated from environmental stimuli, and its release measured over a period of 48 hours. Results indicate that coralline spore release rates do not depend on immediate environmental conditions, but fluctuate on an approximately tidal cycle – even in the absence of external cues.

DIFFERENT MECHANISMS FOR DIFFERENT SPECIES – SMALL SCALE DIFFERENCES IN THE OCCURRENCE AND DISTRIBUTION OF TEMPERATE REEF FISH LARVAE
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Previous studies have shown that gobies and tripterygiids are important constituents of fish larval assemblages at the Arrábida Marine Park (Portugal). These larvae occur mostly in inshore waters, close to the adult reefs. They can exhibit habitat and depth preference at very small spatial scales, with patterns being variable between species. We investigated the vertical distribution of the larvae of these groups and the role of tides as a possible mechanism driving this distribution. Larvae were collected using a plankton net attached to an underwater scooter at two distinct depths, close to the rocky bottom and 1 m below the surface, and during all tidal phases. Light traps were also used to collect larvae at the same sites and depths during June 2007 and 2008. Results showed inter-annual fluctuations but the vertical patterns were the same as shown in previous studies. Tripterygiids dominated the surface assemblages during high tide; while gobies were more associated with the bottom, during ebbing tides. For both tripterygiids and gobies, sampled larvae occurred in several developmental stages indicating local growth and possible larval retention inshore. Nonetheless, while gobies seem to remain close to the bottom possibly avoiding offshore dispersal, tripterygiids must use a different mechanism to be retained nearshore, indicating that distinct biophysical interactions occur. Results are discussed in the light of life history traits and behavior of these species.

† RESILIENCE IN TWO ALTERNATE SOFT-SEDIMENT COMMUNITIES DEPENDS ON COMMUNITY SIZE AND DISTURBANCE TYPE
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Ecological systems can be altered by many factors including habitat modification, eutrophication, species introductions and fishing. Thresholds may exist, allowing a natural system to withstand disturbance or switch to a distinct community. Alternate stable states are distinct communities in similar environments. To persist, alternate stable states must have positive feedback mechanisms that perpetuate the community at the expense of outsiders and allow it to recover from disturbance (resilience). \textit{Boccardia proboscidea}, a native polychaete worm, has recently formed dense patches in a central California estuary adjacent to habitat dominated by phoronid worms. My data show that \textit{Boccardia} and phoronid communities have discrete biological assemblages and physical characteristics (e.g., grain size \(p=0.03\)) and are alternate states. I examined multiple aspects of stability in the \textit{Boccardia} and phoronid community states, including persistence, resilience and presence of positive feedback mechanisms. I experimentally manipulated \textit{Boccardia} and phoronid communities using three sizes of reciprocal transplants, defaunated plots with coarse or fine sediment, and simulated natural and anthropogenic disturbances. Treatments were designed to measure persistence of transplanted communities and resilience in defaunated and disturbed plots. The rate of change in all plots was related to the identity of the surrounding community, the type of physical habitat, the size of the plot, and the community structure of the plot. The initial impacts following disturbance as well as resilience over time differed depending on...
community identity as well as type and spatial extent of disturbance. Results demonstrate the potential importance of resilience and positive feedbacks in understanding community dynamics.

† ENDOCRINE DISRUPTION IN A CALIFORNIA ESTUARY: LINKING INDIVIDUAL-LEVEL EFFECTS TO POPULATION-LEVEL CONSEQUENCES
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Estrogenic and androgenic endocrine disrupting compounds (EDCs) are widespread in the environment and are known to damage the reproductive systems of fishes. A large body of work exists on EDC effects in commonly-used laboratory species (i.e. zebrafish); however, fewer studies have considered fish that inhabit estuaries, which serve both as a nursery and as vital habitat for a number of threatened fish species. Our work utilizes the silverside (*Menidia beryllina*), a euryhaline resident of estuaries on the Atlantic, Pacific and Gulf coasts, as an indicator of EDC exposure in Suisun Marsh, at the western boundary of the Sacramento-San Joaquin Delta, CA. Our investigation is three-tiered. First, solid-phase extracts of water samples from areas exposed to treated wastewater, urban run-off or ranch run-off produce significant evidence of binding to both the nuclear estrogen receptor (ER) and androgen receptor (AR) using the CALUX assay (chemical-activated luciferase gene expression) with ER- and AR-transfected cell lines. Second, immunoanalysis of plasma reveals that wild males collected from Suisun Marsh express choriogenin (egg shell protein); data from an outplanting experiment suggest that the level of expression at marsh sites is significantly greater than laboratory controls and is equivalent at all exposed sites. Third, collections at sites exposed to different sources exhibited significantly different sex ratios, persistent throughout 2009. These results suggest that individual-level effects may scale up to population-level consequences.

HOW DOES FLOW RATE AND SIZE AFFECT LARVAL GROWTH RATES? A STUDY ON THE BLACK FLY SIMULIUM TRIBULATUM
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Little information is available on what internal (genetic) and external (environmental) factors can affect the growth rates of black fly larvae. Previous studies on larval growth rates have focused on the effects of environmental factors such as food availability, temperature, and current velocity, however; none of the studies have addressed ontogenic variables in growth rates. Larval growth rates are regulated in ontogeny but may be influenced by environmental factors such as water flow, which has been shown to play an important role in the feeding and ingestion rates of larvae. The aim of this study, therefore, was to address how both internal (size) and external (flow) factors can impact larval growth rates. The experiment utilized freshly hatched larvae with a mean start size of 0.6mm and larger, older, larvae with a mean start size of 4.2mm under two different flow rates (44 cm/sec and 64cm/sec) produced in a purpose-built laboratory flume. Length measurements were log transformed and evaluated using instantaneous growth rates. Results indicate that both flow and larval size significantly affect the growth rates of larvae. Smaller larvae grew 58% and 102% in 44cm/sec and 64cm/sec, respectively whereas larger larvae grew 11% and 15% in 44cm/sec and 64cm/sec, respectively. These results indicate differential growth rates at different stages of ontogeny appear to be confounding variables in the intrinsic/extrinsic influences of overall black fly growth rate.

A STAKEHOLDERS PERSPECTIVE ON THE NORTH CENTRAL COAST PROCESS THAT ESTABLISHED MPA'S THROUGH CALIFORNIA'S MARINE LIFE PROTECTION ACT
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To protect ecosystem function, and enhance fisheries, the California legislature passed the landmark California Marine Life Protection Act (MLPA) in 1999. The bill mandated a network of Marine Protected Areas (MPAs) to be in place by 2011. Beginning in 2000, the Department of Fish and Game (DF&G) attempted to implement the MLPA. These attempts failed because of widespread public distrust of the process. In 2005 DF&G started over and convened a panel of stakeholders for the California Central Coast. In March, 2007 they formed the North Central Coast Regional Stakeholders Group (NCCRSRG). After two and half years of negotiations and public outreach, the issue of networks of MPAs on the north central coast was decided by a 3 to 2 vote at the August 5th Fish and Game Commission meeting. The 24 NCC stakeholders were a diverse group of commercial and recreational fishermen, divers, conservationists, and government officials. The RSG was charged with designing, locating and recommending protective regulations for, as it turned out, 20.3% of California’s North Central Coast. If this process failed, no MPAs would be implemented in the NCC, putting MPA plans for the entire state in jeopardy. Here we examine RSG sources of guidance, types of MPAs proposed, goals, areas of stakeholder agreement and criteria for MPA selection. Once this network of marine reserves is implemented in January on the North Central Coast, planned monitoring projects may provide some answers to many questions raised by RSG members.
HERBIVORE WASTES IN LABORATORY FEEDING TRIALS: ARE WE USING THE WRONG CONTROL?
Britton-Simmons, K.H.*, Rhoades, A.L., and M.N. Dethier University of Washington
Laboratory feeding trials have long been an important tool for investigating seaweed-herbivore interactions. Although feeding trials vary widely in the details of their methodology, contemporary feeding trials have at their core two basic treatments: (1) a feeding treatment with both algae and herbivores, and (2) a control treatment containing algae only. The design and interpretation of these experiments explicitly assumes that feeding is the only difference between these two treatments. Ignored is the presence of herbivore wastes, which are present in any treatment where feeding occurs and contain nutrients commonly known to limit seaweed growth in nature. We used a novel experimental design that controlled for the effects of both feeding and herbivore wastes to investigate whether herbivore wastes would build up in and influence the results of a choice laboratory feeding trial. In our experiment ammonium levels were 34% to 49% higher in treatments where the isopod Idotea wosnesenskii was present. Phosphate was also elevated, but to a lesser extent. The experimental seaweeds (Fucus, Alaria, Ulva) did not have altered growth in the presence of herbivore wastes, apparently because they were not nutrient limited. Nevertheless, our results demonstrate that the current algal feeding trial design does not control for the presence of nutrients derived from herbivore waste products. Seaweeds are nutrient limited in many regions worldwide and the presence of herbivore wastes in laboratory feeding trials is therefore highly problematic. We suggest that the current design should be modified to control for the presence of herbivore-derived nutrients.

† COSTS OF DISPERSAL, HABITAT SELECTION, AND THE SPATIAL SCALES OF REALIZED CONNECTIVITY.
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The costs of dispersal are usually divided into two categories: (1) direct costs (the risk of mortality during dispersal) and (2) deferred costs (where costs incurred during dispersal are experienced after settlement). In species with non-feeding larval stages, the deferred costs of delaying metamorphosis can be offset by a decrease in habitat selectivity at settlement (i.e., “desperate larva hypothesis”). Though assumed in theoretical models, it is still unclear from empirical studies if settling in response to a less preferred settlement cue affects performance after settlement. Here we show that longer larval durations in Bugula neritina (Bryozoa) result in a greater chance of accepting poor quality habitat. We then go on to demonstrating the link between habitat quality and post-settlement performance and show how deferred costs of dispersal might influence the spatial patterns of population connectivity. We finish by validating some of these predictions with estimates of dispersal duration in the field using the lophophore sizes of settlers. Importantly, we show that costs of dispersal occur through various ways and potentially reduce the spatial scales of realized connectivity.

† SKELETAL GROWTH ANOMALIES AFFLICTING MONTIPORA CAPITATA CORALS: AN ANALYSIS OF SKELETAL MORPHOLOGY AND DISEASE PREVALENCE.
Burns, J.*, Rozet, N. K., Gregg, T. M., and M. Takabayashi University of Hawaii at Hilo
Reports of coral degradation due to disease have been increasing worldwide over the last decade. A comparatively high prevalence of coral diseases has been reported in the Wai`ōpae tide pools on the southeast coast of Hawai`i Island. Here, corals of the genus Montipora are particularly prone to succumbing to reduced health states, with 14.9±0.75% of Montipora colonies suffering from several unhealthy conditions consistently during the last three years of surveys. This study focused on the skeletal growth anomalies (SGAs) impacting Montipora capitata because of their high prevalence and lack of etiological data and definitive field diagnoses. Morphological assessment of the skeletal microstructure using macro photographic image analysis showed that these SGAs can be classified into two diagnosable categories for M. capitata: Type A and Type B. Type A SGAs have a significant reduction in polyp and tubercule density with many tubercule becoming fused and protrusive. Type B SGAs have no discernable polyps and have fused and protuberant coenosteum. Closer analysis revealed that Type A lesions suffer polyp density reduction by 50±0.18% compared to healthy M. capitata tissue. Using these diagnostic criteria, we conducted an exhaustive survey of M. capitata at Wai`ōpae and found the prevalence of Type A SGAs to be 30.7% and Type B SGAs to be 9.1% among all the colonies observed. Impacts of SGAs on the physiology of corals and potential correlations with water quality parameters are presently being investigated in order to assess how this coral population as a whole is impacted by this disease.

† MATING BEHAVIOR OF THE SEA SPIDER ACHELIA SIMPLISSIMA
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Pycnogonids, or sea spiders, are one of a few marine invertebrates that exhibit exclusive male parental care, making them likely candidates for sex-role reversal. However, little is known about the courtship and mating behaviors of sea spiders. During mating, the female transfers her eggs to the male, who fertilizes them externally, and forms them into balls called egg masses, which are glued to a pair of specialized ovigerous legs. He carries the egg masses until they
hatch. The aim of this study was to understand the dynamics of the mating processes of the sea spider Achelia simplissima by exploring the following questions: Is each egg mass the contents of an individual mating event? Is there a behavioral pattern to egg mass placement? Do females mate with multiple males? Male and female pycnogonids were matched and checked for mating every 12-24 hours over a period of four weeks. Results indicate that each egg mass is from a single mating event even though pairs mated up to five times throughout the experiment. Males placed the first egg mass on the right oviger 80% of the time, and the second egg mass on the opposite oviger 100% of the time. Females mated multiple times, but always with the same male. These are the first recorded observations of mating in a sea spider of the family Ammotheidae.

THE CONSEQUENCES OF ALGAL SPECIES RICHNESS FOR RESISTANCE TO URCHIN GRAZING
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A wide variety of studies have shown that disturbance can influence species diversity. More recent work shows that diversity can influence the realized intensity of disturbance. In temperate rocky reefs, the composition of the algal communities remaining after storms remove giant kelp might play a role in buffering against overgrazing by newly starved sea urchins. We investigated whether algal species richness reduced grazing disturbance by purple urchins and whether the effects of species richness depended on the grazing intensity. We performed a field experiment off the coast of Santa Barbara at a site where giant kelp had been removed during the previous winter. We chose plots spanning a natural gradient of algal species richness (4-16 species). We crossed this gradient of richness against a gradient of urchin grazing density (0 - 50 urchins in a 0.5m² plot). After three weeks of grazing, richness did not buffer systems with moderate to high numbers of urchins. At low urchin densities, however, we found a negative relationship between species richness and change in algal cover. Low richness plots increased in cover while high richness plots lost cover. This result was confirmed in a second experiment using the same design, but a lower maximum number of urchins (0-16). Our results show that species richness has little effect on the impact of a strong generalist grazer at high densities. At low grazer density, however, diversity can weaken resistance to mild but sustained grazing due to the presence of many less preferred but slowly recovering species.

† THE EFFECTS OF DIFFERENT TYPES OF SIMULATED FISH PREDATION ON THE GROWTH AND RECOVERY OF SMALL CORALS
Cameron, C.M.*, and P.J. Edmunds CSU Northridge
The effects of damage on corals by fish corallivores may vary depending on the type of damage, species of coral, and life stage affected, and the possibility of discordant outcomes are likely to be important in understanding population consequences of corallivory. The present study differs from previous work by utilizing short-term field experiments to test the effects of corallivory on small colonies (= 5 cm tall) that are thought to be sensitive to damage, and which play important roles in population growth. Our objective was to assess the impacts of artificial damage on two morphologically distinct corals (massive Porites sp. and Pocillopora meandrina) by mimicking the effects of single bites by fishes belonging to different functional feeding groups: excavators, scrapers, and browsers. The experiment was conducted in the lagoon of Moorea, where corals were allocated to replicate cages for 21 d to measure growth in response to treatments. Throughout the experiment, Porites grew faster than P. meandrina for excavating, scraping, and browsing treatments (15%, 19% and 4%). Corals in the excavator treatment grew the slowest for Porites and P. meandrina (1.71 and 0.99 mg cm⁻² day⁻¹), while those in the browser treatment grew fastest (2.47 and 1.79 mg cm⁻² day⁻¹). There was no significant species x treatment interaction for growth, suggesting both species reacted similarly to the treatments. These results suggest that fish predation does not adversely affect the survival of small corals, but the relative abundance of fish in each functional group will affect corals at the population level.

TIDAL RHYTHMS IN THE FORAGING ACTIVITY OF WHELK NUCELLA OSTRINA
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The accurate prediction of the effects of climate change on marine communities requires a mechanistic understanding of both direct and indirect effects of temperature on organisms. A key first step in identifying potential mechanisms requires knowledge of body temperature, which can be difficult for small mobile intertidal organisms that can move across microhabitats that vary in thermal stress. In the case of the whelk predator Nucella ostrina, foraging on their barnacle prey generally requires movement higher on the shore, which potentially increases the risk of thermal stress. How do snails balance the reward of food acquisition with the risk temperature stress? We used laboratory and quasi-field studies to examine foraging patterns of snails on barnacles in natural tidal conditions for 6-8 weeks at Friday Harbor, WA. Foraging activity followed a biweekly pattern; snails emerged from refuges to feed for 2-4 days, then retreated for approximately ten days. The peaks in foraging activity coincided with the onset of spring tides, when aerial exposure was confined to early morning hours. Thus snails apparently acquire prey during times of reduced thermal
risk. These results underscore the importance of understanding the temporal patterns of microhabitat usage in assessing the thermal exposure of mobile organisms.

† SCALING LOCAL MEASUREMENTS OF GIANT KELP CANOPY COVER AND BIOMASS TO REGIONAL ESTIMATES USING SATELLITE OBSERVATIONS
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Little is known about the local to regional scale variability in biomass and productivity of many subtidal ecosystems as direct surveys for these habitats are often time and labor intensive. Here, we combined high-resolution satellite imagery with detailed diver sampling to assess changes in giant kelp (Macrocystis pyrifera) canopy cover and biomass along a ~60 km stretch coastline in the Santa Barbara Channel, California. Kelp canopy extent was determined by using principal component analysis on multispectral SPOT 5 satellite imagery. The kelp cover classification technique compared very well with near-coincident high-resolution aerial camera surveys (r2 = 0.90). Monthly diver observations of biomass and frond density for fixed plots at three sites were strongly correlated with satellite determinations of Normalized Difference Vegetation Index (NDVI) signals (r2 = 0.77). This allowed us to examine the variability of kelp biomass across multiple scales (pixel, plot, kelp bed, region) and illustrated that the relationship between plot scale changes and remote assessments of bed scale changes varied among beds and depended on the relative location of the plot and the size of the bed. By using field sampling to parameterize satellite estimates of kelp biomass, we can observe variability in kelp populations at unprecedented spatial and temporal scales and better understand the key drivers of this variability.

† ASSOCIATIONS BETWEEN NATIVE AND INVASIVE CAPRELLA AND BUGULA: EPIFAUNA-SUBSTRATUM INTERACTIONS
Cerda, J A1*, Sorte, C J 2, and S L Williams1 1 - UC Santa Cruz 2 - Bodega Marine Laboratory, UC Davis
Exotic species are being introduced throughout the world at a rapid rate. As species establish themselves in new environments, they form associations with, and have the potential to positively and negatively affect, native species. We studied the interactions between a native and invasive species of caprellid amphipod and a native and invasive species of biological substratum of caprellids, bryozoan in the genus Bugula. In an experiment examining the substratum preferences of caprellids, we found that the native species of caprellid showed a strong preference for the invasive species of Bugula. The invasive caprellid, when collected from a native Bugula substratum, exhibited a preference for the native species of Bugula. This preference, however, was not apparent when the invasive caprellids were collected from invasive Bugula or the hydroid Obelia. In a separate experiment to test the impact of caprellids on Bugula growth, we found that caprellids had no significant effect on Bugula. Therefore, based on our experiments, the invasive caprellids and Bugula have formed strong associations with the native species, but we detected no net impacts of such interactions on the Bugula substrata.

STORMS AND DROUGHTS: COMMUNITY CONSEQUENCES OF ALTERED ESTUARINE HYDROLOGICAL CYCLES
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Climatic extremes are predicted to increase in frequency and severity due to global climate change. Mounting evidence indicates significant human-driven alterations to the hydrological cycle of the western United States in the last 50 years, including increasing variability and extreme fluctuations in flow. Little is known about the ecological impacts of these changes to the hydrological cycle in downstream, estuarine systems. We used long-term physical and biological data sets and experimental approaches to examine the effects of extreme high and low freshwater outflow levels on estuarine epifaunal communities in San Francisco Bay. We assessed the relative extremeness of outflow levels during our study by comparing them to the historical record. Using time series of sessile invertebrate recruitment, we examined recruitment and survival patterns in different outflow conditions. During high freshwater outflow (wet) years, low salinity levels caused mass mortality of resident adults and altered the composition of recruitment in epifaunal communities. In contrast, during dry years, these communities were dominated by exotic solitary tunicate species. Using removal experiments, we showed that these solitary tunicates depressed overall community diversity and greatly altered community composition. Our experiments mimicking the low salinity levels produced by high freshwater outflow events demonstrated that these dominant solitary tunicate species were susceptible to low salinity levels, and the resulting communities were dominated by recruitment. The changes between the observed climatic wet and dry extremes thus appeared to shift these epifaunal communities from being space-limited in dry years to being recruitment-limited in wet years.
STAGE-STRUCTURED POPULATION MODELING AS A TOOL FOR PREDICTING RESPONSES OF THE INVASIVE TUNICATE Botrylloides violaceus TO CLIMATE CHANGE

Cockrell, M.L.1, and C.J.B. Sorte2 1 - Northeastern University 2 - UC Davis

The role that age may play in physiological and temperature-mediated changes is often overlooked, and can be a confounding factor if not accounted for in studies of thermal tolerance or predictions on climate-driven shifts in communities. In this study, we investigated the effects of temperature on (1) age-specific survival and (2) population growth for the invasive tunicate Botrylloides violaceus. Specifically, we raised Botrylloides individuals in laboratory mesocosms at ambient temperature (13.5°C) and an increased temperature predicted by climate change models (18°C). Based on counts conducted at ten-day intervals over 40 days (the average time to reproductive age), we found that temperature had no significant effect on survival rate at any stage, however, both survival and growth rate varied strongly with age. We used survival and growth rates from the mesocosm experiment, as well as regressions of ocean temperature and recruitment counts as a measure of fecundity, to parameterize a stage-based population model. We modeled population growth at ambient and increased temperature and found that population growth rate and stage structure over time varied between treatments. Changes in the population growth pattern of Botrylloides with temperature would likely have effects on the entire community, leading to altered community composition and interactions. Our study illustrates the potential for using demographic modeling as a tool for predicting ecological responses to climate change.

† POPULATION VARIATION AND EFFECTS OF COPPER IN Watersipora subtorquata

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Watersipora subtorquata is an encrusting bryozoan that is considered cosmopolitan and widely invasive in temperate harbors and ports. This bryozoan is tolerant of copper anti-fouling paints and is known as a facilitator for other invasive marine species. Presumably, these bryozoans have recently invaded California from multiple source locales, and previous studies have shown a great deal of mitochondrial DNA variation within the state. To test for varying copper tolerance between populations in California, larvae from Humboldt Bay, Moss Landing, and Morro Bay were placed in various concentrations of copper (0, 380, 445, 510, and 570µg l-1) and monitored over a 24-hour period. Six day toxicity tests were also performed to link the effect of low level copper exposure (0, 6, 30, 60, and 300µg l-1) at the larval stage to post-metamorphic survival and development. Humboldt Bay larvae showed higher tolerance than the other two populations. As expected, larval mortality was elevated in the presence of copper, yet non-lethal concentrations of copper actually induced settlement and did not prevent post-metamorphic development. These results indicate that low levels of copper from antifouling paints may enhance the likelihood that W. subtorquata larvae settle, the opposite of the desired effect.

† THE INFLUENCE OF REFLECTED LIGHT FROM THE BENTHOS ON CORAL PHYSIOLOGY

Colvard, Nicholas B.*, and Peter J Edmunds  CSU Northridge

Here we test the effect on reef corals of heavily grazed (HG) and macroalgae-dominated (MD) substrata through alterations in reflected light. On shallow reefs in Moorea and Taiwan, the intensity of reflected light was reduced ~20% over MD compared to HG substrata, and its quality was modified through a depressed representation of red light. The effects of these contrasting regimes of reflected light were explored with two series of experiments. First, the photophysiology of Porites lobata and Pocillopora verrucosa on light and dark surfaces was measured at 3-m depth in the Moorea lagoon. Second, mesocosms were used to test for a growth response of Botrylloides violaceus to contrasting regimes of reflected light created under three categories of ambient irradiance mimicking shallow and deep water. For both experiments, the treatment surfaces were created with colored plates simulating HG and MD substrata. In the field, photosynthetic yield (ΦPSII) of P. lobata and P. verrucosa was affected by the substratum reflectance, but the effect differed 3-fold between species. In the mesocosm, growth of M. stellata was suppressed by the darkened surface under conditions simulating a deep-water environment, but the light surface mitigated this effect. We conclude that the reflectance characteristics of the substratum can affect coral physiology in shallow water, and suggest that this affect could represent a previously overlooked mechanism mediating the interactions between reef corals and macroalgae.

† SEASONAL VARIABILITY IN GROWTH RATES AND TRACE METAL CONCENTRATIONS OF Polydora cornuta IN THE TIJUANA ESTUARY ARE RELATED TO RAIN EVENTS.

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Southern California has few major rain events each year, and those that do occur generate storm water run-off that impacts coastal environments in many ways. To assess the impacts of major rain events on estuarine benthos, pre-measured individuals of the spionid polychaete Polydora cornuta were planted into the Tijuana Estuary for several 1-
wk periods between November 2008 to October 2009. These worms feed on suspended and deposited particles near the sediment-water interface and are exposed to a wide range of dissolved and particle-bound pollutants. Because these worms are food for many fishes and birds, the worms’ health and the rates at which they accumulate pollutants can have ecological and toxicological impacts on higher trophic levels. The relative growth rates of individual worms and the concentrations of metals in worm tissues were measured by recovering worms and re-measuring individual worms at the end of each 1-wk deployment period. Growth rates of the polychaetes were approximately 2% per day during deployments that coincided with or were measured within 1 wk after a major rain event and were significantly lower than the typical growth rates of 10% per day during weeks that preceded a rain event (p < 0.05). Samples of sediment and polychaete tissues were analyzed for the concentrations of 15 metals using ICP-OES. Interestingly, concentrations of metals associated with the sediments and polychaetes did not increase immediately following a rain event, but increased 2-3 wk after each rainy period.

† POPULATION GENETICS OF AN ECOSYSTEM-ENGINEER – POCILLOPORA DAMICORNIS (CNIDARIA, SCLERACTINIA) IN THE TROPICAL EASTERN PACIFIC
Combsch, D.J.*, and S.V. Vollmer  Marine Science Center, Northeastern University
The scleractinian coral Pocillopora damicornis is one of the most common and widespread reef coral species throughout the entire Indo-Pacific. Its branching, highly plastic morphology facilitates asexual fragmentation but leads to its reputation as a generally poor reef builder at most locations. In the Tropical Eastern Pacific (TEP), however, P. damicornis is the main reef-builder and the ecologically dominant coral species, covering the upper reef slopes and shallow reef flats with large mono-specific stands. These single-species ‘carpets’ are considered to be maintained predominantly by asexual fragmentation and dominated by a few well-adapted clones. Here, we examined the population genetic characteristics of these ecosystem-defining P. damicornis populations in the TEP. Using six polymorphic microsatellite loci, we analyzed the connectivity and population structure of TEP P. damicornis with samples from nine populations across three regions along the Panamanian Pacific coast. We found high genotypic diversity, indicating generally sexual reproduction in all populations. Gene flow was found to be severely limited between and within regions. Private alleles and significant levels of inbreeding further testify to the limitations of gene flow among populations. Spatially restricted genic dispersal was also detected within populations over distances of 10-50m. The highly significant genetic structure among TEP P. damicornis on multiple hierarchical levels requires regionally and locally operating conservation strategies, like the recently established No-Take Las Perlas Special Management Zone, to preserve these unique ecosystems.

† EFFECTS OF PREDATION ON POPULATION STRUCTURE OF CHLOROSTOMA (TEGULA) FUENBRALIS, AN INTERTIDAL GASTROPOD
Cooper, E.E.  Oregon Institute of Marine Biology
Populations of the intertidal gastropod Chlorostoma funebralis vary greatly in age structure along the west coast of North America. Some populations have no large adult snails older than 10 years (> 9 g) while other populations are dominated by these larger size classes. Because reproductive output increases with size, this variation may lead to differences in reproductive capacities of populations. Predation pressure is one potential source for this variation, since Paine (1969) estimated that annually, 25% adult C. funebralis from the population are removed due to predation by Pisaster ochraceus, the intertidal sea star. If seastar predation is driving the population structure of adult C. funebralis, sites with high densities of P. ochraceus should have the fewest adult C. funebralis. Six populations along the Oregon coast were sorted into three categories by the percentage of population in the age class 10 years and older: High (Otter Rock, Mount Humbug), Medium (Boiler Bay, Cape Blanco), and Low (Sunset Bay, South Cove). At each site, densities of P. ochraceus were sampled monthly from June through August. Densities of P. ochraceus did vary significantly between sites but did not correlate with the number of large adult C. funebralis within each population. The two sites with the highest densities of P. ochraceus had the highest (Mount Humbug) and the lowest percentage (Sunset Bay) of large adult C. funebralis. While predation may have an important impact on populations of C. funebralis, these data indicate it is not the mechanism behind observed differences in age structure.

† UNEXPECTED PATTERNS OF CORAL RECRUITMENT AT DEGRADED SITES WITH BENTHIC CYANOBACTERIAL BLOOMS ON MIDWAY ATOLL
Cover, W. A.*, and D. C. Potts  UC Santa Cruz
Larval recruitment fuels the resilience and replenishment of reef ecosystems. We investigated coral recruitment at degraded sites with anthropogenic iron inputs and benthic cyanobacterial blooms on Midway Atoll (Northwestern Hawaiian Islands), where subtidal dump sites of metal debris provide concentrated sources of iron and other metals normally absent in carbonate reef systems. Iron is a scarce or limiting nutrient on many Pacific atolls, and excess iron, often from shipwrecks or groundings, may be a pollutant leading to blooms of harmful cyanobacteria. Benthic
cyanobacteria often contain toxic compounds known to negatively impact marine life and inhibit coral recruitment on some reefs. At several degraded Midway sites, benthic cyanobacterial blooms, primarily *Hormothamnion enteromorophoides*, occur periodically, cover >50% of the substrate, and grow over live corals. We tested the hypothesis that cyanobacterial blooms inhibit coral recruitment by measuring recruitment rates at two bloom sites, two nearby control sites, and two distant control sites, with 10 pairs of ceramic tiles deployed for 13 months at each site. Contrary to expectations, coral recruitment was significantly higher at bloom sites than at control sites, indicating that *Hormothamnion* does not negatively impact coral recruitment on Midway Atoll. This unexpected result complicates our understanding of cyanobacterial impacts, with implications for management of metal debris on reefs.

MTDNA AND MICROSNATELITE ANALYSIS OF THE INTERTIDAL ALGA *FUCUS DISTICHUS* REVEAL MULTIPLE COLONIZATIONS OF THE NORTH ATLANTIC FROM THE NORTH PACIFIC AND TWO GLACIAL REFUGIA

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Phylogenetic and phylogeographic patterns of many marine organisms in the North Atlantic Ocean have been influenced by several ice ages and trans-Arctic connections. We used sequences from two mtDNA regions (IGS, CoI) and six microsatellite loci to examine phylogeographic patterns in the cold-temperate macroalgal species *Fucus distichus*, a key foundation species in rocky intertidal shores and the only *Fucus* species to occur naturally in both the North Pacific and North Atlantic. A haplotype network and diversity patterns suggested that the species originated in the eastern North Pacific. Between opening of the Bering Strait and before onset of the Last Glacial Maximum, at least two colonization events occurred from the North Pacific to the NE Atlantic and the NW Atlantic. One stemmed from the Japanese Archipelago/eastern Aleutians and another from the Alaskan mainland (east Gulf of Alaska). Hokkaido (Japan) was not ice-covered during Last Glacial Maximum, but the near monomorphism of mtDNA haplotypes suggest a recent single-event recolonization. Two glacial refugia in the Atlantic were identified: the NW Atlantic (New England/Canadian Maritimes) and the NE Atlantic (Andøya, Norway). The Central Atlantic (Greenland/Iceland/Faeroes) may have been colonized by an unidentified and now extinct glacial refugia along southern European coastlines. Highest IGS-CoxI diversity was observed on Knight Island 11 years after heavy disturbance by the 1989 Exxon Valdez oil spill and subsequent clean-up efforts.

WIRED: CHARACTERIZING FIELD TEMPERATURES OF THREE INTERACTING INTERTIDAL SPECIES

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It is well known that temperature strongly affects key ecological processes, such as growth, survival, and species interactions, yet rarely are the precise mechanisms by which temperature controls community structure understood. For intertidal communities, this is in part due to the difficulty in quantifying organismal temperatures that vary on small spatial and temporal scales. We used a combination of field and laboratory techniques to develop physical models of the rockweed *Fucus distichus*, the barnacle *Balanus glandula*, and the whelk *Nucella ostrina* to characterize typical body temperatures in various microhabitats (different solar aspects, tidal heights, and shading). The *Balanus* models, made from a white marine epoxy, were within 1.0°C of live barnacle temperature. In contrast, temperatures among real *Nucella* and *Fucus* were variable even in a controlled environment as a result of posture changes unique to individuals. Our selected *Nucella* model, an epoxy filled shell with embedded thermocouple, fell within the range of real organism temperatures, + 2°C. Physical models for *Fucus* (both the buoyant receptacle and the flattened branches) were also developed. We deployed these models on a rocky shore adjacent to our weather station at the Friday Harbor Laboratories; the continuous temperature data are displayed online in real-time. Preliminary results indicate shaded snails and barnacles (under *Fucus* canopies or in crevices) are protected from the cold during night-time low tides. Ultimately, we will collect a long-term data set to inform our broader studies of the ecological effects of temperature on the three interacting species.

†BALANCING CONSERVATION AND NEARSHORE FISHERIES: A COMPARATIVE SPATIAL ANALYSIS OF TWO MPA SITES IN OREGON

Crowther, D. A.*, and B. N. Tissot Washington State University

Marine conservation efforts, specifically marine protected areas (MPAs), are important recourses for balancing the often opposing values inherent in economic growth and environmental restoration. The state of Oregon has recently deliberated on and approved several proposals for MPAs within the state’s territorial sea. Two pilot sites were selected and four additional sites were recommended for further study with the goal of balancing the biodiversity of the state’s nearshore marine ecosystem without adversely affecting the socioeconomic of coastal communities. However, to date,
there have been no quantitative assessments of how fishing effort varies in relation to the biodiversity benefits of the proposed sites. We examined the lithology, depth ranges, potential fish abundance, and nearshore fishing effort of two sites, Three Arches Rocks and Redfish Rocks, over a three year period using a comparative spatial analysis to identify potential tradeoffs made in the deliberative process of siting MPAs. These tradeoffs include size of the site, proximity to ports, and historic pattern of fishing use. Understanding the balance between fisheries and conservation of these two sites sheds light on the proposal process as well as providing feedback to the state on future site selection.

† FEEDING ECOLOGY AND HABITAT USE OF BROWN STINGRAYS (DASYATIS LATA) IN HAWAI‘I INFERRED FROM STOMACH CONTENT AND STABLE ISOTOPE ANALYSIS
Dale, J.J.*,† and K.N. Holland† 1 - University of Hawai‘i at Manoa 2 - Hawaii Institute of Marine Biology
Elasmobranchs may regulate ecological communities through a variety of density and trait mediated interactions. The brown stingray (Dasyatis lata) is a large benthic ray endemic to Hawai‘i. Although highly abundant in bays and estuaries, little is known about its basic biology, trophic ecology or ecological interactions. Stomach content and stable isotope analysis were used to assess the diet and habitat use of brown stingrays, and to examine the possibility of competitive interactions with juvenile hammerhead sharks (Sphyraena lewini) in Kāne‘ohe Bay. Stingrays fed almost exclusively on crustaceans, with aplheid shrimps and portunid crabs making the greatest contributions to the diet. There were ontogenetic shifts in diet with larger stingrays consuming larger amounts of crabs and fewer shrimps. This was consistent with positive relationships between stingray size and both δ15N and δ13C values. A habitat shift from inner bay to offshore waters was evident from δ13C values suggesting that Kāne‘ohe Bay may be important juvenile habitat. There were low levels of dietary overlap between stingrays and hammerheads. A larger contribution of crabs and smaller contribution of teleosts in the stingray diet relative to hammerheads accounted for the majority of variation between diets. Hammerheads were also depleted in δ13C and enriched in δ15N relative to stingrays, suggesting that primary carbon sources differ between these two species and hammerheads feed at a higher trophic level. Both stomach content and stable isotope analysis indicate that there may be strong dietary resource partitioning between these two sympatric elasmobranch species in Kāne‘ohe Bay.

OLYMPIA OYSTER (OSTREA LURIDA) RECRUITMENT, GROWTH, AND SURVIVAL ALONG PHYSICAL AND BIOLOGICAL GRADIENTS IN A CENTRAL CALIFORNIA ESTUARY
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The native Olympia oyster (Ostrea lurida) was historically highly abundant in west coast estuaries. Following significant population decline in the early 1900s, populations have not recovered and consequently there is increasing interest in restoration. Successful restoration requires scientific knowledge of demographic performance in response to differing habitat characteristics. In this study, we monitored recruitment, growth, and survival of Olympia oysters at intertidal and subtidal sites along physical and biological gradients in Tomales Bay, a low-inflow estuary in central California. Settlement plates were used to monitor recruitment, and plates with lab-settled oysters were used to track growth and survival. Oyster performance was also assessed at each site in the presence and absence of potential competitor species. Patterns of growth differ along the bay between intertidal and subtidal sites. Results thus far show that the presence of competitor species does not significantly affect oyster performance. Data for total recruitment showed a significant main effect for site, with recruitment increasing with distance from the mouth. Results from this study show the importance of site specific knowledge to inform restoration.

† REFUGIA AND TOP-DOWN CONTROL OF THE PENCIL URCHIN EUCIDARIS GALAPAGENSIS IN THE GALÁPAGOS MARINE RESERVE
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Although sea urchins can strongly influence the structure of benthic communities and are abundant in the Galápagos Islands, experimental tests of predation on urchins have not been conducted in this system. Here, we examine how habitat structure and behavioral patterns mediate predation on the pencil urchin Eucidaris galapagensis, a key grazer in rocky subtidal habitats. Results indicate that the distribution, abundance and body sizes of Eucidaris vary predictably by habitat in the central Galápagos. Urchins were 5 times more abundant and significantly smaller in the rubble than in exposed ledge habitats. To test the hypothesis that rubble habitats provide a refuge from predation, tethering manipulations were conducted using small and large urchins as prey. Predation by the hogfish Bodianus diplotaenia, triggerfishes, and the sea star Pentaceraster cumingi, was higher for both small and large urchins in rubble than in exposed habitats, indicating that rubble habitats represent a refuge. Furthermore, documentation of urchin activity over a 24-hour period indicated that Eucidaris is significantly more abundant at night on the exposed substrate, as they emerged from the rubble refugia at dusk. Since the fish that prey on Eucidaris are predominantly diurnal, we hypothesize that the nocturnal activity patterns of the urchins represent a predator avoidance strategy.

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considering how spatial refugia and prey behavior mediate predator-prey interactions, the importance of top-down control of *Eucidaris* may be overestimated in this system.

† STORAGE AND ABIOTIC REGULATION OF INVESTMENT IN SEXUAL VS. VEGETATIVE REPRODUCTION IN THE CLONAL KELP, *LAMINARIA SINCLAIRII* (LAMINARIALES, PHAEOPHYCEAE)

Demes, K.W., and M.H. Graham 1 - University of British Columbia 2 - Moss Landing Marine Labs

Laboratory temperature and nutrient manipulation experiments demonstrated that investment in sexual and vegetative reproduction in *Laminaria sinclairii* (Harvey ex Hooker f. et Harvey) Farlow, C.L. Anderson et D.C. Eaton are regulated by different abiotic factors. Blade growth and sorus production (sexual investment) were significantly higher at 120°C compared to 170°C, regardless of nutrient concentration. Net carbon storage and depletion in rhizomes were observed in the low and high temperature treatments, respectively. Rhizome elongation (investment in vegetative reproduction), on the other hand, was significantly higher in 12µM NO3- than in 2 µM NO3-, irrespective of temperature. This increase in rhizome growth was concurrent with elevated rhizome percent tissue nitrogen levels also observed in treatments with higher nutrients. These results suggest that physiologically, *Laminaria sinclairii* is similar to aclone kelps and that its rhizome functions similar to the stipes of other kelps with respect to carbon and nitrogen storage. Implications for the evolutionary significance of clonality in kelps are discussed.

HOW BAD CAN IT GET? PREDICTING EXTREME EVENTS IN ECOLOGY

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Extreme environmental events can impose dramatic, long-lasting effects on ecological communities. Some extreme events (e.g., earthquakes) are "simple:" they either happen or they don't, and these events are currently unpredictable. In contrast, many extreme ecological events are "compound:" they occur when, by chance, two or more run-of-the-mill environmental factors come into coincidence. We have developed a statistical approach -- the environmental bootstrap -- that allows one to calculate the probability of these compound events. As an illustration of the utility of this approach, we work from a short (7-year) data set of environmental factors to calculate the return time of wave-induced disturbance in the California mussel, *Mytilus californianus*, and the likelihood of thermal death in the owl limpet, *Lottia gigantea*. These two species are competitive co-dominants for space on rocky intertidal shores in California, and their relative rates of disturbance at a given location can have important consequences for community structure and species diversity. The environmental bootstrap can be applied to a wide variety of stressful events in ecology.

MOVEMENT PATTERNS AND HABITAT PREFERENCE OF THE GIANT MANTA RAY, *MANTA BIROSTRIS*, AT A REMOTE PACIFIC ATOLL

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In 2006 the International Union for the Conservation of Nature listed the Giant Manta Ray (*Manta birostris*) as a near threatened species, citing population declines in various parts of the world. Considering manta rays are one of the largest fish species and are found in tropical and temperate waters around the globe there exists surprisingly scarce information on their natural history. In order to address this problem we attempted to investigate aspects of their basic ecology by tracking mantas via acoustic telemetry as well as being the first to explore manta ray movement patterns with a high definition acoustic camera. The study site was Palmyra Atoll, a remote near-pristine coral reef atoll and National Wildlife Refuge in the central Pacific. Palmyra provided an ideal ecosystem for collecting data on manta rays where human presence did not seem to affect their natural behavior. We report the results of movement patterns and activity space sizes provided by acoustic tracking over a short time scale. We also suggest explanations for how these features are affected by habitat and forage availability as well as diel and tidal cycles, information supported by counts and sizes of mantas moving through Palmyra’s lagoon from the high resolution sonar. Information of this type further contributes to the background of knowledge required to fully understand the behavior and habitat requirements of *M. birostris*, information that is essential for the conservation and management of exploited or declining populations.

SEASONAL STABILITY OF *ANTHOPLEURA ELEGANTISSIMA* SYMBIOTIC ALGAL POPULATIONS

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Over part of its range, the intertidal sea anemone *Anthopleura elegantissima* maintains a unique endosymbiosis with two phylogenetically and physiologically distinct algae, the chlorophyte *Elliptochloris marina*, and the dinoflagellate *Symbiodinium muscatinei*. We evaluated the hypothesis that populations of these algae are spatially and temporally stable, with randomized collections of anemones at three shore heights over four seasons on San Juan Island, WA in 2008-2009. *E. marina* was largely limited to anemones from the low shore level (+0.2m) while *S. muscatinei* was
predominant at mid and high shore levels (+1.1 and 2.0m). This distribution remained stable throughout the year, in spite of substantial seasonal variation in light, temperature, and aerial exposure regimes. Algal densities also varied little from season to season. Few anemones hosted mixed populations of the two algal species; one species was typically dominant. These results add support to earlier studies suggesting that this symbiosis is not significantly affected by annual cycles in environmental conditions, and confirm that intertidal zonation of the algae persists throughout the year.

COMPARISON OF REEF FISH ASSEMBLAGE STRUCTURE ACROSS AN EXPLOITATION GRADIENT IN AMERICAN SAMOA
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The U.S. Territory of American Samoa includes five islands and two atolls surrounded by coral reefs similar to other central South Pacific islands. Coral reef fish populations were surveyed during four biennial cruises (2002-2008) to quantify spatial and temporal variability along gradients of human habitation and exploitation. Seven islands with varying human population densities were broken up into three population classes: high, Tutuila and Aunuu (~56,000 people); medium, the Manua group (Ofu, Olosega, and Tau, <400 people/each); and low, Swains (<10 people) and Rose Atolls (uninhabited). Fish assemblage structure is considered at the level of the whole assemblage and among commonly targeted families across three island-population classes. Total mean fish biomass and numeric density were highest around Rose and Swains Atolls (~1.5 t/ha) and lowest around Tutuila/Aunuu and the Manua Islands (~0.7 t/ha). Similarly, biomass of large fishes (>50 cm in total length) was 2-4 times higher around Rose and Swains Atolls when compared to other populated islands in American Samoa. Biomass and numerical density of common fishery targets, such as jacks and groupers, were variable by island but highest at Rose and Swains Atolls. This study mirrors results from other Pacific archipelagoes that span human exploitation gradients and underscores the importance of comparative studies of coral reef fish assemblage structure from remote, uninhabited systems and impacted areas.

DO MARINE RESERVES AFFECT SEagrass COMMUNITIES? OBSERVATIONS AND EXPERIMENTS FROM FLORIDA
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Overharvest of large, marine consumers is predicted to alter seagrass food-webs, resulting in less beneficial grazing on epiphytic algae and reduced seagrass growth and production. However, this prediction has rarely been tested in nature. I evaluated seagrass community composition across a marine reserve boundary in Florida’s Banana River Lagoon (BRL) to determine if the greater abundance of large, vertebrate consumers in the reserve area was associated with a reduced abundance of small, demersal predators, an increased abundance of epifaunal grazers, and a reduced abundance of algal epiphytes relative to the adjacent non-reserve area. I also performed a consumer-exclusion experiment inside the reserve in order to evaluate consumer effects without the potentially confounding influence of geographic variation in water quality and physical conditions. There were clear differences in seagrass community characteristics across the reserve boundary, over time, and among experimental treatments. Some of these differences, such as increased epiphyte density in consumer-exclusion treatments, supported the predicted effects of large consumer removal. However, other, unexpected results emphasized the inadequacy of assuming cascading interactions among whole trophic levels in a system with a high degree of functional diversity, omnivory, and local habitat heterogeneity.

ECOPHYSIOLOGICAL LESSONS FROM COMPARATIVE PROTEOMICS STUDIES IN SHARKS
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Recent years have seen wide application of ‘omics’ technologies in medicine and physiology. In the realm of ecological and comparative physiology, these techniques have been applied in several contexts (e.g., temperature, hypoxia, acidification), typically using cDNA or oligonucleotide microarrays. Because proteins are the major executors of cellular functions, and because gene expression profiles don’t always accurately predict protein expression profiles, our recent work has focused on global study of protein expression patterns (i.e., proteomics) in order to understand how cells and tissues in non-model organisms cope with environmental challenges. This talk will draw on completed studies in three different species of sharks, discussing insights gained from comparing the proteomic response to stressors that vary in their frequency, intensity, and predictability (feeding, salinity change, and oxygen deprivation). Some common themes arise, as well as unexpected developments that warrant further study. The integration of proteomics approaches with other techniques (e.g., biochemistry, immunohistochemistry, confocal microscopy) and levels of organization (e.g., organismal physiology) is a valuable tool for hypothesis generation in non-model organisms and also for examining (1) conserved aspects of the physiological response network, (2) specialization of this response network.
across tissues, species, and ecological conditions, and (3) integration of molecular responses with higher levels of organization and with behavior.

† DIVERSITY OF EPIBOTIC MICROORGANISMS ASSOCIATED WITH INVASIVE MARINE BRYOZOAN SPECIES FROM NORTHERN CALIFORNIA (MONTEREY BAY AND ELK Horn SLOUGH)

Dowell, L.N. †, and A. Lauer CSU Bakersfield

_Bugula neritina_ and _Watersipora subtorquata_ (invasive marine bryozoa) have invaded coastal areas worldwide and outcompeted many endemic invertebrates. Associated bacteria of bryozoa are known to produce antimicrobial compounds, thus helping their host to compete successfully with other sessile invertebrates and prevent overgrowth. Epibiotic microbial communities associated with different bryozoan species from coastal waters of Morro Bay, Monterey harbour, Moss Landing harbour, and Elkhorn Slough are being investigated by a combined approach of classical microbiological methods, Scanning Electron Microscopy (SEM), and molecular biological tools. The bryozoan biofilms were investigated with SEM and the preferred settling areas of diatoms, bacteria, fungi and microalgae were documented. Fungi isolated from the growth environment and bryozoan epibotic fungi, have been identified by sequencing 18S rDNA fragments. The antifungal potential of isolated bacteria has been investigated against a _Chaetomium_ sp. on nutrient media plates. DNA was extracted from bryozoan biofilms and the surrounding water columns. Bacterial 16S rDNA was amplified with the Polymerase Chain Reaction (PCR), and fragments were subsequently separated by Denaturing Gradient Gel Electrophoresis (DGGE) to obtain a fingerprint of the bryozoan associated bacteria. DGGE was performed using amplicons from the associated bacterial communities of bryozoa, neighboring invertebrates, and the surrounding water columns; bands of interest have been sequenced. The resulting DGGE data was further analyzed using the Quantity-One software by Bio-Rad to create a dendrogram. Bands of interest were identified by sequencing. Preliminary results have shown bacterial communities in association with bryozoa analyzed to be unique among locations, and very similar among species.

HERITABILITY OF COLONY FORM IN THE HYDROZOAN, _HYDRACTINIA SYMBIOLONGICARPUS_

Dudgeon, S. R. †, Ryan, C. A. †, Cameron, B. B. ‡, and R. K. Grosberg ‡ 1 – CSU Northridge 2 – UC Davis

Clonal euukaryotic organisms display great variation in morphology both among species and among genotypes within species. Morphological variation is often correlated with ecological traits of interest (e.g., competitive ability) and in colonial invertebrates, like _Hydractinia symbiolongicarpus_ (Hydrozoa), the distribution of morphotypes in populations is thought to represent responses to selection. However, prior evidence for a genetic basis to colony form in hydrozoans comes from variable and typically low estimates of clonal repeatability in common garden experiments of small sample size. We sampled the _H. symbiolongicarpus_ population at Barnstable Harbor, MA to characterize the distribution of morphological phenotypes and estimate heritabilities from common garden and offspring/mid-parent regression experiments for six morphometric variables. The distribution of 121 morphotypes (58 male, 63 female genotypes) ranged from highly stoloniferous (runner) colonies to those displaying a stolonat mat, but lacking peripheral stolons (sheets). Growth of these colonies in a common garden provided upper estimates of broad-sense heritabilities ranging from 0.52 to 0.69. From this distribution of morphotypes, we selectively mated 16 pairs of parents based on their respective morphologies in an attempt to span the range of morphological variation from sheet to runners among the offspring of the 16 different families. Narrow-sense heritabilities ranged from 0.19 to 0.68; the greatest heritability associated with the relative investment in peripheral versus mat stolons. Interestingly, peripheral stolon development was much more variable among siblings from matings of sheet parents than among matings using a non-sheet parent. Phenotypic variance consisted of comparable portions of additive, dominance and environmental variance.

A META-ANALYSIS OF DIETS AND TROPHIC OVERLAP WITHIN THE CALIFORNIA CURRENT.

Dufault, A M †, Marshall, K, and I C Kaplan NOAA Northwest Fisheries Science Center, Conservation Biology Division. Current affiliation: CSU Northridge

A key step toward ecosystem based management (EBM) is to better understand how interactions within food webs affect species of commercial and conservation importance. Here we provide comprehensive diet information and food web analysis for major taxa within the California Current ecosystem, including fish, marine mammals, birds, and invertebrates. We synthesized 75 published diet studies from this ecosystem, and calculated representative diets for each species or aggregated functional group composed of multiple species. To assess diet relatedness, we used hierarchical cluster analysis, and calculated diet overlaps based on percent similarity index (PSI). Both analyses were performed on functional group data and also separately for each vertebrate species. Cluster analysis identified distinct feeding guilds, and revealed both intuitive and novel diet similarities between several species and functional groups. One intuitive diet similarity is that functional groups preying on euphausiids, a key forage species in the California Current, show a high amount of overlap. A novel diet similarity is the significant overlap of shallow small rockfish and baleen whales (e.g. grey whales, _Eschrichtius robustus_), both of which consume large amounts of benthic invertebrates.
Functional groups were significant in explaining the PSI differences between species, which suggests that key ecological interactions will be preserved in ecosystem models that use these functional groups. A visual representation of the complete food web and calculation of food web statistics suggest that there are strong similarities between the California Current and the Benguela, a similar upwelling-driven eastern boundary current.

**PREDATOR RISK CUES AND PREY PHYSICAL STATE IN AN INTERTIDAL FOOD WEB**

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Behavioral responses by prey to the presence of their predators are increasingly recognized as important factors influencing community structure. On Atlantic rocky intertidal shorelines, chemical risk cues released by green crabs (*Carcinus maenas*) are known to suppress foraging by their dogwhelk (*Nucella lapillus*) prey, a trait-mediated interaction (TMI). This suppression has important consequences for the intertidal community by indirectly releasing prey resources (blue mussels, *Mytilus edulis*) from dogwhelk predation, a trait-mediated indirect interaction (TMII). However, the extent to which the strength and consequence of these predator-prey interactions may be altered by variation in prey physical states is not well understood. In a laboratory mesocosm experiment, we explored the role that variation in a single prey state variable – physical injury – plays in altering dogwhelk behavior. We found that dogwhelks with injured shells showed no alterations in resource (mussel) consumption over and above those attributed to predator risk cues even though their shells were significantly weaker in compression than uninjured shells. We then tested susceptibility of injured, repaired and uninjured dogwhelks to natural crab predation in a series of tethering trials. Here, shell injury status had no impact on survival rates suggesting that shell-crushing predators do not preferentially select weaker shells in this species. Together, these results reinforce the importance of risk cue-mediated effects in structuring communities while suggesting that individual prey physical state may not have similar importance.

**THE PHOTOPHYSIOLOGICAL CONSEQUENCES OF VERTICAL STRATIFICATION OF THE DINOFLAGELLATE SYMBIODINIUM IN TISSUES OF THE CORAL PORITES LUTEA**

Edmunds, P.J.*1, Putnam, HM2, and Gates RD1 1 - CSU Northridge 2 - Hawaii Institute of Marine Biology

Understanding the basis of the resilience of corals to environmental challenges is a pressing research need, yet there are few indicators of what makes a coral physiologically robust or vulnerable. Massive corals of the genus *Porites* appear to be robust (“winners”) on contemporary reefs, and are unusual in possessing thick tissues that penetrate deeply into the skeleton, a trait that may contribute to their success. Here, we examined the vertical stratification of *Symbiodinium* within *P. lutea*, and tested the hypothesis that algae deep within the tissue differ photophysiologically from those in outer tissue. The tissue of *P. lutea* penetrated to 4-mm depth within the skeleton, densities of *Symbiodinium* were 5-fold greater in outer compared to inner tissues, and the algae were genetically nearly identical throughout these layers. Dark-adapted quantum yield varied between inner and outer tissues, as well as from the top to the side of colonies, and the photophysiology (rETR and NPQ) of *Symbiodinium* in inner tissue responded to increasing light in ways that differed from those in outer tissue, although the response did not correspond to classic shade adaptation. A 12 h experiment revealed that the algae in both tissue layers were weakly and equally affected by temperature (to 32°C). These results demonstrate that the tissue of massive *Porites* contains vertically stratified *Symbiodinium* phenotypes, and while these are equally affected by short exposure to thermal stress, over lengthy periods they may be important in allowing these corals to function as ecological winners an era of rising temperature.

† SPATIALLY VARIABLE SETTLEMENT CAN PROMOTE COEXISTENCE IN BENTHIC COMMUNITIES

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For diverse communities that compete for one or few resources, environmental variability and spatially structured interactions are thought to be key components allowing coexistence. However, theoretical treatments of coexistence that incorporate these components have outpaced empirical tests of the underlying mechanisms. Spatial variability in recruitment is predicted to allow coexistence in a way that is analogous to the temporal storage effect, but this has not been shown in a natural system. Here we describe how between-species differences in propagule supply over space can enhance the persistence of inferior competitors in a benthic marine community. We first quantify the competitive abilities and spatial settlement distributions of two common species, and estimate the beneficial effect of settlement variation on recruitment of the inferior competitor. We then use experimental data to demonstrate a threefold recruitment increase, and we use an individual-based model to show how this mechanism can allow long-term coexistence. Our results suggest that small-scale variation in propagule supply, which is often treated as background noise, may have persistent effects on the maintenance of diversity in sessile organisms.
NEW CHITONS (MOLLUSCA: POLYPLACOPHORA) FROM SEAMOUNTS OFF SOUTHERN CALIFORNIA

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Thanks to the cooperation of MBARI geologists, who have loaned us material obtained by recent (2004) ROV collections on seamounts ranging from about 550 to 2600m depth, we have studied the external morphology and mitochondrial DNA sequences for four species of chitons. Three appear to be new to science. Species details are under investigation but three of the species are impressive in their size. For example, two belong to the genus, Stenosemus von Middendorff, 1847, whose mostly deep water members seldom exceed 2 cm in length, but most of the specimens of each species are about 4 cm, and one specimen is a giant nearly 6 cm in length, probably the largest specimen of this genus yet observed. Another large-bodied species belongs to the genus Placiphorella Dall, 1879, closely aligned with a recently described species from near hydrothermal vents, off Japan. Members of Placiphorella are well known to be ambush predators, trapping prey under their expanded anterior girdle. Perhaps it is not surprising to find a large carnivorous chiton on seamounts but why the Stenosemus spp. are so large remains a mystery. A single species of a fourth, but small-bodied, species from about 713m depth was revealed to be genetically the same as a new species of the genus Leptochiton Gray, 1847 already under investigation from specimens collected in less than 30m depth off southern California. This is unlike the situation with the other three species, which appear to be restricted to deeper water.

† MOBILE GRAZERS REPLACE THE SPACE SESSILE PLAYERS ERASE: INTERPRETING THE IMPORTANCE OF DIVERSITY IN A TROPHIC CONTEXT

Elahi, R.†, and K.P. Sebens  Friday Harbor Labs, Department of Biology, University of Washington

Resource competition theory predicts an inverse relationship between species richness and resource availability. More species should more fully exploit available resources, decreasing the rate of colonization by both native and exotic species. Space is the limiting resource for sessile organisms on marine rocky substrata, and the availability of space is limited by recruitment and growth and increased through senescence, disturbance and consumption. This study examined the relative importance of sessile species diversity and consumer pressure on space availability in benthic rock wall communities. For two years we quantified the seasonal abundance of sessile taxa in 72 permanent quadrats installed on six transects at three sites in the San Juan Islands, Washington. Gastropods and other small consumers were counted in quadrats, while large consumers including echinoderms and fishes were counted on transects. Within a multiple regression framework, the density of two common consumers, red urchins and chitons, explained 53% of the variation in available space, while sessile richness explained only an additional 6%, suggesting that consumers were responsible for the patterns of available space. To test this hypothesis, we used a combination of consumer gut content analyses and field manipulations of urchin and chiton density. Preliminary data suggest that urchins create space by consuming sessile invertebrates and foliose algae, while chitons maintain space by consuming crustose algae and perhaps algal and invertebrate settlers. Together, these results emphasize the need to understand the role of consumers when trying to predict resource availability and invasibility in communities where space is the limiting resource.

THE EFFECT OF GULL PREDATION ON SEA STAR SIZE, COLOR, AND HABITAT USE IN PUGET SOUND

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Gull predation has been shown to have major effects on populations of intertidal invertebrates (e.g. goose barnacles, crabs). Although gulls are reported to feed on sea stars, relatively little is known about their effects on sea star populations. We have observed gulls feeding regularly on Evasterias troschelii and Pisaster ochraceus at low tide in Puget Sound, WA, and we were interested in determining whether gull predation influenced sea star size, color, and habitat use. We surveyed sea star populations in five intertidal habitat types at low tide: sand/small cobble, cobble, rock, pilings, and floating docks. The feeding behavior of gulls was monitored in these habitats and we also conducted a variety of experiments to determine if gulls preferentially consumed certain sizes, colors, and species of sea stars. Small sea stars (< 7 cm arm radius) of both E. troschelii and P. ochraceus were most abundant in habitats with high structural complexity (e.g. cobble), and were found under rocks or in crevices at low tide. In contrast, large sea stars and individuals of Henricia spp. were often observed out in the open during low tide. In feeding experiments, gulls selectively preyed on small E. troschelii and P. ochraceus, but avoided individuals of Henricia. In model sea star experiments, gulls also avoided red sea stars. We conclude that gull predation limits small E. troschelii and P. ochraceus to intertidal habitats with adequate shelter, and that the bright red color of Henricia spp. likely serves as warning coloration to gulls.
† FACTORS THAT INFLUENCE BODY TEMPERATURE OF THE COMMON SEA ANEMONE, *ANTHOPLEURA ELEGANTISSIMA*, DURING AERIAL EXPOSURE

Emery, M.*, and B.L. Bingham Western Washington University

Extremes in temperature during periods of aerial exposure can make the marine intertidal zone a highly stressful place to live. Though we can measure intertidal temperatures with data loggers, we know little about actual body temperatures of the animals that live there. We used thermocouples to measure internal body temperatures of the common intertidal anemone *Anthopleura elegantissima* in the field during low tides. Our goal was to determine how air temperature, wind speed, irradiance, body size and aggregation affect heating. Irradiance had the strongest effect on anemone heating; stronger sunlight caused the anemones to heat more quickly. Microhabitat, as measured by surface orientation and amount of exposure, therefore, had a major effect on the ability of the anemones to control their internal temperature. Body size had no clear effect on temperature, but being in an aggregation caused individual anemones to heat more slowly. Position within an aggregation had no effect on heating; individuals in the center of an aggregation heated at the same rate as those on the periphery. Temperature control is important for *A. elegantissima* because of its relationship with different species of photosynthetic algae. The identity of the symbiotic alga the anemone hosts may be determined by body temperature of the anemones. That body temperature, in turn, may be largely controlled by the irradiance features of the microhabitat in which the anemone lives.

SPATIAL PATTERNS, SPECIES COMPOSITION, AND TROPHIC STRUCTURE OF MARINE FISHERIES FROM NORTHWEST MEXICO WITH IMPLICATIONS FOR ECOSYSTEM-BASED MANAGEMENT


Widespread support for ecosystem-based management (EBM) approaches to marine fisheries has emerged in Northwest Mexico, but implementation of EBM requires an understanding of how fisheries interact with ecosystems and biodiversity. To that end, the spatial patterns, species composition, and trophic structure of marine fisheries of Northwest Mexico were investigated using commercial landings data from local fisheries offices. Data from fisheries offices showed a clear spatial pattern, whereby they formed eight distinct fisheries regions that were similar in geographic location, coastal habitat type, and species groups. Landings volumes, species composition, and trophic structure varied significantly among regions and between large-scale and small-scale fisheries. Large-scale fisheries made a larger contribution to regional landings volumes, whereas small-scale fisheries targeted a wider range of species groups and had a higher mean trophic index. Important species that drive small and large-scale fisheries in each region and thus serve as immediate priorities for management were identified based on market value and seasonal availability. These results show that small-scale marine fisheries of Northwest Mexico have a significant economic and ecological impact and would benefit from an EBM framework that focuses on the strong connections that exist between coastal habitats, resident species groups, and fishing activities within each fishery region. Moreover, differences in the spatial and ecological characteristics of small and large-scale fisheries demonstrate that commercial marine fisheries of Northwest Mexico should not be managed as a single homogeneous region and that small and large-scale fisheries require separate management strategies.

† THE ROLE OF FISH HERBIVORY IN CONTROLLING THE DISTRIBUTION OF THE DOMINANT CORTICATED ALGA MAZZAELLA LAMINARIIOIDES: IS THERE PREDICTABLE VARIATION ACROSS SEA-SCAPES?

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The red corticated alga Mazzaella laminarioides is a dominant species in the mid intertidal zone of rocky shores of central and southern Chile. Several experimental studies have shown that only the largest keyhole limpets, which are heavily harvested by humans, can consume and control the abundance of this species in the mid shore. However the factors that control the lower limit of vertical distribution are unclear. Specifically, the role that subtidal herbivorous fish may play in controlling the distribution and abundance of intertidal algae is seldom considered. In this study, we present the results from a series of experiments designed to evaluate: 1) the importance of herbivory by fish and benthic consumers at multiple tidal elevations and 2) whether fish herbivory varied predictably with the availability of subtidal rocky reefs versus sandy bottoms (sea-scapes). Overall, we found that fish herbivory strongly limited the vertical distribution of Mazzaella. Fish exclusions yielded a 60% increase in Mazzaella cover after only 3 months. Moreover, transplants were consumed within days in the presence of fish, while they survived and grew well in fish removals, even in the presence of intertidal benthic consumers. Experiments repeated over different “sea-scapes” showed that fish herbivory can be similarly high at rocky sites surrounded by subtidal reefs or by sandy bottoms.
† INFLUENCE OF WATER TEMPERATURE ON SITE FIDELITY, MOVEMENTS AND HABITAT USE OF THE GRAY SMOOTH-HOUND SHARK (MUSTELUS CALIFORNICUS) IN A NEWLY RESTORED ESTUARINE HABITAT
Espinoza, M.†, Farragia, T.J., and C.G. Lowe  CSU Long Beach
The Full Tidal Basin (FTB) of Bolsa Chica Ecological Reserve, a newly restored estuarine habitat in southern California, allows direct access by coastal species. Previous studies have found that some elasmobranchs use shallow bays and estuaries as thermal refuges from colder coastal waters, particularly during summer months. We determined how the gray smooth-hound shark (GSH), a common benthic predator, used this newly restored habitat. Monthly abundance surveys revealed that GSH were most abundant in the FTB during the summer (May-September; n=342), and moved out of the basin during the winter (December-February; n=9), when these shallow waters become colder faster than waters along the coast. VR2W Positioning System was employed to quantify fine-scale, longer-term movements and habitat use of GSH within the FTB. Tagged sharks (n=22) were detected an average of 26 consecutive days inside the FTB (range: 5-102 days) and only during summer months. Three of nine female GSH tagged in 2008 return to the FTB the following summer. Sharks were found mainly in the inner and middle portions of the basin, spending most of their time in warmer areas (19.5 ±1.8°C). Sharks exhibited higher rates of movement at dusk, shifting between warmer and cooler habitats (p<0.05), presumably for feeding. Water temperature may be a key factor influencing the seasonal occupancy and habitat utilization of GSH inside the FTB. However, it is still unclear whether GSH are using this novel habitat differently than more established habitat. Future studies should investigate and compare behaviors of GSH in natural and restored habitats.

† COMPARISON OF KRILL SIZE STRUCTURE COLLECTED CONCURRENTLY USING MIDWATER ROPE Trawls AND STANDARD BONGO NETS.
Ettner, EE, Burchfield, JD, and BB Marinovic  Dept of Ecology and Evolutionary Biology, UC Santa Cruz
Net sampling remains the best method for examining krill population demographics, but net avoidance, particularly with respect to larger individuals is a potentially confounding aspect associated with this sampling approach. Larger equipment such as rope trawls commonly utilized to sample various fish species may avoid the problems associated with net avoidance, however smaller size classes are typically under sampled or avoid collection completely. We present data collected from the 2008 National Marine Fisheries midwater trawl survey which compare concurrently collected midwater trawl and Bongo net samples collected within the Central California Coastal region. Specifically, the size structure obtained from each gear type are compared and examined for discrepancies between larger size classes. These results offer new insights into the efficacy of standard net sampling techniques for characterizing krill population demographics.

TEMPORAL AND SPATIAL VARIATION OF CORAL RECRUITMENT IN SOUTHERN TAIWAN
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The spatio-temporal variability of stony coral recruitment was studied from April 2007 to May 2009 around southern Taiwan. Thirteen sites, each with 20 recruitment tiles replaced every 6 months, and 3 sites, each with 10 recruitment tiles replaced every 2 months, were examined. The relative contribution of the different families of recruits (Pocilloporidae: 63%, Poritidae: 19%, Acroporidae: 3%, others: 15%) is similar to other reefs. The high recruitment rates (average 1298-1316 recruits m-2 year-1) were recorded in Nanwan Bay, Kenting National Park. A marked seasonal variability in recruitment rates was detected, with the peak recruitment recorded in spring to summer, corresponding to the period of mass coral reproduction. Although the mass bleaching event occurred in the summer of 2007, recruitment rates were not significantly decreased in the second year (except 1 site). The pattern of recruitment orientation within tiles and recruitment rates shown areal variation and may reflect the heterogeneity of environmental conditions among areas. The relatively high coral recruitment rates recorded from this study indicate that recruitment may play an important role in determining the population and community dynamics of corals as well as natural recovery from disturbances may be quick.

STABLE ISOTOPE ANALYSIS OF AMPHIPODS IN AN EELGRASS FOOD WEB
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Stable isotopes are useful tools for the study of food webs because they act as natural tracers of feeding habits. Stable isotopes of nitrogen (δ15N) and carbon (δ13C) were used to examine food web structure of amphipods in an eelgrass bed in San Diego Bay, California. Five families of amphipods were collected and analyzed using continuous-flow mass spectrometry. Dietary composition of amphipods were analyzed using mixing models bracketed by primary production (eelgrass and algae). Our results show differences in carbon signatures among families that reflect variation in sources of primary production. Ischyocerid and Hyalid amphipods were specialized feeders on microalgae and seagrass, respectively, whereas other amphipod taxa had a mixed diet. δ15N signatures indicate that amphipods in the family
Oedicerotidae are at least partially carnivorous, feeding at a higher trophic level than other amphipods. Because amphipod biomass is a large component of marine food webs and taxonomic composition may change, differential feeding by amphipods may be important to interpretation of food web structure. Our findings suggest that treating all amphipods as functionally redundant is an oversimplification in eelgrass ecosystems.

† HABITAT RESTORATION THROUGH THE EYES OF A FISH: HOW ARE SHOVELNOSE GUITARFISH (RHINOBATOS PRODUCTUS) UTILIZING A NEWLY RESTORED SOUTHERN CALIFORNIA ESTUARY?
Farrugia, T.J.† CSU Long Beach
Over 90% of the coastal habitat in southern California has been degraded due to urban development, yet these areas are important habitat for many coastal fish species such as the shovelose guitarfish (Rhinobatos productus). Monthly abundance surveys and acoustic telemetry were used between June 2008 and September 2009 to determine whether shovelose guitarfish utilize the newly restored Full Tidal Basin (FTB) of the Bolsa Chica Ecological Reserve (Orange County, CA). Shovelose were found in the FTB every month of the year (total caught: 267), with increased abundances during the warmer summer months. Twenty-three shovelose tagged with acoustic transmitters showed an average (+SE) residency time inside the FTB of 65.1 ± 9.4 days (range: 15-107), with no daily movements in and out of the basin. Two of the 10 individuals tagged in 2008 were detected again in 2009. The Vemco Positioning System estimated positions of acoustically tagged shovelose, which were used to calculate an average home range of 115,038 ± 36,950 m2, representing 10.2% of the FTB area. Rate of movement data showed a diel pattern in activity level indicating shovelose rest during the afternoon and forage at night. Three years after the FTB opening, these apex predators are entering into a restored habitat, establishing home ranges and showing diel activity patterns, suggesting the FTB might help mitigate the loss of coastal fish habitat in southern California.

CHEMICAL COMMUNICATION, KEYSTONE MOLECULES, AND SIGNALS THAT STRUCTURE NATURAL COMMUNITIES
Sensory systems provide critical filters that enable organisms to detect and recognize valuable resources. Trophic cascades, structuring populations and communities, are largely determined by trait-mediated interactions that rely on sensory inputs. Certain molecules, serving as chemical signals, can establish the course of community dynamics at multiple trophic levels. Here, we investigated the roles of surface-adsorbed proteins in mediating predator-prey dynamics on wave-swept shores. For cuticle/shell formation, barnacles (Balanus glandula) are required to produce a high molecular weight, insoluble, glycoprotein complex. A primary subunit (~98 kDa) of this protein complex was isolated, purified, and, in field tests, evoked settlement by conspecific larvae. The subunit thereby operates as a seminal recruitment cue. Moreover, the same compound triggered a predatory response in numerically dominant whelk species distributed throughout the eastern Pacific (Acanthinaeella spirata, Nucella emarginata, N. ostrina, N. canaliculata, N. lamelllosa). Such proteins, therefore, simultaneously influence demographic processes that enhance or diminish barnacle populations. As dominant competitors for space, the relative balance between barnacle recruitment and predation mortality has strong direct and indirect effects which influence community dynamics. Furthermore, the ability of all whelks to detect and respond to these signals suggests that the biogeography of barnacles, and their population stability, is affected in comparable ways. The conserved response of many species to the same signal, and the resultant cascading effects across multiple trophic levels, signify barnacle glycoproteins as keystone molecules that structure communities on wave-swept shores.

HARD PREY PROCESSING IN CHIMAEROID FISHES
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Holoceraphalans were probably the dominant hard prey specialists (i.e., durophagous) of the late Paleozoic, and are uniquely derived in this aspect. The upper jaw is fused to the neurocranium (e.g., holostyly), and all chimaeriform holoceraphalans, extinct and extant, possess tooth plates presumably for durophagy. Presently there are six extant genera in three families. Previous authors have posited that within these families there has been a gradual transition away from a reliance on crushing benthic prey. The Callorhynchidae (Callorhynchus) are the most like ancestral chimaeriforms in their morphology, and crush very hard prey. However, the Chimaeridae (Hydrologus and Chimaera) are described as having “nipping” tooth plates, less suited for crushing, and concomitantly an increased reliance on suction to capture prey. To determine the relationships between morphology and performance in these two chimaeriform groups, and specifically to test the hypothesis that Callorhynchus is capable of generating higher bite forces than Hydrologus or Chimaera, we estimated bite force from cranial and muscular morphometrics and muscle mass. These anatomical data were gathered from Callorhynchus callorhynchus, Hydrologus colliei, and Chimaera monstrosa. (~10 individuals of a range of sizes from each). We also used reconstructions of CT scans of adult animals to compare cranial form and
mineralization and to identify areas of skeletal reinforcement. Bite force performance and skeletal mineralization failed to explain the aforementioned ecological differences. Anterior and posterior bite force estimates suggested similar performance capabilities among the three species and CT scans suggested only subtle differences in the amount of skeletal calcification between Callorhynchus and Hydrolagus. However, Callorhynchus displays an apparent mixture of red and white tissue in the adductor musculature, whereas the other species’ adductors exhibit a paler coloration; we suspect performance differences, if present, might be explained by possible differences in muscle fiber composition.

† THE IMPORTANCE OF LAND-SEA CONNECTIVITY IN THE GIANT KELP FORESTS OF BIG SUR, CALIFORNIA
Foley, M.M.† UC Santa Cruz
Due to increasing human-induced landscape changes around the world, there is a critical need to understand how the movement of subsidies across habitat borders affects species composition, community function, and biogeochemical cycling. Nearshore marine habitats are uniquely located at the land-sea interface where they may be connected to open ocean and terrestrial habitats through the movement of subsidies across habitat borders. The relative contribution of allochthonous subsidies to nearshore habitats is likely to vary spatially and temporally, and our understanding of how these subsidies influence nearshore marine communities is poor. In this study, I used a suite of techniques including water chemistry, trace metal chemistry, stable isotope analyses, and community surveys to examine how nutrient and particulate organic matter (POM) subsidies from terrestrial and open ocean habitats influence nearshore kelp forest community structure and food web dynamics. The results from this study suggest that kelp forest communities along the Big Sur coast are dependent on macronutrient subsidies from upwelling circulation, micronutrient subsidies from stream inputs, and the local production of Macrocytis. This research highlights how the interplay between ocean circulation and stream inputs combine to influence the structure and functioning of kelp forest habitats in Big Sur.

† PRESERVED SPECIMENS EXPOSE THE GHOSTS OF PARASITES PAST: POTENTIAL USES AND LIMITATIONS
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Parasitism can be well-studied spatially but is often temporally constrained. Museum collections of free-living animals may harbor a concealed suite of parasites that can offer insights into the temporal dimension of host-parasite relationships. This study goes back in time to examine the soft tissues of preserved 20th Century intertidal estuarine invertebrates of San Francisco Bay (SFB). Ten macrobenthic species, spanning 1906 – 1980, were screened for metazoan parasites. Seven of these species were exotic, and all were recovered in my samples of the present fauna studies. Copepods and larval trematodes were found in both preserved and recent specimens from similar areas of SFB. However, less apparent parasites, such as larval tapeworms, were not detected in the museum specimens. In the 20th Century, 27.3% of Cryptonya californica, which had a higher relative abundance than today, were infected by gill copepods, while my recent specimens were all uninfected. In the 20th Century and today, Cerithidea californica is more parasitized than its exotic ecological analog, Ilyanassa obsoleta. While parasitic castration of exotic Gemma gemma continues to be rare, 100% of the preserved specimens were parasitized as second intermediate hosts, compared to less than 25% of recent specimens. Although preserved sample sizes are small, when combined with ecological studies, parasite identification in museum hosts represents a novel tool to broadly study how species invasions and host population densities affect parasite populations, how certain (well-preserved) parasites regulate their host populations, and the overall biogeography of parasitism in host species over time.

† HOW MANY NEEDLES IN THE HAYSTACK? APPLICATION OF MARK-RECAPTURE METHODS TO ESTIMATE AVIAN PREDATION ON JUVENILE SALMONIDS IN CENTRAL CALIFORNIA
Frechette, D.M.†, Osterback, A.M., Bond, M.H., Hayes, S.A., Moore, J.W., Shaffer S.A., and J.T. Harvey
Moss Landing Marine Laboratories
In central California, coho salmon (Oncorhynchus kisutch) are endangered and steelhead (O. mykiss) are threatened, under the U.S. Endangered Species Act. Until recently, the role of bird predation in limiting recovery of coho and steelhead in central California has been overlooked. The NOAA Southwest Fisheries Science Center uses Passive Integrated Transponders (PIT tags) to monitor population biology and marine survival of these species. Año Nuevo Island (ANI), an important rookery and roosting site for several species of piscivorous seabirds, has been scanned annually for PIT tags since 2006. To date, 196 unique PIT tags (annual mean = 49, SD =17) have been detected, indicating that avian predation may represent a significant source of mortality for central California salmonids. Tags on ANI represent fish tagged between 2003 and 2009 in 5 watersheds in Santa Cruz and San Mateo counties. Tags are not removed from the island and may be detected on subsequent trips, allowing calculation of tag abundance using mark-recapture methods. POPAN, a variation of the Jolly-Seber model, estimated abundance and net entry of tags on to ANI. Entry of tags on ANI occurs by deposition by birds through regurgitation or defecation. A total of 434 detections were
incorporated into the model, producing an initial tag abundance estimate of 244 (SE = 10.9) and estimates of annual tag deposition ranging from 21 (SE = 10.2) to 93 (SE = 12.5). These estimates improve our understanding of the effect that avian predators have on the recovery of central California coho and steelhead.

† OUT OF THE SAND AND INTO THE SURF: CAN WE DETERMINE SELF-RECRUITMENT IN THE CALIFORNIA GRUNION, LEURESTHES TENUIS.
Fredell, A. W.1*, Martin, K. L.2, and D. Z. Zacherl† 1 - CSU Fullerton 2 - Pepperdine University
Recent research has documented the possibility that some marine larvae recruit back to their birth location. Whether this level of self recruitment occurs in populations over a large scale has implications for the management of marine populations, including culturally and economically important fishery species. This information is especially important for the California grunion, Leuresthes tenuis, a culturally significant recreational fishery in southern California, which relies upon sandy beaches as critical spawning habitat. My research explores recruitment in spatially separated populations of California grunion using natural geochemical tags. I first tested whether embryonic grunion otoliths from sites and/or regions within southern California varied spatially and temporally in their natural geochemical tags. Grunion embryos were collected at 14 beaches from Santa Barbara to San Diego, CA in summer 2008, and from three beaches during two separate spawning events. Thirty otoliths from each beach/spawning run were analyzed by laser-ablation inductively-coupled mass spectrometry. Grunion natal tags varied significantly among multiple regions in southern California (MANOVA, p<0.001) with a jackknife classification success of 87%. Analyses of natural geochemical tags from grunion embryos collected at three beaches showed temporal variability among different spawning events within a year (MANOVA, p<0.001). The spatial variation of natal tags will allow me to track young of the year grunion back to their natal regions and estimate the level of self recruitment. Knowledge about the sources of grunion recruits would allow management decisions to be made with predictions of their potential outcomes.

DENSITY-DEPENDENT HOME RANGE SIZE IN A TEMPERATE REEF FISH, KELP GREENLING (HEXAGRAMMOS DECAGRAMMUS)
Freiwald, J* UC Santa Cruz
The way in which movement of temperate reef fishes is influenced by local population density is critical to understanding how movement contributes to the structure and dynamics of populations and communities as well as for the conservation and management of these ecologically and economically important species on rocky reefs of the eastern Pacific. Using acoustic telemetry to track the movement of individual fish, I investigated how the home range size of kelp greenling (Hexagrammos decagrammuss) changes in response to experimental manipulation of population density. I found a long–term 55% reduction in home range size of male kelp greenling after their density on experimental reefs was reduced to half of the initial density. Such changes in movement patterns in response to changes in population density will have important consequences for the population ecology and management of reef fish species. Smaller home ranges at lower densities may shift energy allocation of individuals from movement and foraging to growth and reproduction. This might lead to a positive demographic effect at low population densities. Smaller home ranges might change the spatial distribution of the effect predators have on prey populations and might change local community structure. Furthermore, the movement of individuals is one of the key determinants of protection provided by marine protected areas (MPAs) to populations within their boundaries. Since densities are predicted to change within MPAs, understanding the movement responses to density is critical for understanding how the level of protection will change over time after the establishment of MPAs.

† HABITAT SELECTION AND MOVEMENT OF THE GIANT PACIFIC OCTOPUS, ENTEROCTOPUS DOFLEINI
Frohbieter, D W† Alaska Pacific University
Very little is known about the process of habitat selection by giant Pacific octopus (GPO). Selection of habitat can either be an active process, where octopus select habitat meeting certain environmental and biological factors, or a passive process if octopuses simply exploit the resources that are available to them when they settle as benthic predators. This study utilized sonic tagging and subsequent tracking of GPO in Prince William Sound from 2008 (N=5) and includes data from octopus in a previous study conducted in 2006 that were tagged in both Prince William Sound and Eldred Passage in Katchemak Bay (N=8). In all cases octopus were fitted with modified Peterson’s disk sonic pinger tags and tracked with a surface hydrophone to reveal their movements underwater. Underwater surveys utilizing SCUBA recorded the habitat that the octopus moved into after release. Spatial analysis with ArcGIS ArcInfo 9.3 was used to interpolate the depth of each octopus at each tracking point and was analyzed to determine vertical movement patterns in relation to depth. Octopus movement was also correlated to diurnal movement of the tides using Nobletree® Tides and Currents software. There was no correlation found with the experimental treatment of each octopus and the
vertical movement over the tracking period. Analysis of the influence on tidal flux on octopus movement found that octopus followed tidal movement as the tide receded and advanced.

† POPULATION DYNAMICS AT A SHIFTING RANGE BOUNDARY BETWEEN SISTER SPECIES OF ESTUARINE SEA SLUG: ROLE OF THE PHYSICAL ENVIRONMENT VERSUS LARVAL SUPPLY
Garchow, M.N.*, and P. Krug CSU Los Angeles
Intertidal animals that occur along linear strips of coastline are ideal models for studying the causes of range limits, and for predicting how ranges may shift due to climate change. The estuarine sea slugs Alderia modesta and A. willowi share a dynamic range boundary between Bodega Harbor and San Francisco Bay, which has likely shifted 180 km north over the last 50 years. We quantified field densities of both species along replicate transects in SF Bay, and correlated abundance with in situ measurements of temperature, salinity and habitat suitability. The southern species Alderia willowi colonizes SF Bay each September, after high temperatures kill off most A. modesta. Conversely, most A. modesta recruit in March after low salinity and possible competitive interactions eliminate A. willowi. Size-frequency distributions revealed two major recruitment events for each species early in their respective seasons, indicating supply-side processes are important to metapopulation dynamics of these slugs. However, the lack of subsequent recruitment refutes the hypothesis that range limits occur because the continuous influx of maladaptive alleles from the range center inhibits adaptation to stressful edge conditions. Instead, the seasonal gradient in conditions exceeds the adaptive potential present in annual settlement cohorts, favoring first one species and then the other. These findings illuminate the biological and physical factors setting the permanent range boundary at Bodega Harbor, and may be used to predict future range shifts of estuarine animals due to increasing temperature and changing hydrology along California’s coastline.

SCALE DEPENDENCE IN THE DISTRIBUTION AND INTENSITY OF SPECIES BOUNDARIES IN INTERTIDAL COMMUNITIES
Garza, C.D.* CSU Monterey Bay
The processes that drive the distribution and intensity of boundaries in rocky intertidal communities are some of the most intensively studied phenomena in the ecological literature. I will present the results of a study in which I examined scale dependence in the relationship between physical forcing factors and the location and intensity of the lower boundary of the mussel Mytilus californianus, a conspicuous occupant of rocky shores on the U.S. West coast. Using a hierarchical sampling design at Point Lobos State Reserve in California, I was able to estimate quantitative changes in the strength of the relationship between boundary location and the physical environment as a function of scale. The results of this study also suggest that the relationship between physical factors, such as wave energy, and the location and intensity of a boundary are related to the complexity of the habitat across which M. californianus is distributed. These findings suggest that the distribution and intensity of boundaries are driven by complex spatially structured processes whose relational strength is sensitive to changes in the scale over which they are observed.

AGE, GROWTH, AND BATCH FECUNDITY OF THE GULF CORVINA, Cynoscion Othonopterus, FROM THE NORTHERN GULF OF CALIFORNIA, MEXICO
Gherard, K.E.* CSU Northridge
The Gulf Corvina, Cynoscion othonopterus, is a vital component of commercial fisheries in the northern Gulf of California, yet little is known about its life history. 383 specimens were collected from the commercial gillnet fishery at the Gulf of Santa Clara in Sonora, Mexico from March to May 2009 to determine the age structure, growth rate, and batch fecundity of adults. Fish ranged from 615 mm to 827 mm in total length and from 2 to 6 years of age. Von Bertalanffy growth model parameters were: L=2940mm, K=-0.017/yr, and t(0)= -18.96 years, and R2=0.95. Mean oocyte diameter differed significantly among development stages. Spawning females produced 71,000 to 1,565,000 oocytes per batch, and batch fecundity was correlated to both total length and gonad-free body weight. The narrow size and age range of fish were likely a result of the mesh size used to harvest fish and resulted in an abnormal von Bertalanffy growth model. The growth rate of C. othonopterus is high in comparison with its congeners, which is likely due to high productivity that characterizes the northern Gulf. The distribution of oocyte diameters and oocyte stages indicate that C. othonopterus are synchronous, multiple batch spawners with indeterminate annual fecundity. The high degree of synchronization in gonadal development among females reflects the semi-lunar spawning cycle of adults, which migrate to spawn in the estuaries of the Colorado River Delta over four days periods during six consecutive spring tides.
THE TEMPORAL AND SPATIAL DISTRIBUTION OF GRAY WHALES ESCHRICHTIUS ROBUSTUS IN NORTHERN CALIFORNIA

The temporal and spatial distribution of gray whales (Eschrichtius robustus) was monitored using weekly shore surveys over the past ten years in northern California. This area is considered the southern terminus of the gray whale Pacific Coast Summer Feeding Aggregation. Between 1999 and 2009, weekly surveys were conducted from five cliff sites along 100 miles of coastline between the Oregon border and Trinidad, California. While peaks in overall abundance occurred during migration (December and March) as expected, whales were also regularly seen along the coast during summer (June - September). Feeding was observed during the summer at all sites. Within a summer, Sighting Rates (SR) (number of whales / hour of observation), maximum number of whales sighted, and tenure length varied between the five sites. Some sites were preferred over others in a given year. This site preference typically shifted in subsequent years as whales seemed to ‘cycle through’ the available sites. An exception was the Klamath River which had high and relatively consistent SRs each summer, while the other sites had peak SRs every 5 to 7 years. In 2009, gray whales did not frequent the Klamath River and overall SRs were below normal throughout the range. Of note were the increased sightings of killer whales during 2009. Long-term and large-scale studies like this effectively establish a baseline from which to address environmental impacts of local and coast-wide management initiatives and global warming concerns.

† POPULATION DECLINE OF THE CHINESE MITTEN CRAB, ERIOCHEIR SINENSIS, IN SAN FRANCISCO BAY
Gonzales, V. A., and B. Tsukimura

As part of an ongoing study to monitor mitten crab larvae in the San Francisco Bay, light trap and plankton tow samples were analyzed for mitten crab megalopae and zoeae. In order to identify Eriocheir sinensis megalopae and zoeae in light trap and plankton tow samples, dichotomous keys were created to distinguish between brachyuran species. The minimal amount of mitten crab megalopae found in light trap samples may be linked to the recent decline of mitten crab zoeae in San Pablo Bay. Plankton tow surveys show that E. sinensis zoeae numbers have been declining in recent years. Zoeae abundance peaked in 2003 with a CPUE of 4034.7. In 2006 and 2007, months with peak abundance had a CPUE of 9.8 and 8.1, respectively. In 2008, no mitten zoeae were found in plankton tow surveys. No adult crabs have been found in otter trawls conducted by the California Department of Fish and Game since 2005. Drops in water temperature are likely responsible for the decline in mitten crab zoeae and subsequent low abundance of E. sinensis megalopae in this region. The data gathered from this research provides a rare opportunity to study the completion of an invasion cycle in this species. Like mitten crab population crashes in other countries, our data may show a temporary decline in what is probably a recurring population cycle of extreme abundance followed by rapid decline. Recently, adult mitten crabs were found in the Napa River indicating there may be population resurgence in this region.

† ENVIRONMENTAL EFFECTS ON LARVAL DEVELOPMENT OF THE SEA SLUG ALDERIA WILLOWI
Gordon, D.* Krug, P. CSU Los Angeles

Environmental cues can trigger phenotypic plasticity in a wide range of organisms. Alderia willowi seasonally switch developmental mode of their offspring between larger non-feeding lecithotrophic larvae in the summer and smaller feeding planktotrophic larvae in the winter. We wanted to maintain lecithotrophic development in the lab for purposes of performing multi-generation selection experiments, but past students were unable to get the slugs to maintain lecithotrophic development when raised under lab conditions. Factors that cause adult A. willowi to switch larval development may be temperature, seawater salinity, or growth rate. I tested the hypothesis that high temperature, high salinity, or both would cause laboratory reared slugs to express lecithotrophic development by mimicking summer conditions. I also tested for effects of growth rate on larval development type. Combinations of high or low salinity and high or low temperature resulted in less than 15% lecithotrophic clutches. However, slugs that grew at a rate of 0.1 mm per day, compared to slugs that grew at 0.04 mm per day, resulted in greater than 90% lecithotrophic clutches. These results suggest that growth rate, rather than environmental cues, may control development mode.

† THE IMPACT OF SEA STAR DENSITY ON MARINE SNAILS VIA NON-CONSUMPTIVE EFFECTS
Gosnell, J. S., and S. D. Gaines UC Santa Barbara

Although consumption by intertidal predators is known to be important to maintaining community diversity, less is known about the impacts of non-consumptive effects and how they vary with predator density. This study evaluated the impact of density on the non-consumptive effects of a keystone predator (ochre sea stars, Pisaster ochraceus) on a secondary predator (emarginated dog whelks, Nucella emarginata). Whelks were held in a flow-through system that
received water from separate containers containing various densities of sea stars (0, 1, or 2). Growth, behavior, and feeding on a shared prey (mussels, *Mytilus* sp.) were monitored over 80 days. Whelks consumed significantly less mussels as the density of sea stars increased. Whelks also grew significantly less in the presence of sea stars, but star density did not have a significant impact on growth. This study demonstrates that non-consumptive effects of predators may have both direct and indirect effects. Also, the lack of dependence of some non-consumptive effects on density may explain how fluctuating predator populations can continually regulate communities. Understanding the interaction between density-dependent and density-independent effects is essential to understanding the full impact of predator populations on communities.

† NON-CONSUMPTIVE EFFECTS IN A MARINE FOOD CHAIN WITH BOTH NATIVE AND INVASIVE SPECIES.
Grason, E.W.*, and B.G. Miner Western Washington University
Top-down effects by predators are important in structuring marine ecosystems, and predators control prey densities and distributions via consumptive and non-consumptive effects. However, in food chains with invasive species, the magnitude of non-consumptive effects is not yet well studied, and might be different from chains with native species due to different evolutionary histories. In particular, invasive species might not have evolved inducible defenses or offenses to native predators, which should reduce or eliminate non-consumptive effects. We tested whether predator effluent from a native crab altered the avoidance behavior and feeding rates of two invasive oyster drills (the marine whelk *Urosalpinx cinerea* and *Ocenebrina inornata*) to determine if non-consumptive effects occur in this system. In both species of drills, individuals increased their avoidance behavior three to five-fold and decreased their feeding rate by 48% - 67% in response to chemical cues from native rock crabs eating conspecific drills. This suggests that rock crabs could help preserve a commercially and ecologically important resource (oysters) through both a consumptive- and non-consumptive trophic cascades. However, the existence of an avoidance response may grant the drills a refuge from predation that prevents the crabs from acting as an effective biotic control. The specificity of the non-consumptive effects was further explored with experiments that attempted to determine what elements of the cue were eliciting a behavioral change. Cue response specificity is particularly relevant in invasive species, as it may help managers predict how novel species will likely incorporate into native communities.

† DOES PREDATOR AVOIDANCE INITIATE TROPHIC CASCADES IN TIDE POOL COMMUNITIES?
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The presence of predators in communities can have cascading effects on lower trophic levels, and these cascades are often caused by changes in prey behavior rather than actual consumption of prey. In order to determine if algal communities in tidepools are indirectly affected by the predatory seastar *Leptasterias hexactis* via behavioral modification of the herbivorous snail *Chlorostoma (Tegula) funebralis*, we studied the 1) association of *Leptasterias*, *Tegula* and other invertebrate and macroalgal community members, 2) direct effect of *Leptasterias* addition or removal on behavioral habitat shifts by *Tegula* and 3) indirect effects of *Leptasterias* addition and removal on micro- and macroalgae. We found a strong negative correlation between *Leptasterias* and *Tegula* density. In pools where *Tegula* were present and *Leptasterias* were absent, the addition of *Leptasterias* did not elicit a response by *Tegula*. Conversely, in pools originally containing *Leptasterias* but no *Tegula*, *Tegula* added to these pools fied the pools more frequently than *Tegula* added to pools where *Leptasterias* had been removed. Further, naturally occurring (not added) *Tegula* shifted habitats into the pools where *Leptasterias* had been removed, but this habitat shift only occurred when *Tegula* had also been added to the pool, suggesting that any indirect predator effects may be intensified by aggregative behavior. Experiments testing cascading effects of *Leptasterias* on macroalgal cover and macroalgal growth in pools were not conclusive. These data suggest that *Leptasterias* have the potential to indirectly effect algae by modifying *Tegula* behavior, but that these effects were not discernible during our brief study.

SEA LEVEL RISE IN A SOUTHERN CALIFORNIA SALT MARSH: PREDICTING CONSEQUENCES AND IDENTIFYING SOLUTIONS USING A MULTI-DISCIPLINARY FRAMEWORK
In southern California, 90% of coastal wetlands are gone and remaining marshes are often squeezed between human development and rising seas. An example is the 30-acre Kendall Frost Marsh (KFM), which continues to perform important ecosystem functions in San Diego’s Mission Bay despite small size and proximity to a highly altered, urban landscape. We used a multi-disciplinary approach to predict the consequences of sea level rise (SLR) for hydrology, sediment dynamics, vegetative zonation, and faunal distributions in the KFM, allowing us to consider solutions to mitigate reduced ecosystem functions while considering policy issues and avenues for public outreach. Elevation
surveys and GIS were used to predict changes in inundation times and vegetation zones under various scenarios of predicted SLR during the 21st century. Temporarily, shallow subtidal habitat, mudflat, and cordgrass (*Spartina foliosa*) could expand with longer inundation times. Once sea level rises by 50cm, all marsh habitats are expected to shrink as a result of “coastal squeeze”. This will decrease trophic support of the marsh and estuarine food web, shrink critical habitat for endangered birds (Belding’s savannah sparrow and the light-footed clapper rail), reduce coastline protection, and diminish water quality. Remediation options could include additions of sediment slurries to increase elevation, marsh restoration, or redirection of a nearby creek. We hope that by taking a holistic, multi-disciplinary perspective of SLR in an urban salt marsh, this project will provide a starting point for managers and decision-makers planning for SLR in coastal wetlands in southern California and other Mediterranean climates.

**MERGING TWO DATA SETS COLLECTED BY HOOK AND LINE FISHING IN ORDER TO ESTABLISH A LONGER BASELINE FOR A CENTRAL CALIFORNIA MARINE PROTECTED AREA.**

Hall, N.C.†¹, Nakamura, R.¹, Starr, R.M.², and D.E. Wendt¹ - California Polytechnic State University, San Luis Obispo 2 - UC Sea Grant Extension Program, Moss Landing

Marine protected areas (MPAs) are a common tool used in the conservation of marine fishes. In many circumstances, fish populations inside MPAs are different than populations outside. However, without baseline data, it is difficult to directly attribute the observed differences to the establishment of MPAs. In 2007 a network of no take MPAs were established along the central coast of California. The same year, the California Collaborative Fisheries Research Program (CCFRP) began sampling the fish populations within the MPAs and adjacent reference areas. The protocol was designed to monitor changes in catch per unit effort (CPUE) and mean length of various fish species to determine MPA effectiveness. We have a separate, spatially resolved dataset covering the same sampling area extending back to 2003. We sought to determine if these data could be used to extend the baseline information for the Point Buchon MPA. CCFRP sampling was conducted using a standardized fishing protocol in four MPAs with volunteer hook and line anglers aboard commercial passenger fishing vessels (CPFVs). The baseline data were collected using a different methodology by Cal Poly State University observers aboard CPFVs by during recreational fishing seasons. We found that catch per unit effort is not comparable between the two studies, likely due to differences in sampling protocol and angler behavior. In contrast, mean length of some rockfish (*Sebastes* spp.) species may be a parameter that can be used to integrate the data sets and establish a longer baseline for the Point Buchon MPA.

**RANGE LIMITS IN SPACE AND RANGE CONTRACTIONS IN TIME ARE DETERMINED BY THE COMBINATION OF THERMAL STRESS AND PREDATION**

Harley, C.D.G.† University of British Columbia

Biogeographers and climate change researchers use climatic envelope models to understand the current distributions of species and predict future distributional change. These models do not, however, account for interspecific interactions that affect the position of current range edges and modify distributional changes through time. Here, I present data to show that distributional patterns of sessile marine invertebrates depend on both local climate and predation by *Pisaster ochraceus*. Increasing temperatures along a spatial gradient result in decreasing vertical distributional extent as upper limits are forced down (temperature effect) while lower limits remain constant (predation effect). The role of predation was confirmed with predator exclusion experiments, which allow certain invertebrates to occur low on the shore at ‘hot’ sites at which they are otherwise rare or absent. A similar vertical “squeeze” occurs through time as well. Following half a century of warming in the Strait of Juan de Fuca, the upper limits of acorn barnacles, goose barnacles, and mussels have significantly decreased in 2009 than they were in 1957-58. Lower limits have not changed during that time. As a result, the vertical extent of goose barnacles (*Pollicipes polymerus*) has decreased by ~40%, and the vertical extent of mussels (*Mytilus californianus*) has decreased by ~50%. Mussels have even gone locally extinct at 2 of 10 sites surveyed. These results suggest that the combination of abiotic stress and biological interactions are responsible for setting current range limits on rocky shores, and drive changes in distribution and abundance through time as well.

†**SPATIAL ARRANGEMENT AFFECTS POPULATION DYNAMICS AND COMPETITION INDEPENDENT OF COMMUNITY COMPOSITION**

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Theory suggests that the spatial context within which species interactions occur will have major implications for the outcome of competition and ultimately, coexistence, but empirical tests are rare. This is surprising given that individuals of species in real communities are typically distributed nonrandomly in space. Nonrandom spatial arrangement has the potential to modify the relative strength of intra- and interspecific competition by changing the ratio of conspecific to heterospecific competitive encounters, particularly among sessile species where interactions among individuals occur on local scales. Here we test the influence of aggregated and random spatial arrangements on population trajectories of competing species in benthic, marine, sessile-invertebrate assemblages. We show that the
spatial arrangement of competing species in simple assemblages has a strong effect on species performance: when conspecifics are aggregated, strong competitors perform poorly and weaker competitors perform better. The effect of specific spatial arrangements depends on species identity but is also strongly context dependent. When there are large differences in species competitive ability, aggregated spatial arrangements can slow competitive exclusion, and so nonrandom spatial arrangements can work synergistically with other trade-off based mechanisms to facilitate coexistence.

† LITTORINE SNAIL DENSITY REGULATES THE RELATIVE IMPORTANCE OF DIRECT AND INDIRECT EFFECTS ON AN INTERTIDAL ROCKWEED
Hart, A.* University of Washington
Epiphytes are known to decrease seaweed growth and survival by inhibiting photosynthesis and increasing drag and dislodgement. Feeding by the littorine snail Littorina sitkana reduces epiphytes on Fucus distichus blades, which suggests that L. sitkana may indirectly facilitate F. distichus by removing epiphytes. However, L. sitkana also feeds on F. distichus tissue and can have a direct negative effect on the rockweed through herbivory. To determine if there is a snail density threshold at which the interaction between F. distichus and L. sitkana switches from indirect facilitation to direct herbivory, I grew F. distichus in mesocosm tanks under a range of L. sitkana densities and measured growth and epiphyte load after two months. I found a decrease in epiphyte load and an increase in F. distichus consumption as snail densities increased. F. distichus growth was maximized at intermediate snail density, where both epiphyte load and herbivory on F. distichus were low. My results suggest that herbivore density determines the relative importance of direct and indirect effects of herbivory.

† DISPERAL AT A SNAIL’S PACE: STRONG GENETIC STRUCTURE IN THE FISHERIES GASTROPOD MEGASTRAEA UNDOSA.
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Knowledge of connectivity through larval dispersal in marine populations is necessary for effective management of fisheries. Many studies use genetic data to infer levels of connectivity between populations. Along with giving insight to current patterns of connectivity, genetic data carry a signature of the historical demography of a species. Historical demography can influence interpretations of genetic data for connectivity. We assessed historical and modern demography of the wavy top snail, Megastraea undosa, a marine snail that is fished in California and Baja California, Mexico. Little is known about stock structure and connectivity of this species which has a five to ten day PLD and possibly limited dispersal. Fifty samples were collected from 15 sites throughout the range (Santa Barbara, CA to Punta Abreojos, Mexico) and amplified at the COI mtDNA locus. Genetic structure is strikingly high, with large shifts in haplotype frequency between southern Baja and southern California. A major cline occurs just north of Punta Eugenia, showing an Fst of over 0.20 across 1,000 km. Genetic data suggest that connectivity may be high in the north and low in the south. Additional analyses based on patterns of haplotype abundance suggest M. undosa has likely recently expanded into the southern California bight. Thus, different patterns of genetic variation between northern and southern populations could be generated through evolutionary history not differences in larval dispersal which may be limited throughout the range. Consideration of the evolutionary history of target species allows for a more accurate interpretation of genetic data for management.

THE PROBABILITY OF DEATH AFFECTS ADAPTIVE ALLOCATION TO GROWTH AND REPRODUCTION: FIELD EVIDENCE FROM A GUILD OF BODY SNACHERS
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The probability of being killed by external factors (extrinsic mortality) should influence how individuals allocate limited resources to the competing processes of growth and reproduction. Increased extrinsic mortality should select for decreased allocation to growth and for increased reproductive effort. There has been little or no data available to allow a cross-species examination clearly testing this hypothesis, partly due to difficulty in acquiring the necessary data. Individual parasitic castrators steal infected host bodies. Selection will operate on the castrators, not the reproductively dead host, concerning optimal allocation of infected host bodies. Because castrator species differ from one another and uninfected hosts in elements of life history, selection may result in allocation schemes that vary not only between uninfected and infected hosts, but also among different castrator species parasitizing the same host species. Therefore, speciose guilds of parasitic castrators should provide study systems that enable powerful tests of factors influencing optimal allocation schemes. Here, I quantify growth, reproductive effort, and extrinsic mortality for eight trematode species that parasitically castrate the same host snail species, and for their uninfected host snails (Cerithidea californica). As predicted, across species, growth allocation decreased with increasing mortality, while reproductive effort increased. Broadly, this research illustrates that parasitic castrator guilds can allow unique comparative tests
discerning the forces promoting adaptive evolution; in this case with findings indicating that extrinsic mortality influences allocation to growth and reproduction in a way that contributes to the diversity of species' life histories.

† OCEAN ACIDIFICATION EFFECTS PERSIST THROUGH THE LARVAL AND JUVENILE PHASES OF THE OLYMPIA OYSTER (OSTREA LURIDA)
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The world’s oceans have absorbed one-third of the anthropogenically produced carbon dioxide since pre-industrial times, leading to changes in seawater chemistry. Consequences on marine organisms are expected to accrue into the foreseeable future. In this study, we investigated the effects of decreased pH and carbonate saturation on larval and juvenile growth in the Olympia oyster (Ostrea lurida). Larvae and juveniles of this and other species may be important targets for future research because they represent critical life history stages that are disproportionately sensitive to environmental stressors. Larvae were reared through the planktonic period and settlement, and into early juvenile life, while held at three carbon dioxide concentrations representing present day (380 ppm) and projected (540 and 970 ppm) levels. After 9 days of exposure to elevated carbon dioxide conditions, larvae in the 970 ppm treatment exhibited 16% less growth in shell size than larvae reared in control conditions. These effects continued into the benthic phase, where shell sizes for individuals in the 970 ppm treatment were 7% smaller at settlement, and 41% smaller ten days later, compared to shell sizes of control individuals. Subsequent to the carbon dioxide exposure experiments, juvenile oysters were moved to a common environment characterized by present-day seawater conditions. Forty-five days after this transfer, juveniles originating in the 970 ppm carbon dioxide treatment still had 28% smaller shells. These results strongly suggest that negative effects of ocean acidification on oyster larvae persist well into the juvenile phase with potential demographic consequences for oyster populations.

ECOLOGY AND EVOLUTION OF PROTIST-ENDOBIONT MOLECULAR GENETIC INTERACTIONS IN THE BOVINE RUMEN
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Anaerobic protists act within the larger rumen ecosystem as self-contained microbial communities with symbiotic bacteria and archaea. Rumen protists and associated symbionts contribute significantly to degradation of plant material with the concomitant generation of methane. To understand the ecophysiological function of protists in the rumen we must study their molecular genetic interactions with associated bacteria and archaea. For this study, ciliate or symbiont-specific fluorescent oligonucleotide ssu rDNA probes were used in whole cell, rRNA-targeted, fluorescent in situ hybridization in combination with anti-cytoskeletal immunostaining. This permitted us to link ciliate morphology with ssu rRNA from eukaryotes and symbiotic bacteria/archaea in freshly fixed rumen fluid. Secondly, metagenome sequencing of a protist-enriched rumen fluid sample was completed using high throughput nextgen Illumina/Solexa sequencing and run through the de novo contig assembler Velvet and BLAST. Cytoskeletal immunostaining illustrated intact microtubules within cilia and flagella and ssu rRNA-targeted probes revealed distinct families of ciliates as well as symbionts isolated to specific compartments of the cell. This is the first time FISH and immunostaining were used in succession to characterize rumen microbes or any uncultivated sample. Four hundred and forty-two protein hits were identified that were primarily in the superkingdom Alveolata, the bacterial phyla Firmicutes, and rumen methanogens. The majority of eukaryotic proteins were putative proteins while over a third had simply conserved domains. Several key protein hits were identified, such as [Fe]-hydrogenase to an uncultured ciliate and Trichomonas vaginalis. This information has provided “proof of principle” to vet proposed future 454 metagenomic sequencing.

† ABOVE- AND BELOWGROUND COMPETITIONS BETWEEN SHOOTS CONTROL MORPHOLOGY AND PROPAGATION IN A CLONAL MARINE ANGIOSPERM (ZOSTERA MARINA)
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In May of 2009, we transplanted shoots of Zostera marina within their natal meadows into three types of plots: control (ambient Z. marina in tact), A- (aboveground biomass removed), and A-/B- plots (above- and belowground biomass removed). We assessed shoot morphologies before transplantation, and again after collecting all shoots 85 days later. As gauged by sheath length, shoots transplanted into control plots did not change in size, while shoots in A- and A-/B- plots became significantly larger, with the increase in shoot size under A-/B- plots being significantly greater than under A- plots. Significant differences in rhizome extension showed that shoots traveled furthest in A-/B- plots, less far in A- plots, and least far in control plots. Shoots in A-/B- plots exhibited extensive branching behavior, with less branching evident in A- plots and little branching in control plots. These results suggest that above- and belowground competitions between shoots exert differentiable degrees of control over Z. marina morphology and patterns of
propagation. Our experiments may contribute to an understanding of clonal plant behavior under varying ramet densities, at the edges of meadows, and following disturbance.

† LONG-TERM CHANGES IN BIOLOGICAL QUALITY OF SEAWATER ON A SHALLOW CARIBBEAN REEF
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It is well established that Caribbean reefs have undergone wide-scale degradation, but little is known about the interactive effects of these changes with the quality of seawater. In August 2008, we assessed the quality of seawater over reefs in St. John (US Virgin Islands) through measurements of the concentration of particulate matter [PM], particulate organic matter [POM], and zooplankton. The possibility that seawater quality has deteriorated was evaluated by comparing our results with those from the same location in 1970, and through a meta-analysis of comparable Caribbean data. Seawater samples were collected throughout the day, at the surface and at 10-m depth at three sites close to Great Lameshur Bay. Mean concentrations of PM (9.3 mg L-1) and zooplankton (0.5 to 18.0 animals•L-1) in surface waters varied between sites and depth, but mean POM concentrations were high (ca. 3.9 mg L-1) and similar among sites and depths. PM and zooplankton concentration were, respectively, 209% higher and 88% lower in 2009 compared to 1970. The meta-analysis identified 14 comparable studies since 1960, and it revealed two trends: (1) PM appears to have increased exponentially, and (2) zooplankton concentrations are variable but have not changed systematically. While the detection of changes in seawater quality is made difficult by the variability of the diagnostic parameters and the paucity of data, nevertheless, our results are consistent with the hypothesis that the biological quality of seawater over Caribbean reefs has changed. It is possible that this change is associated with the large-scale decline in coral cover.

MICROBIAL DIVERSITY EFFECTS ON VARIATION IN PLANT PRODUCTIVITY WITHIN SIMPLE PATHOSYSTEMS
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Species diversity can affect the magnitude of aggregate ecosystem processes such as primary productivity, but less is known about its effect on the spatial or temporal variability of particular species in a community, especially across trophic groups. To test microbial diversity effects on variation in plant productivity, I performed a meta-analysis of manipulative experiments using two or more beneficial micro-organisms (“antagonists”) applied in mixtures to control vascular plant-infecting pathogens (fungi, nematodes, etc.). I examined variation in plant productivity in these simple pathosystems at two scales: (1) spatial variation within single experiments (treatment standard deviation), and (2) spatio-temporal variation across multiple experiments replicated over space, time, or other environmental variables. Data synthesis at each scale showed that modest increases in antagonist diversity from one to several species did not destabilize plant productivity; mixtures were on average less variable than the most variable monoculture. Additionally, mixtures tended to have a small net effect on stability, leading to lower variation in plant productivity than observed in the average microbial monoculture. However, overall diversity effects on stability were not synergistic since host productivity was equally or more variable in the presence of antagonist mixtures than in association with the least variable monoculture. The data suggest that modest levels of microbial diversity may confer some stability in the presence of stress-inducing pathogens, but it is unknown if even greater microbial complexity is required for synergistic effects on the host.

† IMPINGEMENT: THE NEGLECTED INTERTIDAL HYDRODYNAMIC FORCE
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Breaking waves impose severe hydrodynamic forces on intertidal plants and animals, playing a major role in shaping the ecology of wave-swept rocky shores. While classical hydrodynamic forces such as lift, drag, and accelerational forces have long been assumed to be the dominant forces acting on intertidal organisms, another less well known force — the impingement force — may actually be just as important as the classical forces. The impingement force is a sharp, transient impact force occasionally seen by emersed sites at the instant of wave arrival. This impingement force can be up to ten times greater than the forces imposed on organisms by drag and accelerational forces, and has been shown to have an average magnitude twice that of the other forces. Thus, the impingement force is potentially the largest hydrodynamic force experienced by an emersed organism. Several hypotheses suggesting causal mechanisms for this force exist, but have yet to be tested. This study investigated the hypothesis of “delayed drag,” which predicts impingement force that varies with the time required for an emersed object to be fully engulfed by a wave. If delayed drag is responsible for impingement force, we would expect the force duration to vary with object length; forces exerted on cylinders of the same diameter and different lengths were measured using a gravity-driven water cannon to simulate
waves. Data suggest that cylinder length does affect impingement force, and it is likely that a combination of factors contribute to this phenomenon.

COMMUNITY-WIDE EFFECTS OF A LARGE MARINE RESERVE: EVIDENCE OF A TROPHIC CASCADE IN A DIVERSE ASSEMBLAGE OF REEF FISHES?
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Marine reserves can directly replenish heavily fished species. However, the community-wide effects of reserves are less clear. Marine reserves directly reduce fishing mortality rates, but through the restoration of apex predators reserves may have strong indirect effects on non-target species. We explored the effects of a large, fully protected marine reserve in the Bahamas on the community of coral-reef fishes. We examined the effect of the reserve on fish biomass by comparing the density and size of all fishes on similar reefs located both inside and outside the reserve. Total biomass of fish assemblages was much higher in reserve sites, and biomass was strongly concentrated in species of higher trophic levels within the reserve. Analysis based on the relative magnitude of individual species’ responses indicated that, on average, the largest species increased in biomass within the reserve, intermediate-sized species decreased, and the smallest species increased. Species’ responses to the reserve were also examined by pooling species into 9 trophic categories using consumptive relationships. This approach indicated responses consistent with a three-level trophic cascade. Apex predators (e.g., sharks and large groupers) were on average larger and more abundant inside the reserve. Mid-trophic-level species (e.g., small groupers and grunts) had higher average biomass outside of the reserve, where the number of species and biomass of large predators was lower. Finally, low-trophic-level species (e.g., surgeonfish and wrasses) had higher average biomass within the reserve.

† A REGIONAL COMPARISON OF MYTILUS CALIFORNIANUS GROWTH RATES ALONG THE CENTRAL COAST OF CALIFORNIA
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The sea mussel, Mytilus californianus, is common and abundant in the California rocky intertidal, and can be used as a model system for investigating spatial and temporal intertidal community variation. The purpose of this study was to examine growth rates of M. californianus over a four-year period in central California to explore potential relationships between mussel growth, sea surface temperature, and primary productivity. Differences in mussel growth as a function of submersion were also examined, which provided an estimate of total feeding time. The results of this study suggest there are striking differences in mussel growth between sites and study years, and that growth rates are weakly yet significantly related to sea surface temperature. Contrary to the findings of previous work, mussel growth was not statistically related to primary productivity. There were also no significant differences in mussel growth as a function of submersion time between sites or study years. These findings imply that growth of M. californianus is sensitive to temperature differences and not necessarily to variation in primary productivity on the California central coast. Because mussel growth demonstrates a relationship to variation in temperature, growth may help provide estimates of climatically induced shifts in the nearshore marine environment. Furthermore, increases in M. californianus growth rates, as a result of increasing oceanographic temperatures, may enhance its ability to outcompete other benthic species, which would lead to (1) decreased biodiversity and (2) a loss of important ecosystem services in the rocky intertidal through a loss of biodiversity.

† ECOLOGICAL CONSEQUENCES OF HABITAT VARIABILITY: A LOOK AT YOUNG-OF-YEAR ROCKFISH (SEBASTES SPP.) AND PREY COMMUNITY DYNAMICS IN THE CANOPY OF KELP FORESTS
Karr, K.A.¹ UC Santa Cruz
Subtidal ecology often focuses on the effects of large-scale features of a habitat (presence or absence of habitat) in tests of habitat utilization or association. However, animals may respond to the features of a habitat at smaller spatial scales, nested within the major type of habitat. Such small-scale variation can generate large-scale patterns observed at regional scales. Small scale experimental manipulation of Macrocystis pyrifera canopy habitat resulted in differential growth and survival of young-of-year rockfish (Sebastes spp.) in kelp encrusted with sessile invertebrates and non altered canopy habitat along the Monterey Peninsula. Juvenile rockfish grew disproportionally more in kelp habitat encrusted with sessile invertebrates in comparison to non-altered kelp habitat. Analyses of potential prey and prey consumed between habitats indicate that species composition and abundance of small mobile invertebrates (i.e., gastropods, isopods, polychaetes, amphipods) vary between kelp canopy habitats, with abundance and species composition greater in the canopy habitat encrusted with sessile invertebrates. Quantifying the growth and survival of young-of-year rockfish and associated invertebrate prey in various juvenile habitats across space and time provides knowledge not
only of how communities assemble themselves within a geographic range, but also of how their future state may differ in a rapidly changing environment along the Monterey Peninsula.

† DISTRIBUTION OF THE BLACKEYE GOBY, RHINOGOBIOPS NICHOLSI, AROUND TEMPERATE REEFS ALONG THE CENTRAL COAST OF CALIFORNIA
Kelly, M. K. 1*, Lindholm, J. †, Knight, A. †, Kline, D. †, and J. deMarignac2 1 - Institute for Applied Marine Ecology (IfAME), CSU Monterey Bay 2 - SIMoN Program, Monterey Bay National Marine Sanctuary
A clear understanding of how species interact with each other as well as their habitat is necessary for successful management of marine ecosystems. Rhinogobiops nicholsi is an abundant small prey species that frequents the sand/rock interface at the edge of temperate reefs, and is ideal for a habitat interaction study. Because of this, R. nicholsi was used to quantify the halo of productivity around temperate rocky reefs. A halo of productivity is considered to be the area in which reef associated species spill over into the surrounding non-reef environment. To quantify this halo, video transects from a towed camera sled in 2007 to 2008 were analyzed for the presence of R. nicholsi and their relationship to temperate reefs. Data were collected at several locations within the Monterey Bay National Marine Sanctuary. A pair of 10 cm lasers were used to calculate the distance between individual R. nicholsi and the nearest hard substrate. A mean distance of 0.40 m was calculated, indicating that the halo for this species is fairly small. During the data analysis, a distinct green color morph was observed. This color morph is hypothesized to be associated with substrate, with green individuals occurring over rock and white over sand. Corresponding with this, there was also a difference in the distance that the two colors were observed from hard substrate: green 0.14 m and white 0.44 m. This study has provided new knowledge about R. nicholsi, as well as a new data collection method for similar reef associated species.

RANGE LIMITS, CLIMATE CHANGE AND ADAPTIVE POTENTIAL: GEOGRAPHIC VARIATION IN THERMAL TOLERANCE IN THE COPEPOD TIGRIOPUS CALIFORNICUS.
Kelly, Morgan W. *, Sanford, Eric, and Richard K. Grosberg University of California, Davis
The rapid pace of anthropogenic climate change represents an unprecedented threat to the planet’s biological diversity. Models predicting species’ responses to climate change have focused on range shifts rather than adaptation. However, there is a growing appreciation that most species will exhibit some combination of adaptation and range shifts. The ability to adapt to a changing climate will depend on the magnitude of genetic variation for environmental tolerance and also on how this variation is distributed among populations within a species. We are using the intertidal copepod Tigriopus californicus to examine the potential for an evolutionary response to climate change and to test hypotheses about patterns of quantitative genetic variation in edge vs. center populations. Our results indicate that T. californicus is locally adapted to thermal conditions, with the greatest thermal tolerance in populations from southern California. Our data also show a narrow range of variation in thermal tolerance within populations as compared to the species as a whole. We are now using selection experiments to measure heritable variation in thermal tolerance within populations. After five generations, all selected lines had greater thermal tolerance than unselected controls, however lines from southern populations showed a smaller response, suggesting decreased heritability of thermal tolerance in these populations. Our results suggest that in species with strong local adaptation, range-wide occurrence data may fail to predict population-level variation in environmental tolerance. Our data also suggest that populations from equator-ward populations may have a diminished capacity to adapt to climate change.

POPULATION GENETICS AND THE ENDANGERED SPECIES ACT
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Genetic data play an increasingly important role in determining which species or populations qualify for protection under the Endangered Species Act (ESA). Here, I will discuss the mechanics of that Act and the points at which genetic data become relevant. Focusing on the ways in which these data are actually employed, I will suggest ways in which scientists can be more effective in guiding the process to ensure their work is used responsibly. Though agencies invariably make ESA listing decisions with limited data, the fundamental decisions are not scientific but rather policy ones. For example, the question of how distinct a population must be in order to merit protection is informed by data but is ultimately political. Biologists must ensure that data drive these policy decisions, rather than the other way around.

† GEOGRAPHIC VARIATION IN SPOTTING PATTERN IN THE NUDIBRANCH DIAULULA SANDIEGENSIS
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The nudibranch, Diaulula sandiegensis displays phenotypic variation in spotting pattern, and the spots are thought to resemble the oscula of Haliclona permollis, one of its principle sponge prey. To investigate this phenotypic variation and resemblance, D. sandiegensis and H. permollis were located and photographed in their intertidal and subtidal
habitats along the Pacific coast from San Diego, CA to Bamfield, British Columbia. Spots and sponge oscula were counted and measured from photographs collected in the field as well as the Internet. *D. sandiegensis* spot diameters were compared with *H. permollis* oscula diameters. Latitudinal variation in spot number was found, with individuals from northern California, Washington, and British Columbia exhibiting many more spots on their dorsum than individuals in southern California. Variation in spot number was almost twice as great between versus within beaches. Spot patterns also appear to change with nudibranch size, with spot size increasing with increasing nudibranch size. The spot diameters of small *D. sandiegensis* were not significantly different in diameter to the diameters of *H. permollis* oscula, but the spot diameters of larger *D. sandiegensis* were significantly different. These data suggest that for juvenile *D. sandiegensis*, spot patterning may match their prey and help them to be more cryptic. Further research is being pursued to determine why the latitudinal trend in spot pattern may exist, and why adult *D. sandiegensis* do not appear to blend in with their prey background.

A NOVEL STATISTICAL METHOD TO PINPOINT LARVAL ORIGINS AND ESTIMATE RANGE-WIDE CONNECTIVITY IN OPEN COAST MARINE POPULATIONS

Kinlan, B.P.†, and S.E. Koch² ¹ – UC Santa Barbara 2 - UC Los Angeles

Predictive understanding of marine population dynamics at regional to global scales requires quantitative estimates of connectivity across species’ ranges. Yet, the difficulty of tracing individual settling larvae back to their natal populations has stymied efforts to directly estimate connectivity. The few successes in this endeavor are limited to cases of small numbers of distinct potential source populations (e.g., estuarine or island species) with unique natural geochemical or genetic signatures. The problem is much more difficult for open coast marine species, where unsampled potential source populations inevitably outnumber the locations sampled to develop a source atlas. Here, we present a novel statistical approach that couples recruit-to-source assignment with a multivariate model of spatial correlation in natural signatures to account for the contribution of unsampled sources. Applying this technique to geochemical data for a marine gastropod, *Kelletia kelletii*, we produce high-resolution (10km) alongcoast probability profiles of larval origins, estimate dispersal kernels between pairs of sites, and build an empirical connectivity matrix for the entire species’ range. This new assignment method outperforms discriminant function analysis and existing Bayesian assignment techniques, provides full measures of uncertainty, and produces outputs that directly translate into parameters of spatial population models. It can also incorporate available information on the relative reproductive output of potential sources (e.g., from combining adult density, fecundity, and habitat distribution), and evaluate competing hypotheses about dispersal processes via model selection. The result is a direct link between theoretical and empirical studies of spatial marine population dynamics.

† THE ROLE OF HERBIVORY BY BRANTA CANADENSIS (CANADA GEESE) IN THE ANNUAL LIFE CYCLE OF A SAN FRANCISCO BAY ZOSTERA MARINA (EELGRASS) POPULATION

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Annual life histories, induced by abiotic stressors to plants that would otherwise exist in a perennial state, are well documented in many terrestrial and some aquatic environments. Among San Francisco Bay *Zostera marina* (eelgrass) populations, there is one known annual eelgrass bed, at Crown Beach (CB), Alameda. It was previously hypothesized that this 300-acre, relatively shallow population exists as an annual because of abiotic stressors resulting from exposure. However, a 2007 study showed that many plants did not flower before disappearing and that intense herbivory by *Branta canadensis* (Canada Geese) occurred in months just before the annual bed disappeared, prompting a hypothesis that grazing might be more important in inducing the annual life cycle of this population than abiotic factors. We monitored field plots, half of which were caged to exclude Canada Geese, at two elevations (0.0m and -1.0m MLLW), to test the effects of exposure and herbivory on plant growth and persistence. Results showed that excluding geese allowed plants to persist and grow clonally at both elevations. Uncaged plots followed the annual mortality pattern of the bed. A tidal simulator experiment to evaluate exposure effects, showed no significant difference between plants that experienced low tide exposure and plants continuously submerged, and no annual life history was seen. Our results suggest that herbivory by Canada Geese induces annuality in eelgrass at CB. Waterfowl grazing of seagrass is well documented; however, this study is the first to experimentally establish it as a major driver of a seagrass population life history.

UNUSUAL COLONIAL PROTISTS AND OTHER ALGAL DISTRIBUTIONS IN DEEP FALLEN LEAF LAKE, WITHOUT INVASIVE INVERTEBRATES AND PLANTS, NEAR LAKE TAHOE, CALIFORNIA.

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A two-person research submarine, SCUBA, and snorkeling discovered a zone of unusual, delicate, greenish “jellyballs,” ~2 cm in diameter, attached to ancient submerged trees in Fallen Leaf Lake, essentially free of invasive invertebrates
and plants, near more disturbed Lake Tahoe. The organisms first were detected during April, 2009, and disappeared in late June, 2009. Monitoring will detect if/when they reappear. These organisms appear to be a colonial ciliate with symbiotic algae, known as *Ophrydium versatile*, in previous reports from Germany and Massachusetts. In Fallen Leaf Lake, these were confined to depths between 4.8m and 26m. Associated water temperatures ranged 10 to 12°C. Detectable algae on adjacent sediment bottoms extended down to a sharp boundary 39m deep, ~ 2^8 (~0.4%) of surface brightness. Corresponding secchi depth was 12m. During late May, 2009, specimens were collected into sterile Mason jars sealed at depth, and stored sealed, without air space, in dim light (2^12 = 0.05% x full sun) near 20 degrees C for two months, then with even less light for an additional month. Unlike specimens preserved in alcohol, which disintegrated, these sealed, cool, darkened colonies remained intact even beyond these months. Extended depth-of-field photomicroscopy of freshly unsealed containers then revealed numerous live diatoms with green chloroplasts, and other filamentous algae, apparently surviving even heterotrophically, sealed in essentially darkness after collection. A majority of the other diatom frustules were empty, with additional cells containing degraded, brown phaeopigments. But some heterotrophic algal survival may be common for algae in deep alpine lakes.

† ADAPTIVE SHIFTS IN SCALE NUMBER AND BODY SIZE ASSOCIATED WITH HABITAT TYPE IN MARINE SCULPINS

Knucley, J.D.† Moss Landing Marine Laboratories

The idea that evolutionary character shifts represent adaptive responses to habitat conditions is old, but rigorous empirical evidence is surprisingly scanty. Because of their well-described phylogeny and ecology, sculpins of the Northeastern Pacific provide an ideal opportunity to examine whether character shifts associated with invasion of a novel habitat, the intertidal zone, are the result of adaptive evolutionary processes. In this group, the basal species occupy the subtidal habitat, whereas the derived species are found in the intertidal, or in both habitats. We used multiple evolutionary models based on habitat affinity to test the hypotheses that (a) reduction of body size and (b) reduction in number of lateral line scales are adaptive responses to the rocky intertidal habitat. We generated a well-supported, highly resolved molecular phylogeny of 26 species of sculpins based on ~800 basepairs of the mitochondrial cytochrome b gene. In combination with morphometric and habitat affinity data, we then employed OUCH, a recently developed phylogenetic comparative method, to test the adaptive hypotheses. Results show that adaptive evolutionary changes in body size and number of scales to habitat type are supported over a model of neutral evolution, and over a model of stabilizing selection across all habitats. We suggest that loss of scales and reduction of body size in the intertidal possibly facilitates skin breathing in hypoxic tidepools and in air during low tides. This study demonstrates how the combined use of phylogenetic, ecological and statistical approaches helps to identify characters that facilitate radiation into a novel habitat.

† *ETMOPTERUS* SP. NOV., A NEW SPECIES OF LANTERNSHARK (SQUALIFORMES: ETMOPTERIDAE) FROM TAIWANESE WATERS

Knucley, J.D.† Moss Landing Marine Laboratories

A new species of lanternshark, *Etmopterus* sp. nov., is described from the deep-waters off northeastern Taiwan. The new species is similar to other species of the “*Etmopterus pusillus* group” in having concave, flattened dermal denticles that are scattered irregularly across the body, a lateral line that ends in an open groove, no posterior branches on the flank photo-markings, and a relatively cylindrical body, but can be separated from its congeners based on the following characteristics: head length, gill slit height, tooth morphology, fin size and shape, interdorsal space, and flank photo-markings. The new species has a shorter head length and gill length proportionally to other members of the “*Etmopterus pusillus* group.” The teeth in the lower jaw of *Etmopterus* sp. nov. are slender, with relatively oblique cusps compared to those of its congeners. The pectoral fins of *Etmopterus* sp. nov. are more squared posteriorly and the caudal fin is shorter than the other members of the “*Etmopterus pusillus* group.” The new species possesses flank photo-markings which are distinctive when compared to its congeners.

BUILDING EMPIRICAL ESTIMATES OF LARVAL DISPERAL AND POPULATION CONNECTIVITY IN A KELP FOREST SPECIES

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Marine ecologists are interested in larval dispersal, and the resulting connectivity among populations, because of their potentially profound effects on population dynamics, genetics and biogeography. To date empirical measures of larval dispersal have been limited to cases involving self-recruitment or dispersal across a small portion of a species’ range. Here, we address how to design an analytically and empirically effective approach to create a geochemical tag atlas suitable for use in estimating connectivity matrices for open-coast marine species. We used a combination of extensive geographic sampling and geospatial statistics to estimate geochemical tags at larval sources (n = 17) over the entire range (Monterey, California, USA to Isla Asunción, Baja California, Mexico) of Kellet’s Whelk, *Kelletia kelletii*.
Results of recruit assignments to source locations are discussed. Finally, we demonstrate the development of a source atlas with measures of spatial uncertainty, that in turn suggests the scale at which larval dispersal can be resolved given a particular collection of recruits.

† PREDATION BY EASTERN OYSTER DRILLS (*UROSALPINX CINEREA*) ON NATIVE OYSTERS (*OSTREA LURIDA*) IN HUMBOLDT BAY
Koeppel, J.A.*, Craig, S.F., Koeppel, R.D.*, and E. Thomson  Humboldt State University

Oyster reefs serve an important role in estuarine ecosystems. Native oysters (*Ostrea lurida*) were historically plentiful in Humboldt Bay. The population was exploited during the late 1800’s. Although there is no longer commercial harvest of native oysters in Humboldt Bay, populations have not recovered.

In order to determine why these populations have not rebounded, we examined predation as a potential limiting factor on native oysters in north Humboldt Bay, California. Juvenile oysters were cultured using adults from the local population at the Telonicher Marine Laboratory. Plastic tiles seeded with juvenile *O. lurida* were assigned to one of three treatments: (1) open to predation, (2) caged with stainless steel mesh to exclude predators, or (3) fenced, which allowed predators access while controlling for possible cage effects. Results showed that the mean survivorship of juvenile *O. lurida* in caged treatments was significantly greater than treatments open to predation (open and fenced cage control), and many oysters had drill holes from the Eastern oyster drills, which were abundant at the site. If *O. lurida* is recruiting in this area, predation on juveniles may be too strong to allow population growth.

† EXPERIMENTAL WARMING REDUCES INVERTEBRATE DENSITY AND OVERALL SPECIES RICHNESS ON ROCKY SHORES
Kordas, R.L.*, and C.D. Harley  University of British Columbia

The importance of temperature is currently being addressed with renewed vigor as anthropogenic climate change begins to drive global temperatures beyond historical bounds. Climate change scenarios suggest the earth will warm by 1.7-4.4 °C by the end of the century, which constitutes extremes in both the maximum temperatures reached and the rate at which interannual change is occurring. The broad-brush effects of warming are already observable across a wide variety of systems and taxa, however specific responses of species or ecosystems of interest are more difficult to predict. To determine how thermal stress affects population and community patterns in situ, temperature was manipulated by deploying black and white tiles in Strait of Georgia rocky intertidal. Barnacle body size appeared to be smaller in experimentally warmed treatments. Additionally, barnacle populations were smaller and declined more rapidly through time on heated tiles. Green algal populations were affected by thermal treatments, but depended on intertidal zone and time. Finally, species richness was lower in heated treatments and exhibited similar patterns over time within each zone.

TEMPORAL PATTERNING OF METABOLIC ENZYME ACTIVITIES IN GILL AND ADDUCTOR MUSCLE OF *MYTILUS CALIFORNIANUS*

The rocky intertidal zone confronts organisms with widely varying abiotic conditions, notably of temperature, oxygen availability, and stress from desiccation. As a sessile species, the California ribbed mussel *Mytilus californianus*, may face widely different metabolic demands and constraints at different portions of the tidal cycle. A recent study indicated a significant change in gene expression (mRNA levels) with a regular periodicity for genes encoding ATP-generating enzymes, perhaps driven by tidal cycles. To test whether the activities of these enzymes varied as well, we collected specimens from a high-intertidal site over a 52-hour period to analyze two enzymes of energy metabolism: malate dehydrogenase (MDH), which plays roles in aerobic and anaerobic generation of ATP, and citrate synthase (CS), an indicator of capacity for aerobic metabolism. Although significant temporal variability in MDH and CS activity was observed between some time points during the 52-hour period of sampling, neither the period nor the amplitude of response noted for mRNAs for MDH and CS was observed at the level of enzymatic activity. Since mRNA and activity of these ATP-generating enzymes, which are commonly used as indicators of metabolic state in field populations, show temporal variation, our study emphasizes the need to design experiments with proper timing of sampling.

SHIFTS IN COMMUNITY STRUCTURE OF SMALL MOBILE INVERTEBRATES TO OCEAN ACIDIFICATION
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Ocean acidification is considered a threat to marine ecosystems globally. While scientists are beginning to grapple with the possible physiological impacts to organisms, the emergent effects on communities and ecosystems are not well understood. This is primarily due to the difficulties in maintaining complex communities in laboratory settings, or manipulating complex climatic stressors, such as ocean acidification, in the field. This study utilizes shallow water CO2
vents as a model system for addressing the response of benthic marine communities to ocean acidification. Benthic communities were sampled from rocky reefs in each of three pH zones (High=8.00 +/- 0.03; Mid=7.86 +/- 0.03; Low=6.65 +/- 0.19; mean pH(NBS)+/- standard deviation) surrounding CO2 vents in the Mediterranean Sea. Analyses indicate the species composition and abundance of small mobile grazers (i.e., amphipods, isopods, polychaetes, gastropods) vary across pH, with polychaetes decreasing and amphipods increasing in abundance with decreasing pH. Size structure of specific mobile invertebrates appear to vary with pH, indicating possible trade-offs in growth and reproduction in low pH environments. Population-level impacts of decreasing pH may have cascading effects on benthic communities as small mobile grazers can impose substantial grazing pressure and have been shown to impact community structure.

† A TEST FOR SPATIALLY CORRELATED RECRUITMENT AND THE EFFECTS OF PREDATORS AND HABITAT ON RECRUITMENT AND MORTALITY OF A TEMPERATE REEF FISH
Krug, J. M., and M. A. Steele CSU Northridge
Many marine fishes have a pelagic larval stage whose transport is driven by oceanographic processes. Shared exposure of larvae seems likely to cause spatially correlated recruitment of demersal fishes, and correlations in recruitment of predators and prey could significantly affect prey population dynamics. We tested for spatially correlated recruitment of a predator, kelp bass (Paralabrax clathratus) and its prey, señorita (Oxyjulis californica) at eight reefs around Catalina Island, California and determined the effects of predators and habitat on recruitment variation and mortality of señorita. Fish were counted along twenty-seven 30-m3 transects at each of eight sites during 2008. Density and canopy cover of giant kelp, Macrocystis pyrifera, was also recorded along transects at each site. Mortality was estimated at each site as the decay of a cohort through time. Recruitment of señorita and kelp bass was not correlated implying that shared exposure to ocean currents does not lead to similar spatial patterns of settlement for different species or that very early-postsettlement losses disrupt any correlated patterns of larval delivery. Mortality of señorita recruits was not related to the abundance of predators among sites, however it was density-dependent and inversely related to the mean percent cover of giant kelp canopy suggesting that habitat plays an important role in recruitment variation, whereas predators have less of an effect than one might intuitively expect. The results also suggests that oceanography may play little role in setting adult abundance in this species because density-dependent mortality decouples adult abundance from patterns of larval supply.

IDENTIFYING CRYPTIC POPULATIONS: A MULTI-LOCUS GENETIC TEST OF CORAL MORPHOSPECIES
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2 - Australian Institute of Marine Science
Biological life forms are not spread evenly across a morphological continuum. Instead, diversity is clustered into distinctive morphological units. Coral (Order Scleractinia) taxonomy has relied primarily on these morphological discontinuities to categorize different forms with the basic assumption that degree of shared morphology is congruent with degree of shared ancestry. However, the traditional single-locus genetic analyses of species boundaries in coral usually fail to distinguish morphological groupings (even with high levels of diversity). Additionally, several recent studies have shown that morphological convergence is rampant at higher taxonomic levels. Here, we utilize multi-locus DNA sequence data to test whether morphospecies are useful entities for scientific study. We collected 14-17 samples from the Great Barrier reef of each of four closely related morphospecies of Acropora: Acropora cytherea, A. hyacinthus, A. millepora and A. pulchra. DNA sequences were obtained for 9-10 loci from each individual including the mitochondrial control region, one nuclear intron region and 8 nuclear exon regions. Sequences were analyzed in two distinct ways: 1) using sequential runs of the Bayesian clustering program STRUCTURE and 2) using a combination of principal components analysis, ANOVA and K-means clustering. Both techniques support the presence of six populations within our data: the Acropora millepora morphospecies, the A. pulchra morphospecies, and two populations within each of the A. cytherea and A. hyacinthus morphospecies. These results support the use of morphology to identify entities of Acropora, but also suggest the presence of further taxonomic subdivisions without morphological markers.

† DEMOGRAPHIC COUPLING: THE LINK BETWEEN ADULTS AND RECRUITS ACROSS THE YEARS IN THE ST. LAWRENCE ESTUARY.
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Recruitment processes play a fundamental role in structuring benthic marine communities and controlling metapopulation persistence. As many benthic invertebrates have a dispersive planktonic phase, connectivity between local populations remains a key, but elusive, element. To assess the relationship between the abundance of adult mussels and larval recruitment, we conducted a large survey of mussel populations along a 100-km coastline of the
Gaspé Peninsula (Québec, Canada). The direction of net larval dispersal along this shore is influenced by the Gaspé Current (which has a net flow towards the Gulf of St. Lawrence), allowing the use of cross-covariance analyses to link adults, their larval supply and effective recruitment in this system. Previous work has used spatial statistical techniques to show connectivity between adult mussel populations upstream and recruits downstream at spatial scales of 12-18 km and 24-30 km in 2003, but no evidence of connectivity in 2005. Here, we use data from 2007 and 2008 to assess the frequency of such connectivity in this system and determine the stability of the spatial scales over which it may occur, as well as temporal fluctuations in dispersal patterns. This interannual comparison will also allow us to identify the key years of recruitment that create important signatures in long-term demographics of this mussel metapopulation.

GIANT PACIFIC OCTOPUS (ENTEROCTOPUS DOFLEINII) INTERACTION WITH SHRIMP POTS IN PRINCE WILLIAM SOUND
Lee, R.K. Alaska Pacific University
The giant Pacific octopus (Enteroctopus dofleini) lives 3-5 years and is found from the intertidal to 200 fathoms in the northeastern Pacific. Information about the life history, abundance, and distribution of this species throughout the Gulf of Alaska and Prince William Sound, Alaska is limited. Since 2006, E. dofleini has been separately managed as by-catch (primarily in the Pacific-cod pot-fishery) by the Alaska Department of Fish and Game. It is unknown to what extent by-catch data reflect octopus abundance, because willingness to enter and remain in a pot (and hence to be counted as by-catch) is likely to vary with the availability of alternative shelters, local food abundance, the contents of the pot at the time an octopus encounters it, and octopus size. In this study, a digital, underwater camera was used to photograph a shrimp pot during 1-2 d sets in June 2008 and June and October 2009. Few octopuses were recorded in these photographs. Shrimp (Pandalus platyceros) and other species appeared to periodically leave and return to the pot in a pattern over the course of several days, even after the bait had been exhausted. This periodic cycle appeared to have a slight correlation to the tidal flow. In some cases, arrival of an octopus in the photograph appears to be preceded by the departure of crabs (Chionoecetes bairdi) from the vicinity, suggesting prey detection of cephalopod predator at a distance.

EFFECTS OF PROPAGULE SUPPLY AND RESOURCE AVAILABILITY ON ASSEMBLY AND ECOSYSTEM PROPERTIES IN MULTITROPHIC MARINE COMMUNITIES
Lee, S.C.¹ and J.F. Bruno² 1 - Hopkins Marine Station, Stanford University 2 - Department of Marine Sciences, University of North Carolina at Chapel Hill
Although the independent effects of resource availability and propagule supply on species richness are widely recognized, there are conflicting predictions of how resource availability affects the strength of propagule effects. We tested the relative importance and interactive effects of grazer propagule supply and primary productivity (i.e. rate of algal prey growth) by manipulating both in outdoor mesocosms simulating a subtidal, algal-based estuarine community. We also examined secondary effects of grazer propagule supply on algal prey assemblages. Increasing light availability increased both algal biomass and species richness. Despite this increase in food availability and diversity, algal resource availability had no effect on grazer propagule limitation. Instead we found that grazer propagule supply had strong positive effects on grazer richness, at all resource levels. These results highlight important differences in resource use between sessile producers and mobile grazers and suggest fundamental differences in how consumers and plants respond to resource availability.

ASSESSING ECOLOGICAL EFFECTS OF AREA-BASED MANAGEMENT POLICIES ON NORTHERN ABALONE IN HAIWAII, BRITISH COLUMBIA
Lee, L.C.³ and A.K. Salomon Simon Fraser University School of Resource and Environmental Management
Increasing evidence suggests that the depletion of key consumers from coastal marine food webs can profoundly alter nearshore diversity and productivity. The marine ecosystems of Haida Gwaii, British Columbia, have experienced major consumer reductions, affecting coastal food webs and the human communities that depend on them. Archaeological evidence suggests that humans first inhabited Haida Gwaii approximately 10,000 years ago, exploiting resources of the surrounding land and sea. Since the early European colonization of the islands, keystone grazers and predators have been depleted and in some cases locally extirpated, and commercial fishing continues to reduce many fish and invertebrate populations and modify their habitats. Fortunately, ecosystem-based management tools such as zoning and area closures have been implemented to achieve specific management objectives, and more comprehensive marine use planning is underway. On Haida Gwaii, Rockfish Conservation Areas, Abalone Research Closures and the proposed Gwaii Haanas National Marine Conservation Area Reserve are policy initiatives that provide extraordinary opportunities to test the direct and indirect consequences of marine management actions on ecosystem function and resilience. In summer 2009 we initiated field monitoring and experimental research in rocky reef ecosystems to begin evaluating the ecological consequences of management actions. We use observational data for abalone and rocky reef
habitat characteristics to investigate the effects of management policies on northern abalone. Specifically, we ask is there a difference in northern abalone abundance and population structure among sites varying in fisheries management policies? If so, how might difference be related to habitat changes resulting from management actions?

A PUZZLING CLADE OF BANANA SLUGS (ARIOLIMAX (MEADARION); STYLOMMATOPHORA)
Leonard, J.L.†, Pearse, J.S.†, Backelaju, T.‡, and K. Breugelman‡ 1 - Long Marine Laboratory, UC Santa Cruz 2 - Royal Belgian Institute of Natural Sciences
The subgenus Meadarion includes three taxa, A. dolichophallus, A. californicus californicus and A. californicus brachyphantus, with separate but adjacent geographic ranges on the San Francisco Peninsula. A.c. brachyphantus is also found in isolated locations in Monterey and San Luis Obispo Counties. Behavioral and life history data demonstrate strong distinctions between the first two taxa but they are not separable in data from mitochondrial DNA genes (CO1, cyt b, 16 S). The molecular data separate populations from San Francisco and the northern portion of the peninsula from other San Mateo County populations. Behavioral data from southern populations of A. c. brachyphantus show strong similarities to sexual behavior of A. c. californicus, as does egg size, although A. californicus has a transparent hatchling, as does A. dolichophallus, whereas A. brachyphantus has a dark, almost black, hatchling. Populations in northern San Mateo County show a discordance between molecular data, suggesting affinity with A. c. brachyphantus, and behavioral and morphological data, which suggest that the animals are A. c. californicus, as does hatchling color. Specimens collected from Alcatraz Island between Marin and San Francisco Counties cluster with A. californicus on molecular traits but have a novel morphology with a short, blunt epiphallus unlike either A. brachyphantus or A. californicus, although more similar to A. brachyphantus. There may be a zone of overlap between two species; there may be a zone of hybridization and/or the mt DNA may represent past hybrid introgression. Crossbreeding experiments and microsatellite studies are in progress to distinguish between these possibilities.

† PERFORMANCE ACROSS ENVIRONMENTAL GRADIENTS: SOURCE MICROHABITATS INFLUENCE LIFE HISTORY TRAITS IN THE MARINE SNAIL LITTORINA SAXATILIS UNDER COMMON CONDITIONS.
Leroux, C.*, and L.E. Johnson Université Laval
Rocky intertidal shores are characterised by the presence of steep environmental gradients of wave exposure and desiccation. As variation in life-history traits tend to be related to habitat characteristics through mortality regime, resource availability and other environmental pressures, gradients in the intertidal zone are likely to affect such traits in organisms living there. The herbivorous snail Littorina saxatilis is a dominant species in rocky intertidal shores along the St. Lawrence estuary and is found throughout the entire intertidal zone. Large variations in mean size and reproductive output have been observed between populations of snails from different tidal levels, with snails from the lower levels being larger and more fecund than those from the higher levels. However, reciprocal transplant experiments have shown that, when placed in the same tidal level, snails from the higher level tend to grow faster. Patterns of growth and reproduction were investigated with common garden experiments to isolate the effects of tidal level and resource supply on those traits. Experiments were conducted with snails collected from both high and low levels in the intertidal zone and provided two different food abundance treatments. When given abundant food resources, snails from the higher level tended to grow faster but had a smaller reproductive output. When given scarce food resources, snails from both levels nearly stopped growing, and snails from the lower level produced more embryos but lost more body (flesh) mass. These results show that small scale differences in habitats create long-lasting effects on organisms' responses to their environment.

COLONIZATION PATTERNS OFFER A WINDOW INTO METACOMMUNITY STRUCTURE OF SEEPS IN THE NE PACIFIC OCEAN
Levin, L.A.†, Wheeler, S.G.†, Mendoza, G.F.†, Thurber, A.†, Lee, R.†, and T. Washington† 1 - Scripps Institute of Oceanography 2 - San Diego State University
An analysis of deep-sea community settlement patterns was conducted to give insight into the meta-community structure at two reducing systems in the North East Pacific ocean. Key colonization patterns that are thought to contribute to meta-community structure (as reviewed by Liebold et al 2004) are 1) a patch-dynamic paradigm where local species composition is mediated by dispersal and biological interactions 2) a species-sorting perspective where niche specification and environmental conditions control settlement and community structure 3) a mass-effect perspective where dispersal and patch quality result in a source-sink dynamic between populations and 4) a neutral paradigm where ‘everything is everywhere.’ Deep-sea reducing environments have varying sulfide flow regimes, substrate types and often species will have varying tolerances or specifications in response to their environment. The relationship of these models to seep community dynamics was surveyed by a colonization experiment along the NE Pacific ocean at Eel River, CA and Hydrate Ridge, OR. We determined colonization patterns by comparing settlement
of different substrates (wood, carbonate rock, and sediment) and flow regimes (manifested as microbial mats and clam beds). We found location to have the most significant effect of on community assemblage, providing evidence of mass effects. There was no significant effect of substrate, however, species tended to specify to a particular fluid flow regime, demonstrating niche specification and species-sorting. This study reveals highly localized patterns of colonization and identifies the importance of proximity to chemosynthetic habitat as a driving force for settlement.

THE DEMISE OF ROCKFISH SEBASTES SPP. IN PUGET SOUND: ARE THEY WORTHY OF FEDERAL PROTECTION UNDER THE ENDANGERED SPECIES ACT?
Levin, P.S.† NOAA Fisheries
In 2007, the National Marine Fisheries Service received a petition to list five species of rockfish (bocaccio, yelloweye rockfish, canary rockfish, greenstriped rockfish and redstripe rockfish) in Puget Sound / Strait of Georgia region under the U.S. Endangered Species Act (ESA). In April, 2009, the Georgia Basin populations of two of the rockfish species – canary and yelloweye – were proposed for “threatened” status. A third rockfish species – bocaccio – was proposed as “endangered.” An endangered species is at high risk of extinction; a threatened species is vulnerable to extinction in the near future and in need of protection. I will describe the process and the science that underlies these proposed ESA listings. In particular, I will highlight key uncertainties that the marine ecological community could (should!) easily fill for this species (as well as other rockfishes). More information is available at http://www.nwr.noaa.gov/Other-Marine-Species/Puget-Sound-Marine-Fishes/esa-PS-rockfish.cfm

† MICROHABITAT AFFECTS THE DISTRIBUTION OF TWO ALGAL SYMBIONTS HOSTED BY THE INTERTIDAL SEA ANEMONE ANTHOPLEURA XANTHOGRAMMICA
Levine, M.R.† Western Washington University
The intertidal sea anemone Anthopleura xanthogrammica hosts members of two algal phyla, zooxanthellae (Symbiodinium sp.) and zoochlorellae, green algae recently named a new species of Elliptochloris, either alone or in combination (mixed). These symbionts differ both in their intertidal distribution and their potential influence on host nutrition via translocated carbon. Tentacles of individual anemones on the outer Strait of Juan de Fuca, WA, were sampled repeatedly in August 2008, November 2008, and April 2009 from microhabitats providing a range of temperature and irradiance regimes. Algal density and mitotic index were quantified as measures of host symbiotic condition and algal growth. Symbiont distributions in tidepools (habitats that provide constant immersion during low tides) and surge channels (habitats that expose anemones to aerial exposure during emersion) show that anemones host zoochlorellae in increasing densities at lower shore heights in both microhabitats, with mixed individuals more common higher in the intertidal. Across all seasons, there is a trend towards lower algal densities in surge channels than in tidepools, with significantly lower algal concentrations in anemones in the high surge channel environment than in other microhabitats. Temperature data loggers at the site suggest that surge channels experience greater temperature fluctuations on daily and seasonal scales than tidepools, providing a potential driver for differences in algal composition and density. Microhabitat-mediated differences in A. xanthogrammica symbiotic composition occur on very small spatial scales, and these local variations are likely to affect responses to general climatic warming trends.

RECOVERY TRAJECTORIES IN SEAFLOOR COMMUNITIES IMPACTED BY TRAWLING ALONG THE CENTRAL COAST OF CALIFORNIA. (OR TRAWLING: GONE TODAY, HERE TOMORROW?)
Lindholm, J†*, Gleason, M†, Kline, D†, and C Parrish-Kuhn† 1 - Institute for Applied Marine Ecology at CSU Monterey Bay 2 - The Nature Conservancy
The fact that fishing with mobile, bottom-contact fishing gear (such as otter trawls) impacts the seafloor and associated biological communities is now axiomatic. A growing number of trawling bans worldwide indicates that policy-makers have recognized this fact. Considerably less is known, however, about the recovery of the seafloor following such disturbance, particularly in the unconsolidated sediments of California’s continental shelf where trawling predominates. Further, while the current footprint of trawling activity may be at an historical low, there is no guarantee this will remain the case indefinitely. Nor do the data necessarily indicate that trawling bans are warranted in all habitats. To-date, absent well-designed reference areas, we have had to make due with opportunistic studies in temporary fishing closures that may or may not have been closed to protect seafloor habitats, but that were clearly not closed for the purposes of research. These opportunistic studies have nevertheless provided solid insights into the recovery of microtopographic structure and invertebrate communities in previously trawled areas, as examples from the Gulf of Maine and north-central California will show. And now a unique academic-NGO-stakeholder partnership on a project off Morro Bay has the potential to yield important new insights into the recovery of soft sediment communities on the continental shelf. Ultimately, the goal of these studies is to advance ecosystem based approaches to management and marine spatial planning in the interests of those who fish, those who love fish, and those who love to eat fish.
ADDITIONAL CRYPTIC DIVERSITY SUGGESTS A PACIFIC ORIGIN OF THE RED ALGAL FAMILY PALMIARIACEAE

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The red algal family Palmiariaceae is a unique member of the Rhodophyta, having a distinctive life history and unusual cell wall biochemistry. In the mid 1980s, members of the family occurring in British Columbia and northern Washington received systematic treatment by Hawkes, who described two new species from northern B. C., *Palmaria callophylloides* and *P. hecatensis*. Ongoing collecting efforts in Alaska, an area already known for its strong representation of this family, provide records of at least four undescribed species based on both morphological and molecular data. These four species include at least two *Halosaccion*-like taxa and two *Palmaria*-like taxa. Two of the new species are known only from the Aleutian Islands, one from the northern and western Gulf of Alaska, and the fourth is known so far only from Cook Inlet in the northern Gulf of Alaska. One of the *Halosaccion*-like taxa is clearly basal in molecular phylogenetic analyses to other members of the family, including North Atlantic *Palmaria paltmata*, the species previously thought to be basal in the family. Moreover, in phylogenetic analyses of sequence data, specimens identified as *Palmaria callophylloides* and *Devaleraea ramentacea* occur intermixed in separate biogeographic groups.

† REPRODUCTIVE INTERFERENCE AND ALLEE EFFECTS AT A SHIFTING RANGE BOUNDARY

Llaban, A.S.*, and P.J. Krug  CSU Los Angeles

At the edge of a species’ range, low densities and competition from related species may result in negative Allee effects, or density-dependent reductions in fitness. We studied interactions between two marine gastropods at their seasonally fluctuating range boundary in San Francisco Bay. The sister species *Alderia modesta* and *A. willowi* alternate in abundance throughout the year, with recruitment of one species preceding local extinction of the other. We manipulated densities in lab experiments to test whether mating by hypodermic insemination allows the more common species to decrease fitness of the rarer species, by damaging tissue or flooding with incompatible sperm. Within each species, higher densities lowered reproductive output due to costs of mating by hypodermic insemination. Interactions between the species were asymmetric: increasing densities of *A. modesta* lowered the fitness of *A. willowi*, but the density of *A. willowi* did not affect *A. modesta*. The larger *A. modesta* inflicts substantial damage on the smaller *A. willowi* during mating, and may thus inhibit colonization or accelerate the extinction of the few *A. willowi* that survive the winter rainy season. Molecular analysis of offspring produced during mating trials showed no introgression of species-specific nuclear alleles, and we found no evidence of hybridization in field populations containing both species. Egg production was stimulated by conspecific egg masses and suppressed by clutches from the other species, suggesting additional Allee effects may result from phenomones that cue oviposition.

† DIFFERENCES IN TRANSCRIPTOMIC RESPONSES TO HEAT-STRESS IN NATIVE AND INVASIVE BLUE MUSSELS (GENUS *MYTILUS*): MOLECULAR CORRELATES OF INVASIVE SUCCESS.

Lockwood, B.L.*, Sanders, J.G., and G.N. Somero  Hopkins Marine Station of Stanford University

Invasive species are increasingly important factors in marine ecosystems worldwide. Although many studies have examined the ecological effects of invasives, little is known about physiological mechanisms that might contribute to invasive success. The mussel *Mytilus galloprovincialis*, a native of the Mediterranean Sea, is a successful invader on the central and southern coasts of California, where it has largely displaced the native congener, *Mytilus trossulus*. It has been previously shown that thermal responses of several physiological traits may underlie the capacity of *M. galloprovincialis* to out-compete *M. trossulus* in warm habitats. To elucidate possible differences in stress-induced gene expression between these congeners, we developed an oligonucleotide microarray having 8,880 probes representing 4,488 different genes that recognized mRNAs of both species. In acute heat stress experiments, 1,934 of these genes showed temperature-dependent changes in expression in at least one species; 64 genes showed significant changes in expression in both species, at all temperatures. Overall shifts in gene expression were highly similar in the two congeners. However, there were key differences in the expression of genes that reflect level of thermal stress, notably genes associated with cellular damage and its repair. *M. trossulus* showed higher induction of genes involved in apoptotic (cell death) and proteolytic pathways. Conversely, *M. galloprovincialis* showed higher induction of genes involved in protein folding, energy metabolism, anti-oxidant activity, and cell cycle control. These different responses to acute heat stress may help to explain—and predict—the invasive success of *M. galloprovincialis* in a warming world.

† FROM BAJA CALIFORNIA TO TATOOSH ISLAND: THERMAL PHYSIOLOGY OF THE RIBBED MUSSEL, *MYTILUS CALIFORNIANUS*

Logan, C.A.*, Kost, L.E., Mattioli, K., Logan, P.*, and G.N. Somero  Stanford University

The ribbed mussel, *Mytilus californanus*, is a dominant intertidal species that ranges from Alaska to Baja California. Despite its wide latitudinal and concomitant thermal range, multiple studies have concluded that this species is
genetically homogenous. This may be due to high gene flow and lack of strong post-settlement selection pressure (no local adaption). However, preliminary work has suggested that physiological differences in response to temperature do exist between these populations following common garden conditions. These differences could be purely due to phenotypic plasticity, but may be due to previously undetected genetic structure or environmentally induced developmental differences. In this study, we characterize intraspecific physiological differences of this mussel across a large portion of its latitudinal range and begin to unravel the plastic, genetic, or developmental origin of these differences. 150 mussels were collected from 7 populations from the Northwest coast of the U.S. to Northern Baja California. In order to test for phenotypic plasticity, mussels were common gardened and tested for known intergeneric physiological differences within the *Mytilus* species complex: differences in metabolic rate (via citrate synthase and malate dehydrogenase enzyme activities), differences in thermal adaptation of a metabolic enzyme (via measurement of the substrate affinity constant, *Km*, for cytosolic malate dehydrogenase), critical heart rate break temperature, and lethal temperature. We evaluate the results in the context of thermal history and prevalent environmental conditions (e.g. upwelling) at collection sites. This study further elucidates the thermal physiology of this ecologically important species along the West Coast.

**LOCAL CONSUMERS INDUCE RESISTANCE IN SOUTHERN, BUT NOT NORTHERN, SPARTINA POPULATIONS**

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Plant defense theory predicts that inducible plant defenses may vary between populations of single plant species – however, this has rarely been tested using field experiments. We simultaneously manipulated densities of local consumers in the field within Maine and South Carolina populations of the smooth cordgrass *Spartina alterniflora*. Southern but not northern plants induce plant resistance when grazed by local consumers. *Littoraria* snails and planthoppers colonized control more than previously-grazed southern plants, and *Littoraria* snails consumed more control than previously-grazed plants. The inducible feeding deterrents in southern plants appear to be water-soluble, but not phenolic-based. In contrast, grazed and control plants from northern populations did not differ in attractiveness or palatability. Thus, under field conditions, the interactions between *Spartina* and its local herbivores varied spatially. Such variation may be common and if so, will limit the relevance of plant-herbivore interaction studies focusing on single populations.

**COMING TO A HARBOR NEAR YOU: THE INVASIVE ASIAN KELP UNDARIA PINNATIFIDA**

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In March 2000 the Asian kelp *Undaria pinnatifida* was first discovered in southern California. Within 18 months it had spread as far north as Monterey Harbor. It is currently the only invasive kelp in the world, and has the potential to significantly alter community structure once established. In September 2002 the Monterey Bay National Marine Sanctuary lead a collaborative effort to monitor and manage *Undaria* in the harbor. Volunteer divers and sanctuary staff manually removed *Undaria*, targeting pre-reproductive individuals to reduce self-recruitment within the harbor population. In spite of removal efforts, monitoring results indicate *Undaria* persists in the harbor and is on the brink of escaping into Monterey Bay. Furthermore, in May 2009 researchers from the Smithsonian Environmental Research Center found nascent populations of *Undaria* in two San Francisco harbors and at Pillar Point harbor. Initially, 116 individuals were removed from these three sites, each site consisting of both juveniles and reproductive adults. In August 2009 divers revisited South Beach Marina in San Francisco, and removed over 100 individuals from that site alone, many of which were newly recruited. Efforts to remove these nascent populations are ongoing. Given the wide environmental tolerance of *Undaria*, it will likely continue to spread northward along the eastern Pacific, initially infecting northern harbors, and possibly spreading to the open coast.

† **NOTES ON THE DISTRIBUTION, LARVAL DEVELOPMENT AND EARLY LIFE STAGES OF THE GUMBOOT CHITON, CRYPTOCHITON STELLERI**

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Even though the gumboot chiton, *Cryptochiton stelleri*, is a large and fairly abundant inhabitant of Northern Pacific rocky shores, little is known about its early life history. This study describes and documents the early development of *Cryptochiton* and discusses potential cues required for metamorphosis. There are several discrepancies between this description of *Cryptochiton* larval development and the only other publication on this topic, so potential reasons for these differences are addressed. The appearance, behavior, and habitat preference of juvenile *Cryptochiton*, a very rare find in the rocky intertidal, was also documented. Additionally, extensive population surveys were used to determine the spatial distribution of this species and to obtain size-distribution information for several *Cryptochiton* populations.
along the southern Oregon coast. These size-frequency data were converted to age structure and growth rate information using population models. These age structure data were then combined with GIS representations of local population density at several sites in order to make inferences about the factors driving settlement, recruitment, and distribution of Cryptochiton. Preliminary results indicate that this species is clumped in small coves within large rocky intertidal areas, potentially as a result of high recruitment in these areas. The population models and GIS representations used in this study should have some predictive ability about where high densities of Cryptochiton should be found. However, species that have a very uncommon or cryptic part of their life history present unique challenges to modeling, especially in the case of long-lived species such as Cryptochiton stelleri.

**WHAT CONTROLS THE POPULATION OF THE NEW ZEALAND MUD SNAIL, POTAMOPYRGUS ANTIPODARUM, IN ITS NATIVE RANGE?**

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The New Zealand mud snail (NZMS) is rapidly invading western waters. It can dominate animal biomass and may compete with benthic invertebrates, including food sources for secondary consumers such as salmonid fish. Regional economies are potentially affected where fisheries are important. Standard methods of control have failed or are environmentally destructive. The National Management and Control Plan for the New Zealand mud snail recommends considering biological control as a cost-effective and ecologically benign method for suppressing NZMS populations and decreasing the rate of spread. We are examining the safety and efficacy of a promising biocontrol agent, an extremely specialized parasitic castrator trematode (Microphallus sp.). As a first step to assess the efficacy of this possible control agent, we are assessing whether the parasite regulates the pest snail in their native range. We sampled 60 different sites spread throughout New Zealand. At each site, we collected data on snail abundance, demography, fecundity, and levels of parasitism. Also, for each site, we have acquired long-term monitoring data on several additional environmental abiotic and biotic variables. Multivariable analyses of these data will shed light on what abiotic or biotic factors control NZMS abundance in its native range, including whether the castrating parasite has promise as a control agent.

† CONTRIBUTION OF PRE- AND POST- SETTLEMENT PROCESSES TO RECRUITMENT DYNAMICS OF BLACK ROCKFISH, SEBASTES MELANOPS

Lotterhos, Katie E.* Florida State University

Determining the relative contribution of pre- and post- settlement processes to the abundance of recruits is a central question in the population dynamics of marine organisms. This study seeks to elucidate the recruitment dynamics of declining rockfish species on Vancouver Island, British Columbia. Pacific rockfish are long-lived and slow to mature, which makes them susceptible to overfishing and rapid environmental change. Recruitment of black rockfish, Sebastes melanops, has been monitored with Standard Measuring Units for Recruitment of Fishes (SMURFs) since 2005 in Barkley Sound, and has differed substantially among years. The year 2006 was marked by unusually high recruitment, while the year 2009 was marked by an unusually late pulse of recruits in small abundances and low condition (weight:length ratio). I used modeled settlement dates to examine whether correlations between upwelling and settlement can determine recruit abundances. While this partially explains differences in recruitment among years, it does not entirely explain the recruitment patterns in 2009. Using field and experimental data, I show that the weak 2009 cohort is the result of the presence of high abundances of 1-year old Sebastes melanops. Interestingly, this system provides little evidence that the abundance of recruits transfers into older age classes, and there is anecdotal evidence that this population is regulated by over-winter survivorship. Determining which underlying factors are responsible for population regulation in this long-lived genus will be crucial for conservation efforts.

**SPATIAL VARIABILITY IN DISPERSAL OF JUVENILE BIVALVES IN A NEW ZEALAND ESTUARY**

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We developed a biophysical model of Whangarei Harbour, New Zealand, to predict dispersal of larval and juvenile bivalves within the estuary. To validate and refine the hydrodynamic model, we performed a series of field studies in summer 2008/2009. First, we developed a broad scale habitat map of the estuary to estimate spawning and suitable settlement habitat. We determined sediment properties (grainsize, organic content, chlorophyll a) and size and abundance of common bivalves at 42 intertidal sites located throughout the harbour, and at 70 additional sites located on one of the commercial shellfish banks. To validate model predictions of larval dispersal, we sampled seven sites using a combination of sediment traps, plankton nets and colonising macrofaunal cores. Finally, we measured differences in dispersal of post-settlement juvenile bivalves outward from experimentally dyed plots at three sites (exposed, moderate, sheltered). Generally, experimental observations of temporal and spatial variations in larval and
post-settlement abundance matched model predictions, suggesting hydrodynamic differences between sites were strong drivers of between-site differences in bivalve dispersal. Exposed sites had an order of magnitude higher abundance of larval and early post-settlement invertebrates in traps, plankton nets, and cores, matching model predictions. Sheltered and moderate sites had fewer bivalves in nets and traps, and higher temporal variability based on hydrodynamic conditions relative to daily shifts in wind strength and direction. However, differences in abundance of adult bivalves and other common macrofaunal species at each site suggest that both recruitment and post-settlement processes are important in structuring benthic communities in this harbour.

† FAILURE BY FATIGUE IN THE RED MACROALGA MAZZAELA
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Organisms on wave-swept shores endure over 8000 waves each day, with associated water velocities commonly in excess of 10 m/s. Intertidal seaweeds thrive in these conditions largely by streamlining in flow and reducing imposed forces. Nonetheless, wave-induced tattering and breakage occur frequently. For Mazzaella, even during summer months 20-30% of thalli experience tattering and breakage over the course of each two-week tidal cycle. We assess, in the laboratory and in the field, breakage due to repeatedly imposed forces, which happens through fatigue. We have elucidated the entire process of fatigue in Mazzaella fronds, from initial formation of small cracks through the growth of these cracks to eventual specimen rupture. Susceptibility to fatigue varied by species and life history stage. For tested Mazzaella, crack formation spanned most loading cycles required for failure: crack formation often consumed 80-90% of loading cycles to failure, with crack growth and specimen fracture resulting relatively soon after cracks formed. Examination of crack formation revealed trade-offs between reproduction and mechanical failure, in addition to a cost of endophyte infection, as cracks commonly originated from reproductive structures and endophytes. Ongoing field measurements are evaluating the predictions that large, female gametophyte fronds are most susceptible to fatigue failure in the field, while at the opposite extreme, small male gametophytes are unlikely to break.

† IDENTIFYING THE DETERMINANTS OF NATIVE AND INVASIVE SPECIES COMPOSITION IN CANADIAN EELGRASS BEDS AT A REGIONAL AND NATIONAL SCALE
Mach, M.E.*, and C.D. Levings† 1 - University of British Columbia 2 - Department of Fisheries and Oceans Canada

Eelgrass beds are important for structuring invertebrate communities and providing nursery grounds and shelter for many species of fish. It is essential not only that these beds continue to exist along our coasts but that we understand the health of the systems they support. Beds on the British Columbian and Nova Scotian coastlines have been declining in recent years due to anthropogenic disturbance, making spatial comparisons of species composition in Canada’s Zostera marina eelgrass beds important for establishing a baseline of ecosystem health. To analyze local community structure within the Z. marina eelgrass beds, I sampled 18 eelgrass beds on the Pacific and Atlantic coasts of Canada for infaunal, epifaunal and mobile macroinvertebrates. I used this data to compare native and invasive species diversity and abundance between sites on each coast and to look at patterns across coasts. The species sampled in my study demonstrate patterns of species dominance in relationship to habitat disturbance levels at each sampling site; with more disturbed sites dominated by fewer numbers of species, while healthier sites demonstrate a more even dominance of species. Invasive species across sites are highly site specific and are mostly comprised of arthropod and mollusk invaders. Understanding these patterns is important, especially for communities dependent on threatened habitat, as those invertebrates living in Z. marina beds are in the Strait of Georgia and on the outer coast of Nova Scotia. Without such data it would be impossible to assess changes to ecosystems, whether due to human impact or natural variation.

† SETTLEMENT CUES AND THEIR POTENTIAL EFFECT ON DISPERSAL IN TWO SIBLING SPECIES OF ROCKY INTERTIDAL GASTROPODS, LITTORINA PLENA AND LITTORINA SCUTULATA
Maliska, M.E.†  University of Washington, Friday Harbor Labs

Periwinkle snails Littorina ple na and Littorina scutulata (Caenogastropoda: Littorinidae) are an excellent sibling species pair to examine if larval dispersal and larval settlement affect gene flow in marine organisms with planktonic dispersal. No ecological differentiation has been shown in these planktotrophic species and studies have shown L. ple na to have less gene flow than L. scutulata. I hypothesize differences in cues for settlement is the cause of this. I cultured larvae in concentrations of 50-200/L in still flasks and fed them 10^5 cells/ml/day of both Isochrysis galbana and Nanchlororopsis sp. After cohorts of each species were in culture for 19-50 days, I exposed them to the high intertidal alga, Fucus sp., rocks found in the high intertidal or a control. L. ple na and L. scutulata larvae settled and metamorphosed to each cue (n=51 and n=47, respectively), however a greater percentage of each species settled when exposed to rocks versus a control. My work suggests that chemical cues may contribute to settlement and
metamorphosis in *L. plena* and *L. scutulata*, but further work will be needed to assess if there is a difference in settlement time from these cues and if these cues have a more significant effect on one species over the other.

† **EVIDENCE FOR MICROBE-DRIVEN JANZEN-CONNELL EFFECTS IN A TROPICAL CORAL**

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Density-dependent survivorship is an important structuring force in marine communities; for sessile organisms, this should manifest as explicit distance-dependence. We determined whether survivorship of juvenile reef corals depends on distance to the nearest conspecific adult and whether this effect is species-specific and mediated by waterborne pathogens, all of which are predictions of the Janzen-Connell hypothesis. Results from field experiments with settled coral recruits and laboratory experiments with swimming coral larvae show that Montastraea faveolata recruits exhibit distance-dependent survivorship. Furthermore, microbial profiles of reef water surrounding adult coral heads and manipulations of the microbial environment with filters and antibiotics show that bacteria are a primary driver of this effect. Therefore, microbial microenvironments affect survivorship success during a coral’s most sensitive life phase and have important consequences for the dynamics of healthy and recovering coral reefs.

**DIFFERENCES IN MALE/FEMALE RELATIVE ABUNDANCE AND SIZE IN DAYTIME SURFACE SWARMS FOR TWO SPECIES OF MONTEREY BAY KRILL.**

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Species composition, reproductive status and size structure were determined for euphausiids opportunistically sampled from daytime surface aggregations between 1999 and 2009. Such phenomena are both rare and unpredictable, as the underlying mechanism causing their formation remains poorly understood. Distinct differences in both relative abundance and size of males vs. females are documented for the more commonly encountered aggregations of *Thysanoessa spinifera* and the much rarer aggregations of *Euphausia pacifica*. In addition, data from grazing experiments using *T. spinifera* individuals collected from surface aggregations are presented. The results provide new insights into species specific factors that can result in the formation of surface swarms as well as the potential trophic consequences associated with such phenomenon.

**SPATIO-TEMPORAL VARIATION IN GROWTH OF MEGAstrAEA UNDOSA: CONTEXT-DEPENDENT EFFECTS OF TEMPERATURE**

Martone, R.G.¹, Micheli, F.¹, Dunbar, R.B.², and E.B. Roark³ 1 - Hopkins Marine Station, Stanford University 2 - School of Earth Sciences, Stanford University 3 - College of Geosciences, Texas A & M

Spatiotemporal variation in vital rates of organisms, such as growth or fecundity, may greatly alter the nature of population dynamics. Temperature and food availability or food quality are both environmental factors thought to increase individual growth rates. However, these factors are negatively correlated in many coastal marine systems dominated by upwelling. The interactive effects of these environmental processes on vital rates is relatively unexplored. To examine the effects of temperature on growth, we reconstructed time series of growth of *Megastraea undosa* using naturally occurring marks in the calcium carbonate opercula after validating periodicity of growth marks with isotopic analysis. Growth rates were compared with annual and seasonal temperatures obtained from AVHRR. The relationship between temperature and growth varied spatially with different oceanographic conditions. In persistent upwelling zones where nutrients were elevated, individual growth was negatively correlated with temperature, while under conditions of less persistent upwelling and lower nutrients, growth was positively correlated with temperature. Variable growth rates may have important effects on population dynamics. Further exploration of environmental processes on vital rates is particularly important for harvested species and for predicted responses of species to global change.

† **LINKING LARVAL BEHAVIOR AND ALGAL SETTLEMENT PREFERENCE IN CYPHONAUTES LARVAE OF MEMBRANIPORA MEMBRANACEA**

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Settlement represents an important aspect of biphasic life histories in marine invertebrates. Very little is known regarding the behavioral mechanisms for finding suitable substratum. In this study, we tested the settlement preference and behavior of cyphonautes larvae of *Membranipora membranacea* in response to two different algal substrata upon which adult colonies were found in the field. In laboratory settlement experiments, larvae showed a strong preference for settling on the kelp *Nereocystis luetkeana* over the red alga *Mazzaella splendens*. This preference was consistent in both still and flow conditions. Using a raceway flume, we found that larvae exhibited different behaviors on the two species of algae in flowing water. At flow speeds of 4.9 ± 0.3 cm/s at 1 cm above the bottom, larvae were more often
observed in direct contact with the preferred alga (*N. luetkeana*) exhibiting exploratory crawling, rolling, and upstream crawling. On the less preferred alga (*M. splendens*) were most frequently observed rolling and skimming along the surface of the blade. The behavior of cyphonautes larvae appears to help them find and attach to their preferred settlement habitat.

**COMMUNITY STRUCTURE AND DYNAMICS IN ROCKY SUBTIDAL MARINE PRESERVES, SAN JUAN ISLANDS, WASHINGTON**
McCullum, B.A.*, and K.P. Sebens University of Washington, Friday Harbor Laboratories

The use of marine preserves for protecting top predators and recreationally important fish species in the San Juan Islands, WA, has been an important marine conservation tool for the region since 1990. While the preserves have had a positive effect on fish abundance, very little is known about the consequences of marine preserves for the rest of the subtidal community. This study aims to define community structure and dynamics of nearshore rocky subtidal habitats inside and outside previously established marine preserves in San Juan Channel. The benthic community, including algae, sessile invertebrates, and large mobile consumers, was quantified using a combination of random photoquadrats and in-situ sampling each fall beginning in 2006. Preliminary results demonstrate strong zonation of the sessile community over a 30 m depth gradient, and identify several consumer species (urchins, seastars, chitons, crustaceans, fishes) as particularly important based on biomass, which likely have strong community level effects. Space clearing by grazers, rather than by physical disturbance, is expected to be very important for community composition and recruitment of certain species. Vertical surfaces have very different community composition compared to sloping and horizontal surfaces, and may be affected differentially by consumers including top predators. This study is being extended to include additional preserve and non-preserve sites to further our understanding of the effects of predator protection on small prey and non-prey species in the benthic communities of San Juan Channel.

† **STATUS AND DYNAMICS OF THE BLACK-LIPPED PEARL OYSTER, PINCTADA MARGARITIFERA, AT MIDWAY ATOLL, NORTHWESTERN HAWAIIAN ISLANDS**
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The commercially valuable black-lipped pearl oyster, *Pinctada margaritifera*, is widely distributed across the Indo-Pacific and occurs throughout the Hawaiian Archipelago, including Midway Atoll near the northern end of the chain. This species was intensely exploited on neighboring Pearl and Hermes Atoll in 1927-1929, where it has not recovered to pre-exploitation levels. Although *P. margaritifera* exists at Midway Atoll, there are no reports of abundance before 2000 or commercial exploitation there. While adults are rare at Midway, juveniles commonly recruited onto a variety of substrates, including “spat collectors” designed for this purpose, throughout the lagoon and backreef in 2007-2009. We are continuing studies of adult distribution, growth rates, and spatial and temporal patterns of recruitment to extend knowledge of the biology of *P. margaritifera*, enhance understanding of its use as an indicator of reef “health”, and provide a pilot study at Midway for the U.S. Fish and Wildlife Service goal of restoring *P. margaritifera* on Pearl and Hermes Atoll.

† **HOW TO GET A BIGGER HOUSE WITHOUT GOING UNDERWATER: A CASE STUDY IN UNICELLULAR ALGAE**
Miklasz, K.A.*, and M.W. Denny Hopkins Marine Station

Unicellular organisms are faced with a classic scaling problem: is it better to form a larger cell, or to increase in size by living in a colony? For marine phytoplankton, this issue is especially acute, since a larger size incurs a direct cost of increased sinking speed, which more quickly draws organisms away from sunlight and towards potential death. Understanding the role of sinking in constraining phytoplankton size has been difficult because the size-sinking speed relationship in diatoms, the most common phytoplankton group, has not been effectively modeled. This study offers the first attempt to accurately model the size-sinking speed of diatoms. This model is then used to determine the relative benefits and costs of making larger cells versus forming chains. The results of the model indicate that chain formation is a good way to increase in size for non-diatomaceous plankton, but the unique frustule of diatoms prevents them from reaping the benefits of chain formation. Chain-forming diatoms have increased sinking speeds relative to a similarly sized cell: therefore, it seems that diatoms form chains in response to constraints other than sinking.

**HISTORIC POPULATION TRENDS OF CALIFORNIA SCIAENIDS (FAMILY SCIAENIDAE): IMPLICATIONS OF OCEANOGRAPHIC FORCING, CLIMATE CHANGE, AND FISHING.**
Miller, Eric F., Pondella, Daniel J., Beck, D. Shane, and Kevin T. Herbinson MBC Applied Environmental Sciences

Two fishery-independent datasets were examined to characterize the population dynamics of common Southern California Bight sciaenids in relation to anthropogenic stressors and oceanographic conditions. These include scientific gill-net (1995-2007) and power plant entrapment (1972-2005) from San Clemente to Santa Barbara, California. Adult
abundances for nearly all species were found to be declining, although the rate and severity of these declines varied among species, with *Genyenemus lineatus* populations exhibiting the most severe decline while *Umbrina roncador* and *Roncador steurnsi* populations increased slightly. Trends in all species converged at a generally minimal level from approximately 1983 to 1995. Power plant entrapment indices across all species increased after the 1994 nearshore commercial gill-net fisheries closure in California State waters. Species-specific indices significantly related to various oceanographic parameters, especially the North Pacific Gyre Oscillation and seawater temperature. The nearshore *G. lineatus/Seriphus politus* commercial gill-net fishery, in conjunction with oceanographic changes since the 1977 regime shift, greatly impacted the southern California sciaenid population. Since the gill-net fishery closure, evidence of a faunal shift in the community has occurred with more southerly distributed species (*U. roncador* and *R. steurnsi*) increasing locally while more northerly distributed species (*G. lineatus* and *S. politus*) declined in abundance.

**PREDICTING THE FREQUENCY OF LETHAL AND SUBLETHAL STRESS EVENTS FOR A DOMINANT COMPETITOR FOR SPACE IN THE MID-INTERIDAL ZONE OF CALIFORNIA**

Miller, Luke P.†, Denny, Mark W.†, and Christopher D.G. Harley† 1 - Northeastern University 2 - Hopkins Marine Station, Stanford University 3 - University of British Columbia

The distribution of organisms within microhabitats at a site may be driven by a variety of factors, both biotic and abiotic. To examine the potential role of high temperature and desiccation stress on the small-scale distribution of the limpet *Lottia gigantea*, we used a combination of physiological assays and ecomechanical modeling techniques to hindcast the occurrence of sub-lethal and lethal stress events in a population. Sub-lethal and lethal stress exposures were conducted using an environmental chamber designed to recreate stressful field conditions in the laboratory. Heat-shock protein 70 expression was used as a proxy for sub-lethal stress, and lethal temperatures were calculated. These physiological parameters were combined with the output of a bio-physical heat-budget model to predict conditions under which *L. gigantea* would experience significant sub-lethal stress or mortality. These data were compared to existing vertical distributions of *L. gigantea* in the field. Within a subset of the microhabitats at our site, we predict that the upper limit of the vertical distribution of limpets could be set by rare high temperature and desiccation events. The synthesis of these techniques has the potential to help inform ecologists about the role of physical and physiological constraints in shaping communities and their responses to future environmental changes.

† USİNG TRACE-ELEMENT SIGNATURES IN SOFT TISSUES TO DETERMINE POPULATION CONNECTIVITY AND THE NATAL ORIGINS OF NEW RECRUITS

Miller, S.H.†, and S.G. Morgan Bodega Marine Lab, UC Davis

Population connectivity is a crucial and often poorly understood component of marine benthic invertebrate population dynamics. Understanding the connectivity among populations has important implications for such practical applications as fishery management, invasive species control, and marine protected area establishment. Several studies have investigated population connectivity using trace-element signatures of calcified structures such as the otoliths of fishes and natal shells of oysters and mussels. Most marine invertebrate larvae, however, lack significant hard structures that are retained throughout their development. To address this problem, we use trace element signatures of larval and embryo soft tissues to determine population connectivity. To validate the method, we raised porcelain crab (*Petrolisthes cinctipes*) larvae from different locations along the northern California coast in water from a common source to simulate the nearshore mixing of larvae during their development. Larvae were raised through to the megalopa stage and their soft tissues were analyzed for trace-element signatures using solution-based ICP-MS. The signatures of megalopae were then compared to the elemental signatures of embryos from multiple sites to determine if they could be accurately matched to their site of origin. This study has implications for the utility of a field-based application of these methods to determine the connectivity among porcelain crab populations along the northern California coast.

**PARTITIONING OF PRIMARY PRODUCTION AMONG GIANT KELP (MACROCYSTIS PYRIFERA), UNDERSTORY MACROALGAE AND PHYTOPLANKTON ON A TEMPERATE REEF**

Miller, RJ* Marine Science Institute, UCSB

Net primary production (NPP) by autotrophs, whether it originates within or outside an ecosystem, defines the upper limit of energy available to food webs. Seasonal or interannual processes and less predictable disturbances, can cause variations in NPP that propagate through food webs as bottom-up effects. Different groups of autotrophs, however, may be affected differently by these processes and may interact with each other through resource competition, dampening variation in ecosystem NPP. Giant kelp (*Macrocytis pyriforma*) is an ecosystem engineer that forms dense forests on the rocky reefs where it occurs, and may suppress other autotrophs, i.e. understorey macroalgae and phytoplankton, under its shaded canopy. NPP by giant kelp is very high compared to other measured ecosystems, but is more variable on an interannual basis than other productive systems. The potentially high negative effect of giant kelp on other primary producers, however, raises the possibility that interannual variability in ecosystem NPP could be dampened by
competitive release of non-kelp autotrophs. We examined seasonal variability in NPP by giant kelp, understory algae and phytoplankton in a kelp forest off Santa Barbara, CA and experimentally evaluated the effects of giant kelp on the other producers. We also determined the extent to which NPP by understory algae and phytoplankton compensate for the reduction in NPP by giant kelp following wave disturbances that preferentially remove Macrocystis.

THE EFFECT OF DIFFERENT N:P RATIOS AND LIGHT LEVELS ON THE GROWTH RATE OF AND , TWO HARMFUL DINOFLAGELLATES

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Growth rates of the harmful dinoflagellate species Prorocentrum minimum and Karlodinium veneficum were determined in laboratory experiments using varying N:P ratios and light intensities. Two experiments were done each with a different nitrogen source (nitrate or urea). Growth rates were found to be higher when using urea as the nitrogen source than with nitrate for both species. The growth rate of P. minimum was higher in the higher light intensity (300µE m⁻² s⁻¹) treatment in both experiments, but K. veneficum grew at the same rate at all three light levels in both experiments. The N:P ratio had a greater effect on growth of K. veneficum than P. minimum and this effect was expressed both in terms of growth rate and the period over which exponential growth was sustained. Growth rate responses of these species to these different growth conditions may help to explain their competitive dominance in the field.

† LATITUDINAL THERMAL GRADIENT EFFECT OVER THE COST OF LIVING ON THE INTERTIDAL PORCELAIN CRAB PETROLISTHES GRANULOSUS

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Species with wide latitudinal distributions are exposed to important abiotic gradients. Thermal gradients are especially significant for ectothermic intertidal species, since they determine their life history traits and affect their fitness. As a first approach to understand the effect of a thermal gradient over the cost of life for the porcelain crab Petrolisthes granulosus, we analyzed growth and reproductive capacity parameters on three populations spread along a latitudinal gradient of the coast of Chile: Iquique (20°16'12"S), Coquimbo (30°04'12"S) and Concepción (36°35'45"S). The southernmost populations presented larger sizes (P < 0.01), which was explained by the presence of big size classes that were absent on the northern populations. Size at first sexual maturity showed a positive correlation with latitude (P < 0.01), whereas egg mass carried by females was greater at Concepción (P < 0.05). Metabolic experiments were further run to evaluate energetic cost due to the high temperatures organisms are supporting on their own environments and to confirm its effect on the growth and reproductive capacity parameters observed on the field. Standard metabolic rate did not differ between the studied populations (P > 0.05). Thus, the energy cost (expressed as standard metabolic rate) related to the high temperatures experienced by the three populations is not the factor defining the detected differences of growth and reproductive capacity between populations, and others would need to be considered such as food availability.

BEHAVIORAL-PHYSICAL PROCESSES REGULATING LARVAL RECRUITMENT IN UPWELLING REGIONS

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Larvae are thought to be highly vulnerable to offshore transport of upwelling regions limiting recruitment to infrequent wind relaxation and downwelling events. However, larvae could also be transported onshore by upwelled bottom waters, onshore wind-forcing or internal tides throughout the water column. We determined the relative importance of these hypothetical mechanisms for the timing of recruitment of 8 invertebrate taxa during the peak upwelling season in a region of strong, persistent upwelling. Recruitment was determined for 5 yr at an open embayment near the surface and bottom of the water column to examine the interaction of behavioral and physical processes regulating larval recruitment. Postlarvae consistently recruited near the surface or near the bottom depending on the species. Onshore delivery of larvae during wind relaxations and reversals did not best explain recruitment patterns in our area for most taxa. Only mussels consistently recruited more during these events, and they recruited in bottom rather than surface waters. Six crab taxa recruited primarily during upwelling. Recruitment of 7 taxa was intermittently correlated with the maximum tidal range, suggesting that internal waves also may deliver larvae onshore. Thus, larvae may recruit by multiple processes in upwelling regions rather than being limited to infrequent relaxation events, leaving the mechanism responsible for observed spatial patterns in larval recruitment and adult densities unexplained. Comprehensive studies of the behavioral and physical processes underlying larval recruitment and postsettlement
mortality are needed to explain observed temporal and spatial variation in population dynamics and community structure in upwelling regions.

A REVIEW OF POSITIVE INTERACTIONS IN MARINE COMMUNITIES.
Munguia, P*, Ojanguren, AF, Evans, A, Rickman, L, Gemmell, B, Cook, C, and K Duska  The University of Texas at Austin
For the past few decades, ecologists have demanded a greater presence of positive interactions in ecological theory. According to these claims, positive interactions could be as important as competition and predation in determining the structure of ecological communities. However it seems that the scientific community is not responding. Unlike predation, which can be easily observed and measured, both competition and positive interactions, such as mutualisms or symbioses, are elusive and difficult to quantify. Moreover, while predation has an unambiguous effect on the fitness of consumed prey, competition and positive interactions typically have subtle or indirect consequences such as changes in growth or fecundity. Therefore, the deficit in positive interaction articles may be explained by inherent difficulties in studying ambiguous effects of such interactions. Alternatively, the reason for the low proportion of studies on positive interactions could be the ambiguity of some definitions or researcher bias when studying specific taxa, habitats or latitudes. We embarked on a large review process in order to first identify historical trends in ecological publications concerning species interactions in both marine and terrestrial environments. Then, we examined latitudinal variation in positive interactions in order to determine where these interactions are more prevalent. By differentiating prevalence of interactions among taxa, habitats and latitudes, we attempt to answer the question: do positive interactions evolve more frequently in temperate or tropical areas?

†SUBSTRATE RUGOSITY AFFECTS KELP ZOOSPORE AGGREGATION AND FERTILIZATION SUCCESS
Muth, A.M.*  Moss Landing Marine Labs
A critical zoospore settlement density is required for fertilization and recruitment of kelp sporophytes, suggesting that factors regulating kelp zoospore settlement density may be important to kelp population dynamics. In this study I tested to see if zoospore aggregation during settlement enhanced kelp recruitment success when zoospore settlement densities are held constant. Laboratory culture studies established a difference in Macrocystis pyrifera fertilization success between randomly dispersed and aggregated zoospores settled at the same density. I further hypothesized that differences in substrate rugosity can aggregate zoospores during settlement and enhance kelp recruitment in a natural setting. Seasonal field experiments were conducted to test for differences in kelp recruitment onto resin molds that mimicked the rugosity of two local rock formations found in central California kelp forests: the Carmelo Formation sandstone and Santa Lucia granodiorite. Field results indicated that kelp recruitment was significantly higher on the granodiorite molds suggesting that rugosity-induced zoospore aggregation may be an important factor in regulating kelp recruitment, especially at low settlement densities.

†SCALE DEPENDENT CONTROLS OF COMMUNITY INVASION AND FORMATION IN MARINE FOULING COMMUNITIES
Needles, LA1*, Cadotte, MW2, Wendt, DE3, and SD Gaines1 1 - UC Santa Barbara 2 - University of Toronto-Scarborough 3 - California Polytechnic State University San Luis Obispo
At small spatial scales, high resident diversity often results in reduced invasion success, while at larger spatial scales native and invader diversity are positively correlated. This apparent paradox has been attributed to two different mechanisms working at different spatial scales. At small scales, neighborhood interactions reduce establishment of new species and limit their impact (biotic resistance). At larger scales, however, habitat heterogeneity is often used to explain the positive correlation between invader and native diversity. Invasion of communities though is really a question of species coexistence. As resource heterogeneity and species diversity are both mechanisms that have consequence for coexistence, they should influence communities across scales. We tested the simultaneous effects of richness, species identity and habitat heterogeneity on invasibility of assembled marine sessile communities. We hypothesized that communities with low species richness and high heterogeneity would be most susceptible to invasion. We found that species richness and species identity (but not heterogeneity) affected invasibility at small scales. However, at larger scales more heterogeneous communities had increased invader richness and percent cover. We also found a strong interaction between species identity and heterogeneity at larger scales, with one species, Corynactis californica, decreasing percent cover of invaders with increasing heterogeneity. We propose a new framework for thinking about invasibility of communities across scales where species identity, species richness and habitat heterogeneity interact to promote or inhibit coexistence and thus invasion in communities.
THE EFFECTS OF GROWTH MORPHOLOGY ON EARLY SUCCESSION IN A TEMPERATE MARINE FOULING COMMUNITY
Nelson, M.L., and S.F. Craig  Humboldt State University
Marine fouling communities contain a plethora of sessile colonial invertebrates which grow in a variety of different shapes that compete for space, and other resources, in various manners. Few studies, however, have taken the effects of colony morphology into account when studying succession within fouling communities. This study examines three different growth morphologies, representing the most abundant fouling organisms within Humboldt Bay: (1) ‘Sheets’ (e.g. colonial ascidians), which occupy large areas of primary substrate, (2) ‘Trees’ (e.g. erect bryozoans), which are upright branching forms, and (3) ‘Clonal Polyps’ (e.g. sea anemones), a form not previously considered in other studies. Experimental panels containing these three morphologies were placed in Humboldt Bay and the effects of these organisms on the developing community were assessed through time. Organisms possessing these three different morphologies had profound effects on the patterns of succession observed. The physical structure created by these resident organisms always increased larval recruitment into the community. However, biotic interactions with resident adults may have also altered recruitment patterns. Over a the course of the four month experiment, the ‘Sheet’ morphology was able to occupy more substrate than both other forms, although spatial dominance may be dependent on suitable conditions for growth. The 'Clonal Polyp' form curiously maintained more free space within its experimental communities than did other forms. These results demonstrate that individual traits, such as growth morphology, possessed by the interacting species within fouling communities may drive patterns of succession and affect the resulting structure of the ecological community at large.

THE DISTRIBUTION, ABUNDANCE, AND HOST USE OF THE TREMATODE PARASITE, ACANTHOPARYPHIUM SPINULOSUM, IN THREE ESTUARIES OF CALIFORNIA AND BAJA CALIFORNIA.
Digenetic trematodes can reach high abundance and biomass in the estuaries of California and Baja California. As such, they can influence the ecosystem at individual, population, and community levels. These trematodes require two or three hosts to complete their life cycle. Thus, the ecology of a particular parasite larval stage is influenced both by the stage’s target host as well as the distribution and abundance of previous developmental stages and their hosts. Here we present data for Acanthoparyphium spinulosum from its sole first host snail, Cerithidea californica and its several second intermediate hosts (including snails, bivalves and polychaetes) from three wetlands, Carpinteria Salt Marsh, Estero de Punta Banda, and Bahia San Quintin. Comparing data from these different larval stages and their respective hosts addresses aspects of its host specificity and the complicated resultant flow of these parasites through the invertebrate fauna of these estuaries.

† THE COASTAL BOUNDARY LAYER: NEARSHORE VELOCITY ATTENUATION AS ANOTHER CONTRIBUTOR TO PASSIVE PHYSICAL RETENTION OF MARINE LARVAL ORGANISMS.
Nickols, K.J.1*, Gaylord, B.2, and J. Largier3 1 - Bodega Marine Laboratory, UC Davis 2 - Bodega Marine Laboratory and Department of Evolution and Ecology, UC Davis 3 - Bodega Marine Laboratory and Department of Environmental Science and Policy, UC Davis
Dispersal during the larval phase is the primary determinant of population connectivity for many marine species, and characteristics of shoreline geomorphology can strongly influence this process. However, relatively little is known about larval transport in very nearshore waters adjacent to coastlines that serve as locations of origin and settlement for larvae. We have previously presented velocity data from 5 cross-shore transects along the California margin that describe important features of the ‘coastal boundary layer’: a nearshore zone where mean, depth-averaged alongshore velocities attenuate. In particular, we have shown that velocities commonly increase logarithmically with distance from shore, much as they do in small-scale boundary layers that arise in pipes and over flat plates (i.e., the “law of the wall”). Further analysis indicates that coastal boundary layers form over ~24 hours and persist for at least weeks, time scales relevant for pelagic larval durations of a variety of marine taxa. At shorter time scales (<24 hours), coastal boundary layers exhibit lagged oscillations similar to those apparent in individual vertical depth profiles. Current efforts are directed at developing a physically consistent, mechanistic explanation for the observed patterns, focusing on simple mixing length theories and hydrodynamic analogies based on laboratory flow tank studies as points of departure. Regardless of the ultimate mechanisms responsible for creating coastal boundary layers, they have strong potential to reduce alongshore larval movement, and may interact with other features such as behavioral responses, recirculation zones, and obstructing aquatic vegetation (seagrass beds, mangroves, kelp forests) to elevate local retention.
LINEAR RESPONSES FROM NONLINEAR INTERACTIONS: WHY LINEAR MEASURES OF SPECIES INTERACTION STRENGTHS DO AND DO NOT SUFFICE.

Novak, Mark† UC Santa Cruz

Most predators exhibit nonlinear functional responses, their feeding rates becoming increasingly saturated as prey densities increase. Handling times limit their ability to feed on additional prey. Despite this inherent nonlinearity to predator-prey interactions, methods for estimating interaction strengths assuming linear functional responses have proven surprisingly useful for predicting the effects of experimental species manipulations, particularly in intertidal systems. If trophic interactions are nonlinear, why do species respond linearly? I used an observational method to measure the degree to which the feeding rates of two New Zealand whelks — Haustrum haustorium and H. scobina — are in fact saturated by their prey. Whelks require hours to days to handle their prey and therefore exhibit classic saturating functional responses when prey densities are manipulated experimentally. I also determine the extent to which prey attributes can be used to predict prey-specific contributions to the nonlinearity of a predator’s functional response, and investigate how a predator’s diet-richness affects the degree to which it’s overall feeding rate is reduced by handling-time saturation. My results indicate that under natural field conditions feeding rates are generally not strongly saturated, that most prey contribute little to their predator’s saturation, and that increasing diet-richness has a non-additive effect on a predator’s saturation such that the addition of prey reduces a generalist predator’s saturation level relative to that of a specialist. I thereby offer a unappreciated mechanism for why predator-removal experiments typically result in linear prey responses despite the inherent nonlinearity of their trophic interactions.

WARMING STRENGTHENS CONSUMER CONTROL ACCORDING TO GENERAL THEORY

O’Connor, M. I. † NCEAS

Climate change disrupts ecological systems in many ways. Many documented responses depend on species’ life histories, contributing to the view that climate change effects are important but difficult to characterize generally. However, systematic variation in metabolic effects of temperature across trophic levels suggests that warming may lead to predictable shifts in food web structure and productivity. We experimentally tested the effects of warming on food web structure and productivity under two resource supply scenarios. We found that warming strengthened consumer control of primary production when resources were augmented. Warming shifted food web structure and reduced total biomass despite increases in primary productivity in a marine food web. In contrast, at lower resource levels, food web production was constrained at all temperatures. These results demonstrate that small temperature changes could dramatically shift food web dynamics and provide a general, species-independent mechanism for ecological response to environmental temperature change. Moreover, these results are highly consistent with quantitative predictions based on the metabolic theory of ecology, suggesting that this general theory might inform a basic understanding of marine ecosystems as well as how they may change with biogeography and climate change.

† PATTERNS OF KELP COLONIZATION ON ARTIFICIAL AND NATURAL REEFS IN A SOUTHEAST ALASKAN GLACIAL FJORD

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Kelp dominated, rocky reefs in Southeast Alaska provide critical spawning, foraging, and rearing habitat for various fish and invertebrate species. Because of the potential impacts of proposed coastal road construction on nearshore, subtidal habitat, two artificial reefs composed of natural quarry rock were installed near Juneau, Alaska in December 2007. For the sake of comparison, artificial reefs were placed on barren sandy substrate within several meters of natural, kelp dominated reefs. This study 1) validated the use of selected natural reefs as control sites by conducting surveys of outlying natural reefs, 2) demonstrated that kelps can colonize bare space introduced between mid-summer and early-winter by introducing bare substrata at fixed intervals, and 3) compared patterns of initial kelp colonization on artificial reefs and natural reefs by surveying fixed plots and transects. Within six months of artificial reef installation, kelp recruits (< 6 cm tall) appeared on artificial reefs in much higher densities than on natural reefs. However, patterns of colonization varied spatially and differed dramatically by kelp species. Within 19 months adult Laminaria yezoensis and Saccharina bongardiana densities exceeded that on natural reefs; in contrast Agarum clathratum remains conspicuously absent despite high densities on adjacent natural reefs. Our results demonstrate the massive potential of understory kelps in Southeast Alaska to rapidly colonize artificial reefs. However, such potential remains highly species specific and the effects of competitive interactions with future colonizers and compensatory responses to dense colonization remain to be seen.
WHOLE-GENOME POSITIVE SELECTION IN SHALLOW AND DEEP-SEA URCHINS


We examined the protein coding genomes of two closely related Stronglocentrotid sea urchins to assay the extent of positive selection in the genome and identify targets of positive selection. In moving from the adult habitat of the intertidal Stronglylocentrotus purpuratus to the adult habitat of the deep-sea Allocentrotus fragilis, the world changes from light to dark, the temperature drops by ~10º C, and the hydrostatic pressure increases by ~ 100 atm. Their planktonic larvae, however share the pelagic environment, suggesting that environmentally driven selection would act more strongly on those proteins expressed as adults, than those expressed in the larval stage. We aligned 454 pyrosequencing reads of Allocentrotus fragilis to the 28,943 identified protein coding regions of Stronglylocentrotus purpuratus and calculated ratios of non-synonymous to synonymous substitutions for each non-overlapping alignment over 99 base pairs in length. Our comparison of 55,503 alignments across 20,541 genes shows that 3.02% have a significant overabundance of non-synonymous substitutions, suggesting that these genes have experienced positive selection. Using larval through adult time series of gene expression, we also show that genes expressed only as adults have a significantly higher median ratio of non-synonymous to synonymous substitutions (median Dn/Ds=0.30, p<2.2e-16) than any other expression category. This pattern of elevated Dn/Ds in adult transcripts is not restricted to reproductive genes, but is instead shared across a diverse set of functional categories. Panther gene ontology categories that were enriched for rapidly evolving genes include immune functions, gametogenesis, signal transduction, and cell structure.

POPULATION DYNAMICS OF FISH PREDATORS AND COMPETITORS OF A ONCE-ABUNDANT TROPICAL URCHIN, DIADEMA ANTILLARUM, OVER LARGE SPATIAL AND TEMPORAL SCALES

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The macro-herbivore community of the Caribbean experienced a dramatic change when the sea urchin, Diadema antillarum, an extremely abundant and effective reef grazer, experienced a region-wide mortality event in the early 1980s, removing 90-99% of all individuals. With few patchy exceptions, this urchin has failed to recover to any significant degree. This event has had a major impact on the coral reef community dynamics of the Caribbean, whose reefs are among the most threatened on the planet. Insight into the ecological interactions resulting from this event is critically needed in order to manage for the recovery of this ecosystem. We have compiled a Caribbean-wide dataset of reef fish and D. antillarum abundance over the past 50 yrs to examine two major questions regarding the dynamics of this die-off. Firstly, observations of an immediate response by the herbivorous fish community to the die-off were recorded – an expected effect of competitive release. Using meta-analysis, we examine whether this short-term effect translated into a persistent, long-term population-level response by herbivorous fish. Secondly, recent dynamic models indicate that recovery of D. antillarum is highly dependent upon predation pressure. We test empirically, within a meta-analytic framework, the degree to which spatial and temporal variation in abundance of fish predators has impacted urchin recovery.

† ASSESSING DECADAL-SCALE CHANGE IN BENTHIC COMMUNITY STRUCTURE: AN EXAMPLE FROM A NW MEDITERRANEAN CORALLIGENOUS COMMUNITY

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Marine coastal ecosystems worldwide are challenged by global change and local human impacts. Marine management and conservation in the face of such increasing pressures requires a better understanding of long-term responses. A major obstacle to assessing such long-term changes is the scarcity of continuous time-series. Yet, historical data are sometimes available, allowing for comparisons between present-day patterns and those expressed by ecosystems in the past. Using an historical comparative approach, however, requires that some challenges are overcome. In particular, historical data are often collected with obsolete techniques, low replication and inconsistent taxonomic resolution. We examined change over the past 50 years in coralligenous benthic communities from the NW Mediterranean Sea by using historical information available from 1959, 1991 and 1996, while attempting to address the above challenges. Comparing these data with new data we collected in 2008 highlighted major changes in benthic community structure between 1996 and 2008, but not among previous years. Gorgonians (dominant until 1996) nearly disappeared at depths shallower than 25 m and were replaced by algal turfs and the invasive species Caulerpa racemosa, whereas no major changes were detected at greater depths (25-45 m). Such drastic changes may have been caused by positive thermal
anomalies recorded in 1999 and 2003 and, the concomitant shoaling of the summer thermo-cline to shallower depths, though cause-effect relationships should be considered with caution. Comparing present-day patterns with historical data proved to be a useful approach to describing and interpreting previously undocumented long-term changes.

† SWIMMING PERFORMANCE, AS INDICATED BY \( U_{\text{crit}} \) AND \( C\)-START ESCAPE RESPONSES, IN SURFPERCHES (EMBIOTOCIDAE)
Perlman, B.M.† Moss Landing Marine Laboratories
Surfperches are enigmatic labriform swimmers. Angle of insertion of the pectoral fin varies among species and theoretically allows for differing amounts of thrust to be generated, putatively affecting swimming performance. We predicted that speed and maneuverability trade-off in this clade of nearshore fishes. Specifically, we hypothesized that surfperches with lower fin angles would achieve a faster critical swimming speed \( U_{\text{crit}} \), but were less maneuverable, as indicated by bending during the C-start escape response. To address this hypothesis, we collected four surfperch species each with different pectoral fin angles (range: 35 to 51°). \( U_{\text{crit}} \) was measured in a flume. After acclimation, flow was set to 0.5 body lengths per second (BL/s) for 30 minutes, then increased by 0.25 BL/s every five minutes until \( U_{\text{crit}} \) was reached, as indicated by the onset of burst-and-glide behavior. We recorded maximum fin beat frequency and \( U_{\text{crit}} \). In separate experiments, we elicited C-starts from individual fish, recording the escape response with a high-speed digital camera at 250 fps. We measured maximum angle of body curvature during Stage 1, duration of Stage 1, duration of C-start escape response, escape trajectory angle (ETA), and peak angular velocity. ANOVA revealed differences among species in that surfperches with lower fin angles achieved a faster \( U_{\text{crit}} \) and a higher maximum fin beat frequency. For the five C-start variables, we conducted a PCA to reduce the dimensionality of the dataset. PC1 described duration and angle of Stage 1 and ETA. PC2 described C-start duration and peak angular velocity. ANOVA performed on these PCs revealed that species with lower fin angles turned faster and had greater body bending. Contrary to our prediction, species with lower fin angles reached both faster \( U_{\text{crit}} \) and greater body bending than species with higher fin angles.

† THE PURPLE SEA URCHIN GENOME SUGGESTS LOCAL ADAPTATION ALONG A LATITUDINAL GRADIENT DESPITE HIGH GENE FLOW.
Pespeni, M. H.†, Oliver, T. A., and S. R. Palumbi Hopkins Marine Station of Stanford University
Identifying adaptive genes is a central challenge in evolutionary biology, especially when high dispersal disrupts the signal of local adaptation. Here we develop a method for identifying polymorphisms and genotyping individuals with >99% accuracy and scan the genome of a species with a highly open population structure, the sea urchin *Strongylocentrotus purpuratus*. We assayed 50,935 loci, identified 12,431 polymorphisms, and found approximately 100 - 300 (1 - 2.5%) with greater than expected divergence. Gene ontology and stage-specific expression data show a greater proportion than expected of these diverged genes act strictly during larval development. These results suggest that adaptive evolution in purple urchins occurs across a small but significant fraction of the genome and point to early life history stages as critical places to search for the action of environment on fitness.

CONSEQUENCES OF SMALL WORLD CONNECTIONS AND ALLEE EFFECTS ON THE PERSISTENCE OF MARINE PROTECTED AREAS
Peña, T.S.†, Gonzalez, L.I., and T.H. Keitt University of Texas at Austin
Marine protected areas (MPAs) protect biodiversity and endangered economically important species, but some stocks have not yet recovered from depletion even after the creation of MPAs. We present a metapopulation approach to explore processes that can influence recovery and persistence of marine benthic subpopulations off the California central coast. We use a small world network to simulate connectivity patterns between subpopulations, and include fishing pressure with extinction of adults, Allee effects, and local retention of larvae. In a non-MPA scenario, all subpopulations may go extinct under a potential Allee effect, especially when local retention is high, subpopulations are well connected, and connections between subpopulations are more random. In a MPA scenario, protected subpopulations can persist even with Allee effects. However, under a strong Allee effect, persistence of these protected subpopulations decays due to poor local retention, limited connections among subpopulations, and high stochastic connectivity. Current MPA design appears to allow for the persistence of subpopulations under most cases.

† GENETIC SCALES OF LARVAL DISPERAL IN FISH: ARE THEY COMPATIBLE WITH SELF-RECRUITMENT?
Pinsky, M. L.†, and S. R. Palumbi Stanford University
Estimates of larval dispersal distances are important for understanding population dynamics and for successful marine spatial management. Most genetic methods suggest that long-distance dispersal is common in marine species, while recent accounts of high self-recruitment imply dispersal may instead be surprisingly local. These seemingly discordant views impede progress in understanding larval dispersal scales. In this study, we developed fine-scale genetic estimates
of dispersal for comparison to previously published self-recruitment studies. We genotyped populations of Clark’s anemonefish (*Amphiprion clarkii*) at 13 microsatellite loci and uncovered isolation by distance patterns that suggested limited dispersal in two replicate transects. We developed three estimates of local effective density (10 to 125 adults/km) using temporal changes in allele frequencies between generations and from ecological census data. Applying these effective densities with isolation by distance theory suggests that larval dispersal kernels in *A. clarkii* have a spread of 8-29 km. These kernels predict low fractions of self-recruitment in continuous habitats. However, the same kernels predict 15-50% self-recruitment when realistic levels of habitat patchiness are considered. These self-recruitment fractions match closely to previously published estimates in *Amphiprion*. Our results suggest that larval dispersal can be estimated with widely available genetic methods when effective density is measured carefully, and that self-recruitment studies should be interpreted in light of habitat patchiness.

† **UNRAVELING PATTERNS OF NEARSHORE SUBTIDAL COMMUNITY STRUCTURE AND ENVIRONMENTAL VARIABILITY IN THE SOUTHEAST ALASKA ARCHIPELAGO**

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An archipelago of many islands separates the outer coast and mainland coast of southeast Alaska creating a nearshore marine environment with varied ocean and terrestrial influence. Unraveling patterns of subtidal community structure at shallow (< 20 m) nearshore locations may reveal how environmental variability shapes southeast Alaska marine ecosystems and how environmental change in the North Pacific might affect future regional patterns. We define and compare patterns of community structure, benthic habitat, and physical oceanographic conditions at mainland and outer coast locations in southeast Alaska using SCUBA surveys, CTD casts and subtidal moorings. Major physical oceanographic gradients differed between coastal locations; salinity was higher at outer coast sites while temperature was warmer at mainland coast sites. Habitat variables of substrate and macroalgal composition were incorporated using PCA. Faunal assemblages varied between locations along gradients of salinity, temperature, and benthic habitat as described by DCA with vector permutation analysis of environmental variables. Certain species were distinct outer coast inhabitants such as red urchin (*Strongylocentrotus franciscanus*), top snails (*Calliostoma spp.*) and black rockfish (*Sebastes melanops*), whereas several species were not obligate to either location, including the echinoderms, *Pycnopodia helianthoides* and *Parastichopus californicus*, and the anemone *Metridium farcimen*. Species only detected on the mainland coast included Pacific lyre crab (*Hyas lyra*), several hermit crabs (*Elassochirus spp.*), and the seastars, *Evasterias troschelii* and *Leptasterias hexactis*. Our study identifies subtidal community structure between coastal subregions in southeast Alaska. We establish a meaningful baseline for comparison to ecosystems shifts in the Alaskan North Pacific.

† **BIOGEOGRAPHIC VARIATION IN ABUNDANCE, HABITAT USE, AND BEHAVIOR OF THE EUROPEAN GREEN CRAB, CARCINUS MAENAS.**

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The focus of this study was to quantify variation in invasion of a single invader, the European green crab, *Carcinus maenas*, across a broad biogeographic scale. We tested two hypotheses: 1) Do individual and population level indicators of invasion success i.e. abundance, size, behavior indicate more success in invaded than native ranges? 2) Are green crabs more successful in estuaries than on open coast? The objective of this study was to measure parameters describing invasive green crab populations and characterize variation in native and invaded ranges. We sampled the native range of *C. maenas*, the European Atlantic coast, and the invaded ranges the US Atlantic Coast and US Pacific Coast, invaded approximately 200 and 20 years ago respectively. On each coast, we measured individual traits (e.g. average and maximum carapace width, intra- and interspecific aggression) in addition to population traits (e.g. relative abundance, size distribution and habitat use (open coast vs. estuaries), and the ratio of native to invasive crabs. Results include four key findings regarding *C. maenas*: 1) Average carapace width is significantly greater on the US Pacific Coast than on the US and European Atlantic Coasts; 2) Intraspecific aggression is lower on the US Atlantic Coast than in the native range or on the recently invaded US Pacific Coast; 3) Abundance is significantly lower on the US Pacific coast than on the European and US Atlantic coasts; 4) Habitat use is limited to estuaries on the US Pacific coast but not on the European and US Atlantic coasts.

† **LIMITED DISPERSAL DESPITE HIGH DISPERSAL POTENTIAL: THE FINE SCALE POPULATION STRUCTURE OF PATIRIA MINIATA IN THE SOUTHERN CALIFORNIA BIGHT**

Puritz, J B* and R J Toonen Hawaii Institute of Marine Biology, University of Hawaii at Manoa

The bat star, *Patiria miniata*, is a common, omnivorous sea star found in the shallow coastal waters of California. Dioecious broadcast spawners, bat stars have a 6-10 week planktonic larval stage. Despite this high dispersal potential, previous phylogeographic analyses of *P. miniata* (Keever et al. 2009) detected significant population structure across
CHARACTERIZING SYMBIODINUM DIVERSITY AND HOST SPECIFICITY IN THE CORALS OF MOOREA, FRENCH POLYNESIA
Putnam, H.M.1, Stat, M., Pochon, X., and R.D. Gates University of Hawaii at Manoa
The taxonomic composition of the communities of Symbiodinium harbored by corals is implicated as a factor driving the response of corals to environmental stress. This study describes patterns of Symbiodinium diversity in the reef-building corals of Moorea, French Polynesia with the goals of (1) building capacity to monitor changes in Symbiodinium diversity in the corals over time, and (2) providing context for hypothesis driven research aimed at identifying traits in coral symbioses that associate with environmental performance. In April 2007, 132 coral fragments representing 34 coral species from 14 genera and 7 families were collected from the fringing, lagoon, and forereef habitats. Symbiodinium were genotyped using cloning and sequencing of the nuclear rDNA Internal Transcribed Spacer (ITS2) region. 1245 sequences were recovered, comprising 72 unique sequence types. Most corals hosted Symbiodinium from clades A, C, and D; clades F and G were rare. The greatest number of sequence types was found in clade C (59), with clades D and A contributing 7 and 4 to the total, respectively. Folding of the ITS2 RNA secondary structure collapsed the sequences into 17 groupings (9, 4, and 2 in clades C, D and A, respectively). The Pacific wide patterns of clade C dominance are maintained in the corals of Moorea, however, novel associations were found between generalist hosts (i.e. Acropora sp.) and new Symbiodinium sequence types. Further, Symbiodinium C15, a type previously reported as specific to the genera Porites and Montipora, is also found in the genera Leptoseris and Fungia in Moorea.

COMPARISONS OF BAITING AND TRAPPING PROTOCOLS INSIDE AND OUTSIDE OF MARINE PROTECTED AREAS ALONG CALIFORNIA'S CENTRAL COAST
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Marine Protected Areas (MPAs) are useful for the management of fish populations, but often baseline population data from these areas are lacking. Without baseline data it is difficult to attribute differences between an MPA and an adjacent area due to the MPAs establishment alone. From 2004-2008 and 2008-2009 Cal Poly University researchers conducted two separate tag and recapture studies of nearshore fish populations along California’s central coast. Sampling protocols of these studies differed in bait used and size of commercial fish trap. Commercial fishing protocols were used in the 2004-2008 study, while scientific fishing protocols were used in the 2008-2009 study. In 2009 an experiment was conducted to simultaneously compare the different trapping and baiting protocols from the prior studies. Our objective was to find a conversion factor that related catch per unit effort (CPUE) and length frequency distributions between the two studies and thus provide a means connect the two data sets for stock assessments and baseline MPA monitoring. Our sampling showed no significant difference in mean fish length between the two protocols for the five most common nearshore fish species captured, and four of the five species showed no significant difference in CPUE. One species, the cabezon (Scorpaenichthys marmoratus), showed a significantly higher CPUE (1.8x) using the commercial fishing protocols compared to the scientific fishing protocol. These findings provide a means of maintaining data continuity across the entire sample region and inclusion of earlier projects in the analyses of nearshore fish populations of the region.

THE VALUE OF SPATIAL INFORMATION IN MPA NETWORK DESIGN
Rassweiler, A1, Costello, CJ, and DA Siegel UC Santa Barbara
The science of spatial fisheries management, which combines ecology, oceanography, and economics, has matured significantly. As a result, there have been recent advances in exploiting spatially explicit data to develop spatially explicit management policies, such as networks of Marine Protected Areas (MPAs). However, when data are sparse, spatially explicit policies become less viable, and we must instead rely on blunt policies such as total allowable catches or imprecisely configured networks of MPAs. Therefore, spatial information has the potential to change management approaches, and thus has value. We present a general framework within which to analyze the value of information for spatial fisheries management and show examples of how it might be applied to fisheries in southern California. We find
that improved spatial information can increase value significantly (>10% in our simulations), and that it dramatically changes the efficient management approach - switching from diffuse effort everywhere to a strategy where fishing is spatially targeted, with some areas under intensive harvest and others closed to fishing. Using all available information, even when incomplete, is essential to management success, and may as much as double fishery value relative to using assumptions commonly invoked in the literature.

**EFFECTS OF SEA OTTERS ON LOCAL DISTRIBUTION AND DENSITY OF BLACK ABALONE**

Reinhard, L.J., Ammann, K.N., Tinker, M.T., and P.T. Raimondi

Black abalone have recently received protection under the US Endangered Species Act, following a population crash in the southern half of their range. Years of over-harvest and a devastating outbreak of disease have left patchy remnant populations. A major predator, the Southern sea otter, is showing signs of recovery and range expansion following years of federal protection. Along with illegal human harvest, predation by sea otters could affect the recovery of black abalone in areas where disease has dramatically reduced populations and reduce numbers in unaffected areas. One important step in assessment of an endangered species is establishing critical habitat. For most abalone species, including black abalone, these are areas with deep, narrow crevices, which may offer abalone refuge from otter predation. In this study, we examined the relationship between the microhabitat distribution of black abalone and local sea otter density at 13 sites along the central California coast. We found a shift in local distribution to deeper cracks where local otter densities were high. We also found that abalone density was associated with increasing quality of habitat and, very importantly, with higher otter densities. This unexpected result demonstrates that densities of black abalone are greater but shifted to deep cracks and crevices with increasing densities of otters. This may suggest that both otters and black abalone are associated with certain geomorphological features (i.e. cracks and crevices) or more intriguingly, that otters enhance habitats for abalone by fostering local production of abalone food (kelp) through predation on sea urchins.

† **TROPICAL FROSTBITE: THE IMPACT OF LA Niña BLEACHING ON FINGER CORAL-ASSOCIATED FAUNA**

Rhoades, O.K., Witman, J.D., and M. Brandt

Disturbances that impact foundation species affect the structure and dynamics of dependent assemblages. In the Galápagos, the La Niña cooling event of 2007/2008 resulted in extensive stress-related bleaching and death of *Pocillopora* corals. We examined the impact on mobile invertebrates and fish associated with these coral heads, at three time points: 6 months, 1 year, and 18 months after the bleaching event. Six months after bleaching, live corals hosted a richer assemblage of invertebrates and fish relative to dead corals. One year after bleaching, invertebrate and fish richness significantly increased on dead corals, such that dead corals hosted more species than live corals. Eighteen months after bleaching, dead corals still hosted a richer assemblage of invertebrates; however, fish richness lessened on dead corals and was statistically indistinct from that of live corals. Moreover, one year after bleaching, species composition differed between live and dead corals: fish and specialist crabs dominated live corals, while predatory snails were more abundant on dead corals. Only on live corals was surface area tightly correlated with species richness, suggesting that other habitat variables impact species richness. Overall, the disturbed community of dead corals exhibited an inflation in species richness or ‘biodiversity surplus,’ characterized by a loss of specialists and residents, and a gain of a rich assemblage of generalists, including 14 species of predatory snails. As evidenced by the reduction in species on dead corals over the last six months, this surplus is ephemeral, and reliant on the habitat provided by these deteriorating calcareous structures.

**NATIVE SNAIL DISPROPORTIONATELY VULNERABLE TO PREDATION BY INVASIVE PREDATOR**

Ridlon, A.D., Weiskel, H.W., and E.D. Grosholz

Our study examined predation on the native horn snail *Cerithidea californica* and the invasive mud snail *Ilyanassa obsoleta* from San Francisco Bay, California. While the competitive dynamic between these species has been studied locally, relatively little is known about the influence of predation upon those dynamics. The European green crab, *Carcinus maenas*, is a recent invader in the bay that is known in its established invasive ranges to prey upon a variety of snail species. We expected that *C. californica* would be more vulnerable to *C. maenas* predation than *I. obsoleta*, due to morphology (it has a comparatively thin and elongated shell), and that both species would be more vulnerable to predation at pre-reproductive sizes. In laboratory experiments, *C. maenas* were offered native and invasive snails in equal densities at one of two size classes: pre-reproductive (8-13 mm spire length) and reproductive (15-25 mm spire length). Pre-reproductive snails had lower survivorship than their reproductive counterparts, suggesting a size refuge for snails of reproductive status for both species. *C. californica* was more often successfully preyed upon than *I. obsoleta* irrespective of size class, and was most successfully preyed upon by male *C. maenas*, indicating a greater predation
pressure for the native snail. Reproductive *I. obsoleta* maintained high survivorship throughout the experiment, showing the least amount of vulnerability to predation. These results indicate that the San Francisco Bay population of *Cerithidea californica*, already facing competitive displacement by *Ilyanassa obsoleta*, is further beleaguered by greater vulnerability to a second, predatory invader.

**ABALONE AS ECOSYSTEM INDICATORS: ARE "BAD" YEARS "GOOD" FOR ABALONE?**
Rogers-Bennett, L.  Bodega Marine Lab and California Department Fish and Game

Marine populations can be used as indicators of marine ecosystem productivity yet conditions that are good for one species may not be good for others. Cold, upwelling favorable conditions in the California Current have been linked to salmon, rockfish and seabird productivity however sardines do best in warm years. Here we examine red abalone reproduction over 9 years in northern California looking at gonad index 4 times per year and recruitment inside recruitment modules once per year. We track sea water temperature at 10m over the time series. We find that during the warmest two periods in the record, gonad index remains low and spawning appears to occur when temperatures drop from warm to cold. High gonad indexes were not followed by high recruitment. A peak in recruitment to the young of the year size class (3-20mm) occurred only once in the 9 year record in 2005. This year was characterized by warm water with poor upwelling early in the season and an exceptionally late spring transition. In 2005, Coho salmon survival was poor and there was total reproductive failure for Cassin’s auklets. Our conceptual model of recruitment for abalone with non-feeding, short lived larvae (5-7days) suggests recruitment may be enhanced when upwelling and offshore advection are diminished during the spawning season. Biological indicators of marine ecosystems need to be diverse representing divergent larval dispersal strategies and life histories.

† **COMPETITION BETWEEN PISASTER OCHRACEUS AND EVASTERIAS TROSCHELIi IN PUGET SOUND**
Rogers, T.L.*, and J.K. Elliott  University of Puget Sound
Community impacts of *Pisaster ochraceus* have been studied primarily in solid rock habitats on the outer coast and the San Juan Islands, but less is known about the sea star’s use of alternative habitats or interactions with potential competitors in central and south Puget Sound. Although documented to compete with *Leptasterias hexactis*, *P. ochraceus* also co-occurs intertidally with *Evasterias troschelii*, a common, large sea star with a very similar diet. To determine if competition occurs between these species, we surveyed the relative abundances and sizes of *E. troschelii* and *P. ochraceus* in five intertidal habitat types in Puget Sound and the San Juan Islands: sand/small cobble, cobble, rock, pilings, and floating docks. Habitat types with optimal food resources (i.e. mussels on docks and pilings) had a greater proportion of *P. ochraceus*, suggesting partial exclusion of *E. troschelii* in optimal habitats. Average sea star size (mass and arm radius) was larger on docks and pilings, perhaps because of greater food resources and time available for foraging. The mean mass of *P. ochraceus* was always larger than *E. troschelii* for a given habitat, which may provide *P. ochraceus* an advantage in competitive interactions. Observations of behavioral interactions between equally sized *E. troschelii* and *P. ochraceus* in the lab suggested that *P. ochraceus* is dominant and uses its abundant pedicellariae to drive away *E. troschelii*. Thus, we conclude that aggressive behaviors by large *P. ochraceus* may cause *E. troschelii* to be less abundant in habitats with optimal types of food resources (i.e. mussels).

**UNDERSTANDING DIFFERENTIAL RECOVERY RATES OF DIADEMA ANTILLARUM IN THE CARIBBEAN**
Rogers, A1,2, Paddock, M, J2, and K Lorenzen 1 - Imperial College London 2 - Simon Fraser University
Population recovery of the Caribbean long-spined sea urchin *Diadema antillarum* following the 1983 mass mortality event has been unexpectedly slow and patchy. We report estimated current rates of population recovery at spatial scales ranging from country boundary to individual reef and discuss the difficulties associated with choosing the right spatial scale for analyses. Rates of recovery are used in a meta-analysis to look for patterns associated with conspecific Allee effects and environmental factors including fish abundance and habitat complexity. A size-structured population dynamic model for *D. antillarum* suggests that population recovery is highly dependent on predation pressure and where predation is high, on the availability of predation refuges, both in the form of a conspecific spine canopy and natural or cultivated reef habitat complexity. This study aims to test predictions gained from modelling by compiling a database of urchin population densities recorded across the region over the past 50 years and exploring how environmental factors, including predatory fish abundance and habitat complexity, affect *D. antillarum* densities and recovery dynamics. Results show that urchin population densities are clearly linked with fishing pressure supporting the theory that predation pressure has the potential to drive the systems dynamics.

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† HOW POP-EYE FROM BAROTRAUMA AFFECTS VISION IN ROCKFISH (SEBASTES SPP.)
Rogers, B.L.*, Lowe, C.G., and E. Fernandez-Juricic CSU Long Beach
Rockfish (Sebastes spp.) populations along the Pacific Coast have declined due to recreational and commercial harvest impacts, in addition to their susceptibility to injuries from rapid decompression (barotrauma). When brought up from depth, their gas-filled swim bladder organ over-inflates causing stomach eversion, tissue embolisms, and pop-eye (exophthalmia). Recent research shows that rockfishes recompressed to depth can survive the effects of barotrauma, but it is unknown whether pop-eye can negatively affect their vision and long-term fitness. Rockfishes with pop-eye were captured, recompressed in hyperbaric chambers, brought slowly to surface pressure over 4 days, and then tested using a behavioral optokinetic test. The test assesses their vision using moving stimuli of black-and-white vertical bars that can be interleaved with bars of subsequently smaller resolution. Five species of rockfishes responded positively to all six levels of visual testing. Rockfishes assessed again one month later, showed significant increase in the overall frequency of fixational eye movements at all resolution levels. Although pop-eye shows extreme eye protrusion, along with stretching of the optic nerve, behavioral vision tests show minimal visual impairment after 4 d post-trauma and significant improvement (~30 d post-trauma), with no evidence of blindness or critical impairment. Pop-eye appears to be a recoverable injury for recompressed rockfishes.

† RECRUITMENT STRATEGIES OF THE EPHEMERAL, OPPORTUNISTIC MACROALGAE ULVA AND PORPHYRA IN CENTRAL CALIFORNIA
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Ephemeral algae are early colonizers of the rocky intertidal after a disturbance, although the mechanism of early colonization (including benthic microscopic stages and waterborne propagules) is poorly known. Recruitment of ephemeral macroalgae was studied in two types of disturbance manipulations (partial removal where all macroscopic organisms were removed v. complete removal where all macro-and microscopic organisms were removed) and an un-manipulated control at two intertidal heights (high zone and low zone). Replicate disturbances were created in August 2007, November 2007, January 2008, and May 2008 and were monitored until August 2008 on a rocky bench north of Pigeon Point, CA. Ulva colonization by waterborne propagules (complete removals) was observed throughout the year, while Porphyra was restricted to spring recruitment, as expected due to temporal cues (changes in photoperiod) regulating propagule availability. Peak Ulva responses varied in treatments as a function of timing of clearing while peak Porphyra responses varied in locations as a function of timing of clearing. Location and interactions with location (heterogeneity among zones) explained most of the variability in early colonization. Fall and winter clearings experienced opposing responses by Ulva and Porphyra in each zone. Further experimentation is needed to rule out a negative interaction between Ulva and Porphyra in fall and winter disturbances.

† LIMITED DISPERAL OR NATURAL SELECTION? POPULATION GENETIC STRUCTURE IN A NEW ZEALAND BIVALVE.
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For many marine benthic invertebrates dispersal over large distances is only possible during a planktonic larval phase. Understanding dispersal patterns is critical for predicting a population’s response to human activities and environmental change, as resilience or recovery will depend on recolonisation from neighbouring intact habitats. Estuaries provide an opportunity to study the mechanisms that influence gene flow between populations, as they are spatially discrete habitat units with hydrographic barriers that limit dispersal. Here, we examine inter-estuary dispersal and population genetic structure of the cockle Austrovenus stutchburyi, a suspension feeding bivalve endemic to sheltered harbours and estuaries throughout New Zealand. Considerable genetic variation was observed in Austrovenus COI sequences from 25 sites with 106 haplotypes recorded from 311 samples. Population structure was observed at several spatial scales with differences apparent between northern and southern populations and populations on the subantarctic Auckland Islands. In contrast to previous New Zealand studies in which boundaries between subpopulations were well defined and hydrodynamic features inferred as possible dispersal barriers, in Austrovenus populations the relative abundance of haplogroups varied between northern and southern across a latitudinal gradient. It is therefore unclear whether these patterns are due to limited dispersal among regions or environmental differences. Further research using DNA fingerprinting will test specific hypotheses regarding the importance of natural selection, hydrodynamics, and recruitment variation in determining the genetic structure of populations and patterns of connectivity amongst New Zealand’s estuaries.

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MANIPULATIVE EXPERIMENTAL APPROACHES. These approaches examine ecological patterns and processes through data represented by observations. Sagarin, R. D.

A RETURN TO OBSERVATIONAL ECOLOGY

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SIZE-STRUCTURED MATRIX POPULATION MODELS CAN BE EXTREMELY USEFUL TO DESCRIBE THE DYNAMIC OF SPECIES, SUCH AS ABALONES, THAT SHOW SIZE-DEPENDENCY IN LIFE-HISTORY TRAITS SUCH AS MORTALITY AND FECUNDITY. THE CALIBRATION OF SUCH MODELS, HOWEVER, IS OFTEN DIFFICULT DUE TO THE UNCERTAINTY IN THE ESTIMATION OF DEMOGRAPHIC PARAMETERS. GROWTH RATES OF ABALONES ARE GENERALLY DESCRIBED BY VON BERTALANFFY PARAMETERS OBTAINED FROM LINEAR REGRESSION OF LENGTH-INCREMENT DATA. THE AVAILABLE DATA ON GROWTH OF THE GREEN ABALONE HALIOTIS FULGENS, HOWEVER, SHOW HIGH VARIABILITY ESPECIALLY IN THE SMALL SIZE CLASSES AND AN ACCELERATION OF GROWTH RATES IN THE JUVENILE STAGES, MAKING SUCH DETERMINISTIC, MONOTONICALLY DECREASING CURVES UNSUITABLE TO DESCRIBE THEM. FOLLOWING BARDOS ET AL. (2005), WE PERFORM A MAXIMUM LIKELIHOOD ESTIMATE OF A PROBABILISTIC GOMPERTZ MODEL, WHICH EFFICIENTLY CAPTURES THE DISTRIBUTION AND VARIABILITY OF THE DATA. USING THE FITTED PARAMETERS, WE CONSTRUCTED A TRANSITION MATRIX (I.E. A MATRIX OF THE PROBABILITY THAT INDIVIDUALS IN A GIVEN CLASS RECRUT TO THE FOLLOWING ONE) THAT EXPLICITLY INCORPORATES PLASTICITY IN BODY GROWTH. THE MEXICAN ABALONE FISHERY SUFFERED SEVERE DECLINES IN THE LAST 30 YEARS, WITH CURRENT CATCHES LESS THAN 10% OF THE MAXIMUM RECORDED. WE ARE INTEGRATING OUR RESULTS IN A MODEL FOR H. FULGENS TO EXPLORE THE EFFICACY OF DIFFERENT MANAGEMENT STRATEGIES IN PROMOTING THE POPULATION AND FISHERY RECOVERY IN BAJA CALIFORNIA. THE DECLINE IN ABALONE STOCKS REQUIRES IN FACT THE URGENT ADOPTION OF NEW STRATEGIES BASED ON A MORE PRECISE DESCRIPTION OF THE SPECIES DEMOGRAPHY.

RESILIENCE OF INTERTIDAL EELGRASS (ZOSTERA MARINA) TO DIFFERENT TYPES AND MAGNITUDES OF DISTURBANCE

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ZOSTERA MARINA (EEGLASS) FORMS EXTENSIVE MONOCULURE MEADOWS, WHICH, WHEN DISTURBED, MAY RECOVER THROUGH BRANCHING OF RHIZOMES OR SEED GERMINATION. IN THIS STUDY, WE RECORDED THE RESPONSE OF Z. MARINA TO TWO TYPES OF EXPERIMENTALLY-IMPOSED DISTURBANCES IN SMALL-SCALE PLOTS (2X2 M). AT TWO TIDAL ELEVATIONS (+0.6 M AND -0.3 M RELATIVE TO MEAN LOWER LOW WATER), WE ESTABLISHED A CROSSED DESIGN OF SHOOT THINNING (35% REMOVAL) AND MONTHLY CUTTING ABOVE THE LEAF SHEATH. CUTTING INITIALLY REDUCED RELATIVE GROWTH RATE BY 19%, FOLLOWED OVER 3 MONTHS BY SMALLER SHOOT SIZES, BUT DID NOT CAUSE SHOOT MORTALITY. THINNED PLOTS MATCHED CONTROL DENSITIES BY 3 MONTHS. IN A SECOND EXPERIMENT, ALSO ESTABLISHED AT TWO TIDAL ELEVATIONS, WE THINNED VEGETATIVE SHOOTS TO TWO LEVELS (50%, 75% REMOVAL), CROSSED WITH ONETIME CUTTING. CUT PLANTS PRODUCED FEWER BRANCHES (16%) THAN UNTHINNED (32%), WHEREAS THINNED PLOTS HAD HIGHER PER CAPITA BRANCHING (34% UNDER HIGHEST THINNING VS. 14% IN CONTROL) AND PRODUCED LARGER SEEDLINGS (5.6 MM SHEATH WIDTH VS. 4.6 MM IN CONTROLS). EEGLASS AT ITS UPPER LIMIT, WHICH LIKELY EXPERIENCED DESICCATION STRESS, RESPONDED AS IF “CUT”, WITH SMALLER SIZES AND RELATIVE GROWTH RATES, BUT NO DIFFERENCE IN DENSITY COMPARED TO LOWER ELEVATION. OVERALL, THESE STUDIES OF Z. MARINA DEMONSTRATE MECHANISMS OF RESILIENCE AT BOTH SHOOT AND WHOLE-POPULATION LEVELS THAT CAN CONTRIBUTE TO MAINTENANCE OF INTERTIDAL EELGRASS DESPITE SHOOT DAMAGE.

† INTRA-SPECIFIC COMPETITION AS AN AGENT OF MORPHOLOGICAL SELECTION

Ryan, C.A.†, and S.R. Dudgeon  CSU NORTHRIDGE

IN POPULATIONS WHERE MORPHOLOGICAL VARIABILITY IS CORRELATED WITH COMPETITIVE ABILITY, INTRA-SPECIFIC COMPETITION CAN ACT AS A SELECTIVE FORCE TO INCREASE THE PRESENCE OF THE MORE COMPETITIVE MORPHOTYPE. WE PERFORMED A FIELD EXPERIMENT TO TEST THE IMPORTANCE OF THIS TYPE OF COMPETITION IN THREE POPULATIONS OF HYDRACINTHIA SYMBIOLONGICARPUS, A COLONIAL HYDROZOAN WHICH ENCROSTS ON THE BACKS OF HERMIT CRABS ON THE MUDFLATS OF THE GULF OF MAINE. INDIVIDUAL COLONIES HAVE BEEN SHOWN TO HAVE DISCRETE MORPHOTYPES BASED ON THE AMOUNT OF “BRANCHINESS” OF THEIR VASCULAR TISSUE, AND THESE MORPHOTYPES HAVE BEEN SHOWN TO HAVE DIFFERENT COMPETITIVE ABILITIES IN INTRA-SPECIFIC BATTLES FOR SPACE, WHICH IS A LIMITED RESOURCE. THUS, WE WOULD EXPECT THAT INTRA-SPECIFIC COMPETITION WOULD LEAD TO SELECTION FOR THE MORE COMPETITIVELY DOMINANT MORPHOTYPE. A PREVIOUS STUDY TESTING THIS HYPOTHESIS SHOWED SUPPORT FOR THIS IDEA, HOWEVER ASSUMPTIONS MADE IN THE EXPERIMENTAL DESIGN WEAKENED THE CONCLUSIVE POWER OF THE TEST. IN OUR EXPERIMENT, WE FOUND NO EVIDENCE OF AN EFFECT OF COMPETITION BETWEEN INDIVIDUALS ON THE DISTRIBUTION OF MORPHOLOGIES IN THE POPULATION, INDICATING THAT INTRA-SPECIFIC COMPETITION FOR SPACE MAY NOT BE A FACTOR DRIVING DIRECTIONAL MORPHOLOGICAL SELECTION. OUR FINDINGS HIGHLIGHT THE IMPORTANCE OF OTHER, NON-COMPETITION BASED, ENVIRONMENTAL FACTORS WHICH MAY DISCRIMINATE BETWEEN MORPHOLOGIES AND INFLUENCE MORPHOLOGICAL EVOLUTION IN THESE COLONIAL HYDROZOANS.

A RETURN TO OBSERVATIONAL ECOLOGY

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ECOLOGY HAS ENTERED INTO A DYNAMIC PERIOD, DRIVEN BY BOTH THE URGENCY OF LARGE-SCALE ECOCLOGICAL PROBLEMS AND STARTLING NEW ECOCLOGICAL FINDINGS THAT ARE BEING SHARED BROADLY BEYOND THE SCIENTIFIC COMMUNITY. BOTH OF THESE FACTORS ARE WELL REPRESENTED BY OBSERVATIONAL APPROACHES TO ECOLOGY, WHICH ARE RE-EMERGING AFTER A LONG PERIOD OF DEFERENCE TO MANIPULATIVE EXPERIMENTAL APPROACHES. THESE APPROACHES EXAMINE ECOCLOGICAL PATTERNS AND PROCESSES THROUGH DATA
gathered in situations where nature has not been purposefully manipulated. The use of unmanipulated observational data reflects on the work of early naturalists, but is greatly enhanced by technological advances in remote sensing, microscopy, genetics, animal-borne sensors, and computing. Once dismissed as merely “exploratory”, strictly observational approaches to ecology have demonstrated capability in testing hypotheses by correlating variables, comparing observed patterns to output from existing models, exploiting natural experiments, and simulating experiments within large datasets. These approaches can be used in a stand-alone fashion, but are strengthened when reconciled with experimental manipulations to isolate fine-scale ecological mechanisms. This shift in ecology also represents a shift toward a more open and participatory form of science, which raises its own challenges and opportunities.

**CASCADING EFFECTS OF PREDATOR DEPLETION CAN ALTER KEY ECOLOGICAL PROCESSES AND THE RESILIENCE OF A KELP FOREST ECOSYSTEM**

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The relative role of top-down versus bottom-up forces in structuring fished ecosystems has been the subject of controversy. Currently, much of the evidence for top-down effects of fishing has been dominated by observational studies, yet, inferring species interactions from changes in species abundances over time is risky business because simple correlations cannot distinguish trophic interactions from species associations. We help clarify this problem in a kelp forest ecosystem by directly measuring variation in key ecological processes (predation and grazing rates) as a function of predator and prey density and regional oceanographic context. In kelp forests surrounding the Channel Islands, California, per capita predation rates on a key grazer, the purple sea urchin Strongylocentrotus purpuratus, vary non-linearly as a function of both sea urchin and predator density and predator assemblage. Per capita grazing rates by purple sea urchins vary as a function of a ratio between kelp and urchin density. To illuminate the extent to which the loss of predators from this system renders it more or less resilient to a common external perturbation (El Niño Southern Oscillation events), we quantified 3 metrics of community stability using first-order multivariate auto-regressive (MAR-1) models of a twenty year, multi-species time-series. This mechanistic approach, combined with a time series analysis, will improve our ability to forecast the occurrence and magnitude of fishery-induced trophic cascades across a range of oceanographic conditions and assess kelp forest resilience.

**USING MARINE FOOD WEB MODELS TO IDENTIFY TRADE-OFFS INHERENT TO ECOSYSTEM-BASED MANAGEMENT**

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Trade-offs are inherent to ecosystem-based management (EBM) because of its broad focus on communities of species and multiple human use sectors. Widely popularized examples include the negative influence of protected California sea lions on endangered Pacific salmon and the tensions between eco-tourism activities and recreational fisheries. While it is increasingly appreciated that the benefits of enhancing one species or service come with the costs of declines in other species and services, the challenge to scientists is to provide managers with the means to recognize, quantify, and operate along such trade-offs. We use Northeast Pacific marine ecosystem models (Ecopath with Ecosim, Atlantis) to simulate the effects of alternative management scenarios on a variety of ecological and socioeconomic attributes, such as diversity, energy cycling, resilience, and recreational and commercial fisheries yield. The scenarios focus on changes in harvest pressure and modification of nearshore habitat quantity and quality, though the generic approach is transferable to other types of human uses. Binary trade-offs are fairly straightforward to represent and interpret, but may provide incomplete information if they fail to indicate trade-offs among other interdependent ecological and socioeconomic attributes. To avoid this potential pitfall, we examine simultaneously trade-offs among multiple ecosystem attributes predicted by our model simulations. This approach should help decisionmakers to make informed choices about the costs and benefits of alternative policies.

† CLOSELY RELATED SYMBIODINIUM STRAINS SHOW STRONG BIOGEOGRAPHIC STRUCTURING IN THE INTERTIDAL ANEMONE ANTHOPLEURA ELEGANTISSIMA

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The temperate intertidal anemone Anthopleura elegantissima shows remarkable flexibility in its symbiotic partnerships, associating either with chlorophyte or dinoflagellate symbionts in a manner that seems to reflect environmental parameters. However, neither the biogeography nor the fine-scale genetic diversity within symbiont lineages is currently well understood. We used sequence information from the mitochondrial cytochrome b and chloroplast 23S
SPECIALIZATION IN THE DIET OF A GENERALIST PREDATOR, ENTEROCOTUS DOFLEINI

Scheel, D. Alaska Pacific University

Octopuses have been described as generalist predators because their diet includes dozens of animal species across several phyla. However, individual octopuses are reported to specialize on one or a few prey taxa from this set, with individual animals exhibiting different prey choice. This paper examines specialization among Enteroctopus dofleini (the giant Pacific octopus) based on midden samples of their diet. In Prince William Sound, Alaska, fifty-five species were documented in octopus diets over a fifteen year study, but octopuses exhibited size and species selectivity in prey choice. The most frequent seven species comprised 83% of prey. Individual middens displayed little specialization by taxa: 20% of middens in a 2009 sample (N=48) differed significantly from expected in species distributions of prey; and over all years, most middens were only mildly specialized (proportional similarity <0.7). There was limited evidence of dietary specialization at single location over time, and across dens at a single geographic location. Thus, while octopuses may be described as opportunistic foragers at a taxonomic level, they also act similarly to risk-minimizing foragers with regard to prey characteristics of energy content, handling time and encounter rate. It is possible that the dietary breadth of octopuses serves an information-gathering function: rare prey are sampled, but not repeatedly chosen due to low energy content, high handling time, or infrequent encounters.

STRUCTURE - FUNCTION FEEDBACKS CRITICAL TO RESILIENCE OF PACIFIC STAGHORN CORAL


Staghorn coral functions as habitat for many species of tropical reef fishes, but the morphology of the coral makes it particularly vulnerable to physical disturbances. Despite staghorn’s potential for rapid colony growth, the rate of recovery of this important fish habitat can be exceptionally slow: in northern lagoons of Moorea, French Polynesia, the staghorn Acropora pulchra remains far below its pre-disturbance abundance more than two decades after destruction by a cyclone. We found that both persistence and re-establishment of A. pulchra thickets in Moorea require the presence of gardening damselfish (farmerfish) in the genus Stegastes. Established staghorn thickets all contained farmerfish, and there was a strong, positive relationship between the size of the thicket and the number of associated Stegastes. All the recently recruited staghorn propagules we observed were closely associated with farmerfish territories on Porites coral. Transplanted patches of staghorn thrived when protected by a large mesh cage, but were killed by corallivorous fishes within a few weeks when exposed. Subsequent experiments revealed that staghorn benefits from Stegastes defense of their algal territories, and that staghorn propagules survive and flourish in the long term only when transplanted to farmerfish territories. There appears to be a positive feedback loop between Stegastes and A. pulchra: farmerfish protect staghorn, which then grows rapidly and provides expanded habitat space for Stegastes (and other species). While this enables staghorn to persist where corallivores are abundant, it results in low resilience of the coral habitat when physical disturbance disrupts the feedback loop.

†THE GRASS IS GREENER: LOTTIA GIGANTEA HOME RANGE FORMATION BASED ON VARIABLE ALGAL DENSITY

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Lottia gigantea, the owl limpet, is thought to be territorial in order to protect food resources. When exposed to an area with an ample food resource, L. gigantea will prudently graze the area, returning to graze the same spot every 3-4 days. Based on a model by Stamps and Krishnan, this study tested if an individual would return to an area with greater frequency based on the food amount available, i.e. whether or not an individual would favor areas with high food densities. Ten Lottia gigantea were placed in individual corrals with varying algal density (low, medium and high) in each corral, but the total amount of food in each corral was the same. To examine home range formation, time-lapse photography was used to track the ten individual L. gigantea in the lab on a mock intertidal setup for four weeks. Individuals were placed in arenas larger than a territory (territories are correlated with limpet size) and the individuals were inhibited from interacting with one another by wooden barricades. Their movements were scored to examine the probability of return based on the amount of biofilm present. It was expected that the individuals would favor tiles covered in a thick biofilm, but individuals avoided tiles with the greatest algal density, possibly due to the danger of losing grip and being knocked off the substrate.
GOING WITH THE FLOW: NUDIBRANCH GASTROPODS TRACK LARGE-SCALE FLUCTUATIONS IN CLIMATE

Schultz, S.T.¹, Goddard, J.H.R.², Gosliner, T.M.³, Mason, D.E.⁴, Pence, W.E.⁴, McDonald, G.R.⁵, Pearse, V.B.⁵, and J.S. Pearse⁶

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Climate change is restructuring marine ecosystems worldwide, and an understanding of causal mechanisms is essential for informed forecasting and management. We used climate-index response profiling (CIRP), a novel autoregressive technique applied to multi-year time series of population abundance, to test mechanistic hypotheses about recent declines in shallow-water nudibranchs in California. We analyzed historical data from three intertidal sites (Pillar Point, Scott Creek, Asilomar) studied independently during non-overlapping time periods between 1969 and 1995, combined with recent surveys from these same sites. Total abundance, especially of larger more conspicuous species, at each site was generally positively correlated with El Niño conditions, warm phases of the Pacific Decadal Oscillation, elevated local sea level and sea surface temperatures, and negatively correlated with coastal upwelling and the North Pacific Gyre Oscillation. Southern species reflected this overall pattern, but northern species were not as strongly associated with the climate indices, except at Pillar Point where they were correlated in the same direction as the southern species. These results reject thermal stress and trophic collapse hypotheses, and implicate larval advection as the likeliest mechanism linking oceanographic changes with the faunal shifts. CIRP presents a practical and quantitative method for understanding and forecasting population fluctuations of a conspicuous predatory guild in the California Current System.

† LIMPETS AND THEIR ALGAL EPIBIONTS: COSTS AND BENEFITS OF HOSTING ACROSIPHONIA SPP AND ULVA LACTUCA ON YOUR BACK

Seaborn, Travis J. University of Washington, Friday Harbor Labs

Epibiont and basibiont relationships can have positive and negative effects for both organisms involved, ranging in intensity from minor to major effects. Limpets are commonly found with two algal species growing on their backs in the intertidal of the San Juan Islands, Ulva lactuca and Acrosiphonia spp. Previous research has shown that basibionts (substrate organism) and epibionts (organism growing on the surface) have complex interactions that can be positive, negative, or neutral. I hypothesized that limpets with an algal epizoan would experience both positive and negative effects. A force transducer and flume was used to measure the drag forces experienced by a limpet at various water velocities. Presence of either epiphyte significantly increased on limpet drag. Acrosiphonia had a greater effect on drag than U. lactuca, increasing the force substantially. When dropped in a tank, limpets with algal growth landed foot-down significantly more often than limpets without algal growth. Acrosiphonia spp. had a greater effect than U. lactuca. Last, limpets in a wind tunnel with algal growth (especially Acrosiphonia) had cooler body temperatures than limpets without algal growth. In conclusion, the effects on the basibiont for being in this relationship were found to be both positive and negative.

INTERACTIVE EFFECTS OF URCHIN DENSITY AND REFUGE AVAILABILITY ON URCHIN MORTALITY IN A MARINE RESERVE

Segui, L.M.*, and K.A. Hovel San Diego State University

In kelp forest habitat, sheephead (Semicossyphus pulcher) and spiny lobsters (Panulirus interruptus) are thought to exert significant predation pressure on purple (Strongylocentrotus purpuratus) and red (Strongylocentrotus franciscanus) urchins, thereby regulating kelp forest community structure. However, little is known about their relative roles in urchin population regulation. I manipulated urchin density, refuge availability (presence or absence of understory algal cover), and period of exposure (day or night) in a marine reserve to test the interactive effects of all three factors on urchin proportional mortality. I also made video recordings of daytime predation to determine whether sheephead are the primary daytime predator of urchins and if they exhibit an aggregative response to urchin density that may contribute to urchin regulation. For daytime and nighttime trials, urchins with no algal cover experienced inverse density dependence, in which urchin proportional mortality decreased with urchin density, whereas urchins under algal cover showed density-independent mortality. Algal cover significantly reduced urchin proportional mortality during the day, but not at night when urchin mortality rates were low. Video recordings showed a weak positive relationship between urchin density and the number of sheephead present. This work suggests that in a southern California reserve, time of day and the presence or absence of refuge influences urchin mortality and that predator-induced urchin proportional mortality does not increase with urchin density.
DISPERSAL LIMITATION AND POST-SETTLEMENT SURVIVAL OF AN INTRODUCED ASCIDIAN (*BOTRYLLOIDES VIOLACEUS*) IN SAN JUAN ISLANDS, WA

Selden, R. L.*, Cahill, A. E.†, Crim, R. N., and S. Crickenberger* 1 - UC Santa Barbara 2 - State University of New York Stony Brook 3 - University of British Columbia 4 - Clemson University

Distributions of invasive species are often patchy; however, the mechanisms regulating these patchy distributions are poorly understood. Organisms with short-lived larvae provide an opportunity to test whether these distributions are dispersal-limited or mediated through post-metamorphic processes. Here we used the invasive colonial tunicate *Botrylloides violaceus* to examine the roles of dispersal and predation in determining its distribution through field outplants of recently settled juveniles to locations with and without adult *B. violaceus* colonies. Survival and growth were not different between caged and uncaged treatments, suggesting that predation is not controlling the distribution of this species. However, survival and growth were different among sites. One site without established colonies had significantly lower growth and survival than all others, indicating the importance of post-settlement factors at this site. The other site where adults were absent had similar growth and survival to sites with established colonies, indicating dispersal limitation at this site. Growth and survival were also different between sites where adult colonies were previously established. Our study suggests that the distribution of *B. violaceus* is limited both by dispersal and environmental conditions that affect juveniles after settlement and that the mechanisms allowing populations to persist vary spatially.

COMMUNITY DYNAMICS AND CLIMATE CHANGE AT A ROCKY INTERTIDAL SITE IN HUMBOLDT BAY, CA: 11 YEARS OF PHYCOLOGY STUDENT DATA.

Shaughnessy, F.J.† Humboldt State University

The structure of estuarine rocky intertidal communities on the west coast and their dynamics are poorly described. HSU Phycology students have been testing the hypotheses that a riprap site in Humboldt Bay, CA has four distinct zones, that each is numerically dominated by the algae and invertebrates described in the Ricketts intertidal model, and that annual changes to structure are correlated to climate variables. Four putative zones have been randomly sampled during early February for the past 11 years and the percent cover of algal and invertebrate functional groups has been measured. Uni- and multivariate analyses generally support a conclusion of three rather than four zones: the high intertidal ephemeral algae zone (cyanobacteria, diatoms, *Prasiola meridionalis*, *Bildingia minima*); the mid intertidal barnacle-*Mastocarpus* zone; the low intertidal cartilaginous, foliose terete, and filamentous red algal zone. Mussels, fucoids, kelps, and *Phyllospadix* are conspicuously absent even though the site is only a few hundred meters from the open coast. Annual variation in the cover of some functional groups and species is not correlated to any climate variables whereas abundances of microalgae and barnacles are negatively correlated to our desiccation index. Some mid to lower intertidal organisms like the gametophyte of *Mastocarpus* are not correlated to this index but do demonstrate a peak shaped relationship to variables describing aquatic climate change like the ENSO index and a local upwelling index.

ECOLOGICAL AND EVOLUTIONARY DRIVERS OF FEMALE-BIASED SEX RATIOS: TWO SEX MODELS OF PERENNIAL SEAGRASSES

Shelton, A. O.† Center for Stock Assessment Research, UCSC

Among sexually reproducing species, differences between the sexes within species are ubiquitous. Despite the clear effect of sex differences on sex ratios and population growth rates, demographic models rarely consider both sexes explicitly. In this presentation I explore the causes of extreme, female-biased sex ratios in the surfgrass, *Phyllospadix*. Using demographic data, I develop two-sex matrix projection models to assess the magnitude of demographic differences necessary to generate observed sex ratios and the consequences of sex differences for population growth rates. I demonstrate that small sex differences in survival can generate biased sex ratios, but the importance of sexual reproduction differs markedly between species. Even in the absence of a direct tradeoff between sexual and asexual reproduction, the presence of two reproductive modes affect both the importance of sex and sex ratio bias. Using sensitivity analyses, I quantify the contribution of shared and sex-specific vital rates and show that, until males become rare, the sensitivity of sex-specific vital rates are small relative to vital rates shared between the sexes. I demonstrate that placing sex differences in the context of a demographic model that includes biologically motivated life-history tradeoffs can explain the maintenance of sex-specific life histories and the persistence of skewed sex ratios.

† SURVIVAL AT THE EDGE: ECOPHYSIOLOGY AND RANGE LIMITS OF THE ESTUARINE SEA Slug *ALDERIA*

Shimer, E.L.*, and P.J. Krug CSU Los Angeles

Mechanisms that set geographical range limits in marine animals are poorly understood, but of fundamental importance in ecology and evolution. The sea slugs *Alderia modesta* and *A. willowi* respectively occur north and south of San
Francisco Bay, in which they seasonally alternate in abundance. At this dynamic range boundary, *Alderia modesta* displaces *A. willowi* after winter rains, and *A. willowi* recolonizes after peak summer temperatures. We tested whether the sister species differ in tolerance to high temperature and low salinity across three life-history stages by simulating a series of stressful low-tide events in lab assays. Most encapsulated embryos and swimming larvae of the northern species *A. modesta* survived salinities of 8 ppt, but early life stages of *A. willowi* experienced 50% mortality under 16 ppt. Adults of *A. modesta* survived repeated exposure to nearly fresh water (2 ppt), whereas few *A. willowi* survived one exposure to salinities below 6 ppt. Conversely, some *A. willowi* survived repeated exposures to 34°C, but temperatures above 30°C were fatal to *A. modesta*. Field observations confirmed die-offs of *A. modesta* occur when mud surface temperatures exceed 30°C. Differential tolerance for high temperature or low salinity thus sets the range boundary between *Alderia* spp., and may determine future range shifts in response to warming trends and changes in estuarine hydrology.

**COEXISTENCE AND INTERTIDAL ZONATION OF CHTHAMALID BARNACLES ALONG CENTRAL CHILE: INTERFERENCE COMPETITION OR A LOTTERY FOR SPACE?**
Shinen, J.L.*, and S.A. Navarrete Estación Costera de Investigaciones Marinas, Pontificia Universidad Católica de Chile

In open systems, both local (e.g. hierarchical interference competition) and regional processes (e.g. recruitment limitation, source-sink dynamics) can be important in determining patterns coexistence among species. In this study, we define patterns of local distribution and recruitment of two common intertidal chthamalid barnacles (*Jehlius cirratus* and *Notochthamalus scabrosus*) at 15 sites along the shores of central Chile. Surveys revealed patterns of adult distribution to be consistent across the study region; ample overlap in the distribution of these species, with interspecific mixing over scales of few centimeters, occurring over 60-80% of the entire barnacle zone, with slight spatial segregation by tide height. Recruitment rates of the two species were highly correlated among sites (separated by kms), suggesting similar determinants of onshore larval transport between these species. Additionally, we found evidence (observational and experimental) that *Notochthamalus* was recruitment-limited while *Jehlius* experienced higher post-settlement mortality. Densities of established individuals were generally positively correlated at scales of just 25 cm² and largely uncorrelated over scales of 2500 cm² across sites and tidal levels, indicating that asymmetric inter-specific competition is unlikely to affect adult populations. After monitoring individuals under various crowding conditions (single individuals, surrounded by conspecifics, and surrounded by heterospecifics) and at different tide elevations for more than a year, we found no evidence of negative intra- or inter-specific effects on individual growth rates. We conclude that lottery type interactions and species-specific post-settlement mortality rather than an inter-specific competitive hierarchy likely determine patterns of coexistence of *Jehlius* and *Notochthamalus* in central Chile.

**EXPERIMENTAL RE-ESTABLISHMENT OF THE ROCKWEED, SILVETIA COMPRESSA, ON URBAN SOUTHERN CALIFORNIA SHORES**
Smith, J.R.¹*, Whitaker, S.G.², and S.N. Murray¹ 1 - CSU Fullerton 2 - CSU, Fullerton and National Park Service, Channel Islands National Park

Previous research has indicated that many rocky intertidal macrophyte communities in southern California are now characterized by reduced abundances of larger seaweeds, having shifted towards less productive flora dominated by smaller, disturbance-tolerant turf and crustose algae. One species in widespread decline is the canopy-forming, mid-intertidal rockweed *Silvetia compressa*, which provides microhabitat for a diversity of organisms. Restoration has been successful in the re-establishment of depleted, ecologically important species in terrestrial and estuarine habitats but has rarely been attempted on rocky shores. In two phases, we experimentally investigated methods for re-establishing *Silvetia* and examined factors that may affect restoration success. In Phase I, we implemented a three-way factorial design with simulated canopy and herbivore exclusion treatments applied at four sites and used two out-planting methodologies: 1) seeding through relocation of fertile receptacles and 2) transplanting juvenile *Silvetia* thalli. *Silvetia* has been locally extinct at two of these sites for >30 years. The seeding technique was unsuccessful while transplant survival was low, although enhanced by presence of canopy; there was no site effect. In Phase II, we used a two-way factorial design, transplanting two sizes classes of rockweeds on vertical and horizontal surfaces at a single site. Survival of transplanted thalli and naturally occurring thalli, tagged at a nearby site, were compared. Survival of transplanted thalli was lower than natural thalli; however, larger transplants exhibited significantly higher survival rates than smaller thalli, particularly on vertical surfaces. Mortality was higher on horizontal surfaces likely due to differences in desiccation stress and human trampling.
HYDRODYNAMIC REGULATION OF COLONY FORM IN HYDROZOANS

Smith, L.M.*, Vasquez, M.C., and S.R. Dudgeon CSU Northridge

Colonies of the hydrozoan, Podocoryna carnea, grow continuously and lack a determinate size and shape. To respond to environmental changes they must have mechanisms to sense and integrate environmental signals and change their phenotype (e.g., growth form) accordingly. The arrangement of tissues of the gastrovascular system, either highly interconnected networks (sheets) or disparate linear extensions (runners) of stolons, has implications for the distribution of metabolites and communicating environmental information to cells. In Podocoryna sp., the dynamics of circulation in the gastrovascular system regulates morphological development of colonies. We tested the hypothesis that shear stress along the walls of the stolon lumen cues morphogenetic events in colonies. Shear stress was manipulated by adding dextran, a high molecular weight carbohydrate polymer, to seawater changing its dynamic viscosity and, thus, that of the gastrovascular fluid. Velocity gradients were measured in stolons by tracking particles and indicated that increasing viscosity increased shear stress along the lumen wall. We observed increased polyp production in response to shear stress in single polyp, single stolon systems and, additionally, increased extension of stolons in large colonies relative to colonies grown in unmanipulated seawater. Changes in viscosity had no effect on the rate of branch formation. Colonies experiencing increased shear stress at the surface of the lumen wall became more runner-like. The evidence for shear stress as a mechanism of signaling in Porifera, Cnidaria, and Mammalia suggests that it is an evolutionary feature common to regulating development of transport systems among metazoans.

† DIEL PARTITIONING OF SURGE AND SUBMERGENCE INFLUENCES INTERTIDAL BARNACLE SPECIES DISTRIBUTION PATTERNS

Smith, K.A.* University of South Carolina

The relative influence of high and low tide conditions on intertidal organisms is difficult to determine at wave-exposed sites because waves blur tidal movement. Between fully submerged (underwater) and emerged (out of water) conditions, waves can spray organisms, keeping them moist, and wave surge can alternately expose and submerge organisms at a frequency dependent on the wave period. By deploying a water level logger paired with a temperature logger in the mid-low intertidal zone, it is possible to distinguish emergence, splash, surge, and submergence and record their relative durations. Loggers were deployed at 10 wave-exposed sites in the northeast Pacific which are inhabited by Balanus glandula and Chthamalus spp. I estimated long term exposure of barnacles to each of these states by applying the logger data to tide predictions and comparing duration at the low, mid, and high shore levels. There were differences in relative durations of intertidal states among the different sites, even at sites in close geographic proximity. Daily surge durations during the summer tended to be longer at sites in Northern and Central California compared to sites in Oregon. Balanus glandula tend to have a higher percent cover at sites with longer submergence periods (Oregon) while Chthamalus tend to have a higher percent cover at sites with longer surge periods (California). These species likely have adaptations that allow them to exploit these different microhabitats.

† CONSEQUENCES OF COASTAL HABITAT MODIFICATION FOR MARINE FISH INVASION

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Human modified seascapes may be more susceptible to invasion both due to habitat alterations and increased propagule supply. We examined the effects of reef fish habitat expansion via anthropogenic substrates on nearshore colonization success of invasive Pacific lionfish (Pterois volitans) in the Bahamas. We tested the hypotheses that: (1) areas with more artificial structure (docks, jetties, marine debris) contain more lionfish, and (2) lionfish are superior to native reef taxa as colonizers of experimental reefs. We found that lionfish strongly associate with structure at small spatial scales, whether natural or artificial. However at the scale of the entire island, nearshore habitats with more natural structure in the form of patch reefs did not have more lionfish. This pattern was explained by the finding that humans selectively add artificial substrates to hard bottom and seagrass habitats which would otherwise provide less structure than patch reefs. Due to the added structure provided by manmade substrates, marginal habitats supported similar abundances of lionfish as more structurally complex patch reefs. Lionfish therefore tended to occur most often on artificial substrates where natural structure was in short supply. However, when a network of artificial structures was experimentally added to four sites, lionfish were slower to colonize than most native species. Coastal habitat modifications may facilitate reef fish invasion in suboptimal habitats by increasing structure availability even when invaders are poor colonizers relative to native taxa.
† PRIORITY EFFECTS AND INVASIVE DOMINANCE IN A MARINE FOULING COMMUNITY
Sorte, C.J.B.1,3, and J.J. Stachowicz2 I - Bodega Marine Lab, UC Davis 2 - UC Davis
Invasive species are becoming increasingly dominant in systems worldwide. In particular, in the subtidal epibenthic ‘fouling’ community of Bodega Harbor, California, non-natives currently represent 78% of the most common local species compared to only 33% almost 40 years ago. Climate change has been suggested as one of the drivers of this increase, with higher temperatures hypothesized to facilitate invasive species. Linking climate change and invasions is challenging, due to concurrent changes in introduction dynamics such as vector transport and propagule supply, and requires an understanding of the mechanism of temperature effects in a particular system. In the fouling community, space is a limiting resource, and recruitment to free space is a process of primary importance. Previous studies have shown that, on the U.S. east coast, at higher temperatures, invasive species recruit earlier and in greater numbers than native species. We assessed the role of temperature in determining recruitment phenology in the fouling community of Bodega Harbor and whether shifts in recruitment timing lead to differential adult abundances via priority effects. Specifically, we compared recruitment patterns in 2006 (a relatively warm year) to those in 2007 (a relatively cool year). We found that the tunicate Distaplia occidentalis, one of the only common native species in the system, recruited later in 2006 and, subsequently, was less abundant in adult assemblages. We describe the results of field weeding experiments which show that, for this species, temperature-related shifts in recruitment phenology of just a few weeks can have lasting impacts on adult abundances.

† SQUID KIDS IN HOT WATER: OMMASTREPHID PARALARVAE IN THE EASTERN TROPICAL PACIFIC WARM POOL
Staaf, D.J.1 Hopkins Marine Station of Stanford University
The Humboldt squid, Dosidicus gigas (family Ommastrephidae), supports the largest invertebrate fishery in the world—and growing. Little is known of its reproductive biology, but its spawning grounds are thought to include the Eastern Tropical Pacific (ETP). Fellow ommastrephid Sthenoteuthis oualaniensis also spawns in this region and the paralarvae of the two species are morphologically indistinguishable. The purpose of this study was to characterize ommastrephid spawning in general in the ETP, through analysis of paralarvae from evening bongo (subsurface) and manta (surface) tows conducted during research cruises in the ETP from 1998 to 2006. Much greater abundances were found in surface than in subsurface waters, consistent with a hypothesis of diel vertical migration even at this young age. Spatially, the greatest abundance was in the ETP warm pool, concentrated along the countercurrent thermocline ridge. Very few paralarvae were found in the cooler waters of the California Current, the Equatorial cold tongue, or the Peru Current. In 2006, a small subset of samples was preserved in ethanol, allowing molecular identification to species for the first time in this region. Most ethanol-preserved ommastrephid paralarvae were S. oualaniensis, although two geographically distant sampling locations also provided individuals of D. gigas. This limited abundance of D. gigas, along with the general absence of ommastrephid paralarvae in the cold water south of the equator, makes one very curious about the origin of the thousands of tons of adult Humboldt squid caught every year in South American fisheries.

COMPLEMENTARITY IN MARINE BIODIVERSITY MANIPULATIONS: RECONCILING DIVERGENT EVIDENCE FROM FIELD AND MESOCOSM EXPERIMENTS
Stachowicz, J.J.1,2, Best, R.J.1, Bracken, M.E.S.2, and M. Graham3 1 UC Davis 2 - Northeastern University 3 - Moss Landing Marine Labs
Mounting concern over the loss of marine biodiversity has increased the urgency of understanding its consequences. This urgency spurred the publication of many short-term studies, which often report weak effects of diversity (species richness) driven by the presence of key species (the sampling effect). Longer-term field experiments are slowly accumulating, and they more often report strong diversity effects driven by species complementarity, calling into question the generality of earlier findings. However, differences among study systems in which short and long term studies are conducted currently limit our ability to assess whether these differences are simply due to biological or environmental differences among systems. In this paper, we compared the effect of intertidal seaweed species richness on biomass accumulation in mesocosms and field experiments using the same pool of species. We found that seaweed species richness increased biomass accumulation in field experiments in both short (2 month) and long (3 year) experiments, although effects were stronger in the long-term experiment. In contrast, richness had no effect in mesocosm experiments, where biomass accumulation was completely a function of species identity. We argue that the short-term experiments, like many published experiments on the topic, detect only a subset of possible mechanisms that operate in the field over the longer term, because they lack sufficient environmental heterogeneity to allow expression of niche differences and they are of insufficient length to capture population-level responses such as recruitment. Many published experiments therefore likely underestimate the strength of diversity on ecosystem processes in natural ecosystems.
A TEST FOR EQUIVALENCE OF REPRODUCTION OF TEMPERATE REEF FISHES ON ARTIFICIAL VERSUS NATURAL REEFS
Steele, MA¹, Wang, D¹, Schroeter, SC², and DC Reed² 1 - CSU Northridge 2 - UC Santa Barbara

Artificial reefs are commonly used to mitigate damage to or loss of natural reefs, yet how well these artificial reefs function is still widely debated. One major question is whether artificial reefs produce fishes at rates equivalent to those on natural reefs. We tested whether rates of reproduction of five of the most common rocky reef fishes in the Southern California Bight were equivalent on a large artificial reef (Wheeler North Reef) to those on nearby natural reefs. Fishes (California sheephead, kelp bass, barred sand bass, señorita, and blacksmith) were collected during the spawning season in two years (summer 2007 and 2008) and batch fecundity was estimated by the gravimetric method. Preliminary analysis indicates that batch fecundity on the artificial reef was similar to that on natural reefs for the wrasses (California sheephead and señorita) and lower on the artificial reef for the basses (kelp bass and barred sand bass). Blacksmith did not reproduce on either the natural or artificial reefs. This finding implies that artificial reefs may be more effective at enhancing local production of some species than others. It is important to note that the artificial reef studied was relatively young (8-9 years) during this study, and as the reef and the biotic community on it develops more fully, reproductive output of all study species may become more similar to that on nearby natural reefs.

LONG-TERM VARIATION OF BIOGENIC RHODOLITH BEDS AND RECOVERY FROM MAJOR DISTURBANCE EVENT
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This study provides the first long term data reported from any rhodolith beds worldwide. Rhodoliths are unattached branching coralline algae and like corals they are both fragile and form complex biogenic substrates that support diverse communities. This study was conducted in beds dominated by rhodoliths of the species Lithophyllum margaritae in Bahía Concepción, B.C.S. Mexico using opportunistic sampling across 18 years. Rhodolith population parameters were measured at multiple rhodolith beds within the bay and compared over time. Subsequent to initial sampling in 1991, a large-scale disturbance event was detected that resulted in significant declines in biogenic rhodolith sizes. Post-disturbance sampling revealed that recovery was gradual (> 5 years) and varied by site, and that the disturbance affected both long-term and seasonal patterns in rhodolith community structure. Rhodoliths are directly and indirectly disturbed by humans world-wide, and the extended recovery period from disturbance has important conservation and management implications.

† INCREASED PRODUCTIVITY IN WEST HAWAII'S AQUARIUM FISHERY: THE CONTRIBUTION OF FLEET DYNAMICS VS. MARINE PROTECTED AREAS
Stevenson, T. C.¹, Tissot, B. N.¹, and J. Dierking² 1 - Washington State University Vancouver 2 - University of Hawaii Manoa

Marine protected areas (MPAs) have been widely adopted as a tool for enhancing marine fisheries. In 1999, an attempt to minimize resource depletion from aquarium fishing in Hawaii’s western Kona-Kohala shore (West Hawaii) resulted in the establishment of a network of MPAs that closed 35% of the coastline to aquarium fish collecting when combined with existing MPAs. Two recent papers have associated the MPA network with an increase in aquarium fishery productivity as measured by catch per unit effort (CPUE), and a third paper showed the total catch for the most commercially viable fish species, yellow tang (Zebrasoma flavescens), was higher after MPA establishment than in the previous 38 year history. Paradoxically, other studies have detected a 45% decline in yellow tang abundance for areas open to fishing after MPA establishment. Here, we examine West Hawaii’s aquarium fishery and provide explanations for how and why the catch and CPUE may have increased for yellow tang in light of declines in their abundance in areas open to fishing. We investigated changes in fisher demographics, catch composition, and fish harvesting technologies and methods in the context of the MPAs, and examined fisher job satisfaction and discuss their implications within the context of the fishery. Our intention is to underscore the importance of examining social and behavioral characteristics of fishers, and examine how these attributes impact a fishery and management efforts.

† SEASONAL ABUNDANCE OF HUMBOLDT SQUID IN MONTEREY BAY IN RELATION TO UPWELLING
Stewart, J.S.* , and W.F. Gilly Hopkins Marine Station of Stanford University

Humboldt squid (Dosidicus gigas) have been becoming increasingly apparent in the California Current system since the 1997/1998 El Niño. Identifying and understanding patterns between squid presence and oceanography is necessary to assess ecosystem impacts and to successfully manage commercial and recreational fisheries. Currently, optimal physical conditions for Humboldt squid are unknown, due to the high variability in timing of their migrations, the length of their stay and uncertainty in size of local populations. Here we examine trends in Humboldt squid abundance in Monterey Bay from 1997-2008 (data from remotely operated vehicles operated by MBARI) and available physical
indices. Our results suggest that upwelling is an important variable related to local squid abundance, but neither the length of the upwelling season nor timing of its onset (the spring transition) appears to be particularly important. Rather, the overall intensity of spring upwelling appears to be inversely correlated with squid abundance, which is low during the upwelling period and increases the following fall. Thus, years of unusually weak upwelling and correspondingly higher surface temperatures may be favorable to Humboldt squid. The apparent success of Humboldt squid in nutrient-poor years, when much of the ecosystem may be depressed with low recruitment and survival must be considered in conjunction with the squids' high tolerance of temperature fluctuations (based on its daily vertical migrations), its staple diet of mesopelagic micronekton and its ability to rapidly migrate long distances. As is the case for invasive species, establishment in new ecosystems may be easier during altered ecosystem states.

**STREAMLINING BEHAVIOR OF THE RED URCHIN *STRONGYLOCENTROTUS FRANSISCANIS* IN RESPONSE TO FLOW**

Stewart, H.L.*, and K. Britton-Simmons *Friday Harbor Labs*

This work was motivated by subtidal observations of red urchins (*Strongylocentrotus fransiscanis*) moving their spines into streamlined positions as current increased in the field. Trials in a flume across flow speeds from 0-65 cm/s enabled us to observe the change in overall shape of the urchin, and quantify the decrease in the angle of spines from the top of half of the animal. The effect of this behavior on drag was measured with physical models made from urchin tests with spines in the ‘up’ position (typical in stagnant and slow velocities) and in the ‘down’ position (typical of posture in high velocities). Streamlining spines decreased the drag coefficient of urchin models at all flow speeds, particularly between 10-40cm/s, the velocities that they experienced most often over the course of one year at our subtidal field sites around Friday Harbor, Washington. This behavior, while reducing drag and enabling *Strongylocentrotus fransiscanis* to remain attached to the substratum in high currents, may lead to reduced capture of drift kelp, which is entrapped on upright spines, and is likely an important factor defining distribution of this urchin across flow regimes.

† **SPATIOTEMPORAL VARIATION IN PREDATION PRESSURE STRUCTURES REEF FISH COMMUNITIES**

Stier, AC†*, Geange, SW, and KM Hanson† 1 - University of Florida, Department of Biology 2 - Victoria University of Wellington, School Of Biological Sciences 3 - Scripps Institution of Oceanography

Studies examining the role of predation in structuring communities often focus on presence or absence of predators, thus emphasizing fixed rather than variable predator densities. In marine systems, spatiotemporal variation in recruitment strength results in considerable variation in abundance of both prey and predators, yet, to date, experiments quantifying effects of predators have failed to compare variable vs. non-variable predator densities. We conducted a 4-month field experiment to assess how differences in the mean and variance of predator density and timing of predator arrival affect prey fish abundance and community composition. Our experiment contained five replicated experimental treatments: 1) "predator absent"- no predators for four months, 2) "early"- two predators for the first two months and no predators for the second two months, 3) "late"- no predators for the first two months and two predators for the second two months, 4) "low density"- one predator for the entire four months, and 5) "high density"- two predators for the entire four months. Predators reduced abundance and increased diversity compared to the predator absent treatment, with strong effects of increases in predator density and late arriving predator. However, we found no evidence for differences in treatments that experienced equal mean predator densities but differences in predator variance. Our results demonstrate that the magnitude of predator effects in structuring reef fish communities is dependent upon both density and timing of arrival of predators.

**PLASTICITY IN HATCHING FROM A NUDIBRANCH EGG RIBBON AND ITS EFFECT ON DURATION AS A PRECOMPETENT SWIMMING LARVA**

Strathmann, R.R.† *Friday Harbor Labs, University of Washington*

Veligers of the nudibranch *Phestilla sibogae* hatched from their individual capsules when the encapsulated embryos were scattered from a torn gelatinous egg ribbon. Hatching occurred as early as day 4 at 23 to 25 degrees C. The early hatchlings swam but had not yet developed a propodium and were not yet competent to settle and metamorphose. Hatching may therefore be induced by predation: crabs consumed egg ribbons, and a portunid crab, caught in the act of tearing an egg ribbon, scattered encapsulated embryos. When egg masses were undisturbed they hatched as late as day 9 to 11. These late hatchlings had a well developed propodidum and many were competent to metamorphose. Of late hatchlings, 30 to 70% metamorphosed within a day of exposure to the inducer from the nudibranch’s coral prey. A few metamorphosed nudibranchs were found within hatching egg masses. Thus the veligers can hatch so late that many are competent to metamorphose or so early that the obligate planktonic period can last a week. An attack by a predator means the benthic habitat is dangerous for the embryos, and swimming is presumably the safer option. In the absence of disturbance, the veligers hatch when ready or nearly ready to settle.
† POTENTIAL TO ADAPT? HERITABILITY OF LARVAL GROWTH IN AN ACIDIFIED OCEAN
Sunday, J.M. †, Crim, R. ‡, Harley, C.D. ‡, and M.W. Hart † 1 - SFU 2 - UBC
Rising CO₂ levels and the resultant acidification of the oceans will have significant impacts on marine organisms, particularly at the larval stage. Projections of future ecological change rely heavily on measurements made on present-day populations. But what potential exists for evolutionary adaptation among current populations? A key parameter for natural selection is the extent to which trait variability is heritable. Using a full factorial mating design, we estimated the heritability of growth response under elevated CO₂ conditions of larvae of the Northeast Pacific sea urchin, Strongylocentrotus franciscanus, and mussel, Mytilus trossulus. Heritability of growth rates at elevated CO₂ are estimated from sires and dams of both species. Results indicate low sire-based, but high dam-based, heritabilities in both species, generating a mixed prognosis for the efficiency of selection under elevated CO₂.

† SOLDIER CRAB (DOTILLA MYCTIROIDES) DISTRIBUTION, FOOD RESOURCES AND SUBSEQUENT ROLE IN ORGANIC MATTER FATE IN AO TANG KHEN, PHUKET, THAILAND
Takagi KK †, Cherdsumkai P ‡, Mimura T †, Yano Y †, Adulyanukosol K ‡, and Tsuchiya M † 1 - University of the Ryukyus 2 - Phuket Marine Biological Center
This study aimed to elucidate Dotilla myctiroides food resources and how the soldier crab influences the organic matter composition on the intertidal flat. A preliminary assessment of D. myctiroides size, sex and population distribution was conducted to clarify the characteristics of the inhabiting population. Overall, D. myctiroides size and abundance was normal across the tidal flat area. Comparison of different sediment types from the soldier crab habitat (surface sediments, igloos, burrow lining, burrow pellets, feeding pellets and feces) using the fatty acid (FA) analysis technique revealed D. myctiroides removes organic matter via the significantly lower contributions of polyunsaturated FAs, essential FAs, and dinoflagellates in the feeding pellets. D. myctiroides tissue analysis of the hepatopancreas and hindgut in individuals that had been starved for 24 hours confirmed not only the consumption of dinoflagellates, but diatoms and macroalgae as well. In addition, the FA metabolism within the digestive system implied the ability of the soldier crab to synthesize highly unsaturated FAs (HUFAs) such as 20:4n–6, 20:5n–3 and 22:6n–3.

† AN OCEAN ACIDIFICATION MODEL SYSTEM: URCHIN LARVAL RESPONSES TO REDUCED PH AT SHALLOW-WATER CO₂ VENTS
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Shallow-water CO₂ vents in Ischia, (Tyrrenian Sea) Italy present a model system to study the impacts of anthropogenic ocean acidification on marine life, including planktonic larval stages. Arbacia lixula, a common Mediterranean urchin, is absent from areas of high venting which has been attributed to the physiological sensitivity of the adult, yet we hypothesize that abnormal larval development may be a key factor. We used an in-situ larval culturing technique to investigate the response of A. lixula larvae to reductions in seawater pH. A. lixula was spawned in the lab and embryos were transferred to vent settings along a pH gradient (pH range of means; 6.9 to 8.0) occurring at two CO₂ venting sites where temperature regimes were concurrently monitored. Morphological analysis revealed that lowered pH slowed larval growth, reduced the length of skeletal rods and caused increased abnormalities. Survivorship however, was not directly affected by pH. This study documents susceptibility of larval stages to pH reduction and provides insight into one class of ocean acidification impacts likely to affect coastal marine communities.

USING EXPERT JUDGMENT TO ESTIMATE MARINE ECOSYSTEM VULNERABILITY IN THE CALIFORNIA CURRENT
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As resource management and conservation efforts move towards multi-sector, ecosystem-based approaches, we need methods for comparing the varying responses of ecosystems to impacts of human activities to prioritize management efforts, allocate limited resources, and understand cumulative effects. Given the variety of human activities affecting ecosystems, relatively few empirical studies are adequately comprehensive to inform these decisions. Consequently, management often turns to expert judgment for information. Drawing on methods from decision science, we offer a
method for eliciting expert judgment to (1) quantitatively estimate the relative vulnerability of ecosystems to stressors, (2) help prioritize management of stressors across multiple ecosystems, (3) evaluate how experts weight different criteria to characterize vulnerability of ecosystems to anthropogenic stressors, and (4) identify key knowledge gaps. We applied this method to the California Current region to evaluate the relative vulnerability of 19 marine ecosystems to 53 stressors associated with human activities, based on surveys from 107 experts. We found that 89% of the variance in experts’ judgments of vulnerability can be explained by two criteria: the ecosystem’s resistance to the stressor and the number of species or trophic levels affected. Four intertidal ecosystems were judged most vulnerable to the suite of human activities evaluated here. The expert judgment vulnerability rankings for both coastal and offshore ecosystems provide a quantitative, transparent and repeatable assessment to any ongoing or emerging human activity. Combining these results with data on the spatial distribution and intensity of human activities provides a systematic foundation for ecosystem-based management.

**WHY DOES CHLOROSTOMA FUNEBRALIS HAVE A BLACK SHELL?**
Tepler, S.K.*, and M.W. Denny Hopkins Marine Station, Stanford University

The gastropod *Chlorostoma* (formerly *Tegula*) *funebralis* possesses a very high temperature tolerance and are unlikely to overheat in the mid-intertidal zone of the exceptionally cool Monterey Peninsula. Given their physiological adaptations to high temperatures, several researchers have proposed that their black shells and epidermis are an adaptation to exploit solar heating and increase their metabolic rate. But no one has ever asked the snails if, indeed, they prefer warm temperatures. To ascertain whether *C. funebralis* would express a thermal preference, we allowed specimens to wander freely on a temperature gradient in the laboratory, controlling for other possible directional stimuli. Contrary to the hypothesis that *C. funebralis* should seek to be warm to speed its metabolism, we found that they aggregated at ~3°C, just short of the temperature at which they experience heart failure. Analysis of video recordings of snails showed that they aggregated at this cold temperature through a biased random walk. Steps toward the cold were taken more often than steps towards warmth, and steps toward the cold were longer than steps towards warmth. Thus *C. funebralis* may not have a thermal preference per se, but instead use temperature as a behavioral cue to seek crevices. The crevice-seeking habit of *C. funebralis* is striking in the mid-intertidal zone on the Monterey Peninsula, and may enable them to avoid thermal stress and lethal desiccation at far greater shore heights than if they chose to frequent exposed rock.

**THE PHYSIOLOGY OF INVASION: THERMAL TOLERANCE OF CARCINUS MAENAS IN CALIFORNIA**
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Species invasions have been recognized as a major component of global change, and can have profound impacts on biodiversity and ecosystem function. The success of some invasive species seems to lie in broad environmental tolerance and/or the ability to adapt quickly to new environmental conditions. We predict that these qualities may predispose invasive species to success in a changing climate. To test this, we need to understand the processes by which invasive species respond to environmental variation, particularly temperature. An ideal species for this research is the European green crab, *Carcinus maenas*, which inhabits a wide geographic and environmental native range, and has extensively invaded five other continents. The recent invasion of *C. maenas* to the North American west coast has been characterized by low genetic diversity relative to the native range, but has nonetheless been highly successful, spreading from Monterey Bay to Vancouver Island in about 10 years. We have used an IR light-based method to measure cardiac critical temperature in *C. maenas* from central California embayments. Preliminary data suggests that invasive green crabs on the west coast may have a much higher thermal tolerance than native crabs in the same geographic range, and may show differences in thermal tolerance between sexes. We will present initial data on upper critical temperatures for *C. maenas* on the west coast, and discuss the implications of these data. Finally, we will describe plans for a broader comparative study in the future.

† **INDIRECT ECOLOGICAL EFFECTS CHANGE AN EVOLUTIONARY TRAJECTORY**
terHorst, C P Florida State University

The fields of community ecology and evolutionary biology have historically had little influence on one another, but more recently, explanations of community patterns have begun to consider evolutionary explanations. However, evolutionary studies rarely focus on more than one or two species. Multi-species evolutionary scenarios are interesting because both direct and indirect effects occur. Here I consider the evolutionary implications of indirect ecological effects using the natural microcosm community within purple pitcher plants (*Sarracenia purpurea*), containing a diverse array of bacteria and bacteriophores, as well as mosquito larvae predators. Replicate cultures of *Colpoda* sp., a ciliated protozoan, were grown under four selection regimes to measure trait evolution in response to: (a) monoculture, (b) predation, (c) competition, and (d) predators + competitors. The evolution of traits in the latter treatment is particularly interesting because it results from the sum of direct and indirect effects from these associate species. Two
traits (cell size and population growth rate) evolved in all treatments, but the direction of trait evolution was dependent upon treatment. The magnitude of indirect effects on the evolution of these two traits was stronger and in the opposite direction of the direct effects of predation and competition. In natural communities, species typically participate in a web of direct and indirect interactions with many associate species, but evolutionary experiments with one or two species account only for a single direct effect. Given the documented prevalence of indirect ecological effects in natural communities, their evolutionary effects may be widespread, but unappreciated.

† MACROFAUNA, MICROBES, AND METHANE: INTERPLAY BETWEEN INFAUNA AND BIOGEOCHEMICAL CYCLING AT DEEP-SEA METHANE SEEPS.
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During the discovery and description of eight New Zealand methane seeps along a 300 km area off the North Island (600 and 1200 m), an infaunal community dominated by ampharetid polychaetes was found. Multivariate analysis of total assemblage data revealed that unlike the other macro-infaunal assemblages sampled, the ‘ampharetid-bed community’ composition exhibited strong between sample similarity, independent of location, highlighting the distinctness of this community. The ampharetid-bed community reached a maximum density of 84,000 individuals m^-2 and 250 grams m^-2 wet biomass. A stable isotope and fatty-acid biomarker approach indicated that microbial biomass derived from the aerobic oxidation of methane fuels much of this metazoan community. Methane flux from the sediment which harbors this community reached 46 times those from other seep habitats. We hypothesize that these communities, through consumption of microbial biomass and bioturbation, disrupt the anaerobic processes which normally limit methane release and in turn facilitate aerobic processes and increased methane emission. This community illustrates the linkages between metazoan consumption of microbial biomass and the impacts it may have on biogeochemical cycles.

† CAN AFLP-BASED GENOME SCANS DETECT A SELECTION SIGNATURE IN BROADLY DISPERSING ORGANISMS? THE CASE OF SHELL POLYMORPHISM IN THE PERIWINKLE ECHINOLITTORINA HAWAIENSIS
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Polymorphisms in broadly dispersing species are typically thought to result from phenotypic plasticity, but a long cited exception to this paradigm is the variation in shell sculpture between smooth and sculptured morphotypes of the planktotrophic periwinkle Echinolittorina hawaiiensis. To elucidate the potential role of natural selection in maintaining this phenotypic divergence, a genome scan using over 1000 AFLP loci was conducted on smooth and sculptured snails from divergent habitats at four replicate intertidal sites. Two programs were used to identify loci potentially under selection, called outlier loci, and they provided slightly different results; approximately 5% of loci were identified as outliers with Dfdist, while no outliers were identified by BayeScan. The percentage of outliers identified by Dfdist was equal to the percentage expected due to Type I error, and multitest corrections reduced the number of significant outliers to 0. Closer examination of outliers supported the conclusion that these loci were false positives. These results highlight the importance of controlling for Type I error through methods such as using multiple outlier detection approaches, performing multitest corrections, and replicating population comparisons. While the lack of outlier loci suggests that the shell polymorphism in E. hawaiiensis may result from phenotypic plasticity, as opposed to genetic differentiation, these results can also be explained by low levels of linkage disequilibrium in this planktotrophic species, resulting in inadequate genomic coverage to detect selected loci. This study serves as a cautionary note regarding the effectiveness of genome scans to detect selection signatures in broadly dispersing organisms.

ECOLOGICAL EFFECTS OF TRADE IN ORNAMENTAL CORAL REEF SPECIES
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The trade in ornamental species from coral reef ecosystems is a major international industry that targets over 1400 species of reef fishes, live rock, stony corals, gorgonians and molluscs, as well as many other invertebrates for aquariums, curios and jewelry. We reviewed 200 papers from the literature to examine potential ecological effects resulting from the trade. Because the trade is highly selective and often targets large quantities of individual species of high value, the potential for overexploitation and thus for significant ecological effects on coral reef ecosystems is a concern. Harvesting pressure is increased by secondary mortality due to collecting, handling, holding and shipping. Additionally, there have been numerous documented incidences of destructive practices associated with fish capture as well as introduced species originated from aquariums. Although many countries have regulations regarding the trade, very few of them have management plans and thus management is often non-existent or difficult to implement in source
countries, and are often managed as de facto open access fisheries. Thus, the combined consequences of the trade can have multiple effects on coral reef ecosystems and may reduce their resilience to withstand other anthropogenic impacts.

**PATTERNS IN TAXONOMIC DISTINCTNESS OF WEST COAST GROUNDFISHES IN RELATION TO DEPTH AND LATITUDE**

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Large-scale patterns or trends in species diversity have long interested ecologists. The classical pattern is for diversity (species richness) to decrease with increasing latitude. Species richness quantifies only the total number of species and does not recognize the taxonomic complexity or breadth of those assemblages. Taxonomic distinctness is a measure of the relatedness of the species in a sample (eg, branch length through a Linnean tree). Here I examine patterns of taxonomic distinctness in relation to latitude and depth for groundfishes on the continental shelf and slope (50-1220 m) of the US Pacific coast. Depth had the strongest effect with mean taxonomic distinctness (AvTD) highest between 400-600 m. Latitudinal trends in AvTD were depth specific. AvTD increased with latitude in the shallowest areas (50-150 m) but tended to decrease with latitude at deeper depths. Variation in taxonomic distinctness (VarTD) was highest around 200-400 m. As with AvTD, latitudinal trends in VarTD were depth specific. In the shallowest areas (50-150 m), VarTD increased with latitude, while in deeper areas the patterns were more complex. Both AvTD and VarTD showed some patterns in relation to known or suspected biogeographic boundaries. For example, in the shallower portions of the slope (150-400 m), AvTD peaked in the vicinity of Point Conception, Cape Mendocino, and Cape Blanco, with a low in the vicinity or just south of the Columbia River. These patterns are discussed in relation to trends in species richness, evenness and assemblage structure.

† **CHLOROSTOMA (TEGULA) FUNEBRALIS SIZE REFUGE AND ESCAPE RESPONSE FROM LEPTASTERIAS HEXACTIS**

Traiger, SB†, Gravem, SA², and SG Morgan² 1 - UCSC 2 - UCD, Bodega Marine Laboratory

The predatory sea star, *Leptasterias hexactis*, may indirectly affect intertidal algal communities by eating or changing the feeding behavior of its non-preferred prey species, the herbivorous snail *Chlorostoma (Tegula) funebralis*. To determine if predation of *Tegula* by *Leptasterias* or if behavioral responses by *Tegula* have greater potential effects on algal communities, we made field observations of *Leptasterias* predation events, investigated a possible size-refuge of *Tegula* from *Leptasterias* predation, and tested size-dependent responses of *Tegula* to *Leptasterias* chemical cues. We rarely observed *Leptasterias* preying upon *Tegula* in the field (4.9% of *Leptasterias* were eating *Tegula*), and found that *Tegula* reaches a size refuge from predation by *Leptasterias* at 1.9 – 2.2 cm in shell width. We then tested the fear responses of *Tegula* above and below this apparent size refuge to *Leptasterias* chemical cues, but found no differences in standardized escape speed between large (2.2 – 2.6 cm shell width) and small (1.2 – 1.6 cm shell width) *Tegula*. These results contradict previous studies on *Tegula*’s reaction to *Leptasterias* and another predatory seastar *Pisaster ochraceous* where there were differences in size-dependent responses to predator cues. Both size classes of *Tegula* were more responsive to direct contact with *Leptasterias* than to waterborne cue. The ability of *Tegula* to reach a size refuge from *Leptasterias* and the tendency of large *Tegula* to continue to perform escape responses indicates that non-consumptive direct and indirect effects of *Leptasterias* may be more important in tidepool communities than consumptive effects.

† **COMPARATIVE PHYLOGEOGRAPHY OF CARIBBEAN SEA SLUGS WITH LONG-LIVED VS. SHORT-LIVED LARVAE**

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Predicting patterns of gene flow is important for conservation and management of marine animal populations. Biophysical coupling models have been developed for the Caribbean that use ocean currents and the lifespan of planktonic larvae to predict whether populations will be genetically connected or isolated. To test model predictions, we determined population genetic structure for the sea slugs *Elysia patina* and *E. zuleicae* which have a 30-day planktonic larval period. A portion of the mitochondrial cytochrome c oxidase I gene was sequenced for samples from 13 Caribbean locations. Phylogenetically distinct clades were identified by Bayesian Inference, and Analysis of Molecular Variance (AMOVA) was used to determine realized gene flow among islands. Despite its considerable potential for larval dispersal, *Elysia patina* had surprisingly high population structure; clades were up to 10% divergent, and several were restricted to one island. In contrast, the co-occurring *E. zuleicae* had little structure, but also comprised two major clades that were 10% divergent. In contrast to published predictions from oceanographic models, there was no east-west break across the Caribbean, but there were deep barriers to gene flow among neighboring islands in the Bahamas. Larval life span is thus a poor predictor of realized dispersal, and current models do not accurately predict larval
exchange for common Caribbean molluscs. Differences in larval behavior may explain why less migration has occurred among populations of *E. patina* on historical and recent time scales, compared to other *Elysia* spp.

† **GENETIC EVIDENCE FOR PERIODIC COASTAL-DERIVED RECRUITMENT ACROSS OFFSHORE THERMAL AND CURRENT BARRIERS IN KELP BASS (PARALABRAX CLATHRATUS), A TEMPERATE ROCKY REEF FISH**

Trbovich, S.M.*, and R.R. Wilson, Jr. CSU Long Beach

Published studies suggest kelp bass (Paralabrax clathratus) inhabiting the Southern California Bight (SCB) are genetically distinguishable between thermal regimes of the offshore California Current and inshore California Counter-Current. However, revisions in theoretical population genetics have called the statistical methods used in these studies, particularly the Gst measure as applied to polymorphic microsatellite data, into question. We sampled adult kelp bass along an east-west transect line represented by 41 samples from the San Pedro Shelf (SPS), 50 samples taken from Santa Catalina Island (SCAI), 14 from Santa Barbara Island (SBI), and 54 from San Nicolas Island (SNI). We genotyped all samples at five polymorphic microsatellite loci reported in an earlier study and compared 378 bases of single-stranded mitochondrial DNA sequence from the left control region for 51 SNI samples and 39 SCAI samples. Population structuring between the islands is minor and not statistically significant for all five microsatellite loci (Jost’s Dest= 0.051 +/- 0.081 for the most differentiuated locus) as well as the mtDNA sequences for SNI and SCAI (Phi-st=0.003, P=0.619). Average microsatellite heterozygosity was lower at SNI than at SCAI (average difference of HO = 0.09) with a lower allele richness at the two most polymorphic loci. Theta values indicate a lower effective population size at SNI; furthermore the SNI sample shows three distinct peaks in fish size classes. This correlates with a hypothesis that SNI is supplied by periodic influxes of P. clathratus larvae from inshore sources.

† **PREDATOR EFFECTS ON BENTHIC COMMUNITIES IN THE SAN JUAN ISLANDS, WA**

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Marine protected areas (MPAs) can be effective tools to aid the recovery of harvested species, but may also be used to preserve pre-harvest marine communities. Two MPAs in San Juan Channel, WA, closed to bottom fishing have higher predator (lingcod, Ophiodon elongatus, and copper rockfish, Sebastes caurinus) abundance than nearby non-protected areas. The increased numbers of these fishes in MPAs may influence other members of the benthic community. We use surveys of top predatory fishes, smaller fishes (sculpins, gobies), benthic invertebrates, and algae to determine the effects establishment of MPAs in San Juan Channel may have on rocky subtidal communities. Differences in assemblages between areas open and closed to fishing can be attributable to trophic or behavioral interactions with protected species, or to site-specific differences (e.g. localized recruitment, flow dynamics, microhabitat availability). To determine the effects of predators on recruiting communities we affixed settlement plates to gently sloping solid bedrock substrate in and out of MPAs, and manipulated predation pressure using four caging treatments: large-mesh cages, small-mesh cages, no cage, and a cage control. These treatments were designed to quantify the influence of different predator size classes on recruiting organisms, and how these effects change in MPAs. After 11 months recruited communities were compared using non-metric multidimensional scaling. Trends emerged showing both site-specific (locally recruiting encrusting bryozoans) and treatment-specific (differential consumption of foliose red algae) patterns. These results are discussed in the context of trophic webs in the San Juan Islands, and our plans for the extension of this research.

† **BARE SPACE OR BOUNTIFUL BIOTA: AN ANALYSIS OF HUMAN DISTURBANCE ON OUR ROCKY SHORELINES**

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Rocky intertidal habitats support diverse communities in the transition zone between land and sea. Demonstrated sensitivity to human access has raised concerns about impacts from high levels of visitation. We completed one field experiment and two observational studies to help identify the relationship between visitor access and effects to the intertidal community. First, we experimentally applied three levels of visitor densities to plots located on a section of coastline closed to public access for approximately 40 years. Second, to assess levels of visitation, visitor densities were determined at commonly accessed sites within a central California state park. These data were related to experimental densities to gain insights into expected visitor effects on publicly accessible rocky shores. Finally, we conducted a survey of access-indicator organisms along a gradient of visitor density at a commonly visited intertidal site. We predicted that access-indicator organism abundance would increase with decreasing visitor abundance. In our experimental treatments we found five taxa significantly declined in abundance. The observed visitor density at a local state park is between our ‘moderate’ and ‘high’ experimental densities. Despite the occurrence of damaging experimental visitor densities we could not detect a difference in abundance of indicator taxa along a gradient of
visitation at publicly accessed shores. In summary, resource managers can apply the information from this study to help manage the potentially damaging effects of visitors to rocky shores.

† COMMUNITIES CONNECTED BY CURRENTS: A STUDY OF NEARSHORE MARINE SPECIES IN THE SOUTHERN CALIFORNIA BIGHT.
Watson, JR, Siegel, DA, Raimondi, P, Hays, C, Mitarai, S, Dong, C, and JC McWilliams 1 – UC Santa Barbara 2 - UC Santa Cruz 3 - UC Merced 4 - Okinawa Institute of Science and Technology 5 - UCLA
Characterizing the causes of spatial patterns in species abundance is a goal central to ecology and community structure analyses. Here, we explore the causes of non-random spatial patterns in subtidal and intertidal nearshore marine species in the Southern California Bight (SCB). Brays-Curtis distance is used to measure the biological similarity between pairs of locations in the SCB and is predicted in a partial least squares regression framework using distance and environmental variables. Lagrangian particle simulations are used to define the oceanographic distance between nearshore sites. Oceanographic distances reflect the complex ocean circulation of the SCB and as a result differ to Euclidean distances and are asymmetric and time varying. Sea surface temperature, chlorophyll a, kelp extent and the area of rocky substrate are included as environmental predictor variables. Results show that for subtidal species oceanographic distance is the dominant factor organizing biological patterns. For intertidal species environmental factors such as sea surface temperature become more important with distance metrics being less influential. Biological similarity and oceanographic distances are then decomposed into regional spatial management units using hierarchical clustering methods. We show that the resulting subtidal bio-regions correspond strongly with the oceanographic regions of the SCB. These results suggest that ocean circulation is an important consideration for spatial fisheries management.

† SHARED EVOLUTIONARY HISTORY AND THREE WHELKS’ ABILITY TO ADAPT TO NOVEL PREY
Wells, E.H., and E.D. Grosholz UC Davis
Interactions between invasive and native species, and between invasive species from different regions, are often unpredictable. A lack of shared evolutionary history is often assumed to aid the invader in its role as either predator or prey. This paradigm predicts that invasive predators are frequently successful at incorporating native prey into their diets, while native predators are rarely successful at recognizing or handling invasive prey. However, numerous examples of biotic resistance show that novelty can also benefit a native predator in controlling an invasive prey species. We examined the extent to which these ideas about shared evolutionary history predict predation success of one native and two invasive whelk species on familiar and novel prey. We offered Acanthinucella spirata, Ocinebrellus inornatus, and Urosalpinx cinerea various species of mussels and oysters, and created a hierarchy of prey preference for each whelk. All three whelks displayed the same preference hierarchy for oysters, but the native A. spirata preferred Mytilus edulis more than either invasive whelk did, perhaps because A. spirata used a novel predation method on completely naïve prey. We also compared U. cinerea from native East Coast populations to U. cinerea from the West Coast, which have had decades or centuries to adapt to native West Coast and Asian prey species. East Coast U. cinerea, while able to consume novel prey, did not display the same strength of preferences as West Coast U. cinerea, which have had both historical and lifetime experience with these novel prey species.

† THE FIRST RIGOROUS FIELD TEST OF MESOGRAZER IMPACTS IN SEAGRASS BEDS: SAYING GOODBYE TO CAGE ARTIFACTS
Whalen, M.A., and J.E. Duffy Virginia Institute of Marine Science, The College of William & Mary, Small crustacean mesograzers are the dominant primary consumers in many coastal benthic ecosystems and a key node in food webs. Yet, their grazing impacts on vegetated communities under natural conditions remain unknown. Field experiments designed to investigate top-down processes have traditionally employed cages to exclude predators and grazers, yet this method introduces severe artifacts when excluding small crustaceans. Poore et al. (2009) recently developed a novel method to suppress mesograzier abundances without the use of cages, a method which we have successfully utilized for the first time in a seagrass system. Carbaryl, a degradable insecticide used in agriculture and aquaculture, was incorporated into plaster blocks where it was slowly released into the water column. We crossed insecticide treatments with nutrient enrichment to investigate top-down and bottom-up influences on epiphytic growth and concomitant effects on eelgrass, Zostera marina. We ran the experiment in an eelgrass bed in the York River, Virginia for six weeks during summer 2009. Preliminary results suggest that nutrient enrichment increased epiphyte biomass only after the second week of the experiment, while carbaryl treatments lead to increased epiphyte biomass through the successful reduction of mesograzier abundance. This induced trophic cascade attenuated down the food web that increased epiphyte loading did not affect eelgrass growth over the course of the experiment. Our results confirm the promise of this technique for revealing trophic consequences of mesoherbivory in realistic field situations, and corroborate lab and mesocosm results implicating mesogazers as important regulators of benthic community structure and biomass distribution patterns.
MATCHING SPATIAL PROPERTY RIGHTS FISHERIES WITH SCALES OF FISH DISPERsal
White, C., and C. Costello  Marine Science Institute, UC Santa Barbara
Regulation of fisheries using spatial property rights can alleviate competition for high value patches that hinders economic efficiency in quota-based catch share and open access management programs. However, efficiency gains erode when delineation of spatial rights constitutes incomplete ownership of the resource, thereby degrading its local value and promoting over-exploitation. Incomplete ownership may be particularly prevalent in the spatial management of mobile fishery species. We developed a simple game-theoretic bioeconomic model of spatial property rights representing Territorial User Rights Fisheries (TURF) management of nearshore marine fish and invertebrate species with mobile adult and larval life history stages. Strategic responses by fisheries in neighboring management units result in over-exploitation of the stock and reduced yields for each fishery compared with those attainable without resource mobility or with coordination in fishing effort. High dispersal potential of the larval stage — a common trait among nearshore fishery species — coupled with scaling of management units to only capture adult mobility — a common characteristic of many nearshore TURF programs — in particular substantially reduced conservation and economic returns. In a case study of hypothetical TURF programs of nearshore fish and invertebrate species, management units needed to be tens of kilometers in alongshore length to minimize larval export and generate reasonable returns to fisheries. Cooperation and quota regulations represent solutions to the problem that need to be quantified in cost and integrated into the determination of the acceptability of spatial property rights management of fisheries.

IMPROVING FIELD ESTIMATES OF PELAGIC LARVAL MORTALITY BY ACCOUNTING FOR SPATIAL PATCHINESS
The magnitude of mortality during the pelagic larval stage has a strong effect on connectivity and population dynamics in benthic organisms. Nonetheless, empirical estimates of mortality rates in the field remain difficult to obtain, primarily because larvae are patchy in space and time and subject to advection by ocean currents. Currently, the best approach for estimating larval mortality utilizes vertical life tables, which use the ratio of abundances of adjacent life stages to estimate a joint mortality rate while accounting for advective movements. Unfortunately, this approach is stymied by larval samples that are extremely patchy, and often produces implausible mortality estimates. We have developed a likelihood-based approach that improves on existing methods by explicitly accounting for spatial patchiness in larval abundance. This approach also makes it possible to obtain independent mortality estimates for each larval stage. We describe this method and give an example of its implementation, using a 65-day time series of larval abundances for 9 species of intertidal crabs and barnacles sampled in Bodega Bay, CA. In general, mortality rates were on the order of 0.1 - 0.2 day-1, and were typically highest for early larval stages and declined for later stages. These estimates are more precise and biologically plausible than those obtained using the older method. Though computationally expensive, this approach promises to improve our ability to estimate a key demographic parameter.
‡ INDIRECT EFFECTS OF A MARINE ECOSYSTEM ENGINEER ALTER CORAL DISTRIBUTION
White, J.S.S.† Department of Biology, University of Florida
Farmerfish engineer coral communities by facilitating algal turf and exerting resource control through territorial defense: Within territories, these behaviors indirectly (1) increase interactions between coral and farmed turf and (2) decrease interactions with mobile grazers. A small-scale experiment indicated massive Porites were more vulnerable to competition with turf than branching Acropora. In contrast, these delicate branching corals were more vulnerable to predation by mobile corallivores and grew and survived better in the presence of S. nigricans defense. I addressed these indirect effects in a demographic context using size specific population monitoring in the presence and removal of S. nigricans. It appears the disturbance history has played a pivotal role in the types of community changes observed: While S. nigricans usually colonizes Acropora thickets, a series of disturbances virtually eliminated these habitats and farmerfish are found colonizing the dominant disturbance tolerant, but turf sensitive, massive Porites. Taxa with a higher resistance to competition with turf can utilize dead portions of these massive corals. This increase in substrate availability, when coupled with lower mortality rates, has led to enhanced recovery of branching corals within farmerfish territories. Outside territories, branching corals are relegated to high flow, or cracks and crevices, suggesting grazing pressure is constraining role in the absence of this ecosystem engineer. This system supports the idea that disturbance can alter the engineering role: S. nigricans adversely affects branching corals in relatively undisturbed habitats, but can offer a less stressful environment when there is a shift in the community structure of grazing populations.

‡ PARASITE PENTHOUSE: SITE SPECIFICITY OF AN ENDOPARASITIC COPEPOD WITHIN ITS NUDIBRANCH HOST
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Site specificity within a host is common in parasites. Parasitic castrators often reside in the host’s gonad, a non-vital organ. Members of the genus Ismaila (Splanchnotrophiidae, Copepoda), are endoparasites of opisthobranch molluscs, inhabiting the host’s main body cavity and cerata. Ismaila belciki can infect over 60% of the population of their obligate host, the nudibranch Janolus fuscus. We examine whether I. belciki prefer a particular location or nutritional source within the host and their impact on gonad production. Janolus fuscus were collected from sites in Coos Bay, OR and externally examined for infection, noting the position of I. belciki under the host’s transparent mantle. Uninfected and infected J. fuscus were preserved for dissection to examine the parasite’s position. Host body and gonad mass were measured, as well as the sex, mass, location and orientation of each copepod in infected nudibranchs. Gonadal-somatic indices were lower in infected J. fuscus than uninfected nudibranchs. Female I. belciki inhabit the anterior position most frequently, with secondary female infectors beside the large anterior female or in a posterior position. This site preference is surprising, as the host’s posterior has a greater concentration of gonad than the anterior. Male copepods reside in close proximity to the female, often within the embrace of her legs. Copepods were found with cephalic appendages in contact with host gonad, suggesting I. belciki may partially castrate their hosts by consuming gonadal tissue. Potential benefits of site preference in females include access to nutritional sources and for males, access to mates.

COMPARISON OF BIOMASS PRODUCTION OF TEMPERATE REEF FISHES IN A SOUTHERN CALIFORNIA MARINE PROTECTED AREA AND ADJACENT FISHED AREAS
Wormald, C.L.†, Bailey, D.M., Allen, L.G., and M.A. Steele CSU Northridge
Marine protected areas (MPAs) are often used to manage marine resources through the reduction of fishing pressure. These no-take areas frequently demonstrate conservation benefits to fish communities by allowing depleted populations to increase in density and to rebuild their truncated age- and size-structures. Whether these benefits translate into overall enhanced yield will depend, in part, on whether increases in standing biomass and density translate into enhanced biomass production through somatic growth. Because in MPAs biomass may be concentrated in larger size classes, which tend to have low growth rates, it is not clear whether higher standing stock of fishes in MPAs would be expected to result in high rates of biomass production. We examined density, size structure, and biomass production in a community of kelp reef fishes in a Southern California MPA and in similar adjacent areas. In the ecologically and economically important kelp bass (Paralabrax clathratus), biomass production was higher in the MPA than in adjacent fished areas; whereas in another harvested species, the California sheephead (Semicossyphus pulcher), there was no difference in biomass production between the MPA and adjacent fished areas. An abundant prey species, the blackeye goby (Rhinogobiops nicholsii) had significantly higher biomass production in adjacent areas than in the MPA, perhaps because their densities in the MPA were depressed by abundant predators. Our results indicate that the effects of MPAs on biomass production are species specific and require a community-level approach to determine the overall effect of MPAs on total biomass production.

HEATED RESPONSES: FEEDING AND GROWTH RATES OF AN INTERTIDAL SNAIL AS A FUNCTION
OF BODY TEMPERATURE
Yamane, L. 1, Davidson, I. 2, Brown, C.W. 3, Chang, A.L. 3, Ashton, G.V. 1, Ruiz, G. M. 4, and M. Sytsma 2
1 - Smithsonian Environmental Research Center, Tiburon CA 2 - Aquatic Bioinvasion Research & Policy Institute, Portland State University 3 - UC Davis 4 - Smithsonian Environmental Research Center, Edgewater, MD
Climate change is expected to alter changes in both air and water temperatures. Organisms living in the rocky intertidal ecosystem may therefore be faced with thermal fluctuations in body temperatures reached during low and high tides. Temperature is known to affect organismal physiology and the interactions between an organism and its prey or competitors. Understanding the impacts of climate change on the rocky intertidal ecosystem thus requires determining the effects of aerial and aquatic temperatures on both organism physiological and behavioral responses. We manipulated aerial and aquatic body temperatures of the gastropod predator Nucella ostrina under controlled laboratory conditions, using field-relevant temperatures and a simulated tidal cycle. We then assessed the physiological and feeding responses of the snails to the established thermal regimes by measuring growth and predation rates after 20 days. We found that dogwhelks at 12° and 20°C produced significantly more new shell and overall body mass than those at 28°C. Additionally, snails at the highest emersion temperature (28°C) almost completely ceased feeding. Submersion temperatures produced the opposite effect on N. ostrina, resulting in snails growing and feeding at increased rates in the warmer aquatic treatment. This study applies a mechanistic understanding of how organisms respond to temperature to determine the potential effects of changing aerial and aquatic thermal regimes on organismal physiology and the broader rocky intertidal ecosystem.

† MULTIVARIATE BATHYMETRY-DERIVED LANDSCAPE ECOLOGY MODEL ACCURATELY PREDICTS ROCKFISH DISTRIBUTION IN CORDELL BANK NATIONAL MARINE SANCTUARY, CA, USA
Young, M.A. 1*, Iampietro, P.J. 2, Kvitek, R.G. 2, and C.D. Garza 3 1 - Seafloor Mapping Lab, CSUMB and UC Santa Cruz 2 - Seafloor Mapping Lab, CSUMB 3 CSU Monterey Bay
Accurate, efficient estimation of actual and potential species distribution is a critical requirement for effective ecosystem based management and marine protected area design. Here we test the applicability of a terrestrial landscape modeling technique in a marine environment for predicting the distribution of ecologically and economically important ground fish, using three species of rockfish at Cordell Bank National Marine Sanctuary (CBNMS) as a model system. Autoclassification of multibeam bathymetry along with georeferenced submersible video transect data of the seafloor and demersal fishes were used to model the abundance and distribution of rockfish. Generalized Linear Models (GLMs) were created using habitat classification analyses of high-resolution (3m) digital elevation models combined with fish presence/absence observations. Model accuracy was assessed using a reserved subset of the observation data. The resulting probability of occurrence models generated at 3m resolution for the entire 120 km2 study area proved most reliable in predicting the distribution of the two species associated with rocky habitat, S. rosaceus and S. flavidus, with accuracies of 80% and 70%, respectively. The models did not do as well for S. elongatus, a species associated with low relief, mixed and sedimentary habitats, and thus not as amenable to analysis based solely on bathymetry-derived geomorphology metrics. These results indicate that site and species-specific algorithmic habitat classification applied to high-resolution bathymetry data can be used to accurately extrapolate the results from in situ video surveys of demersal fishes across broad areas of rocky habitat.

HULL FOULING AND MOVEMENT PATTERNS OF RECREATIONAL VESSELS IN SAN FRANCISCO BAY AND ENVIRONS
1 - Smithsonian Environmental Research Center, Tiburon CA 2 - Aquatic Bioinvasion Research & Policy Institute, Portland State University 3 - UC Davis 4 - Smithsonian Environmental Research Center, Edgewater, MD
With over 200 nonindigenous species (NIS), San Francisco Bay has been called “the most invaded aquatic ecosystem in North America.” In 1995, Cohen & Carlton suggested that the bay might serve as a point of entry for non-native species which could subsequently spread along the coast. The potential for spread via hull fouling seems high, given the thousands of recreational boats in the bay, yet little was known about where or how frequently these boats travel, or how heavily vessels are fouled. In 2007-2009, we conducted studies of 10 marinas in San Francisco Bay and 3 nearby coastal harbors to gather preliminary data on the potential for recreational boats to spread NIS. Our studies included a questionnaire in which boaters were asked to provide details regarding their boats, hull husbandry practices and vessel use; a quantitative assessment of boat hulls using an underwater pole-mounted camera to determine the extent and broad taxonomic composition of biofouling; and a visual dockside assessments of level of fouling of some 3000 vessels. Extent of fouling varied among marinas: mean cover ranged from 47.5% to 71%. Travel patterns show a strong connection between San Francisco Bay and Monterey and Half Moon Bay. However, 76 percent of 619 boaters who responded to the survey had not traveled outside their home bay in the past year, and the most active boats also had the
least fouling. Based on these data, we categorized boats into different risk categories with potentially different management implications.

† ARE INVASIVE SPECIES MORE TEMPERATURE TOLERANT THAN NATIVES? A MARINE FOULING COMMUNITY CASE STUDY
Zerebecki, R. A.1*, and C. J. B. Sorte2 1 - Northeastern University 2 - Bodega Marine Lab, UC Davis
Two of the greatest threats to marine ecosystems are global climate change and invasive species, yet we still lack an understanding of potential interactions between these factors. In particular, it has been suggested that invasive species are generally more eurythermal than natives and, consequently, will be able to survive better in the warmer conditions predicted by climate change models. In this study, we evaluated the hypothesis that invasive species are more temperature tolerant than native species. Our study system was the subtidal epibenthic ‘fouling’ community of Bodega Harbor, Bodega Bay, CA. We conducted a lethal temperature tolerance experiment (LT50) using 10 fouling species, including 4 native and 6 invasive species. Individuals were exposed to six treatment temperatures ranging from 12.0°C to 32.0°C (4°C intervals). Survival was determined after a 24 hour temperature exposure, and probit analysis was used to calculate the LT50 temperature for each species. We found that, on average, invasive species have a significantly higher LT50 (26.1°C) compared to natives (23.7°C). These results support the hypothesis that invasive species are more thermostolerant than natives. Ocean temperatures greater than 20°C are currently rare in Bodega Harbor. However, based on observations of recent local heat wave and predicted increases in mean ocean temperature and heat-wave severity from models, local temperatures are predicted to exceed the LT50 of native - but not invasive - species more frequently in the next century. These data, thus, suggest that ocean warming is likely to facilitate an increase in invasive species’ abundances within this community.

Coral Reef Fish Assemblages Across the Pacific
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Biennial in situ surveys (2000-2009) of coral reef fishes were conducted at 40 U.S. Pacific Islands as part of the NOAA Pacific Islands Fisheries Science Center’s Coral Reef Ecosystem Division long-term assessment and monitoring program. Here we present the results of these efforts, describing the abundance, biomass, size composition, and trophic structure of fish assemblages inhabiting shallow (10-15 m) fore reef habitats from 14 inhabited and 26 uninhabited islands across 4 regions in the Pacific basin. Fish assemblages across the U.S. Pacific Islands exhibited remarkable differences in abundance and biomass: total mean fish biomass at inhabited islands being a fraction of that at uninhabited ones. At uninhabited islands substantial proportions of biomass were concentrated in large size classes and higher trophic levels, with tertiary consumers such as jacks (Carangidae), sharks (Carcharhinidae), and groupers (Serranidae) accounting for 50% - 75% of total fish biomass. In contrast tertiary consumers were rare or absent at densely populated islands, accounting for < 15% of total fish biomass. Smaller-bodied species from lower trophic groups comprised the greatest proportion of total fish biomass at the inhabited islands. These findings reinforce the growing understanding that human exploitation consistently and dramatically alters the structure of coral reef fish assemblages. Our results also show that the uninhabited U.S. Pacific Islands represent some of the few remaining examples of coral reef ecosystems in a natural state, thus providing an ecological baseline and an opportunity for scientists and managers to gain insights into ecosystem function in the absence of humans.
CONTRIBUTED POSTER ABSTRACTS

† COMPARING SPATIAL ARRANGEMENT OF REEF HABITAT AT TWO BAJA CALIFORNIA FISHING COOPERATIVES
Abshire, C.B.*, and PhD González-Guzmán, L.I. *University of Texas at Austin, School of Biological Sciences
Patterns of patchy distribution characterize many reef habitats which can affect the population dynamics, density and abundance of reef organisms. In order to investigate how spatial arrangement of reef habitat may be associated with the abundance and density of a commercially harvested marine snail, *Megastraea undosa*; we quantified and compared two geographic and topographically similar fishing cooperatives. Locations of reefs at each site were mapped using satellite imagery coupled with on-site delineation of reef boundaries using GPS. This data was then processed using ArcGIS and FRAGSTATS to calculate selected descriptive landscape metrics such as reef area, and indices of Proximity (PROX), Euclidean nearest-neighbor (ENN) and Fractal dimension (FRAC). Comparative analysis shows no significant difference between sites for the calculated metrics (Site1 n=49, Site2 n=37: Area, p=0.18; PROX, p=0.06; ENN, p=0.07; FRAC, p=0.35). Although no significant results were obtained the higher mean for PROX and lower mean ENN suggest a denser habitat arrangement at Site 1 which may contribute to the greater abundance and density of *M. undosa* observed at Site 1 in previous studies. These results suggest that environmental factors other than the spatial arrangement of reefs may play a larger role in determining the variation of *M. undosa* distribution at these sites.

A REVIEW OF THE SYSTEMATICS OF THE GENUS *SQUATINA* IN THE EASTERN PACIFIC OCEAN.
Alioto-Jurado, D.* West Valley College
The systematics of the genus *Squatina* occurring in the Eastern Pacific (EP) have been poorly understood and historically the subject of debate. Currently there exist two valid described species *Squatina californica* and *Squatina armata* which are both harvested in fisheries in some parts of their ranges. Effective conservation and management strategies for these species require a fundamental understanding of their population structures. If their geographic ranges contain genetically distinct sub-populations, management guidelines based on large geographic areas could be inappropriate and lead to the permanent loss of small regional populations and any endemic alleles the sub-population may have contained. Observations in previous studies have suggested that a *S. californica* sub-population in the Gulf of California may even constitute a third distinct species. This study's objective is to clearly define how many distinct species occur in the Eastern Pacific (EP) and further identify the intra- and interspecific population structures by utilizing classical morphometrics and a suite of polymorphic microsatellite markers. Several specimens from both preserved collections and field expeditions were morphologically measured using a newly modified protocol specifically designed for the body shape of angel sharks and also sampled for genomic DNA fragments. Classical morphometric results will be presented with up to the date completed genetic analysis.

† HIGH MOBILITY GROUP PROTEIN 1 (HMGB1) AND ITS ROLE AS A GLOBAL TRANSCRIPTION REGULATOR IN RESPONSE TO TEMPERATURE FLUCTUATIONS IN THE ANNUAL KILLIFISH *A. LIMNAEUS*
Alla, VA*, and JE Podrabsky Portland State University
The effects of temperature are manifested at every level of life from wide scale ecosystem interactions to highly specific cellular processes. Interestingly, many organisms thrive in environments despite the harsh thermal extremes that they encounter. As a result, animals are forced to employ a vast array of cellular mechanisms in order to cope. The annual killifish, *Austrofundulus limnaeus*, persists in an environment where daily temperature fluctuations can change as much as 20°C. Previous laboratory studies have shed light on some of the cellular mechanisms that enable these fish to live in such conditions. One such mechanism appears to be regulation of transcription through the action of high mobility group protein 1 (HMGB1). When fish are exposed to a daily cycling temperature regimen of 20°C-37°C, the transcript levels of HMGB1 (from a cDNA microarray) are strongly negatively correlated with temperature. HMGB1 interacts with the core histone of DNA and helps to bend the DNA enabling nucleosomes and transcription factors to bind. A current hypothesis states that “HMGB1 maintains the nucleoprotein complexes associated with transcription initiation and causes a global change in the rate of transcription.” It is my aim to test if the protein expression levels match the mRNA transcript levels and thereby further clarify the role of HMGB1 in response to temperature in *A. limnaeus*.

† EFFECTS OF DELAYED HATCHING ON NOTOCHORD LENGTH, ENERGY RESERVES, AND SURVIVAL OF THE CALIFORNIA GRUNION, *LEURESTHES TENUIS*
Aryafar, H.*, and K.A. Dickson CSU Fullerton
*Leuresthes tenuis* is unique for its ability to spawn terrestrially and extend embryonic incubation in the sand beyond the initial hatching period of 9-14 days post-fertilization (dpf). Maternally supplied proteins and lipids provide energy for embryonic development. Previous studies showed a linear decline in oil droplet size with time in grunion embryos, but
how energy reserves change during extended incubation is unknown. We quantified changes due to delayed hatching in yolk surface area in *L. tenus*, and tested the hypothesis that delayed hatching results in reduced post-hatching survival. We measured notochord length (NL), yolk surface area, and time to 50% mortality when starved, in larvae hatched after initial incubation (10 dpf) and extended incubation (28 dpf) at 20°C in the laboratory. Larvae were from multiple batches of eggs, each from an individual female fertilized by sperm from one male. NL was significantly greater in 28-dpf larvae than in 10-dpf larvae from 4 of 9 batches, significantly lower in 2, and did not differ significantly in the other 3. This suggests maternal effects, which we will investigate in future studies. Yolk surface area was significantly lower in 28-dpf larvae from all batches studied, and survival time was significantly reduced in 28-dpf larvae. Thus, because of reduced energy reserves and increased mortality, larvae that must delay hatching are at a disadvantage when competing with those that do not. Future experiments will test if additional development during extended incubation results in increased swimming ability that may offset these negative consequences of delaying hatching.

† A FLORISTIC DESCRIPTION OF INTERTIDAL ALGAE AND SEAGRASSES BETWEEN CAPE MENDOCINO, CALIFORNIA AND CAPE BLANCO, OREGON

Augyte, S., and F. J. Shaughnessy Humboldt State University

Marine floral biodiversity data is useful in combination with information about its environment since it suggests ecological and evolutionary processes that have and continue to affect its distribution. Floristic studies can also be useful for implementing management tools such as Marine Protected Areas and Ecosystem Based Management policies. My survey area lies within the Oregon Province and is part of the Eastern Pacific Cold-Temperate Region. Cape Mendocino and Cape Arago experience seasonal upwelling, but in between the two Capes, upwelling appears to be lower and multiple rivers deliver high sediment loads to the shoreline. Yale Dawson made algal collections in this area and in 1965, described about 220 species. The objective of my thesis is to survey the marine algae found in between the two Capes, from 15 intertidal sites, and describe basic habitat attributes of each species. After one field season, I have identified about 100 species and 60 genera. Another year of collecting is needed to complete the species list and to capture seasonal variation.

† THE GENETIC STRUCTURE OF EELGRASS (ZOSTERA MARINA) IN HUMBOLDT BAY

Baibak, Bethany L. Humboldt State University

Approximately forty-five percent of the eelgrass in California is found in Humboldt Bay. Restoration projects are currently underway in Humboldt Bay and additional projects will be mandated due to the use of eelgrass beds for oyster leases and the potential growth of the shipping channel. This project aims to establish population genetic information for Humboldt Bay, which has never been done, to maximize the success of future restoration projects through the identification of unique genotypes and pinpointing pockets of unusual genetic diversity. Sites throughout Humboldt Bay and neighboring sloughs were sampled during summer of 2008 and 2009. DNA has been extracted from 240 samples using a CTAB/PVP protocol for plants at the USGS Alaska Science Center. To determine genetic diversity and if population structure exists, I will use GENEPop, FSTAT, STRUCTURE, and Arlequin Programs. Migrate and BayesAss software will be used to estimate gene flow among populations. GENE CLONE will test for clonality and describe spatial clonal organization. The genetic structure and diversity observed in Humboldt Bay will be compared to other bays and estuaries in the Northwest. A unique genetic structure observed in Humboldt Bay could provide additional reasoning to designate Humboldt Bay as a Marine Protected area.

† HABITAT SELECTION OF CALIFORNIA CENTRAL VALLEY JUVENILE CHINOOK SALMON (*ONCORHYNCHUS TSHAWYTSCHA*): EFFECTS OF TEMPERATURE AND FOOD AVAILABILITY

Bassett, R. ¹*, Beakes, M. P. ²*, Retford, N. ², Moore, J. W. ², Sogard, S. M. ³, and J. E. Merz ² CSU Monterey Bay 2 - Department of Ecology and Evolutionary Biology, UCSC 3 - National Marine Fisheries Service 4 - Cramer Fish Sciences

In recent years Pacific salmon populations have declined considerably in the California Central Valley. Much of the historic salmon spawning and rearing habitat has been altered, degraded or is now inaccessible in this region. For regulated rivers in the Central Valley, understanding the relationship between river discharge and habitat quality and quantity is critical in designing flow regimes. Hydrodynamic habitat models are often used to derive habitat and river discharge relationships. However, many biotic drivers such as food availability are not included in these models although they may play an important role. This study aims to illuminate the importance of food availability and temperature in habitat selection by juvenile Chinook salmon *Oncorhynchus tshawytscha* (40 - 70mm FL) in the American and Mokelumne Rivers. We measured water temperature and water velocity in both occupied and unoccupied habitat in both rivers. The relative difference in food availability between rivers was determined by quantifying invertebrates available in the drift. Our analysis showed no significant difference in the amount of food available in the drift between rivers. However, habitat selection was significantly different between rivers, with fish selecting faster
velocities in the cooler Mokelumne River compared to the warmer American River. These results illuminate the importance of bioenergetics in habitat selection. Hydrodynamic habitat models incorporating bioenergetics may improve prediction of habitat use, and thus will be more effective in helping guide flow regimes for regulated rivers in the California Central Valley.

**DETERMINING GEODUCK LARVAL DISTRIBUTION IN QUARTERMASTER HARBOR, WASHINGTON USING ADAPTIVE TRAPPING AND FISH-C**
Becker, B.J.1, Gruber, J.1, Behrens, M.D.2, Henzler, C.M.2, Hoaglund, E.3, and Y. Shevalier1 1 - University of Washington Tacoma 2 - Pacific Lutheran University 3 – UC Santa Barbara

Despite a century of study, larval transport of marine invertebrates remains a “black box” of ecology. Larvae are patchy and transient, and sampling them can be difficult. Larvae must also be sorted from among non-target particles, and identified to species, which can be difficult or impossible. To meet these challenges, we are developing a method to integrate a new molecular identification tool, fluorescent in situ hybridization with cell sorting (FISH-C) with an inexpensive trapping approach, which will allow for time-integrated sampling and rapid sorting of samples. We will use these techniques to map the distribution of Pacific geoduck clam larvae in Quartermaster Harbor, Washington, a likely retention zone. We have begun testing both the traps and the probe and report our preliminary results. Simple passive traps, using salted DMSO, have been developed and tested using different concentrations of larvae in the lab and in different conditions in the field. A strong correlation between concentration and trap contents has been documented, even at low concentrations. We have identified a geoduck probe and have tested the FISH-C method using available Mytilus larvae. Resulting data from this study will be used to build a hydrodynamic dispersal model of area populations for management purposes. The broader applications of this technique are wide-ranging, including monitoring ballast tanks for target invasive species, studying the contribution of larvae from shellfish farms, and creating a large-scale, multi-species atlas of larval distribution.

† **DO TERRITORIAL OWL LIMPETS (LOT~TA GIGANTEA) ASSESS RISK? TENACITY AND SPEED OF CHASE BEHAVIOR CORRELATES WITH LOCAL NEIGHBORHOOD**
Berriman, J. S., and W. G. Wright Chapman University

Animals engaged in agonistic encounters must take into account many different sources of risk. The territorial owl limpet, Lottia gigantea, often engages in high-speed chases during agonistic encounters. Prior research in our lab demonstrated that such chases increase the risk of dislodgement by waves. However, these observations left unexplained a great deal of variation in the tenacity (resistance to removal by lift force) of chasing limpets. In the present study, we tested the idea that the sizes and numbers of neighboring con-specics might be influencing chase behavior (tenacity and speed). First, we induced foraging subject limpets to engage in territorial chase behavior by placing another limpet in the subject’s paths. When the subject limpet showed aggressive chase behavior, we “plucked” it off the substratum with a line attached to a spring scale and recorded the “force to remove.” We then measured the shell length of the subject limpet, as well as that of all of its neighbors (within a 30 cm radius). We found that among limpets with more than one neighbor, tenacity was positively correlated with the shell-length of the subject’s largest neighbor ($n = 56$; $r = 0.485$; $P = 0.0002$). Furthermore, the speed of the chasing subject limpet was negatively correlated with the total number of neighbors ($n = 70$; $r = 0.255$; $P = 0.033$). These measurements suggest that limpets may be modulating their chase behavior based on a working representation of the sizes and numbers of local competing limpets.

† **TURBINARIA ORNATA AS A REFUGE FOR ASSOCIATE ALGAE.**
Bittick, S.J.1, Bilotti, N.D., Peterson, H.A., and H.L. Stewart UCLA

Habitat associations are an integral part of coral reef community structure. Commonly, one organism lives in such close association within or near another that a spatial refuge occurs, whereby one of the organisms provides protection to the other. This is often the result of defenses of the host deterring an associate organism’s consumers. In Moorea, French Polynesia, the range and abundance of the brown macroalga, Turbinaria ornata, have increased drastically since 1980 such that dense aggregations of this macroalga are a dominant component of the backreef habitat. Turbinaria ornata is both mechanically and chemically defended from herbivores. Other species of macroalgae grow within aggregations of Turbinaria and may benefit from these defenses. This study investigates whether aggregations of Turbinaria create a refuge from herbivory for associate macroalgae. When Turbinaria aggregations were removed experimentally, there was a significant increase in the number of associate algal species. Moreover, an herbivory assay using the palatable local alga Acanthophora spicifera identified herbivory as the mechanism for lower diversity on bommies lacking Turbinaria aggregations. The local increase in algal richness due to the refuge from herbivory afforded by Turbinaria may be an important contribution to macroalgal and community dynamics on reefs in Moorea, French Polynesia.
\[ \textit{Detected of Fluorescence in-Situ Hybridization Products by Flow Cytometry; Applications for Symbiodinium} \]

Boyer, SE \textsuperscript{†} Moss Landing Marine Laboratories

Our ability to understand coral reefs and their fate in a changing climate is limited by our ability to monitor the diversity and abundance of algal symbionts living within the host. Symbiodinium (consisting of phylotypes A-G) contains the zooxanthellae that form symbioses with a range of protists and invertebrates. Recent evidence shows coral-Symbiodinium associations to be diverse both among species of coral as well as within individual colonies. The flexibility of these associations raises the possibility that physiological properties and tolerances of reef corals may vary according to the composition of the associations. Fluorescence in-situ hybridization uses a custom designed oligonucleotide probe with an attached fluorophore to label cells of a particular phylotype. Cells are then analyzed by flow cytometry which generates fluorescence data on a large number of individual cells. This method could be employed to rapidly assess Symbiodinium phylotype distribution in the field across broad scales and infer reef sustainability. Data was collected for cultured Symbiodinium clade B and is being developed for clades A, C and D. For clade B samples, brightly fluorescing hybridized cells were seen ubiquitously through epifluorescence microscopy, a signal that was also evident with analysis by flow cytometry.

\[ \textit{Invertebrate Community Composition Across Turbinaria ornata's Life Stages} \]

Briley, S. K.\textsuperscript{*,} Amirhamzeh, D., McKnight, J., and H.L. Stewart \textit{UCLA Department of Ecology and Evolutionary Biology}

\textit{Turbinaria ornata} is a tropical macroalgae whose range and abundance within French Polynesia has recently expanded to the point of being considered an invasive species. For this reason, studies exploring the ecological role it plays are critically important to the understanding of its impact on reef community structure. \textit{Turbinaria ornata} exhibits three distinct life stages: 1) attached to the substratum, 2) floating in rafts at the ocean surface, and 3) settled and decomposing on the benthos. Because macroalgae in other systems with similar life stages harbor communities of invertebrates, we extrapolated that \textit{T. ornata} would behave similarly. The goal of our study was to quantify and describe the invertebrate community living in association with \textit{T. ornata}, as well as determine community composition changes throughout its three life stages. Samples were collected and analyzed from each of these stages. Each stage harbored a diverse community of invertebrates and the composition of these communities varied between life stages. Species richness was highest in the floating raft and did not differ significantly between the attached and sunken samples. Species diversity was the highest in the sunken stage and lowest in the attached stage, indicating an increase in biodiversity as the \textit{Turbinaria} ages. \textit{T. ornata}’s potential to harbor a unique community of invertebrates could have vast implications in the reef system as a whole. Coupled with \textit{T. ornata}’s recent expansion to invasive status, these implications become greatly pronounced.

\[ \textit{Long-Term Population Dynamics of the Hydrocoral Millepora on Shallow Reefs in St. John, US Virgin Islands} \]

Brown, D J\textsuperscript{*,} and P J Edmunds \textit{CSU Northridge}

While the fire coral \textit{Millepora} is rare on many reefs, when found, it is an aggressive spatial competitor with a “sheet-tree” morphology that confers resilience to storm damage. In this study we examined the dynamics of \textit{Millepora} on reefs in St. John, using photoquadrats to sample the benthos yearly from 1992 to present. As dependent variables, we used colony area, percent cover of the benthos, colony density, branches colony\textsuperscript{-1} and branches quadrat\textsuperscript{-1}. Records of seawater temperature were used to explore the role of thermal forcing in \textit{Millepora} dynamics. Although \textit{Millepora} cover remained <10% throughout the study, it changed strikingly over the 17-y period with losses coinciding with years with large seasonal ranges in temperature or large numbers of “hot” days (i.e., >29.3°C). 1998 was unusually hot, and percent cover and area colony\textsuperscript{-1} decreased from 0.6% to 0.4%, and 32 to 26 cm\textsuperscript{2} respectively, while colony abundance and branches quadrat\textsuperscript{-1} increased by 70% and 35% respectively. The changes in cover were driven by a reduction in colony size through fission, although new recruits probably also contributed to these trends. While our correlative study cannot identify causal relationships, it is likely that the dramatic changes in cover of \textit{Millepora} were a consequence of high temperatures that exceeded the thermal threshold for this genus. Together, these data suggest the dynamics of \textit{Millepora} are strongly affected by abiotic processes, and they reveal how changes in cover of a non-scleractinian invertebrate can affect the availability of free space for other taxa.

\[ \textit{Tracking the Decline of an Established Invader: An Evaluation of the Status of the Atlantic Quahog Mercenaria mercenaria in Colorado Lagoon, Long Beach, CA} \]

Burnaford, J.L.\textsuperscript{†}, Pernet, B.\textsuperscript{†}, and S.Y. Henderson\textsuperscript{†} \textit{CSU Fullerton 2 - CSU Long Beach}

The Atlantic quahog (\textit{Mercenaria mercenaria}) has been introduced repeatedly to the Pacific coast of North America since 1870. Only one population is known to have become established in California, in Colorado Lagoon, a small (low-
tide perimeter ~1700m) urban lagoon in Long Beach (Los Angeles County). In the 1970s and 80s Colorado Lagoon hosted a large, reproductively-active population of *M. mercenaria*, with densities of up to 18 clams/m² in the intertidal and 500 clams/m² in the subtidal. Our study was designed to evaluate the current status of this population. In spring 2009 we collected all bivalves larger than 6mm (smallest axis) from 57 intertidal plots (0.25m² in area and 0.20m deep). We also collected bivalves in the top 15cm of sediment from 13 shallow subtidal locations (each ~0.5m² in area). Our data show major changes in the bivalve community at Colorado Lagoon over the past 20 years. First, no *M. mercenaria* were found among the 2460 live clams of 9 species in our sample plots, a striking difference from the previously-reported high densities. Quahogs are not extinct at the site, however – we did encounter two living *M. mercenaria* in searches outside of our sample plots. Second, the non-native Manila clam *Venerupis philippinarum*, which was not reported in surveys in the 1970s and 80s, made up 88% of the individuals collected in 2009. This shift in community composition from one dominant invader to another raises interesting questions about the population dynamics and community effects of invasive species in urban ecosystems.

† **EFFECTS OF DELAYED HATCHING NO MUSCLE AND SKELETAL DEVELOPMENT AND FEEDING RATES IN THE CALIFORNIA GRUNION, LEURESTHES TENUIS**

Carrillo, A.¹, Treybig, T.A., and K.A. Dickson CSU Fullerton

The California grunion, *Leuresthes tenuis*, spawns on sandy beaches at night during spring high tides. Fertilized eggs develop within the sand for 9-14 days until they are agitated by wave action during the next spring high tide, which mechanically triggers hatching. If this does not happen, embryos may remain viable for up to 35 days post-fertilization (dpf) and hatch during a subsequent spring high tide (= delayed hatching). The purpose of this experiment was to investigate effects of delayed hatching on development and feeding ability of grunion larvae, variables that could influence survival. We tested the hypotheses that 28-dpf larvae would be longer, have more developed skeletal structures, more locomotor muscle, and greater feeding rates than 10-dpf larvae. Batches of eggs from individual females were each fertilized with sperm from one male and incubated at 20°C in the lab until stimulated to hatch at 10 and 28dpf. The 28-dpf larvae were significantly longer, had significantly more dentary and pharyngeal teeth, and had more cartilaginous precursors of the hypural skeletal elements within the caudal fin anlage. The 28-dpf larvae also consumed more rotifers, *Branchionus sp.*, during a 4-h period. However, the cross-sectional area of locomotor muscle did not differ significantly between 10-dpf and 28-dpf larvae. Thus, delayed hatching in *L. tenuis* results in larvae that have more developed skeletal structures and consume rotifers at greater rates. These effects of delayed hatching may improve larval survival, and compensate for known negative effects, including decreased hatching rates and decreased energy reserves.

† **FACILITATIVE EFFECTS OF DOMINANT COMPETITORS ON SUBORDINATE SPECIES IN FOULING COMMUNITIES: IMPLICATIONS FOR THE MAINTENANCE OF SPECIES DIVERSITY**

Claar, D.C.¹, Edwards, K.F., and J.J. Stachowicz Univ of Hawaii Hilo, Bodega Marine Laboratory UC Davis

Although dominant competitors can exclude inferior species by pre-empting space, they can also modify the environment and provide secondary substrate, potentially facilitating coexistence. The solitary tunicate *Ascidia ceratodes* is a dominant competitor in the fouling community in Bodega Harbor, CA. This tunicate preempts primary substratum from competitors, but its thick tunic also allows other species to grow on its surface. The net effect of *Ascidia* on the community as a whole therefore depends on the balance between competitive and facilitative effects. In this study we evaluate the facilitative effects of *Ascidia* on the different life stages of common competing species. Specifically, we quantified larval settlement onto *Ascidia* compared to unoccupied space and compared the growth rate of newly settled individuals of two common species on *Ascidia* versus primary substrate. Some species known to be inferior competitors for space actually settled in greater density on *Ascidia* tunices, whereas others settled preferentially on bare space. Growth rate of recruits of both focal species was decreased on *Ascidia* compared to the control substratum. We found that colonial species established on primary space can escape overgrowth by growing onto *Ascidia*, and this occurred in about half of the observed contacts. This study indicates that the total effect of *Ascidia* on competing species is complex and depends on species-specific and life stage-specific effects. However, our findings are consistent with the idea that inferior competitors may persist locally by growing on secondary substrate provided by superior competitors.

† **UNDERSTANDING THE ROLE OF HABITAT IN MEDIATING PREDATION RISK OF LARVAL FISH EXPOSED TO AN INSECTICIDE**

Compton, V.M.¹*, Anderson, T.W.²*, Morgan, S.G.³, and G.N. Cherr³

1 - San Diego State Univ; UC Davis 2 - San Diego State Univ 3 - Bodega Marine Laboratory, UC Davis

Habitat structure is important in providing prey a refuge from predators, yet its importance relative to other factors in mediating predation risk often is unclear. The importance of habitat structure may be even greater in ecosystems with
higher contaminant loads such as estuaries because fish may suffer from reduced growth, impaired swimming ability, and lower predator vigilance. We explored the role of habitat structural complexity on predation risk of larval topsmelt Atherinops affinis exposed to chronic levels of the common insecticide esfenvalerate. Observations were made on prey swimming behavior prior to and during predation trials exposing topsmelt to piscivorous juvenile sticklebacks Gasterosteus aculeatus aculeatus. Artificial seagrass was used to simulate low and high levels of habitat complexity (densities) of seagrass habitat. Twelve treatments, with three levels of habitat complexity and four levels of contaminant exposure to topsmelt were used in predation trials, with nine replicates for each treatment. Observations of predator behavior were quantified by successful and unsuccessful attempts at capturing prey. Although topsmelt larvae exposed to high concentrations of insecticide were more likely to suffer from uncontrollable "twitching", exposure to the insecticide did not alter their predation risk. In addition, opposite our prediction, increasing habitat complexity resulted in an increase in predatory attempts and the proportion of successful attempts, suggesting that predator encounter rates and efficiency is positively related to habitat complexity. These preliminary results provide an avenue for future studies to explore how habitat and insecticide exposure of both prey and predators may influence predation risk.

† EPIPHYTIC AND BENTHIC MACROALGAL SURVEYS ACROSS FOUR SAN FRANCISCO BAY EELGRASS BEDS: IMPLICATIONS FOR SPECIES INTERACTIONS AND TROPHIC DYNAMICS.
Conahan, Gwen C.*, and Katharyn E. Boyer RTC - SFSU
Seagrasses are important primary producers worldwide, and seagrass beds harbor myriad other species of primary producers, including algal epiphytes on seagrass blades and benthic macroalgae. We conducted a survey of these three producer groups in San Francisco Bay eelgrass (Zostera marina) beds to support mesocosm experiments evaluating the interactions of these groups and their roles in trophic dynamics. We conducted quarterly surveys of four eelgrass beds, estimating biomass of eelgrass, epiphytes, and macroalgae. We found highly variable species composition and relative biomass of producers across these four eelgrass beds as well as large seasonal changes within beds. Both eelgrass and epiphyte biomass frequently varied 2 to 4-fold among sites. Macroalgal species composition was very different among sites, with a different dominant species contributing 1-2 orders of magnitude greater biomass than other algal species. We conclude that the total and relative contribution of biomass among producers varies dramatically across space and time in San Francisco Bay eelgrass beds, with implications for eelgrass health and food availability for higher trophic levels.

PROTEOMIC APPROACHES FOR INVESTIGATING TEMPERATURE EFFECTS ON BARNACLE (BALANUS AMPHITRITE) CEMENT PROTEINS
Daugherty, M. J.*, Hitt, L. R., Johnston, L. A., Brewer, L. H., Tomanek, L., and D. E. Wendt Center for Coastal Marine Sciences, California Polytechnic State University, San Luis Obispo
Barnacles are often the dominant hard foulers in marine waters, attaching to substrates by secreting a proteinaceous adhesive. Environmental variables such as temperature may influence the adhesive properties of barnacle cement. Previous experiments in our lab have shown an inverse relationship between critical removal stress (CRS) and the temperature at which barnacles were reared. The mechanism accounting for the temperature effect is still unknown and could be attributed to compositional changes in the cement. Preliminary experiments using 1D SDS PAGE confirmed the presence of multiple proteins in uncured cement. Currently we are extending the previous experiments to include a proteomic approach of 2D-E to explore potential variations in cement protein expression among barnacles grown at different temperatures. Specifically, we expect to: 1) monitor changes in protein expression at two rearing temperatures, 15°C and 25°C; 2) identify and infer functions of individual proteins and, 3) document and catal

† CONNECTIVITY AMONG POPULATIONS OF NEARSHORE PACIFIC ROCKFISH: IMPLICATIONS FOR MARINE RESERVE DESIGN
Dick, S.J.* University of British Columbia
The worldwide depletion of marine fish stocks due to overfishing is a major concern both ecologically and economically. Efforts to conserve diminishing fish populations are increasingly turning to the implementation of no-take marine reserves. However, the efficacy of marine reserves at promoting population recovery depends critically upon the dispersal characteristics of the species targeted for protection. In many cases, the scales of dispersal of exploited marine fishes are poorly understood. Among these are the Pacific rockfish (Genus Sebastes). Several recent studies have reported relatively low levels of genetic differentiation among rockfish populations on the U.S. Pacific coast, suggesting high dispersal. However, the British Columbia coast is more topographically complex than the U.S., with many deep inlets that may act as barriers to larval dispersal, leading to greater population genetic differentiation. I
am investigating the genetic structure of copper rockfish (Sebastes caurinus) populations along the West Coast of Vancouver Island. I have sampled five outer coast populations and five inner coast (inlet) populations. I will use microsatellite DNA analysis to investigate genetic differentiation among these populations and to infer larval connectivity. In addition, I will examine life history and dietary variation among populations using otolith growth and stable isotope analysis. The findings of my research will help us to identify the optimal size, placement and frequency of Rockfish Conservation Areas (RCAs) in British Columbia.

NITRATE SOURCES AND DYNAMICS IN THE MORRO BAY ESTUARY

Dickson, H. M.*, Moline, M. A., and D. E. Wendt  California Polytechnic State University

Nitrates are an important source of nutrients for marine and estuarine ecosystems. However, high levels of nitrates can be detrimental, causing algal blooms that lead to anoxic dead zones, which are unable to support most aquatic life. Estuaries are prone to nitrate loading because they receive nitrates from both the land (from sources such as sewage treatment plants and fertilizer) and the ocean (from processes such as upwelling). Morro Bay is a small estuary on California’s central coast with only two entry creeks, making it a good system for studying nitrate dynamics. We asked a series of four questions about nitrate levels in Morro Bay: 1) Do nitrate concentrations increase at low tide after a rainfall; 2) Are there peaks in nitrate levels at high tides that may indicate upwelling; 3) Do nitrate concentrations increase during neap tides; and, 4) Is groundwater contributing to high nitrate levels in the bay. Four water quality arrays are deployed in Morro Bay which record seven water quality parameters, including nitrate concentration and tide. One year of data on nitrate tide and rainfall was analyzed (from September 1st, 2007 to August 31st, 2008). Nitrate concentration in the bay increased only after multiple rain events, indicating that it took some time for the soil to become saturated. Nitrates increased only during certain high tides, which could indicate upwelling during those times. Finally, nitrates increased during neap and low tides, suggesting that groundwater was also a significant source of nitrates to the bay.

† EFFECTS OF HABITAT HETEROGENEITY ON ALASKAN KELP FOREST FISH POPULATIONS.

Efird, T.P.*, and B. Konar  University of Alaska Fairbanks

Fish distribute based on habitat preference. Within broad scale habitats, a finer scale of habitat choices is present. Kelp forests offer fish microhabitats based on several aspects. These incorporate spatial factors, such as forest size and location within a forest; as well as other biotic and abiotic factors. How fine scale habitat features affect the associated fish assemblages in Alaska is poorly understood. This should be a topic of concern as Alaska’s kelp forests serve as critical habitat for many commercial, recreational, and subsistence harvested species. Furthermore, kelp forests are in a state of flux; shrinking and undergoing shifts in forest forming algae. The objectives of this study were to investigate if fish abundance differed across a range of kelp forest sizes, and to determine if fish abundance differed between interior and edge microhabitats. To address these objectives diver based visual 100m² belt transects were performed at 10 sites in Kachemak Bay, Alaska. Transects were run along the edge and within the interior of the forest. Sites were mapped with a GPS by circumnavigating the canopy kelp at low tide with a small boat. Kelp forests in this study ranged from 2,522 m² to 1.8 km², representing the distribution of forest sizes in the region. The results of these surveys show distinct patterns of relative abundances among 28 species of fish based on their observed microhabitats. Future management and conservation decisions should take these findings into consideration when addressing Alaska’s dynamic kelp forests and how nearshore fish populations may respond.

† A NEW DEVELOPMENT IN EXTERNAL IDENTIFICATION OF THE SEA URCHIN, TRIPNEUSTES GRATILLA

Espasandin, Carrie L1*, Daly-Engel, Toby2, Nakaya, Jan3, Stankus, Austin3, and Cynthia Hunter2  1 - CSU Long Beach 2 - University of Hawaii at Manoa

Nylon screws were tested as a method of anchoring external identification tags on 30 collector urchins, Tripneustes gratilla (Linnaeus). The screws (nylon, round head, 4-40 x ¼”) were inserted into holes drilled into the upper interambulacral groove, approximately two centimeters from the anus of each urchin. The efficacy of two external tag types, DYMO and Peterson disc, was tested both in the lab and in the field. Tag success was gauged by mortality rate, retention, and visibility in the field. Also taken into account was ease of individual identification, health effects, cost of materials, and time spent inserting the screws. Urchins were observed for nine weeks in open flow sea water tanks and compared to a control of twenty non-tagged urchins. Six urchins were then released with the nylon screw tags affixed and monitored in the field for an additional six weeks. This tagging technique was shown to have a mortality rate of zero individuals over the nine week observation period, the lowest mortality recorded for any tagging protocol of an echinoderm species to date.
COMMUNITY COLLEGE BIOLOGY: A COOPERATIVE APPROACH

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The need for student-centered instruction in biology at the post-secondary level inspired me to develop ten cooperative learning activities that encourage student engagement in biology lecture. Additional goals of the curriculum were for students to gain an appreciation for and an understanding of biology concepts. Community College Biology: A Cooperative Approach is designed to be used in the teaching of general biology, but could be very well be implemented in the instruction of other courses, such as marine biology.

The study was conducted in two lecture sections (n=95) of a general biology course at a small community college in southern California. Instructor observation, rubric scoring of student levels of engagement, student transcripts from online cooperative assignments, individual student interviews, a class exit survey, and examination scores were used to assess the effectiveness of Community College Biology: A Cooperative Approach. Community College Biology: A Cooperative Approach was successful in engaging students in biology course content both in and outside of lecture. Student positive perceptions of the relevancy of biology were reported as a result of the curricular approach. Students conveyed feeling greater at ease with the material and most believed that working with a partner or in small groups helped them to understand and recall course concepts more comprehensively. The inclusion of cooperative learning activities in a lecture setting promoted a community of learners. Students reported that, as a result of working in small groups, they gained an appreciation for others’ viewpoints, contributed more often to discussions, and valued having greater access to the instructor.

PATTERNS OF OCEAN FRONTAL FORMATION OVER THE NORTHERN CALIFORNIA SHELF

Fontana, R.E.†, Largier, J.L., and J. Jahncke2 - Bodega Marine Laboratory, UC Davis 2 - PRBO Conservation Science

The distribution and dynamics of coastal ocean production are temporally and spatially heterogeneous. Physical oceanographic features can enhance productivity. One such type of feature develops at the intersection of two water masses, and is referred to as a frontal system. These features can lead to increased efficiency of energy transfer throughout the food chain. Here, we examine the presence and patterns in distribution of front locations over the shelf region off northern California. We analyzed ten years of underway thermosalinograph data from two different studies: the CoOP Wind Events and Shelf Transport (WEST) project and an ongoing study conducted by PRBO Conservation Science. Data indicate that fronts are more common during spring and summer, in comparison to fall and winter. These sharp frontal gradients in spring and summer are primarily related to temperature differences due to upwelling and surface warming. However, there are also salinity influences associated with upwelling and, mostly in spring, with land runoff (e.g. San Francisco Bay outflow). In the winter, fronts are dependent exclusively on salinity variations due to freshwater outflow. Frontal patterns are predictable both spatially and temporally off northern California and we identify recurrent features, describing the flow features that account for these fronts. These features may produce patches of elevated productivity, which are extremely important areas for feeding by seabirds and marine mammals.

DEVELOPMENT OF A WATERSHED SIMULATION MODEL USING THE TARSIER ENVIRONMENTAL MODELING FRAMEWORK WITH APPLICATION TO THE CARMEL WATERSHED IN CALIFORNIA

Frame, J.M.† CSU Monterey Bay

The Carmel River on the Central Coast of California currently provides fresh water to the majority of the Monterey Peninsula’s residents and supports threatened and endangered habitat. Over the past two decades the use and management of this natural resource has become controversial to a number of stakeholders. An accurate simulation model and visualization of the Carmel Watershed’s hydrologic processes could help in making management decisions and educating stakeholders. Using watershed modeling tools in the Tarsier Modeling Framework a model simulating surface runoff, sediment and nutrients through the watershed is currently being developed. This model uses a 10m DEM, a precipitation series, and land cover data as inputs. The model simulates the drainage of water through a watershed basin by transporting water from DEM cells with higher elevations to cells with lower elevations. When the water reaches the main channel pulses of streamflow and entrained material are passed through a series of links and nodes in a network data set that represents the routing of water downstream. Preliminary results have shown that the model simulates the reaction of the river discharge accurately to heavy rain events, but overestimates the runoff during light rain events. This problem will be fixed with the addition of a bucket style sub model representing the region’s shallow aquifer, into which dry-season flow will infiltrate along the downstream reaches of the river. Improving the accuracy of the landscape characteristics and their effect on surface flow will also increase the performance of the model.
SPINY LOBSTERS, *Panulirus interruptus*, FROM INSIDE MARINE LIFE PROTECTED AREAS,
A growing body of evidence suggests that marine life protected areas (MLPA) can significantly change the density of fished species. Such direct effects can significantly alter marine communities. However, indirect effects of management decisions can be equally profound. The present field study examined the indirect effect of a preserve on the dietary breadth of the California spiny lobster, *Panulirus interruptus*, on Catalina Island, CA. We monitored this keystone predator’s attack behavior inside two separate preserves, and compared it to that of lobsters from neighboring non-protected areas. We used SCUBA to present the relatively unpalatable sea hare, *Aplysia californica* to foraging lobsters at night. No observation of natural attacks by lobsters on *Aplysia* has been reported prior to this study. Our presentations outside the preserves confirmed this lack of attacking behavior (0 attacks; 7 dives; 89 presentations). However, within the two preserves, lobster attack frequency averaged 24.8%. (sem = 3.4, n = 14 dives; 287 presentations). In the most vigilantly protected part of the preserves, this frequency increased to 34.5% (sem = 2.0; n = 7 dives; 93 presentations). We conclude that MLPAs cause lobsters to broaden their diet, thereby consuming less-preferred species. We hypothesize that this effect is mediated through intraspecific competition: The lack of human fishing on lobsters in the preserve increases biomass density of lobsters, thereby reducing available food. The fact that lobsters in the preserves attack and eat *Aplysia* may have important implications for other non-preferred food items with stronger functional connections to the ecosystem.

† GROWTH AND PREDATION SUSCEPTIBILITY OF THE BARNACLE BALANUS GLANDULA TO MODERATE OCEAN ACIDIFICATION.

Gooding, R.A.*, and C.D.G. Harley University of British Columbia

Adult and juvenile barnacles from Friday Harbor, WA, were grown under oceanic carbon dioxide concentrations consistent with current (~390 ppm) and predicted (~780 ppm) levels by the year 2100. After 9 weeks of exposure, barnacles were exposed to predation by the whelk *Nucella lamellosa*. Preliminary results showed that, unlike many previously studied calcareous marine species, *Balanus glandula* experienced no change in growth rates with increased CO2 levels. This finding agrees with recent studies of other crustacean species, suggesting that crustaceans may be more tolerant to moderate ocean acidification than many other groups of organisms.

† A COMPARISON OF FISH ASSEMBLAGES ON ARTIFICIAL AND NATURAL REEFS IN THE SOUTHERN CALIFORNIA BIGHT

Granneman, Jennifer † and Mark Steele CSU Northridge

Despite the extensive use of artificial reefs worldwide, there is currently no optimal design for artificial reefs to increase net production of fishes in an area. In order to determine how closely artificial reefs mimic nearby natural reefs, five pairs of artificial and natural reefs off the coast of Southern California were studied. Midwater and benthic transects were used to census fish and invertebrate assemblages on the reefs as well as to measure physical characteristics of the reefs. Artificial reefs had greater densities and higher species richness of fishes along the benthos than found on natural reefs, but there was a trend for artificial reefs to have lower densities and lower species richness in the water column than found in the water column of natural reefs. Overall, i.e., combining benthic and midwater samples, there was no significant difference in density or species richness between artificial and natural reefs, nor in the average size of fishes. Artificial reefs were found to be more rugose and had greater vertical relief than natural reefs; whereas macroalgae was more abundant on natural reefs. These differences in habitat on the two reef types likely explain the patterns of fish density and species richness observed. The artificial reefs studied were generally smaller than the natural reefs, but largest artificial reefs tended to be most similar to the natural reefs. Overall, the results suggest that large artificial reefs likely function very similarly to natural reefs if they are composed of substrata that mimic natural reefs well.

† THE SPATIAL DISTRIBUTION OF EPSFAUNA IN RELATION TO TIDAL SCOUR AT ELKHORN SLOUGH, CA

Hall, A.*, Gomez, K., and R. Kvitek CSUMB

Elkhorn Slough is one of the most ecologically important and productive estuaries remaining in California, but has experienced rapid habitat loss due to tidal scour with the creation of the Moss Landing Harbor in 1947. In response, the Elkhorn Slough Tidal Wetlands Project (ESTWP) was started to address the impacts of degrading habitats and provide restoration recommendations. In this project, the spatial distribution of tidal scour was examined using geospatial analyses of changes over time of the depth of the main channel. The next step is to determine whether there have been changes in spatial distribution of epifaunal species in association with tidal scour. Surveys were compared from 1993 through 2007 with a 2009 survey conducted by the Seafloor Mapping Laboratory (SFML) at CSU Monterey Bay. Elkhorn Slough is eroding, but at a decreased rate. Erosion is increasing along the deep end of the main channel, near the mouth of the slough while decreasing with some deposition near the head. The results suggest that erosion rates in
Elkhorn Slough may be stabilizing. Changes in the spatial distribution of benthic epifauna along the thalweg have been previously related to this erosion gradient, and will be assessed for recent changes by comparing the results from previous SFML video surveys in 2003 with those from a new survey to be conducted in 2009. The results from this research provide important information for effective ESTWP decision making regarding management alternatives for restoration of Elkhorn Slough habitat.

† SPATIAL PATTERNS IN DENSITY OF THE SEA URCHIN DIADEMA SAVIGNYI: EFFECTS OF PREDATORS
Han, Xueying  Ecology, Evolution and Marine Biology: UC Santa Barbara
Herbivory plays a crucial role in structuring coral reef communities. A decrease in abundance of herbivores increases the probability of state shift from coral to algae domination. Although both fish and sea urchins are important herbivores, many tropical reef systems have suffered from over-harvesting of fishes and therefore, a more thorough understanding the effect of urchins on community structure is essential. This study examines how population dynamics of the urchin Diadema savignyi, affect the reef community of Moorea, French Polynesia. D. savignyi occur either in high density aggregations or as cryptic solitary individuals. I am exploring both potential causes and effects of this spatial variation in density. To test whether variation in intensity of predation contributes to the observed spatial pattern, urchins were tethered at locations around the island to estimate spatial variation in survivorship. There was little temporal variability in survivorship within a location, but substantial spatial differences among the locations. Spatial heterogeneity in urchin survivorship appears to be explained well by variation in abundance of their primary predators (e.g., triggerfish). My results suggest a major influence of top-down control on the structure of the coral reef community in Moorea.

† THE EFFECTS OF OVERSTORY REMOVAL ON UNDERSTORY ALGAL BIOMASS AND NET PRIMARY PRODUCTION IN GIANT KELP FORESTS
Harrer, SL†, Miller, R, and DC Reed  SBC LTER
Rocky reef ecosystems are thought to be one of the most productive in the world. Along the Southern California Bight, these systems are largely dominated by giant kelp, Macrocystis pyrifera, whose quick growth and monopolization of light is well documented as a mechanism for competitive exclusion among most benthos associated primary producers. Relief from intense competition for light is accomplished through disturbance events associated with large winter swells that forcefully uproot Macrocystis individuals reduce surface canopy density and allow ample light to reach the seafloor. As climate change concerns increase, quantification of disturbance induced effects on ecosystem net primary production has become invaluable. Unfortunately, there are very few resources describing spatial and temporal patterns of understory macroalgal production from which the consequences of long term change can be assessed and compared. This is inherently due to the enormous logistical and labor intensive effort associated with collecting productivity data in an extreme system on a consistent basis. To better understand patterns, causes, and ecological consequences of change in macroalgal productivity, we have developed a logistically simple model using mean hourly benthic light data, species specific photosynthesis versus irradiance (PvsE) curves and macroalgal foliar standing crop at three kelp forests along the Southern California Bight.

† SPECIES MIGRATION, DISPERAL LIMITATION, AND TECHNOLOGICAL INNOVATION: THE APPLICATION OF A NOVEL TECHNIQUE TO IDENTIFY AND COUNT MARINE LARVAE TO ASSESS DISPERAL AT SPECIES RANGE BOUNDARIES
Hoaglund, EA††, Henzler, CM†, Hofmann, GE†, and SD Gaines†  1 - Dept. Ecology, Evolution and Marine Biology, UC Santa Barbara 2 - Marine Science Institute, UC Santa Barbara
Species ranges are expected to shift with changing climates, and some species are already moving pole-ward, tracking recent climate warming. However, some species distributions are restricted by physical features that may limit their ability to track changes in climate. We have a poor understanding of whether marine species’ distributions can be established by oceanographic barriers to dispersal, and thus cannot predict how coastal marine organisms will respond to climate change. I will evaluate the dispersal of larvae of multiple marine species that share a distributinal boundary to determine the role of local oceanographic features in establishing this range margin. Determining the dispersal of larvae across oceanographic features requires high-resolution spatial and temporal sampling. Processing these samples the traditional method of morphological identification and manual sorting would inhibit this study as target species in this study are impossible to identify to species level using morphology, and processing the proposed number of plankton samples for multiple taxa is very time consuming. To address these issues, we have developed a novel technique to identify and count marine invertebrate larvae. Larvae are identified by fluorescently-labeled, species-specific molecular probes, which are bound to target larvae within a whole plankton sample using in situ hybridization. The labeled larvae are counted from the entire plankton sample by a cell sorter, which classifies each larva by
fluctuate according to weather and larger ocean processes. The pelagic larvae of marine organisms face a battleground of varying temperatures, salinity, dissolved oxygen, ocean currents produced by wind, and the availability of food. We will test the hypothesis that these physical and biological factors affect the survival and settlement of marine invertebrates at varying depths. We are specifically studying the settlement of red and purple sea urchins (*Strongylocentrotus franciscanus* and *S. purpuratus*, respectively) at the study site located at the Cal Poly Center for Coastal Marine Sciences (CCMS) in San Luis Bay, California. We deployed settlement brushes at four depths in the water column and we have sampled these brushes every two weeks during their settlement season of 2009. Metamorphosed sea urchins and other juvenile invertebrates were collected from standardized settlement surfaces, identified and counted. Simultaneously, oceanographic data including temperature, salinity, dissolved oxygen, wind speed, and chlorophyll levels were being recording continuously at the CCMS. Our current data from January to the end of May 2009 indicate there is a peak in settlement in late February and have shown settlement is favorable highest on brushes nearest the surface. We have also examined whether there are correlations with the physical and biotic parameters and sea urchin settlement across the varying depths and found that while chlorophyll concentration has no affect, temperature and salinity may be deciding factors in urchin settlement.

† PHYSICAL AND BIOLOGICAL CHARACTERISTICS OF *NEREOCYSTIS LUETKEANA* AND *EUALARIA FISTULOSA* KELP FORESTS IN KACHEMAK BAY, AK.

Hondolero, D.E.†, and M.S. Edwards 1 - San Diego State University & NOAA's Kasitsna Bay Laboratory 2 - San Diego State University

Kelps provide mid-water structure in hard-bottom, nearshore temperate marine ecosystems. These kelp forests can harbor diverse communities of invertebrates, providing nursery conditions for juveniles and refuges for adults. Due to their mid-water structure, kelp forests can dampen wave energy and modify currents passing through them. The canopy formed by kelps also attenuates the amount of light reaching the bottom. These physical characteristics can influence the biological composition of the communities found within them, including biodiversity, spatial distribution of organisms, and the nature of species interactions. A series of surveys within forests of two canopy-forming kelps *Eualaria fistulosa* and *Nereocystis lutkeana* in Kachemak Bay, Alaska during 1977 found that *Eualaria* had a wider distribution than *Nereocystis* in the shallow, sublittoral zone. In contrast, surveys during 2009 found that *Nereocystis* has a wider distribution pattern. These two kelps have dissimilar morphologies that may result in differential modulation of current speeds within the two forest types. The goal of our research is to characterize the physical and biological characteristics of these different forest types and examine how species replacements are impacting biodiversity in the Kachemak Bay ecosystem. During the initial field season we gathered data to compare benthic biodiversity, larval settlement, and light attenuation between the two kelp forest types. Significant differences were found in distribution patterns of macroalgae. Future fieldwork will focus on comparing current modulation in addition to collecting more biodiversity and larval settlement data.

† COLLABORATION AMONGST THE KELP: PROVIDING CRITICAL DATA AND MECHANISTIC UNDERSTANDING FOR MARINE MANAGEMENT

Honey, K.T.†, Leary, P.R., Denny, M.W., Litvin, S.Y., Micheli, F., Monismith, S.G., Moniz, R., and C.B. Woodson

Stanford University

In summer 2009, a team of Stanford University researchers began a project at the Hopkins Marine Station under a larger initiative to establish a Marine Life Observatory, which will provide long-term data on the health and functioning of nearshore marine ecosystems. This project, named the Environmental Venture Project (EVP), is a long-term collaboration between ecologists, biomeaniticians and engineers. The EVP goal is to reveal how small-scale physical and biological processes affect nearshore fish assemblages and ecosystem functioning and provide further mechanistic understanding of biophysical processes within kelp forests and nearshore marine systems. Increasingly, there is a growing awareness that large-scale patterns of distribution in marine organisms are often correlated with large-scale ocean dynamics. This suggests that the physical environment strongly influences the dynamics of marine populations. Our ability to predict population dynamics depends on understanding the mechanisms through which individuals are coupled to their physical environment, an understanding that is generally lacking. For example, to accurately assess the efficacy of marine protected areas (MPAs) and other spatial management interventions (e.g., ocean zoning) we need...
improved research strategies for, and interdisciplinary understanding of, how biophysical processes operate at the small scales contained within MPAs. Our EVP project addresses such research needs and will guide future efforts of the Marine Life Observatory. Long-term, this data collection, synthesis, and dissemination will answer questions about the impact of management decisions or environmental changes on marine ecosystems, which can then help inform future decision-making and ocean policy in central California.

† PATTERNS IN ASSEMBLAGES OF NEARSHORE FISHES WITH RESPECT TO LANDSCAPE-SCALE HABITAT CHARACTERISTICS IN CENTRAL CALIFORNIA
Hunter-Thomson, K.I.†, and R.M. Starr2 1 - Moss Landing Marine Laboratories 2 - UC Sea Grant Extension Program
In terrestrial systems, the structures of species assemblages are influenced by landscape-scale habitat characteristics such as the type, amount, and spatial configuration of habitats. In particular, terrestrial studies have shown that species density, species diversity, and size of individuals positively correlate with increased proximity to a habitat edge and with increased perimeter-to-area ratio. We plan to examine the density, diversity, and length frequencies of nearshore fish populations near Point Lobos, California, with respect to two landscape-scale habitat characteristics: proximity to habitat edge and perimeter-to-area ratio. Landscape patches will be defined as discrete areas of isolated hard substrate, as determined from side-scan sonar images. We will use data from visual strip-transects collected from the Delta submersible in 2004, 2007, and 2008 to quantify densities, diversity, and length frequencies of fishes within a landscape patch. This information will enable us to (1) analyze variations in the assemblage structure of nearshore fishes with respect to landscape-scale habitat characteristics, (2) quantify differences in the lengths of individual fishes with respect to landscape-scale habitat characteristics, and finally (3) evaluate patterns of fish density and lengths of individual fishes with respect to landscape-scale habitat characteristics in multiple regions of the central coast. Whereas previous fish-habitat studies have focused on fine-scale associations, this study provides a new approach of quantifying patterns of the nearshore fish assemblages with respect to landscape-scale habitat characteristics.

† SHINY SPHERES OF PLACOZOANS (TRICHOPLAX) FUNCTION IN ANTI-PREDATOR DEFENSE
Jackson, A.M.†, and L.W. Buss2 1 - Department of Ecology & Evolutionary Biology, UC Santa Cruz 2 - Department of Ecology & Evolutionary Biology, Yale University
Placozoans, Trichoplax adhaerens, are small, slow-moving, basal marine invertebrates that lack a nervous system. Aside from their transparency, they would appear vulnerable to predation. When individual placozoans were fed to isolated polyps of a potential predator, the hydroid Podocoryna carnea, polyps became paralyzed in all 27 trials. The time to recovery from paralysis varied with the relative size of the polyp and the placozoan. In a second set of trials, placozoans were disassociated into separate cells and then reaggregated by centrifugation to produce pellets of tissue lacking the vesicles called shiny spheres, normally abundant in the upper epithelium. We fed pellets of two size classes to the hydroid polyps. When the placozoan pellet was smaller than the hydroid, paralysis was eliminated in nine of ten trials. When the placozoan pellet was comparable in size to the polyp, paralysis occurred, but the recovery time was substantially reduced when compared with trials in which polyps were fed intact placozoans possessing shiny spheres. In addition, a query of the Trichoplax genome revealed that it encodes a number of proteins found in toxins or venoms of vipers, elapid snakes, South African puffer frogs, puffer fishes, and wasps that are involved in pre- and post-synaptic neurotoxin activity and/or in proteolytic processes. These findings support a function of shiny spheres in anti-predator defense.

THE RESPONSE OF ECHINOPLUTEUS LARVAE OF DENDRASTER EXCENTRICUS TO HALOCLINES VARIES WITH LARVAL AGE AND MATERNAL EFFECTS.
James, V.R.†, Warneke, A.M.†, Kiel, C.L.†, Miller, W.R.†, and B.T. Hentschel† 1 - Department of Biology, San Diego State University 2 - Patrick Henry High School
How meroplanktonic larvae alter their position in the water column in response to physical and chemical stimuli is poorly understood. We measured the vertical distribution of sand dollar larvae in laboratory haloclines, testing for differences among larvae spawned from different mothers and for changes as larvae grew over 16 days. Larvae from three mothers were cultured on a mixed-phytoplankton diet. On 11 observation days during the 16-d period, subsets of larvae from each culture were photographed for size measurements and added to cylindrical aquaria (7-cm dia) containing a thin layer in which a 1-cm-thick layer of 32-ppt seawater was stratified between 35-ppt and 29-ppt layers measuring 14 cm and 10 cm, respectively. Replicate cylinders were placed in an outdoor water bath to maintain temperature and a natural light cycle. On observation days, 150 larvae were added to each cylinder at 4:00 pm, and the vertical positions of larvae were recorded 18 h later. Larvae from the three mothers did not differ in size. Larvae reached the 6-arm stage by day 5; most had 8 arms by day 14. There was a significant increase in the proportion of larvae aggregating near the central thin layer over time (P < 0.001). On day 3, for example, an average of only 4% of
the larvae aggregated in a 3-cm region surrounding the central thin layer. That average increased to 35% on day 14. We also found strong evidence that the vertical position of larvae differed among the three maternal cultures (P < 0.001).

† EFFECTS OF VARIABLE TEMPERATURE AND NUTRIENTS ON KELP MICROSCOPIC STAGES AND FERTILIZATION SUCCESS
Jeffries, SV1,2, Muth, A2, and MH Graham* 1 - CSU Monterey Bay 2 - Moss Landing Marine Labs
Cultures were conducted on three kelp species (Macrocystis pyrifera, Alaria marginata, Laminaria ephemera) native to the central California coast to test the effects of temperature and nutrients on fertilization success. Cultures were grown under three nutrient levels (1, 5, and 10 μmol nitrate) and two temperature levels (12°C and 18°C) at 40 μM photons m-2s-1 and a 14:10 h light:dark photoperiod. Settlement density and germination success were estimated after 24 and 48 hrs, and cultures were monitored weekly for sporophyte production. All three species produced sporophytes in the 12°C temperature treatment only and all 12°C cultures produced sporophytes at all nutrient levels, demonstrating the primary effect of temperature on sporophyte production. The effect of nutrients on settlement densities, 7-day survivorship and sporophyte densities in the 12°C temperature treatments varied significantly among the different microscopic stages of the three species. These results suggest that temperature variability may be the primary factor driving fertilization success in kelp taxa, and that the effect of nutrients is secondary and species-specific.

† EFFECTS OF PHYSICAL CHARACTERISTICS ON FLAMMABILITY FOR 20 PINES
Johnson, E. 1*, Varner, J.M. 2, and E.A. Engber 1 - CSUMB 2 - HSU
Flammability of plant species is an important topic to understand the ecology and management of ecosystems. Relationships between litter flammability, geographic location, and fire history have been main areas of focus in flammability research. However, little research has investigated the relationship between fuel characteristics and the corresponding effects on flammability. We evaluated litter from 20 pines using standard burn metrics and physical dimensions. Needle length (cm) and needle thickness (mm) were measured and compared to several measures of flammability. Flame height, flame time, ember time and percent combusted were recorded for each species. We collected and burned Bishop pine, Beach pine, Pitch pine, Ghost pine, Red pine, White pine, Torrey pine, Slash pine, Jack pine and Ocote. 10 additional species (Jeffrey pine, Ponderosa pine, Jack pine, Beach pine, Monterey pine, Sugar pine, Slash pine, Longleaf pine, Knobcone pine and Sand pine) characteristics were gathered from published works using the same methodology. Needle length produced more significant linear regressions by each flammability measure than needle thickness. However, the results indicate these two physical dimensions are not strong predictors of flammability. Pitch pine (Pinus rigida) produced the highest average flame height (85.6 cm) but had a low average needle length (7.98 cm). Future work should investigate the roles of other factors (bulk density, surface to volume ratio, or chemical composition) and their effects of flammability on pine needles.

† IMPACTS OF DIADEMATID ECHINOID GRAZING ON THE CRUSTOSE CORALLINE ALGA HYDROLITHON ONKODES IN SOUTHERN TAIWAN
Johnson, M.D. 1, and R.C. Carpenter CSU Northridge
Diadematid echinoids are important grazers on algae in coral reef ecosystems, and are among the few grazers with mouth parts adapted to denude the calcareous thalli of calcified algae. Crustose coralline algae (CCA) are an essential component of reef communities, yet few studies have addressed how CCA are impacted by sea urchin grazing. Preliminary studies were conducted to elucidate the effects of echinoid grazing on Hydrolithon onkodes, a common CCA on Taiwanese coral reefs. H. onkodes fragments were collected from Nan-Wan Bay at 3-4 meters depth and were maintained at the National Museum of Marine Biology and Aquarium in southern Taiwan. Two echinoid species, Diadema savignyi and Echinothrix calamaris, grazed on H. onkodes fragments during night trials in controlled laboratory conditions. The photosynthetic capacity of grazed versus ungrazed CCA was approximated by the relative electron transport rate (rETR) from measurements of light adapted yield using a diving PAM. Photographic analyses estimated surface area grazed and recovery of grazed areas three days after scar infliction. These preliminary results indicate that grazed CCA showed a decrease in rETR, thus photosynthetic capacity was impaired by sea urchin grazing. D. savignyi grazed approximately 56% of CCA fragment surface area, and E. calamaris grazed 63% of CCA fragment surface area. Three days after scar infliction grazed surfaces had recovered by 96-100%. These preliminary results describe the impact of echinoid grazing on CCA, and provide baseline measurements for future experiments that will investigate the impact of ocean acidification on susceptibility of CCA to echinoid grazing.
SHIELD LIMPETS (LOTTIA PELTA) THAT MIMIC SEAWEED LIMPETS (LOTTIA INSESSA) EXPERIENCE A MID-LIFE CRISIS
A limpet's shell can reflect a lifetime history of microhabitat changes. A prime example involves "midlife crisis morph" (MCM) shield limpets, Lottia pelta, found under the rockweed, Silvetia compressa. The shell of an MCM is normal "rockweed morph" on its lower and younger half; broadly oval and cryptically colored like rockweed. Its upper and older half is completely different: it looks just like the seaweed limpet, Lottia insessa, a specialist grazer on the stipes of feather boa kelp (Egregia menziesii). We suspected MCMs were migrants from feather boa kelp, which led to the surprising discovery that the limpet species most common on feather boa kelp was either shield or seaweed, respectively, depending on whether or not there was abundant rockweed nearby. Seaweed limpets are annual species reflecting the seasonal disappearance of feather boa kelp, with renewed recruitment each spring. Shield limpets on feather boa kelp continue to grow by migrating up to the rockweed canopy. We confirmed these general patterns with DNA sequencing of limpets at multiple sites, with or without rockweed, extended to now reliable morphological identification without sequencing. Only long lived limpets have: 1) a dark hooked anterior shell apex as juveniles, retained at the apex in adults; 2) dark tissue pigments at the site of shell attachment; 3) fine radial shell sculpturing when uneroded; 4) nearly parallel lateral shell margins. One implication of our study is that limpets could play an under-appreciated role affecting long-term algal abundance, especially if their habitat shifts might be related to destructive grazing of their associated algal species.

COMPARATIVE PHYSIOLOGY OF THE INVASIVE DECAPOD CARCINUS MAENAS, THE EUROPEAN GREEN CRAB
Kelley, A.L.*, and B.A. Buckley Portland State University
In our increasingly modernized world, biological invasions have reached pandemic proportions, escalating biological homogeneity within and among ecological communities worldwide. The effects of biological invasions are manifold. Such invasions dramatically alter ecosystem function, and annually cause billions of dollars worth of economic damage within the United States alone. As a result, there is an increasing interest in predicting the spread of established bio-invaders. These predictions would inform strategies designed to minimize spread of invasive species, determine ideal monitoring sites for their early detection and facilitate eradication efforts. One of the most prevalent invasive invertebrates is the European green crab, Carcinus maenas, which is native to the Atlantic from northern Africa to Europe, and has invaded many different regions globally. Invasive species arrive in new environments with genomes shaped by natural selection and other evolutionary processes that occurred within a different geographic region. Adaptive phenotypic changes can occur within an individual’s lifetime, and it is likely that such phenotypic plasticity is essential to the initial success of biological invasions. Within the second time scale, intergenerational adaptive changes can occur through selection for more efficient physiological machinery. These adaptive changes in cellular machinery may allow the non-native organism not only to establish self-sustaining populations, but to possibly expand their range due to long term acclimation events. Quantifying physiological changes that occur between generations may be achieved at the organismal physiological and cellular levels. Doing so will distinguish a phenotypic divergence within a single population so that intergenerational exposure to the extreme edge of their thermal limits can push their thermal tolerance threshold. To date, there is little known about the physiology of C. maenas from invasive populations. These divergent environments likely give each invasive sub-population site specific physiological profile that may encourage long-term adaptive change.

IMPACTS OF VISITATION ON THE STRUCTURE OF MUSSEL BEDS MYTILUS CALIFORNIANUS IN CENTRAL CALIFORNIA: ARE THERE BENEFITS OF RESTRICTED ACCESS?
Kerkez, I*, and F Micheli Hopkins Marine Station, Stanford University
A rapidly expanding human population, particularly along the coast places increased pressure on rocky intertidal habitats. Visitation to the intertidal may cause impacts through the harvesting of organisms for food, bait or ornamentation and trampling which crushes and dislodges organisms like barnacles, mussels and macroalgae. Marine reserves were established to provide protection against such disturbance with legislation preventing extractive and destructive activities yet harvesting may continue where enforcement is weak or altogether lacking and trampling associated with foot traffic from the visitors attracted to reserves may threaten the persistence of vulnerable species. De facto reserves or areas where access and/or use are restricted for reasons other than conservation, may provide additional conservation benefits, compared to reserves, because of limited or no public access to these areas. The objectives of this study were: (1) to assess the impacts of human visitation to the shore on an important intertidal biogenic habitat, mussel beds; and (2) to determine whether de facto reserves offer additional protection benefits compared to marine reserves. We compared the structure of intertidal mussel beds (Mytilus californianus) in de facto reserves, marine reserves and open access areas of central California. Results indicate de facto reserves provide benefits
GLOBAL WARMING OR DIMMING: THE EFFECT OF LIGHT RADIATION AND TEMPERATURE VARIABILITY ON THE INVASION OF MARINE FOULING SPECIES IN ELKHORN SLOUGH, CALIFORNIA
Kim, T.* and F Micheli Hopkins Marine Station of Stanford University
Climate change can alter the community structure as species which have adapted to the changed climate can compete better with other species. It can also influence the recruitment and invasion success of marine introduced species. Climate change involves not only global warming but also global dimming. However, it was not tested which of warming or dimming factors more significantly influence the invasion of marine species. To test this, we manipulated both temperature variability and light radiation by deploying different shading devices (black, white, transparent, and no treatment) for recruitment tiles in the warmer region where the species invasion rate is high. We compared the species frequency and coverage between shaded and non-shaded treatments. Interestingly, under opaque white plates where light radiation is lower than under transparent plates but the temperature is higher than under black plates, had the highest frequency and coverage of invasive fouling species. The recruitment tiles under black plates got second higher invasion of exotic species. We also deployed recruitment tiles in 14 different sites to determine if temperature influences the success of invasive species. The coverage of invasive species over native species increased significantly with increasing temperature. The results suggest that both low radiation and higher temperature facilitates the success of species invasion in the intertidal region.

† INVERTEBRATE AND FISH INTERACTIONS
Kingston, R. D. * CSUMB
People have been utilizing traps for many years not only to capture animals for food but also to study organisms. Sometimes these traps capture more than one species, the target species and other organisms that live in a similar habitat or eat the same food items. Observations made during nearshore fish studies in Carmel Bay California with the Department of Fish and Game suggest that invertebrate and fish species in this area might be interacting in and around these traps. Such interactions could inhibit fish from entering the traps and lowering total fish catch. For example, crabs and sea stars blocking trap entrances, Sunflower stars (Pycnopodia helianthoides) wrapped around bait box, and large quantities of invertebrates in traps may deter fish. With the data collected utilizing traps targeting nearshore fish near Carmel Bay, California, I will interpret if there is a correlation between the quantity of fish caught per trap and the number and type of invertebrates associated with each trap in an attempt to answer the question: Does the presence of certain marine invertebrates hinder nearshore fish from entering a trap?

† GRANIVORY AND SEED PREFERENCES OF SMALL MAMMALS IN A COASTAL PRAIRIE
Klauder, K.*† and T. Mata 1 - College of the Atlantic, Bodega Marine Laboratory UC Davis 2 - Bodega Marine Laboratory UC Davis
Many ecosystems are threatened by invasive plant species. An understanding of the forces structuring plant communities impacted by invasive species is important for land managers. It is unclear how granivory and its effect on the propagule pressure of native and invasive species affects grassland plant communities. We used the seed-dish technique to measure the granivory levels and seed preferences of small mammals in three coastal prairie habitat types on two native and two invasive species of grass: Bromus carinatus, Elymus glaucus, Holcus lanatus, and Lolium multiflorum. We hypothesized that seed preference would be positively related to seed size, as shown in other studies. In our system, therefore, small mammals would both prefer native over invasive seeds, as native seeds tend to be larger. Relatively, we hypothesized that granivory levels would be highest in the area dominated by native perennial grasses. We found that granivory levels were low and were not significantly related to habitat type, seed species or the interaction between the two factors. Seed predation in the summer does not appear to play a major role in structuring the coastal prairie plant community.

† SPATIAL SCALES OF LANDSCAPE ATTRIBUTES AND BENTHIC FISH DISTRIBUTIONS AT PIEDRAS BLANCAS: APPLICATIONS OF LANDSCAPE ECOLOGY TO SPATIAL MANAGEMENT
Knight, A.*†, Lindholm, J., Watson, F., and A DeVogelaere 1 - CSU Monterey Bay 2 - Monterey Bay National Marine Sanctuary (NOAA)
Increasing interest in marine spatial planning requires an improved understanding of the distribution of landscape attributes (both physical and biogenic) inside and out of managed areas, as well as the way demersal fishes utilize different attributes. Specifically, the design of effective marine protected areas (MPAs) depends on our knowledge of
the temporal and spatial scales at which fishes associate with the seafloor. We used a towed video camera system to quantify the occurrence of demersal fishes and biogenic habitat features over a variety of substrate patches inside and adjacent to the Piedras Blancas State Marine Conservation Area in Central California. Video transects were conducted through habitat patches and across ecotones; patches were quantified at the scale of meters to tens of meters. Observations of demersal fishes relative to landscape attributes were quantified in an series of non-overlapping ‘video quadrats’ (approx. 10 sec of video per quadrant). A set of generalized linear models (GLMs) were then fitted to the data and compared using Aikake’s Information Criteria (AIC). These models are being used to infer the best predictors (such as substrate type and biogenic structure) for the response (use vs. availability) of a given fish species or taxonomic group. A strong inference (low AIC value) for a fish species or taxa grouping over particular substrates or near particular biogenic forms suggests that these variables can most accurately predict the presence of a given taxa. An understanding of how fishes and groups of fishes are distributed across landscape attributes will inform existing and future spatial management measures that are based on protecting the habitat of target species or groups of species.

† THE SPATIAL AND TEMPORAL DISTRIBUTION OF GRAY WHALES IN SOUTHERN OREGON DURING THE 2009 SUMMER FEEDING SEASON
Korcheck, K. M.1*, Goley, P. D.2, and C. L. Hudson1 1 - Humboldt State University 2 - Department of Biological Sciences, Humboldt State University
The gray whale (Eschrichtius robustus) Pacific Coast Feeding Aggregation (PCFA) area extends from northern California to Kodiak Island, Alaska. Gray whale movement patterns within the PCFA have been tracked using photo-identification. Whales move frequently between sites in British Columbia and Washington, but movement patterns between Oregon and California are not well understood. Whales identified in California are not seen as regularly throughout the PCFA as whales identified in other regions. This may be due to lack of sampling in Oregon, as whales are likely to mix with adjacent areas. The spatial and temporal distribution of gray whales was documented in southern Oregon from June-August 2009. The study objectives were to identify shore sites, to document the distribution of whales in southern Oregon and to identify those whales seen. A concurrent study was conducted in northern California. Four shore locations were identified and surveyed twice weekly, and sighting rates (SR) (number of whales/hour of observation) were calculated. Oregon SRs for June (1.43) and July (0.36) were higher than California this year (0.08, 0.07), and both Oregon and California SRs were below historical averages for July (0.67). Three whales were identified during boat surveys in Oregon and California–these animals have been sighted throughout the range. This pilot study shows the significance of the southern Oregon portion of the PCFA in determining the distribution and range of gray whales found throughout the region. Future studies will help determine the population dynamics of gray whales feeding within the southern PCFA area.

PHYLOGEOGRAPHY OF THE INTERTIDAL LIMPET LOTTIA SCABRA IN CALIFORNIA: ABUNDANT CENTERS AND RANGE LIMITS
Lehman, Joan M.1*, Dawson, Michael N1, Grosberg, Richard K.2, Eernisse, Douglas J.3, and Sarah E. Gilman4 1 - UC Merced 2 - UC Davis 3 CSU at Fullerton 4 - Claremont Colleges, California
The abundant center hypothesis predicts that species should have abundances greatest near the center of their range, where conditions are moderate and organisms best adapted, and decline in abundance gradually towards the range boundaries. However, the frequency distribution of the majority of rocky intertidal marine invertebrates surveyed in the northeastern Pacific, such as Lottia scabra, do not show an abundant center. The hypothesis begins with the premise that ‘species’ is the relevant unit of study. Here, we provide a test case of this previously hidden assumption of the abundant center hypothesis. We conducted DNA analysis of the COI gene in 551 specimens from 40 locations in California and Baja California of L. scabra and found 25 COI haplotypes occurring predominantly in two clades distributed parapatrically between southern California (the ancestral range) and northern California with overlap in central California. We found that northern California and southern California L. scabra represent two distinct evolutionary units and in this case, the entire species is not the appropriate unit of study. We suggest the prevalence of cryptic lineages in northeastern Pacific taxa and environmental heterogeneity may account for many of the observed deviations from the abundant center hypothesis in this region and that, when verified on a case-by-case basis and applied appropriately to evolutionary units, the hypothesis of an abundant ‘ecological’ center may be a reasonable simplifying assumption for modeling species ranges and likely impacts of climate change.

† A COMPARATIVE ANALYSIS OF THE PHYSIOLOGY OF NATIVE AND INVASIVE BLUE MUSSEL SPECIES IN CALIFORNIA
Linsmayer, L.B.1* Hopkins Marine Station, Stanford University
This project addresses the biogeographical distribution and physiological differences between two blue mussel species,
a California native (*Mytilus trossulus*) and an invasive species (*Mytilus galloprovincialis*). The invasive species came to the Eastern Pacific from the Mediterranean Sea in the early twentieth century. It has subsequently out-competed *M. trossulus* in much of southern California and has hybridized with it around Monterey. Because *M. galloprovincialis* is less adaptable to the conditions in which the native species thrives (highly variable salinities and low habitat temperatures), it might be limited in its further northern spread. However, it will continue to flourish in habitats south of Monterey where temperature and salinity conditions mimic the Mediterranean. To evaluate the physiological condition of freshly field-collected specimens of the two species and their hybrids, I measured the metabolic activity of two major enzymes, citrate synthase and malate dehydrogenase. *M. trossulus* had significantly higher enzyme rates than *M. galloprovincialis*. The hybrid enzyme rates were intermediate between the two ‘parental’ species. Since higher intrinsic levels of ATP-generating enzymes enable species to better sustain their metabolic rates at lower temperatures, this suggests that the native *M. trossulus* is more cold-adapted than *M. galloprovincialis*. A follow-up laboratory study is currently underway to determine if each species’ metabolic properties are altered when exposed to specific temperature and salinity variations. Using the physiological understanding of the differences between the native and invasive species will enable the development of a model that predicts the further spread of this invasive species.

**MOVEMENT OF GOPHER ROCKFISH AS DETERMINED BY TAG-RECAPTURE DATA IN CENTRAL CALIFORNIA MARINE PROTECTED AREAS**
Longabach, L.J.¹, Yochum, N.², Starr, R.M.², Nakamura, R.¹, and D.E. Wendent¹ 1 - Cal Poly State University, San Luis Obispo 2 - Moss Landing Marine Labs

The California Collaborative Fisheries Research Program has conducted hook-and-line surveys from 2007 to 2009 within four Central California MPAs (Pt. Buchon; Piedras Blancas; Pt. Lobos; & Ano Nuevo) in order to monitor the effectiveness of the reserves with respect to nearshore rockfish populations. Over 20,000 fishes, comprised of 41 species, were caught and tagged within the MPAs and adjacent reference sites. We aim to gain vital information regarding fish movement and other life history traits through the mark-and-recapture portion of our MPA monitoring endeavor. We have received 60 tag returns and have recaptured 31 fishes during our own hook-and-line surveys. The majority of individuals recaptured were gopher rockfish, *Sebastes carnatus*, which also represented the top overall catch in our survey species assemblage. Available catch location data show that, on average, individual gopher rockfish moved no more than 300m from their original catch location. These data suggest that the size of California marine protected areas is sufficient to have an impact on gopher rockfish and that over time this species will likely show a significant response as a result of reserve implementation.

**TROPHIC ECOLOGY OF THE GOPHER ROCKFISH (SEBASTES CARNATUS) INSIDE AND OUTSIDE OF MARINE PROTECTED AREAS IN CENTRAL CALIFORNIA**
Loury, E.K.¹,², Starr, R.M.², Wendent, D.E.¹, Bros-Seeman, S.³, Cailliet, G.M.¹, and D.A. Ebert¹
1 - Moss Landing Marine Labs 2 - UC Sea Grant Extension Program 3 - Cal Poly State University, San Luis Obispo 4 - San Jose State University

No-take marine reserves are predicted to affect the trophic interactions of an ecosystem by increasing the size and abundance of fish predators within their borders due to the exclusion of fishing pressure. The gopher rockfish (*Sebastes carnatus*) was chosen as a potential indicator of trophic changes in central California marine reserves established in 2007 because of its abundance, territorial behavior, and demersal, generalist feeding habits. Fish were collected from July to October in each of three years (2007–2009) in four central California marine protected areas (Ano Nuevo, Point Lobos, Piedras Blancas, and Point Buchon), and in four unprotected reference sites of similar depth and habitat composition. Additionally, fish were collected from a portion of the Point Lobos State Marine Reserve that has been closed to fishing since 1973. Dietary composition was determined by traditional stomach content analysis, and will be complemented with future stable isotope analysis. Gopher rockfish body mass-to-length ratios, dietary composition, and trophic level will be compared between reserves and reference sites, among geographic locations, and among years. Preliminary results indicate that ophiuroids and decapod crustaceans were dominant prey items at the Point Lobos State Marine Reserve and reference site, with mysid shrimp also dominant in the reference site. Future work on this study will elucidate sources of spatial and temporal variation in gopher rockfish diet, establish a baseline of trophic interactions at four new reserves, and help evaluate the long-term (35 year) trophic effect of the Point Lobos State Marine Reserve.

**AN INDIVIDUAL-BASED MODEL OF LARVAL ANTARCTIC KRILL ENERGETICS DURING FALL AND WINTER**
Lowe, AT, Quetin, LB, Ross, RM, and SA Oakes  Marine Science Institute, UC Santa Barbara

Antarctic krill, *Euphausia superba*, play a crucial role in the transfer of energy from primary producers to apex predators in the Southern Ocean. Krill exhibit a wide variety of adaptations to take advantage of a highly seasonal and
patchy food environment, however our understanding of these adaptations in larval krill remains poor. Larval krill experience two critical periods when food availability is paramount for survival: 1) at development into the first feeding stage, larvae have 10-14 days to find food before starving, and 2) during the first winter, when larvae lack sufficient energy stores to survive more than a month without feeding. Multiple studies suggest larval krill use sea ice microbial communities (SIMCOs) to meet energetic demands when water column Chl-a concentrations are low. The current work presents an individual-based model (IBM) that simulates larval krill physiological condition and growth during fall and winter. Significant advances in our understanding of temperature-dependent respiration and ingestion rates of sea ice and pelagic phytoplankton are incorporated, as well as a novel approach to simulating the ability of Euphausiids to exhibit positive and negative growth dependent on food conditions. The model synthesized experimental and field observations from Southern Ocean Global Ocean Ecosystem Dynamics (SO GLOBEC) cruises in 2001 and 2002, as well as historical data from physiological experiments in order to describe larval energetics during the fall phytoplankton decline and the development of sea ice and SIMCOs during winter.

†PALEOCLIMATE RECONSTRUCTION IN HUNTINGTON BEACH WETLANDS
Maezumi, Shira Y., Whitcraft, Christine, Stevens, Lora, Powers, Mitch
CSU Long Beach
Knowing past climate conditions can improve our understanding of current ecological functioning in wetlands. Sediment cores collected from the Huntington Beach Wetlands in southern California was analyzed for changes in the paleoclimate. Grain size, stable isotopes, pollen and charcoal analysis were performed to document the paleoenvironmental history, including past changes in salinity in this wetland ecosystem. As a proxy for water flow, alternating strata of bedded clays and sands indicate changing water flows through time. Isotopic mass-spectrometry of δ13C in the sediment core documents relative changes in the abundance of C3 and C4 plants. C3 plants, with lighter δ13C values, thrive in lower salinity, while C4 plants, with heavier δ13C values, are found in saltier conditions. Combined with pollen analysis, these δ13C values indicate large fluctuations in salinity through time. Charcoal analysis suggests terrestrial vegetation around Huntington Beach has also experienced significant changes in fire regime. The increased abundance of charcoal provides indirect evidence for drought activity. The timing of past disturbance events, including fires, floods, and drought, established through radiocarbon dating, provides a long-term record of natural variability within this wetland ecosystem.

†EFFECTS OF MICROBIAL MICROENVIRONMENT ON SWIMMING AND SETTLEMENT BEHAVIOR OF CORAL LARVAE
Marhaver, K L
Scripps Institution of Oceanography
Coral larvae actively seek settlement substrates, using microbial cues on the reef to select optimal habitats. Furthermore, pelagic cues such as salinity and pressure are known to alter swimming behavior of coral larvae prior to their arrival on the benthos. To determine whether behavior in seawater depends specifically on the microbial environment, I conducted a series of laboratory experiments with swimming planulae of the Caribbean coral Montastraea faveolata. Alteration of the microbial environment with filters, antibiotics, and cultured bacterial strains reveals that microbes have significant effects on swimming location, swimming rate, and settlement rate in this species. Interestingly, conditions most likely to improve larval survivorship are also most likely to inhibit successful completion of settlement and metamorphosis. Therefore, while microbes serve as a potential source of mortality for swimming and settling larvae, they also play a crucial role in the successful completion of the coral life cycle. The maintenance of “healthy” microbial communities in coral reef waters gains further urgency from these findings.

THE GLOBAL GENETIC DIVERSITY OF SERIOLA LALANDI (YELLOWTAIL)
Martinez-Takeshita, N.*, Franklin, M.P., and L.G. Allen
CSU Northridge
The Yellowtail (Seriola lalandi), one of the most important sport and commercial species off southern California, is the largest member of the Jack family (Carangidae). These cosmopolitan fish can be found in subtropical and temperate waters. Seriola lalandi are commercially fished, recreationally fished, and farm raised in the regions they occupy, thus providing an important food source and a sizeable economic impact for the people in these countries. DNA samples were collected from California (Channel Islands, Catalina Island & San Clemente Island), the Pacific Coast of Baja California, the Gulf of California, New Zealand, and Chile. Further sampling will also include Japan and South Africa. A mitochondrial DNA analysis using the d-loop will be used to determine the population structure and genetic variation between distinct sites. It may also be possible to identify subspecies and changes in population structure due to fishing pressures, as well as, migratory patterns of this global species. The genetic analysis will provide valuable information to help properly manage and sustain these fish populations in the future.
† THE EVOLUTION OF SEXUAL PLASTICITY IN GOBIES OF THE GENUS *LYTHRYPNUS*: A PHYLOGENETIC APPROACH
Maxfield, JM*, and K Crow San Francisco State University
The genus *Lythrypnus*, is comprised of 20 species of fish, 10 in the Atlantic and and 10 in the Pacific (Böhlke 1960, Greenfield, D. W 1988, St Mary 2000). This genus has been suggested as a model for the evolution and maintenance of sexual plasticity (St. Mary 1999). Being a group of closely related species they provide a uniquely compelling model for mixed allocation strategies. Sex allocation has been characterized in 5 species in the genus, *L. dalli*, *L. nesiotes*, *L. zebra*, *L. phorellus*, and *L. spilus*. Though allocation type varies among species it includes, pure females, female biased hermaphrodites and male biased hermaphrodites and pure males (St. Mary 1993, 1998, 1999). The purpose of this study is to evaluate the evolution of plasticity in sex allocation in this genus in a phylogenetic context. Sequence data from multiple molecular loci were used to assess relationships among 12 species. Preliminary data indicate that *L. heterochroma* is the basal member of this taxon with significant statistical support. After the divergence of *L. heterochroma*, the remaining *Lythrypnus* species appear to have diverged after the separation of the Pacific and Atlantic oceans. This Pacific/Atlantic split is supported by statistical analyses using the neighbor joining and maximum parsimony algorithms. Furthermore this analysis suggests that sex allocation arose once in the genus. In addition to proposing a phylogenetic hypothesis for this genus, these data are essential for interpreting sex allocation in an evolutionary context.

LARVAL COMPETENCY OF RED ABALONE *HALIOTIS RUFESCENS* - A NEW TIME FRAME FOR LARVAL DISTRIBUTION
McCormick, T B, Navas, G, Billups, B, and C. D. Buckley* Oxnard College
The effect of delayed metamorphosis on the subsequent survival of post-settlement benthic juvenile is especially relevant to dispersion and recruitment estimates for species such as red abalone (*Haliotis rufescens*) that have a short larval duration. Settling cues in the form of coralline algae were presented daily to groups of hatchery-reared red abalone larvae from day 4 to day 32 post-hatch and survival of post-larvae after settlement was monitored for thirty days. Following exposure to live coralline algae, 85% (mean) of larvae metamorphosed and settled the following day. The number of settled animals gradually increased the longer the settling cue was withheld. Post-settlement juveniles were held in containers with mixed diatoms for up to 34 days. Red abalone larvae remained competent to settle 32 days after fertilization. Larvae that metamorphosed from day 4 through day 19 had longer survival during the next 30 days (mean = 10%) compared to those presented with settling cues from day 20 to day 32 (mean = 8%). Statistical analysis using a threshold cut-point indicated that the 20 day threshold marked a significant change in subsequent post-larval survival. Larvae that swam for less than 20 days had post-metamorphic survival of 8 days or more, while survival was 7 days or less for post-metamorphic abalone that had previously swam for 20-32 days. A larval competency period of 20 days is significantly longer than the 5 - 7 day larval stage often used to estimate transport times for this species.

† DIFFERENCES IN *LOTTIA GIGANTEA* SIZE STRUCTURE AND ABUNDANCE BETWEEN LOCATIONS WITH VARYING VULNERABILITY WITHIN THE MONTEREY BAY NATIONAL MARINE SANCTUARY
Owl Limpets (*Lottia gigantea*) are ecologically important grazers that live on exposed rocky intertidal coasts. They have been impacted by human visitation and illegal harvest due to limitations of enforcement in southern California. The objective of this study is to investigate size structure and abundance patterns of *Lottia gigantea* at locations with different levels of vulnerability of human visitation and human foraging in central California rocky intertidal areas. Limpet surveys were conducted at six locations in the Monterey Bay National Marine Sanctuary (MBNMS), three with low vulnerability and three with high vulnerability. Invertebrate species diversity was calculated and the number of *L. gigantea* were counted and the length of their sagittal plane was recorded over a period of six months in ten permanent plots at each location. The number of visitors and their behavior, either active (collecting, touching species) or passive (observing, not handling species) were recorded at each location. The results of this study demonstrate that there is a difference in *L. gigantea* size distribution and abundance between rocky intertidal communities that differ in levels of vulnerability. The results of this study provide information on the potential impact of human activities on rocky intertidal biological communities. In the longer term, the results of this study may be used to advise the planning of Marine Protected Areas (MPAs) to include rocky intertidal habitats as well as provide baseline data that could be used to assess the health of coastal marine ecosystems.
SUBTLE GENETIC STRUCTURE IN THE COMMERCIALY FISHED WARTY SEA CUCUMBER,
PARASTICHOPUS PARVIMENSIS.
Moller, WT*, Haupt, AJ, Micheli, F, and SR Palumbi Hopkins Marine Station, Stanford University
Understanding dispersal of marine organisms is critical to managing commercially important species at appropriate scales. Several sea cucumber fisheries worldwide have collapsed after short periods of intense local exploitation. The warty sea cucumber, Parastichopus parvimensis, is fished commercially in both California and Baja California, Mexico but little is known about the status of the fisheries or if separate stocks exist. *P. parvimensis* has a long pelagic larval duration of 50-90 days, which may translate to high connectivity throughout the species range (Monterey, CA to Bahia Tortugas, Mexico). In order to assess the possible spatial structure of stocks and levels connectivity among them, over 600 samples were collected at 15 sites throughout the range of the species. Samples previously amplified at the COI mtDNA locus found subtle genetic structure throughout the range. Here we present six microsatellite loci that further support results from the COI locus. Subtle genetic structure data indicate high connectivity throughout the range of *P. parvimensis*.

MOVEMENTS OF NON-BREEDING SOOTY SHEARWATERS (PUFFINUS GRISEUS) IN THE CALIFORNIA CURRENT SYSTEM: SEABIRD RESPONSE TO SPATIAL AND TEMPORAL VARIABILITY IN WINDS AND UPWELLING
Nakagawa, M. S.; Adams, JF; McPhee-Shaw, EJ.; and J.T. Harvey1 1 - Moss Landing Marine Labs, Moss Landing, CA 2 - USGS Western Ecological Research Center, Moss Landing
Sooty shearwaters (Puffinus griseus) are the most abundant avian predator in the California Current System (CCS) and respond rapidly to spatial and temporal changes in environmental variables that affect productivity. Our previous satellite tracking results indicated that sooty shearwaters spent disproportionately more time in upwelling retention areas, than in the corridors between them. Here, we examined the at-sea movements of non-breeding sooty shearwaters in the CCS during the upwelling season of 2008. The objectives were to examine how birds respond to physical forcings (changing of winds, upwelling intensity, sea surface temperature, and chlorophyll a concentration), and whether they redistribute in coordinated movements. We attached satellite transmitters to 28 birds in June-July 2008 in three locations with high-bird use: Columbia River Plume (CR, n=7), Monterey Bay, (MB, n=12) and Santa Barbara Channel (SB, n= 9). Birds had coordinated movements in response to changes in oceanographic conditions. Tagged birds in CR rapidly vacated the CR region dispersing on July 5-6 (86% of CR birds), concurrent with a sudden change in oceanic conditions; downwelling favorable winds shifted dramatically to persistent upwelling favorable winds lasting ~2 weeks. These birds did not return to the CR region for the remainder of the season. By mid-July, most birds aggregated in Morro Bay and San Luis Bay remaining through September, with 40% of MB and 44% of SB birds taking occasional forays northward to CR and MB. We also examined bird response to variability in fine-scale upwelling intensity throughout the CCS region.

† EVOLUTION OF SPECIALIZATION IN CLOWNFISHES
O'Donnell, J. L.* UC Santa Cruz
The extent to which populations are connected is of central importance to ecology, conservation, and evolutionary biology, yet remains poorly understood in marine organisms. By definition, specialized organisms depend on a fraction of the resources available to them, and this differential resource distribution may lead to differences in the population connectivity of generalists and specialists. Consequently, limited connectivity may result in the divergence of two populations via local adaptation or genetic drift. Clownfishes (Pomacentridae: Amphiprioninae) are obligate mutualists of sea anemones found on coral reefs across the Pacific and Indian Oceans. The 28 described species vary in their degree of host specificity in that the most generalized species can be found on up to ten different species of anemone, while the most specialized are only found on a single host species. This raises two questions: First, was the ancestral clownfish a specialist or generalist? Second, is there a difference in the genetic structure or diversity of specialists versus generalists? Here I present a phylogeny of Amphiprioninae and examine the genetic diversity of clownfishes in Kimbe Bay, Papua New Guinea, where nine species of clownfish and all ten species of host anemone may be found. This is a component of a comparative phylogeography of specialist and generalist species across a broader geographic landscape.

TEMPORAL, SPATIAL, AND EXPERIMENTAL PATTERNS OF CONCEPTACLE FORMATION ON THE CORALLINE CRUST PSEUDOLITHOPHYLLUM NEOFARLOWII
O'Neil, C. T.;* and K. A. Miklasz2 1 - Stanford University 2 - Hopkins Marine Station
The patterns of reproductive output of coralline crusts have been little studied. This experiment aimed at determining such patterns of reproductive output in the crust *Pseudolithophyllum neofarlowii*. Specifically, we hoped to identify factors that determine these patterns by diverting reproductive resources elsewhere on the crust. Such factors would
include herbivore or other damage to the crust, and spatial variation (eg tidal height) that would cause desiccation. Over several months a number of crusts were marked and analyzed using a field microscope to quantify reproductive output. Half of the crusts were experimentally damaged in order to determine if herbivory was such a factor. No difference in reproductive output was found between control and damaged crusts, suggesting that herbivory is not a major driver of conceptacle formation. Spatial variation in conceptacle formation was noted within a specific crust, however. The area of the crust nearest the damage site showed almost no change in reproductive output with time, especially just after the experimental damage. This suggests resource partitioning within the crust, where the damage site is spending more resources on recovery and fewer on conceptacle formation. Additionally, conceptacles on crusts at different tidal heights were quantified with and without algal cover in order to determine if spatial factors were important in reproductive output. Being surrounded by fleshy algae may provide protection from desiccation and bleaching at low tide, allowing for a healthier and more reproductive crust. Increased algal cover significantly increased conceptacle density on the crust, suggesting that this is the case.

QUANTIFYING LARGE-SCALE MOVEMENT PATTERNS OF MALE LOGGERHEAD SEA TURTLES (CARETTA CARETTA) IN THE EASTERN INDIAN OCEAN
Olson, E.L.1*, Salomon, A.K.1, Wirsing, A.J.2, and M.R. Heithaus3 1 - Simon Fraser University 2 - University of Washington 3 - Florida International University
Understanding the distribution and movement patterns of endangered species is vital for developing effective conservation and recovery strategies. Loggerhead sea turtles are listed “Endangered” by The World Conservation Union. The Shark Bay World Heritage Property is home to the largest breeding population of loggerhead turtles in Australia and the third largest in the world. Nesting female loggerhead turtles have been monitored in Shark Bay for over a decade, but little is known about the movements of males in this population. Consequently, our objective is to monitor and quantify the large-scale movement and habitat use patterns of adult male loggerhead turtles to inform conservation strategies. In February 2009, we tagged 9 male loggerhead turtles with SPOT5 satellite tags. Data collection to date has revealed previously unknown movement patterns for male loggerheads on their foraging grounds. All 9 individuals have stayed within the protection of the World Heritage Property, exhibiting home ranges considerably smaller than previously thought. To complement the quantitative data gathered from satellite tracking, we interviewed 6 locals and recorded their traditional ecological knowledge concerning loggerhead turtle movement, habitat use and species interactions. The unique combination of natural science and social science in this research will result in the most comprehensive investigation of male loggerhead sea turtle movement behavior and habitat use to date. Furthermore, it is cultivating relationships between North American researchers, local fishermen, and local Aboriginals, forming a basis for collaborative conservation management that incorporates ecological, socioeconomic and cultural dynamics.

† EFFECT OF OCEAN ACIDIFICATION ON METABOLISM AND GROWTH OF OLYMPIA OYSTER OSTREA LURIDA LARVAE
Page, H.P.1*, Hettinger, A.2, Gaylord, B. P. 2, Sanford, E.2, Hill, T. M. 3, Russell, A. D. 4, Forsch, M.5, and K. Sato1 1 - University of North Carolina Wilmington, North Carolina 2 - Department of Evolution and Ecology, Bodega Marine Laboratory, UC Davis 3 - Department of Geology, Bodega Marine Laboratory, UC Davis 4 - Department of Geology, UC Davis 5 - Kalamazoo College, Michigan
Anthropogenic carbon dioxide, a well-known driver of global warming, also enters the ocean and is causing dramatic changes to seawater chemistry. These changes include declines in pH and carbonate saturation state, both of which affect organisms that rely on calcium carbonate as a building block for shell material. This study was undertaken to determine the metabolic rates and growth of Olympia oyster (Ostrea lurida) larvae under elevated seawater CO2 concentrations. Adult oysters collected from Tomales Bay, CA were held in culture cones until veliger larvae were released. Veligers were reared through the larval stage while being exposed to one of 3 CO2 levels: 380 ppm (present-day concentration), 540 ppm, and 970 ppm, the latter two values corresponding to predicted future scenarios of atmospheric CO2 concentrations. Throughout development, respiration rates and protein content (the latter used as a proxy for tissue mass) were determined for groups of 120 veliger larvae, each exposed to a specific carbon dioxide treatment. During early development, larvae from the elevated CO2 treatments exhibited higher respiration rates than the control treatment; however, larvae from these same cultures experienced a decrease in respiration rate as they grew, in contrast with the pattern observed in the control treatment. These patterns provide hints of physiological stress in individuals exposed to elevated CO2. Future research examining such physiological effects of ocean acidification should focus on larvae since they are often more vulnerable than adults to adverse environmental conditions, and can therefore act as sensitive indicators of potential impacts of climate change.
† SEASONAL VARIATION IN THE ABUNDANCE, DIVERSITY AND COMMUNITY COMPOSITION OF KELP FOREST FISHES USING THE REEF CHECK MONITORING PROTOCOL
Parrish-Kuhn, C. D., Lindholm, J., and M Carr 
1- CSU Monterey Bay 2- UC Santa Cruz
Increasing anthropogenic impacts to California’s kelp forest ecosystems, coupled with the recent designation of a state-wide network of marine protected areas (MPAs) throughout California, requires a comprehensive monitoring effort. Yet in these trying financial times monitoring programs (in kelp forests or elsewhere) are increasingly limited by financial and personnel constraints. One response to these limitations is the development of citizen-based monitoring programs (such as Reef Check California) that are intended to augment traditional monitoring programs. The successful incorporation of data from these new programs into the broader monitoring effort throughout California is dependent on a detailed understanding of precisely what types of data are being produced. For instance, it is critical to sample at a frequency that captures seasonal variations in the taxa of interest. We are using the Reef Check California protocols to monitor the diversity, abundance, and community composition of 33 kelp forest fishes at MacAbee Reef in Monterey, California. Monthly sampling began in March 2009 and will proceed through August 2010, with more intensive daily sampling planned for July 2010. Results of monthly sampling to-date suggest that there is considerable variability among the fishes with respect to abundance, with less variation in diversity and community composition over time. We expect the trajectories of these data to change as we sample throughout the winter and with the potential influence of a growing El Nino. Ultimately our goal is to understand how data from citizen monitoring programs can be meaningfully incorporated into the management of California’s MPAs and beyond.

† TOLERANCE OF NON-INDIGENOUS MARINE LIVE BAIT TO SOUTHERN CALIFORNIA COASTAL HABITAT THERMAL CONDITIONS
Passarelli, B., and B. Pernet 
CSU Long Beach
Several species of non-indigenous marine invertebrates – primarily polychaete annelids – are regularly imported into southern California for use as live bait in recreational fishing. These species have the potential to become invasive and to negatively affect existing southern California marine communities. The goal of this study was to determine if non-indigenous bait species can survive at temperatures typically found in southern California coastal habitats. We measured survival of two commonly sold bait species and one associated parasite in three temperature treatments, simulating minimum (12°C), average (16°C), and maximum (25°C) temperatures of southern California coastal habitats. Bloodworms (Glycera sp.) from Maine, lugworms (Perinereis sp.) from Korea, and a potentially non-indigenous parasitic isopod (Ione cornuta) infecting bait ghost shrimp (Neotrypaea californiensis) from Oregon and Washington, were exposed to temperature treatments for five days. All species showed >75% survival over five days of exposure to the two cooler treatments. In the warmer temperature treatment, >75% of Glycera sp. individuals survived, while <50% of the Perinereis sp. and I. cornuta individuals survived. Although we observed a decrease in survival in warmer temperature conditions (typically found only in shallow-water habitats partially isolated from the ocean such as estuaries and lagoons) our results suggest that short term survival of these species is not restricted by thermal conditions in southern California. Future studies should investigate long term survival and reproductive ability to help determine if these species can become established in southern California habitats.

† RAPID RECOVERY OF CORALS ON TWO EASTERN PACIFIC REEFS AFTER AN ENSO DISTURBANCE DEPENDS ON OCEANOGRAPHIC CONDITIONS
Perez, M, Muthukrishnan, R., and Fong, P UCLA
Coral reefs create barriers against wave impact and storms, are the nurseries and feeding grounds of species humans use for food and medicine, and represent billions of dollars in tourism. Reefs are declining worldwide due to many factors, including global climate change. The objective of our research was to quantify the long-term effects of large climatic disturbances on coral recovery and compare the resilience of upwelling to non-upwelling reefs. Uva (non-upwelling) and Saboga (upwelling) Island reefs in the Eastern Pacific were subject to an El Niño Southern Oscillation (ENSO) event in 1983-84, which devastated their coral populations. Twenty 1 m2 plots on each reef were chosen to be monitored for changes in percent coral cover and the abundance of sea urchins. Pocillopora, the dominant regenerative genus in both reefs, increased cover from 1987 – 1999 by 17% on Uva reef and by 47% on Saboga reef. Another ENSO disturbance in 1997-98 reduced Saboga’s coral population to 13% cover while Uva reef did not seem affected. I hypothesize this difference in recovery rate may be attributed to the higher numbers of grazing urchins on Saboga than Uva reef mediating competition between coral and algae. On average, the number of coral colonies increased over time on Uva, but decreased on Saboga, suggesting that colony expansion resulted in fusion of coral colonies on Saboga. Future analysis will focus on individual coral colonies and their independent growth rates in order to further understand how processes enhancing coral recovery differ between these very different oceanographic conditions.
† THE EFFECT OF PH STRESS DURING UPWELLING EVENTS ON THE GENE EXPRESSION OF STRONGYLOCENTROTUS PURPURATUS, THE PURPLE SEA URCHIN
Rivest, E. B. †, and G. E. Hofmann UC, Santa Barbara
In the face of a changing global climate, being able to predict the responses of organisms and assess their vulnerability is essential for the development of successful management and conservation strategies. The objective of this project is to understand the effect of pH stress, due to seasonal upwelling along the California coast, on Strongylocentrotus purpuratus, the purple sea urchin. This study examines the in situ physiological response of S. purpuratus using genomic techniques. Samples of 8 tissue types were collected from adult urchins in March 2009 before the upwelling season and in late July 2009 during an upwelling event. To quantify changes in gene expression associated with pH stress, qRT-PCR will be performed. Primers have been developed for genes involved in metabolic suppression, biomineralization and antioxidant defense. The results of this project will help inform the broader issue of how a keystone species of the temperate coastal ecosystem will be impacted by ocean acidification, one of the major consequences of global climate change for marine ecosystems. Partially supported by an NSF Graduate Research Fellowship to E.B.R.

STANDARDIZING MARINE DEBRIS MONITORING METHODS ON BEACHES OF THE MONTEREY BAY
Rosevelt, C. †*, and H.M. Nevins‡ 1 - CSU Monterey Bay 2 - Beach Combers, Moss Landing Marine Laboratories
New legislation to reduce the use of non-recyclable materials is expected to reduce the amount of land-based debris littering beaches and entering our oceans, negatively impacting marine wildlife. To measure the efficacy of these policy changes I created a standardized method to survey the types and quantities of beach litter at 12 beaches within the Monterey Bay. Beach surveys were conducted twice a month at each location from July through September 2009, then on a monthly basis through July 2010. A minimum of two volunteers conducted the survey method per beach location. Two 50m line transects were used between the wrackline and the back beach. Five quadrats (2 x 2 m2) were placed on each transect line and data were collected per quadrant. Small fragmented plastics were collected and measured, ranging in size from 0.3 - 2.5cm. MANOVA was used within a repeated measures design to test significance of the distribution of debris between beaches. Variables included; beach location, season, remote verses heavily visited beaches, beach slope, and categorical and density measurements. Plastics showed evidence of carrying fouling organisms, being potentially confusable with biota, and spending extensive time in the marine environment. I will provide MBNMS and local municipalities with an online interactive map for monitoring purposes, where data can be added to assess where further monitoring and research is needed. This baseline study promotes community involvement in the scientific process, raises environmental awareness, and will help to evaluate the political successes in abating marine debris.

† UNUSUALLY HIGH, LOCALIZED RECRUITMENT OF THE REEF CORAL, MONTASTREA ANNULARIS, IN ST. JOHN, US VIRGIN ISLANDS
Ross, C.L. †, and P.J. Edmunds CSU Northridge
Montastraea annularis is the most important reef-building coral in the Caribbean. However, population studies from the past forty years have revealed surprisingly few recruits and a substantial decline in cover over the last two decades. These findings suggest that there has been a persistent failure of M. annularis to recruit. St. John, U.S. Virgin Islands, provides a unique environment to observe juvenile M. annularis in a shallow habitat, because the dominance of smooth igneous substratum allows sexual recruits to be distinguished from small fission products. In this study, we report the results of quantitative surveys and anecdotal observations conducted at 1 to 8 m depth over the past fifteen years in Great Lameshur Bay (GLB), and at multiple sites spanning 47 km of the St. John coast in 2009. From 1994 to 2009, 3,000 quadrats were censused and in 2009, approximately 1,107 square meters in 7 regions of the island were surveyed. Between 1994 and 2007, the density of recruits remained below 0.017 m², but it doubled in 2008 and has remained ≥0.029 m². Surveys from the 7 regions reveal that the high recruitment of M. annularis is localized, with >50% of all the juveniles of this species being found in GLB. These results demonstrate that M. annularis can recruit at densities dramatically higher than observed over the past 15 years, but it remains unclear whether this can affect long-term population trajectories for this species.

† INTERTIDAL COMMUNITIES AND THE REINTRODUCTION OF SEA OTTERS (ENHYDRA LUTRIS)
Singh, G G †, and S E Nyrose Institute for Resources, the Environment, and Sustainability, University of British Columbia
The return of sea otters (Enhydra lutris) off of the West Coast of Vancouver Island has prompted changes in marine communities. Sea otters are voracious predators of invertebrates, and can release kelps from grazing pressure, which can subsidize secondary production. In intertidal communities, these two processes can act in opposition as intertidal invertebrates can benefit from increased access to food but suffer increased predation by the introduction of a new
predator. An investigation of intertidal communities along a gradient of sea otter density on the west coast of Vancouver Island shows altered abundances and size structures in various invertebrates with changing otter density. Key species investigated include mussels (*Mytilus californianus*), ochre stars (*Pisaster ochraceous*), and chitons (*Katharina tunicata*). These results agree with foraging theory and field studies suggesting that otters exploit large individuals of a few species giving greatest nutritional rewards first, then move to diverse, smaller prey as their primary prey is depleted. A transplant experiment looking into the impacts of kelp productivity on secondary productivity was conducted by transplanting *M. californianus* in regions where sea otters are present and kelp forests are abundant and in areas where sea otters are absent and kelp forests are scarce. Early results are presented on growth rates of mussels, and these results are discussed in the context of the opposing impacts on invertebrate communities. Direct predation by otters may have a greater impact than kelp subsidies, as suggested by the data.

† **PROTEIN-LEVEL ANALYSIS OF SELECT HEAT-RESPONSIVE GENES IN THE COLD-ADAPTED ANTARCTIC FISH TREMATOMUS BERNACCHII.**

Sleadd, I.M.*, and B.A. Buckley  *Portland State University*

The teleost suborder Notothenioidei comprises highly stenothermal species of Antarctic fish that for millions of years have evolved in a thermally stable environment at or near the freezing point of seawater. During this time, some species have lost the heat-shock response, an otherwise well conserved cellular response to thermal stress. A recent cDNA microarray study revealed the capacity for heat response in the *Trematomus bernacchii* transcriptome. Building upon these data, we used immunoblot analysis to determine protein levels of select gene products in *T. bernacchii* undergoing 4º C heat shock and subsequent recovery at -1.86º C. Protein levels of tumor suppressor C/EBP delta, its putative regulator STAT3-related protein, and histones H4 and H2B all varied in response to heat treatment. Interestingly, anti-STAT3 antibodies recognizing central and C-terminal epitopes detected a ca. 40 kDa protein in lieu of full-length STAT3 (92 kDa). Together, these findings suggest that (i) *T. bernacchii* is able to respond to heat stress at the protein level, (ii) *T. bernacchii* may undergo temporary, heat-induced cell cycle arrest mediated by C/EBP delta, and (iii) processes involving STAT3 signaling and transcriptional regulation may be altered in some fishes due to a predominantly low-molecular-weight STAT3 variant.

† **QUANTIFICATION OF CALCIUM BINDING PROTEINS FROM SKELETAL GROWTH ANOMALIES IN MONTIPORA CAPITATA.**

Spies, Narrissa P.*, and Misaki Takabayashi  *University of Hawaii at Hilo*

Skeletal growth anomalies (SGA) have been documented in a number of coral species residing in oceans worldwide. This condition of unknown origin affects the morphology of coral tissue, and likely affects calcification. Despite the alarming predictions and reports that ocean acidification will lead to reduction in calcification rates of corals and other reef organisms, very little is known about the calcification process at subcellular level. Even less is known about how deviations in cellular processes lead to SGA. Galaxin is a calcium-binding protein found in corals that is involved in skeletogenesis and calcification. Calcyclin is a calcium-binding protein that is involved in several cellular processes and has been shown to be up-regulated during tumor growth and formation in several mammal species. We are employing quantitative reverse transcriptase PCR to compare transcription patterns of calcyclin and galaxin genes in healthy and afflicted *Montipora capitata* colonies. These data will allow us to investigate the roles that these calcium binding proteins play not only in SGA formations but also in calcification process of corals in general.

**EVALUATING ENVIRONMENTAL FACTORS ASSOCIATED WITH FRESHWATER TOXIC CYANOBACTERIA IN PINTO LAKE AND LOCH LOMOND, MONTEREY BAY, CALIFORNIA**

Stanfield, E.R.*  *CSU Monterey Bay*

Cyanobacterial harmful algal blooms (CHABs) threaten humans and other organisms through an array of potent cyanotoxins. CHAB biomass, during their growth phase, can dominate and alter freshwater ecosystems and instigate hypoxia during their declining phase. While correlated with anthropogenic nutrient enrichment, the nutrient dynamics promoting CHAB formation are system specific and depend on regional environmental conditions. Although there have been regular and documented freshwater CHABs across California, CHAB occurrence and associated environmental factors remain understudied in Central California freshwater systems. In this study I examine the presence, abundance, diversity and toxicity of freshwater cyanobacteria in two central California lakes in association with an array of environmental variables including nutrient and ion concentrations, temperature, chlorophyll a levels, photosynthetic active radiation, and cumulative temperature. I employed microscopy for cyanobacteria identification and enumeration while running polymerase chain reaction (PCR) for estimating genetically-based potential toxicity. To estimate cyanotoxin concentrations and to test for expression of toxin-related genes, I will run enzyme linked immunosorbent assays (ELISA). I measured water quality variables in the field and using laboratory analytical methods. This project is important for establishing baseline data to support further research of cyanobacteria toxicity, related environmental
factors and mechanisms of toxin gene expression and production in the Monterey Bay area and Central Coast region of California. These results will also help assess the presence, distribution and risks associated with potentially toxic cyanobacteria throughout the region. This information will assist agencies in prioritizing CHAB research and the development of prevention, prediction, reduction and mediation plans.

ASSOCIATIONS OF THE GENERALIST CARNIVORE HERMISSEND A CRASSICORNIS WITH THE RECENTLY INTRODUCED COLONIAL BRYOZOAN, WATER SIPORA SUBTORQUATA IN HUMBOLDT BAY, CA
Thomson, E.¹, Wilson, E.², and S. F. Craig²* 1 - Bowdoin College 2 - Humboldt State University
Hermissenda crassicornis is an eolid nudibranch found commonly in fouling communities of Humboldt Bay, CA. Unlike most eolid nudibranchs, which specialize on cnidarian prey, H. crassicornis is a generalist carnivore known to prey on several different animal phyla in the bay. Watersipora subtorquata is a recently introduced colonial bryozoan in the bay. Due to frequent observations of H. crassicornis on W. subtorquata, it was hypothesized that this nudibranch preys on W. subtorquata. Chemosensory detection serves as nudibranchs’ main method of locating prey, thus Y-maze trials were used to determine if H. crassicornis can chemotactically detect W. subtorquata. A survey of the nudibranch in the bay was performed to determine location of H. crassicornis in the field and the rate of growth on several prey items was determined in the lab. Results significantly supported the hypothesis that H. crassicornis is often found on W. subtorquata, but did not support the hypothesis that H. crassicornis preys on W. subtorquata. Nudibranchs fed only W. subtorquata lost weight at a rate not significantly different from starved nudibranchs. Furthermore, H. crassicornis was able to chemotactically detect W. subtorquata in a Y-maze, but when given a choice of two prey items always selected against W. subtorquata. Further studies are needed to determine if W. subtorquata, due to its unique structure, serves as protective habitat for this nudibranch, which might explain why this species associates with this recently introduced bryozoan.

† RHODOLITHS AT CATALINA ISLAND: DISTRIBUTION, GROWTH, AND CONSEQUENCES OF DISTURBANCE
Tompkins, P. A.*, and D. S. Steller  Moss Landing Marine Labs
Rhodoliths are free-living coralline algae (Rhodophyta) which form large beds on the seafloor. Globally, these beds serve as a benthic habitat, and support diverse and often unique communities. Fragile and slow growing, rhodoliths are sensitive to disturbance and threatened by a range of human impacts. While Rhodolith beds have been found in California waters, and particularly at Catalina Island, no literature exists regarding their significance. This investigation seeks to (1) map the distribution and characterize the rhodolith beds around Catalina, (2) determine growth and internal banding rates for the algae and (3) examine the sensitivity of the rhodolith habitat to common sources of disturbance. A systematic search of shallow subtidal (0-40 meters) areas around the island revealed the presence of at least five distinct beds, and the area covered by rhodoliths was mapped by divers using SCUBA. Preliminary data on growth and internal banding periodicity was collected by outplanting alizarin-stained thalli, and retrieving samples after six and fourteen months. Samples were then sectioned, imaged, and measured. To test the effects of disturbance on rhodoliths, disturbed and undisturbed areas were compared in terms of habitat characteristics, and a manipulative experiment was conducted in order to test the direct effect of mooring chains on the three-dimensional structure of the habitat.

FLEXIBLE FORAGERS: CHANGES IN THE WINTER DIET OF CALIFORNIA SEA LIONS (ZALOPHUS CALIFORNIANUS) IN MONTEREY BAY DURING DIFFERENT OCEANOGRAPHIC CONDITIONS
Webb, L. A.¹, Baughman, C. S.²*, Frolli. E. E.², and J. T. Harvey¹ 1- MLML 2- CSUMB
Temporal variability in oceanographic conditions has been increasing in the California Current system and resulting changes in prey distribution and abundance have been documented, however predator response is less well understood. California sea lions (Zalophus californianus) are an abundant predator in this system and have a wide breadth of potential prey. We examined the winter diet of California sea lions hauled-out at the United States Coast Guard Jetty in Monterey, California from October 2007 to January 2008 during a La Niña event using scatological analysis (n=62). Samples were rinsed through a series of nested sieves and all identifiable prey remains were enumerated to the lowest taxonomic level possible following methods outlined by Weise (2000). Our data were compared with a prior scatology study conducted by Weise (2000) at the same location during an El Niño event from November 1997 to January 1998. Although a similar suite of prey species was consumed during the two winter periods, during the 2007-08 winter when there was increased upwelling and decreased sea surface temperature significantly greater numbers of sardine (Sardinops sagax), northern anchovy (Engraulis mordax) and Pacific jack mackerel (Trachurus symmetricus) were consumed while significantly lesser numbers of elasmobranchs and market squid (Loligo opalescens) were consumed (G test (0.05,20,62): 938.7981). Our results support the Weise and Harvey (2008) hypothesis that California sea lions...
foraging in central California are “plastic specialists” whose dynamic diet is a result of feeding on seasonally abundant, aggregating prey.

† MATCHING DATA TO USER NEEDS: AN EVALUATION OF THREE APPROACHES TO THE ANALYSIS OF SUBSEA VIDEOGRAPHIC DATA
Wrubel, K. R. *, Lindholm, J. B., and A. Knight CSUMB
Effective marine policy depends on the timely dissemination of research results, informed management agencies, and a knowledgeable public community. Understanding different techniques for analyzing videographic data is important to marine policy because each user-group relies on the information provided. Research cruises were conducted within the Monterey Bay National Marine Sanctuary using a towed camera sled to collect videographic imagery of the seafloor. This project is evaluating the utility of three related approaches to the collection of data from that videographic imagery: a frame-by-frame analysis, data collected at one-minute intervals, and photos and video clips posted on a public website. These multiple sampling schemes are used to compare taxa presence and to count sessile invertebrates and associated habitat. Taxonomic distribution plots are created for each transect to visualize the distribution patterns between taxa and habitat type. A series of video clips is beneficial for the general public, but is not representative of the transect. However, the website does show an equal distribution of species that were observed. The one-minute sampling scale is a good representation of the transect and allows data to be collected quickly to be distributed to management agencies. The frame-by-frame analysis collects thorough data but is time consuming and, due to its meticulousness, causes much of the transect to be discarded. Though intended for separate audiences, the collection of data at separate sampling intervals from the same videographic imagery provides the opportunity to compare the multiple approaches for characterizing the scales at which taxa occur in the Sanctuary.
Restaurants near Embassy Suites, Seaside CA

**Pacifica Café** - in the hotel
# 1441 Canyon Del Rey Blvd, Seaside

**Chili’s Bar and Grill** - Mexican, Steakhouse
1349 Canyon Del Rey Blvd, Seaside, CA

**Phat Burger** - American, Hamburgers, Grill
Del Monte Ave, Seaside, CA

**Nancy’s Café** - American
1520 Del Monte Ave, Seaside, CA

**Yatzeche Restaurant** - Mexican
400 Palm Ave, Seaside, CA

**Jim's Chinese Restaurant**
1584 Del Monte Blvd, Seaside, CA

**Ichi-Riki Japanese Restaurant**
1603 Del Monte Blvd, Seaside, CA

**Mariscos Puerto Nuevo**
1603 Del Monte Blvd, Seaside, CA

**La Pasadita**
1603 Del Monte Blvd, Seaside, CA

**Joe’s Mexican Café**
1603 Del Monte Blvd, Seaside, CA

**Del Monte Café** - soups
1603 Del Monte Blvd, Seaside, CA

**Ferdi’s Creole Restaurant** – Cajun/Creole
740 Broadway Ave, Seaside, CA

**Rosa La Villa** - Mexican
1301 Fremont Blvd, Seaside, CA 93955

**Cabo Hermoso** - Mexican
1620 Fremont Blvd, Seaside, CA 93955

**La Tortuga Torteria** – Mexican
1257 Fremont Blvd, Seaside, CA

**Fishwife** - American, Seafood
789 Trinity Ave, Seaside, CA 93955

**Turtle Bay Taqueria** - Mexican
1301 Fremont Blvd, Seaside, CA 93955

**San Pablo Bakery**
1048 Broadway Ave, Seaside, CA

**El Migueleno Restaurant** - Mexican
1066 Broadway Ave, Seaside, CA

**Café Beach** - Mexican
2600 Sand Dunes Dr, Monterey, CA

**Sweet Elena’s Bakery and Café**
465 D. Olympia Ave., Sand City, CA

**Ol Factory Café** – American
1725 Contra Costa Street, Seaside, CA

**Hula Island**
648 Dias St, Sand City, CA

**Monterey Fish House** - Seafood
2114 Del Monte Ave, Monterey, CA
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<thead>
<tr>
<th>Thurs, Nov 12</th>
<th>Fri, Nov 13</th>
<th>Sat, Nov 14</th>
<th>Sun, Nov 15</th>
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<tr>
<td>Welcome</td>
<td>Registration</td>
<td>PRESIDENTIAL SYMPOSIUM (Laguna Grande) Predicting the Effects of Climate Variation on Marine Organisms, Communities and Ecosystems 0800 - 1100 followed by Lifetime Achievement award and Naturalist of the Year award</td>
<td>Registration</td>
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<td>Registration 1600-2000</td>
<td>Session 1 (Laguna Grande A) Invertebrate Biology 1300-1500</td>
<td>Session 11 (Seaside Ballroom) Population Biology II 1300-1500</td>
<td>Session 21 (Laguna Grande C) Applied Ecology II 1000-1200</td>
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<td>Session 2 (Laguna Grande A) Dispersal &amp; Recruitment I 1530-1800</td>
<td>Session 12 (Laguna Grande C) Fisheries Ecology I 1530-1800</td>
<td>Session 22 (Laguna Grande B) Plant/Algal Biology 1300-1500</td>
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<td>Session 3 (Laguna Grande B) Population Biology I 1300-1500</td>
<td>Session 13 (Laguna Grande B) Habitat- Species Association 1300-1500</td>
<td>Session 23 (Seaside Ballroom) Intertidal Ecology III 1000-1200</td>
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<td>Session 7 (Laguna Grande D) Community Ecology I 1300-1500</td>
<td>Session 17 (Laguna Grande C) Conservation &amp; Restoration Ecology 1300-1500</td>
<td>Session 27 (Laguna Grande B) Physiological Ecology II 1000-1200</td>
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<td>Session 9 (Laguna Grande C) Applied Ecology I 1300-1500</td>
<td>Session 19 (Laguna Grande A) Evolutionary Biology II 1300-1500</td>
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<td>Session 10 (Laguna Grande B) Invasive Species 1530-1800</td>
<td>Session 20 (Laguna Grande D) Community Ecology IV 1530-1800</td>
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<td>Student workshop Laguna Grande 1800-2000</td>
<td>WSN Poster session (Laguna Grande EFG) 1830-2030</td>
<td>WSN Business Meeting (Seaside Ballroom) 1815-1915</td>
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<td>Student mixer Hopkins Marine Station 2030-2400</td>
<td>WSN Attitude Adjustment Hour (tickets required) Laguna Grande 2000</td>
<td>Presidential Banquet (tickets required) Auction for student travel Laguna Grande 1930 (banquet) &amp; 2130 (auction)</td>
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