

Western Society of Naturalists

~ 2007 ~

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88TH ANNUAL MEETING VENTURA MARRIOTT VENTURA, CALIFORNIA

General Information

Registration and Information

Welcome! Registration packets will be available at the registration table for those members that have pre-registered. Those that have not pre-registered but wishing to attend the meeting can pay for membership and registration. **Banquet tickets will not be available at the meeting because the hotel requires final counts of attendees at these events at least 3 days prior to the event.** This year the AAH is included in the registration price. You only need to show your badge for entry, and tickets for your tacos. WSN t-shirts and other paraphernalia must be purchased or picked up at the WSN Student Committee table.

Special Event Information

On Thursday, November 8, there will be a student workshop entitled "Communicating science to a non-scientific audience" held in Puerto Escondido room. Immediately following will be the student mixer, held at **Milano's Italian Restaurant in Ventura Harbor**. On Friday, November 9, the WSN poster session will be held from 5:30-7:30 PM in the Mezzanine, and the Attitude Adjustment Hour (AAH) will begin at 7:30 PM in Costa de Oro. The Presidential Banquet will be held on Saturday, November 10 at 7:30 PM in SALONS 1 and 2, immediately followed by the Auction for the Student Travel Fund at ~ 9:30 PM.

SPECIAL EVENTS

Thursday, November 8

1800 – 2000 WSN Student Workshop (Puerto Escondido room in the Marriott)
2000 – 2400 WSN Student Mixer (Milano's Italian Restaurant in Venture Harbor)

Friday, November 9

1730 – 1930 WSN Poster Session (Puerto Escondido)
1930 – 2230 AAH: Attitude Adjustment Hour (Costa de Oro)

Saturday, November 10

1815 – 1900 WSN Annual Business Meeting (Salon I & II)
1930 – 2130 WSN Presidential Banquet (Las Brisas Jr. Ballroom)
2130 – 2330 WSN Auction (Las Brisas Jr. Ballroom)

PROGRAM OF EVENTS

* Indicates person presenting

† Indicates eligibility for Best Student Paper or Best Student Poster Award

THURSDAY, NOVEMBER 8, 2007

1600 – 2000 **Registration**

1800 **WSN student workshop: “Communicating science to a non-scientific audience”** (Puerto Escondido)

Speakers to include:

Kirsten Carlson, Kirsten Carlson illustration

Jeremy Potter, NOAA Ocean Exploration

Kevin Clerici, Ventura County Star

2000 **WSN Student Mixer** (Milano's Italian Restaurant in Venture Harbor)
Open to all graduate and undergraduate students; no ticket required.

See student desk for directions....

FRIDAY, NOVEMBER 9, 2007

STUDENT SYMPOSIUM

SALONS I & II

A NATURAL HISTORY OF THE CHANNEL ISLANDS

- 0800 INTRODUCTION AND ANNOUNCEMENTS
- 0815 **Lafferty, K.** *US Geological Survey* FISHING AND CLIMATE EFFECTS ON THE STATE OF ROCKY REEFS IN THE CHANNEL ISLANDS
- 0845 **Blanchette C.** *University of California, Santa Barbara* INTERTIDAL COMMUNITIES OF THE CA CHANNEL ISLANDS: ECOLOGY AND NATURAL HISTORY
- 0915 **Bakker, V.** *University of California, Santa Cruz* INCORPORATING NATURAL HISTORY INTO MODELING AND MANAGEMENT OF THE ENDANGERED ISLAND FOX
- 0945 BREAK
- 1005 **Airamé, S.** *Marine Science Institute, University of California, Santa Barbara* MONITORING MARINE PROTECTED AREAS IN CALIFORNIA'S CHANNEL ISLANDS
- 1035 **Miller, K** *University of California, Berkeley* THE BOTTOM LINE: SEAWEED AND SEAGRASS COMMUNITIES IN THE CALIFORNIA CHANNEL ISLANDS
- 1055 **Panel Discussion:** THE ROLE OF NATURAL HISTORY IN SCIENTIFIC EXPLORATION
- 1135 LUNCH

FRIDAY, NOVEMBER 9, 2007

SESSION 1

SALON I & II

PHYSIOLOGICAL ECOLOGY I

Chair: Patrick Krug, CSU Los Angeles

- 1300 † **Jordan, L.K.** * *University of California, Los Angeles* THE SIXTH SENSE AND BEYOND; STINGRAY LATERAL LINE AND ELECTROSENSORY SYSTEM FORM AND FUNCTION
- 1315 † **Lockwood, B.L.** *, **McDonald, L.M.**, and **G.N. Somero** *Hopkins Marine Station of Stanford University* ENZYME ACTIVITIES OF THE BLUE MUSSELS, *MYTILUS TROSSULUS* AND *M. GALLOPROVINCIALIS*, INDICATE DIFFERENTIAL TEMPERATURE ADAPTATION
- 1330 † **Oliver, T A** *, and **S R Palumbi** *Stanford University* CORALS RESISTING WARMING – THE IMPORTANCE OF EXPERIENCE
- 1345 **Galli, GLJ** *, **Shiels, H**, **Gilly, W**, and **B Block** *Stanford University* HEART TEMPERATURE MAY LIMIT THE MOVEMENTS OF PACIFIC BLUEFIN TUNA, *THUNNUS ORIENTALIS*
- 1400 **Miller, L.P.**^{1*}, **Denny, M.W.**¹, and **C.D.G. Harley**² *1 - Hopkins Marine Station, Stanford University 2 - University of British Columbia* ECOMCHANICS MEETS ECOPHYSIOLOGY: PREDICTING THE FREQUENCY OF LETHAL AND SUBLETHAL STRESS EVENTS FOR A MID-SHORE LIMPET, *LOTTIA GIGANTEA*
- 1415 **Krug, P. J.** *, and **V. Rodriguez** *California State University, Los Angeles* WHERE THE SLUGS ROAM: RANGE LIMITS EXPLAINED BY DIFFERENT PHYSIOLOGICAL TOLERANCE TO TEMPERATURE AND SALINITY IN THE SEA SLUGS *ALDERIA MODESTA* AND *A. WILLOWI*
- 1430 **Edmunds, PJ** * *California State University, Northridge* THE EFFECT OF SHORT-TERM THERMAL AND LIGHT HISTORY ON THE RESPONSE OF REEF CORALS TO ELEVATED TEMPERATURE
- 1445 † **Putnam, H.M.** *, and **P.J. Edmunds** *California State University, Northridge* THERMAL HETEROGENEITY PRODUCES DIFFERENT RESPONSES IN CORAL HOSTS AND THEIR ALGAL SYMBIONTS
- 1500 BREAK

PHYSIOLOGICAL ECOLOGY II

Chair: Anne Todgham, UC Santa Barbara

- 1530 **Muehllehner, N*** and **P. J. Edmunds** *California State University, Northridge* **RISING CO₂ DISPROPORTIONATELY AFFECTS EXTENSION VERSUS MASS DEPOSITION IN REEF CORALS**
- 1545 **Ueda, N.***, and **A.A. Boettcher** *Univ South Alabama* **VARIATIONS IN HEAT SHOCK PROTEIN 70 EXPRESSION AMONG LARVAL AND EARLY SPAT DEVELOPMENTAL STAGES IN THE EASTERN OYSTER, *CRASSOSTREA VIRGINICA***
- 1600 **Dutton, JM*** *University of California, Santa Barbara* **EXPRESSION PATTERNS OF HEAT SHOCK PROTEINS IN *MYTILUS* BAY MUSSELS ACROSS THE EASTERN PACIFIC BIOGEOGRAPHICAL RANGE.**
- 1615 † **Koch, S.E.^{1*}**, and **T. Konotchick²** ¹*Cal State University, Fullerton* ²*Scripps Institution of Oceanography* **OCEAN ACIDIFICATION EFFECTS ON MOLLUSC LARVAE**
- 1630 † **Vasquez, M.C.***, and **S.R Dudgeon** *California State University Northridge* **THE INFLUENCE OF COLONY ARCHITECTURE ON MORPHOLOGICAL PLASTICITY IN THE HYDROID *PODOCORYNE CARNEA***
- 1645 **O'Donnell, M.J.^{1*}**, **Hammond, L.M.H.²**, and **G.E. Hofmann²** ¹*UCSB Marine Science Institute* ²*UCSB Department of Ecology Evolution and Marine Biology* **OCEAN ACIDIFICATION AND OTHER BOTHERS; GENE EXPRESSION PATTERNS IN URCHIN LARVAE EXPOSED TO MULTIPLE STRESSORS.**
- 1700 **Todgham, A.E.***, and **G.E. Hofmann** *Department of Ecology, Evolution and Marine Biology, UC Santa Barbara* **DEVELOPING AN OLIGO MICROARRAY TO STUDY IN THE IMPACT OF OCEAN ACIDIFICATION ON PURPLE SEA URCHINS**
- 1715 **Place, S.P.***, and **G.E. Hofmann** *University of California Santa Barbara* **ASSESSING THE PHYSIOLOGICAL RESPONSE OF *MYTILUS CALIFORNIANUS* TO ENVIRONMENTAL FACTORS ON A BIOGEOGRAPHIC SCALE**
- 1730 **Scheel, David***, and **Tania L.S. Vincent** *Alaska Pacific University* **OCTOPUS IMPACTS ON INTERTIDAL CRAB COMMUNITIES**
- 1745 † **Padilla-Gamino, J.L.***, and **R. Gates** *Hawaii Institute of Marine Biology* **EXPLORING CORAL REPRODUCTION IN THE FIELD: DO SIZE AND MORPHOLOGY INFLUENCE THE REPRODUCTIVE OUTPUT OF THE HERMATYPIC CORAL *MONTIPORA CAPITATA* (SPAWNER)?**

PLANT/ALGAL ECOLOGY I

Chair: Hannah Stewart, Friday Harbor Labs, University of Washington

- 1300 † **Henkel, S.K.***, and **G.E. Hofmann** *University of California, Santa Barbara* GENE EXPRESSION AND THERMOTOLERANCE IN SPOROPHYTES AND GAMETOPHYTES OF THE INVASIVE KELP, *UNDARIA PINNATIFIDA*
- 1315 † **Kohtio, D.M.*** *Moss Landing Marine Labs* PHYSIOLOGICAL RESPONSE OF THE INVASIVE KELP, *UNDARIA PINNATIFIDA* TO VARIATION IN SEAWATER TEMPERATURE
- 1330 **Van Alstyne, K. L.***, **Gifford, Sue-Ann**, **Cataldo, Marianne**, and **Amanda Salas** *Western Washington University* ALGAL ALLELOPATHIC INTERACTIONS: THE EFFECT OF EXOGENOUS DOPAMINE ON THE GERMINATION OF FERTILIZED *FUCUS DISTICHUS* EGGS AND THE GROWTH OF *ULVA LACTUCA*
- 1345 † **Mothokakobo, R.K.***, and **M.S. Edwards** *San Diego State University* VARIATION IN PHLOROTANNIN CONCENTRATIONS IN KELP SPECIES IN THE POINT LOMA KELP FOREST, SAN DIEGO, CA
- 1400 † **Fejtek, S. M.*** and **M.S. Edwards** *Department of Biology, San Diego State University, San Diego, California, USA* INVESTIGATING ELK KELP'S, *PELAGOPHYCUS PORRA*, INABILITY TO INVADE THE POINT LOMA GIANT KELP BEDS
- 1415 † **Carney, L.T.***, and **M.S. Edwards** *San Diego State University* DELAYED GAMETOPHYTE PRESENCE IN KELP FOREST SYSTEMS
- 1430 **Stewart, H.L.^{1*}**, **Fram, J.P.²**, **Reed, D.C.²**, **Brzezinski, M.A.²**, **MacIntyre, S.²**, **Williams, S.L.³**, and **B.P. Gaylord³** ¹*Friday Harbor Labs, University of Washington* ²*Marine Science Institute, UC Santa Barbara* ³*Bodega Marine Lab, UC Davis* KELP MAKES ITS BED AND LIES IN IT: GROWTH AND PHYSIOLOGICAL RESPONSE OF THE GIANT KELP *MACROCYSTIS PYRIFERA* TO DIFFERENT PHYSICAL CONDITIONS IN AND AROUND A KELP BED
- 1445 **Fram, J.P.^{1*}**, **Stewart, H.L.²**, **Brzezinski, M.A.¹**, **Gaylord, B.³**, **Reed, D.C.¹**, **Williams, S.L.³**, and **S. MacIntyre¹** ¹ - *Marine Science Institute, UC Santa Barbara* ² - *Friday Harbor Labs, University of Washington* ³ - *Bodega Marine Lab, UC Davis* WHAT SOURCES OF NITROGEN ARE AVAILABLE TO A BED OF GIANT KELP (*MACROCYSTIS PYRIFERA*) AND HOW MUCH OF EACH SOURCE IS UTILIZED?
- 1500 BREAK

FRIDAY, NOVEMBER 9 2007

SESSION 4

COMMUNITY ECOLOGY I

SALON IV

Chair: Heloise Chenelot, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks

- 1530 † **Quaranta, K.L.***, and **L.A. Ferry-Graham** *Moss Landing Marine Laboratories* FEEDING MORPHOLOGY AND KINEMATICS IN SURFPERCHES (EMBIOTOCIDAE: PERCIFORMES): EVOLUTION AND FUNCTIONAL CONSEQUENCES
- 1545 † **Douglass, J.G.***, and **J.E. Duffy** *College of William and Mary, Virginia Institute of Marine Science* DIAGNOSING A DECLINING ECOSYSTEM: SURVIVAL OF THE LAST CHESAPEAKE BAY EELGRASS BEDS DEPENDS ON A TENUOUS BALANCE OF BIOTIC AND ABIOTIC INFLUENCES
- 1600 **Munguia, P.***, and **R Osman** *Smithsonian Environmental Research Center* CHANGES IN HABITAT HETEROGENEITY AND IMPLICATIONS FOR THE CONSERVATION OF BENTHIC METACOMMUNITIES.
- 1615 **terHorst, C P.***, and **T E Miller** *Florida State University* RAPID EVOLUTION IN A COMMUNITY CONTEXT LEADS TO ECOLOGICAL NEUTRALITY
- 1630 † **Bailey, D.M.*** *CSU Northridge; Near-shore Marine Fisheries Research Program* EFFECTS OF PREDATOR ACCUMULATION ON COMMUNITY STRUCTURE OF FISHES IN MARINE PROTECTED AREAS
- 1645 † **Lewis, L.S.***, and **T.W. Anderson** *San Diego State Univ* PREDATION IN EELGRASS BEDS: DO TROPHIC MANIPULATIONS RESULT IN CASCADING EFFECTS?
- 1700 † **Novak, M.*** *University of Chicago* SPECIES RESPONSES TO FOOD WEB PERTURBATIONS: THE USE AND ACCURACY OF QUALITATIVE AND QUANTITATIVE PREDICTIONS.
- 1715 **Shinen, J.L.***, and **S.G. Morgan** *Bodega Marine Laboratory, University of California Davis* RESISTANCE TO A CRYPTIC INVASION AND FUNCTIONAL REDUNDANCY IN ROCKY INTERTIDAL MUSSEL COMMUNITIES
- 1730 **Chenelot, H.^{1*}**, **Konar, B.¹**, **Iken, K.¹**, and **M. Edwards²** ¹*School of Fisheries and Ocean Sciences, University of Alaska Fairbanks* ²*Department of Biology, San Diego State University* SPATIAL AND TEMPORAL DISTRIBUTION OF ECHINODERMS IN ROCKY NEARSHORE AREAS OF ALASKA
- 1745 † **Bowles, C M.***, and **E Grosholz** *UC Davis and Bodega Marine Lab* ALTERNATE STATES, STABILITY, DISTURBANCE AND POSITIVE FEEDBACKS IN CENTRAL CALIFORNIA SOFT-SEDIMENTS

FRIDAY, NOVEMBER 9, 2007

SESSION 5

SALON V

DISPERSAL/RECRUITMENT I

Chair: Todd Anderson, San Diego State University

- 1300 † **Miller, S.H.***, and **S.G. Morgan** *Bodega Marine Lab* TEMPORAL VARIATIONS IN CANNIBALISTIC INFANTICIDE: IMPLICATIONS FOR REPRODUCTIVE SUCCESS
- 1315 **Morgan, S.G.***, **Fisher, J.L.**, and **S.H. Miller** *Bodega Marine Laboratory, UC Davis* MECHANISMS OF LARVAL RETENTION AND CROSS-SHELF MIGRATION IN A ZONE OF STRONG COASTAL UPWELLING
- 1330 † **Green, DH***, and **PJ Edmunds** *California State University, Northridge* EXPLORING VARIATION IN CORAL RECRUITMENT THROUGH TEMPERATURE ALONG THE SOUTHERN COAST OF ST. JOHN, US VIRGIN ISLANDS
- 1345 † **Johnson, D.W.**^{1*}, **Moye, F.**², and **M.R. Christie**¹ ¹*Oregon State University* ²*CSUMB* BIG DADDIES MAKE BETTER BABIES: GENETIC LINKS BETWEEN ADULT SIZE AND LARVAL QUALITY IN A MARINE FISH
- 1400 **Anderson, T.W.***, **Deza, A.A.**, and **K.C. O'Connor** *San Diego State University* PREDATOR SIZE AND RECRUITMENT SUCCESS IN KELP-ASSOCIATED FISHES: IMPLICATIONS FOR MARINE RESERVES?
- 1415 **Selkoe, K.A.*** *Hawaii Institute of Marine Biology* CONNECTIVITY OF KELP BASS POPULATIONS EXPLAINED BY KELP COVER
- 1430 † **Smith, QS***, and **GL Eckert** *University of Alaska Fairbanks, School of Fisheries and Ocean Sciences, Juneau Center* SPATIAL VARIATION AND EVIDENCE FOR MULTIPLE TRANSPORT PATHWAYS FOR DUNGENESS CRAB (*CANCER MAGISTER*) LATE-STAGE LARVAE IN SOUTHEAST ALASKA.
- 1445 **Shears, NT***, **Vilas, CF**, and **JE Caselle** *Marine Science Institute, UCSB* SPATIAL AND TEMPORAL VARIABILITY IN THE SETTLEMENT OF SEA URCHINS (*STRONGYLOCENTROTUS FRANCISCANUS* AND *S. PURPURATUS*) AT THE CHANNEL ISLANDS, CALIFORNIA
- 1500 BREAK

FRIDAY, NOVEMBER 9, 2007

SESSION 6

SALON V

BEHAVIORAL ECOLOGY

Chair: Nick Tolimieri, NOAA Fisheries

- 1530 † **Knight, Ashley^{1*}, Lindholm, James¹, and Michael Domeier^{2 1}** *California State University Monterey Bay* ²*Marine Conservation Science Institute* GENDER-SPECIFIC SEASONAL MOVEMENT PATTERNS OF ADULT CALIFORNIA SHEEPHEAD *SEMICOSSYPHUS PULCHER* IN THE NORTHERN CHANNEL ISLANDS (EASTERN PACIFIC)
- 1545 † **Shulman, D.J.*** *Hopkins Marine Station of Stanford University* BEHAVIORAL REPERTOIRE AND SWIMMING SPEEDS OF *DOSIDICUS GIGAS* PARALARVAE
- 1600 † **Breckenridge, J.K.***, and **S.M. Bollens** *Washington State University Vancouver* VERTICAL MIGRATORY BEHAVIOUR OF DECAPOD LARVAE IN A PARTIALLY-MIXED ESTUARY: FIELD AND EXPERIMENTAL STUDIES
- 1615 **Norton, S.F.*** *Centralia College* WARNING COLORATION AND MULLERIAN MIMICRY BY CHEMICALLY-DEFENDED GAMMARID AMPHIPODS
- 1630 † **Rivers, Trevor J***, and **James G Morin** *Department of Ecology and Evolutionary Biology, Cornell University* EXTREME MALE MATING BEHAVIORAL PLASTICITY IN *VARGULA ANNECOHENAE*, A MARINE BIOLUMINESCENT OSTRACOD.
- 1645 † **Schroeder, S.L.***, and **A.L. Shanks** *Oregon Institute of Marine Biology, University of Oregon* PRELIMINARY OBSERVATIONS OF TERRITORIAL BEHAVIOR IN THE OWL LIMPET *LOTTIA GIGANTEA* USING TIME-LAPSE PHOTOGRAPHY
- 1700 **Tolimieri, N.***, **Levin, P.**, **Andrews, K.**, and **G. Williams** *NOAA Fisheries* HOME RANGE SIZE AND PATTERNS OF SPACE USE FOR LINGCOD, COPPER ROCKFISH AND QUILLBACK ROCKFISH IN PUGET SOUND
- 1715 **Jirik, K.E.***, and **C.G. Lowe** *California State University Long Beach* SEASONAL ABUNDANCE AND HABITAT PREFERENCE OF ROUND STINGRAYS IN A SOUTHERN CALIFORNIA ESTUARY
- 1730 **Andrews, K.S.***, **Williams, G.D.**, and **P.S. Levin** *NOAA Fisheries, Northwest Fisheries Science Center* DIEL PATTERNS OF VERTICAL MOVEMENT FOR SIXGILL SHARKS IN AN URBAN ESTUARY: THE UPS-AND-DOWNS OF AN URBAN PREDATOR.
- 1745 **Adreani, M.A.*** *Florida State University* CONTEXT-DEPENDENT STREAK SPAWNING IN THE HERMAPHRODITIC SEABASS, *SERRANUS SUBLIGARIUS*.

FRIDAY, NOVEMBER 9, 2007

SESSION 7

LA JOLLA

INVASIVE SPECIES

Chair: Clement Dumont, Stanford University

- 1300 **Hoos, P.M.^{1*}, Geller, J.B.¹, and R.C. Vrijenhoek²** ¹*Moss Landing Marine Laboratories*
²*Monterey Bay Aquarium Research Institute* THE INTRODUCTION OF THE WESTERN
ATLANTIC CLAM *GEMMA GEMMA* TO CALIFORNIA: COMPARING
INFERENCES FROM GENETIC AND HISTORIC DATA.
- 1315 † **Foster, N L^{*}** *University of California, Santa Barbara* REDUCED PARASITISM IN A
HIGHLY INVADED ESTUARY: SAN FRANCISCO BAY
- 1330 † **Albins, M. A.^{*}** EFFECTS OF THE INVASIVE INDO-PACIFIC LIONFISH
(*PTEROIS VOLITANS/MILES* COMPLEX) ON BAHAMIAN *Oregon State University,*
Zoology Department CORAL-REEF FISH COMMUNITIES: PRELIMINARY
INVESTIGATIONS
- 1345 † **Sellheim, K.L.^{*}** *University of California, Davis* EXOTIC SPECIES AS HABITAT:
CAN NONNATIVE FOUNDATION SPECIES FACILITATE NATIVE EPIFAUNA?
- 1400 † **Altman, S.^{1*}, Ruiz, G.M.², and A.H. Hines²** ¹*University of Maryland* ²*Smithsonian*
Environmental Research Center EFFECTS OF INVASIVE COMMUNITY DIVERSITY AND
RESOURCE AVAILABILITY ON SUBSEQUENT INVASION IN MARINE FOULING
COMMUNITIES
- 1415 **Dumont, C.P.^{1*}, Urriago, J.D.², Thiel, M.², and C.F. Gaymer²** ¹*Stanford University*
and Universidad Catolica del Norte ²*Universidad Catolica del Norte, Coquimbo, Chile*
PREDATION RESISTANCE OF MARINE COMMUNITIES TO INVASION
- 1430 **Zabin, C.J.^{1*}, Mackie, J.A.², Obernolte, R.³, J. Gentry⁴ J. Geller²** ¹*Smithsonian*
Environmental Research Center and University of California, Davis ²*Moss Landing Marine Laboratories*
³*University of California, Davis* ⁴*Marine Science Institute* GREAT BALLS OF BRYOS:
NOVEL SUBSTRATE ON THE MUD FLATS IN SAN FRANCISCO BAY
- 1445 **Asif, J.H.^{*}, and P.J. Krug** *CSULA* GENETIC EVIDENCE FOR MULTIPLE
INVASIONS AND DISTINCT REGIONAL POPULATIONS OF THE INTRODUCED
ASIAN DATE MUSSEL, *MUSCULISTA SENHOUSIA*, ALONG THE U.S. WEST
COAST
- 1500 BREAK

FRIDAY, NOVEMBER 9, 2007

SESSION 8

LA JOLLA

EVOLUTIONARY ECOLOGY

Chair: Dustin Marshall, University of Queensland

- 1530 † **Erisman, B. E. ***, and **P.A. Hastings** *Scripps Institution of Oceanography* BREAK-DOWN OF THE SIZE-ADVANTAGE MODEL: EVOLUTIONARY CHANGES IN MATING PATTERN INFLUENCE THE LOSS OF SEX CHANGE IN GROUPERS AND SEABASSES
- 1545 **Henzler, C.M.^{1*}**, and **C.W. Cunningham^{2 1}** *University of California Santa Barbara² Duke University* LONG-DISTANCE DISPERSAL BY RAFTING ON DRIFT ALGAE IN THREE SPECIES OF NORTH ATLANTIC AMPHIPODS
- 1600 **Rodriguez, A. ***, and **Krug, P.J.** *Cal State University, Los Angeles* HYBRIDIZATION IN TWO CARIBBEAN SEA SLUGS WITH NON-PLANKTONIC DEVELOPMENT
- 1615 † **Hidalgo, E. ***, and **P. J. Krug** *California State University, Los Angeles* CARIBBEAN PHYLOGEOGRAPHY: POPULATION STRUCTURE IN SEA SLUGS WITH DISPERSING VS. NON DISPERSING LARVAE.
- 1630 † **Hewson, W.E. ***, and **D.J. Eernisse** *California State University, Fullerton* A COMMON SOUTHERN CALIFORNIA LIMPET IS A NEW SPECIES THAT OVERLAPS WITH ITS SISTER SPECIES IN NORTHERN BAJA CALIFORNIA.
- 1645 † **Winchell, C.J. ***, and **D.K. Jacobs** *UCLA* LARVAL EXPRESSION OF THE "APPENDAGE" GENES *DISTAL-LESS* AND *OPTOMOTOR BLIND* IN THE POLYCHAETE WORM *NEANTHES ARENACEODENTATA*
- 1700 **Manier, M.K. *** *Hopkins Marine Station of Stanford University* EVOLUTIONARY CAUSES AND CONSEQUENCES OF SPERM VARIATION IN SEA URCHINS
- 1715 † **Puritz, J .B. *** *Hawaii Institute of Marine Biology, University of Hawaii at Manoa* DOES MARKER VARIATION REALLY MATTER? INSIGHTS FROM THE POPULATION STRUCTURE OF *PATIRIA MINIATA*
- 1730 **Marshall, D. J.^{1*}**, and **M. J. Keough^{2 1}** *Univ of Queensland²University of Melbourne* ADAPTIVE PLASTICITY IN LARVAL SIZE IN A MARINE INVERTEBRATE
- 1745 **Ellingson, R.A.^{1*}**, **Jacobs, D.K.¹**, **Swift, C.C.²**, and **L.T. Findley^{3 1}** *University of California, Los Angeles²Natural History Museum of Los Angeles County³CIAD - Unidad Guaymas, Guaymas, Sonora, Mexico* MOLECULAR GENETICS AND GEOLOGICAL HISTORY OF THE SEA OF CORTEZ: EVOLUTION AND SPECIATION IN THE ESTUARINE GOBY GENUS *GILLICHTHYS*

FRIDAY, NOVEMBER 9, 2007

1730 **WSN POSTER SESSION**

PUERTO ESCONDIDO

1930 **WSN ATTITUDE ADJUSTMENT HOUR**

COSTA DE ORO

The AAH will be held in Costa de Oro of the Ventura Marriott, where you can enjoy food and beverages with your colleagues and see posters in adjacent rooms. **Your WSN name badge is required for admission.**

SATURDAY, NOVEMBER 10, 2007

PRESIDENTIAL SYMPOSIUM

SALONS I & II

MARINE RESERVES OFF CALIFORNIA: WHAT DO WE REALLY KNOW ABOUT THEIR IMPACT ON MARINE FISHERIES?

- 0800 INTRODUCTION (Larry Allen)
- 0815 **Friedlander, A.** *NOAA/NCCOS/CCMA-Biogeography Branch and the Oceanic Institute* HABITAT QUALITY, SIZE, AND MANAGEMENT DETERMINE THE EFFECTIVENESS OF MPAS IN HAWAII FOR BIODIVERSITY CONSERVATION AND FISHERIES REPLENISHMENT
- 0845 **Caselle, J., Kushner, D., Hamilton, S., Malone, D., Carr, M., Moss, M.** *University of California, Santa Barbara, Santa Cruz, and others.* RESPONSES OF NEARSHORE ROCKY REEF POPULATIONS AND COMMUNITIES IN THE NEW NETWORK OF MARINE RESERVES IN THE CHANNEL ISLANDS.
- 0915 **Lowe C. G.^{*1}, Mason¹ T., Bellquist¹ L., Topping¹ D., Hight B.¹ and Caselle² J.** ¹*California State University Long Beach, Dept. of Biological Sciences,* ²*UCSB.* WHAT DO WE KNOW ABOUT MOVEMENT PATTERNS AND HABITAT USE OF ROCKY REEF ASSOCIATED GAMEFISHES AND WHY IS IT ESSENTIAL FOR MPA DESIGN?
- 0945 BREAK
- 1015 **Hovel, K.A.^{*1}, C.G. Lowe², C.L. Loflen¹, T.T. Mai¹, and K. Palaoro¹.** ¹*San Diego State University,* ²*California State University Long Beach.* SPINY LOBSTERS AND MARINE RESERVES: WHAT CAN WE LEARN AND WHAT DO WE KNOW?
- 1045 **Helfman, G.** *University of Georgia* ROUND TABLE DISCUSSION
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- 1130 WSN LIFETIME ACHIEVEMENT AWARD (Paul Dayton)
- 1140 INTRODUCTION OF THE NATURALISTS OF THE YEAR (by Larry Allen)
- 1145 WSN NATURALISTS OF THE YEAR (Genny and Shane Anderson)
- 1215 LUNCH

SATURDAY, NOVEMBER 10, 2007

SESSION 9

SALON IV

PLANT/ALGAL ECOLOGY II

Chair: Jeremy Long, Northeastern University

- 1300 **Mach, K. J.** ^{*} *Hopkins Marine Station of Stanford University* FAILURE BY FATIGUE IN WAVE-SWEPT MACROALGAE
- 1315 † **Spitler, Melissa I.** ^{*}, and **Robert C. Carpenter** *California State University, Northridge* IMPACTS OF HERBIVORY ON THE POPULATION DYNAMICS OF TWO FUCOID SPECIES IN MOOREA, FRENCH POLYNESIA
- 1330 **Lindstrom, S. C.** ^{*} *Department of Botany, University of British Columbia* CRYPTIC DIVERSITY AND PHYLOGENETIC RELATIONSHIPS WITHIN THE *MASTOCARPUS PAPILLATUS* SPECIES COMPLEX (RHODOPHYTA, PHYLLOPHORACEAE)
- 1345 **Rodriguez, G.E.** ^{1*}, and **Lonhart, S.I.** ² ¹*CSU Monterey Bay*, ²*Monterey Bay National Marine Sanctuary* MICROHABITAT VARIATION IN MYCOSPORINE-LIKE AMINO ACID GROWTH AND REPRODUCTION OF INVASIVE KELP SPOROPHYTES (*UNDARIA PINNATIFIDA*), MONTEREY HARBOR, SUMMER 2007
- 1400 **Miklasz, K. A.** ^{*} *Hopkins Marine Station* PREDICTING A SINKING SPEED FOR DIATOMS
- 1415 **Jones, E.** ^{1*}, **Bracken, M.E.S.** ², **Carranza, A.** ¹, and **S.L. Williams** ¹ ¹*Bodega Marine Laboratory, UC Davis* ²*Marine Science Center, Northeastern University* REALISTIC DIFFERENCES IN SPECIES COMPOSITION, BUT NOT DIVERSITY, DETERMINE NITROGEN USE BY INTERTIDAL SEAWEED ASSEMBLAGES
- 1430 **Long, J.D.** ^{1*}, **Toth, G.B.** ², **Pavia, H.** ², and **G.C. Trussell** ¹ ¹*Northeastern University Marine Science Center* ²*Tjarno Marine Biological Laboratory* TRANSATLANTIC VARIATION IN SEAWEED INDUCIBLE AND CONSTITUTIVE DEFENSES
- 1445 **Poray, A K.** ^{*}, and **R C Carpenter** *California State University Northridge* PHYSIOLOGICAL CONSEQUENCES FOR CORAL REEF MACROALGAE INHABITING REFUGIA FROM HERBIVORES
- 1500 BREAK

SATURDAY, NOVEMBER 10, 2007

SESSION 10

DISPERSAL/RECRUITMENT II

SALON IV

Chair: Steve Lonhart, Monterey Bay National Marine Sanctuary

- 1530 **Pelc, R.A.^{1*}, Tanci, T.², Baskett, M.L.³, Gaines, S.D.¹, and R.R. Warner¹** ¹*University of California, Santa Barbara* ²*Department of Environmental Affairs and Tourism, South Africa* ³*NCES*
PRODUCTION, DISPERSAL AND LARVAL EXPORT OF A HARVESTED
INTERTIDAL MUSSEL IN SOUTH AFRICAN MARINE RESERVES
- 1545 **Shanks, A.L.*** *Univ Oregon, Oregon Inst Marine Biology* THE CAUSES OF
VARIATION IN BARNACLE SETTLEMENT AS REVEALED BY DAILY
SETTLEMENT VS. RECRUITMENT AT WEEKLY AND LONGER INTERVALS
- 1600 **Lonhart, S.I.*** *Monterey Bay National Marine Sanctuary, NOAA* GEOGRAPHIC
RANGE CHANGES BY CHITONS IN THE PANAMIC PROVINCE
- 1615 **Ben-Horin, T.^{1*}, Iacchei, M.², and K.A. Selkoe²** *UCSB* ²*Hawaii Institute of Marine
Biology* POPULATION CONNECTIVITY OF CALIFORNIA SPINY LOBSTER
PANULIRUS INTERRUPTUS ACROSS THE US-MEXICO BORDER
- 1630 **Iacchei, M.^{1*}, Ben-Horin, T.², Selkoe, K.A.¹, and R.J. Toonen¹** *Hawaii Inst Marine
Biology UCSB* MANAGEMENT ACROSS BORDERS: AN MTDNA PERSPECTIVE
OF THE CALIFORNIA SPINY LOBSTER, *PANULIRUS INTERRUPTUS*
- 1645 † **Haupt, A. J.* , Micheli, F., and S. R. Palumbi** *Stanford University* ASSESSING
CONNECTIVITY OF A COMMERCIALY IMPORTANT MARINE
INVERTEBRATE WITH MOLECULAR MARKERS.
- 1700 **White, C^{1*}, Watson, J¹, Selkoe, K², Toonen, RJ², and D Zacherl³** ¹*University of
California - Santa Barbara* ² *Hawaii Institute of Marine Biology* ³*California State
University – Fullerton* POPULATION CONNECTIVITY OF AN EMERGING
COASTAL FISHERY SPECIES AND THE INFLUENCE OF ENSO ON LARVAL
DISPERSAL-MEDIATED GENE FLOW
- 1715 † **Stier, A.C.* , and Osenberg C.W.** *University of Florida* ARTIFICIAL REEFS
INCREASE FISH PRODUCTION: A TEST OF SETTLEMENT REDIRECTION
- 1730 **Daly, B*, and B Konar** *University of Alaska Fairbanks* EFFECTS OF MID-WATER
STRUCTURAL COMPLEXITY ON TEMPORAL AND SPATIAL VARIABILITY OF
NEARSHORE CRAB EARLY-LIFE HISTORY STAGES WITHIN A HIGH-
LATITUDE REGION
- 1745 † **Nickols, K.J.^{1*}, Gaylord, B., and J.L. Largier** *Bodega Marine Laboratory* *University of
California, Davis* NEARSHORE FLOWS IN CALIFORNIA: THE PRESENCE OF A
COASTAL BOUNDARY LAYER AND IMPLICATIONS FOR DISPERSAL

SATURDAY, NOVEMBER 10, 2007

SESSION 11

LA JOLLA

FISHERIES ECOLOGY I

Chair: Scott Hamilton, UC Santa Barbara

- 1300 † **Bredvik, J.B.** * *California State University, Northridge* PRODUCTIVITY OF AN HERBIVOROUS TEMPERATE MARINE FISH, *GIRELLA NIGRICANS*
- 1315 † **Anthony, K.M.^{1*}, Lowe, C.G.¹, and M.S. Love^{2 1}** *Cal State University Long Beach*
²*Marine Science Institute, University of California Santa Barbara* TRANSLOCATION AND HOMING BEHAVIOR OF PLATFORM-ASSOCIATED FISHES FROM OFFSHORE OIL PLATFORMS IN THE SANTA BARBARA CHANNEL
- 1330 **McGourty, K.R.^{1*}, Hobbs, J.A.², Ikemiyagi, N.¹, and W.A. Bennett^{1 1}** *Bodega Bay Marine Lab; University of California, Davis* ²*Univeristy of California, Berkeley* *KABATANA* SP., A NEWLY OBSERVED MICROSPORIDIAN PARASITE IN THE LONG-JAWED MUDSUCKER (*GILLICHTHYS MIRABILIS*)
- 1345 † **Plank, S.M. ***, **Lowe, C.G.**, and **J.A. Brusslan** *California State University Long Beach* THE POPULATION GENETIC STRUCTURE OF THE ROUND STINGRAY (*UROBATUS HALLERI*) IN SOUTHERN CALIFORNIA.
- 1400 † **Buckhorn, M.L. *** *U.C. DAVIS* AGE AND GROWTH OF LEOPARD GROUPER, *MYCTEROPERCA ROSACEA*, IN LORETO MARINE PARK, BAJA CALIFORNIA SUR.
- 1415 **Marshman, B.C. ***, **Hobbs, J.A.**, **McGourty, K.R.**, **Ikemiyagi, N.**, and **S.G. Morgan** *Bodega Marine Laboratory*, HITCHHIKER PARASITES: THE EFFECT OF INVASIVE JAPANESE MUD SNAIL (*BATILLARIA CUMINGI*) ON THE NATIVE LONGJAW MUDSUCKER (*GILLICHTHYS MIRABILIS*) THROUGH PARASITISM.
- 1430 **Hamilton, S^{1*}, Caselle, J¹, Loke, K², Young, K², and C Lowe^{2 1}** *UC Santa Barbara*
²*California State University Long Beach* SELECTIVE HARVESTING ALTERS LIFE HISTORIES OF A TEMPERATE SEX-CHANGING FISH: HISTORICAL COMPARISONS AND CURRENT STATUS OF CALIFORNIA SHEEPHEAD
- 1445 † **Button, C.A.^{1*}, and L.K. Rogers-Bennett^{2 1}** *Scripps Institution of Oceanography*
²*CDFG and UCD Bodega Marine Lab* POPULATION DENSITY AND AGGREGATION CHARACTERISTICS OF THE RED ABALONE (*HALIOTIS RUFESCENS*) IN CALIFORNIA
- 1500 BREAK

SATURDAY, NOVEMBER 10, 2007

SESSION 12

LA JOLLA

POPULATION BIOLOGY I

Chair: Clare Wormald, University of Rhode Island

- 1530 **Wormald, C. L.^{1*}, Steele, M. A.², and G. E. Forrester¹** ¹*University of Rhode Island*
²*California State University, Northridge* HIGH POPULATION DENSITY ENHANCES SURVIVAL IN A LARGE HARVESTED CORAL REEF FISH
- 1545 **Paddack, MJ^{1,2*}, Côté, IM², Reynolds, JD¹, and A Watkinson²** ¹*Simon Fraser University* ²*University of East Anglia, Norwich* ASSESSING CHANGE IN FISH POPULATIONS: USE OF META-ANALYSES TO EXAMINE TEMPORAL SHIFTS IN CARIBBEAN CORAL REEF FISHES
- 1600 **Breen, R.T.^{*}** *San Francisco State University* METAPOPOPULATION ECOLOGY OF THE RHIZOSTOME JELLYFISH, *CASSIOPEA XAMACHANA* FROM CALABASH CAYE, BELIZE
- 1615 **Reilly, C. R.L.^{*}, and S. C.P. Renn** *Reed College* EXPLORING GENE DUPLICATION IN RAPID EVOLUTIONARY RADIATIONS
- 1630 † **Pespeni, M.^{*}, Oliver, T., Jacobs-Palmer, E., Manier, M., and S.R. Palumbi** *Stanford University* POPULATION GENOMICS OF THE PURPLE SEA URCHIN: DEVELOPING AN ARRAY-BASED SNP DETECTION METHOD TO IDENTIFY POTENTIALLY ADAPTIVE GENES
- 1645 **Pollard, A M^{*}** *Univ of Oregon, Oregon Institute of Marine Biology* RACCOON AND RIVER OTTER PREDATION ON A LARGE LEACH'S STORM-PETREL COLONY.
- 1700 **Kelly, R.P.^{*}, Oliver, T.A., Sivasundar, A., and S.R. Palumbi** *Stanford University, Hopkins Marine Station* SASHA (SPATIAL ANALYSIS OF SHARED ALLELES): A METHOD FOR DETECTING POPULATION GENETIC STRUCTURE IN HIGH GENE FLOW SPECIES
- 1715 † **Sunday, J M^{1*}, Hart, M W¹, and M Foreman²** ¹*Simon Fraser University*
²*Department of Fisheries and Oceans Canada* DISPERSAL BIOLOGY AND GENETIC STRUCTURE OF THE BAT STAR, *PATIRIA MINIATA*
- 1730 **Pinsky, M.L.^{1*}, van Tuinen, M.², Newsome, S.D.³, and E.A. Hadly⁴** ¹*Hopkins Marine Station*, ²*UNC Wilmington* ³*Carnegie Geophysical Laboratory* ⁴*Stanford University* SEPARATING THE EFFECTS OF MIGRATION AND COLONIZATION: ANCIENT DNA IN THE NORTHERN FUR SEAL, *CALLORHINUS URSINUS*
- 1745 **Baskett, M.L.^{1*}, Gaines, S.D.², and R.M. Nisbet²** ¹*NCES*, ²*UCSB* THE ROLE OF SYMBIONT DIVERSITY IN CORAL RESPONSE TO CLIMATE CHANGE

SATURDAY, NOVEMBER 10, 2007

SESSION 13

SALONS I & II

INTERTIDAL ECOLOGY I

Chair: Carlos Robles, CSU Los Angeles

- 1300 **Robles, C.D.** * *California State University at Los Angeles* INTERTIDAL MUSSEL ZONATION AS AN EQUILIBRIAL PROCESS
- 1315 † **Kane, T. L.** *, and **P. Fong** *UCLA* QUANTIFYING RATES AND MECHANISMS CONTROLLING SEDIMENT NITROGEN FIXATION AND DENITRIFICATION IN INTERTIDAL MUDFLATS OF UPPER NEWPORT BAY ESTUARY, SOUTHERN CALIFORNIA
- 1330 † **Gravem, S.G.** *, **Chang, L.E.**, and **N.L. Adams** *Cal Poly SLO* MICROHABITAT VARIATION IN MYCOSPORINE-LIKE AMINO ACID CONCENTRATIONS IN THE GONADS AND EPIDERMIS OF THE PURPLE SEA URCHIN, *STRONGYLOCENTROTUS PURPURATUS*
- 1345 **Boller, M.L.** *, and **T. Finkler** *Hopkins Marine Station* VERTICAL VARIATION IN INTERTIDAL WAVE-GENERATED WATER VELOCITY
- 1400 † **Parker, M. A.** * and **Nielsen, K.J** *Sonoma State University* A TALE OF TWO HEADLANDS: RECRUITMENT AND REPRODUCTIVE OUTPUT OF *BALANUS GLANDULA* AND *CHTHAMALUS DALLI* ALONG THE NORTHERN CALIFORNIA COAST
- 1415 **Eernisse, D. J.**^{1*}, **Hewson, W. E.**¹, and **R. P. Kelly**^{2 1} *Calif. State Univ. Fullerton*
²*Columbia Univ. and American Museum of Nat. Hist* ECOLOGICAL CONVERGENCE AND DIVERGENCE IN LIMPETS
- 1430 † **Neufeld, C.J.** * *Univ. Alberta and Bamfield Marine Sciences Centre* SOURCE POPULATION INFLUENCES THE CAPACITY FOR PLASTICITY IN FEEDING STRUCTURES OF A COMMON INTERTIDAL BARNACLE (*BALANUS GLANDULA*)

1445

1500 BREAK

SATURDAY, NOVEMBER 10, 2007

SESSION 14

INTERTIDAL ECOLOGY II

SALONS I & II

Chair: John Pearse, UC Santa Cruz

- 1530 † **Gravem, S.G.***, **Chang, L.E.**, and **N.L. Adams** *Cal Poly SLO* MICROHABITAT VARIATION IN MYCOSPORINE-LIKE AMINO ACID CONCENTRATIONS IN RED MACROALGAE (PHYLUM RHODOPHYTA) ON CALIFORNIA'S CENTRAL COAST
- 1545 **Pincebourde, S.^{1*}**, **Sanford, E.²**, and **B. Helmuth¹** *University of South Carolina, Dept Biological Sciences, ²Bodega Marine Laboratory* ENVIRONMENTAL VARIATIONS AND KEYSTONE PREDATOR PERFORMANCE IN THE INTERTIDAL
- 1600 † **Smith, K.A.***, and **B. Helmuth** *Univ South Carolina* WHEN MUSSELS DIE...AN ASSESSMENT OF THE MECHANISMS DETERMINING THE UPPER LIMIT OF *MYTILUS CALIFORNIANUS* BEDS ALONG THE PACIFIC COAST OF NORTH AMERICA.
- 1615 **Szathmary, P.L.***, **Smith, K.A.**, **Wethey, D.S.**, **Brin, L.**, and **B. Helmuth** *Univ South Carolina* ECOLOGICAL FORECASTING IN THE INTERTIDAL ZONE: ACCURACY OF MUSSEL TEMPERATURE PREDICTIONS OVER A RANGE OF TIME SCALES
- 1630 † **Jorve, J.P.*** *Moss Landing Marine Laboratories* TEMPORAL AND SPATIAL VARIABILITY IN THE EFFECT OF HABITAT-FORMING SPECIES ON INTERTIDAL MICROCLIMATE
- 1645 **Zimmer, R.K.***, **Ferrier, G.A.**, **Vallejo, J.M.**, and **C.A. Zimmer*** *UCLA* THE SENSORY BASIS FOR ECOLOGICAL PARADIGMS ON WAVE-SWEPT SHORES
- 1700 † **Goetz, F.G.***, **Hancock, L.P.**, **McDonald, P.S.**, and **P. Dinnel** *Western Washington University* THE ECOLOGY AND POTENTIAL CONTROL OF THE INVASIVE BAMBOO WORM, *CLYMENELLA TORQUATA*, IN SAMISH BAY, WA, A NORTHEASTERN PACIFIC ESTUARY.
- 1715 † **Ferrier, G.A.***, **Zimmer, R.K.**, **Kim, S.J.**, and **C.A. Zimmer** *UCLA* CHEMICAL CUES AND THE KEYSTONE SPECIES HYPOTHESIS
- 1730 **Pearse, J.S.***, **Pearse, D.E.**, and **V.B. Pearse** *University of California, Santa Cruz* RISING SEA LEVEL AND CHANGES IN INTERTIDAL ZONATION: PROFESSOR SNADROCK 60 YEARS LATER
- 1745 **Grupe, B.M.*** *South Slough National Estuarine Research Reserve* THE SEDENTARY LIFESTYLE OF INTERTIDAL PURPLE SEA URCHINS (*STRONGYLOCENTROTUS PURPURATUS*) AS REVEALED BY PHOTO-MONITORING

SATURDAY, NOVEMBER 10, 2007

SESSION 15

SALON V

COMMUNITY ECOLOGY II

Chair: Jeff Goddard, Marine Science Institute, UCSB

- 1300 **Perotti, E.A.** * *University of California, Berkeley* DOES GEOLOGY MATTER? THE EFFECTS OF SUBSTRATUM ON COMMUNITY ECOLOGY IN THE TEMPERATE ROCKY INTERTIDAL.
- 1315 **Goddard, J.H.R.**^{1*}, **Schultz, S.T.**², **Pearse, J.S.**³, and **T.M. Gosliner**⁴ ¹*Marine Science Institute, UCSB* ²*University of Zadar, Croatia* ³*UCSC* ⁴*California Academy of Sciences* NUDIBRANCHS AND THE 1976-77 CLIMATE SHIFT IN THE NE PACIFIC
- 1330 **Wood, S.A.**^{1*}, **Lilley, S.A.**², **Schiel, D.R.**², and **J.B. Shurin**¹ ¹*University of British Columbia, Canada* ²*University of Canterbury, New Zealand* AN EMPIRICAL ASSESSMENT OF COMMUNITY-WIDE SPECIES INTERACTION STRENGTHS IN THE ROCKY INTERTIDAL.
- 1345 † **Byrnes, J.E.** * , and **J.J. Stachowicz** *UC Davis, Bodega Marine Lab* THE CONSEQUENCES OF ACCELERATING TROPHIC SKEW IN MARINE FOULING COMMUNITIES
- 1400 **Granek, E.F.**^{1*}, and **B. Ruttenberg**² ¹*Portland State University* ²*Universidad Autónoma de Baja California* THE PROTECTIVE CAPACITY OF MANGROVES DURING TROPICAL STORMS: A CASE STUDY FROM WILMA AND GAMMA IN BELIZE
- 1415 † **Overstrom-Coleman, M.** * *Moss Landing Marine Laboratories* ECOLOGICAL SIGNIFICANCE AND SPATIOTEMPORAL VARIABILITY OF KELP-DERIVED PARTICULATE ORGANIC MATTER (POM) IN STILLWATER COVE, CA.
- 1430 † **Figurski, J.D.** * *UC Santa Cruz* THE DISTRIBUTION, ABUNDANCE, AND DYNAMICS OF DRIFT ALGAE WITHIN KELP FOREST ECOSYSTEMS OF CENTRAL CALIFORNIA
- 1445 † **Olyarnik, S.V.** * and **Stachowicz, J.J.** *Bodega Marine Lab, UC Davis* EXPLORING THE TOP-DOWN AND BOTTOM-UP FACTORS THAT AFFECT SEASONAL MACROALGAL ABUNDANCE IN A SEAGRASS COMMUNITY
- 1500 BREAK

SATURDAY, NOVEMBER 10, 2007

SESSION 16

SALON V

COMMUNITY ECOLOGY III

Chair: Mark Steele, CSU Northridge

- 1530 † **Chang, A.L.**^{*} *University of California Davis* ECOLOGICAL CONSEQUENCES OF HISTORICAL AND MODERN FRESHWATER DISTURBANCE EVENTS IN AN ESTUARINE ECOSYSTEM
- 1545 † **Idjadi, J A**^{*}, and **R H Karlson** *University of Delaware* SPATIAL AGGREGATION PROMOTES COEXISTENCE AMONG CORAL SPECIES
- 1600 † **White, J. S.**^{*}, **Osenberg, C.W.**, and **J.L. O'Donnell** *Department of Zoology, University of Florida* INDIRECT EFFECTS OF A MARINE ECOSYSTEM ENGINEER ALTER CORAL HABITAT COMPOSITION
- 1615 † **Price, N N**^{*} *University of California, Santa Barbara* THE INCREDIBLY SLOW RACE FOR SPACE: COMPETITIVE REVERSALS AMONG CORALLINE ALGAE.
- 1630 **Konar, Brenda**^{*}, and **Katrin Iken** *University of Alaska Fairbanks* COMMUNITY DYNAMICS IN COASTAL BEAUFORT SEA BOULDER FIELDS
- 1645 † **Arkema, K.K.**^{*}, **Reed, D.R.**, and **S. Schroeter** *University of California, Santa Barbara* TEMPORAL VARIABILITY IN GIANT KELP ABUNDANCE INFLUENCES BENTHIC COMMUNITY COMPOSITION
- 1700 **Bergsma, G.S.**^{*} *UCSB* MUTUALIST INDUCED CORAL STRUCTURE PROVIDES HABITAT FOR REEF FISH
- 1715 **Fan, T.Y.**^{*}, **Lin, N.C.**, **Shao, K.T.**, **Edmunds, P.J.**, and **L.S. Fang**^{*} *National Museum of Marine Biology and Aquarium, Pingtung 944, Taiwan* AN UNUSUAL PHASE SHIFT FROM SCLERACTINIAN- TO ACTINIARIAN-DOMINANCE IN CORAL REEFS
- 1730 † **Roth, M.S.**^{*} *Scripps Institution of Oceanography* DISTRIBUTION, ABUNDANCE AND MICROHABITAT CHARACTERIZATION OF JUVENILE CORALS AT PALMYRA ATOLL
- 1745 **Steele, M. A.**^{1*}, **Forrester, G. E.**², and **J. F. Samhuri**³ ¹*California State University Northridge* ²*University of Rhode Island* ³*NOAA Fisheries - Northwest Fisheries Science Center* LARGE-SCALE EXPERIMENT REVEALS EFFECTS OF HABITAT STRUCTURE ON CORAL REEF FISH ASSEMBLAGES

SATURDAY, NOVEMBER 10, 2007

1815 **WSN Annual Business Meeting** **SALONS I & II**

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

1930 **Presidential Banquet** **LAS BRISAS JR. BALLROOM**

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

2130 **WSN Auction for student travel** **LAS BRISAS JR. BALLROOM**

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 11, 2007

SESSION 17

SALON I & II

CONSERVATION & APPLIED ECOLOGY I

Chair: Rafe Sagarin, Nicholas Institute, Duke University

- 0900 **Janousek, C.N.***, **Lorber, J.D.**, and **W.D. Gubler** *University of California, Davis* MICROBIAL DIVERSITY EFFECTS ON PLANT PATHOGENS IN AGROECOSYSTEMS
- 0915 † **Freiwald, J.*** *University of California Santa Cruz* MOVEMENT OF TEMPERATE REEF FISHES: INFORMING MPA SIZE
- 0930 **Sagarin, R D***, and **L Crowder** *Nicholas Institute, Duke University* THREE PHILOSOPHIES OF ED RICKETTS AND THE CHALLENGES OF ECOSYSTEM BASED MANAGEMENT
- 0945 † **Graiff, K.W.^{1*}**, **Tissot, B.N.¹**, and **Yoklavich, M.M.^{2 1}** *Washington State University, Vancouver²National Marine Fisheries Service, NOAA* FISHING INTENSITY AND THE ABUNDANCE AND DISTRIBUTION OF DEEP-WATER MEGAFUNAL INVERTEBRATES AT THREE SITES WITHIN THE MONTEREY BAY NATIONAL MARINE SANCTUARY
- 1000 † **Thompson, S.A.^{1*}**, **Nielsen, K.J.¹**, **Blanchette, C.A.²**, **Brockbank, B.¹**, and **H.R. Knoll^{1 1}** *Sonoma State University²University of California, Santa Barbara* EXAMINING THE RESPONSE OF *POSTELSIA PALMAEFORMIS* TO COMMERCIAL COLLECTION ACROSS SITES IN CALIFORNIA.
- 1015 † **Fitzpatrick, J. M.***, **Lippé C.**, and **Carlson D. B.** *Department of Zoology, University of Hawaii Manoa* HOW MANY POPULATIONS? THE GENETIC STRUCTURE OF THE EMBER PARROTFISH (*SCARUS RUBROVIOLACEUS*) THROUGHOUT THE INDIAN AND PACIFIC OCEANS.
- 1030 † **Thurber, A.R.*** *Scripps Institution of Oceanography* HIGH SPATIAL VARIABILITY IN THE DISTRIBUTION OF ANTARCTIC MEGABENTHOS WITH IMPLICATIONS FOR MANAGEMENT
- 1045 **Lester, S.E.^{1*}**, and **B.S. Halpern^{2 1}** *Institute of Marine Sciences, University of California, Santa Cruz²National Center for Ecological Analysis and Synthesis, University of California, Santa Barbara* ECOLOGICAL EFFECTS OF NO-TAKE MARINE RESERVES: TESTS OF LATITUDINAL VARIATION, ADULT SPILLOVER, AND PARTIAL PROTECTION
- 1100 BREAK

SUNDAY, NOVEMBER 11, 2007

SESSION 18

SALON I & II

CONSERVATION & APPLIED ECOLOGY II

Chair: Hunter Lenihan, UC Santa Barbara

- 1200 **Carlson, D. B.**^{*} *Department of Zoology, University of Hawaii at Manoa* HOW MANY POPULATIONS TOO? THE GENETIC STRUCTURE OF THE URCHIN *TRIPNEUSTES GRATILLA* FROM PANAMA TO THE RED SEA
- 1215 † **Yau, A.J.**^{*}, and **H.S. Lenihan** *Bren School of Environmental Science and Management, University of California, Santa Barbara* POPULATION DYNAMICS OF A TROPICAL GIANT CLAM (*TRIDACNA MAXIMA*) AND IMPLICATIONS FOR THE MANAGEMENT OF AN ARTISANAL FISHERY
- 1230 **Grupe, B.M.**^{*}, and **S.S. Rumrill** *South Slough National Estuarine Research Reserve* THE NATURE OF FECAL COLIFORM BACTERIA AT A POPULAR OREGON BEACH
- 1245 **White, J.W.**^{*}, **Botsford, L.W.**, **Hastings, A.**, and **J.L. Largier** *UC Davis* POPULATION PERSISTENCE IN MARINE RESERVE NETWORKS WITH REALISTIC CURRENTS: AN EXAMPLE FROM COASTAL CALIFORNIA
- 1300 **Liu, P-J**^{1*}, and **T-Y Fan**^{2 1} *Department of Life Sciences, National Chung-Hsing University, Taichung, Taiwan 250, ROC* ²*National Museum of Marine Biology and Aquarium, Pingtung, Taiwan 944, ROC* RECOVERY OF A CORAL COMMUNITY IN A NATURE RESERVE OF SOUTHERN TAIWAN: SIX YEARS AFTER SHIP GROUNDING OF BULK CARRIER AMORGOS
- 1315 **Lenihan, H. S.**^{1*}, **Brooks, A.**¹, **Holbrook, S. J.**¹, **Schmitt, R. J.**¹, **Hench, J. L.**², and **A. Alldredge**¹ ¹*UC Santa Barbara* ²*Stanford University* THE LIFE AND TIMES OF JUVENILE CORALS ACROSS A CHANGING REEFSCAPE
- 1330 **Jacobs, D. K.**^{*} *UCLA, Dept. of Ecology and Evolutionary Biology* THE TIDEWATER GOBY- ENDANGERMENT, AND METAPOPULATION DYNAMICS OF A SEASONALLY-CLOSED ESTUARY SPECIALIST- IMPLICATIONS OF ESTUARY HISTORY FOR MANAGEMENT
- 1345 **Weng, K.**^{1*}, **S. Jorgensen**², **J. O'Sullivan**², **M. Ezcurra**², **C. Farwell**², **C. Winkler**³, **C. Lowe**⁴, **M. Blasius**⁴, and **B. Block**⁵ ¹ - *University of Hawaii at Manoa* ² - *Monterey Bay Aquarium* ³ - *Aquatic Research Consultants* ⁴ - *California State University at Long Beach* ⁵ - *Stanford University* SURVIVAL, BEHAVIOR AND MOVEMENT OF THE GREAT WHITE SHARK, A FLAGSHIP SPECIES FOR MARINE CONSERVATION, FOLLOWING RELEASE FROM CAPTIVITY

SUNDAY, NOVEMBER 11, 2007

SESSION 19

SALON IV

FISHERIES ECOLOGY

Chair: Brian Kinlan, UC Santa Barbara

- 0900 **Pondella, D. J.^{1*}, Froeschke, J. T.², Wetmore, L. S.³, Miller, E.⁴, Valle, C. F.⁵, and L. Medeiros⁶** ¹*Occidental College* ²*Texas A&M University - Corpus Christi* ³*Texas A&M University - Galveston* ⁴*MBC Applied Environmental Sciences* ⁵*California Department of Fish and Game* ⁶*Rosenstiel School* DEMOGRAPHIC PARAMETERS OF YELLOWFIN CROAKER, *UMBRINA RONCADOR*, (PERCIFORMES: SCIAENIDAE) FROM THE SOUTHERN CALIFORNIA BIGHT
- 0915 **Williams, J.P.^{1*}, Pondella, D.J. II¹, and E.F. Miller^{2 1}** ¹*Occidental College* ²*MBC Applied Environmental Sciences* LIFE HISTORY OF SPOTFIN CROAKER (*RONCADOR STEARNSII*) IN THE SOUTHERN CALIFORNIA BIGHT
- 0930 **Williams, G.D. *, Katz, S., Andrews, K., Moser, M.L., Levin, P., and D. Farrer** *NOAA* INDIVIDUAL VARIABILITY IN MOVEMENT PATTERNS OF SEVENGILL SHARKS *NOTORYNCHUS CEPEDIANUS*: INFERENCES ABOUT BEHAVIORAL ECOLOGY OF AN ESTUARINE APEX PREDATOR
- 0945 **Kinlan, B P*, Deborah McArdle, Katherine Emery, and Steven D. Gaines** *University of California, Santa Barbara* POPULATION DYNAMIC RESPONSES OF THE CALIFORNIA SPINY LOBSTER (*PANULIRUS INTERRUPTUS*) TO 120 YEARS OF VARIABLE OCEAN CLIMATE AND FISHING PRESSURE
- 1000 † **Floyd, Alyssa J*, Loke, Kerri A, Lowe, Christopher G, and Kelly A Young** *California State University, Long Beach* FECUNDITY OF CALIFORNIA SHEEPHEAD, *SEMICOSSIPHUS PULCHER*, REVISITED.
- 1015 **Markis, J.A. *, and B. Konar** *University of Alaska Fairbanks* AN EXAMINATION OF HABITAT STRUCTURAL COMPLEXITY AND FISH DISTRIBUTION IN NEARSHORE WATERS OF KACHEMAK BAY, ALASKA
- 1030 † **Martin, C.J.B. *, and C.G. Lowe** MIDWATER FISH ASSEMBLAGES *Department of Biological Sciences, California State University, Long Beach* ASSOCIATED WITH PETROLEUM PLATFORMS ON THE SAN PEDRO SHELF: A COMPARISON WITH SANTA BARBARA CHANNEL PLATFORMS
- 1045 **Shane, M.A., Bellquist, L.F. *, and M.A. Drawbridge** *Hubbs-SeaWorld Research Institute* VALIDATED AGE, GROWTH, AND OTOLITH MORPHOLOGY OF WHITE SEABASS, *TRACTOSCION NOBILIS* FROM THE SOUTHERN CALIFORNIA BIGHT: PRELIMINARY RESULTS
- 1100 BREAK

SUNDAY, NOVEMBER 11, 2007

SESSION 20

SALON IV

INVASIVE SPECIES & INVERTEBRATE BIOLOGY

Chair: Gretchen Hoffman, UC Santa Barbara

- 1200 † **McKittrick, T.R.***, and **A.W. De Tomaso** *Stanford University* ISOLATION AND CHARACTERIZATION OF *UNCLE FESTER*, A PUTATIVE ALLORECOGNITION RECEPTOR IN THE PRIMITIVE CHORDATE, *BOTRYLLUS SCHLOSSERI*.
- 1215 † **Cheng, B.S.***, and **K.A. Hovel** *San Diego State University* INVASION RESISTANCE TO A NON-NATIVE BIVALVE IN SOUTHERN CALIFORNIA
- 1230 † **Jessop, H.^{1*}**, **Lessios, H.A.²**, **Takabayashi, M.¹**, and **M.J. deMaintenon¹** *University of Hawai'i at Hilo²Smithsonian Tropical Research Institute* SIBLING SEA URCHIN SPECIES OF THE GENUS *ECHINOTHRIX* IN HAWAI'I: MORPHOLOGY, GENETICS, & ECOLOGY
- 1245 † **Harvey, E.L.*** *Western Washington University* THE EFFECTS OF HIGH DENSITY ULVOID MACROALGAE EXPOSURE ON THE SETTLEMENT OF CRAB MEGALOPAE AND SURVIVAL AND GROWTH OF YOUNG JUVENILES
- 1300 † **Hammond, L. M.***, **O'Donnell, M. J.**, and **G. E. Hofmann** *UC Santa Barbara* LITTLE URCHIN LARVAE IN A BIG CO₂ WORLD: USING MORPHOMETRICS TO DETERMINE THE EFFECTS OF CO₂ ON SPICULE GROWTH IN *LYTECHINUS PICTUS* LARVAE.
- 1315 † **Roach, J.E.,*** and **B.J.Becker** *University of Washington, Tacoma* THE EFFECTS OF PARTICULATE FOOD DEPRIVATION AND THE PRESENCE OF DISSOLVED ORGANIC MATERIAL ON THE SURVIVAL, GROWTH AND DEVELOPMENT OF *MYTILUS GALLOPROVINCIALIS* LARVAE.
- 1330 **Wells, E. H.*** *UC Davis* INVASION AND PAST PREDATION: DOES SHARED EVOLUTIONARY HISTORY PREDICT PREDATION PREFERENCE IN COASTAL SYSTEMS WITH MULTIPLE INVADERS?
- 1345 **Tepolt, C.K.^{1*}**, **Bagley, M.J.²**, **Darling, J.A.²**, and **M.J. Blum³** *Hopkins Marine Station of Stanford University²U. S. Environmental Protection Agency³Tulane University* EUROPEAN GREEN CRABS (*CARCINUS MAENAS*) IN THE NORTHEASTERN PACIFIC: GENETIC EVIDENCE FOR HIGH POPULATION CONNECTIVITY AND CURRENT-MEDIATED EXPANSION FROM A SINGLE INTRODUCED SOURCE POPULATION

SUNDAY, NOVEMBER 11, 2007

SESSION 21

SALON V

INVERTEBRATE BIOLOGY

Chair: Rebecca-Vega Thurber, San Diego State University

- 0900 **Hentschel, B.T.***, **Matthews, J.A.**, **Gray, V.**, and **A. Mejia** *San Diego State University*
MEASURING IN-SITU GROWTH RATES OF AN INFAUNAL SPIONID
POLYCHAETE
- 0915 **Ryan, C. A.^{1*}**, **Dudgeon, S. R.¹**, **Cameron, B. B.²**, and **R. K. Grosberg^{2 1}** *California State University, Northridge* ²*University of California, Davis* CHARACTERIZING COLONY FORM IN COLONIAL HYDROZOANS.
- 0930 **Vega-Thurber, R.L.***, and **F.L. Rohwer** *San Diego State University*
ENVIRONMENTAL STRESS INDUCES VIRAL OUTBREAKS IN THE CORAL
PORITES COMPRESSA
- 0945 **Romero, M.^{1*}**, **Kelstrup, H.C.P.²**, and **R.R. Strathmann^{2 1}** *California State University, Los Angeles, California* ²*University of Washington, Seattle, Washington* HIGH-SPEED VIDEO REVEALS DIRECT PARTICLE CAPTURE BY CILIA DURING FEEDING OF A GASTROPOD VELIGER
- 1000 † **Johnston, LA***, and **DE Wendt** *California Polytechnic State University*
INFLUENCES OF TEMPERATURE AND SALINITY ON ADHESIVE PROPERTIES OF CEMENT FROM THE BARNACLE, *BALANUS AMPHITRITE*
- 1015 † **Gehman, A. M.*** *Western Washington Univ, Shannon Point Marine Center* EFFECT OF MATERNAL SIZE ON SURVIVAL OF JUVENILE *LEPTASTERIAS AEQUALIS*
- 1030 **Fradkin, S.C.*** *Olympic National Park, National Park Service* PERSISTENCE, DYNAMICS AND APPARENT INVASION OF PARCHMENT TUBEWORM (*EUDISTYLIA VANNCOUVERI*) AGGREGATIONS ON WASHINGTON'S OLYMPIC COAST.
- 1100 BREAK

SUNDAY, NOVEMBER 11, 2007

SESSION 22

SALON V

REPRODUCTIVE ECOLOGY

Chair: Chris Lowe, CSU Long Beach

- 1200 † **Merrill, L. ***, and **S.I. Rothstein** *UC Santa Barbara* THE PARASITE AND THE PARENT: IMMUNE DEFENSE AND BREEDING STRATEGY IN AN AVIAN BROOD PARASITE AND ITS CLOSEST NON-PARASITIC RELATIVE
- 1215 **Mull, C.G. ***, **Jirik, K.E.**, **Young, K.A.**, and **C.G. Lowe** *California State University Long Beach* SEASONAL AGGREGATIONS OF FEMALE ROUND STINGRAYS (*UROBATUS HALLERI*) IN A COASTAL ESTUARY: USING ULTRASOUNDS AND HORMONE LEVELS TO DETERMINE PREGNANCY
- 1230 **Sanford, E. ^{1*}**, and **B.A. Menge²** *¹Bodega Marine Laboratory, University of California Davis ²Department of Zoology, Oregon State University* VARIATION IN THE REPRODUCTIVE OUTPUT OF THE SEA STAR *PISASTER OCHRACEUS*: ARE SOURCE POPULATIONS PREDICTABLE AND CONSISTENT?
- 1245 † **Bermudez, D.S. ***, and **L.J. Guillette** *Department of Zoology, University of Florida* THE THYROID-GONAD AXIS: INSIGHTS ON A NOVEL MECHANISM OF COMMUNICATION IN THE AMERICAN ALLIGATOR
- 1300 † **Kosman, E.T. *** *CSU Long Beach* DOES SIZE MATTER? VARIABILITY IN LARVAL SIZES AND ITS EFFECTS ON POST-METAMORPHIC SUCCESS IN BRYOZOANS
- 1315 † **Geange, S.W. ^{1*}**, and **A.C. Stier²** *1 - Victoria University of Wellington, New Zealand 2 - University of Florida* SEQUENCE AND TIMING OF SETTLEMENT DETERMINES THE OUTCOME OF COMPETITION BETWEEN TWO REEF FISHES
- 1330 **Fogelman RM ^a**, **Kuris A. M ^b**, and **Grutter A. S ^a**. *^aSchool of Integrative Biology, The University of Queensland, Australia ^bDepartment of Ecology, Evolution and Marine Biology, UCSB, USA* PARASITIC CASTRATION OF A VERTEBRATE: EFFECT OF THE CYMOTHOID ISOPOD *ANILOCRA APOGONAE* ON THE CARDINALFISH *CHEILODIPTERUS QUINQUELINEATUS*

SUNDAY, NOVEMBER 11, 2007

SESSION 23

LA JOLLA

SPECIES-HABITAT ASSOCIATIONS

Chair: Brian Tissot, Washington State University, Vancouver

- 0900 † **Bright, J. L.^{1*}, Tissot, B. N.¹, and M. Love^{2 1}** *Washington State University Vancouver, Vancouver, Washington* ²*UC Santa Barbara, Santa Barbara, California* ABUNDANCE AND DISTRIBUTION OF DEEP-SEA CORALS AND OTHER BENTHIC STRUCTURE-FORMING INVERTEBRATES AND THEIR ASSOCIATION WITH ROCKFISH ON THE SANTA CRUZ ISLAND "FOOTPRINT".
- 0915 † **Deza, A. A.^{*}, and T.W. Anderson** *San Diego State University* EFFECTS OF HABITAT FRAGMENTATION AND PATCH SIZE ON RECRUITMENT AND THE ABUNDANCE OF KELP FOREST FISHES.
- 0930 † **Moore, E.C.^{*}, and K.A. Hovel** *San Diego State University* SEAGRASS HABITAT STRUCTURE: RELATIVE EFFECTS OF STRUCTURAL COMPLEXITY AND LOCATION WITHIN THE PATCH ON EPIFAUNAL ABUNDANCE AND DIVERSITY.
- 0945 † **O'Connor, K.C.^{*}, and T.W. Anderson** *San Diego State University* CONSEQUENCES OF HABITAT DISTURBANCE AND RECOVERY TO RECRUITMENT AND THE ABUNDANCE OF KELP FOREST FISHES
- 1000 † **Wedding, L.M.^{* 1}, and A.M. Friedlander^{2 1}** *University of Hawaii at Manoa* ²*NOAA Biogeography Branch* EXPLORING THE RELATIONSHIP BETWEEN FISH ASSEMBLAGE STRUCTURE AND HABITAT COMPLEXITY USING REMOTE SENSING DATA IN HAWAII
- 1015 **Vilas, C.^{1*}, Drake, P.², and E. Pascual²** *1 - Marine Science Institute, University of California Santa Barbara* *2 - Instituto Ciencias Marinas de Andalucia (CSIC, Spain)* DISTRIBUTION OF THE KEY MYSID COMMUNITY IN A TEMPERATE ESTUARY (GUADALQUIVIR ESTUARY, SW SPAIN).
- 1030 † **Goldenheim, W.M.^{1*}, Irving, A.D.², and M.D. Bertness^{2 1}** *California State University, Northridge* ²*Brown University* PHYSICAL ENVIRONMENT AND SPATIAL DISTRIBUTIONS OF COBBLE BEACH PLANT POPULATIONS
- 1045 † **Blaine, J.M.^{*}** *Friday Harbor Laboratories, Washington* PACIFIC SAND LANCE (*AMMODYTES HEXAPTERUS*) PRESENT IN THE SANDWAVE FIELD OF CENTRAL SAN JUAN CHANNEL, WA: ABUNDANCE, DENSITY, MATURITY, AND SEDIMENT ASSOCIATION
- 1100 BREAK

SUNDAY, NOVEMBER 11, 2007

SESSION 24

LA JOLLA

POPULATION BIOLOGY II

Chair: Ben Miner, Western Washington University

- 1200 **Coyer, J.A.^{1*}, Miller, K.A.², Engle, J.M.³, Veldsink, J¹, Cabello-Pasini, A.⁴, Stam, W.T.¹, and J.L. Olsen¹**¹*University of Groningen (Netherlands)* ²*University of California, Berkeley* ³*University of California, Santa Barbara* ⁴*Universidad Autónoma de Baja California Ensenada* EELGRASS MEADOWS IN THE CALIFORNIA CHANNEL ISLANDS AND ADJACENT COAST REVEAL A MOSAIC OF TWO SPECIES, EVIDENCE FOR INTROGRESSION, AND VARIABLE CLONALITY
- 1215 **Miner, B.G.^{1*}, Donovan, D.A.¹, and T. Goulding²**¹*Western Washington University* ²*University of California, Santa Barbara* LIFE HISTORY PLASTICITY IN EMBRYOS OF *NUCELLA LAMELLOSA*
- 1230 † **Martone, R.G.^{*}, and F. Micheli** *Hopkins Marine Station, Stanford University* GEOGRAPHIC VARIATION IN LIFE HISTORY STRATEGY OF *MEGASTRAEA UNDOSA*: TO GROW OR TO REPRODUCE?
- 1245 † **Fenberg, P.B.^{*}, and K. Roy** *UC San Diego* THE ECOLOGICAL CONSEQUENCES OF SIZE-SELECTIVE HARVESTING: THE OWL LIMPET (*LOTTIA GIGANTEA*) AS A CASE STUDY.
- 1300 † **Shelton, A.O.^{*}** *University of Chicago* THE ORIGIN AND COST OF MALE RARITY IN THE SURFGRASS *PHYLLOSPADIX SCOULERI*
- 1315 † **Adam, T. C.^{*}** *University of California Santa Barbara* COMPETITIVE AND FACILITATIVE INTERACTIONS BETWEEN ADULT AND EARLY POST-SETTLEMENT STAGES OF THE BLUESTREAK CLEANER WRASSE, *LABROIDES DIMIDIATUS*.
- 1330 **Samhuri, J.F.^{1*}, Steele, M.A.², and G.E. Forrester³**¹*NOAA Fisheries - Northwest Fisheries Science Center* ²*CSU - Northridge* ³*University of Rhode Island* INTERCOHORT COMPETITION DRIVES SHELTER-MEDIATED DENSITY DEPENDENCE IN A CORAL REEF FISH
- 1345 **Brooks, A.J.^{1*}, Stewart, H.L.², Holbrook, S.J.³, and R.J. Schmitt³**¹*Coastal Research Center, Marine Science Institute, University of California, Santa Barbara, CA 93106* ²*Friday Harbor Laboratories, University of Washington, Friday Harbor, WA 98250* ³*Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara, CA 93106* MAXIMIZING THE RENT: CORAL MORPHOLOGY AND THE BENEFITS OF RESIDENT FISHES TO CORAL GROWTH?

ABSTRACTS

STUDENT WORKSHOP: COMMUNICATING SCIENCE TO A NON-SCIENTIFIC AUDIENCE

SCIENCE + ART + DESIGN: HOW TO VISUALIZE AND COMMUNICATE DATA TO DIVERSE AUDIENCES

Carlson, K.*

Kirsten Carlson illustration

In addition to graphs and tables, information can be conveyed using scientific illustration and graphic design concepts. Kirsten's career focuses on using these tools to communicate scientific research to different audiences- from the scientific community to the general public. Discover ways to transform data into dynamic visuals, and how visual communication can positively impact scientific communication.

Kirsten has over 10 years experience in the fields of scientific illustration and graphic design. Her background in biology (at the University of Missouri-Columbia) and marine science (at Moss Landing Marine Laboratories) led her to combining science and art, after coming back from a research trip to Antarctica. Her clients include Monterey Bay Aquarium Research Institute, Monterey Bay Aquarium, Monterey Bay National Marine Sanctuary, National Geographic/Sea Studios, and University of California-Santa Cruz. She is a member of the Guild of Natural Science Illustrators and the Society of Children's Book Writers and Illustrators, and is bringing the natural world and science to diverse audiences by combining science + art + design.

IT'S A VISUAL WORLD – COMMUNICATING RESEARCH THROUGH WRITING AND IMAGERY

Potter, J.*

NOAA Ocean Exploration

As the Operations Coordinator for the NOAA Office of Ocean Exploration (OE), it's my job to work with many of the scientists that we send to sea. Our Operations Group helps to facilitate the communication of research results to the public. During the workshop, we'll discuss the opportunities and challenges associated with sharing research via writing and photography. I'll focus on many of the tough lessons that I've learned as well as recent trends affecting both researchers and funding agencies. Hopefully you'll learn from my mistakes and have a few laughs at my expense in the process. NOAA's Office of Ocean Exploration (OE) was created in response to the recommendations of the President's Panel on Ocean Exploration in 2000. With the establishment of OE, NOAA developed a great opportunity to reach out to teachers, students, and the general public to share the excitement of discovery. As exciting expeditions are the core of our NOAA program, outreach efforts are focused around these cruises. Through various initiatives, OE works with the science community to share the excitement of ocean science and discovery with a wide variety of audiences.

STUDENT SYMPOSIUM: A NATURAL HISTORY OF THE CHANNEL ISLANDS

MONITORING MARINE PROTECTED AREAS IN CALIFORNIA'S CHANNEL ISLANDS

Airamé, S.*

Marine Science Institute, University of California, Santa Barbara

Marine protected areas (MPAs) in California's Channel Islands provide new opportunities for scientists to study marine ecosystems in a more natural state than surrounding waters, which are subjected to various impacts of human activities. In 2003, following an extensive public process, the state of California established a network of 10 fully protected marine reserves and 2 conservation areas that allow limited take in state waters (0-3 nautical miles) around the northern Channel Islands. In 2006, the Pacific Fishery Management Council expanded the MPAs to protect benthic species and habitats in state and federal waters up to 6 nautical miles offshore. In 2007, the Channel Islands National Marine Sanctuary expanded the MPAs to protect pelagic species and habitats up to 6 nautical miles

offshore, complementing state and Council protected areas. In response, scientists expanded existing monitoring programs and developed new monitoring programs to ask questions about the MPAs. Now, several monitoring programs have five or more years of data from monitoring in and around the Channel Islands MPAs. The scientists are working with state and federal agency staff to answer key questions that are relevant to marine management and policy. Specifically, scientists are using monitoring data to understand ecological and socioeconomic impacts of the MPAs for a five-year review by California's Fish and Game Commission. Results from monitoring the Channel Islands MPAs will inform management and monitoring of the existing MPAs as well as future design of MPAs and monitoring programs throughout California.

INCORPORATING NATURAL HISTORY INTO MODELING AND MANAGEMENT OF THE ENDANGERED ISLAND FOX

Bakker, V.*

University of California, Santa Cruz

The endemic island fox (*Urocyon littoralis*) inhabits the six largest of the California Channel Islands. Fox populations on four of these island exhibited dramatic decreases in the 1990s and were listed as federally endangered in 2004. Declines of this ecologically naïve species are attributed to golden eagle (*Aguila chrysaetos*) predation and exotic disease. Golden eagle populations appear to have colonized the Channel Islands recently by preying primarily on abundant introduced feral pigs (*Sus scrofa*), which supported hyperpredation on foxes. Current fox recovery efforts focus on ameliorating eagle predation and disease threats. To assist recovery, I synthesized existing data on fox natural history and worked with a collaborative team of scientists and land managers to build models of fox population dynamics based on observed ecological drivers, including density dependence, eagle predation, and El Niño events. Incorporating ecological drivers into fox population models increased the realism of the models as well as their practical utility for management. I give examples of how these models have been used to guide fox management, including the establishment of recovery criteria.

INTERTIDAL COMMUNITIES OF THE CA CHANNEL ISLANDS: ECOLOGY AND NATURAL HISTORY

Blanchette, C.A.*

University of California, Santa Barbara

The California Channel Islands lie within one of the most biogeographically and oceanographically diverse regions in the world. The mixing of warm and cold ocean currents in this region leads to a highly diverse assemblage of marine species within a narrow latitudinal band. The marine intertidal communities of these islands have been the focus of ecological investigations for decades, particularly on Santa Cruz Island, the largest of the CA islands geographically located in the center of the biogeographic transition zone. The intertidal communities of these islands have experienced great change in recent times since the near extinction of black abalone following the 82-83 El Niño to recent population booms of seastar predators. Here we examine spatial patterns of community similarity among 22 intertidal sites spread across 7 islands in relation to the prevailing oceanographic currents. Nearshore oceanographic conditions, as indexed by sea surface temperature (SST), were highly correlated to the overall pattern of community similarity. Similar to findings from a smaller-scale study at Santa Cruz Island, we observed strong associations between SST and patterns of community structure. At a smaller scale we also examined recruitment of mussels and barnacles around Santa Cruz Island and found invertebrate recruitment to be much higher at the warmer eastern sites than at the colder, western sites where upwelling is typically strongest. Here we suggest that the strong links between ocean temperature and invertebrate recruitment and macroalgal growth may underlie much of the spatial patterns of community structure across these islands.

FISHING AND CLIMATE EFFECTS ON THE STATE OF ROCKY REEFS IN THE CHANNEL ISLANDS

Lafferty, K.*

US Geological Survey

Temperate reefs may occur in two qualitatively distinct states, algal-covered forests and echinoderm dominated barrens. Long-term data from the National Park Service suggests that a number of factors may influence these states in the Channel Islands. For instance, fishing may lead to barrens in warmer biogeographic regions where spiny lobsters (and, perhaps, sheephead) are important predators of sea urchins. With reduced lobster density, urchins

become abundant and foliose algae can be over-grazed in a trophic cascade. This can lead to differences in rocky reefs between protected areas and fished areas. Under fishing, in addition to a reduction in algae, urchin populations may become dense enough for the efficient transmission of bacterial diseases. Such epidemics reduce urchin populations leading to an intermediate recovery of algae. Climate can also influence the state of rocky reefs. Large storms can disturb reefs, leading to the episodic removal of kelp beds. Kelp forests may or may not recover following storms. In particular, if storms are associated with ENSO, a lack of nutrients might make it difficult for kelp beds to re-establish. Recovery following storms also appears to be diminished in fished areas, perhaps because dense urchin populations inhibit the recruitment of algae. In combination, global warming and fishing might interact to broadly switch temperate reefs from forests to barrens. However, in colder biogeographic regions, where lobsters are less abundant, other urchin predators, such as sea stars (*Pycnopodia*) and sea otters can reduce urchin abundance. Because these species are not currently fished, the indirect effects of fishing on temperate reefs are likely to be less important in colder regions. This pattern contrasts somewhat with recent theory suggesting that the indirect effects of fishing should be stronger at higher latitudes where biodiversity is lower.

THE BOTTOM LINE: SEAWEED AND SEAGRASS COMMUNITIES IN THE CALIFORNIA CHANNEL ISLANDS

Miller, K.A.*

University of California, Berkeley

The Channel Islands represent most of the near-pristine habitats for seaweeds and seagrasses in southern California. These communities have much to teach us about resilience and stability in the face of physical and biotic challenges, including changing oceanographic conditions, intense herbivory and introduced species. My life with the seaweeds has taught me that the foundation of our grip on natural history is simple: our ability to identify species and to understand their stories (and interactions) through time and space. This foundation depends on two simple things: our appreciation of the discoveries of those who have preceded us and our willingness to spend time out there observing closely and deeply. Our powers of observation are enhanced but not replaced by modern technologies. If we could just relax and enjoy natural history as the basis and inspiration of our inquiries instead of wondering if there's something more modern, rigorous and important we should be doing out there, we might have a chance of glimpsing the great integration of millions of subtle evolutionary and ecological processes as they unfold.

PRESIDENTIAL SYMPOSIUM:

MARINE RESERVES OF THE CALIFORNIA: WHAT DO WE REALLY KNOW ABOUT THEIR IMPACT ON MARINE FISHERIES?

Synopsis: An alternate, and probably more accurate, title for this symposium could very well be “Marine reserves: show us the data!” The general premise of the symposium is that marine reserves appear to be the wave of the future (dare I say, the panacea?) as management tools for marine fisheries. This contention seems to be based on a great deal of theory and some empirical evidence, very little of which is from California waters. We know and hopefully can show in this symposium that reserves are effective in the enhancement of some local marine populations. But, can marine reserves REALLY enhance near shore fisheries (e.g., via excess larval production)? Marine reserves are barriers to both commercial and recreational fishing. Does the monetary and sociological cost outweigh the potential benefits to future fisheries production? If our goal is sustainable fisheries, do reserves help get us there? Hopefully, this symposium will provide insight and a few answers to these important questions, at least in California waters.

Focus will be on reef-associated fisheries species such as, kelp bass, sheephead, numerous rockfish species, and lobsters.

HABITAT QUALITY, SIZE, AND MANAGEMENT DETERMINE THE EFFECTIVENESS OF MPAS IN HAWAII FOR BIODIVERSITY CONSERVATION AND FISHERIES REPLENISHMENT

Alan Friedlander *NOAA/NCCOS/CCMA-Biogeography Branch and the Oceanic Institute*
Makapu'u Point

Coral reef fisheries resources in Hawaii have declined dramatically over the past 100 years. To date, conventional management strategies such as size and bag limits, seasonal species closures, and gear restrictions have done little to alter these downward trends in catches and stock health. It is now becoming evident that ecosystem-based management, in the form of marine protected areas (MPAs), is necessary to conserve biodiversity, maintain viable fisheries, and deliver a broad suite of ecosystem services. Over the past four decades, Hawaii has developed a system of MPAs to conserve and replenish marine resources around the state. Initially established to provide opportunities for public interaction with the marine environment, these MPAs vary in size, habitat quality, and management regimes, providing an excellent opportunity to test hypotheses concerning MPA design and function using multiple discreet sampling units. Digital benthic habitat maps for all MPAs and adjacent habitats were used to evaluate the efficacy of existing MPAs using a spatially-explicit stratified random sampling design. Results showed that a number of fish assemblage characteristics (e.g., species richness, biomass, diversity, size and trophic structure) were significantly higher in MPAs compared with adjacent fished areas across all habitat types. Habitat type, protected area size, and level of protection from fishing were all important determinates of MPA effectiveness with respect to their associated fish assemblages. Although size of these protected areas was positively correlated with a number of fish assemblage characteristics, all appear too small to have meaningful influence on the adjacent fished areas. This is even more evident when fish stocks in the main Hawaiian Islands (MHI) are compared with the northwestern Hawaiian Islands (NWHI) Marine National Monument, now the largest MPA in the world. Differences in assemblage structure represent both near-extirpation of apex predators and heavy exploitation of lower trophic levels in the MHI compared to the largely unfished NWHI. The results from this work provide criteria for more effective MPA design and establish baselines to assess future management strategies in Hawaii and other coral reef ecosystems worldwide.

RESPONSES OF NEARSHORE ROCKY REEF POPULATIONS AND COMMUNITIES IN THE NEW NETWORK OF MARINE RESERVES IN THE CHANNEL ISLANDS.

Caselle, J., Kushner, D., Hamilton, S., Malone, D., Carr, M., Moss, M.
USCB

In April 2003, the California Department of Fish and Game and the Fish and Game Commission established a network of marine protected areas (MPAs) in the Channel Islands (CI). The network includes 10 no-take reserves and 2 conservation areas. In 2008, the California Fish and Game Commission (Commission) will conduct a 5-year review of the Channel Islands marine protected areas. Researchers from PISCO (Partnership for Interdisciplinary Studies of Coastal Oceans) and the National Park Service have been monitoring communities that inhabit rocky reefs in the Channel Islands since 1981 (NPS) and 1999 (PISCO). Several research priorities were developed by the Department in consultation with local scientists and were identified in the "Channel Islands Marine Protected Area Monitoring Plan". In this talk we will address several of these research priorities. Specifically, we ask: How has abundance, size structure, biomass, and reproductive output of species in MPAs changed relative to outside MPAs? Further, is community structure different inside versus outside MPAs? We focus on both fished and unfished species and relate observed patterns to physical oceanographic and environmental data. We compare our analyses of the relatively new CI MPAs with results from studies of three existing MPAs in central California (Hopkins, Big Creek and Pt Lobos) and one existing MPA in the CI (Anacapa). We found differences in the density and size structure of individual species as well as community structure differences inside versus outside of these older MPAs. To date, the differences observed in the new CI MPAs are not of similar magnitude, suggesting that it may take longer than 5 years to see strong effects of MPAs in the Channel Islands,

WHAT DO WE KNOW ABOUT MOVEMENT PATTERNS AND HABITAT USE OF ROCKY REEF ASSOCIATED GAMEFISHES AND WHY IS IT ESSENTIAL FOR MPA DESIGN?

Christopher G. Lowe^{*1}, Tom Mason¹, Lyall Bellquist¹, Darin Topping¹, Barbara Hight¹ and Jenn Caselle²
¹California State University Long Beach, Dept. of Biological Sciences, 1250 Bellflower Blvd., Long Beach, CA 90840, ²University of California Santa Barbara; phone: 562-985-4918; email: clowe@csulb.edu

Marine protected areas (MPAs) are being established at record rates, many for the explicit purpose of fisheries management and restoration. Obviously, bigger MPAs would work better for this purpose; however, political and economic compromises ultimately result in smaller MPAs. So, how small is too small and how far can we put them apart and still make networks of MPAs effective? Unfortunately, answers to these questions require detailed

knowledge of fish movement patterns and habitat use, which is largely unknown. Home range sizes, habitat associations, and degree of site fidelity of four nearshore gamefishes of southern California were quantified using active and passive acoustic telemetry tracking and layered in a GIS. These species had home ranges ranging from 90 to 117,335 m² and showed high annual site fidelity. Kelp bass (*Paralabrax clathratus*) and sheephead (*Semicossyphus pulcher*) preferred rock/boulder habitat and ventured into sand ecotone, while ocean whitefish (*Caulolatilus princeps*) and barred sandbass (*Paralabrax nebulifer*) preferred sand ecotone and occasionally moved into rock/boulder habitat. Adult female leopard sharks (*Triakis semifasciata*) showed diurnal preference to shallow, warmer water habitats during summer, but left these areas in the winter. This kind of information can help resource managers better design MPAs to meet conservation objectives.

SPINY LOBSTERS AND MARINE RESERVES: WHAT CAN WE LEARN AND WHAT DO WE KNOW?

University, ²California State University Long Beach.

Hovel, K.A.^{*1}, C.G. Lowe², C.L. Loflen¹, T.T. Mai¹, and K. Palaoro¹. ¹San Diego State

The California spiny lobster *Panulirus interruptus* supports a valuable commercial and recreational fishery in Southern California, as well as a much larger fishery in Baja California. Little is known about the ecology of this species, especially in comparison to (e.g.) the American lobster, the Caribbean spiny lobster, and the Australian rock lobster, some of the most intensively studied marine organisms. Marine reserves have successfully enhanced densities of several spiny lobster species, particularly in Australia and New Zealand, and top-down effects of lobsters may be stronger in reserves, resulting in different community structure between protected and non-protected areas. In California, intense fishing for over 100 years has contributed to sharp reductions in *P. interruptus* density and mean body size, yet lobster habitat requirements, behavior, and community-level interactions are not well known. We combined surveys for lobsters and their predators with tracking, observations on lobster shelter use, and experiments on lobster relative survival to assess movement rates and home range, behavior, and lobster habitat requirements in Southern California coastal habitats, including heavily fished and marine reserve locations. Similar to other spiny lobster species, *P. interruptus* moved up to several hundred meters per night, but often established relatively small home ranges. Notably, vegetated areas including shallow-water surfgrass beds were heavily used by male and female lobsters. Lobster densities were higher in the small (2.1 km²) no-take La Jolla Ecological Reserve than outside the reserve, but high densities of lobster predators in the reserve elevated lobster mortality risk outside of shelter. Likely in response to elevated mortality risk, lobsters formed larger aggregations, used smaller shelters relative to their body size, and limited their nocturnal movements, all of which help deter predation. Preliminary results suggest high retention in the reserve. Marine reserves may be a useful tool to protect lobsters, but in California, important issues such as spillover and whether spiny lobster populations are self-sustaining remain largely unresolved.

CONTRIBUTED PAPERS

† COMPETITIVE AND FACILITATIVE INTERACTIONS BETWEEN ADULT AND EARLY POST-SETTLEMENT STAGES OF THE BLUESTREAK CLEANER WRASSE, *LABROIDES DIMIDIATUS*.

Adam, T. C.*

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Many organisms preferentially associate with conspecifics despite evidence for strong intraspecific competition. This common observation suggests that these associations provide substantial benefits (either direct or indirect) that outweigh the costs of competition. Like many coral reef fishes, newly recruited bluestreak cleaner wrasse, *Labroides dimidiatus*, are often found in close proximity to adult conspecifics, possibly due to habitat selection during the settlement phase. *L. dimidiatus* are obligate cleaners, and short-term benefits of settling near an adult could include greater access to parasitized client fishes visiting “cleaning stations” for the removal of ectoparasites. Here, I use a manipulative field experiment to disentangle the positive and negative effects of associating with adult conspecifics and uncover potential mechanisms for these effects. The results of the experiment indicate that the net effect of settling near an adult is positive despite evidence that adults have a direct negative influence on the growth rate of recruits. Both the positive and negative effects appear to be driven by the influence of food availability on the growth rates of recruits and the results suggest that while adults compete with recruits for access to parasitized

clients, they generally occupy favorable habitat where these clients are most abundant. In addition to occupying favorable habitat, evidence from this and other experiments indicates that adults are likely to directly facilitate recruits by attracting and concentrating parasitized client fishes at cleaning stations.

CONTEXT-DEPENDENT STREAK SPAWNING IN THE HERMAPHRODITIC SEABASS, *SERRANUS SUBLIGARIUS*.

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In many hermaphroditic marine reef fish, individuals playing the male role employ three spawning strategies: pair spawning, group spawning, and streak spawning. The behaviors involved in each of these strategies have been studied and described very well. However, it is less clear how environmental factors influence the expression of each tactic and the expected reproductive success of each tactic. The belted sandfish, *Serranus subligarius*, offers an excellent opportunity to examine the roles of environmental factors on behavioral expression and reproductive success, in particular habitat quality, population density, and male condition. I recorded mating behaviors during the summers of 2005 through 2007 at three sites with different local population densities within St. Andrews State Park, Panama City, Florida. I observed focal individuals for 15-minute increments and quantified a variety of environmental and demographic factors over the course of the reproductive season. Several factors were associated with male-role behavioral variation. The frequency of streak spawning increased sharply late in the spawning season (late August to early October). Sites with greater algal cover promoted more attempts at streak spawning by small individuals. There is greater algal cover later in the season, so both habitat and season effects may be caused by a common factor. Small individuals that appear late in the season are newly recruited, which implicates life-history variation as an important element in spawning strategy deployment. Ongoing work will refine these patterns and use genetic methods to quantify reproductive success of individuals deploying different strategies.

† EFFECTS OF THE INVASIVE INDO-PACIFIC LIONFISH (*PTEROIS VOLITANS/MILES* COMPLEX) ON BAHAMIAN CORAL-REEF FISH COMMUNITIES: PRELIMINARY INVESTIGATIONS

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The state of Caribbean coral reefs and their associated communities has been substantially degraded over the last several centuries by numerous natural and anthropogenic disturbances. These communities now face a new and potentially devastating threat: the invasive Indo-Pacific lionfish. Lionfish are voracious predators with defensive venomous spines. Using oversized, ornate pectoral fins, they herd and ambush small reef fishes and crustaceans, a novel strategy in the invaded system. Over the last several years, our team has observed increasing densities of lionfish at regularly visited sites within Exuma Sound, Bahamas. During the summer of 2007, a combination of observational and experimental investigations was initiated to determine the effects of this invasive predator on native coral-reef fish communities. Observations of lionfish recruitment to a matrix of artificial and transplanted natural patch reefs revealed a high rate of recruitment (~14 fish per hectare per day). Stomach-content analysis in combination with aquarium feeding observations confirmed that lionfish prey on a wide variety of native animals, including bony fishes and crustaceans, and that lionfish are capable of consuming both large prey relative to their size and large numbers of prey. We ran a controlled experiment (lionfish present vs. absent) using a matrix of artificial (concrete-block) and transplanted coral patch reefs to examine the effects of lionfish on the survival of reef-fish recruits. Initial results suggest that lionfish may reduce early post-settlement survival of recruits. Future investigations will include an examination of potential competitive interactions between the invasive lionfish and commercially valuable native predator species.

† EFFECTS OF INVASIVE COMMUNITY DIVERSITY AND RESOURCE AVAILABILITY ON SUBSEQUENT INVASION IN MARINE FOULING COMMUNITIES

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Community diversity and resource availability are commonly used to explain the mechanisms driving successful invasion of non-native species. The diversity resistance hypothesis predicts that high diversity should lead to community resistance to invasion. In contrast, the fluctuating resources theory states that resource availability, disturbance, and environmental fluctuations affect community invasibility. Manipulative experiments examining the

combined effect of invasive community diversity and resource availability on invasion success were conducted using marine fouling communities. Treatments included communities of varying levels of species richness and bare substrate. Experiments were run during the fall and summer seasons. Results from the fall experiment suggest that two weeks after treatments were established, a significant increase in invasive recruit abundance was seen as resources increased ($F= 4.65$, $P=0.03$) and a significant decrease was seen as diversity level increased ($F= 4.89$, $P=0.01$). When diversity increased from the lowest treatment levels, the average number of recruits fell by nearly half. There appeared to be no difference in abundance of recruits between the higher diversity treatments and there did not seem to be a strong effect of resource availability at higher diversity levels. Similar trends were seen on a species-specific level. During the summer season, diversity did not appear to have an effect on invasive recruitment, and all treatments quickly became dominated by one species, the invasive tunicate *Ciona intestinalis*. These results suggest that recruitment of invaders into the community can be affected by diversity, but that the relationships between seasonality, recruitment, space availability and diversity are not straightforward.

PREDATOR SIZE AND RECRUITMENT SUCCESS IN KELP-ASSOCIATED FISHES: IMPLICATIONS FOR MARINE RESERVES?

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Piscivores influence the survival of recently settled reef fishes and in many cases have the potential to regulate their prey populations through density-dependent mortality. Although the relative sizes of predators and prey influence prey survival, assessing the independent effects of predator size is logistically challenging in a field setting. At Santa Catalina Island, we manipulated the size of kelp bass (*Paralabrax clathratus*) as small (9-13 cm) and large (25-30 cm) predators in large field enclosures (~ 60 m³) with a standard amount of giant kelp, *Macrocystis pyrifera*. We then monitored recruitment of kelp-associated fishes in the enclosures for a 1-mo period, collecting recruits at 2-wk intervals. We also conducted laboratory experiments to assess size-selective predation by kelp bass, manipulating the sizes of both predators and recruits. Recruitment within field enclosures with large predators was half that recorded in small-predator enclosures, and the size distribution of recruits also differed with predator size even though the smallest predators could consume the full range in size of recruits. Our results and observed patterns in the size distribution and densities of predators and recruits among sites within and outside of a marine reserve suggest that a consequence of marine reserves may be lower recruitment success and differential size distributions of recruits relative to non-reserve areas.

DIEL PATTERNS OF VERTICAL MOVEMENT FOR SIXGILL SHARKS IN AN URBAN ESTUARY: THE UPS-AND-DOWNS OF AN URBAN PREDATOR.

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Understanding life histories of apex predators is crucial for understanding how marine ecosystems respond to human perturbations as well as for effectively conducting ecosystem-based management. Even so, we lack basic knowledge of many large predatory fishes. In Puget Sound, we are investigating diel vertical movement patterns of sixgill sharks, a large, abundant predator in the region. We acoustically tagged 39 sixgill sharks with pressure sensor acoustic transmitters and monitored their movement patterns via passive and active acoustic receivers in Puget Sound, WA. Many sharks tracked in shallow locations (<50m) showed distinct diel vertical movements at dawn and dusk, sharks ascended to shallower water at dusk and descended to deeper water at dawn. It was common for these sharks in shallow water to remain within a narrow depth range during the day, but to show larger variability in depth at night. Individual sharks tracked in deeper locations (>100m) displayed much more variable vertical movements during all times of the day, without the definitive dawn/dusk movements. When most sharks made ascents or descents at times other than dusk or dawn, these movements were not associated with significant changes of light intensity at the surface. Overall, larger sharks varied more in their vertical movement patterns, particularly at night, than smaller sharks. The ascent/descent rates of sixgill sharks max out ~3.5m/min, slower than other large fishes. These data along with spatial movement patterns will form the basis of empirically based movement and bioenergetics models.

† TRANSLOCATION AND HOMING BEHAVIOR OF PLATFORM-ASSOCIATED FISHES FROM OFFSHORE OIL PLATFORMS IN THE SANTA BARBARA CHANNEL

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The lack of a Rigs-to-Reef program for California's offshore oil platforms has ignited debates over the ecological significance of these offshore structures as habitat for economically important species of rockfishes whose numbers have been depleted on natural reefs. California's complete removal policy of oil platforms could have devastating effects on the local—and potentially regional—population of important rockfishes and other groundfish species. One option to mitigate the effects of explosives on platform associated fishes may be to translocate individuals from platforms to natural reefs before the decommissioning process takes place. The goals of this study were (1) to determine if translocating platform-associated fishes was a logistically feasible mitigation option, and (2) assess the movements and homing behavior of platform-associated fishes moved from oil platforms and placed on natural reefs of comparable depth. Eighty rockfishes (*Sebastes* spp., representing twelve species) and lingcod (*Ophiodon elongatus*) were tagged with acoustic transmitters from three oil platforms in the Santa Barbara Channel and translocated to a natural reef at Anacapa Island. Over a 1-year study period, 18 (23%) tagged fishes homed back, 89% of which returned to their platforms of capture. Of the 23% of fishes that returned to platforms, 78% did so in fewer than seven days; one returned as quickly as 10.5 hrs. These preliminary results suggest translocation may not be a feasible option to salvage a subpopulation of overexploited rockfishes; however, these behavioral responses may provide additional insight into the ecological value of platforms for these species.

† TEMPORAL VARIABILITY IN GIANT KELP ABUNDANCE INFLUENCES BENTHIC COMMUNITY COMPOSITION

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One type of indirect species interaction occurs when an organism influences the outcome of competition among two others. In giant kelp forests, shade from the *Macrocystis pyrifera* canopy negatively affects understory algae, which compete with sessile invertebrates for space. Whether *Macrocystis pyrifera* thus indirectly and positively affects the abundance of sessile invertebrates has not been experimentally tested. In this study we first asked, does kelp influence the outcome of competition among algae and invertebrates? We experimentally manipulated kelp abundance on a system of artificial reefs in San Diego and found a direct and negative effect of kelp on algae, and an indirect, positive effect on invertebrates. We then asked, do the multiple interactions we observed experimentally in space, lead to predictable patterns through time? Kelp forest ecosystems are uniquely appropriate for exploring questions about temporal variability because the abundance of kelp changes dramatically on short time scales. We examined 6 years of annual monitoring data for kelp, algae, and invertebrate abundance at 13 locations on natural reefs in Santa Barbara. We found that temporal variability in the abundance of giant kelp significantly predicted temporal variability in the relative abundance of understory algae and sessile invertebrates. In other words, sites where the abundance of kelp varied from one year to the next were also sites where the abundance of algae and invertebrates was highly variable through time. Our results demonstrate how temporal heterogeneity in natural systems, as well as spatial heterogeneity, can emerge from multiple interactions among species.

GENETIC EVIDENCE FOR MULTIPLE INVASIONS AND DISTINCT REGIONAL POPULATIONS OF THE INTRODUCED ASIAN DATE MUSSEL, *MUSCULISTA SENHOUSIA*, ALONG THE U.S. WEST COAST

Asif, J.H.^{*}, and P.J. Krug

CSULA

Non-indigenous marine invertebrates have invaded every major estuary along the west coast of the United States. Molecular methods offer the opportunity to estimate gene flow among estuaries, and to identify independent invasions and source populations. The Asian Date Mussel *Musculista senhousia* now occurs from Mexico to British Columbia. The initial invasion is attributed to oyster mariculture, and subsequent introductions via ballast water are probable; however, larvae of this invader spend 3 weeks in the plankton and may also disperse among bays. To infer population structure in *M. senhousia*, a portion of the mitochondrial cytochrome *c* oxidase I gene was sequenced

from specimens collected from San Diego, CA to Washington State. Molecular analyses revealed a genetic break in central California dividing the coast into two distinct populations, one in the north from San Francisco Bay to Hood Canal, WA, and one in the south ranging from San Diego Bay to Long Beach. Phylogenetic analysis indicated three different source populations contributed to the northern invasion, and two of those three sources also contributed to independent invasions of the south. No haplotypes were shared between northern and southern populations. The central California coast serves as a dispersal barrier to larvae, and each population may be considered an independent unit for management and eradication efforts. New Zealand was invaded from one of the same source populations as the U.S., based on our analysis of *M. senhousia* specimens from a recently founded population in Auckland.

† EFFECTS OF PREDATOR ACCUMULATION ON COMMUNITY STRUCTURE OF FISHES IN MARINE PROTECTED AREAS

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One goal of community ecology is to understand how communities are structured and how they function. Marine protected areas (MPAs) are changing community structure. One change is that older, larger fish accumulate in MPAs. Predation pressure from these large piscivores may increase mortality in juveniles, smaller fishes, and conspecifics, potentially altering the community. This study investigates whether predator accumulation in an MPA has altered the size structure of the fish assemblage. Replicated underwater visual transects were used to quantify the size structure of the fish assemblage inside and outside of an MPA near Santa Catalina Island, California (USA). All demersal species were surveyed at 8-week intervals over a 12-month period. Size of each fish encountered was estimated to the nearest cm. Non-metric multidimensional scaling (nMDS) was used to evaluate whether the species and size structure of the assemblage inside the MPA differed from that found outside. Initial results of nMDS indicate that fish assemblages inside the MPA were distinguished from those outside by greater abundance in large predatory species and unexpectedly, in small size classes. However, trends of lower abundance appeared among larger individuals of these smaller size classes. Preliminary cohort analysis suggested greater mortality in small species and size classes within the MPA. These trends suggest more intense predation on juveniles and slightly larger species of small size classes. This implies that large predators in MPAs alter assemblage structure. These findings provide a basis for more realistic predictions of how MPAs may be expected to affect marine fish communities.

THE ROLE OF SYMBIONT DIVERSITY IN CORAL RESPONSE TO CLIMATE CHANGE

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Given climate change, thermal stress-related mass coral bleaching events present one of the greatest anthropogenic threats to coral reefs. While corals may have the potential to respond to future temperatures through adaptation, acclimation, and shifts in the community composition of corals and their symbiotic algae, the climate may change too rapidly for coral response. In order to explore this potential, we develop a multi-species model of coral and symbiont ecological dynamics as well as symbiont evolutionary (quantitative genetic) dynamics. Model results without variation in symbiont thermal tolerance predict coral reef collapse within a few decades under multiple future climate scenarios, consistent with previous threshold-based predictions. However, model results with sufficient genetic-level and/or community-level variation in symbiont thermal tolerance can predict potential coral reef persistence in the next century, provided low enough greenhouse gas emissions occur. Therefore, the level of greenhouse gas emissions will have a significant effect on the future of coral reefs, and our results show that accounting for biodiversity and biological dynamics is vital to estimating the size of this effect.

POPULATION CONNECTIVITY OF CALIFORNIA SPINY LOBSTER *PANULIRUS INTERRUPTUS* ACROSS THE US-MEXICO BORDER

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The California spiny lobster is one of several commercially important fishery species occurring in the coastal waters along the California-Mexico border region that peak in abundance along central Baja, Mexico and exhibits attenuation of its range north of Point Conception. There is direct and indirect evidence suggesting peaks in recruitment occur in southern California when prevailing currents run northward in association with El Niño anomalies, with little or no recruitment during non-El Niño years. Southern California spiny lobster populations are generally assumed to rely heavily on seeding from populations off central Baja, yet this assumption has never been tested directly. We examined the support for high connectivity between California and Mexican populations with an analysis of genetic differentiation at seven microsatellite loci among 749 individuals sampled at 18 locations across this species' recognized range from Bahia Magdalena, Mexico to the northern Channel Islands, California. Results are presented here on spatial patterns of genetic structure and diversity to begin ascertaining the patterns of dispersal across the international border.

MUTUALIST INDUCED CORAL STRUCTURE PROVIDES HABITAT FOR REEF FISH

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Tube-dwelling amphipods mutualistic with *Montipora* corals in French Polynesia induce the growth of long, finger-like branches in otherwise encrusting or plating corals. The structure induced by the amphipods may provide habitat for coral associated reef fish, and could play an important part in reef fish population dynamics. Surveys were conducted to determine whether fish utilized the habitat provided by the mutualist induced coral fingers, and coral outplants were used to determine whether the added structure provided settlement habitat for reef fish recruits. We found that in some parts of the reef, corals with fingers attracted more settlers and housed larger fish populations than corals without fingers.

† THE THYROID-GONAD AXIS: INSIGHTS ON A NOVEL MECHANISM OF COMMUNICATION IN THE AMERICAN ALLIGATOR

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Thyroid hormones are known to have a cooperative role in gonadal development and function. There is a growing body of work demonstrating that thyroid hormones play a crucial role in the development of Sertoli and Leydig cells in the testis. Thyroid hormones at proper levels are necessary for ovulation and severe hypothyroidism can cause ovarian atrophy and amenorrhea. Thyroid receptors are found in various parts of the ovary such as granulosa cells, oocytes and cumulus cells of the follicle, and corpora lutea, indicating that thyroid hormones can play a role in various cells of the ovary. The mechanisms of action are still not well understood. In many vertebrate species, including humans, thyroid disorders are more frequent in the female population. In addition, studies have shown that neoplastic thyroids have a higher number of estrogen receptors (ER) compared to normal tissue, suggesting a relationship between the sex of an individual and susceptibility to thyroid abnormalities. Recently, it has been shown that thyroid hormone concentrations parallel sex steroid patterns in American alligators. We investigate the mechanism of communication between the thyroid and gonad axis of the American alligator. Previous studies have demonstrated a one directional endocrine pathway from the thyroid to the gonad. We describe a possible new avenue of communication from the gonad to thyroid via the estrogen receptor located on alligator thyroid follicles. Through the use of genetic markers for thyroid and gonad physiology, we describe a novel mechanism of communication between these two axis.

† PACIFIC SAND LANCE (*AMMODYTES HEXAPTERUS*) PRESENT IN THE SANDWAVE FIELD OF CENTRAL SAN JUAN CHANNEL, WA: ABUNDANCE, DENSITY, MATURITY, AND SEDIMENT ASSOCIATION

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In October, 2006, Pacific sand lance (*Ammodytes hexapterus*) were found at a large sandwave field in central San Juan Channel, WA. In order to characterize the burying population at this site, bottom samples were collected at 21 random locations with a VanVeen bottom grab during day and night sampling trips. Of the 421 total fish caught,

almost all were sexually immature juveniles with a mean length of 79 mm (+/- 6 mm) and were most strongly associated with coarse grain sand. Density was significantly greater during the day than at night (120 fish/m² and 48 fish/m², respectively). The total abundance of sand lance in this sandwave field was conservatively estimated to range between 44.5-63.7 million fish. Predator avoidance, prey availability, current velocity, and tidal exchange are considered as explanations for the differences between catches.

VERTICAL VARIATION IN INTERTIDAL WAVE-GENERATED WATER VELOCITY

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In the history of intertidal ecology, much attention has been given to vertical gradients in temperature and desiccation and their influence on species distributions. However, vertical patterns in water velocity and wave force have not been thoroughly investigated in the intertidal zone. As a result, the influence of vertical patterns of wave-force on organismal dislodgement, damage and fatigue of tissues, gamete and propagule dispersal, productivity, and herbivory intensity remains an open question. To explore vertical patterns of wave force, we designed and installed autonomous digital wave-force dataloggers along vertical transects with different shoreline slopes at Hopkins Marine Station. To date, over 100,000 individual waves have been measured across a variety of sea states and tidal cycles. Topography influences the pattern of wave-force observed: wave force was positively correlated with shore height on steep slopes but negatively correlated with height on gentle slopes. These results support previous studies indicating that topographic variation can strongly influence patterns of hydrodynamic force and further suggest that "exposure" at a location varies with shore height. These data suggest the possibility of a physical factor, i.e. wave force, influencing the lower limit of a species distribution in certain circumstances.

† ALTERNATE STATES, STABILITY, DISTURBANCE AND POSITIVE FEEDBACKS IN CENTRAL CALIFORNIA SOFT-SEDIMENTS

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Ecological systems can be modified by many factors including habitat modification, eutrophication, introduction of species 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. Alternate stable state theory may be important for understanding dynamics and managing ecological systems, but experimental evidence is limited and controversial. To persist, alternate stable states must have positive feedback mechanisms, mechanisms to promote the community at the expense of outsiders and recover from disturbance (resilience). *Boccardia proboscidea*, a native polychaete worm, has recently formed dense patches in Bodega Harbor mudflats adjacent to habitat dominated by venerid clams and phoronids. These dense patches have not been observed historically and may represent alternate stable states. I monitored the biological, physical and chemical characteristics of the *Boccardia* and clam-phoronid communities. Data show *Boccardia* and clam-phoronid communities are discrete biological assemblages with different physical characteristics. I experimentally manipulated *Boccardia* and clam-phoronid communities using transplants and disturbances to study community structure, stability and recovery. Experimental and monitoring data show some evidence for stability, including persistence and resilience.

† VERTICAL MIGRATORY BEHAVIOUR OF DECAPOD LARVAE IN A PARTIALLY-MIXED ESTUARY: FIELD AND EXPERIMENTAL STUDIES

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Vertical migratory behaviour may result in both predator avoidance and horizontal transport. We predicted that if migration was a response to both predation and dispersal pressures, the majority of exported estuarine decapod zoea would be found deeper in the water column during daylight and flood tides and shallower only during nighttime ebb tides. We tested this by collecting pump samples at discrete depths over several tidal cycles in Willapa Bay, WA. Preliminary analyses indicate that at least one of the sampled species, *Neotrypaea californiensis*, was most abundant during nighttime ebb tides. Pinnotherid zoea showed a decreased abundance only during daytime flood tides. For both groups, however, abundance was independent of depth. We also experimentally examined whether

discontinuities in the water column could alter the vertical extent of a migration. In the laboratory, zoea of *N. californiensis* introduced to columnar tanks containing either a homogenous or a salinity-stratified water column demonstrated reduced vertical migration in the presence of a halocline. Our results add to the understanding of larval migration and will increase our ability to predict dispersal and recruitment dynamics in response to ocean condition variability.

† **PRODUCTIVITY OF AN HERBIVOROUS TEMPERATE MARINE FISH, *GIRELLA NIGRICANS***

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Herbivorous fishes are an important component of the marine environment because they have the ability to alter the composition of the community and convert primary production into fish tissue. Grazing of algae by herbivores can alter marine communities by impacting the growth, recruitment, and mortality of algae. By grazing algae, herbivorous fishes serve as a link between primary producers and secondary consumers. *Girella nigricans* (opaleye) is one of the few herbivorous fishes in the temperate waters of Southern California. The purpose of my study is to estimate productivity of opaleye off of Santa Catalina Island as well as the age and growth rate of these fish. Productivity was estimated by measuring the density of various size classes along underwater transects and combining these data with the estimated growth rates. Productivity for all size classes was 7.71 gWWt/m²/yr with the juvenile and sub-adult size classes having the highest contribution to opaleye production. When compared to productivity estimates of entire systems, opaleye productivity ranks among the higher published estimates. High productivity estimates indicate the importance of this fish for energy transfer throughout the temperate kelp forest community that opaleye inhabit.

METAPOPULATION ECOLOGY OF THE RHIZOSTOME JELLYFISH, *CASSIOPEA XAMACHANA* FROM CALABASH CAYE, BELIZE

Breen, R.T.*

San Francisco State University

Populations of the upsidedown jellyfish, *Cassiopea xamachana* were surveyed at four locations in Calabash Caye mangrove complex, Belize. Jellyfish at two clearwater sites and two blackwater sites were counted, measured, and weighted along 30 meter long transect lines and within 0.50 meter square pvc quadrats. Counts were made of umbrella contractions. Zooxanthellae concentrations were counted from oral tentacle tips taken from 70 to 90 mm jellyfish. Physical and chemical parameters were established, including quantum meter readings taken at solar noon from all four locations. Zooxanthellae populations varied significantly among individual jellyfish, from site to site and seasonally. Jellyfish populations and their symbiotic algae were subjected to extreme irradiance regimes throughout the depths of their habitat at Calabash Caye. A source population and 3 sink populations were identified within this oceanic mangrove system and dispersal patterns calculated. Diameter-weight and density-diameter relationships were calculated for *C. xamachana*. Nutrient levels at all four sites were higher than previously reported for other oceanic mangroves.

† **ABUNDANCE AND DISTRIBUTION OF DEEP-SEA CORALS AND OTHER BENTHIC STRUCTURE-FORMING INVERTEBRATES AND THEIR ASSOCIATION WITH ROCKFISH ON THE SANTA CRUZ ISLAND "FOOTPRINT".**

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Large structure-forming invertebrates and their associated habitats are of major importance when determining essential fish habitat as required by the Sustainable Fisheries Act. The objective of this study is to investigate the distribution and abundance of deep sea corals and other structure-forming invertebrates at the "Footprint" off Santa Cruz Island between 1995-2004: a high-relief area of the continental shelf at 150-350m depths. Of particular interest is the newly described black coral, , commonly called the Christmas tree coral. This multi-branched black coral forms colonies that can reach 2.5m in height and are relatively common in the "Footprint". An additional aspect of this study is to investigate potential associations between other structure-forming invertebrates, such as gorgonians

and sponges, and their relationship to fishes. Habitats in the area are extremely complex, consisting primarily of rock ridge habitat and the most abundant large invertebrate are foliose sponges. Several species of fish co-occurred with structure-forming invertebrates more than expected by chance.

MAXIMIZING THE RENT: CORAL MORPHOLOGY AND THE BENEFITS OF RESIDENT FISHES TO CORAL GROWTH?

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Hermatypic corals are functional mixotrophs that rely on water flow for the delivery of dissolved nutrients and prey. As the external morphology of individual colonies affects the rate of water flow through the colony, coral morphology may exert a strong influence on the flux of materials within the interior spaces of the colony itself. We explored the relationships between local water flow, abundance of resident fishes, external coral morphology and coral growth rates for a common species of branching coral, *Pocillopora eydouxi*, in lagoons of Moorea, French Polynesia. Colonies of *P. eydouxi* provide structural habitat and refuge space for a variety of reef fishes. In turn, these fishes may augment nutrient supply to their host coral while sheltering through the natural excretion of ammonium. To measure coral growth rates, we outplanted small coral nubbins into colonies of *P. eydouxi*. Mesh cages were used to exclude resident fishes from half of these colonies. Flow rates within host corals were measured using fluorescent dye and external morphology was quantified using digital photographs. Our experiments revealed that colonies of *P. eydouxi* containing resident fishes grew substantially faster than neighbors that did not. Coral growth rates were significantly correlated with within colony concentrations of ammonium. Our estimates of water flow within colonies indicated that flow varied considerably among experimental colonies under the same general flow regime, suggesting that coral morphology may modulate the effects of resident fishes on coral growth rates by influencing the overall flux of nutrients within a coral colony.

† AGE AND GROWTH OF LEOPARD GROUPER, *MYCTEROPERCA ROSACEA*, IN LORETO MARINE PARK, BAJA CALIFORNIA SUR.

Buckhorn, M.L.*

Graduate Group in Ecology, U.C. DAVIS

Mycteroperca rosacea, the leopard grouper, is considered one of the most important reef finfish species in the Gulf of California and is the most heavily fished serranid species in this area (Sala, Aburto-Oropeza et al. 2003). Leopard grouper were collected from fishermen during the spawning season from 2004-2007 in Loreto Marine Park. Sagittal otoliths were sectioned and annuli counted using a dissecting microscope. Age information is used to assess age structure of adults surveyed participating in spawning events. Leopard grouper reach reproductive maturity at an average age of 3 years (~300 mm), grow to be a meter in length and up to 30 years of age. In this study the oldest individual aged was 20 years; average age 7.13 years. When compared to survey data, the average age of leopard grouper at the spawning site is 5.42 years; and compared to all sites surveyed the average age is 3.48 years. This data suggest that the age structure of this population is in decline and measures should be taken to rebuild and protect older age classes.

† POPULATION DENSITY AND AGGREGATION CHARACTERISTICS OF THE RED ABALONE (*HALIOTIS RUFESCENS*) IN CALIFORNIA

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Fishing prior to the 1990's dramatically reduced abalone populations in southern California, while the red abalone fishery in northern California remained successful. In 2002, The California Department of Fish and Game drafted a plan which outlined the primary management concerns for the abalone populations in California. One of these concerns is that abalone population growth is reduced at low population densities due to stunted fertilization success. A theoretical minimum spawning density of 2,000 abalone per hectare is used to estimate the population viability although aggregation densities may be more relevant to estimating the overall reproductive potential of the

population. Prior to this study, aggregation characteristics of the red abalone in California had not yet been surveyed. The purpose of this study is to ascertain the correlation between the large-scale population density used to determine population viability and smaller-scale aggregation characteristics. Transect densities, nearest-neighbor distances, and aggregation sizes were surveyed at multiple sites along the coast of California and at San Miguel Island.

† THE CONSEQUENCES OF ACCELERATING TROPHIC SKEW IN MARINE FOULING COMMUNITIES

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Marine food webs are changing as predators and consumers are eliminated due to anthropogenic influences and invasive filter feeders and detritivores proliferate. Docks and marinas serve as a case in point. Due to physical restriction and a variety of stressors, these habitats contain a lower diversity of consumers as compared to nearby rocky areas. At the same time, non-native ascidians, bryozoans, and mussels can cover up to 100% of the available substrate. This contrasts starkly to nearby subtidal habitats where not all space is occupied and non-native species are rare. Here we show the potential consequences of further changes to this already skewed food web for sessile species community structure. We manipulated the density and diversity of four fouling consumers (chitons, limpets, small crabs, and urchins) in a combination additive-replacement design. Our results show that when chitons were present, cover of sessile organisms was low, regardless of the presence of other consumers. When chitons were absent, however, high densities of other consumers were needed to achieve equal reductions in cover. Even then, cover was often higher than predicted in multi-consumer assemblages due to interguild interactions. Our results demonstrate that high consumer diversity can mask the effects of interguild predation, and that loss of consumer species may result in increases in sessile species abundances, further accelerating trophic skew.

HOW MANY POPULATIONS TOO? THE GENETIC STRUCTURE OF THE URCHIN *TRIPNEUSTES GRATILLA* FROM PANAMA TO THE RED SEA

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“Fishing down food webs” in the tropics is changing the structure and function coral reef ecosystems. Tropical fisheries of key reef herbivores have moved beyond local communities, and global trade is delivering Pacific parrotfish species to the tables of New York City and London. Many of these key reef species have broad biogeographic ranges and long planktonic larval dispersal, but little is known as to the number of interbreeding populations within species’ ranges. My lab is using microsatellite markers and Bayesian population models to examine the population structure of heavily exploited reef herbivores in the tropical Pacific. In this talk, I focus on results from the urchin *Tripneustes gratilla*, and a companion talk by Fitzpatrick et al. focuses on parrotfish across a similar range. A previous phylogeographic study using mtDNA found broadly distributed haplotypes within *T. gratilla* and two subspecies across the Eastern Pacific, Central Pacific, Indian Ocean, and Red Sea. Here we present data from >1000 individuals genotyped at 11 microsatellite loci sampled across the entire geographic range. The population model STRUCTURE found three distinct subpopulations correlated with geography and phenotypic variation: (i) *T. gratilla elatensis* in the Red Sea, (ii) *T. depressus* in the Eastern Pacific, and (iii) *T. gratilla ss* spanning Easter Island, Hawaii, the Central Pacific, and the Indian Ocean. A long larval PLD (~50 days) links much of the Central Pacific and Indian Ocean, but genetic and phenotypic novelty is maintained in the Red Sea and in the Eastern Pacific by either barriers to larval dispersal, natural selection, or both.

† DELAYED GAMETOPHYTE PRESENCE IN KELP FOREST SYSTEMS

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Kelp population persistence may depend on the presence of a bank of microscopic stages that delay development during unfavorable conditions and then reproduce once conditions improve. Little is known, however, about the processes that regulate delayed development of these stages. We conducted laboratory experiments to determine the importance of nutrient concentration (1-100 $\mu\text{mol L}^{-1}$ nitrate), irradiance ($<10\text{-}60 \mu\text{mol photons m}^{-2}\text{s}^{-1}$) and seeding density ($10^2\text{-}10^5$ spores ml^{-1}) in regulating development of the microscopic stages in the most conspicuous kelp species in the Point Loma kelp forest in San Diego, California. Our results indicate that gametophytes of *Macrocystis pyrifera* grown under limiting nutrient concentrations can delay their development for at least 200 days while retaining the ability to reproduce. When nutrients were increased for gametophyte cultures of *Macrocystis*, *Pterygophora californica*, *Pelagophycus porra* and *Laminaria farlowii* 1, 14 and 37 days after being grown under limiting nutrient conditions, the time to reproduction decreased with length of delay. Further, while sporophyte production took more time at higher spore densities for both delayed and non-delayed gametophytes, sporophytes were more reliably produced from delayed gametophytes, suggesting delaying development may allow them to escape the effects of density dependence. Our repeated culture work with the delayed stages of *Macrocystis* shows that initially delaying the gametophytes increases reproductive success once development is resumed, suggesting that spores attained from the field may not always be prepared for reproduction and that a delay allows this to develop.

† ECOLOGICAL CONSEQUENCES OF HISTORICAL AND MODERN FRESHWATER DISTURBANCE EVENTS IN AN ESTUARINE ECOSYSTEM

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Historic climatic fluctuations in the San Francisco Bay region have been shown to significantly exceed those experienced since the advent of most European settlement 160 years ago. Meanwhile, anthropogenic climate change is predicted to have wide-ranging impacts on northern Californian climate regimes, including precipitation, yet the potential consequences of these and past changes are still quite unknown. Salinity, a key estuarine variable, is directly influenced by precipitation and is widely recognized as a potentially important factor governing community composition in estuaries. Using observational and experimental approaches, I assessed the effect of seasonal changes in water column conditions on community diversity over several years, including the success of native and non-native species. I examined correlations between sessile invertebrate recruitment and survival patterns and seasonal variation in salinity and temperature in San Francisco Bay. I then experimentally manipulated temperature and salinity levels to directly assess their effects on survival. I demonstrate that more extreme fluctuations even in today's more benign climate regime can have dramatic effects on estuarine communities, significantly altering the diversity, distribution, abundance, and timing of recruitment of estuarine invertebrates. In relatively dry years, recruitment is tightly linked to seasonal temperature fluctuations, while in wet years, recruitment is much more strongly correlated with salinity fluctuations. Dramatic shifts in community composition are also evident. We suggest that the ability of dominant species to withstand these salinity fluctuations can be especially important in determining the resulting community's composition and structure.

SPATIAL AND TEMPORAL DISTRIBUTION OF ECHINODERMS IN ROCKY NEARSHORE AREAS OF ALASKA

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Amongst nearshore invertebrates, echinoderms play an important role in the structure and function of rocky intertidal and shallow subtidal communities because of their high densities, biomass, and versatile ecological functions, e.g. in food web structure. Alaska has a variety of nearshore echinoderm species, but little is known about their spatial and temporal distribution. Rocky habitats were surveyed following the Natural Geography in Shore Areas (NaGISA) program protocols in three areas of the Gulf of Alaska (Prince William Sound, Kachemak Bay, and

Kodiak Island) in 2003 and 2004. Within each area, two to three sites were destructively sampled. We recorded the abundance of echinoderms collected within five 25x25cm quadrats in each of the following zones: high, mid, and low intertidal heights and 1m, 5m, and 10m depths. We attempted to detect interannual variability in the distribution of echinoderms and to evaluate whether distribution was different along horizontal scales between regions 100's of kilometers apart and, within each region, between sites 10's of kilometers apart. We also looked at tidal height as a factor of variation and tried to determine if any vertical patterns were consistently observed over time and over regional and local areas. No clear patterns in diversity and abundance of echinoderms were identified over time and over (regional and local) horizontal gradients. However, different echinoderm groups showed distinctive distribution patterns over the vertical immersion gradient, with asteroids and holothuroids being more abundant in the intertidal and shallow subtidal zone and ophiuroids being more abundant at deeper depths.

† INVASION RESISTANCE TO A NON-NATIVE BIVALVE IN SOUTHERN CALIFORNIA

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Increasingly, a major goal of invasion ecology is to describe ecosystems that are intrinsically more or less susceptible to intrusion by non-native species. Theory predicts that these systems may be characterized by differing levels of invasion resistance which in turn affects the probability of establishment by invaders. In Mission Bay, California, we evaluated how biotic and abiotic factors interact to allow benthic communities to resist invasion by the introduced Asian mussel *Musculista senhousia*. These mussels exhibit a distinct pattern of invasion with extremely high densities in back bay sites (<10,000 m⁻²) in contrast to a near complete absence in front bay sites. We transplanted Asian mussels throughout the bay to assess the relative contribution of physiological stress and predation to invasion resistance. Mussel survival in plots caged from predators was high, but in front-bay sites native predators such as spiny lobsters (*Panulirus interruptus*) and a gastropod (*Pteropurpura festiva*) decimated Asian mussels in uncaged plots. Strong effects of predators were detected for small and large mussels (8-12 and 15-25 mm) in both seagrass and unvegetated habitats. Additionally, ongoing infaunal surveys have identified recruitment of Asian mussels at two front bay sites, suggesting that propagule supply is not a limiting factor. Our findings indicate that biotic resistance in the form of predation may have a major role in determining the invasibility of benthic communities in Mission Bay.

EELGRASS MEADOWS IN THE CALIFORNIA CHANNEL ISLANDS AND ADJACENT COAST REVEAL A MOSAIC OF TWO SPECIES, EVIDENCE FOR INTROGRESSION, AND VARIABLE CLONALITY

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A narrow-leaved species (*Z. marina*) and a wide-leaved species, variously designated as *Z. marina*, *Z. pacifica* or *Z. asiatica* occur off the California Channel Islands and adjacent California-Mexico coast. Our goal was to confirm species identification genetically and to link patterns of genetic diversity, connectivity, and hybridization with historical sea levels or the contemporary environment using DNA polymorphisms of the rDNA-ITS cistron (nuclear), the *matK* intron (chloroplast), and nine microsatellite loci (nuclear). Wide-leaved plants were *Z. pacifica* whereas narrow-leaved plants were *Z. marina*. Microsatellite genotypes were consistent with hybridization between the two species in three populations. The current distribution of *Z. pacifica* follows a glacial age land mass rather than present oceanographic regimes, but no link was observed between the current distribution of *Z. marina* and past or present environments. Island populations of *Z. marina* often were clonal and characterized by low genotypic diversity compared to populations along the Baja California coast. The high level of clonal connectivity around Santa Catalina Island indicates the importance of dispersal and reestablishment of vegetative fragments. Future eelgrass restoration efforts must recognize two species that can hybridize and must consider the degree of genetic and genotypic variation in candidate donor populations.

EFFECTS OF MID-WATER STRUCTURAL COMPLEXITY ON TEMPORAL AND SPATIAL VARIABILITY OF NEARSHORE CRAB EARLY-LIFE HISTORY STAGES WITHIN A HIGH-LATITUDE REGION

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Larval and post-larval crab distribution was surveyed in three different habitats in Kachemak Bay, Alaska to determine temporal and spatial variability. Distribution varied temporally and spatially from June 2005 to September 2006. Nine sites of varying habitat complexity were surveyed monthly using scuba surveys and light traps to measure habitat variables and quantify crab zoea and megalopae. A total of 10,016 crabs belonging to seven families were identified. Four species comprised the majority (97%) of the total crab assemblages and included *Cancer oregonensis*, *Fabia subquadrata*, *Telmessus cheiragonus*, and *Pugettia gracilis*. Peak abundances occurred in summer but varied on small temporal scales (days and weeks) with species. No single bay-wide variable determined the appearance of all species. Depending on species, appearance may be influenced by seasonality of environmental variables. Spatially, highest abundances occurred in habitats with less structural complexity. Spatial differences in crab abundance may have resulted from variability on physical transport mechanisms.

† EFFECTS OF HABITAT FRAGMENTATION AND PATCH SIZE ON RECRUITMENT AND THE ABUNDANCE OF KELP FOREST FISHES.

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San Diego State University

Habitat loss from disturbance often results in the fragmentation of remaining habitat. Few studies of the effects of habitat fragmentation exist in marine systems, and rarely have such effects been applied to fishes. On temperate rocky reefs, large expanses of kelps are subject to significant variation in loss and fragmentation due to natural or anthropogenic disturbance. We investigated the effects of fragmentation and patch size of giant kelp *Macrocystis pyrifera* forests on recruitment and the abundance of kelp forest fishes. To investigate the effects of habitat fragmentation, we experimentally removed sections of giant kelp from natural occurring kelp forests at three sites near Santa Catalina Island, California, creating fragments of varying areas. In 2005 and 2006, we recorded the densities of recruits and older life stages of fishes and extrapolated these values to abundance per fragment area. Fish abundance did not scale linearly with fragment area and varied among species. To examine the relationship between recruitment and patch size of giant kelp at smaller scales, giant kelp was translocated and anchored to a sandy substratum. Recruitment of kelp bass (*Paralabrax clathratus*) revealed a linear relationship with patch size, whereas recruitment of señorita (*Oxyjulus californica*) showed an asymptotic relationship. Our results suggest that fragmentation and patch size of kelps on rocky reefs may have important consequences for fish assemblages.

† GEOGRAPHIC VARIATION IN ROCKY INTERTIDAL ALGAE PALATABILITY.

Dolecal, R.E.^{*}, and J.D. Long

Northeastern University

Consumer-prey interactions often occur across a broad geographic range where environmental conditions influence the nature of these interactions. This geographic variation has largely been overlooked with respect to the feeding preferences of marine herbivores. For example, feeding preferences are often determined by testing the preference of single herbivore populations feeding on single populations of seaweed, and these preferences are assumed constant throughout the species ranges. To test this assumption, we conducted multi-choice feeding assays of the common periwinkle, *Littorina littorea*, on 5 co-occurring seaweeds (*Fucus vesiculosus*, *Ascophyllum nodosum*, *Mastocarpus stellatus*, *Ulva lactuca*, and *Porphyra umbilicalis*) from 3 regions (Massachusetts, Maine, and New Brunswick). Consistent with previous studies, *Littorina* strongly preferred the two ephemeral species (*Ulva* and *Porphyra*) regardless of source population of seaweed or snail. However, the relative palatability of these two ephemerals varied with region so that *Ulva* was preferred to *Porphyra* in the south whereas *Porphyra* was preferred to *Ulva* in the north. These preferences were consistent between snail populations suggesting that the relative differences were between seaweeds rather than the snails that were feeding on them. When snails were offered the choice of *Ulva* from each region, they preferred to feed on southern *Ulva*. Given the apparent opposing geographic pattern for *Ulva* and *Porphyra* palatability, ultimate mechanisms influencing seaweed palatability, such as snail densities and per

capita grazing rates, appear insufficient to explain these patterns. Our results suggest that geographic variation in seaweeds strongly influences herbivore feeding preferences.

† **DIAGNOSING A DECLINING ECOSYSTEM: SURVIVAL OF THE LAST CHESAPEAKE BAY EELGRASS BEDS DEPENDS ON A TENUOUS BALANCE OF BIOTIC AND ABIOTIC INFLUENCES**

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Burgeoning nutrient and sediment inputs from development, in concert with diminution of filter-feeding oysters and menhaden, have severely reduced water quality in Chesapeake Bay. Apparently in response, formerly extensive eelgrass (*Zostera marina*) beds have shrunk to low levels. The remnant beds may now be vulnerable to other negative influences, including climate change and food web alteration. We examine eight years of field monitoring data from a surviving eelgrass bed to determine if the dynamics of the community are consistent with hypothesized modes of top-down and bottom-up control. We show evidence of top-down control of invertebrate grazers by predators, which could link eelgrass health with fisheries activity. However, we also find that every part of the biological community in the eelgrass bed has close, direct links with seasonal and interannual changes in the abiotic environment, suggesting that climate change could have an even stronger influence on the ultimate persistence or extirpation of eelgrass in Chesapeake Bay.

PREDATION RESISTANCE OF MARINE COMMUNITIES TO INVASION

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Biological invasion into coastal environments has become a ubiquitous conservation problem with a constant increase of invaders through global transport and commerce. The purpose of this study was to examine the role of benthic predators in preventing or regulating invasion in native communities. Thus, we postulated that the invasion resistance is higher on benthic than fouling communities due to biotic resistance of native species. We performed field experiments to identify the predators and examine the survival of an invasive and native ascidian in both fouling and benthic communities in northern Chile. We showed that both recruits and adults of the invasive ascidian *Ciona intestinalis* had a very low survival rate on rocky bottom but an absence of mortality on floating structures during the same time period. In contrast, although recruits of the native ascidian *Pyura chilensis* had a low survival on rocky bottom, the adults did not suffer from mortality either on rocky bottom or floating structure. Addressing a difference in invasion resistance between fouling and benthic communities, we suggest an invasion process where biotic resistance may repel or regulate growth and spread of invader populations.

EXPRESSION PATTERNS OF HEAT SHOCK PROTEINS IN MYTILUS BAY MUSSELS ACROSS THE EASTERN PACIFIC BIOGEOGRAPHICAL RANGE.

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Along the eastern Pacific coast two members of the *Mytilus* mussel complex, *Mytilus galloprovincialis* and *Mytilus trossulus*, inhabit protected bay habitats between Baja California, Mexico, and the Gulf of Alaska. Because these mussels occupy a narrow coastal zone across a large latitudinal gradient, they provide an ideal opportunity to examine latitudinal acclimatization of physiological characteristics across their ranges. Little is known about the variation of such characters in field populations across a species distribution. Variation in stress response pathways is of particular interest, as it may have implications for environmental tolerances affecting the overall range limits of the species. One major stress response is the regulation of heat shock proteins (Hsps) which assist in the stabilization and refolding of damaged proteins. Subtidal mussels were sampled at multiple field sites between San Diego, CA, and Puget Sound, WA, and tested using quantitative PCR to measure the induction profile of transcripts for two heat shock proteins: the constitutive protein Hsc71 and the inducible protein Hsp70. Field samples were also collected at each site for global gene expression analyses using cDNA microarray techniques. Results of the experiment indicate a shift in the hsp70 induction profile across latitude, suggesting local acclimatization and varied thermal sensitivity across the species range.

THE EFFECT OF SHORT-TERM THERMAL AND LIGHT HISTORY ON THE RESPONSE OF REEF CORALS TO ELEVATED TEMPERATURE

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The response of corals to high temperature has been at the forefront of investigations of the effects of climate change on coral reefs, yet little is known of the extent to which this response is modified by preceding conditions. This study tested the effects of history on the susceptibility of corals to high temperature using sequential exposures to winter-like and summer-like conditions created in microcosms. Massive *Porites* and *P. irregularis* from Moorea, French Polynesia, were acclimated for 15 d to cool or ambient temperature at low or high irradiance, and then were exposed for 7 d to ambient or high temperature at ambient light. Both species responded to acclimation with a light x temperature interaction, which for massive *Porites*, affected biomass, and for *P. irregularis*, affected growth. Acclimation influenced the response to the subsequent treatment for massive *Porites* (but not *P. irregularis*), notably with an acclimation x treatment interaction for growth. For massive *Porites*, the negative effects of high temperature on growth were mitigated by acclimation to ambient temperature and low light, but were accentuated by acclimation to low temperature and low light. The association of these trends with changes in tissue weight suggests that biomass is implicated in determining the susceptibility of corals to temperature stress.

ECOLOGICAL CONVERGENCE AND DIVERGENCE IN LIMPETS

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We have documented striking examples of ecophenotypic convergence or divergence in the shells of West Coast limpets (Lottiidae) related to their feeding ecology and habitat. These examples typically involved a conflict between conventional limpet taxonomy and the results of our preliminary mitochondrial 16S rDNA molecular phylogeny. We sequenced more than 400 limpets representing 30 species of *Lottia* and related genera from western North America. Our analysis supported each species as reciprocally monophyletic and also supported the monophyly of some species groups within Lottiidae. Although deep relationships within Lottiidae were not well resolved, the resolution achieved was sufficient to infer or corroborate interesting patterns of limpet ecology and morphology, including: 1) dramatic shifts in feeding ecology: limpets living on surf grasses ("*Lottia*" *paleacea*) or eel grasses ("*L.*" *depicta*) are in a clade apart from *Lottia*, and this clade also includes a coralline alga specialist, "*L.*" *rosacea*; 2) profound ecomorphological variation: *Lottia* "*ochracea*" is a rock ecomorph of a species, *L. instabilis*, known for its habit of living on kelp stipes; 3) striking parallelisms: "*L.*" *rosacea* is phylogenetically distant from a morphologically similar coralline alga specialist, *Lottia triangularis*; another parallel example is of a new species that is highly convergent to the *L. "ochracea"* rock ecomorph; 4) sibling species: certain species that were once each considered widespread species were instead each supported as separate northern versus southern sibling species with a similar broad range of ecophenotypic variation that is probably more ancient than their likely allopatric divergence.

MOLECULAR GENETICS AND GEOLOGICAL HISTORY OF THE SEA OF CORTEZ: EVOLUTION AND SPECIATION IN THE ESTUARINE GOBY GENUS *GILlichthys*

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The longjaw mudsucker *Gillichthys mirabilis* inhabits muddy channels and pits in estuarine settings from northern California down to Baja California and around the Sea of Cortez. Endemic to the northern Gulf of California, *G. seta* is a denizen of high rocky shorelines and sandy tidal streams. It is thought that *G. seta* became isolated from *G. mirabilis* as a consequence of adaptation to the unique conditions of the northern Gulf. In contrast, our molecular clock estimates indicate that *G. seta* may be older than the Gulf itself, suggesting speciation occurred prior to opening of the Gulf. A third species of *Gillichthys* previously named *G. detrusus* Gilbert & Scofield 1898 was synonymized with *G. mirabilis* just nine years after its description. However, our genetic data from populations endemic to the immediate delta region of the Colorado River support resurrection of the species status of *G. detrusus*. This localized nominal species is younger than *G. seta* and adapted specifically to the massive estuarine system at the mouth of the Colorado River. Other groups of marine organisms also exhibit high levels of endemism

in the northernmost Gulf, and are threatened by elimination of fresh water in that system. Evolution and speciation in *Gillichthys* spp., as well as other northern Gulf endemic taxa, will be discussed in the context of the formation of the Baja California peninsula and opening of the Sea of Cortez.

† **BREAK-DOWN OF THE SIZE-ADVANTAGE MODEL: EVOLUTIONARY CHANGES IN MATING PATTERN INFLUENCE THE LOSS OF SEX CHANGE IN GROUPERS AND SEABASSES**

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Current theory on sexual allocation and the evolution of sex change in animals proposes that sexual pattern is determined by aspects of the social and mating system of a species, and these predictions are well-supported by numerous empirical and theoretical studies. However, very few studies have tested predictions of sex-change theory against the evolutionary patterns of reproduction in specific taxa within a strict phylogenetic context. Using a phylogenetic approach, we investigated the evolution of sexual and mating patterns in groupers and seabasses to determine whether changes in sexuality were influenced by changes in mating pattern. We also compared the intensity of sperm competition between gonochoric (separate-sexed) and hermaphroditic species, to further test theoretical predictions regarding the influence of mating behavior on sexuality. Results from a concentrated-changes test suggest that transformations in sexual pattern were associated with changes in mating pattern. Similarly, sperm competition intensity was significantly higher in gonochoric species than hermaphroditic species. Overall, these results suggest that the loss of sex change in some groupers and seabasses was driven by shifts in mating pattern from paired to grouped spawning.

AN UNUSUAL PHASE SHIFT FROM SCLERACTINIAN- TO ACTINIARIAN-DOMINANCE IN CORAL REEFS

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A phase shift from scleractinian- to macroalgal-dominance has occurred on many reefs throughout the world, but the processes favoring such transitions still are not fully understood. In southern Taiwan, two nearby coral reefs have displayed contrasting community trajectories between 1992 and 2007, and this has created the opportunity to explore the functional basis of the differences. One reef changed rapidly and repeatedly, first from *Acropora* dominance prior to 1994, to dominance by the actiniarian *Condylactis* sp. from 1994 to 2002, then in 2003 to turf algae that persisted until 2006, and finally to macroalgae in 2007. On the second reef, a single change occurred from *Acropora* dominance prior to 1992, to dominance by a different actiniarian (*Mesactinia ganensis*) in 1992 that has persisted to 2007. Because both reefs are exposed to eutrophic conditions, manipulative experiments in microcosms were used to test the hypothesis that eutrophication promotes the dominance of anemones over *Acropora*. These experiments reveal that nutrients enhance the fission rates of anemones (*M. ganensis*), and in turn, this promotes the competition between anemones and corals that leads to lesions and partial mortality on the *Acropora*. This study is important as it reveals how a unique combination of local taxa and nutrient regimes can support an unusual phase transition from scleractinian- to actiniarian- dominance.

† **INVESTIGATING ELK KELP'S, *PELAGOPHYCUS PORRA*, INABILITY TO INVADE THE POINT LOMA GIANT KELP BEDS**

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The Elk Kelp, *Pelagophycus porra*, is commonly observed in deep (20-30m) water on the outer edge of Giant Kelp, *Macrocystis pyrifera*, forests in southern California and northern Baja California, but rarely occurs in shallower water or within the giant kelp beds. In the field we implemented a series of transplant, clearing, and artificial seeding experiments as well as physiological measurements to investigate *P. porra*'s apparent inability to encroach into the more abundant giant kelp beds along the southern California coast. Our results indicate that transplanted *P. porra* juveniles exhibit similar growth and survival across a vertical gradient. Experimental removal of *M. pyrifera* and the addition of *P. porra* reproductive spores to these cleared areas offers insight to the potential dispersal capabilities of Elk Kelp. Physiological measurements using PAM fluorometry indicate that while this species exhibits characteristics of a species adapted to low light environments, such as deep-water habitats, individuals are able to photoacclimate to increasing light levels as they grow towards the surface. Culture experiments were carried out in

the laboratory to investigate the affects of increasing light levels on the microscopic life history stages of *Pelagophycus*, both gametophyte and embryonic sporophytes.

† THE ECOLOGICAL CONSEQUENCES OF SIZE-SELECTIVE HARVESTING: THE OWL LIMPET (*LOTTIA GIGANTEA*) AS A CASE STUDY.

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Size-selective harvesting, where the large individuals of a particular species are preferentially taken, is common in both marine and terrestrial habitats. Preferential removal of larger individuals of a species has been shown to have a negative effect on its demography, life history and ecology and empirical studies are increasingly documenting such impacts. In this study, we use the Owl limpet, *Lottia gigantea*, as a model organism to examine the ecological consequences of size-selective harvesting on *L. gigantea* and the surrounding intertidal community. The loss of large territorial females has cascading effects on the space occupancy of the mid-intertidal zone, on individual growth rates and on the settlement patterns of juvenile *L. gigantea* from exploited populations. In addition, we will examine the genetic population connectivity and abundance patterns of *L. gigantea* throughout its geographic range.

† CHEMICAL CUES AND THE KEYSTONE SPECIES HYPOTHESIS

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Sensory systems provide critical filters that enable organisms to detect and recognize valuable resources. Trophic cascades, structuring populations and communities, are determined to a large degree by trait-mediated interactions that rely on sensory inputs. Certain molecules serve as chemosensory stimuli and play keystone roles in determining outcomes of predator-prey dynamics at multiple trophic levels. Here, we investigated the potential contributions of surface-adsorbed proteins as signal molecules within wave-swept, rocky intertidal habitats. As indicated by initial results, barnacles (*Balanus glandula*), were constrained to produce a high molecular weight, insoluble, glycoprotein complex for cuticle/shell formation. These compounds evoked settlement by conspecifics larvae in field assays, and thus, could operate as seminal cues for recruitment. Moreover, the same substances triggered predation by a numerically dominant whelk species (*Acanthinucella spirata*) on barnacle juveniles and adults in lab and field experiments. Such proteins, therefore, influence simultaneously demographic processes that would enhance, or diminish, barnacle populations. As dominant competitors for space, the relative balance between barnacle recruitment and predation mortality may have strong, cascading direct and indirect effects on community dynamics. Hence, surface-adsorbed proteins could play keystone roles within rocky intertidal habitats.

† THE DISTRIBUTION, ABUNDANCE, AND DYNAMICS OF DRIFT ALGAE WITHIN KELP FOREST ECOSYSTEMS OF CENTRAL CALIFORNIA

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Giant kelp, *Macrocystis pyrifera*, forms underwater forests along the California coast that are among the most productive and diverse habitats on earth. Kelp can grow a foot a day resulting in an annual production of >9,500 metric tons/km of coast (i.e. the equivalent biomass of 50 blue whales). Much like litter in terrestrial forests, the majority of kelp production becomes drift that settles to the rocky reef below where it nourishes a complex detritus-based food web. Understanding the distribution, dynamics and fate of drift kelp is integral to understanding how it is utilized and its role in structuring kelp forest ecosystems. I surveyed the standing stock biomass of drift algae and physical characteristics (e.g. depth, substrate, aspect, relief) of 6 kelp forests along central California for 3 years over four seasons. I found that drift kelp biomass varies considerably (i.e. from 1 to 15% cover) between forests and that this pattern is consistent across seasons and years. Seasonal differences appear to be driven by increased kelp production in summer, but factors that affect the ability of the reef to retain drift (e.g. exposure, depth, substrate, aspect, and relief) drive relative differences in drift biomass between forests. These results suggest that it may be possible to predict the relative abundance of drift kelp among kelp forests by comparing easily

measured physical characteristics of the reef. This approach can help us understand and predict the relative importance of drift kelp in structuring different kelp forest communities along the California coast.

† HOW MANY POPULATIONS? THE GENETIC STRUCTURE OF THE EMBER PARROTFISH (*SCARUS RUBROVIOLACEUS*) THROUGHOUT THE INDIAN AND PACIFIC OCEANS.

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Overfishing and pollution are affecting consumers on coral reefs and impacting ecosystem structure and function. To protect and conserve these valuable ecosystems, we need knowledge of reef connectivity and dispersal patterns to inform proper establishment and design of effective fisheries management tools, such as MPAs. In the tropical Pacific, many species of reef herbivores have long planktonic larval durations and enormous biogeographic ranges, yet patterns of the population structure are largely unknown. To determine how many populations (defined as interbreeding units) exist within the range of the ember parrotfish (*Scarus rubroviolaceus*) we sampled populations from Panama to Africa and genotyped over 300 individuals at 14 microsatellite loci. We used traditional measures of population structure and the population model STRUCTURE to determine how many populations are found within the species' range. This analysis found four populations defined by the following biogeographic regions: 1) Hawaii, 2) East Pacific, 3) Central West Pacific, and 4) Indian Ocean. Further, pairwise comparisons revealed the largest *FST* values between Hawaii and all other populations and the East Pacific and all other populations. The isolation of Hawaii and the East Pacific from all other populations are likely the result of unsuccessful dispersal over vast stretches of water that lie between favorable habitats. However, there is a high degree of dispersal in the larvae of these fish indicated by the panmixia found at smaller scales, e.g. within Hawaii and Samoa. Our results require confirmation with other key reef herbivores, but suggest management strategies should be built around population cohesiveness within at least four regions, and emphasize the uniqueness of Hawaii and the Eastern Pacific.

† FECUNDITY OF CALIFORNIA SHEEPHEAD, *SEMICOSSYPHUS PULCHER*, REVISITED.

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Size selective fishing pressures can alter reproductive parameters and output particularly for sex changing fishes. California Sheephead (*Semicossyphus pulcher*) is a sequential protogynous hermaphrodite that is targeted by both commercial and sport fisheries. Sheephead populations declined as the result of increased fishing pressure in the late 1990s, increasing the need for a reevaluation of reproductive parameters of this species. Female sheephead were collected from Santa Catalina, Santa Barbara, and San Nicolas Islands throughout their spawning season (June-September). Oocytes were counted and measured from ovarian subsamples from 16 females ranging in size from 221-428 mm standard length. Ovaries ranged in weight from 2.48-147.20g and had gonadal somatic index of 1.06-34.39 (gonad weight/SL*100). Eggs were categorized based on developmental stage. Across the 16 mature females assessed, 5% of the oocytes within each ovary were hydrated, 45% were in the developed stage, 20% were intermediate oocytes, and 30% were developing. The mean diameter (\pm SEM) of hydrated oocytes was 918.6 $\mu\text{m}\pm$ 34, 480.1 $\mu\text{m}\pm$ 12 for developed, 339.4 $\mu\text{m}\pm$ 8 for intermediate, 269.7 $\mu\text{m}\pm$ 9 for developing, and 73.0 $\mu\text{m}\pm$ 2 for immature. Diameters of each developmental stage were significantly different from all other groups ($p=0.0001$). The relationships between SL and both total fecundity (F) and batch fecundity (BF) showed a power function and revealed $F=7E-09x5.4495$ ($R^2=0.7659$) and $BF=2E-16x7.8826$ ($R^2=0.4648$). This information can provide more accurate estimates of fecundity and population output and therefore vastly improve reproductive parameters for stock assessments.

PARASITIC CASTRATION OF A VERTEBRATE: EFFECT OF THE CYMOTHOID ISOPOD *ANILOCRA APOGONAE* ON THE CARDINALFISH *CHEILODIPTERUS QUINQUELINEATUS*

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Parasitic castration, characterized by the specific blocking of host reproductive output, is a host-parasite interaction common to many invertebrates, particularly crustaceans, echinoderms and mollusks. It can reduce host density and alter host population dynamics and the evolution of host life-history traits. Here we show that an ectoparasitic isopod, *Anilocra apogonae*, castrates its vertebrate host, the five-lined cardinalfish, *Cheilodipterus quinquelineatus*. Parasitized fish gonads are smaller and parasitized female fish have substantially fewer and smaller ova than do the gonads of unparasitized fish. Parasitized male fish fail to mouthbrood their young. Parallel to the parasitic castrators of invertebrate hosts, *A. apogonae* on *C. quinquelineatus* are uniformly dispersed among infested hosts (one adult female isopod per host), are site specific, and their body size is highly correlated with that of their host. These isopods are large relative to the body size of their hosts, averaging 3.8% of the weight of the host. Parasitized fish also weigh less and are shorter than unparasitized fish of the same age. Despite the presence of other potential hosts, *A. apogonae* only infests *C. quinquelineatus*. This study suggests that parasitic castration of a vertebrate is likely controlled by sophisticated physiological regulation as has been shown for parasitic castrators of invertebrate hosts. It also indicates that certain life history traits are predictors of a parasitic castration host-parasite relationship and that this type of association will be recognized for other parasites of vertebrates.

† REDUCED PARASITISM IN A HIGHLY INVADED ESTUARY: SAN FRANCISCO BAY

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San Francisco Bay (SFB) is the most heavily invaded estuary in the nation (Cohen and Carlton 1995). The 'enemy release hypothesis' (Torchin et al. 2003) is often invoked to explain the extraordinary successes of dominant invaders. Hence, as an ecosystem becomes heavily invaded it may have fewer parasites. A novel first step to explore the effects of reduced parasitism on community ecology is to quantify parasitism for full assemblages of native and ecologically similar exotic invertebrate and fish species. A total of 71 free-living species from 15 benthic and fouling SFB sites were screened for parasites. Only 5 of the 8 major host groups had abundant populations of native species, while all contained abundant exotic populations. Parasitism within host groups varied widely, as did representation of parasite guilds in natives and exotics. Generally, exotics had fewer parasites than did their native counterparts. More surprisingly, parasitism among most guilds of native species in SFB was lower than in corresponding populations at other California embayments. This suggests that dense populations of exotic species may affect infectious processes in invaded areas in at least three ways: 1) arriving with few native parasites, 2) displacing native ecologically similar native species, and 3) diluting parasite transmission.

PERSISTENCE, DYNAMICS AND APPARENT INVASION OF PARCHMENT TUBEWORM (*EUDISTYLIA VANNCOUVERI*) AGGREGATIONS ON WASHINGTON'S OLYMPIC COAST.

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The parchment tubeworm, (*Eudistylia vanncouveri*), is a Sabellid tubeworm that colonizes rocky intertidal platforms on sand-dominated stretches of the Olympic coast of Washington State. colonize gregariously into patchy aggregations, or groves, that create habitat for a variety of organisms that otherwise do not persist in this waveswept habitat. The size and persistence of tubeworm groves on a rocky platform were monitored over a 6 year period in relation to water temperature and wave action. Results, including the apparent invasion of groves by the Sabellid tubeworm will be discussed.

WHAT SOURCES OF NITROGEN ARE AVAILABLE TO A BED OF GIANT KELP (*MACROCYSTIS PYRIFERA*) AND HOW MUCH OF EACH SOURCE IS UTILIZED?

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To determine the relative importance of different sources of nitrate to the annual nitrogen demand by *Macrocystis pyrifera*, we measured ambient nitrate concentrations at a kelp forest for 13 months in 2005-2006, and we characterized physical supply using water column thermal structure and flow data obtained in the forest and at its edge. Monthly nitrate supply varied by a factor of 50 over the 13 month study, while measured net uptake of

nitrogen varied only five fold. Maximum net nitrogen acquisition rates for fronds in the forest interior were 0.18 mmol N g⁻¹ month⁻¹ during spring upwelling in 2005 and declined four-fold during autumn until upwelling resumed the following year. Modeled gross nitrogen uptake with consideration of Michaelis-Menten uptake kinetics for nitrate and mass transfer limitation was higher than measured acquisition except during the warm stratified summer and autumn months when observed net uptake exceeded modeled gross uptake. This late summer and fall shortfall suggested that the kelp forest received over half of its nitrogen from sources other than seawater nitrate, possibly ammonium from epibionts. Internal waves and local streams combined supplied less than 9% of the total nitrate supply, but internal waves delivered 20% of the nitrate during stratified periods. Kelp utilized less than 5% of the nitrate supplied to the forest. Nitrate delivery to this modest sized kelp forest was roughly equivalent between alongshore (45%) and cross-shore flows (55%), which distinguishes it from large kelp forests in which cross-shore flows dominate exchange.

† MOVEMENT OF TEMPERATE REEF FISHES: INFORMING MPA SIZE

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Understanding how species and habitat characteristics interact to influence movement patterns of fishes is of critical importance for understanding how species can be managed within a spatially explicit management context such as marine protected areas (MPA). Spatial protection of populations in MPAs is only possible if a reserve encompasses an area that will contain individuals in sufficient numbers of a local population within the reserve boundaries. On the other hand, spillover and associated local fisheries benefit if adult individuals move far enough to cross reserve boundaries into fished areas. Therefore, it is important to know the scale of adult movement relative to reserve size. Results from movement studies can often be interpreted either as estimates of movement range sizes or as rate estimates of continuous, directional movement. Understanding what type of movement species exhibit is critical for developing models for MPA design and evaluation. My review of the literature on the movement of temperate reef fishes along the American west coast has generated estimates of the movement distances for temperate reef fishes. Most species move less than 3km. This literature review indicates that a movement range rather than a rate can be assumed in models informing MPA size. Further, movement distance depends on the depth range of species. Deeper species move over larger distances than shallow species. This type of information is critical for informing MPA size design and evaluation and has been used during the MLPA process for establishing MPAs along the California central coast.

HEART TEMPERATURE MAY LIMIT THE MOVEMENTS OF PACIFIC BLUEFIN TUNA, *THUNNUS ORIENTALIS*

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Pacific bluefin tuna, *Thunnus orientalis*, make extensive horizontal and vertical migrations where they inhabit a broad range of thermal niches. Although tuna are capable of conserving metabolic heat, the hearts of these fishes operate at near ambient water temperatures, and must therefore be able to function at a broad range of temperatures. This study investigated the effects of thermal acclimation and acute temperature change on aspects of sarcolemmal and intracellular calcium cycling in isolated cardiac myocytes from the Pacific bluefin tuna. Atrial and ventricular myocytes were isolated from bluefin tuna acclimated to either 15 or 23 °C, and the effect of experimental temperature (15, 19 and 23 °C) on the sarcoplasmic reticulum load (SRload) and L-type calcium channel density (ICa) was assessed using whole-cell voltage-clamp. Our results suggest thermal acclimation has little effect on ICa or the ability of the SR to accumulate calcium. Acute reductions in temperature significantly decreased both ICa and SRload in atrial and ventricular myocytes from both acclimation temperatures. Results indicate that acute reductions in temperature reduce calcium flux both across the sarcolemmal membrane and through the SR. This will place a significant burden on the heart of the bluefin tuna and may limit the amount of time these animals can spend in cold waters.

† SEQUENCE AND TIMING OF SETTLEMENT DETERMINES THE OUTCOME OF COMPETITION BETWEEN TWO REEF FISHES

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Many communities undergo repeated periods of development due to seasonally regenerating habitats, or pulsed arrival of young-of-year. When a species' persistence in regenerating communities depends on the strength of competitive interactions, changes in the timing of arrival relative to the arrival of a competitor can modify competitive strength, and ultimately establishment in the community. Furthermore, reversals in the sequence of arrival between competing species may result in reversals in competitive dominance. We asked whether previously identified competitive interactions between recent recruits of the reef fishes *Thalassoma hardwicke* and *T. quinquevittatum* are dependent on the sequence, and temporal separation of their arrival into communities. To achieve this, we manipulated the sequence and timing of arrival of each species onto experimental patch reefs by simulating settlement pulses. Reversals in sequence of arrival resulted in reversals of competitive dominance, with the earlier arriving species having higher survival than later arriving species. Changes in the temporal separation of arrival between species showed that survival declined as each species entered the community progressively later than its competitor. This study highlights the complex processes acting on the intensity and outcomes of interspecific competition between these species, and suggests that (1) the identity of competitors affect competitive outcomes, and (2) these competitive interactions are further modified by the sequence and timing of events. Our findings suggest that variability in the timing of settlement pulses of *T. hardwicke* relative to *T. quinquevittatum* can have dramatic effects on recruitment strength and success of both species.

† EFFECT OF MATERNAL SIZE ON SURVIVAL OF JUVENILE *LEPTASTERIAS AEQUALIS*

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Leptasterias aequalis is a six-rayed brooding seastar with crawl-away juveniles. Larger female *L. aequalis* produce embryos with higher energy contents. I hypothesized that embryos with more energy would become juveniles with a higher probability of survival. To test this hypothesis, I collected brooding *L. aequalis* from Lonesome Cove (San Juan Island), Shannon Point Beach and Burrows Island, Washington. Adults from these three beaches vary significantly in size and likely have embryos with varying energy reserves. After the brooded juveniles had undergone metamorphosis, I collected them from the adult stars and began tracking their survival (with no feeding). Surprisingly, the size of the newly metamorphosed juveniles was not significantly different among beaches despite differences in maternal size. Six months after metamorphosis, there has been only 12% mortality in the juveniles, and there is no significant difference in survival of juveniles from the three beaches. Neither juvenile size nor longevity seems to be affected by adult size. I am currently measuring movement of the juveniles as an index of energy use. Preliminary observations suggest that larger juveniles are more active. An increase in activity could indicate increased dispersal ability or a greater likelihood of encountering prey, both of which may increase chances of survival. Larger females may produce juveniles that are more fit, not in terms of body size, but in terms of energy available for foraging.

NUDIBRANCHS AND THE 1976-77 CLIMATE SHIFT IN THE NE PACIFIC

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Biological responses to multi-decadal variation in ocean climate have been documented recently from a variety of habitats and trophic levels. We utilized a previously unpublished, three-year, monthly data set from the mid-1970s to document relatively rapid changes in the abundance, community composition and geographic range of intertidal nudibranch gastropods from central California associated with the 1976-77 climate shift in the northeast Pacific Ocean. Within two years of this climate shift: (1) southern species (n = 13) at Scott Creek in Santa Cruz County increased in abundance, while northern species (n = 31) declined. (2) The geographic ranges of two southern species, *Cadlina sparsa* and the large aeolid *Phidiana hiltoni*, expanded northward. (3) The above changes resulted in significant shifts in overall community composition of nudibranchs at Scott Creek. Data obtained sporadically since 1978 indicate that these changes have persisted for the past three decades, with variations in the abundance of

northern and southern species reflecting both the sign and magnitude of the Pacific Decadal Oscillation (PDO) Index values. Presence/absence data, gathered independently from 10 neighboring intertidal sites in the 1970s and 1990s, support the findings at Scott Creek. With their conspicuous coloration, annual to subannual life cycles and planktonic larval development, nudibranchs from temperate waters therefore appear to be useful and sensitive indicators of changes in coastal ocean climate.

† **THE ECOLOGY AND POTENTIAL CONTROL OF THE INVASIVE BAMBOO WORM, *CLYMENELLA TORQUATA*, IN SAMISH BAY, WA, A NORTHEASTERN PACIFIC ESTUARY.**

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Clymenella torquata is a tube-building, infaunal polychaete commonly known as the Atlantic bamboo worm. The species was accidentally introduced to the West Coast and subsequent negative impacts to oyster culture operations have resulted in its listing as a priority species of concern in Washington State. Tidelands have been made unsuitable for aquaculture because bioturbation by *C. torquata* destabilizes sediments and causes overlying oysters to sink into the substrate. In the present study, ecology of the worm and possible control measures were investigated in the field. Surveys were conducted in which physical and biological data were collected and compared to worm biomass and tube mass at each station. The data confirms a significant negative relationship between sediment compaction and worm biomass. Additionally, changes in the vertical redistribution of sediment grain size were associated with *C. torquata*. Worm activity increased with distance perpendicular to shore with the highest biomass at + 30 cm MLLW. A field experiment investigated the suitability of physical disturbance as a control method and effects on worm biomass, tube mass, sediment compaction and eelgrass (*Zostera* spp.). Of five treatments, rototilling was found to be the most effective in decreasing worm biomass and tube mass and increasing sediment compaction.

† **PHYSICAL ENVIRONMENT AND SPATIAL DISTRIBUTIONS OF COBBLE BEACH PLANT POPULATIONS**

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Recent theoretical models describing the assembly and maintenance of natural communities have emphasized the inclusion of positive interactions among species as determinants of community structure. Density-dependence is often considered a negative influence on population- and community-level processes (e.g. juvenile survivorship), but may also have positive effects on species in physically stressful habitats. We tested the hypothesis that the direction of density-dependence (positive vs. negative) within intertidal populations of the annual halophytic forb *Suaeda linearis* would vary with physical stress on New England cobble beaches. High-shore habitats were more physically stressful than low-shore habitats (temperature, evaporative stress, etc.). Experimental manipulations of plant density (dense vs. sparse) were established both high and low on the shore at two sites, and for two life-history stages (seedlings vs. adults). Sampling of plant biomass, length, and number of leaves/branches revealed that *S. linearis* exhibited strong positive density-dependence in the physically harsh, high-shore habitat, but exhibited strong negative density-dependence in physically benign, low-shore habitat. Such responses were consistent between seedlings and adults, and generally consistent between sites. These data support recent models of population and community dynamics that describe how environmental stress can alter the outcome of key interactions that structure and maintain natural populations.

† **FISHING INTENSITY AND THE ABUNDANCE AND DISTRIBUTION OF DEEP-WATER MEGAFAUNAL INVERTEBRATES AT THREE SITES WITHIN THE MONTEREY BAY NATIONAL MARINE SANCTUARY**

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Deep-water megafaunal invertebrates such as corals and sponges contribute to biodiversity, create fish habitat and can indicate long-term environmental conditions. These structurally complex invertebrates are easily damaged by commercial and recreational fishing gear. This is of concern because the long-term viability of fish populations may be threatened by habitat degradation, specifically the removal and destruction of structure-forming invertebrates.

This study examines the abundance and distribution of megafaunal invertebrates on the continental shelf at three sites within the Monterey Bay National Marine Sanctuary, CA. These sites are Big Creek, Point Sur and Portuguese Ledge; each of which have been subjected to varying levels of fishing effort and gear types. Underwater video surveys, conducted in the 1990s using the *Delta* submersible, were used to describe habitat and quantify invertebrates. The dominant habitat type at Big Creek and Point Sur was high relief rock, whereas Portuguese Ledge consisted of both rock and mud. We quantified a total of 59,474 invertebrates, in which crinoids (*Florometra serratissima*), Brachiopods and sea pens were the dominant species. Frequency of observed discarded fishing gear was greatest at Portuguese Ledge, followed by Point Sur and Big Creek. The findings of this study are critically important, because these sites have recently been designated as marine protected areas. These historical data will serve as a reference point for future analyses of the sites in terms of how habitat conditions and invertebrate abundances have benefited from the implementation of new management regulations.

THE PROTECTIVE CAPACITY OF MANGROVES DURING TROPICAL STORMS: A CASE STUDY FROM WILMA AND GAMMA IN BELIZE

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Globally threatened mangrove forest habitat is often considered an important buffer protecting coastlines from wave and storm impacts and coastal erosion. However, there is little empirical data quantifying the protective effects of mangroves during storms, primarily because of the difficulty of predicting where and when a storm will intersect the shoreline, to facilitate data collection before and after storm events. In 2005, opportunistic results from an ongoing study quantifying differences between intact and cleared mangrove areas on Turneffe Atoll, Belize, provided such pre- and post-storm data from tropical storms ‘Wilma’ (later a Category 5 Hurricane) and ‘Gamma’. We compared differences in equipment retention rates of 3 types of experimental devices previously installed in adjacent intact and cleared mangrove areas. Retention rates were greater in intact mangrove areas, empirically demonstrating the protective capacity of mangroves during moderate magnitude storm events. The results support the assumption that removal of mangroves diminishes coastal protection not only during catastrophic storm events such as hurricanes or tsunamis, but also during less energetic but more frequent events, such as tropical storms. This highlights the importance of improved coastal zone management, as storm events may increase in frequency and intensity with changing climate, and coastal mangrove forest habitats continue to decline in size and number.

† MICROHABITAT VARIATION IN MYCOSPORINE-LIKE AMINO ACID CONCENTRATIONS IN RED MACROALGAE (PHYLUM RHODOPHYTA) ON CALIFORNIA’S CENTRAL COAST

Gravem, S.G.^{*}, Baker, H., and N.L. Adams

Cal Poly SLO

Microhabitat variation in mycosporine-like amino acid (MAA) concentrations was studied in red macroalgae (Phylum Rhodophyta) on California’s central coast. Ten algal species were collected from four intertidal microhabitats including north-facing walls, south-facing walls, and two types of horizontal tide pools containing herbivorous purple sea urchins burrowed in pits or not in pits. Significant differences in total MAA concentration were found among algal species ($p < 0.001$) and a trend toward lower total MAA concentration was found in the shady north-facing microhabitat. MAA concentrations will further be compared to irradiance level and tidal height.

† MICROHABITAT VARIATION IN MYCOSPORINE-LIKE AMINO ACID CONCENTRATIONS IN THE GONADS AND EPIDERMIS OF THE PURPLE SEA URCHIN, *STRONGYLOCENTROTUS PURPURATUS*

Gravem, S.G.^{*}, Chang, L.E., and N.L. Adams

Cal Poly SLO

Microhabitat variation in mycosporine-like amino acid (MAA) concentrations was studied in purple sea urchin (*Strongylocentrotus purpuratus*) gonadal and epidermal tissue on California’s central coast. Sea urchins were collected from four intertidal microhabitats including north-facing walls, south-facing walls, pools with sea urchins burrowed in pits, and pools with sea urchins not in pits. The gonadal tissue from sea urchins in pits had significantly lower total MAA concentrations ($p = 0.001$) than those in the other three microhabitats. Gonadal concentrations of

total MAAs increased from November 2006 to January 2007 ($p=0.007$) and were significantly higher in females than in males ($p=0.008$). The dominant MAA found in ovaries was shinorine with a maximum absorbance of 334nm, while the dominant MAA found in testes was palythine with a maximum absorbance of 320 nm, suggesting a difference in resource allocation to the gonads between males and females. Sea urchin gonadal indices were higher for males ($p=0.014$) and were lower in the south-facing microhabitat compared to the other three microhabitats ($p<0.001$). Total MAA concentration of gonadal and epidermal tissues will be compared to investigate potential trade-offs in resource allocation in adult versus reproductive tissue.

† EXPLORING VARIATION IN CORAL RECRUITMENT THROUGH TEMPERATURE ALONG THE SOUTHERN COAST OF ST. JOHN, US VIRGIN ISLANDS

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Studying the effects of environmental factors, such as temperature, on scleractinian corals has been popularized by the increased frequency of bleaching, however few studies have documented these effects on scleractinian recruitment. The goals of this study were to test for kilometer-scale variation in seawater temperature and coral recruitment on the southern coast of St. John, US Virgin Islands, and to explore to the extent to which temperature might affect coral recruitment. To measure temperature and recruitment, a logging thermistor and settlement tiles were deployed at 5-6 m depth at 10 sites in August 2006. The thermistors and settlement tiles were replaced and analyzed every six months in order to capture seasonal variation in biological and physical events. The two sampling periods occurring between August 2006 and July 2007 revealed a strong east-to-west relationship in temperature and recruit densities, which probably is a result of the prevailing water currents. The abundance of coral recruits differed significantly among sites, with mean densities declining from ≈ 1.7 recruits tile⁻¹ in the east, to ≈ 0.4 recruits tile⁻¹ in the west, during both sampling periods. Seawater temperature also varied significantly among sites over both sampling periods, and this effect was attributed to greater daily variation in temperature at western sites compared to eastern sites. Together, these results suggest that small-scale variations in seawater temperature may be associated with the rate of coral recruitment among locations on the southern coast of St. John.

THE NATURE OF FECAL COLIFORM BACTERIA AT A POPULAR OREGON BEACH

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South Slough National Estuarine Research Reserve

Since 2004, water testing at Sunset Bay State Park beach, Charleston, Oregon, has commonly revealed *enterococcus* levels exceeding the state standard (158 colony-forming units/100 mL), leading to health advisories lasting between 2 and 88 days. Sunset Bay, the most visited beach in Coos County, Oregon, is a semi-protected embayment whose only tributary is Big Creek. Because no residential area or sewer systems occur in the watershed, local citizens blame sea gulls, sea lions, or dogs for the occasional beach advisories. In this project, we set out to: 1) determine whether bacteria in the surf zone of Sunset Bay are marine or terrestrial in origin and identify factors that may contribute to elevated bacteria counts; 2) stage intensive sampling to learn how *enterococcus* levels fluctuate with significant rain events ($>0.5''$ in 24 hours) and tides; 3) investigate the hydrodynamics of Sunset Bay by observing the trajectories of floating drogues and deploying an Acoustic Doppler Current Profiler in the middle of the bay. Preliminary results lend strong evidence that the main source of fecal coliforms is Big Creek, as *enterococcus* levels are nearly always higher in the lower portion of the creek than in Sunset Bay. Water samples are more likely to contain bacteria after significant rain events, but tidal flushing usually leads to reduced bacteria levels within 72 hours. Surprisingly, *enterococcus* persists in extremely high numbers in sediments, revealing a factor that should be investigated further. These findings will improve the abilities of regulatory agencies to predict the incidence and duration of fecal coliform contamination at Sunset Bay and other recreational beaches in Oregon.

THE SEDENTARY LIFESTYLE OF INTERTIDAL PURPLE SEA URCHINS (*STRONGYLOCENTROTUS PURPURATUS*) AS REVEALED BY PHOTO-MONITORING

Grupe, B.M.*

South Slough National Estuarine Research Reserve

Purple sea urchins (*Strongylocentrotus purpuratus*) are conspicuous grazers in rocky intertidal communities that

consume drift algae and are capable of excavating pits in rock. In a given tidepool, sea urchins inside pits are smaller than those outside pits (t-test, $p < 0.001$), suggesting that individuals tend to emigrate from protective microhabitats as they grow larger. I investigated movement tendencies in *S. purpuratus* in 21 haphazardly-selected intertidal plots. Each plot was photographed at low tide 26 times over the course of one year (June 2005 - June 2006), and photos were analyzed for changes in the abundance and location of urchins. Of all *S. purpuratus* visible in the final set of photos, an astounding 94% were sedentary throughout the entire study. During the year, the abundance of sea urchins in the plots decreased by 15% (688 to 583), which could be attributable to either movement or mortality. Nonpit urchins decreased in abundance by 47% (143 to 67) while pit urchins decreased by only 5% (545 to 516). A manipulation revealed that disturbed *S. purpuratus* (via clipped spines) were more likely to be found in pits than in nonpit microhabitats ($p < 0.001$). These results suggest that intertidal *S. purpuratus* are unlikely to move, especially out of pits, which act as refuges. An individual's selection of microhabitat involves considerable trade-offs; remaining in pits or other protective microhabitats probably increases relative survivorship, while growth rates are significantly higher in nonpit microhabitats.

SELECTIVE HARVESTING ALTERS LIFE HISTORIES OF A TEMPERATE SEX-CHANGING FISH: HISTORICAL COMPARISONS AND CURRENT STATUS OF CALIFORNIA SHEEPHEAD

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Size-selective harvesting often targets larger individuals of a population and has been shown repeatedly to affect size structure, growth rates, the timing of maturation, and reproductive output. For sex-changing species, such as the California sheephead (*Semicossyphus pulcher*), selective fishing practices may alter additional traits such as the mature population sex ratio and the timing of sexual transformation. Collections corresponding to the peak of commercial live-fish landings in 1998 demonstrated striking changes in the timing of maturation and sex change (compared to historical samples) at sites in Southern California and Baja California that depended on the relative intensity of recreational or commercial harvest. Recent sampling from San Nicolas Island in 2007 revealed a rapid recovery in size structure, sex ratio, and the timing of maturation and sex change. We are currently exploring, through analyses of age structure and growth rates, whether this recovery is related to management actions implemented in 1999 that were targeted to regulate the commercial live-fish fishery and which may have coincided with a strong recruitment pulse. In contrast, the population on Catalina Island has not exhibited signs of recovery to historical sizes and sex change schedules and continues to bear the signature of size-selective removals, which may be a sign of continued intense recreational fishing pressure. We also present data on spatial variation in life history traits of this species throughout the Channel Islands, which will be informative for future stock assessments of California sheephead.

† LITTLE URCHIN LARVAE IN A BIG CO₂ WORLD: USING MORPHOMETRICS TO DETERMINE THE EFFECTS OF CO₂ ON SPICULE GROWTH IN *LYTECHINUS PICTUS* LARVAE.

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UC Santa Barbara

Marine invertebrate larvae are unavoidably susceptible to an onslaught of environmental factors and potential stressors, including variable temperature, levels of salinity, oxygen content, food availability, currents, and wave forces. Another factor of increasing importance is CO₂. Carbon dioxide sequestration into the ocean plays an important role in calcium carbonate (CaCO₃) uptake in marine calcifiers. One such group of marine calcifiers are urchins. On the most fundamental level, urchin larvae take up CaCO₃ to form their spicules. While an increase in oceanic CO₂ may seem beneficial to urchins, it is in fact unbeneficial as the complicated carbonate chemistry results in a decrease in CaCO₃ uptake. Measuring the length of larval spicules in variable CO₂ concentrations using morphometrics would provide a way to quantify the changes in the larvae's ability to form its skeleton. For this experiment, *Lytechinus pictus* urchins were spawned and reared in ambient seawater at 3 different CO₂ concentrations: 380 ppm (the current oceanic CO₂ concentration), 540 ppm, 970 ppm. Larvae were sampled at four time points during early development and preserved for morphometric analysis. The results show that larvae raised at 970 ppm were significantly smaller and had less total skeleton than larvae raised at 380 ppm. These results suggest that an increase in CO₂ has strong potential to affect the morphology and, consequently, the competence of the larvae within the environment. These results also serve as a foundation for future, more in-depth experiments and analyses of the effects of increased CO₂ on marine calcifiers.

† **THE EFFECTS OF HIGH DENSITY ULVOID MACROALGAE EXPOSURE ON THE SETTLEMENT OF CRAB MEGALOPAE AND SURVIVAL AND GROWTH OF YOUNG JUVENILES**

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Over the past decade harmful algal blooms (HAB), including those comprised of macroalgae, have been occurring on an increasing basis, and have been shown to result in a variety of deleterious effects, including altering faunal communities. Research has also shown that crabs prefer to settle in complex habitats, such as macroalgae, rather than less complex areas. Thus, the settlement of megalopae in areas of high-density macroalgae will expose early juvenile stages to potentially harmful conditions. This investigation seeks to determine whether exposure to ulvoid macroalgae, implicated in HAB, affects settlement and survival in post-larval crab stages, whose settlement times coincide with likely bloom conditions. This study was conducted in Padilla Bay, WA, as well as in the laboratory. Field studies determined whether juvenile crabs preferentially inhabit high-density macroalgae areas. Laboratory studies investigated time to metamorphosis and potential toxic effects on megalopae and juvenile crabs. If crab settlement is altered and juvenile crabs negatively affected by these high-density macroalgal areas, then survival and distribution of crab species will be impacted.

† **ASSESSING CONNECTIVITY OF A COMMERCIALY IMPORTANT MARINE INVERTEBRATE WITH MOLECULAR MARKERS.**

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Stanford University

Understanding dispersal of marine organisms is critical to managing commercially important species at appropriate scales. Sea cucumber populations worldwide have a history of collapsing rapidly after periods of intense 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 fishery or if independent stocks exist. In order to assess the number of stocks and connectivity among them, over 600 samples were collected throughout the range of the species (Monterey, CA to Bahía Tortugas, Mexico) at 15 sites. Samples were amplified at the COI mtDNA locus and analyzed for genetic structure throughout the range. Given the 50 to 90 day pelagic larval duration of *P. parvimensis*, we would expect high levels of connectivity between sites; a single stock appears to exist with some subtle genetic structure.

† **GENE EXPRESSION AND THERMOTOLERANCE IN SPOROPHYTES AND GAMETOPHYTES OF THE INVASIVE KELP, *UNDARIA PINNATIFIDA***

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Given the ecological and economic impact of invasive species, knowledge of traits that allow the invasive kelp *Undaria pinnatifida* to expand its invasion in California is important for developing prevention and eradication efforts. Physiological mechanisms of thermotolerance may be significant as they can influence patterns of distribution and abundance. An established measure of thermotolerance is the heat shock response where heat shock proteins (Hsps) protect cellular proteins from misfolding and degradation. In *Undaria*, gametophytes have been shown to have a broader temperature range for growth and survival than sporophytes. Furthermore, it is hypothesized that Hsp production varies with developmental stage in many species. Thus, we examined up-regulation of the *hsp70* gene in sporophytes and gametophytes of invasive *Undaria*. Fertile sporophytes were collected from four California harbors. Sporophylls were excised, spore release was induced, and gametophytes were cultured. Sporophyte blade tissue was then heat shocked at 7 temperatures for 1 h. After being held in controlled light and temperature conditions to allow for substantial vegetative growth, gametophyte tissue was similarly heat shocked. Quantitative real-time PCR was used to determine relative amounts of *hsp70* transcript. Expression of *hsp70* was much higher in sporophytes than gametophytes, indicating that gametophytes of *Undaria* are more thermotolerant than sporophytes. To confirm these results, photosynthesis measures of gametophyte tissue at a subset of temperatures are underway. These data suggest that gametophytes are the stage by which *Undaria* travels across oceans and establishes in a variety of thermal habitats.

MEASURING IN-SITU GROWTH RATES OF AN INFAUNAL SPIONID POLYCHAETE

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We have developed methods for transplanting and recovering individual spionid polychaetes from intertidal sediments to directly measure changes in the growth of individuals. Most spionids are small, tube-dwelling macrofauna that tend to deposit feed in still water and suspension feed in faster flows. Because these worms rapidly colonize disturbed sediments and are important items in the diets of bottom-feeding fishes and shorebirds, knowledge about the population dynamics of spionids can help gauge the functioning of benthic ecosystems. Live *Polydora* were collected from the Tijuana Estuary, and the body sizes of individual worms were measured by microscopy and image analysis. We then transplanted small vials containing individual, pre-measured worms back into the intertidal sediments in a marsh channel. After 14 days in the field, we successfully recovered approximately one third of the transplanted worms and re-measured their body sizes. Recovered worms more than doubled in size during the 14-day period. On average, the relative growth rates of individuals were 9% per day. There also was a trend toward faster growth of worms planted at lower elevations in the intertidal. These in-situ growth rates are between those from still-water laboratory experiments and those measured in laboratory flumes, in which suspension-feeding worms were continuously submerged in flowing seawater. The transplantation methods we developed allow for a variety of hypotheses concerning the growth of infauna to be tested in situ, including the effects of hydrodynamic conditions, spatial and temporal variability of organic inputs, and the density of individuals.

LONG-DISTANCE DISPERSAL BY RAFTING ON DRIFT ALGAE IN THREE SPECIES OF NORTH ATLANTIC AMPHIPODS

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While many marine invertebrates disperse by a planktonic larval phase, some species lack planktonic larvae and rely on rafting on drift algae or other alternative methods to disperse. For many such species, rafting is the only means of long-distance dispersal to remote locations. The presence, and even prevalence, of these species on isolated islands and seamounts attests to the success of rafting as a dispersal mechanism, but little is known about its success or frequency. The Pleistocene glacial history of the North Atlantic provides an ideal system for investigating rafting as a long-distance dispersal mechanism in these species, as Pleistocene glaciations obliterated shallow-water marine habitats in Greenland, Iceland, and the Faroe Islands. Today, however, many marine species that rely on rafting to disperse, including multiple amphipod species, are found in these areas. Using the mitochondrial COI gene and a comparative phylogeographic framework, the frequency and direction of dispersal in three species of rafting amphipods is investigated in the North Atlantic. Two species show evidence of colonization from Europe to Greenland, Iceland and the Faroes, as predicted by major extant surface currents, while a third shows a more complicated pattern of colonization. All three species show evidence of strong founder effects in Greenland, Iceland and Faroe Islands populations, indicating that rafting is a successful but rare method of dispersal in these species.

† A COMMON SOUTHERN CALIFORNIA LIMPET IS A NEW SPECIES THAT OVERLAPS WITH ITS SISTER SPECIES IN NORTHERN BAJA CALIFORNIA.

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We have discovered a new northeastern Pacific limpet species that is common in the mid-intertidal of southern California. We have distinguished it from its sister species to the south, *Lottia strigatella* (Carpenter, 1864), and a morphologically similar species to the north that is not as closely related, *L. paradigitalis* (Fritchman, 1960). Morphological comparisons reveal substantial plasticity and overlap, but all these species can be unambiguously distinguished based on our combined or separate analyses of 16S and COI mitochondrial DNA markers. Although previous authors already distinguished *L. strigatella* and *L. paradigitalis* with DNA sequence comparisons and morphology, their study was primarily focused on sampling in the vicinity of each species' type locality, Cabo San Lucas, Baja California Sur, Mexico, and San Francisco Bay, California, respectively. Approximately 1500 km of intervening coastline was not sampled, including the postulated biogeographic boundary, Point Conception, California, which was predicted as the respective northern and southern range endpoints for *L. strigatella* and *L. paradigitalis*. Our more extensive sampling has revealed that the new species dominates populations between Punta

Baja, Baja California, Mexico, and Pt. Conception, California, a range that corresponds to the warm temperate Southern California Bight. We explore the evolutionary, ecological, and phylogeographic implications of these range transitions, and these help support the Southern California Bight as a distinctive biogeographic province.

† CARIBBEAN PHYLOGEOGRAPHY: POPULATION STRUCTURE IN SEA SLUGS WITH DISPERSING VS. NON DISPERSING LARVAE.

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For marine invertebrates, the time that planktonic larvae spend dispersing in the water column is positively correlated with gene flow among populations. However, oceanographic barriers to gene flow may generate phylogeographic breaks, even in species with dispersing larvae. Biophysical coupling models make clear predictions of where such breaks should fall in the Caribbean, based on surface currents. We compared the population genetic structure of two Caribbean sea slugs with contrasting modes of larval development, using mitochondrial gene sequence data. *Elysia crispata* has direct development (larvae metamorphose inside a benthic egg mass), and consequently no potential for planktonic dispersal; *Elysia tuca* has lecithotrophic larvae that disperse for less than a week before settling on their host alga, *Halimeda incrassata*. *Elysia crispata* was highly genetically structured ($F_{st} = 0.80$); all populations were significantly different from each other, and most exhibited reciprocal monophyly. As predicted, *E. tuca* had less overall population structure with a common haplotype shared among six of ten sites. Genetic data suggest a recent re-colonization of the central Caribbean, possibly following local extinctions due to Pleistocene sea level fluctuations. Results for both species show that the edges of the range (Panama, Bermuda) are very polymorphic, and may have acted as refugia where populations survived during periods of low sea level. The patterns of connectivity do not support predictions from biophysical coupling models; genetic data are thus needed from diverse organisms to groundtruth models, before they can be used in management of threatened reef ecosystems.

THE INTRODUCTION OF THE WESTERN ATLANTIC CLAM *GEMMA GEMMA* TO CALIFORNIA: COMPARING INFERENCES FROM GENETIC AND HISTORIC DATA.

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The negative ecological and economic impacts of invasive species are increasingly being felt. Consequently, efforts have intensified to understand pathways that characterize successful introductions and subsequent establishment of non-native species. Genetic markers have been used to verify, or more commonly determine, pathways and sources of invasions. Often, however, a species is examined well after it has been introduced. Effects of this time lag on the inferences derived from genetic data must be more fully understood, before conclusions drawn from such studies can be considered robust. Invasions of the gem clam *Gemma gemma* into five bays/estuaries in California provide an unusual opportunity to study the agreement between present day genetic inferences and information drawn from historical documentation. Detailed historical records describing introductions of *Crassostrea virginica* oysters, the vector of *Gemma*, along with samples of *Gemma* collected during the time of introduction events into San Francisco Bay provide information regarding likely sources, the sizes of introduction events, and genetic diversity of the founder populations. These results were then compared to those derived from genetic analysis of the mitochondrial cytochrome c oxidase subunit I gene (COI) in present day invasive *Gemma* populations. Striking patterns of discordance were found regarding the contribution of different sources to the introduction events, the size of introduction events in California, and haplotype frequencies and diversity over time in San Francisco Bay. Together, it seems evident that elapsed time may confound our ability to clearly understand some aspects of invasions.

MANAGEMENT ACROSS BORDERS: AN MTDNA PERSPECTIVE OF THE CALIFORNIA SPINY LOBSTER, *PANULIRUS INTERRUPTUS*

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1 - Hawaii Institute of Marine Biology 2 - University of California, Santa Barbara

International fisheries management has become essential for species whose adult movement, and more frequently, larval dispersal does not adhere to geopolitical borders. The California spiny lobster, *Panulirus interruptus* is fished both commercially and recreationally throughout its range from Baja Magdalena, Mexico in the south to Point

Conception, California in the north. A variety of studies have provided indirect evidence that California spiny lobster populations may receive a substantial number of recruits from populations in northern and central Baja. We used a 500 base pair fragment of mitochondrial DNA from the highly variable control region to investigate whether lobster populations in California are locally self-seeding or rely on cross-border recruitment to persist. We evaluated over 400 samples from 15 populations within the range of *P. interruptus*. Preliminary results suggest that the California spiny lobster may require international cooperation to maintain its sustainability.

† SPATIAL AGGREGATION PROMOTES COEXISTENCE AMONG CORAL SPECIES

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Coexistence among species that share limited resources yet have different competitive abilities has long been a focus of ecologists. Intraspecific spatial aggregation has been identified as one possible mechanism promoting coexistence. We address this coexistence hypothesis in coral reef communities which are often diverse, highly competitive, and resource-limited. We use two common species of scleractinian corals to test whether within-patch aggregation of a strong coral competitor enhances the growth and competitive success of a weaker coral competitor. Corals grown in aggregated arrangements, where the number and type of competitors were held constant, grew almost twice as much as those in non-aggregated arrangements. These growth results suggest that species coexistence is promoted by aggregation within competitive neighborhoods where there is no competitive refuge for the weaker competitor. The benefit of aggregation was further supported at the community level by a discrete space, two-species model. Thus, spatial aggregation may be one of several important mechanisms contributing to the persistence of weak competitors and species coexistence on coral reefs.

THE TIDEWATER GOBY- ENDANGERMENT, AND METAPOPOPULATION DYNAMICS OF A SEASONALLY-CLOSED ESTUARY SPECIALIST- IMPLICATIONS OF ESTUARY HISTORY FOR MANAGEMENT

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The federally endangered tidewater goby exists in summer-closed estuaries produced by the variable stream flow in the Mediterranean climate of California. The tidewater goby is the most locally differentiated "marine" vertebrate species on the west coast; in addition, regional metapopulations vary in their dynamics from persistent, to source/sink, to equal extinction probability. Extirpation and migration dynamics are closely linked to desiccation of small estuarine systems during drought years and the degree of opening of the system to the sea, respectively. Anthropogenic reduction in number, and reduction in size of habitats is of concern in putting metapopulations at risk. One of the most pervasive anthropogenic impacts has been filling of estuaries for development. Somewhat larger systems are of critical importance as size implies persistence. Paradoxically many of these are "managed" as open systems, even though they would naturally close, precluding their function as tidewater goby habitat. This is particularly important in the San Diego/Orange County areas as this metapopulation appears to merit status as a separate taxon and there is substantial planned and ongoing estuary "restoration" in this region. We present preliminary application of mitochondrial and microsatellite data to metapopulations and discuss these implications of estuary history for management.

MICROBIAL DIVERSITY EFFECTS ON PLANT PATHOGENS IN AGROECOSYSTEMS

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Changes in the diversity of biological assemblages may be an important factor in the regulation of ecosystem processes such as primary productivity. Diversity might also affect services in managed agricultural ecosystems, such as suppression of fungal pathogens that cause economic loss. Fungal diseases of fruit crops are typically controlled via application of synthetic fungicides which are generally more efficacious than anti-fungal bacterial isolates ("biofungicides"). To investigate whether diverse mixtures and/or sequential rotation of multiple microbial products enable greater disease control than products used alone, we experimentally manipulated biofungicide

diversity in grape and pumpkin spray trials in the field. We measured pathogen population responses to these treatments and, in the case of grapes, also quantified the effect of microbial treatments on culturable fungal assemblages resident on treated fruit. Finally, we present a meta-analysis of microbial diversity effects on pathogen populations from a variety of agricultural systems.

† SIBLING SEA URCHIN SPECIES OF THE GENUS *ECHINOTHRIX* IN HAWAI‘I: MORPHOLOGY, GENETICS, & ECOLOGY

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Sympatric sibling species have the potential to be especially informative regarding processes of speciation in the sea, but they must first be recognized. The sea urchin genus *Echinothrix* of the Indo-Pacific is currently comprised of two very similar co-existing species which can sometimes be difficult to distinguish, although they do possess some color and morphological differences. Indeed, it has been suggested that a substantial array of subtle physical differences between color morphs is indicative of additional unrecognized *Echinothrix* species. Furthermore, multiple independent mitochondrial DNA clades are also suggestive of possible cryptic sibling species of *Echinothrix*. To begin to unify genotype with phenotype in this genus, we have examined the morphology, genetics, and ecological partitioning of *Echinothrix* specimens from Hawai‘i and nearby Kingman Reef. Our data support the hypothesis that sets of physical characteristics distinguishing Hawaiian *Echinothrix* species are congruent with reciprocally monophyletic mitochondrial DNA clades. However, we find no support for additional genetic divergence beyond the two currently recognized species, and color morphs in Hawai‘i are the result of polymorphisms and/or plasticity instead of divergent evolutionary histories. We herein also present preliminary field survey data of interspecific differences in *Echinothrix* distribution patterns on Hawaiian coral reefs. Our synthesis of morphological, genetic, and ecological investigations provides improved recognition and elucidation of *Echinothrix* diversity in Hawai‘i.

SEASONAL ABUNDANCE AND HABITAT PREFERENCE OF ROUND STINGRAYS IN A SOUTHERN CALIFORNIA ESTUARY

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Sexual segregation among elasmobranchs often results in differential habitat use, with females of some species moving into shallow, inshore habitats during certain times of year. The presence of round stingrays (*Urolophus halleri*) in bays and estuaries in southern California has been well-documented, but it is still unclear why rays utilize these areas. Patterns of habitat use can be complicated further when individuals have a choice between restored and natural habitats. The objectives of this study were to determine whether round stingray densities differ between restored and natural habitats within a southern California estuary, whether ray densities correlate with seafloor water temperature, and if evidence exists for sexual segregation. Rays were seasonally abundant with the highest densities occurring from May-August and fewest rays present from October-April. Higher ray densities correlated with warmer seafloor water temperatures. Ray densities were also higher in the restored habitat than the natural habitat, except during September. Sex ratios were highly skewed toward female rays in restored habitats, while sex ratios in natural habitats were only skewed toward females during summer. In addition, ultrasound analysis on female rays from July-September indicated that many females in restored areas carried developing embryos. These results suggest that water temperature influences ray habitat preference and pregnant females that aggregate in restored areas may attain a thermal reproductive advantage by selecting warmer habitats during gestation.

† BIG DADDIES MAKE BETTER BABIES: GENETIC LINKS BETWEEN ADULT SIZE AND LARVAL QUALITY IN A MARINE FISH

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Wild populations of fish may evolve in response to direct selection on life-history traits such as adult size and growth rate. However, some traits may evolve indirectly through genetic correlations with traits that are under direct selection. In this study we evaluated the degree to which traits that affect the survival of larval fish (size at hatching

and swimming performance) may evolve in response to selection on adult size in bicolor damselfish (*Stegastes partitus*) in the Bahamas. To estimate the genetic covariance between adult size and larval quality, we combined mark-recapture demographic studies with quantitative genetic analyses. Using standard quantitative genetic methods, we compared the asymptotic size of adult males to the size and swimming performance of their larval offspring. Results from both natural breeding and a cross-fostering experiment indicated that size of the male parent was strongly and positively correlated with both the size and swimming performance of larval offspring. We combined this information with heritability estimates for adult and larval traits to predict how quickly larval quality may change with selection on adult size (e.g., removing the largest 10% of adults would reduce average larval size by 0.085 SD per generation). Such a change is estimated to reduce the relative rate of post-settlement survival by a difference of 6%. Because the dynamics of many fish populations are sensitive to changes in survival of early life history stages, these results suggest that even moderate rates of selection on adult size can have substantial consequences for population viability.

‡ INFLUENCES OF TEMPERATURE AND SALINITY ON ADHESIVE PROPERTIES OF CEMENT FROM THE BARNACLE, *BALANUS AMPHITRITE*

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Removal of biofouling from ship hulls and water intake systems is problematic and costs billions of dollars each year. Due to recent tightening of environmental regulations on toxic anti-fouling coatings, research is being conducted to improve non-toxic foul-release alternatives. Barnacles are a model fouling organism due to their world wide distribution and ability to strongly adhere to most substrata. Marine coatings must function over varying oceanographic conditions, yet we currently have no understanding how these conditions affect performance of foul-release coatings or barnacle adhesion. In this study we examined how temperature and salinity affected the critical removal force of the acorn barnacle, *Balanus amphitrite*. Barnacles were settled and reared on T2 (Dow Corning), a foul-release coating, under a range of temperatures and salinities. Results show a significant inverse relationship between temperature and critical removal force. In addition, changes in cement protein composition were investigated by 1D SDS PAGE gels, using uncured cement collected from the barnacles. Taken together, our results demonstrate how barnacle attachment varies in response to changes in salinity and temperature. Our work helps elucidate how environmentally benign marine coatings will function under different oceanographic conditions.

REALISTIC DIFFERENCES IN SPECIES COMPOSITION, BUT NOT DIVERSITY, DETERMINE NITROGEN USE BY INTERTIDAL SEAWEED ASSEMBLAGES

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Evidence suggests that the species diversity of an ecosystem influences that system's functioning. However, most studies linking diversity with ecosystem processes have used random assemblages of species to test these ideas. In contrast, we surveyed natural seaweed assemblages from two tide heights (high and mid intertidal) and two wave exposures (protected and exposed) on the Bodega Marine Reserve (Bodega Bay, CA) to create species assemblages based on the mean richness and abundance for each area (protected high, protected mid, exposed high, exposed mid). In particular, we found more seaweed species in the mid-intertidal plots than the high-zone plots. We measured nitrate utilization by each seaweed assemblage to test whether differences in diversity or species composition influenced nitrogen uptake rates. We found that only one assemblage (protected mid) differed in nitrate utilization – it was characterized by lower nitrate uptake rates than the other three assemblages – and that there was no consistent effect of seaweed diversity. The protected mid-intertidal assemblage lacked the presence of *Ulva* spp., which are species that rapidly take up nitrogen. We also measured total nitrogen (%N) in the individual seaweed species from each assemblage to investigate whether field patterns of stored nitrogen matched our lab uptake rates, and found that *Ulva* spp. were characterized by higher tissue nitrogen levels than other algal species, consistent with their higher uptake rates. Our data suggest that species composition (in this case, the presence or absence of *Ulva*), rather than simply diversity, may be an important determinant of nitrogen use by algal assemblages.

† THE SIXTH SENSE AND BEYOND; STINGRAY LATERAL LINE AND ELECTROSENSORY SYSTEM FORM AND FUNCTION

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Elasmobranchs (sharks, skates, and rays), demonstrate remarkable sensory capabilities that are used for a variety of purposes including locating and capturing prey. This study compares the sensory anatomy to detection capabilities of the mechanosensory lateral line system and the electrosensory system in the benthic feeding round stingray, *Urobatis halleri*, benthopelagic bat ray, *Myliobatis californica*, and the pelagic stingray (*Dasyatis* or *Pteroplatytrygon violacea*). These systems allow elasmobranchs to locate prey through detecting water movements and electrical fields respectively. Predictions based on detailed maps of the sensory anatomy were tested in behavioral detection experiments. *U. halleri* feeds primarily on small epifaunal benthic invertebrate prey and the lateral line of this species shows a high proportion of ventral non-pored canals while the electrosensory pores are highly concentrated around the mouth. *M. californica* feeds primarily on infaunal benthic invertebrates as well as some more mobile invertebrates and fishes. The extensive pored lateral line system in this species is highly branched with a large number of pores. The electrosensory system shows a high pore number and density and is highly concentrated anteriorly. Both systems in *M. californica* have dramatic lateral extension toward the wing tips on the anterior edge of the pectoral fins. *P. violacea* feeds primarily on squid and teleost fishes, and has an intermediate proportion of pored and non-pored canals with no secondary branching of pored canals and a significantly reduced electrosensory pore number and density. Responses of each species to water jets at 10cm/s are compared, *M. californica* responds to water jets over a significantly greater proportion of its disc width. Responses to weak electrical fields were comparable to those observed for sharks with minimum responses below 1 nanovolt per centimeter. Implications of these results are discussed within the context of the ecology of these species.

† TEMPORAL AND SPATIAL VARIABILITY IN THE EFFECT OF HABITAT-FORMING SPECIES ON INTERTIDAL MICROCLIMATE

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Organismal responses to physical stress can dictate structure in the rocky intertidal. Habitat-forming species can ameliorate such stress, but the effects of morphological variability in habitat-forming species on environmental conditions have not been explored. This study addressed the effect of *Mastocarpus papillatus* on sub-canopy temperature, irradiance, and humidity, and the extent to which any effects occurred both within and among sites (from local to latitudinal variability). Replicate 10 cm diameter Polyvinylchloride (PVC) cores of 100% cover of *Mastocarpus* were sampled at 7 locations within central CA for frond density, length, and surface area. Significant differences in *Mastocarpus* morphological characteristics and microclimate conditions occurred both within and among sites. Among site distribution of material within cores varied due to changes in individual thalli at regional scales, while within site relationships of the morphology: microclimate association varied based on ambient conditions. Current research is addressing seasonal variability in the association as a function of ambient conditions, and whether the morphology: microclimate relationship affects the associated macroinvertebrate community.

† QUANTIFYING RATES AND MECHANISMS CONTROLLING SEDIMENT NITROGEN FIXATION AND DENITRIFICATION IN INTERTIDAL MUDFLATS OF UPPER NEWPORT BAY ESTUARY, SOUTHERN CALIFORNIA

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Estuaries are highly productive and critically important habitat to many species, and perform ecosystem services including filtering nutrient-rich water entering as runoff. As urban development continues, few functional estuaries remain in southern California, and these are highly eutrophic from excessive nitrogen loading. Little is understood about complex nitrogen cycling through estuarine systems, especially bottom-up forces of microbial transformations. Nitrogen fixation acts as a source of nutrients by converting atmospheric nitrogen to ammonium, affecting availability of nitrogen to primary producers. Denitrification removes nitrogen from the system by converting nitrate to atmospheric nitrogen. Our research quantifies rates of nitrogen fixation and denitrification in Upper Newport Bay Estuary, southern California, and investigates causal relationships between nitrogen enrichment

and these microbial processes. Field surveys over two years measured fixation and denitrification rates and relationships to abiotic characteristics in intertidal mudflats along tidal creeks. Surveys showed high spatial variability, with low nitrogen fixation activity compared to east coast systems. Denitrification rates appeared to be more important in this highly eutrophic estuary. Physical characteristics including sediment organic content, grain size and nutrients explained a portion of variability; other processes clearly need to be studied. Manipulative experiments investigated quantitative relationships between fixation, denitrification and factors associated with eutrophication, specifically increased water nitrate and macroalgal mat density. Nitrate enrichment resulted in decreased fixation and increased denitrification. The effect of macroalgae on intertidal mudflats is more complex. Relationships between these microbial processes and eutrophication, especially macroalgal influences, are not well studied and will provide insight into eutrophic estuaries worldwide.

SASHA (SPATIAL ANALYSIS OF SHARED ALLELES): A METHOD FOR DETECTING POPULATION GENETIC STRUCTURE IN HIGH GENE FLOW SPECIES

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Many species exhibit high levels of gene flow among populations, making accurate assessment of population subdivision difficult. F_{ST} and its analogues (such as Φ_{ST}) require impractically large sample sizes to be precise when migration rates are high. Consequently, many studies of wild populations lack the statistical power to identify weak, though biologically significant, subdivision. Here, we address this problem by introducing a novel method for investigating genetic structure that compares the observed spatial arrangement of shared alleles to their expected distribution under panmixia. This approach, called SAShA (Spatial Analysis of Shared Alleles), has three strengths: 1) it explicitly incorporates geographic information into the analysis, 2) it is allele-based, rather than population-based, and therefore does not require the user to define the limits of natural populations, and 3) it allows each allele to be analyzed independently, revealing the way in which each contributes to the overall pattern in the dataset. Using simulated datasets generated under a modified stepping-stone model of gene flow, we show that this method is more likely than Φ_{ST} to detect spatially restricted gene flow at migration rates ranging from 20% to 75%. We then use this method to show clear differences in the genetic patterns of two nearshore Pacific molluscs, *Tegula funebris* and *Katharina tunicata*, that are not appreciably different by traditional population genetics analyses. SAShA meaningfully complements F_{ST} , Mantel, and other existing geographic genetic analyses, and is especially appropriate for evaluating species with high gene flow and subtle genetic differentiation.

POPULATION DYNAMIC RESPONSES OF THE CALIFORNIA SPINY LOBSTER (*PANULIRUS INTERRUPTUS*) TO 120 YEARS OF VARIABLE OCEAN CLIMATE AND FISHING PRESSURE

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Long historical data sets that encompass wide variation in abundance, fishing pressure and ocean conditions are rare, but invaluable for understanding population dynamic responses of exploited species to past and future changes in climate and fishing. We used catch and effort records from the beginning of the California spiny lobster (*Panulirus interruptus*) fishery to the present (1888-2006), to reconstruct likely changes in abundance, size structure, growth, recruitment, and mortality of *P. interruptus* since the fishery's inception. Information from process-oriented field and laboratory studies of lobster growth, mortality, and recruitment was synthesized with historical information on lobster fishing in an hierarchical Bayesian statistical framework, which was used to estimate a size-structured state-space population model. The results reveal a complex interplay between inter-annual and decadal fluctuations in ocean climate (ENSO and PDO), changes in fishing effort (new technologies, closures and reductions of effort during wartime), and density-dependent population dynamics, and highlight historical changes in lobster abundance and biomass that span several orders of magnitude. We conclude by exploring the possibility of long-term feedbacks between lobster abundance and lobster habitat quality via their trophic role in the kelp forest, with implications for ecosystem-based fishery management in the Southern California Bight.

† **GENDER-SPECIFIC SEASONAL MOVEMENT PATTERNS OF ADULT CALIFORNIA SHEEPHEAD *SEMICOSSYPHUS PULCHER* IN THE NORTHERN CHANNEL ISLANDS (EASTERN PACIFIC)**

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California sheephead *Semicossyphus pulcher* (Labridae), a protogynous hermaphrodite, is found on temperate, rocky reefs from Baja California to Monterey Bay. Historical data suggest that sheephead life history traits vary significantly across its range and recent acoustic tracking studies from Santa Catalina Island showed seasonal variation in movement patterns and no statistical difference between male and female movements. To investigate the potential of variability in movement patterns across the geographical range of sheephead, we tagged 52 adult individuals at Anacapa Island in the northern Channel Islands, offshore of Ventura, California. Terminal phase males (n=21) and intermediate phase females (n=31) were tagged internally with acoustic transmitters and their movements monitored for up to 26 months. Transmitters were detected by a 44-node passive acoustic receiver array that surrounded the island, encompassing the shallow near-shore to nearly 2 km offshore. Analysis to-date suggests that tagged males were, on average, detected over a larger area than tagged females. Additionally, more than half of males that were detected for greater than one year showed a seasonal shift to deeper, offshore stations during mid-day (10:00 h – 16:00 h) of the summer months (June – September). This offshore range expansion occurred during peak spawning season (June - September) when large males have been found to defend a specific, well-defined spawning territory used to court females after sunset. In contrast, tagged females showed little movement offshore at any time of day or year. These data suggest that the movement patterns of sheephead may differ across its range.

† **OCEAN ACIDIFICATION EFFECTS ON MOLLUSC LARVAE**

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Increasing atmospheric carbon dioxide and the resulting acidification of surface ocean waters has known negative structural effects on marine organisms such as corals. Some calcifying animals begin forming biogenic carbonates (e.g. spicules, shells, otoliths, and statoliths) in early life history stages. Hence, effects on larvae may serve as an indicator of long-term effects on adult populations. Molluscs in particular may be sensitive to ocean acidification because their larval shells and statoliths are composed of aragonite, a more soluble form of calcium carbonate. To examine the effects of predicted CO₂-induced pH changes on mollusc larvae, we exposed limpet, *Lottia digitalis*, trochophores to CO₂ manipulated seawater at pH 7.8, 7.6 and 7.4. We examined the resulting mortality, larval behavior, protoconch dimensions and overall appearance, and statolith size and shape. Decreasing the pH of seawater more than quadrupled the mortality rates of larvae. Of the larvae that survived, decreasing pH had significant negative effects on protoconch condition and larval behavior. Eighty eight percent of larvae cultured in pH 7.4 had little or no measurable protoconch. High-intertidal limpet species such as *L. digitalis* would be more vulnerable to desiccation and predation after settlement with reduced or missing shells. These results suggest that mollusc larvae may be particularly sensitive to ocean acidification with the potential to seriously affect future adult population demographics via larval and juvenile mortality.

† **PHYSIOLOGICAL RESPONSE OF THE INVASIVE KELP, *UNDARIA PINNATIFIDA* TO VARIATION IN SEAWATER TEMPERATURE**

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Physiological response to environmental variability can be an important factor in determining the persistence of invasive species. My studies have indicated that despite constant cold seawater temperatures consistent with the appearance of sporophytes in its native range *Undaria pinnatifida* is not present year round in Monterey Harbor, California. Population fluctuation and reproductive condition appear to respond to seasonal variations in temperature range rather than a specific temperature tolerance, as previously thought. This study investigated the hypothesis that *U. pinnatifida* behaves responsively to seawater temperature with respect to reproduction and nutrient allocation. Experiments were held outdoors in ten, 189-liter tanks, over a 55 day period. Two temperature treatments of 9-13°C and 17-21°C were replicated five times each. Individuals with newly developed sori that were not yet releasing spores were acclimated in cold tanks than randomly distributed amongst treatments. Reproduction was measured by

quantifying spore release and nutrients were measured using CHN analysis. Results revealed higher c:n, increased blade senescence, shorter time to reproduction, and decreased peak spore output in warm treatments. Unlike the usual photoperiodic controls of growth and reproduction in many algal species, Monterey populations of *U. pinnatifida* appear to be driven by variation in seawater temperature. Because *U. pinnatifida* is an opportunistic species which can respond to changes in an unpredictable environment it may have a distinct advantage when it comes to invasion success.

COMMUNITY DYNAMICS IN COASTAL BEAUFORT SEA BOULDER FIELDS

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The coastal Beaufort Sea is mostly dominated by soft bottom habitats characterized by low faunal diversity. In isolated regions, boulder deposits provide a hard substrate for attachment and increase structural complexity for mobile and encrusting organisms. This on-going study is examining community structure and dynamics of these Beaufort Sea boulder deposits. Results have shown that boulder fields can be very different in their composition and general structure. As a macroalgal example, encrusting coralline algae are the dominant cover in Stefansson Sound whereas, this algal group is completely absent from Camden Bay. Similarly, for invertebrates, gastropods and bivalves dominate Camden Bay but are rare in Stefansson Sound. Our most recent observations indicate that Camden Bay may be subject to large, episodic sedimentation events of pelagic material, which may be preventing recruitment of encrusting forms. As part of this on-going study, we also are looking at various community dynamics in Stefansson Sound. Stability of the epilithic community and recruitment of sessile organisms have been monitored for five years. Uncleared control rocks have shown no significant temporal variation, implying a somewhat stable community. However, recruitment has been minimal on cleared rock surfaces, implying a fragile community that may need significant recovery time after a disturbance. Interestingly, when sediments were excluded from settling surfaces, recruitment increased. From our observations, it appears that sedimentation is a major parameter influencing both community structure and recruitment in coastal Arctic boulder fields.

† DOES SIZE MATTER? VARIABILITY IN LARVAL SIZES AND ITS EFFECTS ON POST-METAMORPHIC SUCCESS IN BRYOZOANS

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Per-offspring investment (POI) has strong fitness-related effects on later stages of development, and variation in POI may affect a population's approach to an optimum offspring size. I measured larvae released from individual colonies to determine the amount of variation in POI found within and among broods in four species of bryozoans. I also examined the effects of interspecific variation in POI on juvenile size and survivorship in a low food environment. I found greater variability in larval volume within broods than among broods in three of the four species. There was a positive relationship between mean larval volume and mean lophophore volume ($R^2=0.94$, $p=0.02$), surface area ($R^2=0.97$, $p=0.011$), and number of tentacles in the first zooid ($R^2=0.95$, $p=0.017$). Juveniles that metamorphosed from the largest larvae (those of *Watersipora subtorquata*) survived significantly longer in a low food environment than those of the other three species of bryozoans. These results suggest that great variation in POI within broods may be common among bryozoan species that produce lecithotrophic larvae, and that as POI increases, additional energy is allocated to producing larger juvenile feeding structures and juvenile maintenance.

WHERE THE SLUGS ROAM: RANGE LIMITS EXPLAINED BY DIFFERENT PHYSIOLOGICAL TOLERANCE TO TEMPERATURE AND SALINITY IN THE SEA SLUGS *ALDERIA MODESTA* AND *A. WILLOWI*

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Range boundaries offer fundamental insights into the ecological niche of a species and evolutionary limits on adaptation. Understanding the physiological and ecological basis for range limits is also critical to predict accurately how species will respond to climate change. Intertidal organisms are ideal models because their ranges are north-south strips of shoreline; however, we have little data on the proximal basis for range limits in marine animals. The

cosmopolitan sea slug *Alderia modesta* has a southern limit of San Francisco Bay, which lies just inside the northern limit of its sibling species *A. willowi*. Over three years, San Francisco Bay was seasonally dominated by the southern *A. willowi* from September to December, until winter rains occurred; the northern *A. modesta* then colonized the Bay from January to August, until summer temperatures peaked. These demographic transitions suggest differences in physiological tolerance set range limits in *Alderia* spp. Lab experiments confirmed adult *A. modesta* were efficient osmoregulators, surviving 1 week at 2 ppt, whereas adult *A. willowi* suffered significant mortality below 8 ppt; salinity stress was intensified at elevated temperature in both species, but *A. willowi* generally enjoyed a survival advantage from 28-32 degrees. In Tomales Bay, the northernmost population of *A. willowi* has experienced strong selection for low salinity tolerance, but exhibits trade-offs in growth and reproduction that likely place a cap on further adaptation to wet northern conditions. These data will help us model how global warming and the changing hydrology of California may shift ranges for estuarine taxa.

THE LIFE AND TIMES OF JUVENILE CORALS ACROSS A CHANGING REEFSCAPE

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The physical and biological structure of coral reef communities are altered on decadal times scales by natural catastrophes, including storms, bleaching events, and predator outbreaks. How human activities influence the intensity and frequency of natural disturbances, and impact reefs additionally through low-level, chronic disturbances (e.g., fishing, pollution, and coastal development), are well studied but not well understood. Using surveys and manipulative field experiments, we tested whether a long-term shift in coral species composition documented in Moorea, French Polynesia is associated with taxonomic differences in the performance of juvenile corals during the recovery process. Results of a multi-year demographic study indicated that coral recruitment is relatively high but that juvenile coral growth and survival are highly variable across reefscales. Coral performance was regulated by multiple abiotic (hydrodynamics and sedimentation) and biotic (competition with algae and vermetid gastropods, and corallivory) factors, the magnitude and form of which were controlled largely by the physical structure of reef substrate. Results from manipulative experiments indicated that shifts in the relative abundance of acroporid, pocilloporid, and poritid corals are due in part to variation in the intensity of predation on juvenile corals executed by pufferfishes, butterflyfishes, and parrotfishes. The intensity of predation, and its effect on coral growth and survival, depended on substrate type, local hydrodynamic conditions, and the timing and intensity of other abiotic or biotic disturbances.

ECOLOGICAL EFFECTS OF NO-TAKE MARINE RESERVES: TESTS OF LATITUDINAL VARIATION, ADULT SPILLOVER, AND PARTIAL PROTECTION

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The study and implementation of marine reserves has increased rapidly over the past few decades, providing ample data on the biological effects of reserve protection for a wide range of geographic locations and organisms. Reserves have been shown to support more intact communities, with a greater abundance and biomass of key species compared to areas outside. Nonetheless, numerous questions remain about their potential benefits and management utility. We conducted a survey of peer-reviewed scientific literature to compile a global database of studies documenting biological effects for multiple taxa in no-take marine reserves. We show that reserves generate strong positive effects for the biomass, density, species richness, and size of organisms within their boundaries, effects which are consistent with or greater than those from past reviews. We then address several core issues in marine reserve science. First, contrary to common assertions that marine reserves are less likely to be effective in temperate environments, we show that reserves have parallel if not greater positive impacts in temperate versus tropical ecosystems. Second, we present emerging evidence that spillover of adults into unprotected waters is a general and quantifiable phenomena and likely scales with reserve size. Lastly, we evaluate the relative benefit of partial protection versus full protection (no-take reserves) and show that while partial protection affords some ecological benefits over open-access, on average greater responses are likely to be found for fully protected areas. These results have important implications for future efforts to design and implement marine reserves.

† PREDATION IN EELGRASS BEDS: DO TROPHIC MANIPULATIONS RESULT IN CASCADING EFFECTS?

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Seagrasses provide important nursery grounds to fishes and invertebrates throughout the world. Although much work has been conducted in these habitats, it remains unclear how trophic interactions influence ecosystem function in seagrass beds. Previous work suggests that an abundance of fishes that feed on invertebrate grazers may, in turn, allow epiphytic algae to grow and smother seagrasses. The aim of our research is to explore the importance of microcarnivorous fishes in the functioning of eelgrass (*Zostera marina*) habitats in San Diego Bay, California. We conducted a 12-wk field experiment in summer 2007 for which we manipulated the abundance of microcarnivorous fishes and observed their direct and indirect effects on invertebrates, algae, and eelgrass performance. We used the following four treatments: fish enclosures, fish exclosures, open plots, and cage controls. Contrary to our expectations, our results indicate that fishes had positive indirect effects on eelgrass performance (e.g., growth); possibly by directly removing invertebrates which appeared to damage eelgrass leaves. These results suggest that microcarnivorous fishes exert top-down effects that ultimately benefit eelgrass.

CRYPTIC DIVERSITY AND PHYLOGENETIC RELATIONSHIPS WITHIN THE *MASTOCARPUS PAPILLATUS* SPECIES COMPLEX (RHODOPHYTA, PHYLLOPHORACEAE)

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Mastocarpus papillatus is a common intertidal red alga found along the west coast of North America from Baja California to Alaska. Sequencing of both the chloroplast-encoded *rbcL* gene and the nuclear ribosomal ITS regions of ca 200 specimens from California to Alaska revealed that *M. papillatus* is actually a complex of at least five species. All five species have high bootstrap support in phylogenetic analyses of both genetic regions, and in the case of the ITS marker, the species also have distinctive patterns of indels. Three of the species are found in the mid to upper intertidal whereas two of the species occur in the low intertidal. The species also have different geographic ranges that overlap in the Vancouver Island area of British Columbia. No distinctive, reliable morphological differences were observed among the species. Although a variety of names are available for species in the complex, it is not yet clear which name goes with which species. As part of the survey, we also sequenced other species of *Mastocarpus* in the northeast Pacific region, and we provide new distribution records for *M. jordinii* and for a nonpapillate and probably undescribed species of *Mastocarpus*.

RECOVERY OF A CORAL COMMUNITY IN A NATURE RESERVE OF SOUTHERN TAIWAN: SIX YEARS AFTER SHIP GROUNDING OF BULK CARRIER AMORGOS

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The bulk carrier Amorgos grounded on a coral reef of Longken Nature Reserve, Kenting National Park in southern Taiwan in January 2001. Benthic communities on a reef were denuded (coral coverage was 0 - 0.5% in 2002) resulted from the mechanical abrasion of broken wrecks due to several typhoons. Three damaged sites and three undamaged sites were randomly selected to monitor coral recovery using 1_i × 1_i m permanent quadrates at depths of 6 to 12 m from June 2002 to April 2007. Coral coverage of two undamaged sites was ranged between 8.1 to 30.0%, and that of the third undamaged site was higher (56.6 - 81.1%). Coral coverage and number of recruited coral colonies of two damaged sites were 18.3% and 57 as well as 20% and 62, respectively; while those of the third damaged site (located deeper and influenced by drifting sands) were 3.4% and 30. The recruited coral species were dominated by the Faviidae. It is similar to the structure of nearby coral communities. These results suggest that the damaged sites were recovering.

† ENZYME ACTIVITIES OF THE BLUE MUSSELS, *MYTILUS TROSSULUS* AND *M. GALLOPROVINCIALIS*, INDICATE DIFFERENTIAL TEMPERATURE ADAPTATION

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The blue mussels, *Mytilus trossulus* and *M. galloprovincialis*, are native to different thermal environments in the North Pacific and Mediterranean, respectively. To investigate whether these species have undergone differential temperature adaptation, we compared the enzyme activities of citrate synthase (CS) and malate dehydrogenase (MDH) between these two species under common-garden conditions. For each of three tissue types (gill, adductor muscle, and mantle) *M. trossulus* had significantly higher CS and MDH activities than *M. galloprovincialis*. These results suggest that *M. trossulus* is more cold-adapted than *M. galloprovincialis*, which is consistent with their native distributions.

† A TIERED HEAT SHOCK RESPONSE IN GENE EXPRESSION DEFINES MODERATE VERSUS EXTREME LEVELS OF THERMAL STRESS IN THE EURYTHERMAL GOBY FISH, *GILLICHTHYS MIRABILIS*.

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The long-jaw mudsucker, *Gillichthys mirabilis*, is a highly eurythermal estuarine goby fish that can survive temperatures from 4°C to 40°C. Previous studies have described a subset of expressed genes that allow individuals to cope with moderate heat stress, however, it is unclear how they can survive more extreme temperatures. Patterns at the transcript and protein level are hypothesized to reveal an integrated tiered heat stress response. To characterize this response, 90 mudsuckers were collected from the UCSB Lagoon and acclimated to low (9°C), medium (19°C), and high (28°C) temperatures in the laboratory for one month. Animals then underwent a heat shock event at an ecologically relevant ramp (4°C/hour) until they reached their critical thermal maxima. Three fish were sacrificed every hour and total RNA from gill tissue was extracted to measure the transcriptional profiles for over 9,000 genes using cDNA microarrays. Results reveal genes that are differentially expressed at moderate levels versus extreme levels of heat stress. Interesting transcript candidates will later be analyzed at the protein level using mass spectrometry to determine relative expression. These data significantly enhance our understanding of how this eurythermal fish can cope in fluctuating thermal environments.

TRANSATLANTIC VARIATION IN SEAWEED INDUCIBLE AND CONSTITUTIVE DEFENSES

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Recent work on European (Swedish and English) populations of *Ascophyllum nodosum* has detected inducible defenses in response to snail grazing. However, tests of induced responses in other *Ascophyllum* populations are lacking and we thus have a limited understanding of how widespread such responses are in fucooid algae. We exposed Massachusetts *Ascophyllum* population to *Littorina obtusata*, the same snail species used in previous studies, and tested for inducible responses. In contrast to European populations, the Massachusetts population of *Ascophyllum* did not develop any such responses. Exposure to either direct grazing or just waterborne cues associated with grazing for 26 d failed to suppress the palatability of artificial foods made from seaweed tissues exposed to these treatments. Although Massachusetts *Ascophyllum* lacked inducible responses, they had stronger constitutive defenses measured by phlorotannins and palatability of non-induced individuals. Background phlorotannin levels were 2X greater in Massachusetts. Grazing on non-induced Massachusetts *Ascophyllum* was 86% less than grazing on non-induced Swedish conspecifics – regardless of snail source or greenhouse location. Thus, *Ascophyllum* displays transatlantic variability in its response to a single herbivore species, and inducible and constitutive defenses were negatively correlated. Recent experiments suggest that 1) similar variability of inducible responses is observed across smaller spatial scales (100s rather than 1000s of kms) in the Gulf of Maine and 2) co-occurring northern populations of *Ascophyllum* and *Fucus vesiculosus* have stronger inducible responses within the Gulf of Maine than southern populations.

GEOGRAPHIC RANGE CHANGES BY CHITONS IN THE PANAMIC PROVINCE

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When the second edition of Keen's "Sea shells of tropical West America" was published in 1971, it served as the most complete reference for intertidal and subtidal molluscan fauna within the Panamic Province. In 2000, Skoglund

published a comprehensive supplement to Keen's volume, detailing taxonomic and geographic range changes from 1971 to 2000. Focusing initially on 50 polyplacophoran species, I analyzed changes to geographic range over a 30-year period coincident with a "warm" Pacific Decadal Oscillation regime. Six of the species were excluded due to unresolved taxonomic issues. For the remaining species, each was described as having no change in geographic range, range expansion only, range contraction only, or range expansion/contraction. Of the 44 species, 21 showed no change, 20 expanded their range, two contracted, and one expanded its northern limit while contracting its southern limit. For the species with range expansions, 5 northern endpoints moved towards the north pole, 8 endpoints moved towards the equator, and 7 expanded towards and/or across the equator and/or towards the southern pole. Using a conservative estimate of the distance between old and new range endpoints, the mean expansion of the range limit for these 20 chiton species was 1728 km. While these results may not "fit" with expectations associated with the warm PDO regime (i.e. 75% of species moved towards the equator), they must be tempered by the roles of field sampling bias, extent of occurrence vs. area of occupancy, and the dynamic nature of geographic ranges.

FAILURE BY FATIGUE IN WAVE-SWEPT MACROALGAE

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Why do wave-swept seaweeds break? A seaweed on a wave-swept shore may endure more than 8000 wave-induced loadings each day, and perhaps not surprisingly, many intertidal seaweeds experience dislodgment and breakage in particular seasons as well as throughout the year. Nonetheless, this breakage remains incompletely understood. Typical assessments of algal material properties involve pull-to-break tests applying a single, increasing load until breakage occurs. These traditional pull-to-break tests have often predicted no, or very little, breakage in algal populations upon comparison of measured strength and maximum wave-imposed drag forces. I employ an alternate strategy to assess algal breakage, considering failure in the context of *repeated* wave-induced loadings, a process called fatigue. Previous fracture mechanics work has suggested that several macroalgae may break frequently by fatigue. Here I use a standard method of fatigue analysis, applying repeated loading cycles comparable to field conditions, to characterize fatigue behavior in the red macroalgae *Mazzaella*. In this way, I generate plots of loading stress versus number of cycles to failure. Using Miner's rule to sum accumulated fatigue damage, I predict failure in various field wave conditions from these laboratory-generated baseline fatigue data. Such examination of fatigue promises to clarify the discrepancy between known and traditionally predicted algal breakage rates.

EVOLUTIONARY CAUSES AND CONSEQUENCES OF SPERM VARIATION IN SEA URCHINS

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Although sperm are of universal importance to sexually reproducing organisms, they are curiously variable in size and shape. Much of this variation may be evolving under sexual selection, especially in species with high rates of sperm competition, which occurs when a female mates with two or more males. The gametes of sea urchins and other broadcast spawners frequently engage in sperm competition, by nature of their mass spawning events. At the same time, individual male green sea urchins *Strongylocentrotus droebachiensis* produce sperm that differ in head size from other males. These differences are consistent across multiple spawnings and do not vary significantly over time. Furthermore, this species shows significant variation in sperm head length among populations occupying the eastern Pacific, western Atlantic and eastern Atlantic Oceans. The functional significance of this variation was investigated using sperm competition experiments in which sperm from two different males were mixed with eggs from a single female. Potential female effects were explored by replicating experiments using the same pairs of males with different females. We also identified genetic mechanisms controlling sperm head shape using whole genome oligonucleotide arrays. By surveying the entire sea urchin genome, we have been able to identify cellular pathways whose patterns of gene expression are associated with variation in sperm head length. These pathways are involved in diverse processes including cell metabolism, vesicle-mediated transport, cell division and ubiquitination.

AN EXAMINATION OF HABITAT STRUCTURAL COMPLEXITY AND FISH DISTRIBUTION IN NEARSHORE WATERS OF KACHEMAK BAY, ALASKA

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In temperate regions kelp can dominate hard-bottom nearshore communities, providing structure at the substrate and throughout the water column. Complex kelp and rock habitats can be beneficial to fish, however, the use of these complex habitats by fishes is poorly understood in northern latitudes, particularly for juvenile fish. This study examined nearshore kelp habitats to examine the potential effects of kelp density and substrate topography on nearshore fish communities. Fish were collected from multiple sand, understory, and understory-canopy sites, along with kelp and substrate complexity measurements. The dominant fish families encountered were gadids, pleuronectids, hexagrammids, and sebastids. Their habitat use differed significantly both temporally and in relation to size class, but these differences were family specific. Low complexity sand habitats were particularly important for juvenile pleuronectids and complex nearshore kelp habitats may be essential fish habitat for juvenile Pacific cod. These data indicate that fish habitat preferences are specific to the family level in Alaska's nearshore waters and may require varying management strategies depending on fish family. Although these high complexity nearshore environments may be hard to sample, they support large fish assemblages and may be essential to multiple fish life stages belonging to a variety of families and species.

ADAPTIVE PLASTICITY IN LARVAL SIZE IN A MARINE INVERTEBRATE

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Mothers must balance the size and number of offspring that they produce and for any one environment, a single offspring size is predicted to maximise maternal fitness. Whilst the number of studies showing that different environments select for different offspring sizes is accumulating, there are few that examine whether mothers do actually adjust the size of their offspring in response to local conditions. We manipulated the level of interspecific competition that mothers experienced in the field for the bryozoan *Watersipora subtorquata*. We found that interspecific competition strongly affected the relationship between offspring size and subsequent performance and that mothers changed the size of their offspring according to the level of competition that they experienced. We suggest that offspring size is a plastic trait in marine invertebrates and maternal allocation strategies are tuned to local dynamics.

HITCHHIKER PARASITES: THE EFFECT OF INVASIVE JAPANESE MUD SNAIL (*BATILLARIA CUMINGI*) ON THE NATIVE LONGJAW MUDSUCKER (*GILlichthys MIRABILIS*) THROUGH PARASITISM.

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While the direct effect of invasive species on native species is a primary focus of ecological research, the indirect effects from parasites that accompany invasive species and can displace the endemic parasite fauna is a burgeoning field for exploration. The introduction of new parasites can have deleterious effects on native host species, which can be more severe than those effects caused by native pathogens. In this study, we investigate the impact of the non-native trematode, *Cercaria batillariae*, which often accompanies the invasive Japanese mud snail, *Batillaria cumingi*. This trematode disproportionately infects fish as its definitive host and native fish populations, such as the longjaw mudsucker, *Gillichthys mirabilis*, can suffer as a result. Two populations of *Gillichthys mirabilis* (Tomales Bay and Bodega Bay) were sampled and collected specimens were necropsied to determine parasite infection and burden. The population at Tomales Bay, where the *Batillaria* is well established, had high levels of *Cercaria batillariae* infection (>95%). This population also exhibited simultaneous parasite infections, including nematodes (9%) and microsporidia (45%) and lower average condition factors (1.36), indicating poorer individual health. The population at Bodega Bay, where *Batillaria* is only recently introduced, saw no *Cercaria batillariae* infections, a lack of other parasite infections, and higher average condition factors (1.54). This study clearly demonstrates the effect invasive parasites can have on native fish populations. As *Batillaria* continues to spread, the health of native fish populations will likely decline even further.

† MIDWATER FISH ASSEMBLAGES ASSOCIATED WITH PETROLEUM PLATFORMS ON THE SAN PEDRO SHELF: A COMPARISON WITH SANTA BARBARA CHANNEL PLATFORMS

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Recent ecological studies of petroleum platforms in the Santa Barbara Channel have led to increased support for their protection as “Essential Fish Habitat.” However, fish communities associated with the more southern platforms on the San Pedro Shelf have remained largely unstudied. Bimonthly SCUBA-based fish surveys were conducted in the midwater regions at six of the seven platforms on the San Pedro Shelf for the period of one year. Diver surveys indicate fish assemblages at the San Pedro Shelf platforms are dominated by nearshore reef species (e.g. blacksmith, California sheephead, garibaldi, kelp bass, and barred sand bass) most of the year while pelagic species (e.g. jack mackerel, Pacific mackerel, sardines) are dominant during summer months. Among the San Pedro Shelf platforms, a higher richness of nearshore reef species was observed at platforms closer to shore. Compared with species composition data from some Santa Barbara Channel platforms, the San Pedro Shelf platforms are shown to possess significantly different fish assemblages due to a higher observation of nearshore reef species and a lower observation of rockfish species. This disparity among platform fish assemblages separated by a relatively small spatial scale (100 km) highlights the need for a thorough ecological assessment of all southern California petroleum platforms before decommissioning decisions are made. Further research is needed to assess the site fidelity and production of the dominant nearshore reef species to platform structures and how potential decommissioning strategies may impact local fisheries in southern California.

† GEOGRAPHIC VARIATION IN LIFE HISTORY STRATEGY OF *MEGASTRAEA UNDOSA*: TO GROW OR TO REPRODUCE?

Martone, R.G.^{*}, and F. Micheli

Hopkins Marine Station, Stanford University

Geographic variation in life history traits underlies patterns of population persistence, biogeography, evolutionary biology, and response to global change; but, data on geographic variation in individual performance and life-history strategy is rare. Recent studies along the west coast of North America show local and mesoscale variation in reproductive output of intertidal invertebrate populations correlated with coastal topographic features and nearshore nutrient circulation. However, individual performance in reproductive output may also reflect trade-offs among life history traits such as energy allocation to growth and reproduction, which can be influenced both by environmental conditions and species interactions. We explore geographic variation in life-history strategies of a harvested invertebrate species *Megastrea undosa*, the wavy-turban snail, at the southern edge of its range in central Baja California. We measured density and size structure, calculated key demographic rates (growth, size at maturity, and fecundity) and characterized the environment (substrate type and complexity, food availability, and resident biotic assemblage) of populations existing 10-150km apart. Individuals exhibit within-region variability in trade-offs between growth and reproduction, with higher growth rates leading to greater sizes at maturity and lower investment in gonadal production. Our data suggest a complex interaction between food availability, habitat structure and predation, as well as possible temperature effects.

***KABATANA* SP., A NEWLY OBSERVED MICROSPORIDIAN PARASITE IN THE LONG-JAWED MUDSUCKER (*GILlichthys mirabilis*)**

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Since 2002, the Pacific Estuarine Ecosystem Indicator Research Consortium (PEEIR) has been monitoring the resident estuarine fish *Gillichthys mirabilis* on an annual basis in San Francisco and Tomales Bays. Beginning in 2006, a destructive genus of Microsporidian parasite (*Kabatana*) has been observed in *Gillichthys mirabilis* in Tomales Bay. *Kabatana* has been observed in a closely related host, *Eucyclogobius newberryi*, in Humboldt, Mendocino, and Marin Counties. The entire lifecycle of *Kabatana* occurs in direct contact with host muscle cell cytoplasm. *Kabatana* has been observed to cause muscle liquification and mortality of cultivated fish species in the Western Pacific. Observed average infection rate of *Gillichthys mirabilis* in Tomales Bay is 18.9% of the study population. Infected individuals range from 65 to 135 mm, suggesting that *Kabatana* infects both juvenile and adult *G. mirabilis* cohorts.

† ISOLATION AND CHARACTERIZATION OF *UNCLE FESTER*, A PUTATIVE ALLORECOGNITION RECEPTOR IN THE PRIMITIVE CHORDATE, *BOTRYLLUS SCHLOSSERI*.

McKittrick, T.R. *, and A.W. De Tomaso
Stanford University

Botryllus schlosseri is a seasonally abundant, colonial ascidian, typically found on submerged surfaces of floating docks. As this ascidian is continuously undergoing asexual propagation, it often comes into physical contact with both conspecifics and congeners. If two individuals of the same species share one or both alleles at a highly polymorphic locus, called the FuHC, they will fuse and form a chimeric colony. However, if no alleles are shared, the two colonies will reject in a classic blood-borne inflammatory reaction, preventing vascular fusion and the subsequent transfer of mobile, parasitic somatic and germ stem cells between colonies. In contrast, if *Botryllus schlosseri* encounters a congener, the two species will grow into each other and the allorecognition reaction is never initiated. All botryllid species studied to date possess a within species allorecognition system that is similar to that of *B. schlosseri*. However, the capacity to xeno-react with a congener is species-specific, with some species violently reacting to both congeners and conspecifics immediately after contact. We are interested in the molecular mechanisms that govern this process. This pattern suggests the presence of a species-level activation phase of the allorecognition response, followed by allelic discrimination of the Fu(HC) by its putative receptor, a transmembrane protein termed *fester*. Recently, we have characterized another locus called *uncle fester*, which is functionally behaving as an allorecognition receptor.

† THE PARASITE AND THE PARENT: IMMUNE DEFENSE AND BREEDING STRATEGY IN AN AVIAN BROOD PARASITE AND ITS CLOSEST NON-PARASITIC RELATIVE

Merrill, L. *, and S.I. Rothstein
UC Santa Barbara

The field of ecological immunology is founded upon the assumption that there are trade-offs between immune function and other activities that share common resources. Numerous studies have examined the relationship between reproduction and immunity and found that an increase in reproductive effort was correlated with a drop in immune response, and that increases in parasite burden were correlated with decreases in reproductive output. The immune system is costly to maintain and variation in immunity may indicate that energy resources are being allocated elsewhere. To examine the link between breeding life history strategy and immunocompetence I have focussed my research on the brood parasitic Brown-headed Cowbird (*Molothrus ater*) and the Red-winged Blackbird (*Agelaius phoeniceus*), which is the closest non-parasitic relative to cowbirds. This past spring and summer I collected data on both innate and acquired immunity in males and females from the two species by injecting a general antigen (phytohemagglutinin) to stimulate a swelling response, and measuring the bacteria-killing ability of the birds' plasma. I found significant differences in both measures of immunity between males and females of the same species, and between species within the same sex (e.g. between female Brown-headed Cowbirds and female Red-winged Blackbirds). These results suggest that brood parasites invest resources to immune defense at different rates than their non-parasitic relatives.

PREDICTING A SINKING SPEED FOR DIATOMS

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Hopkins Marine Station

As one of the ocean's primary producers, we would like to understand the movement and flux of diatoms through the water column, or how fast diatoms of different sizes should sink. Fluid dynamic theory predicts that for small objects such as diatoms, the relationship between size (r) and sinking speed (V) should be $V \sim r^2$. Unfortunately, empirical data collected for diatoms over the last fifty years suggests an exponent much lower (between 1 and 1.5). This data is further complicated by a diatom's ability to physiologically regulate its cell's density, thus controlling its sinking speed. Since the empirical data does not correspond to the prediction from fluid dynamics, it is unclear what the sinking speed of a diatom should be, and how much control a diatom has over its buoyancy. Through considering the density of the diatom's frustule and cytoplasm separately, this study reconciles the discrepancy between empirical data and fluid dynamic theory. Preliminary data comparing the sinking speed of cleared and fixed diatoms has confirmed that separating the diatom's density in this way can help explain the discrepancy.

ECOMECHANICS MEETS ECOPHYSIOLOGY: PREDICTING THE FREQUENCY OF LETHAL AND SUBLETHAL STRESS EVENTS FOR A MID-SHORE LIMPET, *LOTTIA GIGANTEA*

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1 - Hopkins Marine Station, Stanford University 2 - University of British Columbia

The development of heat budget models for intertidal organisms has demonstrated that accurate predictions of body temperatures can be made using physical data about organisms in combination with simple environmental data. Furthermore, by combining forecasts or hindcasts of body temperature with physiological data for organisms, it has become possible to make predictions of the frequency and intensity of thermally stressful events which can ultimately affect the distributions of intertidal organisms. Using a temperature, light, and humidity-controlled wind tunnel, we subjected *Lottia gigantea* to a variety of stress profiles designed to mimic field stress events. These realistic perturbations reveal a lethal limit lower than that determined by more traditional physiological thermal stress techniques. Coupled with heat budget model predictions of body temperature, western blot techniques demonstrate that the onset of expression of heat shock protein 70 occurs at temperatures which can be reached many times per year, even at “cold” field sites. These emerging techniques have the potential to help inform ecologists about the role of physical and physiological constraints in shaping communities and their responses to future environmental changes.

† TEMPORAL VARIATIONS IN CANNIBALISTIC INFANTICIDE: IMPLICATIONS FOR REPRODUCTIVE SUCCESS

Miller, S.H.^{*}, and S.G. Morgan

Bodega Marine Lab

Clouds of eggs and larvae of benthic marine organisms are released amid high densities of filter-feeding and predatory adults and are highly subject to being consumed, even by conspecifics or their own parent. Behaviors of adults and larvae, chemical defenses and chemical recognition of propagules by parents can reduce consumption until these clouds diffuse and disperse into open waters where predation may be reduced. In laboratory feeding trials, female shore crabs (*Hemigrapsus oregonensis*) that had released their larvae more than 4 wk before the experiment ate significantly more conspecific larvae than females that had recently released their larvae. The number of larvae they ate increased with increasing starvation time, but the intensity of filter feeding varied between years. Additionally, crabs ate more larvae from a different species (*Carcinus maenas*) than larvae of conspecifics. Thus, suppression of filter-feeding by females that have recently released larvae and chemical recognition of offspring may both reduce conspecific predation of newly-released larvae, but adult suppression of filter feeding varied between years, which could lead to interannual variation in reproductive success. This is possibly the first time these results have been shown in benthic marine invertebrates, but the behaviors may be ubiquitous and have important ecological ramifications.

LIFE HISTORY PLASTICITY IN EMBRYOS OF *NUCELLA LAMELLOSA*

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Despite many species of marine invertebrates that develop from encapsulated embryos attached to the benthos, few investigators have studied plasticity in time to hatching. Time to hatching has important consequences for the evolution of life histories and the ecology of organisms. To begin to understand how species alter time to hatching in the presence of predators, we studied the embryos and larvae of the dogwinkle *Nucella lamellosa*. We performed a factorial experiment where we manipulated the presence and absence of two types of caged predators--the crab *Hemigrapsus oregonensis* and the isopod *Idotea wosnesenskii*. Larvae hatched from capsules earliest when reared without predators and latest when reared with both predators. These results suggest that capsules protect embryos from predators, but also that there is a benefit to hatching early when predators are absent—assuming this plasticity is adaptive. It was also determined that predators slow larval development. This result suggests that predators reduce metabolic activity in embryos and larvae, but contrasts with the results from an experiment on adult *N. lamellosa* where oxygen consumption increased in the presence of predators. Therefore, the physiological response of *N. lamellosa* to predators might change during ontogeny.

† SEAGRASS HABITAT STRUCTURE: RELATIVE EFFECTS OF STRUCTURAL COMPLEXITY AND LOCATION WITHIN THE PATCH ON EPIFAUNAL ABUNDANCE AND DIVERSITY.

Moore, E.C.* , and K.A. Hovel
San Diego State University

In many marine habitats, such as seagrass beds, habitat structure at multiple spatial scales often covaries, making it difficult to distinguish the relative effects of structure at different scales on organismal distribution and species interactions. Variation at fine-scales (i.e. structural complexity) and at landscape-scales (e.g. patchiness and patch edge vs. interior) influences faunal distributions and predator-prey interactions, but their relative effects have rarely been tested simultaneously. We surveyed eelgrass (*Zostera marina*) beds in San Diego Bay, California to determine how structural complexity (shoot density, length, and biomass) and the mobile epifauna community varied between bed edge and interior. We also conducted an experiment to assess how structural complexity, location within the bed (edge vs. interior), and predator presence interactively influence epifaunal abundance and diversity. Epifaunal prey were allowed to colonize artificial seagrass units (ASUs) of varying shoot densities, locations, and predator exposure (open, caged, and cage-controls) for 4 weeks at which time plots were collected and communities of epifauna were compared. Seagrass structural complexity generally increased from the edge to the interior of patches. Epifaunal community structure varied with seagrass shoot density and with location in the patch, though the relative influence of structure at fine-scales vs. landscape-scales varied among taxa. Some taxa (e.g. grass shrimp *Hippolyte* spp.) were more abundant in ASUs with predators excluded, although others did not seem to be influenced by predator presence. Lastly, these patterns are considered in relation to observed predatory fish distributions in the eelgrass beds.

MECHANISMS OF LARVAL RETENTION AND CROSS-SHELF MIGRATION IN A ZONE OF STRONG COASTAL UPWELLING

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Along the coast of California, USA, larvae are thought to be largely at the mercy of strong prevailing upwelling winds, resulting in recruitment-limited adult populations. We investigated whether larval retention and export occurs in a small embayment and the nearshore open ocean for over 30 species of crustaceans. The relative abundance of larval stages indicated that larvae of most species were retained close to shore, whereas some species migrated offshore. Surprisingly, larval concentrations were similar or even higher in the open ocean than in the protected embayment, revealing that larval retention occurs along the open coast and not just in the lee of headlands. Larvae of species that are retained occurred deep in the water column, where Ekman transport is weak and prevailing flow is onshore. In contrast, larvae that are exported occurred nearer to the surface, where Ekman transport may carry them offshore. Larvae also undertook ontogenetic and diel vertical migrations either occurring deep in the water column or near the surface late in development. In general, barnacles remained deep in the water column throughout the day, whereas all other species migrated in the neuston at night. Thus, multiple behaviorally mediated transport mechanisms enable larvae to recruit during both upwelling and relaxation conditions in upwelling regions.

† VARIATION IN PHLOROTANNIN CONCENTRATIONS IN KELP SPECIES IN THE POINT LOMA KELP FOREST, SAN DIEGO, CA

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The production of secondary metabolites in primary producers is known to be influenced by many factors; in brown algae the production of phlorotannins as a secondary metabolite can be influenced by abiotic factors such as light intensity and nutrient availability, and by the type and intensity of herbivory. These carbon-based compounds are thought to be herbivore deterrents and have been found to increase in production for cellular functions such as growth and healing. Manipulative studies examining the ability of brown algae individuals to turn on and off the production of phlorotannins has primarily focused on the accessible intertidal rockweeds, with little work examining subtidal kelps. This project focuses on the abiotic and biotic forces that influence phlorotannin production within kelps. Working at the Point Loma kelp forest, San Diego, CA, we are examining correlations with in situ nitrogen as well as removing the *Macrocystis pyrifera* canopy to examine influences of increased light on under-story species. Variability patterns seen throughout the thallus of *Macrocystis pyrifera* highlight the need to understand how biotic

and abiotic factors can cause differences between tissue types as well as position of tissue within the water column.

† RISING CO₂ DISPROPORTIONATELY AFFECTS EXTENSION VERSUS MASS DEPOSITION IN REEF CORALS

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The production of mineral skeletons by reef corals has long interested biologists, but recent attention has focused on the role of increasing levels of atmospheric CO₂ in depressing rates of coral calcification. As atmospheric pCO₂ rises, seawater pH decreases, aragonite saturation state declines, and it becomes energetically more challenging for biogenic aragonite deposition. Although ocean acidification is known to decrease calcification in corals, such effects have been measured almost exclusively in terms of the mass deposition of aragonite. Interestingly, it remains virtually unknown how this translates into morphological consequences in a taxon well known for morphological plasticity. This study used manipulative experiments to test the hypothesis that increasing pCO₂ has unequal relative effects on different components of growth that contribute to colony size and morphology. First, increased levels of CO₂ (700 vs. 350 μatm) were tested for effects on the mass deposition (mg cm⁻² day⁻¹) and linear extension (μm day⁻¹) of *Acropora hyacinthus* and *A. pulchra* from French Polynesia, and second, the results were used to explore the covariance between each growth component. Overall, mass deposition and linear extension were significantly reduced by high pCO₂, and in both species the linear extension was reduced more than twice as much (>52%) as mass deposition (≈26%). For these species, the inhibitory effects of elevated pCO₂ on aragonite deposition apparently were modulated by changes in skeletal density and/or shape. These results are important as they reveal the potential role of morphological plasticity in modifying the effects of ocean acidification into coral reef accretion.

SEASONAL AGGREGATIONS OF FEMALE ROUND STINGRAYS (*UROBATUS HALLERI*) IN A COASTAL ESTUARY: USING ULTRASOUNDS AND HORMONE LEVELS TO DETERMINE PREGNANCY

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The round stingray (*Urobatis halleri*) is a common nearshore elasmobranch in southern California and is known to breed in the late spring. Large aggregations of round stingrays have been observed at Seal Beach, CA in the summer and fall, although no behavioral or physical evidence of mating has ever been observed. Mating in this population is thought to occur in nearby Anaheim Bay estuary, which is part of the Seal Beach National Wildlife Refuge (SBNWR). SBNWR is composed of 1.1 km² of estuary and four mitigation ponds. Round stingrays were sampled in mitigation ponds every month from June 2005 to September 2007. All captured rays were weighed, sexed, and examined for mating scars as evidence of recent breeding behavior. From June 2006 to September 2007 blood was sampled via the caudal vein from a subset of rays and analyzed for progesterone and estradiol using radioimmunoassay. In addition, in summer 2007 a subset of rays were examined using ultrasound to determine pregnancy state. All females examined during July and August exhibited developing embryos, but by September 20% of the females appeared to have pupped. Progesterone levels were elevated in females sampled through July and August (0.75 ng/ml) and levels decreased significantly to 0.16 ng/ml by September. The density of females appears to be regulated by temperature and correlated with reproductive state. Female round stingrays may be entering these warm shallow ponds to increase the gestation rate, purported to be three months, which is relatively short for a live bearing elasmobranch.

CHANGES IN HABITAT HETEROGENEITY AND IMPLICATIONS FOR THE CONSERVATION OF BENTHIC METACOMMUNITIES.

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Theoretical ecology suggests that habitat heterogeneity is one of the major mechanisms affecting diversity in spatially structured communities, or metacommunities. Often, benthic communities that occur on hard substrates tend to have patchy distributions because of heterogeneous landscapes where hard substrate interlaces with soft

sediments. With human modification of coastlines however, heterogeneity levels are changing: hard substrates are increasing in frequency by the incorporation of man-made structures such as jetties and docks, creating a change from a patchy to a continuous distribution of habitat. Sessile marine species have varying life history traits creating both spatial and temporal overlaps in their population dynamics, and thus in community structure. How will species with different life histories respond to changes in habitat heterogeneity due to anthropogenic modifications? For example, dispersal-limited species could increase in abundance and distribution; good competitors may dominate larger areas driving poor competitors to local extinction. The present study is aimed at understanding changes in heterogeneity, which may alter the benthic community of Long Island Sound in the northwestern Atlantic. This benthic community is comprised of a large number of sessile benthic species, including bryozoans, ascidians and mussels. The community tends to change over patches as a “shifting mosaic;” altering species dominance that may span different temporal and spatial scales. Here, we use a series of modeling techniques to understand community dynamics where habitat heterogeneity undergoes gradual changes through succession. Species with different life history traits, ranging from broadcast spawning to brooding species, were simulated and their population dynamics followed over time.

† SOURCE POPULATION INFLUENCES THE CAPACITY FOR PLASTICITY IN FEEDING STRUCTURES OF A COMMON INTERTIDAL BARNACLE (*BALANUS GLANDULA*)

Neufeld, C.J.*

University of Alberta and Bamfield Marine Sciences Centre

On rocky shores, water movement varies dramatically both in space and in time. Therefore, rocky shores provide an ideal testing ground for the study of developmental plasticity of body form in response to variable environmental conditions. Prior work has revealed dramatic differences in the form of barnacle feeding legs between protected bays and nearby wave-exposed shores. Furthermore, in one species feeding leg size and form is due to developmental plasticity and responds quickly (within 2-3 weeks) to changes in flow when barnacles are continually immersed. However, it is not known how quickly barnacles respond to changes in flow under field conditions in the intertidal where immersion times are often limited. To answer this question I transplanted barnacles (*Balanus glandula*) from two source populations to each of four outplant locations that spanned a range of maximum water velocities. Contrary to past work, I found that *B. glandula* responded slowly to changes in flow (within approx. 6-8 weeks) suggesting barnacles may be more limited than previously thought in their ability to adapt leg form to temporal variation in wave force. Additionally, the protected-shore source population responded more slowly to changes in flow and expressed a different reaction norm (the pattern of leg form expressed across a range of maximum water velocities) than the nearby exposed-shore source population. This provides evidence for underlying genetic differences between populations and suggests that there is strong selection for different reaction norms in different wave-force regimes.

† NEARSHORE FLOWS IN CALIFORNIA: THE PRESENCE OF A COASTAL BOUNDARY LAYER AND IMPLICATIONS FOR DISPERSAL

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Nearshore flow is an important and understudied issue in coastal marine ecology. The movement of ocean waters near the coast has important implications for larval dispersal and recruitment as well as other ecological processes. Of particular interest are velocity gradients caused by the interaction of the coastline and alongshore flow, referred to as the Coastal Boundary Layer (CBL). Here, we examine the presence of a CBL at multiple sites on the South and Central California coast. We deployed Acoustic Doppler Current Profilers in transects perpendicular to the shore to measure velocity gradients in the nearshore waters. Data indicate the presence of a CBL whose characteristics reflect interactions of flow with bottom slope and coastal topography. Slower flows nearshore due to the presence of a CBL may be responsible for decreased alongshore transport and increased local retention of some particles, such as larvae.

WARNING COLORATION AND MULLERIAN MIMICRY BY CHEMICALLY-DEFENDED GAMMARID AMPHIPODS

Norton, S.F.*

Centralia College

Experiments with terrestrial insects and tetrapod predators have demonstrated that chemical defense is often accompanied by warning coloration and may lead to the formation of mimicry complexes. Central to both warning coloration and mimicry is learning by naïve predators. In laboratory feeding arenas, individual naïve tidepool sculpins, *Oligocottus maculosus*, were presented over several days with one of three chemically-defended gammarid amphipod species: *Chromopleustes oculatus*, *Ch. lineatus*, or *Cryptodius kelleri*. Initially, tidepool sculpins primarily captured but then spit out individuals of all three prey species – “taste and reject.” Overwhelmingly, individuals of all three amphipod species survived this treatment. On subsequent encounters (same day and subsequent days), predators were more likely to visually identify the defended amphipods and turn away – “inspect and reject”. After several days, predators, now experienced with one amphipod species, were switched to another. Predators with prior experience with one *Chromopleustes* species maintained high levels of “inspect and reject” when exposed to the congener, as if they had prior experience with the new species – Mullerian mimicry. However, when predators that had prior experience with *Cryptodius* were switched to *Ch. oculatus* (or vice versa), their behaviors were similar to those of completely naïve individuals.

† SPECIES RESPONSES TO FOOD WEB PERTURBATIONS: THE USE AND ACCURACY OF QUALITATIVE AND QUANTITATIVE PREDICTIONS.

Novak, M.*

University of Chicago

A principal objective of applied food web ecology is to predict the responses of species to community perturbations. The complexity of direct and indirect interactions typical of real food webs renders such predictions difficult to make with any degree of certainty. Quantitative and qualitative methods lie at two ends of a spectrum of approaches for making such food-web-based predictions. While quantitative approaches require estimation of the strengths of all top-down and bottom-up interactions in a food web, qualitative approaches are essentially interaction-strength free, requiring only knowledge of the topology of a food web. In this talk I will present (1) an evaluation of the utility and practical limits that empirical ecologists face when using Loop Analysis to make qualitative predictions in real food webs, and (2) an assessment of the empirical accuracy with which species interaction strengths will have to be measured to make correct predictions when using a quantitative approach.

† CONSEQUENCES OF HABITAT DISTURBANCE AND RECOVERY TO RECRUITMENT AND THE ABUNDANCE OF KELP FOREST FISHES

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San Diego State University

Complete or partial removal of kelp forests has resulted in large reductions in the density of some rocky reef fishes. The effects of partial removals of kelp that explicitly simulate a gradient in disturbance, however, have not been explored. Manipulations corresponding to 0%, 33%, 66%, and 100% removal of giant kelp (*Macrocystis pyrifera*) were established in 2005 along the leeward side of Santa Catalina Island, California. Surveys of fishes conducted post-disturbance revealed differences in recruitment of kelp perch and a trend for seniority, and differences in the density of older life stages of blacksmith, kelp bass, and kelp perch. For surveys in 2006 and 2007 to monitor the recovery of giant kelp and the density of fishes, there were no differences in recruitment or the abundance of older juvenile and adult fishes among disturbance treatments. To address the effects of a mature vs. recovering giant kelp forest on recruitment of kelp-associated fishes, we conducted an experiment manipulating the distribution of fronds of giant kelp. Total recruitment was significantly higher on adult giant kelp and bundled fronds of juvenile giant kelp than on a dispersed distribution of juvenile kelp, indicating that distribution and not morphology of fronds primarily influences differential recruitment. Our results indicate that although there are clear effects of variable habitat disturbance on the abundance of kelp forest fishes, recovery occurs in a relatively short period of time.

OCEAN ACIDIFICATION AND OTHER BOTHERS; GENE EXPRESSION PATTERNS IN URCHIN LARVAE EXPOSED TO MULTIPLE STRESSORS.

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1 - UCSB Marine Science Institute 2 - UCSB Department of Ecology Evolution and Marine Biology

Ocean acidification and the biological consequences of this altered seawater chemistry have emerged as a significant environmental threat to healthy marine ecosystems. Because a more acidic ocean interferes with fixation of calcium carbonate to form shells or calcified skeletons, future ocean chemistry may significantly alter the physiology of calcifying marine organisms. These alterations may be manifest themselves directly in the calcification process, or more have more insidious effects, such as diminishing the ability of organisms to deal with other environmental stresses. Using manipulative experiments we are exploring mechanisms that may be involved in the deleterious impact of ocean acidification during the development of sea urchins of the species *Strongylocentrotus franciscanus*. Our goals are to explore the direct effects of growing under conditions of elevated CO₂, as well as the response of larvae reared under such conditions to other environmental stresses such as temperature stress. We are using quantitative PCR to assess the expression of a variety of genes associated with biomineralization as well as genes associated with the heat shock response. Larvae raised at elevated CO₂ levels (control = 380ppm vs. higher concentrations of 540 and 970ppm) exhibited a muted transcriptional response to acute thermal stress and expression levels of a variety of biomineralization genes were muted. These results indicate that looking at multiple environmental factors simultaneously may reveal previously unsuspected biological impacts of atmospheric changes.

† CORALS RESISTING WARMING – THE IMPORTANCE OF EXPERIENCE

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Stanford University

Even mild temperature increases can lead to coral bleaching. This breakdown in the symbiosis between a coral animal and its dinoflagellate endosymbionts can have ecosystem scale effects and often leads to coral mortality. Studies have demonstrated that corals hosting certain genotypes of symbiont better resist such temperature increases. However, the role of these resistant genotypes and the relative importance of other mechanisms of adaptation are little known. This study compared resistance to temperature stress among groups of the coral *Acropora hyacinthus* that not only hosted distinct symbionts but also were sampled from two distinct habitats – a lagoonal pool with extreme swings in its temperature profile and a more moderate pool. Replicate branches were taken from 32 corals, and housed in either a tank held at ambient temperature, or a tank held ~2.5 degrees higher. Sublethal effects were monitored using a proxy for the photosynthetic health of the symbionts, the maximum quantum yield (MQY) of PSII. Both visual bleaching and mortality we recorded using a color reference card. MQY measurements showed that there was both a genotype and pool effect: corals fared significantly better either if they hosted a resistant genotype, or came from the variable pool. However, with regard to both color loss and mortality, the only discernable effect was higher resistance of the corals from the variable pool. As the coral populations were not genetically distinct, these results highlight the importance of acclimatization and suggest that bleaching thresholds can vary considerably, depending on a coral's environmental experience.

† EXPLORING THE TOP-DOWN AND BOTTOM-UP FACTORS THAT AFFECT SEASONAL MACROALGAL ABUNDANCE IN A SEAGRASS COMMUNITY

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Macroalgal blooms present a growing threat to coastal systems worldwide. By sequestering light and nutrients, reducing dissolved oxygen, and changing habitat structure, fast growing macroalgae can harm foundation species and alter trophic interactions. Explanations for these blooms have emphasized bottom-up increases in nitrogen from anthropogenic sources such as fertilizer runoff, leaky septic systems, etc. In Bodega Bay, California, we observed both interannual and seasonal variation in green algal (*Ulva* sp.) abundance over a period of three years, with densities ranging from 0 kg/m² in winter to 4 kg/m² (wet mass) in summer during the largest bloom. The goal of this research was to gain greater understanding of the relative contributions of top-down and bottom-up forces in regulating algal abundance in this community. We conducted an outdoor mesocosm experiment that measured the effect of food web effects on *Ulva* biomass using the following three treatments: 1) *Ulva* only, 2) *Ulva* and

invertebrate herbivores (amphipods and isopods), and 3) *Ulva*, herbivores, and fish predators. *Ulva* was significantly reduced in the presence of invertebrate herbivores compared to the control, but there was no reduction in *Ulva* biomass in treatments that included fish. In addition to this lab experiment, we also conducted field experiments that crossed consumer treatments with two nutrient treatments (ambient and elevated nutrients), and these were repeated across the spring and summer to take advantage of seasonal shifts in the food web and ambient nutrient levels. Top-down effects varied between spring and summer, but there was no significant effect of elevated nutrients on *Ulva* biomass in any of the trials. These results suggest factors other than available nutrients are regulating *Ulva* abundance in this system.

† ECOLOGICAL SIGNIFICANCE AND SPATIOTEMPORAL VARIABILITY OF KELP-DERIVED PARTICULATE ORGANIC MATTER (POM) IN STILLWATER COVE, CA.

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Kelp-derived productivity is an important component of kelp forest food webs. Most investigations of kelp trophodynamics have focused on interactions involving direct grazing, however nutrient transfer from drift kelp, particulate organic material (POM) and dissolved organic material (DOM) are hypothesized to be important. Based on the high productivity and biomass of kelp in central California, especially the species *Macrocystis pyrifera*, it is likely that, within kelp systems, plankton-derived POM is enriched by kelp-derived POM, with potential impacts on the productivity and diversity of these systems. Benthic water samples were pumped from the surface, while invertebrate percent cover and tissue samples were collected on SCUBA, in Stillwater Cove, central California. POM quantities were consistently higher inside (>2-fold) and reduced external to the kelp bed, however there was significant variability in the magnitude of POM as well as the beds outer boundary. Water from within the benthic boundary layer and samples from benthic filter-feeding invertebrates were analyzed for stable isotopic concentrations of d13C and d15N to determine POM origin and assimilation of kelp-derived POM. Significant differences between outside and inside the bed were observed, however the system was highly dynamic likely due to variability in upwelling, terrestrial inputs and small-scale habitat complexity.

ASSESSING CHANGE IN FISH POPULATIONS: USE OF META-ANALYSES TO EXAMINE TEMPORAL SHIFTS IN CARIBBEAN CORAL REEF FISHES

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Coral reef ecosystems are under threat worldwide: an estimated 30% of coral reefs are already severely degraded, and nearly 60% are projected to be lost in the next three decades. Despite these alarming observations, our understanding of the scope and ramifications of these changes is still limited. While quantitative estimates of loss of coral cover have recently been published there is currently no estimate of the extent of change in coral reef fish abundance despite increasing natural and anthropogenic pressures upon these organisms. The aims of this project are: (1) to assemble, for the first time, all available information on temporal changes in fish communities on Caribbean coral reefs, and (2) to analyze these data to test predictions about how abundance and community composition change with variation in habitat structure and fishing intensity. We have just completed the data-compilation phase of the project and are currently in the process of using meta-analysis to define patterns in Caribbean reef fish abundance, quantify the magnitude of observed change(s), and identify the primary drivers. Initial results indicate that significant changes in fish abundances have occurred for some guilds of fishes and that using refined definitions of fish functional groups allows more information to be detected. This talk will cover the utility of meta-analysis techniques for marine ecological studies, the challenges of data-gathering, and initial results of the analyses.

† EXPLORING CORAL REPRODUCTION IN THE FIELD: DO SIZE AND MORPHOLOGY INFLUENCE THE REPRODUCTIVE OUTPUT OF THE HERMATYPIC CORAL *MONTIPORA CAPITATA* (SPAWNER)?

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Hawaii Institute of Marine Biology

Modular organisms such as corals grow by adding polyps (or individual modules). This growth is not indefinite however, and eventually colony size will be limited by extrinsic (i.e. nutrient availability, microenvironment within the colony) or intrinsic (i.e. senescence, changes in physiology) factors. Although individual coral polyps grow to full size, polyps do not start producing gametes until the whole coral colony has reached a particular size. While there have been several studies analyzing the size at which corals become sexually reproductive, very few studies have focused on the reproductive ecology of the larger colony size classes, mostly due to the difficulty in transporting huge colonies to aquaria or collecting of the gametes in the field. To better understand the relationships between size, morphology and reproductive capacity, this study examined the reproductive output (gametes) in situ of the hermaphrodite coral *Montipora capitata*. As this coral grows, the morphological complexity of the colony also increases. This coral is highly morphological plastic in response to environmental factors. For example in areas with lower light levels, these species acquires a more flat-shape morphology than in areas with more light (branching morphology). Gametes from different environments were collected in situ during most of the reproductive season (June, July & August). Regardless of differences in morphology and environment, colonies spawned simultaneously and had similar offspring characteristics (egg size, # eggs/bundle).

† **A TALE OF TWO HEADLANDS: RECRUITMENT AND REPRODUCTIVE OUTPUT OF *BALANUS GLANDULA* AND *CHTHAMALUS DALLI* ALONG THE NORTHERN CALIFORNIA COAST**

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Recruitment and reproductive output of barnacles in rocky intertidal zones may be affected by coastal morphology and upwelling intensity. Prior research has shown that recruitment rates tend to be higher in the lees of headlands and lower at headlands sites, and that reproductive output is greatest at sites with high nearshore primary productivity. We monitored recruitment and reproductive output of *Balanus glandula* and *Chthamalus dalli* at two headland sites in Northern California (Bodega Head and McClure's Beach). *Chthamalus*, the competitive subordinate, was more abundant at both sites than *Balanus*, consistent with prior modeled and empirical evidence about the impact of upwelling intensity on competition between these two species. However, recruitment of both species was at least an order of magnitude higher at McClure's Beach than at Bodega Head, and even exceeded recruitment at two nearby lee sites. The proportion of the population brooding larvae for both species was also higher at McClure's than at Bodega Head. Despite the fact that McClure's Beach is a headland, its ecological response mimics that previously seen in upwelling retention zones (e.g., the lee of headlands). Oceanographic evidence and coastal morphology, in concert with the data presented here suggest that MB is located within an upwelling trap or detention zone and that not all headlands behave the same way.

RISE IN SEA LEVEL AND CHANGES IN INTERTIDAL ZONATION: PROFESSOR SNADROCK 60 YEARS LATER

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Global warming has led to sea level rise in many parts of the world over the past century. Since the 1940s, sea level has risen about 15 cm in central California. In July 1947, three students surveyed the abundance and position of six taxa of invertebrates (limpets: *Lottia austrodigitalis/digitalis*, *Lottia scabra*, snails: *Littorina keenae*, *Littorina plena/scutulata*, barnacles: *Chthamalus dalli/fissus*, *Balanus glandula*) along four vertical transects differing in wave exposure in the high rocky intertidal zone at Hopkins Marine Station in Pacific Grove. We resurveyed those transects in July 2007. The same pattern was seen in 1947 and 2007 with respect to wave exposure: for all six taxa, the median height of their distribution was higher along the more exposed transects. However, there a striking shift in the vertical distribution of all the animals. Median height along the transects was higher for all six taxa in 2007, in some cases much higher, and the increase was greatest at the more wave-exposed transects. In addition, incidental taxa characteristic of tidal zones lying mostly below the transects (mussels, owl limpets, chitons) are now more abundant within the lower portions of the more wave-exposed transects. In all the transects, the abundance of the six taxa was lower in 2007 than in 1947, in some cases, much lower; these differences in abundance may reflect interannual variation rather than long-term trends. In contrast, the shift in the median height of the distribution of species almost certainly is a response to rising sea level.

PRODUCTION, DISPERSAL AND LARVAL EXPORT OF A HARVESTED INTERTIDAL MUSSEL IN SOUTH AFRICAN MARINE RESERVES

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Connectivity by larval dispersal influences the ability of populations in a reserve to be self-sustaining and to enhance nearby fished areas through larval spillover. As high-density, high-fecundity source populations for otherwise depleted species, marine reserves are ideal sites of ecological experiments to measure the dispersal of larvae. We measured estimated larval production and recruitment patterns of a harvested intertidal mussel, *Perna perna*, inside and a range of distances outside three marine reserves in South Africa. In two reserves, mussels were more abundant and larger inside reserves, with significantly higher expected production. Recruitment was highest inside these reserves and declined over scales of 5-15 kilometers outside the boundaries. In the third reserve, where harvest outside reserve boundaries is managed by community members, no differences in production or recruitment were found inside versus outside the boundaries. The results suggest that in areas with high fishing pressure, enhanced larval production in reserves leads to the export of larvae outside reserve boundaries, with a larval spillover cloud on the scale of a few kilometers.

DOES GEOLOGY MATTER? THE EFFECTS OF SUBSTRATUM ON COMMUNITY ECOLOGY IN THE TEMPERATE ROCKY INTERTIDAL.

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Evaluating the effects of geology and geologic history on communities and species is imperative for understanding the ecology of extant and extinct communities. Rocky intertidal communities, which have been a hotbed for conceptual advances in community ecology, exist in a mosaic of rock types that differ in many ways. Surprisingly, the role of substrates and their properties on shaping communities has not been adequately tested, despite increasing alteration to the world's coastlines in the face of growing populations and industry. Using techniques in ecology, geology, and molecular biology, this study begins to 1) compare communities on different substrates, 2) identify and characterize rock properties that may be important for supporting unique communities and biofilms, and 3) investigate the role of substratum on recruitment of important herbivores, patellogastropod limpets. Results demonstrate striking differences in abundance, dominance, and size in communities on natural and artificial substrates. Surface roughness at specific scales does not appear to be as important in structuring communities as anticipated from previous studies. Differences between rock types are unique and are likely driven by species-specific responses. Additionally, surface microstructure and mineralogy of these substrates may be important to communities by influencing water retention, biofilm communities, and erosion. Preliminary results suggest that patellogastropod recruitment may be strongly influenced by these features, which are determined by the rock properties characterized here.

† POPULATION GENOMICS OF THE PURPLE SEA URCHIN: DEVELOPING AN ARRAY-BASED SNP DETECTION METHOD TO IDENTIFY POTENTIALLY ADAPTIVE GENES

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The distribution of a species along an ecological cline presents the opportunity to study how natural selection drives local adaptation despite the homogenizing effects of gene flow. The purple sea urchin (*Strongylocentrotus purpuratus*) species range is from Alaska to Baja California, Mexico. Their population sizes are large and gene flow is high, thereby minimizing the effects of demography and maximizing the effects of selection. The challenge in this high gene flow system is to identify which among all 23,000 genes are the targets of selection. Single nucleotide polymorphisms (SNPs) can be used as markers for the identification of potentially adaptive genes. Here, we are developing a method to detect restriction cut-site polymorphisms using the purple sea urchin genome sequence and high-density oligonucleotide arrays. Initial results show predicted signal intensities for negative and positive control features, such as low signal intensity in features with randomly generated sequences and high signal intensity for features in multi-copy ribosomal genes. We have also found very low variation among replicate features across an

array, among replicate arrays, and among control features across individuals. We are optimizing the distinction between SNP and non-SNP features within an individual; however, feature signal intensity variation among individuals within and among populations can be used to distinguish SNPs and non-SNPs. The downstream application of this technology will be to survey the genomes of individuals from populations along the environmental gradient. Diverged SNP frequencies among populations will be used to identify potentially adaptive genes for further functional studies.

ENVIRONMENTAL VARIATIONS AND KEYSTONE PREDATOR PERFORMANCE IN THE INTERTIDAL

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Intertidal organisms have to cope with both marine and terrestrials environments and, as such, they have to deal with abiotic variations in both. We tested if water temperature (during low tide) and aerial body temperature (during high tide) interact with each other in altering the feeding rate of a keystone predator, the starfish *Pisaster ochraceus*. Tide cycle was simulated in water tanks and starfishes were given Californian mussels as prey. Based on field records from Bodega Bay, CA (water temperature between 10°C and 16°C, aerial body temperature up to 30°C), we crossed three aerial temperature treatments and three water temperature treatments, all applied daily during 21 days. Results suggest that cold water helps starfish to recover relatively quickly from aerial thermal stress. In another 21 days-trial run, we measured feeding rates when 10 day-periods of exposure to aerial thermal stress, warm water (16°C) or cold water (10°C) are occurring simultaneously or not (controls are constant temperatures). All treatments have the same temperature average over the 21 days. Surprisingly, starfish performs better over the 21 day-period when aerial and water stressful conditions occur simultaneously. Overall, our results highlight (1) the importance of looking at the interaction between water and aerial abiotic conditions when studying the impacts of environment on species performance in the intertidal, and (2) the importance of temporal pattern of multiple environmental stress signals, which is largely neglected in studies on determinants of variation in species interactions.

SEPARATING THE EFFECTS OF MIGRATION AND COLONIZATION: ANCIENT DNA IN THE NORTHERN FUR SEAL, *CALLORHINUS URSINUS*

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Genetic diversity within and among populations is frequently analyzed to understand evolutionary history and to inform conservation and management of marine species. Separating equilibrium from nonequilibrium genetic patterns, however, is a constant challenge. For example, genetic studies can rarely separate the effects of migration between populations from the effects of recent population colonization, though the implications of these processes are quite different. Previous genetic studies in the northern fur seal (*Callorhinus ursinus*) implied high rates of migration across 4500km of the species' entire range, an unexpected result for a land-breeding pinniped. Using 156bp of the mitochondrial control region, we examined genetic diversity from *C. ursinus* bones and teeth excavated from archeological sites in Alaska, Oregon, and California. Both ancient and modern samples showed very high haplotype diversity ($h = 0.997$ and $h = 0.988$, respectively) and nucleotide diversity ($\pi = 0.048$ and $\pi = 0.046$, respectively). Tests of genetic differentiation indicate that ancient samples have significant population structure ($F_{st} = 0.078$, $p = 0.02$), while modern samples do not ($F_{st} = 0.0028$, $p = 0.17$). We suggest that recent rookery extirpations and colonizations have prevented an accurate assessment of migration rates in this species, and that actual migration is much lower than previously suspected. Surprisingly, genetic diversity does not appear to have been impacted by these events.

ASSESSING THE PHYSIOLOGICAL RESPONSE OF *MYTILUS CALIFORNIANUS* TO ENVIRONMENTAL FACTORS ON A BIOGEOGRAPHIC SCALE

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In this study, we utilized a newly constructed cDNA microarray to profile gene expression in the intertidal mussel *Mytilus californianus* across major portions of its biogeographic range. Overall, the expression pattern for the majority of genes identified in this study varied as a function of collection site and provides support for the hypothesis that the physiological response of *M. californianus* is distinct across populations. Gill tissue was dissected from adult, field acclimatized *M. californianus* collected from four sites across 17° of latitude along the west coast of North America. First strand cDNA prepared from 5 biological replicates from each site were competitively hybridized to a 2,496 feature cDNA microarray. Gene expression patterns in mussels from Strawberry Hill, Oregon displayed a unique expression phenotype that was not comparable to any of the other three mussel populations sampled. In contrast, mussels sampled from Bamfield, British Columbia and Jalama Beach, California showed comparable expression patterns to each other. These data provide empirical support for the argument that environmental impacts on abundance and distribution of intertidal organisms such as *M. californianus* cannot be predicted by latitudinal gradients. This study further serves to highlight the usefulness of genomics-based approaches in assessing physiological responses to environmental variation across large spatial scales.

† THE POPULATION GENETIC STRUCTURE OF THE ROUND STINGRAY (*UROBATUS HALLERI*) IN SOUTHERN CALIFORNIA.

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Round stingrays are known for their year-round aggregation in Seal Beach, CA near a warm water outfall. These stingrays may either be cycling in and out of this location, mistaking it for the warmer waters of an estuary, or part of a larger population. Stingrays were collected monthly at Seal Beach over a five year period to test for variation in population genetic structure. To test the relative size of the Seal Beach population, stingrays were also collected from the Seal Beach National Wildlife Refuge (SBNWR) and San Diego Bay. Additional collections were made at Santa Catalina Island, which is separated from the mainland by a deep channel and is a potential geographic barrier to the stingrays. Results from microsatellite loci indicate that there is no variation in the genetic structure at Seal Beach over time and structure does not vary from the genetic structure found at either SBNWR or San Diego Bay. This is representative of a large, homogeneous population. However, the stingrays at Catalina exhibited a different structure than the other location sampled and may represent a relatively new subpopulation.

RACCOON AND RIVER OTTER PREDATION ON A LARGE LEACH'S STORM-PETREL COLONY.

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Leach's Storm-Petrels (*Oceanodroma leucorhoa*) are burrow-nesting seabirds that breed on islands in the northern Pacific and Atlantic. There are 7 significant colonies of Leach's Storm-Petrels in Oregon. The 3rd largest in the most recent colony survey (1989) was located on Saddle Rock (N 42.250 W -124.414) with an estimated 87,500 birds nesting. This site is vulnerable to terrestrial predation due to its contiguity with the mainland at low tide. In recent years, an increase in visitation of raccoons and river otters to Saddle Rock has resulted in increased bird mortality. In summer 2007 I monitored nesting density and burrow occupancy rates on Saddle Rock to assess predation pressure. I compared these data with those from the nearby, mammalian predator-free Hunters Island (N 42.324 W -124.425). Saddle Rock now hosts significantly lower densities than Hunters Island, when historically, Saddle Rock had the higher density. Comparisons of Saddle Rock nesting density and burrow occupancy with data from 1979-1997 show a steep population decline. I collected storm-petrel carcasses and mammalian scat bi-monthly from February 2007 through October 2007. Carcass collection conservatively estimates predation rates ranging from 0 to 47 birds per night, with predation occurring on 7 of 11 nights checked. Predator scat analyses indicate that the local raccoons rely more heavily on storm-petrels than the river otters. My data suggest that the Saddle Rock Colony, once thought to be one of the largest in Oregon, is now in danger of extirpation.

DEMOGRAPHIC PARAMETERS OF YELLOWFIN CROAKER, *UMBRINA RONCADOR*, (PERCIFORMES: SCIAENIDAE) FROM THE SOUTHERN CALIFORNIA BIGHT

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Yellowfin croakers, *Umbrina roncadore*, are a common nearshore and surf zone species in the southern California bight. Individuals (n = 1209) were aged using otoliths. The maximum age was 15 and size at age was modeled using the von Bertalanffy growth curve ($L_{\infty} = 307.754$, $k = 0.278$, $t_0 = -0.995$). Females ($L_{\infty} = 313.173$, $k = 0.307$, $t_0 = -0.771$) grew significantly faster and larger than males ($L_{\infty} = 298.886$, $k = 0.269$, $t_0 = -1.072$). Age and growth modeling based upon otolith measures were presented and were consistent with body measures. Males and females were found at all size classes and in 51:49 ratio that was not significantly different from a 50% sex ratio ($X^2 = 0.7$; $P > 0.1$) indicating that these fishes were gonochores. Fishes were reproductive in the summer months with gonadosomatic indices (females = 5.65% and males = 5.51%) consistent with group spawning fishes. In two separate monitoring programs, their abundance fluctuated appreciably from 1992-2004 on both spatial and temporal scales and catch was declining significantly by the end of this program. Based upon samples collected between 2003 and 2004, annual and instantaneous mortality estimates were $A = 0.4492$ and $Z = 0.5964$. Using annual survivorship, back calculated recruitment year classes were determined. Year class strength was variable and declining significantly by the end of this study. Considering the high variation in abundance, catch, and recruitment coupled with a group spawning reproductive scenario, we recommend a cautious approach for the future management of this species.

PHYSIOLOGICAL CONSEQUENCES FOR CORAL REEF MACROALGAE INHABITING REFUGIA FROM HERBIVORES

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Benthic algae are essential components of reef communities, and as key primary producers, their distribution and abundance can greatly influence reef productivity. For this study, a series of quantitative assessments and manipulative experiments were used to test the role of herbivory and habitat suitability on the physiology of macroalgae across the back reef of Moorea, French Polynesia. Surveys of Algal distributions revealed that the majority of macroalgae are limited to cracks and holes in large coral heads and absent from open available spaces. Because characteristics pertaining to size and shape are predicted to influence habitability, analysis of habitat dimensions (depth, width, and length) allowed for the classification of microhabitats as either narrow crevices or deep, open holes. These functional groups were used for all mensurative and experimental approaches throughout the study. Herbivore assay experiments, comparing consumption of macroalgal individuals placed within a crevice or hole versus the open reef, suggest that microhabitats provide structural refuge from herbivores due to lack of accessibility. Macroalgae also may be limited physiologically due to the physical characteristics of their microenvironment. Light profile measurements indicated substantial decreases in light availability with increasing distance into a microhabitat. Additionally, estimates of light-adapted quantum yield indicate a decrease in photosynthetic performance for macroalgae in refugia compared to individuals in the open. These results suggest that algae escape herbivory by inhabiting spatial refugia but do so at a physiological cost.

† THE INCREDIBLY SLOW RACE FOR SPACE: COMPETITIVE REVERSALS AMONG CORALLINE ALGAE.

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Temporally or spatially dependent competitive reversals are common and often attributed to changes in resource availability. Encrusting coralline algae compete for space on the reef via overgrowth. The competitive strengths among various species of crustose coralline algae (CCA) can depend jointly upon species-specific characteristics and environmental conditions. Corallines depositing thick thalli (>10mm) are predominant on exposed surfaces, presumably because they deter overgrowth from competitors, shed epithelial layers to prevent fouling, and recover quickly from intensive grazing that both removes filamentous epiphytes and stimulates crust accretion. CCA with thinner crusts are relatively more abundant in light limited, cryptic habitats. This series of manipulative field studies

parse out the biotic and abiotic factors that influence relative abundance and competitive abilities of four common species of CCA in Moorea, French Polynesia. Pair-wise field competition experiments revealed that the two thick-crust coralline species are indeed superior space competitors on exposed reef, but this competitive dominance reverses in cryptic habitats. CCA producing thin thalli are relatively more susceptible to urchin grazing and are abraded more frequently in manipulative field experiments. However, both thick and thin crusted species are able to photo-acclimate in a reciprocal transplant experiment. In a four-year recruitment study, the thin crusted species are quicker to colonize and grow laterally to occupy available space, but thick CCA eventually dominate exposed surfaces. Thus, the relative abilities of each species of calcareous algae to colonize, extend thalli, and survive herbivory, not only resource limitation, will determine which species will dominate the competition for space.

† DOES MARKER VARIATION REALLY MATTER? INSIGHTS FROM THE POPULATION STRUCTURE OF *PATIRIA MINIATA*

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Molecular ecologists and conservation geneticists often face a fundamental experimental design question: What is the appropriate amount of marker variation for the proposed population genetic analysis? Potential genetic markers are often abandoned for too little or too much variation. Intuitively, a marker with too little or no variation cannot be used to discern differences between populations, but can a marker be too polymorphic for population genetics? To examine, the population structure of *Patiria miniata*, the bat star, was assessed using two independent nuclear loci. A hypervariable intron in the alpha subunit of ATPsynthase and a moderately variable intron in glucose phosphate isomerase, were sequenced and genotyped in 170 individuals across 7 different populations throughout the range of *P. miniata*. Additionally, results from both nuclear loci will be compared to results obtained from ongoing collaborative work using microsatellite and mitochondrial loci. Implications for congruent patterns in all marker sets will be discussed.

† THERMAL HETEROGENEITY PRODUCES DIFFERENT RESPONSES IN CORAL HOSTS AND THEIR ALGAL SYMBIONTS

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The effects of high temperature on corals have been studied extensively, but little is known of the response to frequent thermal fluctuations that are common on shallow reefs. In the lagoons of French Polynesia, daily variations of ~3°C create a potentially challenging physical environment, yet coral communities in these habitats are extensive and largely healthy. Using the corals *Pocillopora meandrina* and *Porites rus* as model systems, this study explored the extent to which fluctuating temperatures affect the physiology of corals. Indoor microcosms were used to create three treatments of 30°C, 28°C, 26°C, and a fourth treatment oscillating from 26°-30°C on a diel cycle. Corals were incubated in these treatments for 12 d, and their responses assessed from changes in “symbiont traits” (dark-adapted yield [FV/FM], chlorophyll-a content, and *Symbiodinium* density) and a holobiont trait (skeletal growth). A multivariate approach identified one principle component (PC) that accounted for much of the variance (40%) in all four physiological traits, and this PC was significantly affected by the treatments. Univariate analyses revealed that the multivariate effect was driven primarily by large declines (17-45%) in *Symbiodinium* density in the oscillating treatment, but in contrast, growth was unaffected. These results are interesting because they show, for two coral species, that variable lagoon environments can have negative effects on symbiont traits, yet they have little effect on a fitness-related trait of the holobiont. It is possible that the fitness of corals may be conserved in thermally heterogeneous environments through plastic responses of their symbionts.

† FEEDING MORPHOLOGY AND KINEMATICS IN SURFPERCHES (EMBIOTOCIDAE: PERCIFORMES): EVOLUTION AND FUNCTIONAL CONSEQUENCES

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Morphological differences in feeding mechanisms are assumed to relate to differences in feeding mode and prey capture performance. Such differences are thought to explain how the Embiotocidae manage to co-exist in spite of

tightly overlapping geographic ranges. Embiotocids can possess one of several different feeding modes: browser-picker, crusher, and oral-winnower. We hypothesize that mechanical models, such as the anterior jaws 4-bar linkage model, can be used to interpret the differences in underlying morphology, tying anatomy to feeding mode and ultimately performance. Several specimens ($n \sim 10$) representing each of the 14 genera of Embiotocidae were examined using the concepts of lever mechanics to quantify the anterior jaw musculoskeletal system. Preserved specimens were dissected and the components of the anterior 4-bar linkage measured along with other morphological variables associated with feeding (e.g. gape, jaw protrusion, and muscle mass). Trends in these variables among species seem to provide a basis for variation in feeding mode. However, our findings do not suggest that function is reflected in the underlying morphology. Genera containing more than one species were observed to have similar morphology regardless of feeding behavior. Therefore, we hypothesize that the primary determinant of feeding ecology is linked to evolutionary relationships in embiotocids. A subset of these species was investigated using high-speed video (250 - 500 fps) in order to identify differences in prey capture behavior with different feeding modes. This kinematics study further suggested that differences in the feeding mechanism directly relates to differences in feeding behavior and not underlying morphology.

EXPLORING GENE DUPLICATION IN RAPID EVOLUTIONARY RADIATIONS

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The cichlid fishes of the African rift lakes are one of the most speciose vertebrate groups. This species diversity is the result of repeated rapid adaptive evolutionary radiations. Gene duplication events are thought to be a major driver of such evolutionary adaptation. I am using microarray-based competitive heterologous genomic hybridizations to identify duplicated and diverged genes corresponding to these explosive radiations. I have identified a list of genes which are apparently duplicated in several derived, lacustrine species relative to a more ancestral, generalist, riverine species, and am currently validating a subset of these apparent duplications with non-array methods. Such studies may provide insight into the genes, or categories of genes, involved in evolutionary radiations.

† EXTREME MALE MATING BEHAVIORAL PLASTICITY IN *VARGULA ANNECOHENAE*, A MARINE BIOLUMINESCENT OSTRACOD.

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Throughout the year, about an hour after the sun sets, a complex and ritualized light show of precise, vertically placed luminescent pulses erupts over the shallow grassbeds of the western Caribbean. These are the most complex displays known in marine systems. Displays consist of repeated trains of secreted bioluminescent pulses in a specific pattern ejected into the water column for courtship by male *Vargula annecohenae*, small (<2mm) myodocopid ostracod crustaceans. The development of new observational techniques using image intensification and infrared videography has allowed us to observe the swimming and display behavior of individual ostracods in both the laboratory and the field. Using frame-by-frame video analysis, we observed the behaviors of individual males during multiple courtship displays in the lab. We discovered that each participating male is capable of 1) initiating a luminescent display train, 2) entraining on another displaying male in loose luminescent synchrony, and 3) ‘sneaking’ silently on a luminescing male. *Vargula annecohenae* exhibits mating behavior plasticity at a rate unparalleled in any other described system, and can switch among these three tactics during a single, 10-second train. Although extremely plastic, there appear to be fairly simple rules that, when followed, allow us to predict with high accuracy which alternative mating tactic will be chosen under particular circumstances.

† THE EFFECTS OF PARTICULATE FOOD DEPRIVATION AND THE PRESENCE OF DISSOLVED ORGANIC MATERIAL ON THE SURVIVAL, GROWTH AND DEVELOPMENT OF *MYTILUS GALLOPROVINCIALIS* LARVAE.

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Marine bivalves spend a part of their lives as pelagic larvae where they face the risks of unpredictable food availability, competition for resources, and predation. If larvae were able to utilize dissolved organic material

(DOM) as a source of nutrition when particulate food was unavailable, it could improve their rate of survival. In this study *Mytilus galloprovincialis* larvae were maintained in tanks of 0.45 μ m filtered seawater, seawater with added DOM, and a normal particulate food supply. Larval survival, growth and development were measured over time. *M. galloprovincialis* larvae were found to remain functionally viable without feeding for 26 days. Added DOM or particulate food did not make a significant difference. The rate of development was found to be increased in both the DOM and particulate food treatments over the filtered seawater. Larval shell length increased in the presence of particulate food, but not in the DOM or seawater treatments. The differences in shell length continue even after all larvae were placed on particulate food, suggesting early food limitations could have long term effects on fitness.

INTERTIDAL MUSSEL ZONATION AS AN EQUILIBRIAL PROCESS

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Classical theory maintains that intertidal beds of the mussel *Mytilus californianus* occur in a spatial refuge from predation. The lower boundary of the mussel bed is believed to be fixed at a critical shore level above which tidal emersion prevents effective foraging by predatory sea stars, *Pisaster ochraceus*. The theory was tested with a large-scale experiment in Barkley Sound, British Columbia. Sea stars were removed repeatedly from four rock benches and added to four matched benches. The removal and addition sites were compared with matched control sites. After three years, the location of the lower boundary of mussel beds was forced up- or down-shore by increasing or decreasing sea star densities. At the outset of the manipulations, rectangular plots 1.2 m square with the lower side along the lower boundary were cleared of mussels. Predation kept addition plots free of the mussels, whereas plots on removals and controls developed significant numbers of reproductive mussels. Analysis of sea star diets, indicated that as small prey became scarce on addition sites, the sea stars increasingly consumed the large mussels comprising the matrix of the lower boundary, causing it to fragment and recede up-shore. The results demonstrate that the lower boundary is not fixed to a critical shore level, but rather they suggest that the lower boundary is a manifestation of complex biotic equilibria that include adjustments in size-size dependent predation over the tidal emersion gradient.

COMPARATIVE PHYLOGEOGRAPHY AND INTROGRESSIVE HYBRIDIZATION IN TWO CARIBBEAN SEA SLUGS WITH NON-PLANKTONIC DEVELOPMENT

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For benthic invertebrates, dispersal depends on planktonic larvae or rafting by adults. *Elysia pratensis* and *E. subornata*, sister species of Caribbean sea slugs, lack a dispersing larval stage; thus, populations from different islands are predicted to diverge genetically. To compare phylogeographic patterns, *E. pratensis* and *E. subornata* were sampled from Florida, five Bahamas islands, Bermuda and Jamaica. Portions of the mitochondrial cytochrome c oxidase I (COI) and nuclear large ribosomal subunit (28S) genes were sequenced from all specimens. Bayesian phylogenetic analysis of COI haplotypes revealed four distinct clades up to 8% divergent in *E. pratensis*; analysis of molecular variance revealed highly significant differences among populations ($F_{st}=0.935$), with most sites exhibiting reciprocal monophyly. Two *E. pratensis* clades from the northern Bahamas were more closely related to *E. subornata*, suggesting hybridization and historical introgression of the mitochondrial genome from *E. subornata* into *E. pratensis*. A fixed difference in the nuclear 28S gene, morphology and host use distinguished the two species, supporting the hypothesis of introgression and “mitochondrial capture.” Less population structure ($F_{st}=0.389$) and no phylogeographic breaks were evident in *E. subornata*, comparable to results for *Elysia spp.* with short-lived larvae; adult *E. subornata* may raft between sites on their buoyant host alga, *Caulerpa racemosa*. These data offer insight into Caribbean population connectivity, critical to conservation and management of threatened reef ecosystems. Introduction of *E. subornata* into the Mediterranean has been suggested for biological control of invasive *Caulepa spp.*, but its potential for dispersal and hybridization with native species urges a cautious approach.

HIGH-SPEED VIDEO REVEALS DIRECT PARTICLE CAPTURE BY CILIA DURING FEEDING OF A GASTROPOD VELIGER

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Ciliary feeding in invertebrate larvae is variable in both arrangement and mechanism. Opposed band feeders, such as gastropod veligers, are characterized by circumferential, parallel running bands of preoral (i.e., prototroch) and postoral (i.e., metatroch) cilia, which function to capture food particles. The mechanism by which cilia of the prototroch capture incoming particles could be direct (i.e., sieving or adhesion), indirect (via water current flow), or both, but unequivocal evidence for either mechanism is lacking. Through the use of high-speed video, we present evidence that the veliger larvae of *Lacuna vincta* intercept particles directly, contacting each particle with a single prototochal cilium. Metatrochal cilia have been suggested to retain captured particles, but we show for the first time that they also directly intercept particles. Also, we provide evidence that cilia capture and transport larger particles than can be ingested, confirming the hypothesis that veliger cilia do not discriminate among particles based on size.

† DISTRIBUTION, ABUNDANCE AND MICROHABITAT CHARACTERIZATION OF JUVENILE CORALS AT PALMYRA ATOLL

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Coral population dynamics are poorly understood, particularly in early life history stages. In surveys, juvenile corals are often categorized with larger and older corals or are overlooked entirely due to their small size and cryptic nature. To overcome these difficulties, this study aided the detection of juvenile corals with equipment to visualize corals' autofluorescence during daylight. This research characterized the distribution, abundance and microhabitat of juvenile corals at Palmyra Atoll, Central Pacific. In this study, juvenile corals were defined as corals ≤ 5 mm in diameter. Juvenile densities up to 59.5/m² (± 0.94 CV) were observed on the forereef, with the highest juvenile densities at a depth of 14m. In contrast, juvenile densities on the backreef were over eight times lower than the forereef. Overall, juvenile corals accounted for 33% of the coral population from all habitats and depths. The microhabitat of juvenile corals on coral rubble was best described as an exposed surface covered with crustose coralline algae without another coral within a 20mm radius. These results show that juvenile corals constitute a significant portion of the total coral population and their abundance varies among reef habitats. Additionally, this research showed the feasibility of effectively surveying corals in early life history stages. Because juvenile corals are susceptible to stressors, they could be monitored as canaries or early indicators of changing environmental conditions on a coral reef.

CHARACTERIZING COLONY FORM IN COLONIAL HYDROZOANS.

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Colonial marine invertebrates often show great variation in colony morphology that is associated with ecologically important traits. The continuum of morphological variation in encrusting forms, like hydractiniid hydrozoans, spans from 'sheet' colonies characterized by densely packed polyps on a stolonial mat consisting of highly anastomosed stolons with few, if any, peripheral stolons to 'runner' colonies characterized by widely spaced polyps, many occurring along sparsely branched long peripheral stolons extending beyond the anastomosed stolonial mat. These qualitative descriptions are typical and characterize morphological variation, yet previous work has rarely incorporated more than one or two of these morphological variables into studies of colony form. We sought to develop an image analysis method to quantitatively characterize colony form encompassing the aforementioned variables using *Hydractinia symbiolongicarpus*. We collected 68 male and 53 female colonies of *H. symbiolongicarpus*, propagated 5 replicates of each genotype onto glass slides and grew them in a common garden for 15 days at which time colonies were photographed. Image analysis macros collected data on polyp numbers on mat and stolons, respectively, peripheral stolon number, and the areas and perimeters of stolonial mat and peripheral stolons, respectively. Multivariate data were used in a discriminant analysis to distinguish 3 morphotypes; runners, sheets and intermediate forms and the morphological variables that best correspond to each. Runners and sheets are correctly distinguished from each other >95% of the time, but each can be confused with intermediate phenotypes. Multivariate descriptors, in addition to individual variables, characterizing form are useful in heritability studies of morphology

THREE PHILOSOPHIES OF ED RICKETTS AND THE CHALLENGES OF ECOSYSTEM BASED MANAGEMENT

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Ecologist Ed Ricketts' philosophy of "non-teleological thinking" which stresses the importance of "is" rather than "should" statements is appealing to conservation biologists who root their work in natural history. Yet when it comes to applying our science to the policy arena, by contrast, we tend to suggest a priori rules and definitions and expect positive policy outcomes to follow. This is especially true in the case of the current struggle to implement "ecosystem based management" (EBM) in marine systems. Through a review of current literature and conservation programs based on EBM concepts, we show how even broad guidelines for implementation often fail to account for the full scope of impacts in a given situation. Here, Ricketts holistic philosophy, which builds individual observations of humans and nature into a complete ecosystem picture, can play a guiding role. Finally, Ricketts' philosophy of "breaking through", which stresses that true progress often follows a period of extreme crisis, is applicable to the current crisis in marine conservation biology. We argue that EBM may be the way to break through this crisis, but only if it is applied in the holistic framework that Ricketts espoused.

INTERCOHORT COMPETITION DRIVES SHELTER-MEDIATED DENSITY DEPENDENCE IN A CORAL REEF FISH

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For many organisms with complex life cycles, regulatory density dependence occurs during the early life history stages. Density-dependent mortality of recently-settled juvenile reef fishes, often due to competition for enemy-free space, appears to be particularly widespread. Less well-known is how the density of older age-classes influences survival of younger juveniles. Here we experimentally test the hypothesis that competition for enemy-free space between adult and juvenile goldspot gobies (*Gnatholepis thompsoni*) determines mortality and somatic growth of juveniles during their first month of reef-based life. We added rocks, which provide shelter from predators, to one half of each of five entire coral reefs in the Bahamas, and measured the survival and growth of recent settlers in relation to adult goby densities. Increasing adult goby density negatively affected juvenile survival in both low- and high-shelter habitats, though experimental shelter addition reduced the intensity of this density dependence. Juvenile growth also declined with increasing adult goby density, but this effect was similar in both low- and high-shelter habitats. We suggest that both demographic patterns were likely a consequence of adult aggression toward juveniles. Given the typically large difference in sizes of juveniles and adults, similar stage-structured interactions may be common but underappreciated in many marine species.

VARIATION IN THE REPRODUCTIVE OUTPUT OF THE SEA STAR *PISASTER OCHRACEUS*: ARE SOURCE POPULATIONS PREDICTABLE AND CONSISTENT?

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A common goal of marine reserve design is to identify and protect reproductive sources that may replenish surrounding areas through larval export. However, few studies have tested whether patterns of reproductive output are in fact predictable and consistent spatially and temporally. During six years between 1995 and 2005, we examined nutrient storage and gonad production in the sea star *Pisaster ochraceus* at two rocky intertidal sites on the central coast of Oregon. Sea stars accumulated energy in the pyloric caeca during a short season of intensive feeding (May-September). Within a site, the size of the pyloric caeca attained by the fall accurately predicted reproductive output during the following spring. Consistent with hypotheses regarding bottom-up effects, the pyloric caeca were generally larger at the site where high quality prey (i.e., mussels) were more abundant in the diet, indicating a greater accumulation of surplus energy. Surprisingly, however, gonad indices were consistently 50% lower at this site, suggesting striking differences in allocation to reproduction. This difference between populations was maintained despite marked variation among years in oceanographic conditions and reproductive output. These results suggest that (1) source populations may be consistent spatially, but (2) identifying those sources may be more complex than simply targeting areas with high quality resources and strong bottom-up influences. Rather, predicting patterns of per capita reproductive output may require a more detailed understanding of the causes of spatial

variation in allocation to maintenance, growth, and reproduction.

OCTOPUS IMPACTS ON INTERTIDAL CRAB COMMUNITIES

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Intertidal dynamics have been a principle laboratory for the formulation and testing of ecological ideas over the past half-century. In this study, we have collected evidence of size-selective predation by octopuses (*Enteroctopus dofleini*) on small crabs in intertidal habitats in Prince William Sound, Alaska; and are interested in predation as a modifier of interactions in intertidal communities. Using measurements of size, population density, energy content of crabs, and midden content of octopuses, we show that octopuses select larger individuals of common prey species. However, certain prey species are selectively chosen over others, and these preferences cannot be accounted for on the basis of the energetic content of the prey. Size selectivity increases in the face of declining size of individuals in the prey community, which likely affects foraging costs of the octopuses. Sites with greater octopus abundance had significantly lower dominance, as octopuses selectively preyed upon and depressed the abundance of one of the most abundant crabs in the community. This suggests, first, that octopuses may chose prey on the basis of a search image (although this remains to be tested), and second, may indicate the importance of octopuses in mediating negative interactions between large crabs and small crabs as well as other intertidal organisms negatively impacted by large crabs.

† PRELIMINARY OBSERVATIONS OF TERRITORIAL BEHAVIOR IN THE OWL LIMPET *LOTTIA GIGANTEA* USING TIME-LAPSE PHOTOGRAPHY

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Territory, defined as an exclusive area defended by an animal or group of animals, is thought to have evolved as a means to acquire limited resources such as food, nest sites or mates. Most studies of territoriality have focused on vertebrates, which have large territories, and even larger home ranges. While there are many models used to examine territory and territorial interactions, testing of the models is limited by the logistics of working with the typical model organisms – vertebrates – and their large territories. An ideal organism for the experimental examination of territoriality would exhibit clear territorial behavior in the field and lab, would be easy to maintain in the lab, would defend a small territory, and have movements and social interactions that were easily followed. *Lottia gigantea*, the owl limpet, is just such a model animal. With a small territory and slow movements, the interactions of *L. gigantea* can be easily monitored. To begin examining limpet territoriality, time-lapse photography was used to track nine individual *L. gigantea* in the lab on a mock intertidal setup for seven days. Limpet behavior was the same as observed in the field. Limpet size was strongly correlated with home range area; larger limpets had larger home range areas. Seven of the nine individuals defended a territory while two individuals repeatedly intruded on adjacent territories. Territorial interactions resulted 91% of the time when a territory holder encountered an intruder.

CONNECTIVITY OF KELP BASS POPULATIONS EXPLAINED BY KELP COVER

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Like many marine species, kelp bass (*Paralabrax clathratus*) shows high rates of gene flow and little evidence for isolation by distance. In the Southern California Bight, linear distance between sites would not be expected to be a strong driver of genetic patterns because circulation is highly complex. Using a landscape genetics approach, I investigated several alternative drivers of genetic differentiation measured with 7 microsatellite markers for kelp bass sampled at 8 sites in the Southern California Bight: latitude, kelp cover, bottom area for 0-30m depth, rocky reef area, population density, and degree of upwelling. Together, latitude and kelp cover explained >95% of the variance (R²) in FST values; individually, latitude explained 50% and kelp cover explained 88%. The correlation with kelp cover peaked at a 14 km radius from the sampling site, indicating that the mechanism responsible acts on a surprisingly localized scale given the 30 day larval period and low overall genetic differentiation. The kelp cover correlation likely occurs because kelp bass recruit to kelp, so a site with high kelp cover is able to “catch” more incoming juvenile kelp bass from offshore, and thus is better connected to other sites. Because population density,

and perhaps spawning success, is higher to the south, latitude also reflects access to immigrant recruits. These results may be valuable to marine reserve network design, and suggest that kelp bass populations in the southern- and northern-most portions of the Bight have better connectivity than at the center.

† EXOTIC SPECIES AS HABITAT: CAN NONNATIVE FOUNDATION SPECIES FACILITATE NATIVE EPIFAUNA?

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The introduction of non-native organisms into estuaries via international shipping and aquaculture has greatly impacted these communities. Native and exotic sessile invertebrates act as foundation species in these systems, and may influence the distribution and diversity of associated epifauna. I measured epifaunal recruitment on monocultures of native and exotic sessile foundation species to test the hypothesis that non-native foundation species facilitate non-native epifauna (i.e. invasional meltdown). I also examined the role of structural complexity in determining epifaunal species composition by comparing total surface area of treatments with abundance, species richness, and diversity of epifauna. Diversity and species richness of mobile invertebrates were significantly greater in more complex treatments, but total abundance was not correlated with habitat complexity. Total cover of sessile epifauna also differed between treatments, with less evidence of competition for space over time in more complex treatments. I found no evidence of invasional meltdown, and my results suggest that the structurally complex non-native bryozoan *Watersipora subtorquata* facilitates native species by providing more heterogeneous habitat and ameliorating competition for space. Because the epifaunal assemblages of live *W. subtorquata* and structurally complex mimics had similar native:exotic ratios, facilitative impacts are likely due to complexity per se rather than any particular characteristic of this species. These results suggest that the impact of a non-native foundation species depends largely on the quality of habitat it provides.

VALIDATED AGE, GROWTH, AND OTOLITH MORPHOLOGY OF WHITE SEABASS, *TRACTOSCION NOBILIS* FROM THE SOUTHERN CALIFORNIA BIGHT: PRELIMINARY RESULTS

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Growth parameters were estimated for white seabass (*Atractoscion nobilis*) occurring off southern California based on otolith annuli. Sagittal otolith annuli were validated using tagged and released, hatchery-reared white seabass, recovered up to an age of 12 years. Frontal sections of sagittal otoliths were used to validate ages for 371 fish of known age (163 to 1193 mm TL). Discrete ages were also estimated by three readers from images of sectioned otoliths from known-age fish, and the accuracy and precision among readers was quantified. In addition, ages were estimated from sectioned otoliths of 790 wild white seabass (135 - 1524 mm TL) and precision among readers was quantified. Otolith morphology was examined and the mass of the otolith was found to be an appropriate estimator of age. For wild fish, likelihood ratio tests indicated no significant difference ($X^2 = 0.019$, $P = 0.891$) between the Von Bertalanffy growth parameter estimates for males (to = -1.814, $K = 0.156$, $L_{inf} = 1459$) and females (to = -1.814, $K = 0.160$, $L_{inf} = 1462$). Growth parameter estimates were compared between hatchery-reared and wild white seabass. A significant difference ($X^2 = 13.055$, $P = 0.0003$) was detected between the wild (to = -1.7, $K = 0.165$, $L_{inf} = 1455$ mm TL) and hatchery-reared (to = -1.7, $K = 0.125$, $L_{inf} = 1355$ mm TL) seabass when gender was not considered. This suggests that wild white seabass may grow slightly faster and achieve a larger maximum size than the hatchery-released fish.

THE CAUSES OF VARIATION IN BARNACLE SETTLEMENT AS REVEALED BY DAILY SETTLEMENT VS. RECRUITMENT AT WEEKLY AND LONGER INTERVALS

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Studies of the daily settlement of crabs and barnacles find that settlement varies with the spring to neap cycle and weak or no correlation with wind. When recruitment has been measured weekly or monthly, researchers report settlement varying with the winds; larger settlement during downwelling. To reconcile these differences, I replicated both types of experiments at the same place and time. Safety Walk barnacle settlement plates were divided into four

sections, which were counted daily, weekly, biweekly, or every four weeks. While settlement on plates was high, recruitment was extremely low. In the sun, Safety Walk plates heat up rapidly reaching temperatures of 40 to 50 oC within 15 min; at these temperatures cyprids rapidly desiccated. Recruitment to the biweekly plates, but not to the weekly or four-week plates, was correlated to cyprid settlement. There were, however, no significant correlations between any physical variable and recruitment on weekly, biweekly, or four-week plates. Recruitment provided no insight into the causes of variable settlement, but measurements of daily settlement did. Daily settlement was pulsed with peaks 14 days apart situated between the neap and spring tides. Settlement was significantly cross-correlated with tidal range. In a cross-Fourier analysis, 70% of the variation in settlement at the 14-day period was explained by the daily tidal range. Removing the tidal correlation from the settlement data, I found a weaker roughly 10-day cycle in settlement that was related to the wind; higher settlement at the onset of upwelling.

**SPATIAL AND TEMPORAL VARIABILITY IN THE SETTLEMENT OF SEA URCHINS
(*STRONGYLOCENTROTUS FRANCISCANUS* AND *S. PURPURATUS*) AT THE CHANNEL ISLANDS,
CALIFORNIA**

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Sea urchins are potentially the most commercially and ecologically important herbivore on temperate reefs worldwide. Understanding spatial and temporal variability in the recruitment of sea urchins is necessary for ecosystem-based management of fisheries in order to predict where fishing sea urchins, or their predators, may have community-level effects on kelp forests. We investigated settlement patterns of red and purple urchins (*Strongylocentrotus franciscanus* and *S. purpuratus*) at 14 sites spanning the Channel Islands and Santa Barbara Channel between April and October 2007. Settlement collectors (scrubbing brushes) were attached at 5 and 15 m depth to moorings located adjacent to reef habitats at each site. Peak settlement occurred across all sites in June, prior to maximal summer temperatures, and low levels of settlement occurred until late September. Purple urchins made up 94% of the settlers collected, but the spatial and temporal variation for both species was consistent among sites. Settlement was consistently low at the mainland sites, where the densities of both species were low. There was clear spatial variation among the Channel Island sites with settlement consistently highest at Anacapa Island sites. Settlement patterns were broadly reflected in the size structure of urchins among the sites examined suggesting some level of interannual consistency in the observed spatial variation. Further investigations into the underlying oceanographic processes associated with these patterns are underway.

† THE ORIGIN AND COST OF MALE RARITY IN THE SURFGRASS *PHYLLOSPADIX SCOULERI*

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The surfgrasses (genus *Phyllospadix*) are dominant, habitat generating species of intertidal rocky shores throughout the north Pacific. Surfgrasses are dioecious (have separate sexes) and a persistent feature of surfgrass populations is male rarity. The origin and implications of female-biased sex ratios for surfgrass populations has never been explored. At seven sites in Washington state, I demonstrate widespread rarity of flowering male *Phyllospadix scouleri* patches (< 15% male at all sites). Using a new set of sex-specific AFLP markers I assay sex ratios at multiple life stages (seedlings to large patches) to identify the origin of male rarity. While vegetative shoots sampled from large beds are similar to flowering sex ratios (< 15% male), seedling sex ratio is approximately 50% male indicating that increased male mortality drives adult sex ratio skew. Field surveys show substantial declines in seed set and seedling recruitment as male become more rare, indicating a demographic cost of male rarity. Preliminary demographic modeling suggests that skewed sex ratios persist because population growth rate is insensitive to sexual reproduction relative to vegetative reproduction in *P. scouleri*.

**RESISTANCE TO A CRYPTIC INVASION AND FUNCTIONAL REDUNDANCY IN ROCKY
INTERTIDAL MUSSEL COMMUNITIES**

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The rocky intertidal communities of northern California mark the invasion front the Mediterranean bay mussel,

Mytilus galloprovincialis. Previous studies of competition among *Mytilus* spp. indicate that *M. galloprovincialis* may be competitively superior to native mussels, and is contributing to the decline of *Mytilus trossulus* in its southern range. In this study, we examined whether native predators generate biotic resistance to the invader. Evidence from both field and laboratory predation experiments suggests that the dogwhelk, *Nucella ostrina*, may be the most important and selective predator of *M. galloprovincialis*, however the rates of predation suggest that predators alone might not limit further invasion. Given the likelihood of further spread, we also examined the impact of *M. galloprovincialis* invasion by comparing the equivalence of biogenic habitat created by native and invasive *Mytilus* spp. through the development of epibiont communities associated with mussel shells. Among artificial mussel beds (shells only), *M. californianus* supported the greatest species richness and diversity. In contrast, *M. galloprovincialis* and *M. trossulus* supported comparably lower species richness and diversity, indicating functional redundancy. Among living mussels, species richness and diversity were lowest on *M. galloprovincialis* and highest on *M. californianus*. Overall, displacement of *M. trossulus* by *M. galloprovincialis* may have minimal impact on associated community structure. However, continued spread of the invader at the expense of *M. californianus* could cause reduced epibiotic species richness and diversity. These findings demonstrate the importance of investigating multiple mechanisms of biotic resistance and highlight the danger of overlooking invasions of cryptic species.

† **BEHAVIORAL REPERTOIRE AND SWIMMING SPEEDS OF *DOSIDICUS GIGAS* PARALARVAE**
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Adult Humboldt squid (*Dosidicus gigas*) are highly mobile, abundant predators that form an important prey resource for large fish and mammals, including humans. Their behavior has been studied primarily with the use of tags. Paralarvae and juvenile *Dosidicus* are almost certainly of great ecological relevance as well, but these smaller life stages are more difficult to find and cannot be tagged like adults. However, in June of 2006, we discovered an egg mass of *Dosidicus gigas* for the first time in the wild. Hatchlings from this egg mass were maintained in the laboratory for seven days and their behavior was recorded on video. The video was then analyzed to describe the variety of behaviors exhibited, and to quantify the speed and mechanics of paralarval swimming. These results are compared with similar studies of loliginid hatchlings. Despite their smaller size and relative lack of development, *Dosidicus* hatchlings are active, capable swimmers that can easily alter speed and direction. They are negatively buoyant, and must swim continuously to counteract sinking, indicating that *Dosidicus* likely has high metabolic demands even from the time of hatching.

† **WHEN MUSSELS DIE... AN ASSESSMENT OF THE MECHANISMS DETERMINING THE UPPER LIMIT OF *MYTILUS CALIFORNIANUS* BEDS ALONG THE PACIFIC COAST OF NORTH AMERICA.**

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Marine intertidal organisms live in a habitat which is characterized by acute environmental gradients. The degree to which organisms extend upshore is thought to be set by some aspect of temperature and/or desiccation stress. However, we still do not fully understand the relative importance of thermal stress versus other factors such as submergence time in setting these upper “zonation” patterns. *Mytilus californianus* is one of the dominant species in the marine intertidal habitat along the Pacific Coast of North America, and frequently is used for examining ecological principles. The purpose of this study is to investigate the importance of temperature in setting patterns of *M. californianus* zonation by using a technique that combines field surveys and physiological studies with a theoretical model of mussel body temperature. Surveys of tide height, slope, and orientation of *M. californianus* upper limits were conducted at 15 sites ranging from Washington to Southern California. Physiological studies at three of these sites indicate that mussels die at approximately 36 degrees C for time periods greater than 30 minutes. By utilizing this information in the theoretical model, we reveal locations where upper limits of *M. californianus* may or may not be determined by temperature and thus demonstrate the value of a multidisciplinary technique for selecting sites to explore ecological questions.

† SPATIAL VARIATION AND EVIDENCE FOR MULTIPLE TRANSPORT PATHWAYS FOR DUNGENESS CRAB (*CANCER MAGISTER*) LATE-STAGE LARVAE IN SOUTHEAST ALASKA.

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Time series of relative larval abundance using light traps reveal large pulses of Dungeness crab (*Cancer magister*) late-stage larvae (megalopae) in Glacier Bay, with high variability among years. Because it is unclear whether processes affecting larval supply in Glacier Bay are broadly applicable to the larger region of Southeast Alaska, and whether larval abundances inside a marine reserve are different from areas with commercial fishing, we investigated megalopal abundance in the surrounding region. Megalopal abundances in Berner's Bay, 60 km further inland was 56 times smaller than the Glacier Bay site and showed a possible 2 day lag in peaks of abundance in 2005. Higher abundances of megalopae were collected near the surface compared to 10m depth, and larval abundance was greater at high tidal amplitudes during new moons, indicating possible tidal transport. In 2006 we increased the geographic extent of sampling along a 350 km gradient from the outer coast to the inside waters. We found that Glacier Bay had, on average, five times larger megalopal abundances than other sites, and a 2-D tidal circulation model suggests the presence of a circulation barrier to the east of Glacier Bay. Morphometric differences in megalopae suggest a difference in larval size on either side of the barrier, indicating that larvae may have multiple transport pathways into inside waters. Our findings show that *C. magister* megalopae abundance in Southeast Alaska is highly spatially variable, that Glacier Bay may not be representative, that circulation patterns are complex, and multiple transport pathways are likely.

† IMPACTS OF HERBIVORY ON THE POPULATION DYNAMICS OF TWO FUCOID SPECIES IN MOOREA, FRENCH POLYNESIA

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Prey species that share common predators may have positive, negative, or neutral effects on one another depending on predator preferences and prey functional responses. Furthermore, selective predation can have strong impacts on population and community demographics. *Turbinaria ornata* and *Sargassum mangarevense* are common invasive macroalgae that inhabit the back-reef habitats of Moorea, French Polynesia. *Turbinaria* is found throughout the lagoon, primarily on the tops of coral bommies. *Sargassum* is found predominantly on the reef-crest (where high flow limits herbivore activity), and in a patchy distribution within the lagoon in conjunction with *Turbinaria*. This study tests the hypotheses that the disjunct distribution of *Sargassum* in Moorea results from associational and spatial refugia from herbivores. *Turbinaria* has a high phenolic content, stiff thalli, and sharp, leathery blades that likely provide a refuge for *Sargassum*. To test the hypothesis that *Sargassum* experiences escape from herbivory as a result of its coexistence with this highly defended alga, *Turbinaria* abundance was manipulated (absent/present) around *Sargassum* individuals. Within 24h, a significant increase in predation occurred only where *Turbinaria* was absent. Results of a follow-up feeding assay experiment suggest that *Sargassum* was significantly more palatable than *Turbinaria* although both species experienced significant spatial refuge from predation by growing on the top of coral bommies. The results of this study suggest that a relationship exists between *Sargassum* and *Turbinaria* that modifies the consequences of fish grazing, which may have broader implications for the importance of spatial and associational refugia in maintaining species coexistence on coral reefs.

LARGE-SCALE EXPERIMENT REVEALS EFFECTS OF HABITAT STRUCTURE ON CORAL REEF FISH ASSEMBLAGES

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The structure of coral reef fish assemblages is usually strongly correlated with attributes of reef structure. Experimental studies on small patch reefs have improved our understanding of how certain attributes of reef structure (e.g., shelter hole size) influence these assemblages, but it is not clear if the results of small-scale experiments will extrapolate to large spatial and temporal scales. We manipulated the abundance of rubble habitat to evaluate how this shelter-providing habitat affected the structure of coral reef fish assemblages at large scales. We added several tons of limestone rubble and conch shells to one half of each of 5 large (3,000-15,000 square meters),

isolated reefs near Lee Stocking Island, Bahamas. We tracked changes in the reef fish assemblage with underwater visual censuses over 4 years. On rubble addition halves of reefs, several species of small fishes (damselfishes, wrasses, and gobies) became more abundant, whereas there was little change in the abundance of larger species. Thus, the abundance of many smaller species appeared to be limited by the availability of appropriate habitat. It is unclear whether larger species will eventually respond to the manipulation, which enhanced shelter for juveniles of these longer-lived species and enhanced abundance of potential prey.

KELP MAKES ITS BED AND LIES IN IT: GROWTH AND PHYSIOLOGICAL RESPONSE OF THE GIANT KELP *MACROCYSTIS PYRIFERA* TO DIFFERENT PHYSICAL CONDITIONS IN AND AROUND A KELP BED

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Beds of the giant kelp *Macrocystis pyrifera* function as ecosystem engineers, altering physical factors within and around them and creating the foundation of kelp forest ecosystems. However, such modification has the potential to affect the performance of kelp individuals within the bed. Measurements of flow velocities, light, temperature, and seawater nitrate concentrations tracked changes to these factors for one year inside and outside of a kelp bed off the coast of Santa Barbara, California. When bed density was high (May-Nov; before winter storms) flow speeds in the bed were 30% of incident flow, light was reduced to 10% of surface irradiance, and cool, nitrate rich water reached the edge of the bed up to twice as often as it penetrated into its interior. Semi-monthly analyses of kelp tissue nitrate and carbohydrate storage compounds (mannitol, laminarin) indicated physiological differences between kelp on the inside and edge of the bed, and the strength and direction of these differences was correlated to density dependent variation in ambient light and flow. Data on frond morphometrics and elongation rates indicated that kelp grew faster and into bushier shapes at the edge of the stand relative to the interior, and these differences were more pronounced at higher frond densities. These data indicate that the growth and physiology of giant kelp *M. pyrifera* within a kelp bed is a function of the extent to which the bed modifies seasonal variation in ambient physical conditions.

† ARTIFICIAL REEFS INCREASE FISH PRODUCTION: A TEST OF SETTLEMENT REDIRECTION

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The structure of coral reef ecosystems has undergone dramatic changes due to increasing nutrient and sediment inputs, overfishing, and increased levels of disturbance. As a result, restoration of coral reefs may be required to reverse long-term degradation. One common restoration technique is to add artificial reefs or to propagate and outplant corals. New reefs quickly accrue organisms. However, the effect of new habitat in increasing production remains unclear, primarily because habitat addition may simply redistribute individuals, rather than increasing the regional size of a population (this uncertainty reveals the “attraction-production” controversy). Our past theoretical work, which incorporated habitat addition into a modified Beverton-Holt recruitment function, suggested that redistribution of larvae might enhance populations by lowering densities on existing reefs (e.g., by dispersing settlers) and thereby reducing the strength of density dependent survival. We designed a field experiment (in which we manipulated habitat density and monitored larval settlement), to quantify the degree to which new habitat increases settlement (or redirects it). Habitat addition increased total settlement, but decreased density. However the effect on settlement was much less than expected based on the increase in reef habitat: habitat increased 6-fold, but settlement increased less than two-fold. Thus, settlers are redirected to new habitat, but total settlement increases, and local density decreases. Based on the observed strength of density-dependence, habitat addition should lead to an overall increase in fish production.

† DISPERSAL BIOLOGY AND GENETIC STRUCTURE OF THE BAT STAR, *PATIRIA MINIATA*

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The bat star, *Patiria miniata*, has a higher than expected amount of population genetic structure in the northern part

of its range (British Columbia and Alaska) given its long (6-week) planktotrophic larval duration. Two major hypotheses are considered to explain this structure; historical population vicariance, and contemporary dispersal-driven population isolation. Using a depth-stratified oceanographic current model developed by the Department of Fisheries and Oceans Canada, in combination with studies of *Patiria miniata* larval behaviour, I pursue the following question: To what extent can larval behaviour, coupled with contemporary tidal and oceanic currents, explain the genetic structure sampled for this species? Preliminary results are presented. Predictive value of the model, and implications for marine speciation are discussed.

ECOLOGICAL FORECASTING IN THE INTERTIDAL ZONE: ACCURACY OF MUSSEL TEMPERATURE PREDICTIONS OVER A RANGE OF TIME SCALES

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The ecological responses of coastal populations to climate change can occur rapidly and in unexpected locations. Ecological forecasting is a useful technique for predicting where damage to coastal ecosystems is most (or least) likely to occur, which allows us to know in advance where to look for effects of climate change. The rocky intertidal zone has long served as a model system to investigate these effects. Short-term intertidal temperature forecasts can provide advanced warning about imminent stressful events so ecologists can observe impacts and test hypotheses. We developed a biophysical model that predicts body temperatures of intertidal mussels at 30-minute intervals using weather forecasts generated by the National Weather Service. We have generated intertidal mussel body temperature forecasts from one to seven days in advance along the west coast of North America since June 2006. Maximum forecasted daily mussel temperatures are published online at <http://tbone.biol.sc.edu/forecasting/westcoast.html>. We compared archived forecasts from four sites in California and Oregon with mussel temperatures, as measured by biomimetic temperature loggers deployed at associated field sites, from June 2006 to August 2007. Accuracy of forecasts was determined at a range of time intervals using daily, weekly, and monthly maximum temperatures. Our results demonstrate the levels of uncertainty of short-term ecological forecasts and the time scale at which these forecasts are most accurate.

EUROPEAN GREEN CRABS (*CARCINUS MAENAS*) IN THE NORTHEASTERN PACIFIC: GENETIC EVIDENCE FOR HIGH POPULATION CONNECTIVITY AND CURRENT-MEDIATED EXPANSION FROM A SINGLE INTRODUCED SOURCE POPULATION

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Understanding the mechanisms by which invasive species expand intraregionally may shed light on the species' future expansion, inform management decisions, and offer insights into the potential spread of other invasive species in the same region. The spread of the European green crab (*Carcinus maenas*) throughout the Pacific coast of North America provides an excellent system in which to investigate the regional spread of an established introduced species. The Pacific coast population of *C. maenas* was established recently and spread rapidly, from San Francisco Bay in 1989/1990 to Vancouver Island, BC, in 1998. This spread has been well documented, and the altered oceanic conditions associated with periodic El Niño events have been implicated in its dramatic range expansion. We used eight microsatellite loci and one mitochondrial DNA locus to investigate the genetic history of this expansion, using collections made in sites between San Francisco Bay, CA, the site of initial *C. maenas* establishment, and Vancouver Island, BC, believed to be the current extent of the species' range. These samples represent crab cohorts which settled between 1993 and 2006, encompassing time periods before and after the major 1997/1998 El Niño event that mediated a period of dramatic range extension. We found no evidence for multiple introductions of *C. maenas* from extraregional sources. Microsatellite analyses showed that the genetic diversity is not decreased at the range extent in comparison to the initial establishment site, and there is little indication of population structuring by geography, indicating a significant level of propagule exchange between embayments.

† EXAMINING THE RESPONSE OF *POSTELSIA PALMAEFORMIS* TO COMMERCIAL COLLECTION ACROSS SITES IN CALIFORNIA.

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The Sea Palm *Postelsia palmaeformis* is an iconic rocky intertidal species endemic to the West Coast of North America and an increasingly popular commercial product. However, little is known about the impact of commercial collecting on *Postelsia* populations. California's commercial collecting regulations for 'edible seaweeds' do not take a precautionary approach and leave *Postelsia* susceptible to over-exploitation. *Postelsia* is especially vulnerable to over-exploitation because of its annual life history and limited dispersal. Collectors claim their collection methods are sustainable, but there is no scientific evidence to support this claim. We studied the effects of current commercial collection methods practiced by collectors in Northern California by mimicking these methods in a controlled field experiment at two California sites representing central and southern range limit populations. We found that frond regrowth, reproductive output and germination success of spores were all strongly impacted by frond clipping, but there was geographic and temporal variation in these responses. Population-level estimates of the production of viable spores varied strongly between sites and was highly impacted by frond clipping. The changes induced by mimicking commercial collecting methods in reproductive output and timing may have important consequences for the stability, persistence, and genetic diversity of local populations, and thus the sustainability of commercial exploitation of *Postelsia*.

† HIGH SPATIAL VARIABILITY IN THE DISTRIBUTION OF ANTARCTIC MEGABENTHOS WITH IMPLICATIONS FOR MANAGEMENT

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Logistical challenges associated with field sampling in the Antarctic have resulted in sampling with low spatial resolution or small sample size being extrapolated to large areas. This study assess spatial variability in trawl samples and from these data analyze the validity of extrapolating across spatial scales in the Antarctic environment. A total of 34,373 individuals were identified to putative species as collected by sixty eight randomly located trawls between 50 and 500m water depth along the South Shetland Archipelago, including Elephant Island. Little of the variability observed, whether examining large taxonomic groupings or putative species data, were explained by either proximity between samples or sample depths, suggesting low predictive power of trawl based survey data. The greatest variability occurred within the shallowest depth bin, exhibiting as little as 65 percent similarity for all samples within an island group. We suggest caution be exercised when making management decisions in systems where variability across scales has not been quantified.

DEVELOPING AN OLIGO MICROARRAY TO STUDY IN THE IMPACT OF OCEAN ACIDIFICATION ON PURPLE SEA URCHINS

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As the research community explores the impact of ocean acidification (OA) on marine ecosystems, a key link to forecasting the effects of this altered seawater chemistry is understanding the response at the organismal level. Since the response is likely to be complex and involve several cellular and molecular mechanisms, we are hoping to leverage genomic tools to better understand the physiological responses to OA. Specifically, I am investigating the genome-level response to OA in the purple sea urchin, *Strongylocentrotus purpuratus*. As calcifying marine organisms, urchins stand to be highly impacted by climate change as we begin to understand the effects of increased CO₂ on the biomineralization process and the development of skeleton. In the Hofmann lab, I have designed a custom oligo microarray for the purple sea urchin that is designed to reveal genome-wide molecular responses to changes in environmental conditions. We have identified a suite of genes that, if targeted, can tell us a lot about how ocean acidification and elevated CO₂ will impact biomineralization and skeleton formation in larval and adult sea urchins. We have also included hundreds of genes known to be important in urchin development, cell signaling, cellular responses to environmental stressors and metabolism. While it is unclear which aspects of an animal's physiology will be impacted by OA, by targeting candidate pathways that we would predict might be altered, we can begin to address how this change in environmental conditions will be felt at the organismal level in terms of performance, tolerance and ultimately fitness.

HOME RANGE SIZE AND PATTERNS OF SPACE USE FOR LINGCOD, COPPER ROCKFISH AND QUILLBACK ROCKFISH IN PUGET SOUND

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For marine fishes the estimation of home range size has received attention because of its importance in designing marine reserves. How individuals use this space may also be important to the management of the species or for understanding behavioral processes like optimal foraging or predation avoidance. We used an acoustic tracking system (VRAP) to examine patterns in home range size and movement for three demersal fishes in Puget Sound: lingcod, copper rockfish and quillback rockfish. Data were collected over eight weeks in the summer of 2006 and a three weeks in the winter of 2007. Home ranges were relatively small (~2500 m²) and did not differ among species or seasons. However, there was substantial variation in home range size within species. In all three species, some individuals remained fairly sedentary using small home ranges 600 – 1000 m². Other individuals made repeated movements between two areas of activity and had larger home ranges >2000 m². These movements were related to both diel and tidal cycles. For example, approximately half of the lingcod moved from a core area used at all times of day and on all tides to a second area used only during the morning flood tide. Some rockfish of both species made similar movements either at night or during the day but generally into the ebb or flood tide. These movements appear related to feeding as the individuals move away from shelter and frequently into the oncoming tide.

VARIATIONS IN HEAT SHOCK PROTEIN 70 EXPRESSION AMONG LARVAL AND EARLY SPAT DEVELOPMENTAL STAGES IN THE EASTERN OYSTER, *CRASSOSTREA VIRGINICA*

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Heat shock proteins (HSPs), a group of molecular chaperones that aid in the proper folding of proteins, function as key metabolic regulators during normal cellular processes and as defense mechanisms in the face of stress. Two types of HSPs have been identified, constitutively expressed forms (HSCs) which may be localized in sub-cellular compartments and support translocation of newly synthesized polypeptides, and stress induced forms (HSPs) which are involved in re-folding of damaged proteins in the cells. Due to the induction in response to stresses, HSPs have been extensively studied to quantify stress levels in organisms. In addition to stress-regulated expression, developmental regulation of these proteins is reported in many species, however, little is known about developmental regulation of HSPs in marine invertebrates. In our studies, differences in expression patterns of HSP 70 in the Eastern oyster, *Crassostrea virginica*, during larval and early spat stages were examined. In addition, the effects of temperature on expression patterns of HSP 70 were also studied in order to better understand how the combination of developmental changes and environmental stress impact the expression of these proteins. We found differences in the expression of both constitutive and inducible forms of HSP 70 among larval and early spat stages. The current results indicate differences in stress tolerant strategies between early and later life stages of *C. virginica*.

ALGAL ALLELOPATHIC INTERACTIONS: THE EFFECT OF EXOGENOUS DOPAMINE ON THE GERMINATION OF FERTILIZED *FUCUS DISTICHUS* EGGS AND THE GROWTH OF *ULVA LACTUCA*

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Dopamine is produced by the bloom-forming green alga *Ulvaria obscura* and occurs at tissue concentrations of approximately 1% of the alga's fresh mass. When *U. obscura* is desiccated and rehydrated, it releases dopamine into the surrounding water where it can occur at concentrations estimated to be as high as 800µM. The oxidation product of dopamine, dopamine quinone, is known to have both cytotoxic and genotoxic properties. In laboratory assays, we determined that dopamine/dopamine quinone can affect the germination of fertilized *Fucus distichus* eggs and the growth of *Ulva lactuca* at concentrations approximating those occurring in the field. The deleterious effects of dopamine may also be a result of free radicals that are generated when dopamine is oxidized.

† THE INFLUENCE OF COLONY ARCHITECTURE ON MORPHOLOGICAL PLASTICITY IN THE HYDROID *PODOCORYNE CARNEA*

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Phenotypic plasticity has been investigated in a variety of unitary (e.g., insects, fish, snails) and clonal organisms

(e.g., plants, cnidarians, bryozoans) and differences in plasticity among genotypes is evidence of a genotype x environment interaction. In clonal taxa, it is often difficult to distinguish whether morphological plasticity is regulated more by genotype, or colony architecture. We investigated morphological plasticity in the colonial hydractiniid hydroid, *Podocoryne carnea*, to partition plasticity due to genotype, colony architecture and size. *Podocoryne carnea* exhibits a loose network of widely spaced polyps along long, sparsely branched stolon connections allowing us to experimentally establish three different architectures (linear, loop and T shape) at two different colony sizes (1 polyp and 2 polyps). We hypothesized that the differing architectures and sizes would change patterns of gastrovascular circulation through stolons hence, a change in morphology. These data suggest that architecture and size affect branch number and length. Flow rate of fluid through stolons differed among genotypes, but not among architectures. We speculate that loop morphologies exhibit more branches due to their ability to continually pump nutrient rich fluid through stolons. Current investigations are focusing on distinguishing whether clonal differences in flow rate are a result of differing stolon diameters. If this is the case, these data would suggest that colony architecture is more important than genotype in regulating morphological plasticity.

ENVIRONMENTAL STRESS INDUCES VIRAL OUTBREAKS IN THE CORAL *PORITES COMPRESSA*

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Increasing coral disease has resulted in reduced coral cover world-wide, yet the culprits of these diseases have been difficult to identify. To date most research has focused on bacterial, fungal, and protozoan induced diseases, but little is known about viruses that may infect corals. Using a combination of viral metagenomics and quantitative PCR we characterized the viral consortia present in apparently healthy corals and show that while *Porites compressa* corals naturally harbor a suite of eukaryotic viruses, distinct from those in the water column, the viral consortia shifts in response to environmental stressors. In particular, when exposed to reduced pH and elevated nutrients and thermal stress the abundance of a herpes-like virus increased over time, indicative of a viral outbreak. These data support the hypothesis that corals experience viral infections exacerbated by environmental stress, and that viral disease is an important and under appreciated aspect of coral reef health.

SALINITY AND INTRA-GUILD INTERACTIONS DETERMINE THE SPATIAL DISTRIBUTION OF THE KEY MYSID COMMUNITY IN A TEMPERATE ESTUARY (GUADALQUIVIR ESTUARY, SW SPAIN).

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Results of field surveys and laboratory measurements of oxygen consumption, body fluid osmolality and survival experiments at different salinities in the mysids *Neomysis integer*, *Mesopodopsis slabberi*, and *Rhopalophthalmus tartessicus* from the Guadalquivir estuary (SW Spain) were used to test the hypothesis that osmotic stress (oxygen consumption vs. isosmotic points) was lowest at salinities that field distributions suggest are optimal. The three species showed overlapping temporal distributions within the estuary but clear spatial segregation along the salinity gradient: *N. integer*, *M. slabberi*, and *R. tartessicus* displayed maximal densities at lower, intermediate, and higher salinities, respectively. Adults of *N. integer* were extremely efficient hyperregulators (isosmotic point 30‰) over the full salinity range tested (3‰–32‰), and their oxygen consumption rates and survivals were independent of salinity; adults of *M. slabberi* were strong hyper and hyporegulators at salinities between 7‰ and 29‰ (isosmotic point, 21‰) and showed higher oxygen consumptions at the lowest salinity (6‰); adults of *R. tartessicus* hyperregulated at salinities between 19‰ and seawater (isosmotic point, 36‰), with the lowest oxygen consumption at salinity around their isosmotic point (35‰). Thus, the osmoregulation capabilities of *M. slabberi* and *R. tartessicus* seem to determine the salinity ranges in which most of their adults live, but this is not so for adults of *N. integer*. Moreover, maximal field densities of *M. slabberi* (males and females) and *R. tartessicus* (males) occur at the same salinities as the lowest oxygen consumption and higher survivals. In contrast, field distribution of *N. integer* was clearly biased toward the lower end of the salinity ranges within which it osmoregulated. We hypothesize that the greater euryhalinity of *N. integer* makes it possible for this species to avoid resource competition with *R. tartessicus* by inhabiting the more stressful oligohaline zone.

† EXPLORING THE RELATIONSHIP BETWEEN FISH ASSEMBLAGE STRUCTURE AND HABITAT COMPLEXITY USING REMOTE SENSING DATA IN HAWAII

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Habitat complexity plays a major role in determining the distribution and structure of coral reef fish assemblages. Applying remote sensing techniques that can rapidly identify structurally complex habitat at a broad spatial scale may greatly assist resource managers in locating areas that are important to protect and sustain nearshore fish populations and support optimal location and design of marine protected areas (MPAs). In this study, we evaluated the utility of remotely sensed LIDAR (Light detection and ranging data) for deriving substrate rugosity (a measure of habitat structural complexity) on a coral reef in Hawaii. We also assessed the potential application of LIDAR data for examining the relationship between habitat complexity and various reef fish assemblage characteristics. LIDAR was found to provide valuable rugosity measures at our study site and these findings extend prior work on Florida patch reefs to a contiguous coral reef environment in Hawaii. Lidar-derived rugosity was found to be a good predictor of fish biomass and demonstrated a strong relationship with several other fish assemblage metrics in hard bottom habitat at multiple spatial resolutions. The results of our study suggest that lidar-derived rugosity may be used as a surrogate for various measures of fish assemblage structure in comparable habitat and has the potential to assist in prioritizing areas for conservation and management actions.

INVASION AND PAST PREDATION: DOES SHARED EVOLUTIONARY HISTORY PREDICT PREDATION PREFERENCE IN COASTAL SYSTEMS WITH MULTIPLE INVADERS?

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UC Davis

Invasive species research has often focused on how invasive species differ from native species, for example a) how invasive predators impact native prey species differently than native predators, or b) the lack of predation on invasive species in their new environment. The key question is whether a shared evolutionary history makes predation more or less likely. Previous work supports two contrary views: first, that successful invasions may be due to a lack of predators in a new environment (the enemy release hypothesis, or ERH, Torchin et al. 2003); and second, that native predators actually prefer to prey upon newly arrived species (Parker, Burkepile, and Hay 2006). Here I present the results of prey preference trials between native and invasive invertebrate predators on familiar and novel prey items in the San Francisco Bay area. As coastal systems acquire more invasive species, and predators have more prey choices, the question of prey preference between novel and familiar prey becomes more important in understanding how predation dynamics are changed by invasion.

SURVIVAL, BEHAVIOR AND MOVEMENT OF THE GREAT WHITE SHARK, A FLAGSHIP SPECIES FOR MARINE CONSERVATION, FOLLOWING RELEASE FROM CAPTIVITY

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The white shark, *Carcharodon carcharias*, is one of the best known marine vertebrates on the planet, but is under threat from human predation and our knowledge of its biology is limited. Until the project detail here, it had never been maintained in captivity in stable condition and successfully released to the wild. Two white sharks were maintained at the Monterey Bay Aquarium where we made observations and took physiological measurements to improve understanding of the species' biology. Following their release with satellite tracking devices, both sharks displayed active swimming and diving behaviors and traveled toward Southern California Bight and Baja California nursery grounds. The satellite tags from both animals were recovered at sea using a custom radio direction finding system, yielding high-resolution data on behavior and environment. The first animal, a female, spent 198 days in captivity before making a journey from Monterey Bay to Point Conception over 30 days. The shark moved up to 160 km offshore and dove as deep as 250 m where waters were 9 °C. The second shark, a male, was tracked for 90 days and swam from Monterey Bay to waters near Cabo San Lucas, Baja California Sur – a distance of 3,500 km. The behavior, habitat preferences, and migratory patterns of both sharks were similar to those of wild white sharks tracked in the region, indicating that captivity did not prevent the animals from resuming normal behavioral patterns.

This project represents the first successful husbandry and wild release of the white shark. It improved our understanding of the species' biology and yielded a large increase in public awareness and support for the conservation of sharks and the marine environment.

† POPULATION CONNECTIVITY OF AN EMERGING COASTAL FISHERY SPECIES AND THE INFLUENCE OF ENSO ON LARVAL DISPERSAL-MEDIATED GENE FLOW

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Management of fishery species having a pelagic larval phase is plagued by poor estimates of their population connectivity. Meeting this challenge, we assessed variability in mtDNA COI and 11 microsatellite markers across 26 populations spanning the entire range of the subtidal gastropod *Kelletia kelletii* (hereafter *Kelletia*), an ecologically significant and rapidly emerging fishery species along western North America's coast that recently expanded its range north of Point Conception (PC). Spatial-genetic clustering indicates limited gene flow across biogeographic boundaries Punta Eugenia and PC, as well as isolation of western-most Channel Island populations. High genetic diversity in populations north of PC suggests that *Kelletia*'s expanded range was colonized by multiple sources. Within *Kelletia*'s historic range, genetic isolation-by-distance (IBD) slopes estimate mean dispersal distance to be in the tens of kilometers, indicating low migration rates among non-proximate populations. IBD was strongest in the Santa Barbara Channel (SBC), despite presence of islands and complex oceanography. *Kelletia*'s range expansion was likely marshaled by positive el Niño Southern Oscillation (ENSO) oceanographic conditions; however it is unclear if ENSO influences local dispersal dynamics. For each of 7 years in the 1990s, representing a range of ENSO indices, we simulated *Kelletia* larval dispersal trajectories and calculated connectivity probabilities among our sampling sites in the SBC using a realized oceanographic flow model. Pairwise genetic population differentiation consistently negatively correlated with oceanographic connectivity, and a significant positive relationship between ENSO index and slope of the correlation suggests gene flow among *Kelletia*'s SBC populations predominantly occurs under la Niña conditions.

† INDIRECT EFFECTS OF A MARINE ECOSYSTEM ENGINEER ALTER CORAL HABITAT COMPOSITION

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The marine ecosystem engineer *Stegastes nigricans* modifies coral reef habitats by farming algal turf and exerting resource control through territorial defense. These behaviors may affect coral species through two trait-mediated indirect interactions: 1) competition with farmed turf; and 2) decreased predation by corallivores due to reduced reef access. We assessed the indirect effects of farmerfish on the growth and mortality of common coral taxa by coupling a manipulative field experiment with field sampling. In general, massive corals (Poritids) were more vulnerable to competition with farmed algal turf than branching corals, with variation in turf abundance predicting 72% of the variation in the frequency of overgrowth for *Porites* spp. In contrast, delicate branching corals (Acroporids) experienced a 50 – 60% reduction in the frequency of destructive predation in the presence of *S. nigricans* relative to when removed or absent. On reefs where *S. nigricans* were removed, reef access was ~ 3 times higher for herbivorous fishes, and 2 – 5 times higher for corallivorous fishes, supporting an indirect positive effect of territorial behavior. Thus, differential responses of corals to farming and defense behaviors by *S. nigricans* can indirectly modify habitats: Dominant massive Poritids suffered loss of living tissue through competition with turf, while branching corals were indirectly protected by territorial exclusion of corallivores. These changes can have population level consequences for other community members. For example, enhanced recovery of branching corals within *S. nigricans* territories has been shown to decrease density dependent mortality in juvenile Labrids.

POPULATION PERSISTENCE IN MARINE RESERVE NETWORKS WITH REALISTIC CURRENTS: AN EXAMPLE FROM COASTAL CALIFORNIA

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Spatial patterns of demographic connectivity are essential to population persistence in marine reserve networks, where larval replenishment is shaped by oceanography, but persistence has been analyzed only for idealized dispersal patterns. Drawing on data from coastal California, we modeled the performance of various marine reserve configurations under dispersal scenarios that approximated realistic connectivity patterns hypothesized for abalone, sea urchins, and crabs on a coastline with a protruding headland and a leeward, high-retention embayment. Such headland-embayment features are common in eastern boundary current systems. The three dispersal scenarios encompass a range of spatial heterogeneities previously unexamined in such models, and they exhibited subtle yet important differences in the relationship between reserve configuration and population persistence. Nonetheless, results generally followed a similar pattern: if reserves were small and few, persistence required protecting the embayment, where self-connectivity was high. However, if reserves elsewhere on the coast ensured persistence, harvesting in the embayment produced the highest fishery yields. In many cases, individual reserves were too small to be self-persistent, but the larger population persisted nonetheless because a “network effect” offset local shortfalls in self-recruitment. This work provides general guidelines for the placement of marine reserves in areas with heterogeneous flows and calls attention to relative dependence on self-persistence versus network effects.

INDIVIDUAL VARIABILITY IN MOVEMENT PATTERNS OF SEVENGILL SHARKS *NOTORYNCHUS CEPEDIANUS*: INFERENCES ABOUT BEHAVIORAL ECOLOGY OF AN ESTUARINE APEX PREDATOR

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Large apex predators must move to forage, and patterns of movement are considered a key factor in their survival and success. Understanding how they move is the first step in clarifying ecological interactions and is crucial for developing rigorous ecosystem-based management plans. However, understanding why predators move involves more subtle analyses of individual movement data that integrates knowledge of individual animal characteristics (e.g., gender, maturity) with local environmental parameters and prey populations. For the third consecutive year, we acoustically monitored sevengill sharks *Notorynchus cepedianus* in Washington coastal estuaries to document the extent, duration, and timing of habitat use by these large, highly mobile predators. During 2005 we implanted acoustic tags in 32 sevengill sharks (16 male, 16 female) in two adjacent estuaries (Grays Harbor and Willapa Bay, WA); since then we have maintained acoustic receiver arrays in both estuaries. Ongoing monitoring reaffirms previously-described patterns of seasonal estuarine use (March through October) and high regional fidelity, with 70% of sharks tagged in 2005 being detected two years later in 2007. However, more focused analysis of individual shark movements show temporal patterns of sexual segregation, the influence of tidal exchange on movement direction, and possible correlated movements between individuals. We provide evidence that suggests reproductive and foraging behavior explains much of the individual variability in these movement data.

LIFE HISTORY OF SPOTFIN CROAKER (*RONCADOR STEARNSII*) IN THE SOUTHERN CALIFORNIA BIGHT

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To further our understanding of the common nearshore fishes of southern California, life history parameters were studied for spotfin croaker (*Roncador stearnsii*). Plankton tows were performed near Huntington Beach Generating Station in 2004 where 120 larval spotfin croaker samples were captured. A total of 935 juvenile and adult spotfin croakers were captured in heat treatments, beach seines and gill net surveys from 1994 to 2003. Day specific ages for the larvae and the year specific ages for the juveniles and adults were determined by analyzing sagittal otoliths and growth parameters were calculated. Captured larvae were determined to be between three and 28 days old, and showed a distinct difference in growth between Spring hatches and Summer hatches. The von Bertalanffy growth parameters ($L_{\infty} = 500.5$, $K = .1093$, $t_0 = -3.688$) show a smaller length at age than Joseph (1962) found using scales. The oldest fish was determined to be 24 years old - nine years older than the fish that was determined to be the oldest in previous studies.

† **LARVAL EXPRESSION OF THE "APPENDAGE" GENES *DISTAL-LESS* AND *OPTOMOTOR BLIND* IN THE POLYCHAETE WORM *NEANTHES ARENACEODENTATA***

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Diverse types of animal appendages share several genetic aspects controlling their development. One example involves the *Drosophila* hedgehog and vertebrate Sonic hedgehog genes, which are closely related in sequence and function: they establish polarity along the anterior-posterior axis of developing wings and limbs, respectively. Do such striking developmental-genetic parallels extend to the appendages of other, “non-model” animals? To address this question, we are characterizing the expression patterns of two “appendage” genes in the polychaete annelid *Neanthes arenaceodentata* (Nereididae), a worm with numerous appendages for sensing, feeding, and crawling. Our preliminary results show that expression of a *Neanthes* Distal-less gene occurs in rings around the proximal bases of developing appendages (antennae, feeding palps, and sensory cirri). This is in stark contrast to many other animals, whose Distal-less transcripts accumulate in distal portions of appendages. The other gene, *optomotor blind*, appears to play a conserved role in specifying the dorsal portions of legs in arthropods; its vertebrate homologs function similarly to Sonic hedgehog in limb development. Expression of the *Neanthes* *optomotor blind* gene, however, is not consistent with these functions, but it may play a conserved role in eye formation. Our results imply that annelids employ unique mechanisms of appendage development. The genetic similarities between *Drosophila* and vertebrate appendage development most likely reflect convergent evolution of a similar developmental program, deployed for making novel structures. We are also using antibody staining and confocal microscopy to better characterize expression domains of Distal-less and *optomotor blind* in the cephalic nervous system of *Neanthes*.

AN EMPIRICAL ASSESSMENT OF COMMUNITY-WIDE SPECIES INTERACTION STRENGTHS IN THE ROCKY INTERTIDAL.

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The strength of interactions between species in communities underpin higher order properties of ecosystems such as stability and the distribution of species abundances. Theory predicts that positive facilitative interactions should dominate in more stressful environments, and negative competitive interactions in less stressful habitats. I test these predictions in an analysis of community-wide distributions of species interactions from 30 species removal experiments in the rocky intertidal, across a range of habitat types in distinct biogeographic regions. The results of these experiments confirm that rocky intertidal communities are characterized by many weak and few strong interactors, but that community-wide species interactions are not predominately facilitative or inhibitory. This balance between weak and strong, and positive and negative interactions appears to be generalizable across a variety of ecological contexts and may be a stabilizing force in communities.

HIGH POPULATION DENSITY ENHANCES SURVIVAL IN A LARGE HARVESTED CORAL REEF FISH

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Effective conservation and management strategies are needed to sustain harvested coral reef fish populations that are impacted by overexploitation and habitat loss, however, little is known about how the demographic rates of harvested reef fish respond to fluctuations in population density or to changes in habitat quality. We tested the influence of population density and habitat features on the growth and survival of an exploited coral-reef fish, the schoolmaster snapper (*Lutjanus apodus*). Schoolmaster density was closely tied to habitat quality, specifically the density of large coral heads. We evaluated correlative evidence for density dependence in growth and survival; and used a large-scale density manipulation experiment to uncouple the relationship between density and habitat, thus producing rigorous tests for density dependence in growth and survival. Growth rates differed among sites but were unrelated to density or habitat features. Survival was positively correlated with density (i.e., inversely density dependent). The experimental manipulation of density revealed that the positive relationship between survival and density was causal and not driven solely by the positive effect of habitat on density and survival. The positive effect of density on survival of the schoolmaster contrasts with the results of most studies on small, non-exploited coral

reef fishes. The inverse density dependence detected in the schoolmaster implies that regulatory mechanisms that would help populations recover from overfishing may be absent in this species, but that marine protected areas may be particularly effective for management of this species.

† POPULATION DYNAMICS OF A TROPICAL GIANT CLAM (*TRIDACNA MAXIMA*) AND IMPLICATIONS FOR THE MANAGEMENT OF AN ARTISANAL FISHERY

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An important challenge in fisheries management is the identification of factors driving and limiting population growth. Giant clams are brightly colored mixotrophic bivalves that live in shallow waters throughout the Indo-Pacific. Although they are extensively aquacultured and harvested, surprisingly little is known about natural population dynamics. In Mo'orea, French Polynesia, a coral reef lagoon management plan restricts artisanal harvest of the giant clam *Tridacna maxima* to clams over 120 mm in total shell length, and prohibits harvest in marine reserves. To better understand specific factors affecting the population dynamics inherent in this managed population, an analysis of the biotic and abiotic factors affecting mortality and growth was performed on a continuing demographic study of *T. maxima* in Mo'orea. Preliminary results demonstrate distinct patterns in mortality and growth. Growth rates do not vary with initial size, color, site, height in the water column, orientation on substrate, or substrate type. However, mortality does vary with initial size, site, height in the water column, and substrate type. Similar mortality patterns inside and outside reserves suggest that the lagoon management plan is not effective or not being enforced. The paucity of live legal size clams and the abundance of legal size shells in recent midden piles suggest that this population of *T. maxima* is overfished. High mortality and scarcity of large fecund clams and low recruitment indicate that reproductive input may be limiting population growth, thus prohibiting effective fishery management.

GREAT BALLS OF BRYOS: NOVEL SUBSTRATE ON THE MUD FLATS IN SAN FRANCISCO BAY

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A non-native bryozoan has established on the mudflats in South San Francisco Bay, forming free-living balls. Previously unreported from the Bay, these bryoliths exist in two morphologies: 1) fluted and open and 2) dense and compact. The balls range from golf ball to football size and form fairly dense patches over a significant portion of the South Bay. Scanning electron images of zooids and COI mitochondrial DNA nucleotide sequence data indicate both colony forms are indeed the same species, identified as *Schizoporella errata* a widely invasive species of uncertain origin. While *S. errata* is known to form multi-layered "reefs" and bryoliths in other locations, extensive aggregations like those in San Francisco Bay have not been reported. In the bay, bryoliths appear to form around bivalve shells, adding new layers as they are turned, presumably by currents or via bioturbation. More than two dozen species of algae and invertebrates have been found living on and in the bryoliths. These associated organisms include many non-native fouling organisms that require hard substrate and thus would not normally live on the mudflat. Several free living forms, including the Asian clam, *Venerupis philippinarum*, and the polychaete *Marphysa sanguinea*, also inhabit the bryoliths. In addition, the bryoliths appear to serve as a "nursery" for the Atlantic oyster drill *Urosalpinx cinerea*; we have found numerous eggs, tiny juveniles, and shells of drilled bivalves in the interstices of the bryozoan balls.

THE SENSORY BASIS FOR ECOLOGICAL PARADIGMS ON WAVE-SWEPT SHORES

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The rocky intertidal has provided significant examples of predators mediating prey populations, but still elusive is how predators locate preferred prey in this dynamic habitat. In seminal studies, Murdoch (1969) predicted that numerically dominant, predatory whelks (*Acanthinucella spirata*) stabilize populations by switching prey species in response to relative abundances. Moreover, Paine (1966) found strong trophic cascades and community-wide impacts initiated by seastar predation on mussels. At sites along the southern California coast, we revisited these ecological paradigms through lab and field experiments. Our results contrasted with those of Murdoch, showing strict preference of *A. spirata* for barnacles (*Balanus glandula*), regardless of alternative prey densities. The

efficiency of whelks in finding live barnacles within a bed was explained by tenets of optimal diet theory. Specifically, whelk ability to exploit barnacle prey depended on an insoluble proteinaceous cue. A protein complex of ~200 kDa was extracted from *B. glandula*, purified, and placed in acid-washed, heat-treated barnacle tests. The extracted protein caused arrestment and feeding in *A. spirata*, but there was no significant effect of equivalent preparations from alternative prey (mussels, *Mytilus* spp.; turban snails, *Tegula funebris*). Further experiments examined the interaction between seastars (*Pisaster ochraceus*) and mussels. The force exerted by tube feet on rocky substrata was enhanced significantly by protein additions from mussel prey, but not from alternative, non-prey (control) species. Combined results identify contact proteins as essential determinants of major trophic interactions on wave-swept shores.

RAPID EVOLUTION IN A COMMUNITY CONTEXT LEADS TO ECOLOGICAL NEUTRALITY

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Ecologists have long struggled to determine the mechanisms that allow species to coexist. Niche partitioning, in which species evolve to use different resources to avoid competitive exclusion, has served as the foundation for most theories of biodiversity. In contrast, the neutral theory of biodiversity posits that if some species compete for similar resources and are ecologically equivalent, they may coexist because their similarity precludes competitive dominance. Despite its simplicity and some empirical support, neutral theory remains divisive as it provides no mechanism for the origin or maintenance of species equivalence over evolutionary time. We simulate the evolution of suites of species using substitutable resources to follow the simultaneous evolution of multiple competitors. The model demonstrates that both convergence and divergence may occur and the evolutionary outcomes depend on initial similarity in resource use and the rate of evolution. Species using similar resources are likely to suffer extinction unless they evolve sufficiently fast to converge in resource use and avoid competitive exclusion. Convergence proves to be a viable evolutionary strategy when considering the rapid evolution of multiple species in response to one another; such a scenario is rarely considered theoretically or experimentally, but is commonplace in natural communities. The divergence and convergence of multiple species leads to the formation of ecological functional groups. We suggest that neutral processes may be important for determining diversity within functionally similar groups, while niche processes drive diversity among functional groups.

POSTER ABSTRACTS

† HOW SMART ARE CORAL LARVAE? DIVERGENT SWIMMING AND SETTLEMENT BEHAVIOR CAN EXPLAIN VERTICAL ZONATION IN TWO ECOMORPHS OF THE CARIBBEAN CORAL *FAVIA FRAGUM*.

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Two ecomorphs of the coral *Favia fragum* have diverged in morphology, ecology, and molecular markers in Bocas del Toro, Panama. The “Tall” ecomorph is most abundant in seagrass habitat <1 m depth, while the “Short” ecomorph occurs most often on reefs >4 m depth. To investigate the role of larvae in setting these patterns, we compared in situ swimming behavior and larval settlement choices between larvae of both ecomorphs. Larval swimming was assayed in situ at three depths 0.5 m, 3, and 6 m. To measure settlement choice, larvae from each morph were offered pre-conditioned plates from 0.5 and 4 m depth. Larvae from the Tall ecomorph swam up regardless of depth, while Short ecomorph larvae swam up at 3 and 6 m depth, but reversed direction at 0.5 m. There was no difference in settlement rates between plates conditioned at 0.5 and 4 m, but larvae from the Tall ecomorph preferentially settled on the bottom of plates regardless of depth, whereas Short ecomorph larvae settled on the bottom of plates from 0.5 m and on the tops of plates from 4 m. Ambient light did not vary between treatments, so these differences are likely related to biological cues associated with depth-specific conditioning. The vertical distribution, and microhabitat preferences of adults appear to be set by complex larval swimming and settlement behavior. Further, these differences may result in low levels of hybridization and backcrossing between “incipient” coral species. Supported by NSF grants DEB 05-43661 and an REU supplement.

† WATER FLOW MINIMIZES NEGATIVE EFFECTS OF MACROALGAE ON CORAL PHOTOSYNTHESIS

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In coral reef communities scleractinian corals and macroalgae compete for resources such as light and space. When factors favor algal growth, a phase shift can occur from a coral- to a macroalgal-dominated reef. Macroalgae exude dissolved organic carbon (DOC) and this has been hypothesized to lead to death of corals. It has been suggested that DOC promotes microbial growth, and elevated microbial respiration may lead to local anoxia on the coral surface, causing coral stress or mortality. However, water flow present on a reef may diminish negative effects of DOC produced by algae by diluting DOC concentrations adjacent to corals and supplying oxygen to prevent local anoxia. To test whether algae have a negative effect on coral under different flow conditions, we exposed pieces of *Montipora capitata* to two different species of macroalgae, without physical contact, under flowing and stagnant water treatments. We used PAM fluorometry to measure photosynthetic performance of the corals and an oxygen microsensor to quantify oxygen profiles at the coral surface. The oxygen boundary layer over corals was negligible in flowing water, with near ambient oxygen concentrations at the coral surface, even with algae present. In stagnant water, algae had a small negative effect on coral photosynthesis. In the presence of water flow, corals showed increased photosynthetic performance, although the effect differed between algal species. These results suggest that negative effects of the putative release of DOC by macroalgae on adjacent corals is mitigated by water flow.

EVOLUTIONARY ECOLOGY OF AN INTRODUCED SNAIL: INSIGHTS FROM BIOGEOGRAPHIC COMPARISONS

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Although traditionally thought to operate on different time scales, there is mounting evidence that evolutionary and ecological processes interact to determine community dynamics and structure. With much of the evidence for rapid evolution in communities coming from species introductions, it is imperative that we develop a better understanding of how evolution may mediate the impacts of invasive species. A promising approach is to study exotic species in both their introduced and native ranges, comparing their community interactions in each context. I report results from such a study, focusing on how Atlantic oyster drills (*Urosalpinx cinerea*) from native and invasive populations respond to different predators. To examine variation in escape behaviors, I conducted laboratory trials on *U. cinerea* populations from California (Tomales Bay) and Rhode Island (Narragansett Bay), looking at snail behavioral responses to chemical cues from green crabs (*Carcinus maenas*) and native *Cancer* sp. crabs. Results show differences in the response to crab treatments and crushed conspecific treatments, indicating the possibility of a short-term behavioral response to crab predators. However, population differences are less clear. The reported study is an important first step in understanding the role that both ecology and evolution play in mediating the community effects of an invasive species.

† HABITAT-MEDIATED RECEPTION BY FIXED ACOUSTIC RECEIVER ARRAYS AND THE IMPLICATIONS FOR QUANTIFYING FISH SITE FIDELITY

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The efficacy of marine reserves is dependant on size, shape, location, and the behavior of various fish species targeted for protection. Automated acoustic telemetry is widely utilized to address questions about the movement of aquatic organisms in relation to marine reserve boundaries. While this technology allows researchers a previously unavailable view of fish behavior, it is not without its limitations. Environmental factors, such as changes in temperature and salinity affect the ability to detect acoustic transmissions from fish implanted with acoustic transmitters. It is also suspected that seafloor complexity may play a role in limiting the operating range of acoustic tracking devices. The purpose of this project is to quantify the affects of seafloor topography on the ability of acoustic telemetry to quantify movement of aquatic species and estimate site fidelity. By conducting geo-positioned transects from VR2 receivers (Vemco Ltd.) in various terrains, and comparing results with high resolution bathymetric data, I will examine how topographic features influence receiver operating range. This information will enable researchers to better interpret automated acoustic tracking data providing a better understanding of fish

behavior and requirements for effective marine reserves.

POSSIBLE EFFECTS OF OCEAN ACIDIFICATION ON FERTILIZATION AND DEVELOPMENT OF THE PURPLE SEA URCHIN, *STRONGYLOCENTROTUS PURPURATUS*

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Anthropogenic increases in levels of atmospheric CO₂ are causing global warming and are predicted to cause elevated acidification of oceans. Changes in pH may dramatically affect the development and physiology of marine organisms. Very little work has been performed investigating effects of ocean acidification on marine organisms. We are investigating how ocean acidification will effect marine invertebrates, using the purple sea urchins, *Strongylocentrotus purpuratus*, as a model organism. We conducted a preliminary study to examine how changes in ocean pH may affect fertilization and development of sea urchin eggs and embryos. Adult sea urchins were spawned and gametes were exposed to a series of pH treatments ranging from low to normal seawater pH (7.0-8.2) prior to fertilization. Fertilization assays were performed with eggs and sperm across multiple treatments and the fertilization rates were recorded for each assay treatment combination. Development of subsequent live cultures was examined for each pH treatment to document effects of pH on early sea urchin development. The fertilization success and development of *S. purpuratus* was negatively affected by a decrease in pH. These results indicate that ocean acidification can have detrimental effects on development of marine invertebrates, which could lead to larger population-level perturbations.

† THE EFFECTS OF NITRATE STRESS ON PROTEIN EXPRESSION IN THE CALIFORNIA MUSSEL *MYTILUS CALIFORNIANUS*

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The water quality of estuaries and near shore coastal zones in California is greatly influenced by winter rain run-offs. One potential contaminant is inorganic nitrogen in form of nitrate. In order to study the effect of nitrate on the health of marine organisms we characterized its effect on protein expression in mussels that are commonly found in California. Mussels of the genus *Mytilus* are good indicator species for pollution of coastal waters due to their bioaccumulation abilities. We applied proteomics to investigate the effects of high nitrate concentrations and to characterize proteins that can serve as biomarkers for nitrate stress: California mussels (*Mytilus californianus*) were acclimated in re-circulating sea water tanks at 11°C for two weeks and subsequently exposed to varying concentrations of nitrate (25 mg/L, 50 mg/L, 100 mg/L) under controlled temperature conditions for 24 hours. Gill tissues were dissected on ice cold sea water and frozen immediately with liquid nitrogen. Proteins were precipitated and concentrations were determined. Proteins were separated, first, according to their isoelectric point using isoelectric focusing along a pH gradient from 4-7 and, second, according to their molecular weight with sodium dodecyl sulfate- polyacrylimide gel electrophoresis (SDS-PAGE). All gels were stained with Colloidal Coomassie Blue to detect protein spots and subsequently scanned with an Epson transparency scanner. Quantitative analysis of the protein expression profiles were performed with a 2D gel image analysis software (Delta2D). Protein spots that were differentially expressed with nitrate treatment (p<0.05, t-test) were identified with matrix-assisted laser desorption ionization tandem time-of-flight (MALDI-TOF-TOF) mass spectrometry.

ECOLOGICAL CONSEQUENCES OF EXPOSURE TO NATURAL OIL CONTAMINATION: POPULATION-LEVEL COSTS OF THE MULTIDRUG RESISTANCE MECHANISM

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Microbial metabolites of naturally occurring hydrocarbons, such as crude oil, are substrates of P-glycoprotein (P-gp) transport proteins. Given the abundance of life near areas of natural oil seepage, resident animals might be expected to suppress the toxicity of crude oil biodegraded water-soluble fractions (BWSF) using such transporters. Consistent with this hypothesis, our results indicate that the sea urchin, *Strongylocentrotus purpuratus*, exhibits different levels of multidrug resistance transport activity as a function of its habitat when exposed to BWSF and fluorescent calcein-AM. Embryos from control parents accumulated 1.7-fold more calcein, indicating a significantly (P < 0.001) lower multidrug efflux activity than embryos of animals collected from an oil seep. Furthermore, *S. purpuratus* exhibit

similarly greater efflux activity ($P < 0.001$) in embryos from an oil seep when exposed to known synthetic inhibitors of both P-gp and multidrug resistance-associated protein: MK571, PSC833, musk xylene, and galaxolide. Therefore, urchins that are pre-exposed to natural hydrocarbon contamination confer multiple types of xenobiotic resistance proteins to their progeny. Since there can be a significant energetic cost to production and storage of these proteins in eggs, a question raised by this finding is whether a population-level cost of this adaptive change in transporter activity exists. Future research will examine the reproductive costs (via the gonadosomatic index) of adaptation to oil seeps and the energetic costs of accumulating transporters in eggs. Incorporating this information into larger scale dynamic energy models will provide insight into the population-level effects of transporter-mediated adaptation to contaminants.

† DECADAL-SCALE CHANGES IN POPULATION DENSITY OF NON-SCLERACTINIAN INVERTEBRATES ON A CARIBBEAN REEF

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It is likely that the recent declines in abundance of scleractinian corals have important consequences for the invertebrates that normally live on “healthy reefs”, but there is surprisingly little empirical data that quantifies these trends. In this study, photographs from a time-series analysis of reefs in St. John, US Virgin Islands, were used to evaluate changes in abundance of the invertebrates associated with these communities. Macroscopic invertebrates that are conspicuous in planar photographs were quantified at four intervals between 1988 and 2007 for eight sites ranging from 5 to 14 m depth, for which declines in coral cover have been reported. The results reveal that the conspicuous non-scleractinian invertebrates have not shown significant changes in population density at shallow protected sites, but in deeper water (≥ 9 m), the population density of sponges and sea fans have changed significantly, with the mean sponge density increasing by $\approx 350\%$, and the mean sea fan density decreasing by $\approx 40\%$. Interestingly, the suspension feeder *Callyspongia vaginalis* and bioeroder *Echinometra lucunter lucunter* have increased in mean abundance by $\approx 650-700\%$ at the deeper site, and in all cases the changes in population densities of non-scleractinian invertebrates were intensified at sites exposed to stronger wave forces (i.e., near the tips of headlands). These results are important, because they are some of the first to describe how the abundances of invertebrates, other than stony corals, have changed in recent decades, and they provide some support for the hypothesis that suspension feeders and bioeroders are becoming more abundant.

† IN SITU SOLAR UVB RADIATION DELAYS DEVELOPMENT OF PURPLE SEA URCHINS STRONGLYOCENTROTUS PURPURATUS

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Stratospheric ozone depletion has caused increases in damaging ultraviolet radiation B (UVB, 280-320 nm) wavelengths from polar to temperate regions. We tested effects of specific wavebands and doses of *in situ* solar UVR (290-400nm) on sea urchin embryos, *Stronglyocentrotus purpuratus*. We exposed embryos to three treatments: (1) Control = photosynthetically active radiation (PAR 400-700 nm) only, (2) “UVA”=UVA+ PAR (320-700 nm), and (3) “UVR”=UVB+UVA+PAR (280-700 nm) at two ocean depths (surface and 1 meter) in San Luis Obispo Bay, California (n=3). We calculated delays in division experienced by embryos exposed to UVR or just UVA compared to control treatment (PAR). Embryos exposed to full UVR experienced a significantly longer delay in mean percent cleavage delay than embryos exposed to UVA ($P < 0.0001$ (2-way ANOVA)). As expected, embryos at the surface experienced a greater UV-induced delay than embryos held at 1 meter ($P = 0.02$). Multiple linear regression analysis comparing cleavage delay and UV dose among PAR, UVA and UVB wavebands demonstrated that delays in development are significantly correlated with UVB dose ($P = 0.01$), but not with UVA or PAR dose ($P = 0.72$ and 0.91 respectively). These results indicate that natural UVB radiation in shallow coastal waters delays development of sea urchin embryos in a depth-dependent fashion (to at least 1m), whereas solar UVA and PAR have little to no negative effect on development.

† A NOVEL APPROACH TO MONITORING CORAL RECRUITMENT: ASSESSMENT OF BIOTIC AND ABIOTIC DRIVEN POST-SETTLEMENT PROCESSES ON NYLON LINES.

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For demographically open coral populations, larval delivery, settlement, and post-settlement processes determine the local abundance and distribution of adults. It is often difficult to assess the relative importance of each process as settlement events are infrequent and predation and growth rates can occur on different time scales. In Moorea, French Polynesia, we incorporated a novel system for estimating coral recruitment on the fore-reef using nylon lines suspended for 8 months at six MCR-LTER monitoring sites. Preliminary data have suggested a relationship between the size-frequency distribution of pocilloporid corals on the ropes and depth that fluctuates annually; this pattern may be driven in part by differential delivery, light attenuation, and intensified predation closer to the existing reef. The current manipulative field study investigated the joint and separate effects of predation and light attenuation on transplanted pocilloporid recruits at three depths on the fore-reef (1m, 5m, and 10m) over two weeks. At the surface where the light intensity is strongest, pocilloporid transplants increased the most in buoyant weight. At intermediate depths, the corals in the control treatment grew faster than those in the cage treatment, suggesting a negative cage effect, perhaps due to shading. However, at the deepest sites nearest to the reef and potential predators, the caged recruits had relatively higher growth rates than the cage-controls. The experimental results suggest a trade-off in importance of biotic and abiotic factors determining coral abundance across depth. The nylon line technique for monitoring coral recruitment may capture spatially dependent dynamics previously overlooked.

SEASONAL PATTERNS OF LARVAL SETTLEMENT AT TRINIDAD HEAD: IMPLICATIONS FOR RETENTION AND TRANSPORT

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Most benthic invertebrates have planktonic larvae, which must remain nearshore to settle to benthic adult habitat. Seasonal variation in nearshore oceanographic factors provides clues to understanding the mechanisms influencing retention and onshore transport of invertebrate larvae. In this study, we used three levels of sampling intensity and two levels of spatial resolution to investigate the influence of seasonal upwelling on the settlement of post-larvae in Trinidad Bay, California, a small, south facing inlet formed by Trinidad Head. Our primary sampling site is located in the lee of this small headland; similar studies on the central coast have indicated that such headlands can be important locations for near shore larval retention and accumulation. At our primary site, we sampled settlement weekly from April 2006 to August 2007 and sampled every other day for the month of June 2007. During the upwelling season of 2007 (June and July), we performed twice-weekly sampling at nearshore sites on the north and south of Trinidad Head (two sites each). At each site, we tracked settlement of crabs (Canceridae, Grapsidae, Majidae, Porcellanidae, and hermit crabs), barnacles, bivalves, urchins, snails, and polychaetes to Tuffly® collectors and barnacle plates at the surface and near the bottom. Weekly samples exhibited most crab settlement from April to October in both 2006 and 2007. However, settlement of grapsids were an exception, occurring mostly from January to April. Barnacle settlement also occurred primarily in spring and summer and settlement in 2006 was positively correlated with upwelling indices at 42°N latitude.

† ULTRAVIOLET RADIATION B (280-320 NM) DELAYS MITOSIS AND DEPHOSPHORYLATION (ACTIVATION) OF CDC2 AT TYR15 IN EMBRYOS OF THE PURPLE SEA URCHIN, *STRONGYLOCENTROTUS PURPURATUS*

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Solar UVR (290-400 nm) can damage marine organisms and cause delays and abnormalities in development of marine organisms. Our laboratory has previously shown that UVR can cause delay in mitosis and activity (dephosphorylation) of one component of the mitosis promoting factor, Cdc2, at tyrosine 15 (Tyr15, inhibitory site) and threonine 161 (Thr161, activating site that becomes dephosphorylated after mitosis) in embryos of the purple sea urchin, *Strongylocentrotus purpuratus*. This current study examined how variable wavelengths of light (PAR (700-400 nm), UVA (400-320 nm), UVB (320-280 nm) affect the activity/phosphorylation of Cdc2 at Tyr15 and T161, in embryos of *S. purpuratus* by exposing batches of sea urchin embryos to three treatments of photosynthetically active radiation (PAR, PAR + UVA, or PAR + UVB). Samples were taken at specific time points during the first cell cycle to determine cleavage delay rates and to create protein lysates that were analyzed by SDS-

PAGE and western blotting techniques to determine relative amounts of total and phosphorylated Cdc2 (Tyr15 & Thr161). Our preliminary results demonstrate that UVB radiation is responsible for causing most of the delay in the dephosphorylation (activation) of Cdc2 at Tyr15 (n=2). There is no delay in cleavage or the dephosphorylation of Cdc2 at Tyr15 in embryos that were subjected to UVA + PAR alone. These results underscore the importance of understanding how increased levels of UVB due to ozone depletion affects marine inhabitants at the molecular to organism levels.

† HAS THE STATEWIDE BAN ON *CAULERPA* SPECIES BEEN EFFECTIVE? A RE-SURVEY OF SOUTHERN CALIFORNIA AQUARIUM RETAIL STORES

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The *Caulerpa taxifolia* invasion in the Mediterranean Sea raised awareness of the potential for introduced seaweeds to impact coastal communities. Subsequent introductions of *C. taxifolia* appeared in southern California in 2000, presumably from the release of aquarium specimens, resulting in an expensive (~\$5 million) eradication effort. Besides *C. taxifolia*, other *Caulerpa* species being sold for aquarium use may have the potential to invade southern Californian and U.S. waters. Surveys of southern California aquarium retail stores in 2000-2001 revealed that 26 of 50 stores sold at least one species of *Caulerpa* and seven stores sold *C. taxifolia*. In recognition of the threat imposed by the release of aquarium specimens, in 2001, California imposed a ban on the importation, sale, or possession of nine *Caulerpa* species; the City of San Diego expanded these regulations to include all *Caulerpa* species. To determine the effectiveness of the ban, in 2005-2006 we re-surveyed 44 retail stores from our previous study. Similar to previous methods, specimens of *Caulerpa* species were purchased, preserved, and identified. Of the 44 stores, 23 sold *Caulerpa* and four stores sold specimens of *C. taxifolia*. Three additional stores had *Caulerpa* species in stock but not for sale. These results suggest that the California ban on *Caulerpa* species has not been effective and that the retail aquarium industry continues to represent a potential vector for introducing *Caulerpa* specimens, including *C. taxifolia*. This study underscores the need for outreach and enforcement programs to increase awareness among the aquarium retail industry and aquarium hobbyists.

VARIATION IN THE POPULATION DYNAMICS OF JUVENILE CARIBBEAN CORALS OVER 10 KM OF COAST

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Testing for scale dependence of ecological patterns is an important objective on coral reefs where community structure varies over multiple spatio-temporal scales. Because of the importance of coral recruitment, the scale dependence of this process has attracted considerable attention, and here we ask to what extent does spatial variation affect our conclusions regarding coral community dynamics developed from a few kilometers of coast in St. John (USVI)? Over the last decade, our research has revealed an association between coral recruitment and temperature, and evidence that early life stages of corals now grow more slowly than they did 30 years ago. To expand the scale of this work, in 2006, juvenile corals were tagged at 8 sites to measure growth and mortality, and in 2007, the population density was assessed at 10 sites spanning ~10 km of coast. The results reveal that growth rates were low (6.2 mm/y) relative to historic figures, and that among sites, mean growth rates ranged from 2.1-6.2 mm/y, mortality ranged 7-36%/y, and densities ranged 0.8-4.6 corals/0.25 m². Although there were significant differences among sites in growth and density, overall the dynamics of juvenile corals were relatively similar on a scale of 1 km and a scale of 10 km. Significantly, the slow growth rates at all sites underscores the likelihood that juvenile corals are growing more slowly than they did in the 1970's.

† GEOGRAPHIC VARIATION IN ROCKY INTERTIDAL ALGAE PALATABILITY.

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Consumer-prey interactions often occur across a broad geographic range where environmental conditions influence the nature of these interactions. This geographic variation has largely been overlooked with respect to the feeding preferences of marine herbivores. For example, feeding preferences are often determined by testing the preference of

single herbivore populations feeding on single populations of seaweed, and these preferences are assumed constant throughout the species ranges. To test this assumption, we conducted multi-choice feeding assays of the common periwinkle, *Littorina littorea*, on 5 co-occurring seaweeds (*Fucus vesiculosus*, *Ascophyllum nodosum*, *Mastocarpus stellatus*, *Ulva lactuca*, and *Porphyra umbilicalis*) from 3 regions (Massachusetts, Maine, and New Brunswick). Consistent with previous studies, *Littorina* strongly preferred the two ephemeral species (*Ulva* and *Porphyra*) regardless of source population of seaweed or snail. However, the relative palatability of these two ephemerals varied with region so that *Ulva* was preferred to *Porphyra* in the south whereas *Porphyra* was preferred to *Ulva* in the north. These preferences were consistent between snail populations suggesting that the relative differences were between seaweeds rather than the snails that were feeding on them. When snails were offered the choice of *Ulva* from each region, they preferred to feed on southern *Ulva*. Given the apparent opposing geographic pattern for *Ulva* and *Porphyra* palatability, ultimate mechanisms influencing seaweed palatability, such as snail densities and per capita grazing rates, appear insufficient to explain these patterns. Our results suggest that geographic variation in seaweeds strongly influences herbivore feeding preferences.

SEA TO LAND TRANSITIONS IN ISOPODS: *LIGIA* SPP. AND THEIR BACTERIAL SYMBIONTS

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Symbiotic associations of animals with microorganisms often evolve in situations of nutrient limitation or when components of a diet are difficult to digest. Novel metabolic capabilities acquired from microbial symbionts allow animals to expand their distribution and occupy unfilled niches, for example during the transition from marine to terrestrial habitats. Isopods in the suborder Oniscidea have marine intertidal as well as purely terrestrial representatives and apparently have acquired hepatopancreatic endosymbionts involved in cellulose digestion and phenol oxidation during the evolution from marine to terrestrial existence. If this holds true then one would expect to see a correlation between bacterial abundance in the hepatopancreas and habitat preference of hosts, where isopods with a stronger connection to the marine environment are expected to have fewer symbionts. This hypothesis was investigated in the primitive supralittoral genus *Ligia* with 2 representative taxa *Ligia pallasii* and *L. occidentalis* that vary in the degree of connectedness to the marine environment. The occurrence and distribution of both *Ligia* species was surveyed in southern Oregon and California. Microbial abundance in the hepatopancreas was quantified, the presence of microbial associations confirmed for both species of *Ligia* and microbial abundance data compared to published values for terrestrial and freshwater isopods.

† SPATIAL ANALYSIS OF HEAVY METAL CONTAMINATION OF LOS ANGELES HARBOR SEDIMENTS

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The purpose of analyzing the marine sediments in the Los Angeles Harbor was to investigate and document CAM-17 heavy metal contamination. The hypothesis- if marine sediments in the Los Angeles Harbor are tested for CAM-17 metals, then contamination above acceptable levels will be found, was determined to be correct. Public safety divers routinely subject themselves to prolonged exposure to the water and sediments in the LA harbor. Two of the CAM-17 metals found to be at dangerous levels, lead and mercury, are able to be absorbed through the skin and are known to cause severe health issues. Bioaccumulation of heavy metals was documented in some of the marine life tested by EMAX Laboratories for the study. ArcGIS was used to construct a map of the study area. The spatial analysis extension was used for interpolation of the results with an ordinary kriging spherical prediction map to show probable values of contamination levels in areas not sampled. The contaminant levels were manually classified to the four NOAA SQUIRT table threshold limits for marine sediments. Lead and mercury levels were found to be above the Threshold Effects Level throughout the LA Harbor. Keywords: Los Angeles Harbor, Heavy Metal Contamination, GIS Spatial Analysis

REPRODUCTIVE BIOLOGY OF THE SEA ANEMONE *MESACTINIA GANENSIS* IN SOUTHERN TAIWAN

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An unusually dense population (coverage up to 80.4% per 10 m) of the anemone *Mesactinia ganensis* became established on dead *Acropora* coral skeletons located in southern Taiwan, and this new population appears to constitute a phase change from the previous coral-dominated state since 1992. To gain insight into the causes of the explosive population growth of this anemone, the reproduction of *M. ganensis* was studied through field censuses and histological means for 2 years at monthly intervals. In most months, the population was dominated by small individuals (< 0.5 g, wet weight). Mean monthly asexual longitudinal fission rates ranged from 0.75 to 12.8%, and although fission occurred in all size classes, it was significantly more common among polyps > 3.5 g. The histological analyses revealed that *M. ganensis* is dioecious, with sexual maturity achieved at a small size (0.5 g), a strongly skewed sex ratio of 7:725 (male:female polyps), and synchronous spawning of large numbers of small eggs (60 µm in diameter) between July and September when seawater temperatures are high. The abundant small individuals throughout the year and frequent fission suggest that the dense aggregation of *M. ganensis* is possibly resulted from asexual reproduction.

† USING THE TRACE METAL COMPOSITION OF *MACROCYSTIS PYRIFERA* SIEVE TUBE SAP TO IDENTIFY EFFLUENT PLUMES IN LOS ANGELES COUNTY WATERS

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Metal concentrations in kelp sieve tube sap (STS) may be useful in determining the dispersal of coastal effluent plumes. Common trace metals are sequestered into STS from the surrounding seawater at concentrations averaging a 100 times their total seawater concentration. In this study, concentrations of 19 different metals were measured in STS using ICP-MS. STS was collected from *Macrocystis pyrifera* fronds obtained from several coastal southern California locations, including a presumed “non-polluted” reference site on the seaward side of Catalina Island. Results indicate the presence of 8 new elements not formerly identified within *Macrocystis* STS including: Rb, Pd, Ag, Sn, and Cs. Several metals (e.g. Cr, Cu, Mn, Co, Zn, Pb) were found at significantly higher levels within STS collected from populations inside the Port of Los Angeles/ Long Beach in comparison to Catalina Island. Significant differences in levels of other metals (e.g. Fe, As, Ag, Cd) were found between populations separated only by the harbor breakwall. Populations from three locales within Santa Monica Bay were also examined; results indicate higher levels of many of the stated trace metals in STS collected along Palos Verdes compared to a Malibu site. However, STS from Malibu populations were higher in Ag, As and Cd. These results indicate the potential usefulness of this method in spatially describing metal pollution arising from coastal sources.

EELGRASS (*ZOSTERA MARINA*) GENOTYPES DIFFER IN NUTRIENT UPTAKE ABILITY

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Genetic diversity in foundation species can have important ecological consequences at the population, community, and ecosystem level. However, the mechanisms that drive these effects have seldom been documented. We examined whether morphological and physiological variation among clones of eelgrass (*Zostera marina*) could contribute to effects of genotypic diversity in this system. We grew replicate shoots of eight genetically distinct eelgrass clones collected from Bodega Bay, CA, in a common garden environment and then quantified leaf nitrate uptake, root ammonium uptake, and a variety of morphological variables. We found that both root and shoot nutrient uptake rates varied between genotypes, even when corrected for genotype-specific biomass differences. In addition, the rank order of uptake ability differed for ammonium and nitrate, indicating that multiple genotypes are needed to maximize both processes. These results suggest that niche complementarity among genotypes could contribute to positive effects of eelgrass clonal diversity on resource utilization and biomass production.

CENTRAL COAST MARINE BIRD HEALTH STUDY

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The Central Coast Marine Bird Health Study (CCMBHS) is based out of California Department of Fish and Game -

Marine Wildlife and Veterinary Care and Research Center in Santa Cruz. This study collaborates with Moss Landing Marine Laboratories, and aims to supply a quantitative demographic assessment of disease and other mortality factors affecting seabird populations in California. CCMBHS supplements existing beach survey programs, cultivates collaboration among scientists and rehabilitation centers, and provides a regional information center for federal, state, and local resource managers. Seabirds are important indicators for environmental change and marine ecosystem health. CCMBHS focuses on identifying and quantifying mortality events, species-specific disease factors, body condition, and histology by conducting necropsies on specimens collected from beach survey programs, rehabilitation centers, state and federal resource agencies. Field investigations to measure baseline health, entanglement of wild seabirds, and chronic oiling, are also conducted. In 2007 alone, there were two unusual investigated seabird mortality events: The Common Murre (*Uria aalge*) wreck of March 2007, and the Horned Puffin (*Fratercula corniculata*) mortality event of July 2007.

KELP FOREST COMMUNITIES NORTH OF CAPE MENDOCINO: INITIAL SURVEYS IN HUMBOLDT AND DEL NORTE COUNTIES

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Despite increased research and monitoring of subtidal communities statewide, the California coast north of Cape Mendocino remains understudied. With a scarcity of coastal access points, high sedimentation, and rough ocean conditions, this region particularly challenging for subtidal studies. However, this region produces 29% of the total market value of commercial fisheries in California (CFG 2006) and such surveys can provide fisheries-independent data and a more comprehensive assessment of marine ecosystem health, which are critical for management under the Marine Life Protection Act. In this study, we performed an initial survey of two sites with bull kelp (*Nereocystis luetkeana*) beds in this understudied region: Trinidad in Humboldt County and Crescent City in Del Norte County. Using a modified PISCO protocol, a team of eight divers gathered baseline data on the benthic community at each site. While the Trinidad and Crescent City sites had similar substrate composition and topography, there were higher sediment loads in Trinidad, which was reflected in community structure. Coralline and non-coralline crustose reds were more abundant in Trinidad, while articulated coralline algae and colonial tunicates were more common at Crescent City. While the constituents of the kelp community (*Laminaria setchelli*, *Nereocystis luetkeana*, and *Pterygophora californica*) were similar between sites, overall abundances were higher at Crescent City, and kelps grew at deeper depths. *Pisaster brevispinus* were notably abundant at Trinidad. The differences in sedimentation between these two sites and its effects on community structure may help us understand larger scale differences in benthic communities north and south of Cape Mendocino.

† PHENOTYPIC CHANGES IN THE DOGWINKLE *NUCELLA LAMELLOSA* IN RESPONSE TO CHEMICAL CUES OF CRAB AND SEA STAR PREDATORS

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A considerable amount of research has demonstrated that many organisms change their phenotype in response to their environment. However, organisms are usually exposed to many different environmental factors simultaneously, and often these factors are not correlated. The question therefore becomes can we predict how organisms will respond to multiple factors from experiments with only single factors? To begin to answer this question we studied how the dogwinkle *Nucella lamellosa* morphologically responded to the presence of different types of predators. We performed a factorial experiment in which dogwinkles were exposed to caged crabs, *Cancer productus*, and seastars, *Pisaster ochraceus*. The results indicated the following: 1) crabs induced dogwinkles to produce thicker shells, and that this response was greater for larger dogwinkles, 2) seastars reduced the ability of dogwinkles to retract into their shells when disturbed, and 3) that the presence of an additional predator did not affect the response to the other predator. These results suggest that we can make reasonable predictions about how organisms respond to multiple factors from studies that only investigate single factors.

† SECONDARY EFFECTS OF *ACANTHASTER PLANCI* PREDATION ON SURVIVORSHIP OF RESIDENT DAMSELFISH.

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The complex nature of coral reefs make them an ideal habitat to observe and quantify the relationships between organisms, and the combined effects of multiple species on the growth and survival of another. The predatory Crown of Thorns Sea Star, *Acanthaster planci*, is widely known for its structurally and biotically destructive impact on coral communities. What is not well documented, however, are the secondary effects of these predators on coral associated reef fish. I conducted a laboratory experiment in French Polynesia, to determine if *Acanthaster* feeding on branching corals displace fish residing within the coral, thereby increasing their susceptibility to piscivorous predators. To quantify damselfish survival, trials consisting of a fixed number of the damselfish, *Chromis viridus* residing within a colony of live *Pocillopora meandrina* were exposed to treatments with or without both the predatory Spotfin Squirrelfish, *Neoniphon sammara*, and *Acanthaster*. Results indicate that the combined effects of *Acanthaster* and *Neoniphon*, considerably reduce the number of resident *Chromis*. These findings suggest a greater impact of *Acanthaster* on reef dynamics than previously thought, and further investigation is needed to determine its effect on fish populations.

† **GRAZING REDUCTION BY *TEGULA FUNEBRALIS* IN THE PRESENCE OF A KEYSTONE PREDATOR, *PISASTER OCHRACEUS*: EVIDENCE FOR TRAIT-MEDIATED INDIRECT INTERACTIONS**

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Classical trophic cascade models focus on predation as the source of indirect effects (density-mediated indirect interactions, DMII) in a three-level food chain. Yet a growing body of work indicates that trait-mediated indirect interactions (TMII) complement density-mediated indirect interactions by altering the behavior and habit of prey species. We tested the strength of trait-mediated indirect interactions in rocky intertidal communities by examining interactions among a keystone predator, *Pisaster ochraceus*, an herbivore, *Tegula funebris*, and the algal community in and around mid-high intertidal pools at Horseshoe Cove, Bodega Bay, CA. Laboratory experiments demonstrated a reduction in grazing by *Tegula* when caged *Pisaster* were added. Initial field experiments with diatom-covered plates to estimate grazing also saw a reduction in herbivory when *Pisaster* was added. This trend disappeared when repeated at a later date. When *Pisaster* was added *Tegula* density remained similar to the control treatment throughout the field experiment. Algal percent cover and composition in and around pools did not change significantly from each other over the 7 week period. Trait-mediated indirect interactions appear to have an important temporal relevance and the importance of density-mediated indirect interactions and trait-mediated indirect interactions needs to be explored.

MACROZOOPLANKTON COMMUNITY OF WILLAPA BAY, WASHINGTON: DISTRIBUTION, ABUNDANCE AND COMPOSITION

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Willapa Bay is a large, partially-mixed, tidally influenced estuary located between the Columbia River and Gray's Harbor estuaries on the coast of Washington. Macrozooplankton comprise a highly sensitive community that fluctuates in response to changes in the environment. Major sources of variation expected to affect the macrozooplankton community are system productivity, season, and distance from the mouth of the estuary. In 2006, six stations within Willapa Bay were sampled fortnightly for macrozooplankton, chlorophyll, and various abiotic variables. Results show an initial spring bloom in March consisting mostly of two copepod species: *Calanus pacificus* and *Centropages abdominalis*. A second, smaller bloom occurred two months later and consisted of mainly decapods, including *Neotrypaea californiensis*. Zooplankton abundance and composition varied as a function of distance from the mouth of the bay, with upper reaches of the estuary supporting different macrozooplankton than closer to the mouth. This pattern may be a result of markedly different productivity levels, as suggested by chlorophyll *a* concentrations. This and other possible factors underlying the temporal and spatial patterns of macrozooplankton in Willapa Bay will be discussed.

† FLOW THROUGH *ZOSTERA MARINA* (EELGRASS) CANOPIES, THE SPECIES ASSEMBLAGE AND IMPLICATIONS FOR HABITAT USE IN ELKHORN SLOUGH, CA

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Seagrass beds are known to alter hydrodynamics of the water column by dampening flow within the bed, increasing current velocity over the bed, and increasing turbulence within the bed. These processes can have both positive and negative effects on the plants and animals of the seagrass assemblage. The goal of this study was to determine the role of *Zostera marina* in habitat provisioning in Elkhorn Slough, CA through laboratory and field investigations. A salt-water flume was used to measure flow within *Zostera* beds at three densities and four flow velocities. Velocity inside the bed, diffusivity of particles through the bed, and blade angle were quantified using video analysis. In the field, the average density of fish and invertebrate species was measured using a 1-m³ throw trap. Three habitats were sampled with the throw trap; *Zostera marina*, algae (predominantly *Ulva sp.*) and bare substrate. Flume experiments revealed that velocity was dampened at low and medium densities, diffusivity was greatest at slow flow and in the high-density bed, and blade angle was most extreme at high flow velocity for all densities tested. To date, fishes caught in *Zostera* are mostly juveniles, and the invertebrates found in *Zostera* are potential food items for those fishes based upon published diet data. Combined results suggest *Zostera* has the potential to serve multiple habitat functions in Elkhorn Slough such as; refuge from flow, nursery habitat or trophic subsidy to those species using the habitat.

† SEASONAL OCCURRENCE AND MOVEMENT PATTERNS OF LINGCOD IN CARMEL BAY, CALIFORNIA.

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Lingcod comprise a major component of recreational and commercial fisheries along the west coast of North America, yet their populations have fluctuated dramatically in recent years. For fisheries managers, knowing how lingcod move over space and time is useful for creating stock models, designing marine protected areas, and deciding when, where, and if seasonal fishery closures should occur. From a biological perspective, movement patterns are important for understanding life history processes such as spawning events and behavioral differences related to sex and age class. Using acoustic tracking techniques, we are investigating the occurrence and movement patterns of lingcod in Carmel Bay, Ca, over a relatively long term (> 1 year) time scale. Specifically, we are examining if and how movements vary among different size classes and sexes of lingcod. Since 2005, we have utilized an array of Vemco VR2 receivers to monitor the movements of tagged lingcod throughout Carmel Bay. The receivers are moored along 6 km of coastline and function as remote tracking stations, recording time and depth information of lingcod with surgically implanted 69 kHz acoustic transmitters. Thirty fish, including male and female lingcod in two size classes, were tagged and released in 2005 and 2006. Initial analyses have indicated that fifty percent of the tagged lingcod are demonstrating residential behavior, as defined by their presence in the array for over 90% of the days of the study.

AN ANALYSIS OF ROCKFISH (*SEBASTES*) CATCH ABOARD COMMERCIAL PASSENGER FISHING VESSELS ON THE SOUTH CENTRAL COAST OF CALIFORNIA FROM 1988-2007

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Rockfish (*Sebastes spp.*) have historically been a large part of recreational marine fisheries in California. There is evidence that in areas of California the numbers of this resource are declining. In 2003, California Polytechnic State University, San Luis Obispo placed observers on commercial passenger fishing vessels out of Morro Bay and Port San Luis. Through September of the 2007 season, 375 trips have been included in this survey. Data from this current survey was compared to historical data from the region to show trends of the fishery for the last 20 years. One publication has come out of this project, which included analyses for data through the 2005 fishing season. This poster is an update, including the most recent data collected. Annual catch per unit effort (CPUE) and average size were calculated for each species included in the survey. In general, CPUE in the area has fluctuated over time, but

shows no consistent trend among rockfish species. Sizes of rockfish have remained fairly consistent over time and are generally just above the size of 50% maturity.

DETECTING OSMOTIC STRESS RESPONSE PROTEINS OF *CIONA INTESTINALIS* THROUGH FUNCTIONAL PROTEOMICS

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We characterized protein expression profiles (PEP's) in *Ciona intestinalis*, a sea squirt commonly found in hard-substrate subtidal fouling communities, to identify protein expression levels which differ significantly during acute hyposmotic stress. *Ciona intestinalis* was exposed to 100% and 70% seawater for 20 hours. We removed the tunic and an outer layer of mucus before homogenizing the entire animal, including the pharyngeal gill basket, the digestive and reproductive system. Proteins were separated first according to their isoelectric point (pI) by isoelectric focusing using an immobilized pH4-7 gradient gel strip, and, second, by molecular mass using SDS-PAGE. The gels were stained with Colloidal Coomassie Blue. Analysis on the resulting two-dimensional gel electrophoresis images detected 527 protein "spots." 50 of those spots showed statistically significant differences ($p < 0.10$) and normalized expression levels above background of at least 0.10. Ten of these spots clearly represent actual changes in expression while the remaining 40 are inconclusive to some degree. We are currently identifying relevant protein spots using matrix-assisted laser desorption ionization (MALDI) tandem mass spectrometry. The peptide mass fingerprints (PMFs) of the majority of these spots have good signal to noise ratios and we are currently matching them with proteins in the annotated genome database.

EFFECT OF COASTAL WATERSHED LAND USE PATTERNS ON INTERTIDAL BACTERIAL LOADING

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Recent studies have shown that overland flow increases with various types of land use patterns. As a result of increased overland flow, land use patterns can contribute to increased transfer of fecal bacteria into rivers. However, few studies have begun to determine if bacterial levels of downstream intertidal zones are also affected by land use patterns. The study proposed here will attempt to determine if there is a correlation between ocean and terrestrial systems regarding bacterial loading, specifically fecal coliform and *E.coli*. Watershed land use patterns will include human population density, agriculture and logging. Bacterial levels of three key intertidal components, water, sediment and mussel tissue, will be observed for one year. For all project components, a combination of field/laboratory research and GIS database analysis will be used. The study sites include: Cascade Head, Yachats Bench, Coquille Point, Cape Blanco, and Chetco Point. It is proposed that higher levels of human population density, agriculture and/or logging within each watershed will increase bacterial loading of the corresponding intertidal zone. The main products of this project will be a year of continuous data documenting intertidal bacterial levels and a predictive model that uses watershed land use patterns to predict water quality and ecosystem health of downstream nearshore marine habitats.

† PROTEMOIC ANALYSIS OF THE PACIFIC OYSTER, *CRASSOSTREA GIGAS*, IN RESPONSE TO NITRATE STRESS

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Pacific oysters (*Crassostrea gigas*), native to the coast of Japan, are farmed along the Pacific coast of North America. Their filter-feeding activity can lead to the accumulation of pollutants especially those of anthropogenic origin. Inorganic nitrogen enters aquatic ecosystems via urban and agricultural runoff, sewage effluents and fertilizers, all of which have been found toxic at some level to many aquatic animals. Adult oysters were obtained from an oyster farm in Morro Bay, located on the Central Californian Coast. In order to investigate the tolerance of oysters to nitrate, the protein expression profiles of oysters in response to nitrate exposure was studied. Gill tissue was exposed to 0 mg/L, 5 mg/L, 25mg/L, 50mg/L and 100mg/L NaNO₃ dissolved in filtered sea water. Proteins were separated according to their isoelectric point (pI) and molecular mass with two-dimensional gel

electrophoresis. We detected over a 1000 protein spots within the range of pH4-7, using large-format gel electrophoresis. Protein spots that we identified as potential biomarkers for nitrate exposure, using Delta 2D gel image analysis software, were excised, digested with trypsin and analyzed with a matrix-assisted laser desorption ionization (MALDI) tandem time-of-flight mass spectrometer. Several candidate biomarkers were identified after peptide mass fingerprinting and de novo sequencing of peptides. We are currently analyzing the mass spectrometry data to assemble a nitrate-specific protein expression profile for Pacific oysters.

† **RESOURCE PARTITIONING BETWEEN TWO SPECIES OF CLEANER WRASSE - *LABROIDES BICOLOR* AND *LABROIDES DIMIDIATUS***

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A common interaction on coral reefs involves cleaner fish that remove ectoparasites from a wide variety of client fishes. While many species of fish have been observed to exhibit cleaning behavior, few rely on cleaning as their primary food source during all life stages. Co-occurring species of obligate cleaners are likely to compete for access to parasitized clients and could benefit from resource partitioning. In order to determine if there is any evidence for resource partitioning between the two most common species of cleaners in the lagoons on the north shore of Moorea, French Polynesia, we conducted surveys, behavioral observations and gut content analyses of *Labroides dimidiatus* and *Labroides bicolor* at one site. Surveys of microhabitat indicated that *L. bicolor* and *L. dimidiatus* recruits occupy different kinds of microhabitat with *L. bicolor* spending more time in coral cavities and less time in the open than *L. dimidiatus*. Additionally, while both species were observed to clean a wide variety of client fishes, *L. dimidiatus* cleaned a broader range of client families than *L. bicolor* which cleaned significantly more Holocentrids than *L. dimidiatus*. Finally, the gut contents of both species consisted primarily of parasitic gnathiid isopods. These results suggest that while there is considerable overlap in resource use between *L. dimidiatus* and *L. bicolor*, *L. bicolor* restricts much of its cleaning to fishes occupying coral cavities.

PATTERNS OF GENETIC DIFFERENTIATION IN *BALANUS GLANDULA* SUGGEST A SIGNIFICANT ROLE FOR COMMON SELECTIVE FORCES ACTING UPON MULTIPLE LOCI.

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Genetic clines among populations of marine organisms may be established by introgression of historically diverged populations, current limitations to dispersal, and/or natural selection. In a previous study exploring genetic variation in the acorn barnacle *Balanus glandula*, a strong cline was identified in the mitochondrial gene cytochrome oxidase I and the nuclear gene elongation factor 1 alpha along a 475 kilometer region of coastline centered roughly on San Francisco Bay. We have found that similar north-south clines are present in at least three additional nuclear loci across seven populations on the California coast. These genetic signatures appear to be stable over time, suggesting a limited role for historical divergence in cline maintenance. This lasting and widespread pattern instead indicates that common selective forces operating on genes scattered throughout the genome, balanced by gene flow, are likely responsible for maintaining the genetic clines in *Balanus glandula*.

† **SEA URCHIN HERBIVORY IN HAWAIIAN SHALLOW WATER ECOSYSTEMS: *ECHINOTHRIX* AS ALLIES WITH *TRIPNEUSTES***

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A great deal of research has already been done to investigate sea urchin herbivory in Hawai'i, particularly focusing on the species *Tripneustes gratilla*. This work has demonstrated that *T. gratilla* urchins are important grazers on Hawaiian coral reefs, helping to prevent overgrowth of algae and also significantly consuming invasive algal species that have become problematic in Hawai'i. However, sea urchins of the genus *Echinothrix* co-exist with *T. gratilla* and are also prevalent on Hawaiian reefs, but as yet they've been relatively little studied. We have initiated studies of Hawaiian *Echinothrix* herbivory by conducting laboratory feeding trials and ecological field surveys, with a focus on elucidating interspecific ecological differences between *T. gratilla* and *Echinothrix*, and with a goal of assessing

their comparative potential grazing impacts on invasive algal populations. Our experimental data support the hypothesis that *T. gratilla* and *Echinothrix* species exhibit similar feeding rates on the Hawaiian invasive algae *Gracilaria salicornia*, under no-choice experimental conditions. Additionally, our field surveys documenting urchin abundances and distribution patterns reveal habitat partitioning between *Echinothrix* species and *T. gratilla*. With grazing rates that are significant and similar, and with differences in spatial distributions on reefs, our results suggest that *Echinothrix* species may be important allies with *T. gratilla* in the control of both native and invasive algae in Hawai'i. These results should be useful to conservation managers working to understand and prevent coral reef degradation and macroalgal phase shifts in Hawai'i.

† IN-SITU CULTURING OF LARVAL SAND DOLLARS, *DENDRASTER ECCENTRICUS* IN FRIDAY HARBOR, WASHINGTON.

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Scientists raise larvae in mesocosms in their natural environment to answer questions about their ecology, biology, and behavior in nature. The artificial nature of in-situ culturing often leads to high mortality and highly unrealistic results. Expensive systems have been attempted to improve these problems. In order to attempt a more realistic approach, large, simple mesocosms (150L) were used to raise *Dendroaster eccentricus* off of Friday Harbor Laboratories, San Juan Island, Washington. Mesocosms were designed to maximize water flow and facilitate cleaning, while providing a stable and relatively inexpensive study vessel for larvae. Thirteen-day old *D. eccentricus* larvae were introduced into the mesocosms for one week. Daily water samples were taken to assess the number of surviving larvae and the physical and chemical water parameters. At the end of the study period, the mesocosms were retrieved and the contents were concentrated to determine the number of surviving larvae. Analysis is near completion and results will be presented. This approach will be further refined for use in ecological and elemental fingerprinting studies.

† EFFECTS OF LIGHT AND COLUMN HEIGHT ON DIEL VERTICAL MIGRATION OF THE MARINE GASTROPOD *KELLETIA KELLETII*

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Previous studies have shown that larval behavior, specifically diel vertical migrations (DVM), can profoundly influence dispersal outcomes. Marine veliger *Kelletia kelletii* larvae exhibit DVM; larvae ascend at night and are demersal during the day. We investigated how light and vessel height influenced DVM behavior and hypothesized that DVM behavior would be light-initiated and would not be affected by column height. We placed 100 larvae in replicate cultures (n = 4) under two different light treatments, natural (16:8) and a dark-only photoperiod (0:24), and two different column heights (15 or 125 cm). Vertical positions in the column were recorded every 4 h for 24 h. Column height and the interaction between photoperiod and time were significant (3-way full-factorial ANOVA for photoperiod, column height and time). Cultures in shorter columns had significantly greater proportions of demersal larvae. During daytime, natural photoperiod treatments had higher proportions of demersal larvae than dark-only treatments; at night there was no significant difference between light and dark treatments. Unraveling the timing of and the cues initiating DVM behavior in *K. kelletii* larvae can help build predictive models of dispersal outcomes for this developing fishery species.

† SEAWEEDS, STRESS AND SMALL GRAZERS: CHARACTERIZING THE INTERACTION BETWEEN *IDOTEA WOSNESENSKII* AND *POSTELSIA PALMAEFORMIS*

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Environmental stress models (ESMs) predict that plants are more susceptible to herbivory when under high stress conditions. In California, we observed infestations of the isopod *Idotea wosnesenskii* (an intertidal mesograzers) on the kelp *Postelsia palmaeformis*, at the upper edge of their intertidal distribution where they are known to be physiologically stressed. Although we know a lot about the impact of large marine herbivores on seaweeds, we know very little about the interaction between seaweeds and mesograzers. This small marine herbivore is known to

feed on algae, particularly furoid algae, but *Postelsia* has not been previously documented in its diet. From laboratory feeding preference experiments, we learned that *Idotea* prefer *Postelsia* over *Fucus*. From field observations, *Idotea* appear to feed preferentially on *Postelsia* fronds where their reproductive structures occur. Thus infestations of *Idotea* on physiologically stressed *Postelsia* (found at the upper edge of its intertidal distribution) may have large negative consequences for the already compromised reproductive potential of these individuals. In contrast, the nutritional quality of *Postelsia* may decrease with increasing tidal height because high zone individuals have higher C:N ratios, suggesting that less stressed, low zone *Postelsia* may be of higher nutritional value to *Idotea*. We propose to further explore the predictions of ESMs and examine the interactions between *Idotea* and *Postelsia* through a combination of field and laboratory experiments. The results of these studies will provide insights into the role of mesograzers in intertidal ecosystems, and increase our understanding of how environmental stress impacts species interactions.

EASTERN PACIFIC NaGISA, A BIODIVERSITY PROGRAM

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Coastal marine biodiversity is a concern in the protection and monitoring of marine resources and ecosystem functioning. NaGISA is a field project of the Census of Marine Life (CoML) focused on nearshore biodiversity in macroalgal and seagrass communities. The three-dimensional structure of these habitats makes them especially important for many associated species. These shallow water coastal areas also are the areas most impacted by humans, resulting in potential severe effects on nearshore biodiversity. NaGISA uses a standard set of protocols to select larger core areas and replicate sample sites within the core areas. Standard protocols are used for depth-stratified sampling of the intertidal and shallow subtidal communities. The protocols involve non-destructive sampling using photography and observational techniques within replicate random quadrats. In addition, destructive sampling involves the clearing of macrophytes, small macrobenthos, and meiobenthos within replicate random quadrats. All flora and fauna are sorted and quantified. Data are stored in OBIS (Ocean Biogeographic Information System), an international database. In the Eastern Pacific, sampling has been conducted at various locations in Alaska, British Columbia, California, and Baja. While the Eastern Pacific NaGISA has been active since 2002, we are still looking for new collaborations and are always hoping to recruit new investigators.

† EFFECTS OF VARIATION IN PREDATOR DENSITY ON GROWTH AND SURVIVAL OF THE TEMPERATE REEF FISH *LYTHRYPNUS DALLI*

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Predators can play a key role in driving dynamics of prey populations, yet the influence of natural variation in predator density on prey populations of temperate reef fishes is not well known. We used field experiments at 3 sites that varied in predator density to test whether predator density affected the mortality rate, growth rate, or the strength of density-dependence in these rates of the bluebanded goby (*Lythrypnus dalli*) at Santa Catalina Island, CA. The density of populations of adult *L. dalli* was manipulated on small artificial reefs. Densities of one major predator, the kelp bass (*Paralabrax clathratus*), were significantly higher at the site within a marine protected area than at the other two sites; but another predator, the rock wrasse (*Halichoeres semicinctus*), tended to be more abundant at the two non-MPA sites. Survivorship of *L. dalli* was density-dependent at all three sites, but the strength of this density dependence was not related to the density of predators. The density-independent mortality rate was, however, significantly different among sites, although not related to predator density. Growth rates of *L. dalli* also differed significantly among sites but were not density-dependent, although there was some evidence the predator density affected the growth of prey. This study suggests that the influences of predator density on the dynamics of temperate reef fish populations are likely to be complex and may be obscured by correlated differences in habitat and interactions among different species of predators.

PCEIS: PACIFIC COAST ECOSYSTEM INFORMATION SYSTEM - CHANGING THE WAY SCIENTISTS VIEW THE NATURAL HISTORY OF SPECIES.

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The Pacific Coast Ecosystem Information System (PCEIS) is a database that provides biological, ecological and geospatial information for over 8100 species from Alaska to Baja. PCEIS goes beyond capturing species' taxonomic information by integrating monitoring information from Coastal EMAP (EPA's Environmental Monitoring and Assessment Program) with data from regional monitoring programs and published literature. One goal of the database is to include natural history data for each species. The PCEIS team is creating data entry forms that summarize and group environmental parameters and life history details. This information will be standardized and queryable for all species within the database. Environmental categories for the species are biogeography, ecosystems, habitat, energy, temperature, and salinity. The species' life history information is grouped by feeding, reproduction, and life style. In addition, species classified as introduced will have a list of invasion vectors that can be entered, and a second biogeography section for the documented invasions. Overall, these standardized forms for data entry, and table structures for information storage and retrieval, will substantially improve the current methodology for adding natural history information to biological databases. The result moves natural language text to queryable form for use in monitoring, mapping, and modeling research.

A NEW GENUS AND SPECIES FROM THE ALEUTIANS MAY PROVIDE KEY TO KELP EVOLUTION

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A small population of a previously unknown kelp was recently discovered at Kagamil Island in the central Aleutian Islands during a coastal survey (EMAP) being conducted by the Alaska Department of Environmental Conservation. The kelp reaches 3 meters in length and has a distinctive morphology: it has the simple paddle-shape of some species of *Laminaria*, but it is unique in having a compressed, golden-yellow stipe and a thin membranous blade supported by a thickened margin at the transition zone, creating a golden V just above the stipe. The holdfast is discoidal. The blade has typical anatomical features of advanced foliose species of kelp including trumpet-shaped hyphae, but no hair pits or mucilaginous ducts were found on the blade or stipe. No reproductive structures were observed. Molecular phylogenetic analyses using chloroplast, nuclear, and mitochondrial genes indicate that the distinctively-shaped kelp, provisionally named Golden V Kelp, does not belong to any previously known species or genus of kelp, nor does it fit easily within any recognized family. It showed a closer relationship to species of Alariaceae but was not strongly allied with that family. Because of that we forego assigning it to a family, but we place the new species in its own genus within the Laminariales. The distinctive morphology of the Golden V Kelp, its unique geographic location, and its position in phylogenetic trees clearly mark it as a significant element in understanding the evolution and spread of this important group of organisms.

LINKING TECHNOLOGY TO RESEARCH QUESTIONS AND MANAGEMENT OBJECTIVES IN THE MONTEREY BAY NATIONAL MARINE SANCTUARY

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1 - California State University Monterey Bay 2 - Monterey Bay National Marine Sanctuary 3 - National Marine Fisheries Service 4 - Moss Landing Marine Labs

There are a variety of platforms for the collection of videographic data on seafloor habitats and communities along the continental shelf of California, including occupied submersibles, remotely operated vehicles, autonomous underwater vehicles, and towed camera sleds. Each platform offers unique advantages and disadvantages which must be reconciled with the ultimate goal of a given research or monitoring objective. This project is assessing the functionality of a towed camera sled for collecting data on seafloor habitats and associated communities in the Monterey Bay National Marine Sanctuary. The primary goals of this project, in its first year, include: 1) the collection of baseline data within and adjacent to new marine reserves along the central coast of California, 2) the exploration of sites of interest throughout the Sanctuary to continue the on-going characterization of the continental shelf, and 3) the sampling of replicate sites by the towed camera sled, the DELTA submersible, and a remotely operated vehicle to provide a detailed comparison of each platform's utility for sampling invertebrate and fish fauna along the seafloor. These and other objectives will ultimately be linked directly to research and monitoring needs as identified in the Sanctuary's Management Plan.

† EFFECT OF ALGAL TOXICITY AND PREDATION ON ALGAL CHOICE FOR DECORATION BY TWO MAJID CRAB SPECIES

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Laboratory tests were used to determine if two species of decorator crabs, *Oregonia gracilis* and *Pugettia gracilis*, decorate differently in terms of type and amounts of the algae, *Ulva* spp. and *Ulvaria obscura* in the presence and absence of a predator. Normally, *O. gracilis* decorates its carapace and legs, while *P. gracilis* only decorates the tip of its rostrum. The algae species are similar in texture and physical appearance, but *Ulvaria* contains dopamine, which acts as a chemical defense against herbivory (Van Alstyne, 2003). In the choice experiment, a trend showed that both crab species decorated with more *Ulvaria* than *Ulva*, but the results were not statistically significant (*O. gracilis* $p=0.177$; *P. gracilis* $p=0.266$). Increased sample size may reveal a stronger relationship in choosing *Ulvaria obscura*. Regression analysis indicated that the amount of decoration either species of crab used was not linearly related to crab size. The presence of a predator did not affect how much either species decorated with *Ulva* spp. or *Ulvaria obscura*. Total decoration used by *O. gracilis* was less in the presence of the predator *Hexagrammos decagrammus* ($p=0.021$), which may be explained by reports that this crab remains still to avoid detection by predators (Wicksten, 1980).

NUTRIENT ENRICHMENT TRIGGERS A MACROALGA TO OVERGROW AND A SEA ANEMONE TO ATTACK CORAL

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A nutrient-addition mesocosm experiment demonstrated that nutrient enrichment triggered aggressive competition for space by a macroalga and a sea anemone on coral when the levels of herbivory and carnivory were reduced as a result of simulated overfishing. The phase change which occurred during the experimental period replicated what has happened in the field over the past 10 years. In low-nutrient controls, abundances of alga *Codium edule* and sea anemone *Mesactinia genesis* remained low, and they coexisted with branching coral *Acropora muricata*. Combined nitrogen and phosphorus additions markedly increased the photosynthetic efficiencies of coral, coverage of macroalga, and asexual reproduction of sea anemone. After 35 d of nutrient addition, the macroalga began to overgrow the coral where it was in contact with live coral, but not with dead coral. The coral finally died after 122 d when totally overgrown by the macroalga. Within a few days of contact with live coral, sea anemone was observed to induce and develop acrorhagi tentacles which were used to attack and kill neighboring coral. Nevertheless, the sea anemone was not observed to attack the macroalga, but avoided the prolific macroalga in enriched tanks. The response of the macroalga to nutrient enrichment was more rapid, and its negative impacts on the coral were more severe than those of the sea anemone. Our results indicate that nutrient enrichment might be a major cause of the phase shifts from coral- to macroalgal- or sea anemone-dominated reefs.

† OCEANOGRAPHIC MECHANISMS AFFECTING REPRODUCTIVE SWEEPSTAKES OF A PACIFIC COAST ROCKFISH

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Many natural populations exhibit high variance in reproductive success among individuals. This phenomenon may be particularly important in marine species, where the unpredictability of oceanographic currents may subject species with pelagic larval durations to “chance events,” by which only the individuals that spawn at the optimal time will be successful (Hedgecock 1994). The observation that several marine taxa exhibit considerable variance in reproductive success has coined this phenomenon the “recruitment sweepstakes” hypothesis (Hedgecock, 1994). However, there is a poor understanding of whether asynchrony between reproduction and appropriate environmental conditions may result in high reproductive variance. My research will examine how the timing and intensity of large-scale oceanographic events such as upwelling in relation to spawning affect the successful recruitment of the black rockfish, *Sebastes melanops*. I predict that reproductive sweepstakes will occur some years and not others,

depending on the timing and duration of the transition to sustained upwelling in relation to spawning.

IN SITU* SOLAR ULTRAVIOLET RADIATION DELAYS MITOSIS AND DEPHOSPHORYLATION (ACTIVATION) OF CDC2 IN EMBRYOS OF THE PURPLE SEA URCHIN, *STRONGYLOCENTROTUS PURPURATUS

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Solar ultraviolet radiation (sUVR) penetrates into seawater and can delay cell division and development. The Mitosis Promoting Factor regulates entry into mitosis and consists of a cyclin dependent kinase, Cdc2, and Cyclin B. When active, Cdc2 is phosphorylated at the threonine 161 (T161) activating residue and dephosphorylated at the tyrosine 15 (Y15) and threonine 14 (T14) inhibitory residues. Our laboratory has shown that artificial UVR induces delays in dephosphorylation of Y15 on Cdc2 leading to delays in the first embryonic division. This current study tested whether sUVR affects phosphorylation of Cdc2 at Y15 and T161 in embryos of the sea urchin, *Strongylocentrotus purpuratus* over time. Embryos were exposed to (+UV) or protected from (-UV) sUVR in the ocean at the Cal Poly Pier for 30 minutes post-fertilization. Batches of embryos were sampled over time to prepare protein lysates and to determine cleavage rates. UV-exposed embryos experienced a mean (\pm S.D.) delay in the first cell division of 22.67 (\pm 3.21) minutes compared to the controls (n=3). SDS PAGE and western blotting analysis were used to identify the relative concentration of total Cdc2 and Cdc2 phosphorylated at T161 or Y15. Percent phosphorylation of Cdc2 at Y15 or T161 was not significantly affected by UV treatment or time alone ($p > 0.05$, split-plot ANOVA). Nevertheless, there was a significant interaction between time vs. treatment ($p = 0.016$) and sUVR delayed dephosphorylation of Y15 and T161 at time points just prior to division (90 or 110 mins post-fertilization respectively).

POTENTIAL EFFECTS OF CLIMATE CHANGE ON THE GREEN URCHIN, *STRONGYLOCENTROTUS DROEBACHIENSIS*, AT HIGH LATITUDES IN THE NORTHEASTERN PACIFIC.

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Current research suggests that anthropogenic-induced climate change will result in elevated ocean temperature and ocean acidification. These changes in seawater chemistry are predicted to have significant impacts on calcifying marine organisms. Importantly, the biological consequences of ocean acidification are expected to be particularly strong at high latitudes. The goal of this project is to study the response of the green urchin, *Strongylocentrotus droebachiensis*, to synergistic effects of temperature and ocean acidification within a global climate change scenario. This species represents a dynamic habitat-modifying and commercially important species in high latitude systems. However, it is especially susceptible to ocean acidification through dissolution of their calcareous endoskeleton and reduced growth. The research proposed here seeks to identify physiological responses of *S. droebachiensis* to carbon dioxide concentrations and the synergistic action of temperature at multiple life stages (larval, post-settlement, and adult) by using a combination of field and laboratory experiments. Future goals of this work include use of a microarray containing genes involved in biomineralization and other metabolic processes recently developed for a congener species, *S. purpuratus*. This technology will enable detection of patterns in gene expression due to environmental forcing at the genome-level. This information will help better understand physiological mechanisms responsible for limiting current distributions of *S. droebachiensis* as well as potential future changes due to climate change and ocean acidification.

MATERNAL CARE AND MALE-MALE AGGRESSIVE SYSTEMS IN THE CAPRELLID, *CAPRELLA MUTICA* (SCHURIN, 1935)

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As brooders, caprellid amphipods exhibit many interesting behaviors. Of these, I am exploring maternal care and male-male aggression. Caprellid amphipod females have a brood pouch in which they carry developing eggs. Juveniles hatch out of the eggs within the brood pouch, climb out of the brood and cling either to the female or the substratum around her. While the juveniles are in this location, she is able to protect her young from other caprellids.

Nothing is known of the maternal care for *Caprella mutica*, as knowledge of maternal care in caprellid amphipods is limited to only a few species. Male-male aggression is exhibited in other species while in the presence of a receptive female. It is believed that a protrusion on the propodus of the second gnathopod, called the “poison tooth”, is the cause of death in male-male interactions. My future experiments are to test the following hypotheses: (1) parental females will fight other caprellids regardless of species and sex in order to protect her offspring, (2) females will not adopt juveniles from another species but will adopt conspecific juveniles, (3) the presence of a single female causes conspecific males to fight, and (4) males cause fatal injuries via the poison tooth.

USING FISH ABUNDANCE AND DISTRIBUTION TO DETERMINE HABITAT QUALITY OF INTERTIDAL SALT MARSHES IN SAN FRANCISCO AND TOMALES BAYS

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1 - University of California Davis, Bodega Marine Lab 2 - University of California Berkeley, Bodega Marine Lab 3 - San Deigo State University

Since 2002, the Pacific Estuarine Ecosystem Indicator Research (PEEIR) project has been monitoring resident saltmarsh ichthyofauna (*Gillichthys mirabilis*) as an indicator of ecosystem health at four sites (China Camp, Stege Marsh, Tom’s Point, and Walker Creek) in San Francisco and Tomales Bays.

UNDER PRESSURE: VENTILATION AND FEEDING IN THE WHITE-SPOTTED RATFISH, *HYDROLAGUS COLLEI* (CHIMAEROIDEA)

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Moss Landing Marine Laboratories

Holocephalans are the only aquatic vertebrates with a fused upper jaw, non-suspensory hyoid, and robust tooth plates; features associated with a durophagous foraging habit. However, extant holocephalans tend to show a trend towards reduction of tooth plates and may rely on suction to capture prey. This implies suction is being generated in a mechanical system where the upper jaw cannot protrude and the hyoid cannot depress. As a first attempt at understanding if, and how, suction is generated within the extant Holocephali, intra-oral pressures were measured in nine individuals of *Hydrolagus collei* during ventilation and prey capture. Pressure transducers were implanted in orobranchial and parabranchial cavities, and pressure was recorded during several modes of respiration. In each of the modes there appeared to be a trend whereby a single pump dominated; the two-pump models prevalent in elasmobranchs and actinopterygians appears to function only partially in *Hydrolagus*, and only the pressure pump appears to operate consistently. Subambient pressure drops were recorded during prey capture, suggesting that suction could be generated. Pressure inside the orobranchial cavity decreased by as much as 1000 Pa during strikes on prey items, however, pressure in the parabranchial cavity increased up to 300 Pa. High-speed video revealed that the labial folds on either side of the mouth descend to create a small, tubular mouth opening. This opening is ascribed to enhanced suction producing abilities in other aquatic lineages and the labial folds may be convergent in this sense.

† PREDICTING HABITAT ASSOCIATIONS FROM THE PECTORAL AND CAUDAL FIN ASPECT RATIOS OF SURFPERCHES (EMBIOTOCIDAE)

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It has been suggested that the dynamics of different swimming modes of fishes may constrain their ecology. Two labriform modes used by embiotocids are flapping and rowing. Flapping has a dorso-ventral thrust generation as rowing is in the antero-posterior direction. Extrapolating from the literature, we expect that flappers have a high fin aspect ratio whereas rowers have low aspect ratios. This study was conducted to determine if morphological aspects of the pectoral and caudal fins of embiotocids were correlated with habitat associations. We used 19 species of embiotocids with three replicates per species and placed them into 7 different habitat types, ranging from calm to high wave-swept areas, chosen based upon literature describing where the 19 species are primarily found. Angle of the fin base with the long axis of the body was measured to infer flapping versus rowing. The aspect ratios were calculated by measuring the length and surface area of the fins (L²/SA) using the Image J program. Only flat fins on the left side of the body of preserved specimens were used. Pectoral fin aspect ratio was negatively correlated with

the fin base angle, as expected. The pectoral fin aspect ratio was positively correlated with habitat when ordered from calmer to more wave-swept areas. Caudal fin aspect ratio was much more variable. Closely related species tended to group together, suggesting a phylogenetic reason for fin shape. However, there were outliers which we hypothesize exist because species can change how they use their fins, making morphology alone a poor predictor of function.

† FEEDING PREFERENCES OF THE MARINE GASTROPOD *APLYSIA VACCARIA*

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Herbivores can exert a large impact on algal community structure. Understanding herbivore feeding preferences provides insight into their relative importance in structuring their communities. *Aplysia vaccaria* is a large herbivorous marine gastropod found along the California coast. Little is known about this species regarding its feeding ecology due to its temporally and spatially patchy distribution. To determine if *A. vaccaria* exhibits feeding preferences, we performed a series of paired-choice feeding trials. The algae used included two brown kelps commonly found in its habitat, *Egregia menziesii* and *Macrosystis pyrifera*, along with the red algae *Plocamium cartilagineum*, which is a primary food source for its cousin *A. californica*. Lastly, we used the green alga *Ulva lobata* which is available within its habitat and is commonly used to rear aquarium animals. We hypothesized that *E. menziesii* would be preferred over other algal species because it is prevalent in *A. vaccaria*'s habitat and is thought to induce larval metamorphosis. After feeding trials, we analyzed for preferences by comparing differences in the amount (g) of algae consumed using paired t-tests. *E. menziesii*, *M. pyrifera* and *U. lobata* were significantly preferred over *P. cartilagineum*, while there was no significant difference in average consumption between *E. menziesii*, *M. pyrifera*, and *U. lobata*. Studying the feeding ecology of *A. vaccaria* may determine its importance as a grazer as well as any disturbances it may create in marine algal communities.

COMPARISONS OF SIZE, WEIGHT AND CATCH OF NEARSHORE FISH SPECIES IN BIG CREEK MARINE ECOLOGICAL RESERVE AND OFF POINT ESTERO

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Commercial live-fish traps were used to capture Cabezon and other nearshore fish species around Point Estero, and in Big Creek Marine Ecological Reserve. Point Estero is fished commercially and recreationally, while Big Creek has not been fished since 1993. Captured fish's GPS location, weight, and length were recorded. We found that Cabezon in Big Creek are significantly longer ($42.58\text{cm} \pm 0.365$ (n=240), than those around Pt. Estero ($38.25\text{cm} \pm 0.125$ (n=1239)). In Big Creek, the Cabezon are also significantly heavier ($1.67\text{kg} \pm 0.0512$ (n=160) versus Pt. Estero ($1.107\text{kg} \pm 0.0146$ (n=800)). Big Creek had an average of 0.21 Cabezon caught per trap hour, while Point Estero had 0.33. Black and Yellow Rockfish, and Gopher Rockfish differed from this, and had higher significantly higher CPUEs in Big Creek than Pt. Estero. Big Creek had a CPUE of 0.118 for Black and Yellow Rockfish, while Pt. Estero had 0.059. Gopher Rockfish had a CPUE of 0.084 in Big Creek, and 0.016 at Pt. Estero. CPUE was lower for Cabezon in Big Creek, and this is possibly due to the larger Cabezon have increased metabolic needs and territories compared to smaller ones, resulting in less fish per unit area. The higher CPUE of the Rockfish species in the Marine Protected Area could be indicative of an increase in their prey's abundance, or of the fishing pressure around Pt. Estero.

† ASSESSING THE EFFECTS OF ANGLING-INDUCED BAROTRAUMA ON GREEN-BLOTCHED ROCKFISH (*SEBASTES ROSENBLATTI*) USING T2-WEIGHTED MAGNETIC RESONANCE IMAGING

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The physical consequences of barotrauma on the economically important green-blotched rockfish (*Sebastes rosenblatti*) were evaluated using a novel method of T2-weighted Magnetic Resonance Imaging (MRI) in combination with image segmentation and analysis. Fish were captured on hook-and-line, ascended from 100 m, anaesthetized and scanned in a GE 3T Clinical Imaging System. Comparisons were made between the two fish, one exhibiting swim bladder over-inflation and exophthalmia, and the other showing no visible signs of barotrauma.

Determination of gas expansion volumes has previously been limited because dissections to evaluate internal damage releases gas thereby changing overall organ morphology. With MRI data, however, air space volumes in the body were easily quantified by defining separate anatomical regions from 3D images using image segmentation techniques. It was found that the swim bladder, everted stomach, and orbital eye space volumes were larger for the fish exhibiting barotraumatic injuries. In this fish, images revealed the first observation of an orbital space behind the eyes, filled with gas, which could not be observed via gross dissection. The fish without visible trauma was also found to have a small orbital space behind one eye, despite lack of visual evidence of exophthalmia. Exophthalmia also resulted in stretching of the optic nerves, which were clearly visible in the MRI's and validated with dissections. This MRI method of evaluating rockfish after experiencing decompression is useful for directly comparing specific consequences associated with decompression for fishes with high numbers of post catch mortality.

â€ RECRUITMENT STRATEGIES OF THE EPHEMERAL, OPPORTUNISTIC MACROALGA *ULVA* (LINNAEUS) 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 the ephemeral *Ulva* spp. 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 tidal heights (high *Porphyra* zone and low *Mazzaella* zone) was monitored from August 2007 to October 2007 on a rocky bench north of Pigeon Point, CA. *Ulva* recruitment into partial removals resulted from both waterborne propagules and microscopic fragments left on the substrate post-disturbance, while *Ulva* recruitment to complete removals resulted only from waterborne propagules. After two months $\hat{A}^{3/4}$ of the higher intertidal manipulations were inundated with sand but the exposed plots had *Cheatomorpha* recruitment to the partial removals, no recruitment to the complete removals and no change in controls. In the lower intertidal, *Ulva* recruited to all partial removals, $\hat{A}^{3/4}$ of the complete removals, and $\hat{A}^{1/2}$ of the controls. Current data indicate differences in ephemeral recruitment among plot types, with natural disturbance (i.e. sand scour) possibly causing *Ulva* presence in controls. Manipulations will continue to be monitored for a total of one year, with future manipulations established in fall 2007, winter 2008, and spring 2008. A better understanding of the mechanism by which *Ulva* efficiently colonizes disturbed substrate will define its ecological role in intertidal communities.

† ASSOCIATIONS AMONG DEMERSAL FISHES AND THEIR ASSOCIATED HABITATS ON A GULF OF ALASKA FISHING GROUND

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The continental shelf and upper slope of the Gulf of Alaska support a diverse community of demersal fishes. This study was undertaken to define the relationships that exist among fishes and their associated habitats around Kodiak Island, Alaska. Twenty-two video strip-transects were conducted on Albatross Bank from 1999-2005 using the *Delta* submersible. Dive locations were selected to maximize the variety of habitats sampled and to groundtruth existing habitat maps. The dives covered approximately 75,000m² in depths from 10-360m. A total of 18,475 video frames (3,531 containing fish) were collected and analyzed. Fish taxa and abundance were recorded. Habitat was described in terms of depth, primary substrate (>50%), secondary substrate (>20%), and rugosity. A total of 5,762 fish were counted from 33 taxa. Rockfishes (*Sebastidae*) accounted for 69% of observed fish. Fish assemblage composition patterns were largely correlated with depth, but primary substrate and rugosity also were significantly correlated. Highly complex habitats, i.e., those classified as hard substrate (cobbles, boulders or bedrock) or having high rugosity (>25cm relief), showed greater fish abundances per video frame compared to habitats of lower complexity. However, specific fish-habitat association patterns varied by taxa. Total fish and taxa abundance were significantly higher per unit of seafloor at 10-200m compared with 200-360m. Despite these differences, distribution patterns of fish in these two depth ranges were strikingly similar in terms of frequency of frames containing fish, and patterns of fish associated with hard, medium and soft primary substrate.

† **SETTLEMENT OF *OSTREA CONCHAPHILA* AS A FUNCTION OF TIDAL HEIGHT IN NEWPORT BAY, CA**

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Recent interest in restoration of *Ostrea conchaphila*, the native west coast oyster, motivates an interest in understanding factors influencing population persistence. Not only survival of adults, but also settlement of spat can affect the persistence of future generations. Processes controlling settlement dynamics of this species are of particular concern because we can exploit natural settlement of spat for seeding restoration habitat. Here, we examined the effect of tidal height on settlement rates in Newport Bay, CA using replicate stationary PVC arrays (n=4) that suspended PVC tiles at different tidal heights during two consecutive tide series. Settlement varied inversely with tidal height (Two-way ANOVA, $p < 0.0001$) and between tide series ($p = 0.02$). Results from this study also suggested that tile distance from the mudflat bottom may be more important than tidal height in determining settlement rates. Future studies will aim to tease out the relative importance of these two factors.

† **THERMOREGULATION AND CHANGE IN CARAPACE COLOR IN *UCA PUGILATOR*.**

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Brachyurid species have various coloration patterns that fluctuate among individuals due to behavioral interactions or a changing environment. In the fiddler crab *Uca pugilator*, the historical notion is that color change is regulated by circadian rhythms. Color patterns of *Uca pugilator* were affected by changes in temperature; crab carapaces become light in warm temperatures and dark in colder temperatures. The response to temperature occurred within 15 minutes (often within 5 min. of exposure to the treatment), suggesting that thermoregulation may play a key role in color change, and it is activated not through a hormonal pathway, but rather a direct response of the chromatophores. Color change occurred differently between day and night for each sex, which implies that endogenous rhythms are not the sole mechanism for color change in *Uca pugilator*. Both sexes became darker in the cold treatment, however there were differences between the sexes with high temperatures. Females did not show significant coloration changes, while males became significantly lighter and more speckled. Results from this study suggest sex-specific constraints in thermoregulation that could be associated to morphological body mass to surface area ratios, as males have large cheliped, which may be involved in thermoregulation. Constraints could also be associated to different diel activities that each sex performs or visual cues associated with mating behaviors.

† **THE INDUCTION OF DIMETHYLSULPHIDE (DMS) BY THE GREEN MACROALGAE *ULVA LACTUCA*.**

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Many green macroalgae produce dimethylsulfoniopropionate (DMSP) which may serve as an activated defense by releasing acrylic acid and the volatile compound dimethylsulfide (DMS), as feeding deterrents towards some herbivores. The mechanisms regulating DMSP production are not well known, but volatile compounds in terrestrial plants are known to induce chemical defense production in nearby plants. A field experiment was conducted near Shannon Point Marine Center, Washington to evaluate whether DMS or acrylic acid could induce DMSP production by green macroalgae *Ulva lactuca*. *U. lactuca* responded to DMS in field conditions by significantly increasing intracellular DMSP concentration after 11 days. There was no detectable response to acrylic acid. By increasing DMSP concentrations in response to released DMS during grazing, nearby algae may have a survival benefit over those algae that do not respond. Overall, algae can be more successful by responding to potentially damaged neighbors.

† **EFFECTS OF MIXED DIET ON GROWTH AND SHELL COLOR OF CULTURED RED ABALONE, *HALIOTIS RUFESCENS*.**

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California commercial ocean-based abalone farms feed their stock a diet of kelp harvested from wild populations,

leading to pale abalone shell color and a dependency on variable kelp populations. We built an experimental farm to grow kelp and red algae to supplement abalone diets and conducted a feeding experiment to determine the effect of a mixed diet on cultured abalone growth and shell color. Maximum harvesting yield of a vegetatively propagating species, *Gracilariopsis andersonii* was high: 25g outplants resulted in 183.1g of harvested biomass after 35 days. Total expected yield was 1,220.1g per linear meter per harvest. The kelps *Macrocystis pyrifera*, *Nereocystis luetkeana* and *Alaria marginata* were cultivated from gametophytes on twine and outplanted onto vertical lines, and grew well at depths greater than 2 meters. The feeding experiment consisted of five different feed treatments (n=3): an all kelp diet, diets of 2.5%, 5%, and 7.5% red algae by weight, and an alternating diet consisting of 5% red algae one week followed by three weeks of all kelp. Abalone fed any amount of red algae quickly developed a red pigmented shell along their growing edge, and showed a greater increase in shell length, width, and biomass. Abalone fed an all kelp (control) diet lacked any shell pigmentation. Due to the relatively small amount of red seaweed needed to increase shell pigmentation and growth, commercial seaweed farms may be critical to integrated mariculture plans, particularly within the Monterey Bay National Marine Sanctuary.

PHOTOSYNTHETIC PERFORMANCE AND MORPHOLOGY IN THE HAWAIIAN CORAL *MONTIPORA CAPITATA* FROM DIFFERENT FLOW ENVIRONMENTS

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Water motion is known to have an impact on coral growth and ecology. Photosynthesis in corals has been shown to be positively correlated with increases in flow speed. Recent studies suggest that the positive correlation between flow and photosynthesis are the result of both coral morphological and physiological plasticity. To test whether photosynthetic performance differed between flow environments, photosynthetic yield of *Montipora capitata* was measured on individuals from high and low flow environments at three different flow speeds. Polyp tissue of corals from the high flow environment showed significantly higher fluorescence yield than those from the low flow environment. To test if these differences were based on either morphological or physiological traits, a transplant experiment was conducted and after 10 days, photosynthetic yield was measured at three flow speeds and a variety of small-scale morphological characteristics were quantified. Photosynthetic yield of both polyp and coenosarc tissue were highest for corals from the high flow habitat placed back in their original habitat. Skeletal morphology was not significantly different for corals from the two flow environments, however, polyp density was significantly higher in corals from the low flow environment. These results suggest that increased photosynthetic performance in corals from the high flow environment might result from higher rates of delivery of zooplankton and DOM to corals and that nutritive enhancement stimulates symbiont photosynthesis. Increased polyp density in corals from low flow environments is consistent with this conclusion. These results suggest that corals respond to environmental variation through both morphological and physiological mechanisms.

† FUEL FOR THE FUTURE: BIOLOGICAL CONTROL OF INVASIVE SPECIES A FEASIBILITY ANALYSIS FOR MAKING USE OF THE INVASIVE GIANT REED *ARUNDO DONAX* FOR BIOMASS ENERGY PRODUCTION

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The establishment of invasive plant species has great potential to negatively impact natural systems and human society. However, many of these species also have the potential to be used as valuable natural resources. The same properties that make the giant reed *Arundo donax* an excellent natural resource also make it a threat to biological diversity and natural ecosystem processes around the world. In southern California, giant reed has invaded wetlands and riparian communities, out-competing native species and altering ecological dynamics to further promote its propagation. However, the harvest of this pervasive natural resource for biomass energy may provide raw material for clean energy and a mechanism for conservation. To quantify the potential incentives of this harvest, a feasibility analysis was conducted to determine the energetic and economic potential of giant reed biomass in the Santa Clara River, while accounting for the ecological and socio-economic services provided by the removal of this plant, especially from riparian areas that are a priority for conservation.

† SHIFTING RANGES IN PAST AND PRESENT CLIMATE: THE INABILITY OF NORTHERN

WHELKS TO DRILL THE RANGE EXTENDING BARNACLE *TETRACLITA RUBESCENS*

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Little is known about the role that species interactions may play in impeding or facilitating the success of geographic range extensions. The volcano barnacle *Tetraclita rubescens* is an intertidal invertebrate that has recently expanded its range >300 km northward along the coast of California, USA. In newly colonized northern habitats, *Tetraclita* has joined an assemblage of intertidal barnacles (including *Balanus glandula* and *Semibalanus cariosus*) that are preyed upon by two species of whelks (*Nucella ostrina* and *N. canaliculata*). In field enclosures at Bodega Marine Reserve we exposed small barnacles of three species (*B. glandula*, *S. cariosus*, *T. rubescens*) to whelks (*N. ostrina*) from a northern and southern population. *Tetraclita* were seldom preyed upon as juveniles, regardless of which region the whelks came from. In a laboratory experiment, we tested the ability of whelks to prey upon larger *Tetraclita* relative to its northern ecological equivalent, *S. cariosus*. We additionally performed lab experiments on whelks taken from populations of the recently genetically identified southern whelk congener *N. emarginata*. Our results suggest that as *Tetraclita* grow larger, they are nearly immune to drilling predation by northern whelks, perhaps as a result of superior morphological defenses (including thicker shell walls, a shell that consists of only 4 plates, and recessed opercular plates). Our results also show that *N. emarginata* was able to consume significantly greater levels of *Tetraclita*, despite the fact that this species is nearly indistinguishable morphologically from its northern analogues. These results suggest that northern whelks will have few negative impacts on the range expansion of *Tetraclita*. Rather, preferential predation on other barnacles may facilitate the establishment and growth of northern *Tetraclita* populations by removing potential competitors for space. We suggest that a comprehensive understanding of climate driven range shifts will incorporate species interactions into a framework similar to that applied to invasive species. Specifically, the success of a population established beyond a species' historical range boundary will be influenced by the functional traits of that species in relation to the composition and evolutionary history of the surrounding community.

A CARIBBEAN PARADOX: LESS GENE FLOW IN SEA SLUG SPECIES WITH HIGHER LARVAL DISPERSAL POTENTIAL

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Predicting gene flow based on ocean currents and larval lifespan is important for conservation and management of marine animal populations. Biophysical coupling models make distinct predictions about how far and in what directions larvae should disperse in the Caribbean. However, no comparative genetic data exist for related species that vary in larval type and hence dispersal potential. We are therefore comparing population genetic structure for species in the sea slug genus *Elysia* that have long-lived, short-lived, or no swimming larval stage. Previous work revealed modest population structure in *E. tuca*, which has larvae that spend only a few days in the plankton, with high gene flow among six of ten Caribbean sites. To test whether species with long-lived larvae experience more gene flow as predicted by models, we analyzed samples of *Elysia patina*, which has a 30-day larval stage, from ten Caribbean locations. A 590 base-pair region of the mitochondrial cytochrome c oxidase I (COI) gene was sequenced, and Analysis of Molecular Variance (AMOVA) used to determine realized gene flow among islands; phylogenetically distinct clades were identified using Bayesian Inference. AMOVA revealed significant population structure in *E. patina*, with only one haplotype shared among sites, indicating a low migration rate. Further, five divergent lineages up to 10% genetically distant were detected, indicating a long history of regional isolation. Surprisingly, less phylogeographic structure is evident in four other *Elysia* spp. with more limited dispersal potential, suggesting that factors other than larval period strongly influence patterns of population connectivity.

† EXPRESSION OF A DACHSHUND HOMOLOG IN *NEANTHES ARENACEODENTATA* (ANNELIDA, NEREIDIDAE).

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Much of what is known of the developmental-genetics of animals stems from ecdysozoans and deuterostomes. These data permit hypothetical reconstruction of the protostome-deuterostome ancestor (e.g., its putative genomic

and morphologic complexity). Evidence from the other protostome clade, the Lophotrochozoa, is needed to better assess these hypotheses. We are using a lophotrochozoan model, *Neanthes arenaceodentata* (a polychaete annelid), to determine whether the genetic control of appendage development is similar across disparate phyla. Here, we report preliminary data concerning the larval expression of a *Neanthes dachshund* homolog. *Dachshund* is an appropriate candidate gene for studying appendage development in lophotrochozoans because of its known functions and/or expression patterns in the developing appendages of arthropods and vertebrates (regardless of whether these patterns reflect conservation or convergence). For example, in diverse arthropods, *dachshund* is known as a leg gap gene--it specifies middle portions along the proximal-distal leg axis. A *dachshund* homolog in mice is also expressed in the middle portions of appendages, but later moves to the distal tips. Our results show that *dachshund* is strongly expressed along the ventral midline, and in the head of *Neanthes*. It is not expressed in the developing parapodia or cephalic appendages. Therefore, we do not find support for an ancestral role for *dachshund* in proximal-distal axis formation in appendages. Other roles of *dachshund* involve sensory organ development (such as eyes) and brain development (e.g., mushroom bodies of *Drosophila*). Because the expression patterns of *Neanthes dachshund* are more consistent with these roles, further investigation of the nervous system is required.

† ANALYSIS OF THE HEAT SHOCK RESPONSE IN LABORATORY ACCLIMATED PURPLE SEA URCHINS (*STRONGYLOCENTROTUS PURPURATUS*) USING 2-DIMENSIONAL GEL ELECTROPHORESIS

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Purple sea urchins inhabit intertidal zones with extreme temperature variations. The objective of this study is to characterize the protein expression profiles in response to heat stress using proteomics. We acclimated sea urchins to 11°C and 18°C for four weeks and subsequently exposed animals to 12°C (control) to 18°C and 25°C, and 18°C to 25°C for 4 hours. Afterwards we brought animals back to their respective acclimation temperature (11°C for 11°C-acclimated group and 18°C for 18°C acclimated group) for 16± .5 hours (recovery period). We cut off foot tissue immediately afterwards and collected the tissue on dry ice. We homogenized the tissue in urea-containing buffer, precipitated the protein sample and subsequently rehydrated the pellet in the same buffer. Proteins were separated using two-dimensional gel electrophoresis: first we used an immobilized pH gradient to focus proteins according to their charge and, second, we used standard sodium dodecyl sulfate- polyacrylamide gel electrophoresis (SDS-PAGE) to separate proteins according to their molecular weight. Gels were stained with SYPRO Ruby and scanned with a Typhoon Trio laser scanner. 2D gel images were subsequently analyzed using an image analysis software (Delta2D) to determine which protein spots are up-regulated in response to heat stress. Differentially expressed proteins were excised, digested with trypsin and prepared for mass spectrometry. We used matrix-assisted laser desorption ionization tandem time-of-flight (MALDI-TOF-TOF) mass spectrometry to identify differentially expressed proteins. The preliminary results provide insights into the global response of the proteome to environmentally relevant heat stress following different thermal conditions (laboratory acclimation).

† THE EFFECTS OF ELEVATED ATMOSPHERIC CO₂ ON *OSTREA LURIDA* LARVAE FROM TOMALES BAY, CALIFORNIA

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Increased levels of atmospheric CO₂ rapidly equilibrate with ocean surface waters in effect causing a pH decrease. The present study addresses a possible futuristic (2100) atmosphere of 900 to 1050 ppm CO₂ and its effect on larvae of the west coast native oyster, *Ostrea lurida*. Sea water pH was lowered to an average value of 7.74 by increasing pCO₂ with a CO₂ incubator. Fluorescently tagged veliger larvae were subjected to lowered pH water for three days; shell growth was measured and compared to control growth (larvae in 380 ppm pCO₂). We saw a 23.5% decrease of larval shell growth in elevated pCO₂ conditions. Data from a Tomales Bay study over the period of 1987 to 1995 support the idea of a CO₂ heavy atmosphere decreasing pH. Oyster broodstock collected from Tomales Bay were assumed to be offspring of generations that withstood a 142.1 ppm pCO₂ increase and a decrease in pH of 0.1 during the nine years.

† THE LIGHT'S ON BUT NOBODY'S HOME: NEGATIVE PHOTOTACTIC RESPONSE OF *KELLETIA KELLETII* LARVAE TO LIGHT INTENSITY AND WAVELENGTH

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Many marine invertebrate larvae control their vertical position in the water column, potentially influencing dispersal outcomes. Previous laboratory studies with marine gastropod *Kelletia kelletii* larvae revealed that this species exhibits diel vertical migration (DVM) that is partially controlled by light. We explored light intensity and wavelength as potential cues initiating downward swimming and verified that DVM occurs in the field with plankton tows. We varied full-spectrum light intensity (ranging from 2.5 to 126 PAR) in six replicate 10 cm diameter by 125 cm tall columns each containing 100 one-week old dark-adapted larvae and determined their vertical positions after 2 hrs light exposure. As light intensity decreased, significantly fewer larvae descended (ANOVA, $p < 0.0001$). At 2.5 PAR the percent larvae at the top of columns was similar to that in the dark control ($p = < 0.05$). The effect of wavelength was tested by comparing blue/green light (450-550 nm) at 14 PAR to full spectrum light (380-740 nm) of equivalent intensity. The proportion of descending larvae was significantly different (ANOVA, $p = 0.0006$) indicating that *K. kelletii* larvae respond differentially to varying wavelengths of light. Surface plankton tows ($n=5$) were conducted at 1200 h and 2400 h off the coast of Palos Verdes, CA to examine whether laboratory findings were consistent with field vertical distributions of larvae. As predicted by lab studies, there were significantly more larvae at the surface at 2400 hr versus 1200 hr (T-test, $p = 0.0008$). Findings from this study will help develop mathematical models of larval distributions aimed at estimating dispersal outcomes.

SIMULATION OF HUMAN ACTIVITIES AND CORRESPONDING IMPACTS TO THE TEMPERATE INTERTIDAL

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Trampling, collecting, and handling impact the organisms inhabiting the intertidal zone. Many studies have sought to simulate human impacts through trampling studies imitating levels of foot traffic to a given area. Most studies rely on a given number of steps to simulate trampling levels, while ignoring other activities (touching organisms/manipulating), as well as foot traffic other than simple steps back and forth. Our design is seeking to simulate more realistic activities. Our study is ideal being situated on several miles of land, without public access for approximately the past 25 years. Sixteen 4m x 2m plots have been established and monitored once a month for the past eight months to determine “before” densities and condition of organisms. Visitor use data from near-by Montana de Oro state park will be used to calculate realistic visitor densities, which will then be applied to treatment plots at three levels of “use” (people in each 4m x 2m plot / time period). Plots will be sampled immediately after the impact treatments. Control plots will also be monitored. Before and after impact data will be analyzed for changes in species abundance to identify effects not due to natural variation. Given that the site has little to no human impact at this time, we hope to identify indicator organisms that may be used in other areas to determine presence or levels of human use to intertidal areas. This critical information can then be used to set appropriate levels of access to the intertidal community.

MANGLED MUTUALISM: INTERPRETING DIRECT CONSUMPTION OF EELGRASS BY MESOGRAZERS IN THE CHESAPEAKE BAY

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Eelgrass (*Zostera marina*) provides structural habitat for taxa ranging from small fouling organisms to economically important crabs and fish. However, eelgrass beds in the Chesapeake Bay are declining, along with the important ecosystem services they provide. Mesograzers, small crustaceans that consume epiphytes, are believed to be critical to eelgrass health by preventing algal overgrowth. Despite the putative benefit of mesograzers to eelgrass, evidence from both field monitoring and mesocosm experiments suggests that, under some conditions, mesograzers harm eelgrass by grazing directly on shoots. We examine the effect of season and the abundance of particular mesograzers on the degree of direct grazing on eelgrass, and evaluate the potential relationship between overgrazing and eelgrass dieback events.

† THE CONTRIBUTION OF DIFFERENT HABITAT TYPES TO REGIONAL LARVAL SUPPLY: IMPLICATIONS FOR MARINE RESERVES

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Global fisheries are in steep decline and species losses have led to negative impacts on biodiversity and ecosystem services. In response, marine reserves are being implemented to help safeguard ecosystem health and provide spillover of larvae, juveniles and adults into non-reserve areas. Consequently, the reproductive output of local species in potential reserve areas is an important consideration for reserve spatial planning. We are examining the associations among coastal features and habitat type on reproduction and recruitment of the keystone predator, *Pisaster ochraceus*, and its preferred prey, *Mytilus californianus*. In northern California these two species are found primarily in two dominant intertidal habitat types: expansive rocky benches and on boulders, cobbles and small benches embedded along sandy shores. These two habitat types present different potential resources and stressors for *Pisaster* and *Mytilus* that we hypothesized would lead to predictable variation in reproductive output. Instead, our early results indicate that oceanographic features and trophic interactions may be more influential than habitat type. We found *Mytilus* reproductive output was correlated with local phytoplankton concentration rather than habitat type, which may highlight the importance of potential retention zones where food is retained near shore. In contrast, *Pisaster* reproductive output was more correlated with diet composition rather than habitat type or oceanographic conditions per se.

† EFFECTS OF CADMIUM ON THE GROWTH AND PHOTOSYNTHESIS OF TWO SPECIES OF MARINE PHYTOPLANKTON, AND TROPHIC TRANSFER TO CILIATE GRAZERS

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We compared the effects of added cadmium on the growth and photosynthesis of two species of marine phytoplankton, *Heterocapsa triquetra*, a dinoflagellate, and *Heterosigma akashiwo*, a toxic, bloom-forming raphidophyte. Cadmium uptake by the phytoplankton was also measured. The growth rate over 8 days of *H. triquetra* was reduced at nominal cadmium concentrations of 36 and 60 fYM. *H. akashiwo* was even more tolerant, exhibiting reduced growth only at 100 fYM, the highest concentration used. Photosynthetic capability, as assessed by photosynthesis-irradiance curves from 14C uptake experiments, was reduced at 60 fYM cadmium for the *H. triquetra*, and at 100 fYM for the *H. akashiwo*. Significant accumulation of cadmium occurred in both species at all cadmium levels (from 21-100 fYM) within the first 48 hours. Both species of phytoplankton used showed a high tolerance for cadmium as compared to those used in similar studies. In a second experiment, a ciliate grazer, *Favella* sp., was added to *H. triquetra* cultures with cadmium to assess trophic transfer of the metal. The growth rate and cadmium uptake of the *Favella* were measured over a 72-hour period. Growth rates were not significantly different from the controls at a nominal cadmium concentration of 36 fYM, and the *Favella* cells had less than one-tenth the amount of cadmium per cell as the phytoplankton cells they were eating. *Favella* did not appear to biomagnify the cadmium, and appeared to be fairly tolerant as well.

† EXAMINING THE IMPACTS OF CLIMATE CHANGE ON MARINE ORGANISMS: EFFECTS OF OCEAN ACIDIFICATION ON LARVAL MARINE SNAILS

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Currently, 33% of the carbon dioxide given off from burning fossil fuels enters the ocean, reducing its alkaline pH. Estimates suggest that a drop in pH to 7.9 from 8.05 could decrease calcification rates of many marine organisms up to 60% by the end of the century. As a consequence of the predicted elevated levels of greenhouse gases, it is important to understand the underlying mechanisms between calcification and biomineralization in marine organisms. This information may provide us with how organisms might be able to adapt or alter their physiological responses to climate change. This research centers on determining the calcification response to elevated carbon dioxide in *Nucella veligers*, an intertidal snail. Using molecular techniques, such as quantitative PCR, and physical measurements, such as shell thickness and hardness, can provide a template for understanding how “shell forming”

organisms might be affected in the near future. Most importantly, this research may give us insight into the environmental impacts on marine ecosystems and structure we might expect as the oceans become more acidic.