

SCHEDULE OF EVENTS

THURSDAY, NOVEMBER 11, 2010

1800 WSN STUDENT WORKSHOP (Salon ABC)
BECOMING A BETTER BIOLOGICAL BLOGGER: USING THE WEB TO COMMUNICATE SCIENCE TO THE PUBLIC

Speakers include:

Carol Blanchette, *Marine Science Institute, University of California Santa Barbara*
Miriam Goldstein, *Scripps Institution of Oceanography, UCSD*
Kristen Marhaver, *CARMABI, Scripps Institution of Oceanography, UCSD*

2030 WSN STUDENT MIXER
Point Loma Sports Grill and Pub (2750 Dewey Rd, San Diego, CA)
Open to all graduate and undergraduate students; no ticket required.
See the student desk for directions.

FRIDAY, NOVEMBER 12, 2010

0855-1200 STUDENT SYMPOSIUM (Salon ABC)
HUMAN IMPACTS ON COASTAL ECOSYSTEMS
1200-1300 LUNCH
1300-1745 CONTRIBUTED PAPERS
1830-2030 WSN POSTER SESSION (Salon ABC)
1930-2230 ATTITUDE ADJUSTMENT HOUR (AAH) (Salon ABC)

SATURDAY, NOVEMBER 13, 2010

0800-1115 PRESIDENTIAL SYMPOSIUM (Salon ABC)
*CREATIVITY, CONTROVERSY, AND ECOLOGICAL CANON:
A SYMPOSIUM HONORING PETER F. SALE*
1115 AWARDED OF LIFETIME ACHIEVEMENT AWARD (by Phil Levin)
1130 AWARDED OF NATURALIST OF THE YEAR (by Phil Levin)
1135 WSN NATURALIST OF THE YEAR (Shara Fisler)
1200-1300 LUNCH
1300-1800 CONTRIBUTED PAPERS
1800-1900 ANNUAL BUSINESS MEETING (Roosevelt Room)
1900-2100 PRESIDENTIAL BANQUET (Salon ABC)
2100-0100 WSN AUCTION followed by DANCE (Salon ABC)

SUNDAY, NOVEMBER 14, 2010

0830-1230 CONTRIBUTED PAPERS
1230-1330 LUNCH
1330-1445 CONTRIBUTED PAPERS

FRIDAY, NOVEMBER 12, 2010

STUDENT SYMPOSIUM (0855-1200)

SALON ABC

HUMAN IMPACTS ON COASTAL ECOSYSTEMS

0855 **INTRODUCTION AND ANNOUNCEMENTS** (Megan McKinzie)

0900 **Peter Roopnarine** *California Academy of Sciences*
MODELING THE ROBUSTNESS AND FRAGILITY OF COASTAL MARINE
COMMUNITIES

0930 **Lisa Levin** *Scripps Institution of Oceanography*
HETEROGENEITY, DIVERSITY, AND THE HUMAN IMPACT ON CONTINENTAL
MARGINS

1000 **Ted Grosholz** *Bodega Marine Laboratory, University of California Davis*
ECOSYSTEM IMPACTS OF COASTAL INVASIVE SPECIES

1030 **BREAK**

1100 **Ben Halpern** *National Center for Ecological Analysis and Synthesis*
ASSESSING AND MANAGING CUMULATIVE IMPACTS OF HUMAN ACTIVITIES IN
MARINE SYSTEMS

1130 **PANEL DISCUSSION**

1200-1300 **LUNCH**

FRIDAY, NOV 12 1300-1500		† eligible for Best Student Paper Award		
Time	Session 1: SALON A Intertidal Ecology I Chair: Jen Burnaford	Session 2: SALON B Fisheries Biology I Chair: Todd Anderson	Session 3: SALON C Community Ecology I Chair: Jeremy Long	Session 4: ROOSEVELT ROOM Plant/Algal Biology Chair: Matt Edwards
1300	Conway-Cranos, LL AN INVESTIGATION OF THE RELATIVE IMPORTANCE OF MECHANISMS DRIVING VARIATION IN THE RECOVERY OF MUSSEL BEDS	Longo, C THE ROLE OF INDIVIDUAL BODY SIZE IN FISH DIVERSITY PATTERNS – A MEDITERRANEAN CASE-STUDY	Salomon, AK BEYOND THE OUTER SHORES; COMPARING KELP FOREST DYNAMICS FROM HAIDA GWAI, BRITISH COLUMBIA TO THE CHANNEL ISLANDS, CA	† Schuster, MD PHLOROTANNINS AND URCHIN (<i>STRONGYLOCENTROTUS POLYACANTHUS</i>) FEEDING PREFERENCES IN THE ALEUTIAN KELP <i>EUALARIA FISTULOSA</i>
1315	† Augyte, S A PRELIMINARY FLORISTIC ANALYSIS OF MARINE INTERTIDAL ALGAE FROM CAPE MENDOCINO, CA TO CAPE BLANCO, OR	Miller, EF CLIMATE-DRIVEN CHANGES IN SOUTHERN CALIFORNIA COASTAL FISHES, 1972-2009	† Hensgen, GM THE EFFECTS OF HABITAT FRAGMENTATION ON THE ABUNDANCE AND DIVERSITY OF SMALL NEKTON IN SUBTROPICAL SEAGRASS MEADOWS	Carney, LT GENETIC AND EXPERIMENTAL EVIDENCE FOR A GAMETOPHYTE BANK OF MIXED-AGE AND MIXED-ORIGIN IN A SOUTHERN CALIFORNIA KELP FOREST
1330	Burnaford, JL LONG-TERM CHANGES IN ABUNDANCE OF THE INTERTIDAL CANOPY-FORMING KELP <i>SACCHARINA SESSILE</i> : COMMUNITY EFFECTS AND POSSIBLE CAUSES	† Espasandin, CL EVALUATING ECOSYSTEM RECOVERY IN A RESTORED SOUTHERN CALIFORNIA ESTUARY BY ACOUSTIC MONITORING OF THE CALIFORNIA HALIBUT	† Blake, R DIFFERENCES IN THE CHESAPEAKE BAY, VA EELGRASS (<i>ZOSTERA MARINA</i>) COMMUNITY AS A FUNCTION OF LOCAL SHORELINE DEVELOPMENT.	Edwards, MS CLIMATE CHANGE AND KELP FORESTS: BALANCING PHOTOSYNTHESIS AND RESPIRATION
1345	Ferrier, GA SENSORY BIOLOGY AND THE ROCKY INTERTIDAL: A MULTIFUNCTIONAL BARNACLE PROTEIN DRIVES ECOLOGICAL INTERACTIONS	† McKinzie, MK FINE-SCALE HORIZONTAL AND VERTICAL MOVEMENT OF BARRED SAND BASS, <i>PARALABRAX NEBULIFER</i> , WITHIN A KNOWN SPAWNING AGGREGATION	† Segui, LM URCHIN POPULATION REGULATION IN CALIFORNIA KELP FORESTS: USING AN INDIVIDUAL-BASED MODEL TO EXAMINE THE ROLE OF PREDATOR BEHAVIOR	Lindstrom, SC NEW, RESURRECTED AND REDEFINED SPECIES OF <i>MASTOCARPUS</i> (PHYLLOPHORACEAE, RHODOPHYTA) FROM THE NORTHEAST PACIFIC

1400	Goddard, JH DECLINE IN NUDIBRANCH GASTROPODS FOLLOWING A CLIMATE-RELATED RANGE SHIFT OF A LARGE PREDATORY AEOLID IN THE NE PACIFIC OCEAN	† Pirtle, JL HABITAT STRUCTURE INFLUENCES SURVIVAL AND PREDATOR-PREY INTERACTIONS OF EARLY JUVENILE RED KING CRAB, <i>PARALITHODES CAMTSCHATICUS</i>	Long, JD TRAMPLING EFFECTS ON BARNACLE ABUNDANCE AND COVERAGE VARY WITH ONTOGENY	† Demes, KW VARIATION IN ANATOMICAL AND MATERIAL PROPERTIES EXPLAINS DIFFERENCES IN HYDRODYNAMIC PERFORMANCES OF FOLIOSE RED MACROALGAE (RHODOPHYTA)
1415	† Moulton, OM FOUNDATION SPECIES SURFGRASS MORPHOLOGY AND COASTAL GRADIENTS INFLUENCE INVERTEBRATE COMMUNITIES ON THE OREGON COAST	Thompson, AR INFLUENCE OF SCALE ON THE DYNAMICS OF THE LARVAL FISH ASSEMBLAGE IN THE SOUTHERN CALIFORNIA BIGHT	† Swanson, SA THE UNIQUE BIOLOGY AND ECOLOGY OF THE ECHINOID <i>ECHINOSTREPHUS ACICULATUS</i> IN MOOREA, FRENCH POLYNESIA	† Harrer, SL NON-DESTRUCTIVE METHODS FOR PREDICTING BENTHIC UNDERSTORY MACROALGAL BIOMASS AND PRODUCTIVITY
1430	Pister, B TWENTY YEARS OF ROCKY INTERTIDAL MONITORING AT CABRILLO NATIONAL MONUMENT: DETECTION AND ANALYSIS OF LONG TERM TRENDS	† Westphal, MJ GROWTH OF JUVENILE RED KING CRAB <i>PARALITHODES CAMTSCHATICUS</i> IN THE LAB AND FIELD	† Darling, ES ALL STRESSED OUT? SYNERGIES, RESILIENCE AND COTOLERANCE ON EAST AFRICAN CORAL REEFS	Rodriguez, GE PATTERNS OF BIRTH AND LOSS: WHAT EXPLAINS THE BIOMASS DYNAMICS OF THE WORLD'S MOST PRODUCTIVE MARINE ORGANISM?
1445	† Hutto, SV DIFFERENTIAL RECRUITMENT OF <i>POSTELSIA PALMAEFORMIS</i> ACROSS SUBSTRATE TYPES AND THE POTENTIAL FACILITATIVE EFFECTS OF TURFING ALGAE	† Loury, EK DIET OF THE GOPHER ROCKFISH (<i>SEBASTES CARNATUS</i>) INSIDE AND OUTSIDE OF THE POINT LOBOS STATE MARINE RESERVE	† Cameron, CM THE EFFECTS OF DAMAGE VARYING IN EXTENT AND ORIGIN ON THE GROWTH OF SMALL CORALS	† Hondolero, DE PHYSICAL AND BIOLOGICAL CHARACTERISTICS OF KELP FORESTS IN KACHEMAK BAY, ALASKA
1500	Break	Break	Break	Break

FRIDAY, NOV 12 1530-1745		† eligible for Best Student Paper Award		
Time	Session 1: SALON A Invertebrate & Molecular Biology Chair: Brian Hentschel	Session 2: SALON B Invasive Species I Chair: Kevin Britton- Simmons	Session 3: SALON C Community Ecology II Chair: Danielle Zacherl	Session 4: ROOSEVELT ROOM Population Biology I Chair: Ginny Eckert & Jodi Pirtle
1530	† Goulding, T THORNY-HEADED WORMS INFECTING MOLE CRABS: A COSMOPOLITAN MARINE PARASITE OR CRYPTIC SPECIES COMPLEX?	† Clarke Murray, C BIOMECHANICS OF INVASION: INTERSPECIFIC ADAPTATIONS FOR TRANSPORT IN HULL FOULING COMMUNITIES	† Bryson, S FACILITATION BECOMES INHIBITION UNDER EXTREMELY STRESSFUL CONDITIONS	† Ashander AQUACULTURE-INDUCED CHANGES TO DYNAMICS OF A MIGRATORY HOST AND SPECIALIST PARASITE: A CASE STUDY OF PINK SALMON AND SEA LICE
1545	† Matthews, JA THE EFFECTS OF SIMULATED SUBLETHAL PREDATION ON THE IN-SITU GROWTH AND PALP REGENERATION RATES OF <i>POLYDORA CORNUTA</i>	† Wells, EH RAPID AND DIFFERENTIAL LEARNING FOR AN INVASIVE CRAB PREDATOR ON TWO NON-NATIVE SNAILS	Weitzman, BP THE EFFECTS OF SEA OTTER RECOLONIZATION ON BENTHIC INTERTIDAL INVERTEBRATE COMMUNITIES IN GLACIER BAY, ALASKA.	Parnell, E LOW FREQUENCY CLIMATE FORCING OF GIANT KELP IN SOUTHERN CALIFORNIA
1600	† Olivier, TJ DOWNSTREAM HATCHING MIGRATION OF THE RIVER SHRIMP <i>MACROBRACHIUM</i> <i>OHIONE</i> IN THE LOWER MISSISSIPPI RIVER SYSTEM	Britton-Simmons, K DENSITY-DEPENDENT AND DENSITY-INDEPENDENT RESPONSES OF A NATIVE HERBIVORE TO A NON- NATIVE SEAWEED	Byrnes, JE CLIMATE CHANGE, STORM FREQUENCY, AND THE FUTURE OF KELP FOREST FOOD WEBS	† Painter, SM THE INFLUENCE OF POPULATION DENSITY AND SEX RATIO ON INDIVIDUAL SEX CHANGE IN A TEMPERATE REEF FISH, <i>LYTHRYPNUS DALLI</i>
1615	† Conner, SL INFECTION OF ADULT MIGRATORY RIVER SHRIMPS <i>MACROBRACHIUM OHIONE</i> BY A BRANCHIAL BOPYRID ISOPOD, <i>PROBOPYRUS</i> <i>PANDALICOLA</i>	† Passarelli, B THE MARINE LIVE BAIT TRADE IN CALIFORNIA: A PATHWAY FOR THE INTRODUCTION OF NON- INDIGENOUS SPECIES?	† Gravem, SA MICROCLIMATE CHANGES THE STRENGTH OF THE PREDATOR-PREY INTERACTIONS IN ROCKY SHORE COMMUNITIES	† Block, HE SPATIAL AND TEMPORAL VARIATION IN LARVAL TRAITS IN AN ABUNDANT KELP FOREST FISH, <i>OXYJULIS CALIFORNICA</i>

1630	† Skillings, DJ GATEWAYS TO HAWAII – GENETIC POPULATION STRUCTURE OF THE TROPICAL SEA CUCUMBER <i>HOLOTHURIA ATRA</i>	† Linnenbrink, JM GENETIC DIVERSITY IS RECOVERED QUICKLY IN NEWLY FOUNDED GOBY POPULATIONS: A PARADIGM FOR BIOLOGICAL INVASION?	Reed, D WAVE DISTURBANCE OVERWHELMS BOTTOM-UP AND TOP-DOWN CONTROL IN CALIFORNIA KELP FORESTS	Karl, SA MICRO-SPATIAL GENETIC AND THERMAL ARCHITECTURE OF HAWAIIAN CORAL REEFS
1645	† Raith, MR PHYLOGENETIC RELATIONSHIPS OF OSTREIDAE FROM THE GULF OF CALIFORNIA AND OUTER BAJA CALIFORNIA	† Vogt, SC THE CONSUMER'S DILEMMA, NATIVE OR NON-NATIVE SEAWEEDS?	† Tyburczy, WR TIMING IS EVERYTHING: THE EFFECTS OF SPECIES DENSITIES AND SEASONAL PREY RECRUITMENT ON PREDATORS IN A WHELK- BARNACLE SYSTEM	† Marhaver, KL DISTANCE-DEPENDENT MORTALITY OF JUVENILE CORALS IS MICROBE- MEDIATED, SPECIES- SPECIFIC AND MAY DRIVE BEHAVIORAL EVOLUTION OF LARVAE
1700				† Cavanaugh, KC SEASONAL TO DECADAL DYNAMICS OF GIANT KELP BIOMASS IN THE SANTA BARBARA CHANNEL
1715				Eberl, R PHYLOGEOGRAPHY OF THE HIGH INTERTIDAL ISOPOD <i>LIGIA PALLASII</i> : ALEUTIAN ISLANDS TO MONTEREY BAY
1730				Donovan, MK DEMOGRAPHIC VARIABILITY IN AN INTRODUCED HAWAIIAN REEF FISH
1745				Ingram, T FOOD WEB CONSEQUENCES OF STICKLEBACK ADAPTATION TO AN INTRAGUILD PREDATOR

SATURDAY, NOVEMBER 13, 2010

PRESIDENTIAL SYMPOSIUM (0800-1115)

SALON ABC

**CREATIVITY, CONTROVERSY, AND ECOLOGICAL CANON:
A SYMPOSIUM HONORING PETER F. SALE**

0800 **INTRODUCTION** (Phil Levin)

0810 **Essington, T** *University of Washington*

WHAT'S (TROPHIC LEVEL) GOT TO DO WITH IT? FISHING DOWN AND THROUGH
MARINE FOOD WEBS

0835 **Ruckelshaus, MH** *Stanford University*

SIMPLIFYING NATURE'S COMPLEXITY: BEING SMART ABOUT DUMBING-DOWN
ECOSYSTEM SCIENCE FOR THE PEOPLE

0900 **Rice, J** *Fisheries and Oceans Canada*

ADVOCACY SCIENCE - THE SIREN SONG FOR APPLIED ECOLOGY

0925 **BREAK**

0950 **Simberloff, D** *University of Tennessee*

COMPETITION, HISTORICAL GEOGRAPHY, AND COMMUNITY ASSEMBLY
RULES – BIRDS OF THE BISMARCK AND SOLOMON ISLANDS

1015 **Sale, PF** *United Nations University*

SHIFTING BASELINES, RESILIENT PARADIGM, AND OUR ENVIRONMENTAL
CRISIS

1040 **PANEL DISCUSSION**

1115 **INTRODUCTION OF WSN LIFETIME ACHIEVEMENT AWARD** (by Phil Levin)

1130 **INTRODUCTION OF THE NATURALIST OF THE YEAR** (by Phil Levin)

1135 **WSN NATURALIST OF THE YEAR** (Shara Fisler)

1200-1300 **LUNCH**

SATURDAY, NOV 13 1300-1500		† eligible for Best Student Paper Award		
Time	Session 1: SALON A Intertidal Ecology II Chair: Karina Nielsen	Session 2: SALON B Dispersal & Recruitment I Chair: Josh Idjadi	Session 3: SALON C Ecosystem Assessment Chair: Phil Levin	Session 4: ROOSEVELT ROOM Physiological Ecology I Chair: Bob Carpenter
1300	† Ben-Horin, T ENVIRONMENTAL VARIANCE AND THE TRANSMISSION OF WITHERING SYNDROME IN BLACK ABALONE	† Hedge, LH MANIPULATING THE INTRINSIC ELEMENTS OF INVASIVE PROPAGULE PRESSURE: ARRIVAL FREQUENCY MORE IMPORTANT THAN INTENSITY	Williams, GD A SYSTEMATIC FRAMEWORK FOR EVALUATING AND RANKING ECOSYSTEM INDICATORS FOR THE CALIFORNIA CURRENT LARGE MARINE ECOSYSTEM (CCLME)	Edmunds, PJ INTERACTIVE EFFECTS OF HIGH PCO ₂ , HETEROTROPHY, AND TEMPERATURE ON THE CALCIFICATION AND PHOTOPHYSIOLOGY OF MASSIVE <i>PORITES</i> SPP.
1315	† Gyory, J TURBIDITY AS A CUE FOR SYNCHRONOUS LARVAL RELEASE IN THE BARNACLE <i>SEMIBALANUS BALANOIDES</i>	Morgan, SG EVENT PROFILING REVEALS LARVAL ADVECTION AND CONTROL IN A RECRUITMENT-LIMITED UPWELLING SYSTEM	Samhour, JF SURROGATES, INDICATORS, AND ASSESSMENTS, OH MY! EMPIRICAL TESTS OF THE INDICATOR SPECIES CONCEPT FOR U.S. PACIFIC GROUND FISH	† Jacobson, LM THE ALLOCATION PRIORITIES FOR TISSUE ENERGY RESERVES IN SCLERACTINIANS EXPOSED TO TOTAL NUTRIENT LIMITATION
1330	Groesbeck, AS ANCIENT CLAM MARICULTURE ON BRITISH COLUMBIA'S COASTLINE: AN EMPIRICAL ANALYSIS OF SECONDARY PRODUCTIVITY	Idjadi, JA NO EVIDENCE OF A FISH AGGREGATION (FAD) EFFECT FOR SUBMERGED LIQUID NATURAL GAS STRUCTURES IN MASSACHUSETTS BAY	Tolimieri, N STATUS OF WEST COAST GROUND FISHES: PRELIMINARY RESULTS FROM THE CALIFORNIA CURRENT INTEGRATED ECOSYSTEM ASSESSMENT	Matterson, KO THE EFFECT OF SETTLEMENT ANGLE ON JUVENILE GROWTH OF THE TEMPERATE SCLERACTINIAN, <i>OCULINA ARBUSCULA</i>
1345	Robles, CD A KEYSTONE PREDATOR'S SOMATIC RESPONSE TO CHANGING PREY AVAILABILITY: INDETERMINATE GROWTH IN <i>PISASTER OCHRACEUS</i>	† Fanslow, C POPULATION CHARACTERIZATION OF THE DUNGENESS CRAB, <i>CANCER MAGISTER</i> : CONSIDERATION OF EFFECTS OF CURRENTS ON LARVAL DISPERSAL	Beaudreau, AH IN THE EYE OF THE BEHOLDER: FOLK BIOLOGICAL CLASSIFICATION SYSTEMS AND PERCEPTIONS OF SPECIES ABUNDANCE TRENDS IN PUGET SOUND	Putnam, HM PHYSIOLOGICAL RESPONSE OF <i>POCILLOPORA DAMICORNIS</i> TO INTERACTIVE CLIMATE CHANGE STRESSORS

1400	<p>† Anderson, KM INDUCED DEFENSES IN INTERTIDAL ALGAE: SPECIFICITY AND EFFECTIVENESS IN RELATION TO HERBIVORY</p>	<p>† Miller, SH INTERANNUAL VARIABILITY IN TRACE ELEMENT SIGNATURES ALONG THE NORTHERN CALIFORNIA COAST</p>	<p>Morzaria-Luna, H COMPLIANCE WITH EXISTING FISHERIES REGULATIONS YIELDS ECONOMIC AND ECOLOGICAL BENEFITS FOR THE NORTHERN GULF OF CALIFORNIA</p>	<p>Carpenter, RC ORIGIN-SPECIFIC RESPONSES BY THE TROPICAL CORALLINE ALGA <i>HYDROLITHON ONKODES</i> TO AMBIENT, ELEVATED, AND VARIABLE PCO₂</p>
1415	<p>Nielsen, KJ WIND-DRIVEN DYNAMICS, WAVE TRANSPORT AND PHYTOPLANKTON 'BLOOMS' IN THE ROCKY INTERTIDAL</p>	<p>† Morton, DN SPATIAL PATTERNS OF INVERTEBRATE SETTLEMENT IN A GIANT KELP FOREST</p>	<p>Kaplan, I SCREENING FISHERY MANAGEMENT SCENARIOS FOR THE CALIFORNIA CURRENT INTEGRATED ECOSYSTEM ASSESSMENT</p>	<p>† Johnson, MD THE EFFECT OF ELEVATED PCO₂ ON CALCIFICATION OF THE CRUSTOSE CORALLINE ALGA <i>HYDROLITHON ONKODES</i> IN MOOREA, FRENCH POLYNESIA</p>
1430	<p>Bird, CE BETWEEN TIDE AND WAVE MARKS: A UNIFYING MODEL OF PHYSICAL ZONATION ON LITTORAL SHORES</p>	<p>† Pusack, TJ GENE FLOW AND LARVAL DISPERSAL IN A METAPOPOPULATION OF A CORAL-REEF FISH</p>	<p>Orr, D ASSESSMENT OF EFFECT AND PREDICTIONS OF RECOVERY DYNAMICS WHEN BASELINE DATA ARE SCARCE: A CASE STUDY OF THE COSCO BUSAN OIL SPILL</p>	<p>Bartlett, JN CHANGING SEXES IN A COMPLEX ENVIRONMENT - SHIFTS IN SKELETAL MYOSIN ISOFORMS IN COASTAL POPULATIONS OF CALIFORNIA SHEEPHEAD</p>
1445	<p>Flegel, RL LANDSCAPE PATTERN AND PROCESSES IN THE DISTURBANCE PARADIGM: AN ALTERNATIVE VIEW OF MUSSEL BEDS</p>	<p>Trbovich, SM QUANTIFYING GENETIC DIFFERENTIATION AMONG KELP BASS (<i>PARALABRAX CLATHRATUS</i>) SUBPOPULATIONS IN THE SOUTHERN CALIFORNIA BIGHT</p>	<p>Tompkins, PA RHODOLITHS AT CATALINA ISLAND: DISTRIBUTION, GROWTH, AND CONSEQUENCES OF DISTURBANCE</p>	<p>Campanale, JP DEVELOPMENT AT THE EXPENSE OF DEFENSE; SEA URCHIN SMALL MICROMERES LOSE MULTIDRUG EFFLUX ACTIVITY AT THEIR FORMATION</p>
1500	Break	Break	Break	Break

SATURDAY, NOV 13 1530-1745		† eligible for Best Student Paper Award		
Time	Session 1: SALON A Behavioral Ecology I Chair: Ryan Hechinger	Session 2: SALON B Invasive Species II Chair: Steve Lonhart	Session 3: SALON C Community Ecology III Chair: Jayson Smith	Session 4: ROOSEVELT ROOM Applied Ecology I Chair: Mark Steele
1530	Hechinger, RF EUSOCIALITY IN A FLATWORM: TREMATODE PARASITES FORM SOLDIER AND REPRODUCTIVE CASTES	Tomas, F DOES THE ENEMY RELEASE HYPOTHESIS APPLY TO MARINE INVASIONS? AN EXPERIMENTAL TEST WITH FOULING COMMUNITIES	† Brown, AL FLOW-DRIVEN OUTCOMES OF CORAL-ALGAL COMPETITION	Sagarin, R THE PUBLIC TRUST DOCTRINE AND THE BP GULF DISASTER: TIME TO UNIFY NATURAL HISTORY AND ENVIRONMENTAL POLICY
1545	† Coates, JH PINK ABALONE (<i>HALIOTIS CORRUGATA</i>) MOVEMENT FOLLOWING ARTIFICIAL AGGREGATION: TESTING A POTENTIAL RESTORATION TECHNIQUE	† Santschi, CA INFLUENCE OF ENVIRONMENTAL VARIABLES ON THE RECRUITMENT AND DEVELOPMENT OF FOULING ASSEMBLAGES IN HARBORS	† Stier, AC MULTIPLE PREDATOR EFFECTS IN INVERTEBRATE CORAL REEF COMMUNITIES	† Kane, TL TIDAL CYCLES AND NITROGEN INPUTS INFLUENCE NITROGEN FIXATION AND DENITRIFICATION IN SOUTHERN CALIFORNIA ESTUARIES
1600	Lees, DC THE RELATIONSHIP BETWEEN MOVEMENT AND AVAILABLE FOOD IN THE SEA URCHINS <i>STRONGYLOCENTROTUS FRANCISCANUS</i> AND <i>S. PURPURATUS</i>	Radecki, JR GENETIC DIVERSITY OF THE INVASIVE CHAMELEON GOBY (<i>TRIDENTIGER TRIGONOCEPHALUS</i>) REVEALS MULTIPLE SOURCE POPULATION ADMIXTURE	† Muthukrishnan, R BENTHIC COMMUNITY STRUCTURE AND STABILIZING MECHANISMS PROVIDE SUPPORT FOR ALTERNATE STABLE STATES IN A TROPICAL REEF ECOSYSTEM	† Jorve, JP SITES EXPOSED TO FERRY TRAFFIC EXHIBIT HIGHER INTERTIDAL SEAWEED ABUNDANCE AND SPECIES RICHNESS
1615	Andrews, KS JELLIES ON THE MOVE: VERTICAL AND HORIZONTAL PATTERNS OF MOVEMENT OF JELLYFISH IN PUGET SOUND.	Lonhart, SI SMALL-SCALE, SHORT-TERM GROWTH AND DISTRIBUTION OF AN INVASIVE BRYOZOAN IN MONTEREY HARBOR	† Abbott, JM EELGRASS GENOTYPIC IDENTITY AFFECTS THE PREFERENCE AND PERFORMANCE OF A DOMINANT HERBIVORE MORE THAN NITROGEN ADDITION	Pinsky, ML BEWARE OF ASSUMPTIONS: GLOBAL METAANALYSIS REVEALS THAT FISHERIES COLLAPSES ARE NOT MORE COMMON AMONG LARGE, TOP PREDATORS

1630	† Selden, RL FISHING-INDUCED CHANGES IN CALIFORNIA SHEEPHEAD SIZE ALTER PREDATION RATES AND KELP FOREST ECOSYSTEMS	Clark, GF TEMPORAL DEPENDENCE OF THE DIVERSITY-INVASIBILITY RELATIONSHIP IN SESSILE MARINE INVERTEBRATES	† Best, RJ TROPHIC CASCADES IN SEAGRASS MEADOWS DEPEND ON MESOGRAZER VARIATION IN BOTH FEEDING RATES AND PREDATION SUSCEPTIBILITY	Steele, MA GROWTH, REPRODUCTION, AND TISSUE PRODUCTION OF TEMPERATE REEF FISHES ON ARTIFICIAL VERSUS NATURAL REEFS
1645	Olson, EL QUANTIFYING LARGE-SCALE MOVEMENT PATTERNS OF MALE LOGGERHEAD SEA TURTLES (<i>CARETTA CARETTA</i>) IN THE EASTERN INDIAN OCEAN	Kim, T BOTH GLOBAL DIMMING AND WARMING MAY ACCELERATE INVASION OF MARINE NON-INDIGENOUS SPECIES	† Han, X EFFECTS OF VARIATIONS IN MORTALITY AND RECRUITMENT RATES ON THE SPATIAL PATTERNS OF <i>DIADEMA SAVIGNYI</i>	† Compton, VM UNDERSTANDING THE ROLE OF HABITAT IN MEDIATING PREDATION RISK OF LARVAL FISH EXPOSED TO A PYRETHROID INSECTICIDE
1700				† Lee, LC ASSESSING RECOVERY OF NORTHERN ABALONE: ECOLOGY AND PLACE MATTER
1715				† Baughman, CS NUTRIENT SUCKING FIENDS: DOES THE DE-WORMING MEDICATION PROFENDER® REDUCE GASTROINTESTINAL PARASITES IN CALIFORNIA SEA LIONS?
1730				† Tingco, LF IMPACT OF DISTURBANCE ON <i>CHARADRIUS ALEXANDRINUS NIVOSUS</i> ROOSTING AND FORAGING BEHAVIOR

SUNDAY, NOV 14 0830-1000		† eligible for Best Student Paper Award		
Time	Session 1: SALON A Behavioral Ecology II Chair: Alex Cheroske	Session 2: SALON B Dispersal & Recruitment II Chair: Andy Chang	Session 3: SALON C Species-Habitat Association Chair: Hannah Stewart	Session 4: ROOSEVELT ROOM Population Biology II Chair: Ray Wilson
0830	Pruitt, JN DIVERSITY BEGETS DIVERSITY: INDIVIDUAL VARIATION IN ONE TROPHIC LEVEL FACILITATES VARIATION IN OTHERS	Selkoe, KA HOW WELL DOES POPULATION GENETICS INFORM MARINE LARVAL CONNECTIVITY?	Stewart, H THE ROLE OF ONTOGENY AND ENVIRONMENTAL STRESS IN DEFINING A MUTUALISM	Lorda, J PERFORMANCE AND ABUNDANCE DISTRIBUTION OF THE INTERTIDAL HORN SNAIL, <i>CERITHIDEA</i> <i>CALIFORNICA</i> , THROUGHOUT ITS NORTHERN DISTRIBUTION
0845	Adreani, MS MATING BEHAVIOR AND FERTILIZATION DYNAMICS OF THE SIMULTANEOUSLY HERMAPHRODITIC SEABASS, <i>SERRANUS</i> <i>SUBLIGARIUS</i>	Basch, LV REEF-BUILDING CORAL RECRUITMENT IN NATIONAL PARKS AND MARINE PROTECTED AREAS ALONG THE KONA COAST, HAWAI'I ISLAND.	† Hunter-Thomson, KI DO TERRESTRIAL PARADIGMS APPLY TO SUBTIDAL REEFS? FISH COMMUNITY STRUCTURE IN LANDSCAPE-SCALE HABITATS	† Martinez-Takeshita, N THE GLOBAL GENETIC DIVERSITY OF <i>SERIOLA</i> <i>LALANDI</i> (YELLOWTAIL)
0900	† Gooding, RA THERMAL COPING BEHAVIOR OF THREE LITTORINE SNAILS WITH SALINITY AND PH	Chang, AL GOING WITH THE FLOW OR STAYING CLOSE TO HOME? POPULATION DYNAMICS AND CONNECTIVITY OF BIVALVES IN SAN FRANCISCO BAY	† Hitchman, SM IDENTIFYING SOURCE HABITAT FOR AN EXPLOITED ROCKFISH SPECIES WITH IMPLICATIONS FOR MARINE PROTECTED AREA DESIGN	† Driscoll, RM DETERMINING POPULATION STRUCTURE OF THE ANTARCTIC EUPHAUSIID <i>THYSANOESSA MACRURA</i> (G.O. SARS 1885)
0915	† Thomas, KN THE DISTRIBUTION OF TWO MARINE CLADOCERANS DURING UPWELLING AND DOWNWELLING EVENTS OFF THE OREGON COAST	† Nickols, KJ NEARSHORE VELOCITY GRADIENTS LOWER THE SPEED LIMIT FOR COASTAL DISPERSERS	† Fontana, RE COASTAL OCEANOGRAPHIC FRONTS OFF NORTH- CENTRAL CALIFORNIA: PATTERNS, PREDICTABILITY, AND BIOLOGICAL IMPORTANCE	Lowe, AT SIMULATED GROWTH AND CONDITION OF LARVAL ANTARCTIC KRILL IN RESPONSE TO ENVIRONMENTAL VARIABILITY DURING WINTER

0930	† Tait, KJ RELATIVE EFFECTS OF STRUCTURAL COMPLEXITY, PREDATION RISK, AND FOOD AVAILABILITY ON HABITAT SELECTION OF SEAGRASS FAUNA	† Puritz, JB COASTAL POLLUTION LIMITS PELAGIC LARVAL DISPERSAL	† Jones, CL EVALUATING EELGRASS HABITAT QUALITY BY FISH SETTLEMENT, PERFORMANCE, AND SURVIVAL	† Gherard, KE AGE, GROWTH, AND BATCH FECUNDITY OF THE GULF CORVINA, <i>CYNOSCION OTHONOPTERUS</i> , FROM THE NORTHERN GULF OF CALIFORNIA, MEXICO
0945	† Thurber, AR DANCING FOR FOOD IN THE DEEP SEA: A UNIQUE SYMBIOSIS BY A NOVEL SPECIES OF YETI CRAB	Ross, CL UNUSUALLY HIGH LOCALIZED RECRUITMENT OF <i>MONTASTRAEA ANNULARIS</i> COMPLEX ON THE FRINGING REEFS OF ST. JOHN, U.S. VIRGIN ISLANDS	† Hooton-Kaufman, BS HABITAT ASSOCIATIONS OF NATIVE FISHES WITH THE INVASIVE KELP <i>UNDARIA PINNATIFIDA</i> IN MONTEREY HARBOR	
1000	Break	Break	Break	Break

SUNDAY, NOV 14 1030-1230		† eligible for Best Student Paper Award		
Time	Session 1: SALON A Conservation & Restoration Chair: Sean Anderson	Session 2: SALON B Fisheries Biology II Chair: Larry Allen	Session 3: SALON C Physiological Ecology II Chair: Pete Edmunds	Session 4: ROOSEVELT ROOM Evolutionary Biology Chair: Pat Krug
1030	Anderson, SS ECOTOXICOLOGY OF THE GULF OIL SPILL	† Aryafar, H HOW DOES DELAYED HATCHING IN THE CALIFORNIA GRUNION, <i>LEURESTHES TENUIS</i> , AFFECT LARVAL SWIMMING, DEVELOPMENT, AND SURVIVAL?	† Kuo, ES NO CHANCE TO REFUEL: EFFECTS OF OCEAN ACIDIFICATION AND ELEVATED TEMPERATURE ON LECITHOTROPHIC LIMPET LARVAE	† Aguilar, A A GENOMIC SCAN FOR POSITIVELY SELECTED GENES IN TWO CLOSELY RELATED MARINE FISHES: <i>SEBASTES CAURINUS</i> AND <i>S. RASTRELLIGER</i>
1045	† Crowther, DA BALANCING CONSERVATION AND NEARSHORE FISHERIES: A COMPARATIVE SPATIAL ANALYSIS OF TWO MPA NETWORKS IN OREGON	Barnas, K MORE THAN JUST A FISH IN A BUCKET: EXAMINING SPORTFISH STOCKING IN THE PACIFIC NORTHWEST	† Borrás Chavez, R ALGINIC AND BROMATOLOGIC ANALYSIS OF <i>MACROCYSTIS PYRIFERA</i> UNDER SHORT AND LONG TERM HARVESTING	Eernisse, DJ A CLADE OF CHITONS WITH EYES IS SPLIT UNCONVENTIONALLY INTO NEW WORLD VERSUS OLD WORLD LINEAGES
1100	† Hall, AM THE RELATIONSHIP OF TIDAL SCOUR AND THE DISTRIBUTION AND ABUNDANCE OF EXOTIC EPIFAUNA	† Withy-Allen, KR CALIFORNIA SPINY LOBSTER MOVEMENT BEHAVIOR AND HABITAT USE: IMPLICATIONS FOR MARINE RESERVES IN SOUTHERN CALIFORNIA	Cumbo, VR TEMPERATURE AND PCO ₂ AFFECTS ON THE PHYSIOLOGY OF THE EARLY LIFE STAGE OF <i>POCILLOPORA DAMICORNIS</i>	† Kelly, MW LIMITED POTENTIAL FOR ADAPTATION TO CLIMATE CHANGE IN THE TIDEPHIL COPEPOD <i>TIGRIOPUS CALIFORNICUS</i>
1115	Marshman, BC PREVENTING EXTINCTION: MAINTENANCE OF CAPTIVE POPULATIONS OF THE ENDANGERED WHITE ABALONE (<i>HALIOTIS SORENSENII</i>)	† Kay, MC FISHING, HABITAT, AND DISTANCE FROM MPA BORDERS INFLUENCE SPINY LOBSTER ABUNDANCE ON REEFS AT THE SANTA BARBARA CHANNEL ISLANDS	† Carrillo, A THE EFFECTS OF EXTENDED INCUBATION ON MORPHOLOGY AND FEEDING ACTIVITY OF THE CALIFORNIA GRUNION, <i>LEURESTHES TENUIS</i>	Johnson, DW WHY AREN'T DAMSELFISH HUGE?

1130	<p>† Forrest, MJ NOTHING A HOT BATH WON'T CURE: GEOTHERMAL ECOSYSTEMS AS REFUGES FOR AMPHIBIANS FROM CHYTRIDIOMYCOSIS</p>	<p>Greenley, AP MARINE RESERVES AS BUFFERS AGAINST NATURAL MORTALITY FOR PINK (<i>HALIOTIS CORRUGATA</i>) AND GREEN (<i>H. FULGENS</i>) ABALONE IN BAJA, CA</p>	<p>† Nishizaki, MT PHYSIOLOGICAL AND BEHAVIORAL RESPONSES OF THE BARNACLE (<i>BALANUS GLANDULA</i>) TO TEMPERATURE AND FLOW.</p>	<p>† Froman, LD ARE BROODING CHITONS ON SANTA CATALINA ISLAND GONOCHORIC, UNLIKE THEIR HERMAPHRODITIC AND SELF-FERTILIZING NORTHERN RELATIVES?</p>
1145	<p>† Kolupski, ML CONNECTING THE LAND TO THE SEA: SEDIMENTATION AND RESUSPENSION ON CORAL REEFS, ST. JOHN, US VIRGIN ISLANDS</p>	<p>White, C NEW GRIDS ON THE BLOCK: USING MARINE SPATIAL PLANNING TO ASSESS TRADEOFFS AMONG OFFSHORE WIND FARMS, FISHING, AND CONSERVATION</p>	<p>Denny, MW SPREADING THE RISK: SMALL-SCALE BODY TEMPERATURE VARIATION AMONG INTERTIDAL ORGANISMS: IMPLICATIONS FOR SPECIES PERSISTENCE</p>	<p>Nydam, ML INTROGRESSION DESPITE SUBSTANTIAL DIVERGENCE IN A BROADCAST SPAWNING MARINE INVERTEBRATE</p>
1200	<p>† Goldstein, MC ABUNDANCE AND DISTRIBUTION OF PLASTIC MICRODEBRIS IN THE NORTH PACIFIC CENTRAL GYRE</p>	<p>Valencia, SR DO WE HAVE TO CHOOSE? BALANCING HARVEST AND CONSERVATION GOALS IN REBUILDING STOCKS.</p>	<p>† Dufault, AM EFFECTS OF DIURNALLY OSCILLATING SEAWATER DIC CHEMISTRY ON THE GROWTH AND SURVIVAL OF CORAL RECRUITS</p>	<p>Marshall, DJ THE GENETICS OF STRESS RESISTANCE IN MARINE INVERTEBRATE LARVAE - IMPLICATIONS FOR STUDIES OF CLIMATE CHANGE</p>
1215	<p>Paddack, MJ SEEKING RESILIENCE & MONITORING FOR SOLUTIONS ON CORAL REEFS OF A CARIBBEAN ATOLL</p>	<p>Allen, LG HOW TO COUNT BARRED SAND BASS (<i>PARALABRAX NEBULIFER</i>) IN THEIR SPAWNING AGGREGATIONS</p>	<p>Brown, DB COMPARATIVE INTERACTIVE EFFECTS OF OCEAN ACIDIFICATION AND TEMPERATURE ON TWO TROPICAL SCLERACTINIAN CORALS</p>	<p>Krug, PJ REDUCED GENE FLOW AND REPRODUCTIVE ISOLATION FOLLOW POPULATION-LEVEL SHIFTS TO NON-DISPERSING LARVAE IN A CARIBBEAN SEA SLUG</p>
1230	Break	Break	Break	Break

SUNDAY, NOV 14 1330-1445		† eligible for Best Student Paper Award		
Time	Session 1: SALON A Community Ecology IV Chair: Kelly Andrews	Session 2: SALON B Community Ecology V Chair: Bengt Allen	Session 3: SALON C Community Ecology VI Chair: Dan Reed	Session 4: ROOSEVELT ROOM Conservation & Evolutionary Biology Chair: Matt Craig
1330	† Schoenrock, KM THE EFFECT OF ENDOPHYTE INFECTION ON GROWTH AND SURVIVORSHIP OF ANTARCTIC MACROALGAE (RHODOPHYCEAE)	Wall, CB THE ROLE OF ARBUSCULAR MYCORRHIZAL FUNGI IN MODULATING WETLAND COMMUNITY STRUCTURE	Schiel, DR MANAGING DIVERSITY ON ROCKY SHORES: WHAT DO WE MEAN, HOW IS IT PARTITIONED IN SPACE AND TIME?	Craig, MT BOUNDLESS BOUNDARIES: THE ENIGMA OF DISCORDANT PHYLOGEOGRAPHIC AND BIOGEOGRAPHIC BREAKS IN COASTAL CALIFORNIA
1345	† Elahi, R URCHINS MEDIATE NATURAL VARIATION BETWEEN BIODIVERSITY AND RESOURCE USE	† Jones, E HABITAT CHOICE BY A MARINE ISOPOD IS RELATED TO THE PRESENCE OF A PREFERRED EPIPHYTE	† Granneman, JE AN ASSESSMENT OF FISH COMMUNITIES AND PRODUCTION ON ARTIFICIAL AND NATURAL REEFS IN THE SOUTHERN CALIFORNIA BIGHT	† Wilson, JR SPATIAL VARIABILITY IN FISHING PRESSURE AND DEMOGRAPHY AND THE IMPLICATIONS FOR MANAGEMENT OF A NEARSHORE FISH
1400	† Grupe, BM COMMUNITY STRUCTURE AND TROPHIC PATTERNS ON ROCKS, WOOD, AND BIOTIC SUBSTRATES AT A DEEP-SEA METHANE SEEP OFF COSTA RICA	† Lee, W RELATIONSHIP BETWEEN PREDATION AND PREY ABUNDANCE IN AN ESTUARY: IMPLICATIONS FOR PREY PERSISTENCE ACROSS A LANDSCAPE	Markel, RW INDIRECT EFFECTS OF SEA OTTERS ON ROCKFISH RECRUITMENT, CARBON SUPPLY, TROPHIC POSITION, AND GROWTH	† Kroeker, KJ QUANTIFYING THE VARIATION IN BIOLOGICAL RESPONSES TO OCEAN ACIDIFICATION
1415	† Gil, MA THE RESPONSE OF CORALS TO EUTROPHICATION: THE GOOD, THE BAD, AND THE UNCLEAR	† Gowan, JC CORAL-ALGAL INTERACTION FREQUENCIES AND OUTCOMES ALONG FLOW AND SEDIMENTATION GRADIENTS	† Singh, GG COMMUNITY CONSEQUENCES OF A KEYSTONE PREDATOR INTERACTING WITH AN ECOSYSTEM ENGINEER	Day, JL SAVING A LIVING DINOSAUR: AN INTEGRATIVE APPROACH TO GREEN STURGEON RECOVERY

CONTRIBUTED TALKS

† **Abbott, J.M.^{1*}, Tomas F.², Balk M.¹, Steinberg C.¹, Williams, S.L.¹, Stachowicz J.J.¹**

EELGRASS GENOTYPIC IDENTITY AFFECTS THE PREFERENCE AND PERFORMANCE OF A DOMINANT HERBIVORE MORE THAN NITROGEN ADDITION

1 - Bodega Marine Laboratory, University of California Davis 2 - Institut Mediterrani d' Estudis Avançats, Illes Balears, Spain

Trait variation among genotypes of habitat-forming species can influence important ecological processes. However, few studies have characterized differences in functional traits across genotypes and linked them to the influence of plant genotype on community interactions. Moreover, little is known about the relative magnitude of the effects of genotypic identity compared to other environmental stressors. We evaluated the influence of genotypic identity and nutrient addition on interactions between the seagrass, *Zostera Marina* and an herbivorous isopod, *Idotea resecata*. We grew four genotypes of *Z. marina* in mesocosms with and without nitrogen addition and examined the separate and interactive effects of genotype and nutrients on herbivore preference and performance. Isopods expressed strong preferences among fresh tissue from each genotype. Freeze-dried, powdered, and reconstituted plant material elicited the same preference hierarchy, suggesting that chemical rather than structural differences among genotypes determine palatability. Indeed, the most palatable genotype had high nutritional content (low C:N) and the lowest concentration of a putatively defensive phenolic compound. Isopods also showed higher growth and survival on the more palatable genotypes. Nutrient addition decreased palatability of fresh plant material across all genotypes, but isopod genotypic preference remained the same, indicating that genotype effects are relatively strong. Reconstituted plant material weakened the effect of nutrient addition, suggesting that nutrient addition elicits structural changes that affect palatability. Our results illustrate clear differences among genotypes in their interaction with herbivores that are strong enough to overwhelm effects of eutrophication. These effects have potential implications for ecological processes, including rates of trophic transfer and secondary production.

Adreani, M.S.*

MATING BEHAVIOR AND FERTILIZATION DYNAMICS OF THE SIMULTANEOUSLY HERMAPHRODITIC SEABASS, *SERRANUS SUBLIGARIUS*

Florida State University

In the simultaneously hermaphroditic marine fish, *Serranus subligarius* (belted sandfish), male role individuals are known to pair spawn, group spawn and streak spawn. While these mating tactics, which are common among marine reef fish, have been well studied, it remains unclear whether these competing strategies affect fertilization success for the female role individuals. To investigate this issue, I observed mating behaviours and quantified fertilization success in natural and experimental setting during the summers of 2005-2008 at three sites with different local population densities. I observed focal individuals in 15-minute increments and recorded the total number of spawns, number of streak spawns, size of participating spawners and fertilization rate. The occurrence of small sized individuals in the local population is associated with higher frequencies of streaking behavior. Spawns that included one or more streak spawners had a significantly lower average fertilization rate (89%) than pair spawns without a streak spawner (97%). This pattern was confirmed in a field manipulation experiment in which spawning events that included streakers again showed lower fertilization rates (93%) than spawning events that included streakers (98%). Spawns that included multiple males produced, on average, 20% more sperm than spawns involving only one male. These results indicate that females incur a significant fitness cost when streakers invade a spawning event, that streak spawning males fully participate in spawning and that sperm number is not a limiting factor responsible for the lower fertilization rates.

Ainsworth, C.H., Morzaria-Luna, H.*, Kaplan, I.C., Levin, P.S., Fulton, E.A.

COMPLIANCE WITH EXISTING FISHERIES REGULATIONS YIELDS ECONOMIC AND ECOLOGICAL BENEFITS FOR THE NORTHERN GULF OF CALIFORNIA

NOAA Fisheries, NWFSC

The Northern Gulf of California, Mexico, is an ecologically important area with a high degree of biodiversity, endemism, and productivity. However, its marine resources show clear signs of overexploitation to the chagrin of impoverished coastal communities that rely on them. A raft of new management regulations has been proposed in recent years to restrict fishing and protect endangered species. Unfortunately, compliance with existing fisheries regulations is low. The rules in place, if followed, may in fact go a long way towards achieving the economic, social and ecological goals of management. We conducted a review of existing fisheries regulations in this area. Then, using Atlantis - a biogeochemical marine ecosystem model- we estimate the effects of compliance with existing fisheries regulations. Under a full compliance scenario, we find a 50% increase in protected species biomass within 25 years, and a near tripling of exploitable species biomass. Catch under full compliance is reduced initially

to 20-80% of status quo depending on fleet (due to reductions in fishing effort), but increases slowly over time as target populations increase in biomass. These results highlight the substantial impacts that illegal fisheries now have in the Gulf. We also weigh the relative benefits of different types of management approaches, including spatial protection, gear regulations, seasonal closures and effort restrictions. This exercise helps provide a benchmark by which to assess the value of proposed regulations, and it quantifies the benefits of improved fisheries enforcement and education.

Allen, L.G.*

HOW TO COUNT BARRED SAND BASS (*PARALABRAX NEBULIFER*) IN THEIR SPAWNING AGGREGATIONS
Southern California Marine Institute, California State University Northridge

We conducted a hydroacoustic (sonar) assessment of barred sand bass standing stock (abundance and biomass) using high resolution split beam sonar verified by both rod and reel sampling over sonar targets and underwater video observations. Once a target was verified (e.g., as an aggregation of barred sand bass), its target strength was related quantitatively to abundance and biomass. This feasibility study was conducted over five days in July (peak spawning months for barred sand bass) of 2010 over the 20-30m depth contour at Huntington Flats. Hydroacoustic transects were run on July 15, 16, 22, and 23, 2010 aboard the *RV Yellowfin* using a high resolution, split beam sonar unit, the *Biosonics DT-X*. Ten to twelve randomly placed, replicate, sonar transects were run each day. On shore, the complete BioSonics data files were transferred into Echoview ® 4.90 software files for full analysis of target identification, spatial location, target frequency analysis, target strength, and, ultimately, integration of target numerical density and biomass with defined regions of the daily cruise track. Mean target strength of barred sand bass was determined to be -35 dB. Estimated barred sand bass abundances varied between 16.8 and 239.8 bass per hectare over the four days of assessment. At 0.5 kg each, this corresponded to a range of standing stock between 8.4 to 120 kg per hectare. The highest densities were encountered on July 16, 2010 when most sonar marks were large groups of fish which resulted in a large standard error of the estimate.

Anderson, S.S.*

ECOTOXICOLOGY OF THE GULF OIL SPILL

California State University Channel Islands

The largest oil spill in U.S. history, infused with dispersants, was released into the waters of the northern Gulf of Mexico over Spring and Summer of 2010. This still-unfolding disaster has created an unprecedented threat to the ecology of coastal and marine communities. Most initial efforts were understandably directed towards stemming the flow of oil from the wellhead, documenting the appearance of oil on the sea surface, and quantifying conspicuous impacts. With apparently limited ecotoxicological information, governmental and private entities are now preparing to create and fund large-scale and long-term monitoring efforts across the Gulf. Our national working group is creating a conceptual framework outlining potential long-term, direct, and indirect ecotoxicological impacts upon Gulf populations and communities, with a primary goal of providing this information to guide decision-making and funding entities on an expedited timetable. I will discuss our most recent findings from this on-going effort to understand the impacts of this disaster to the marine and coastal communities of the Gulf of Mexico.

† Anderson, K.M.^{1*}, Bretsch, K.²

INDUCED DEFENSES IN INTERTIDAL ALGAE: SPECIFICITY AND EFFECTIVENESS IN RELATION TO HERBIVORY.

1 - University of British Columbia 2 - Stony Brook Southampton

Induced defenses, such as the production of anti-herbivory compounds and tougher morphologies, are well documented in marine algae. However, there is debate concerning the exact nature of these defenses and whether algae induce them in response to the physical damage inflicted by an herbivore, or to the presence of an herbivore itself. If an alga is responding to the damage only, it may be responding to other sources of damage (e.g. abrasion due to wave action) when herbivory is not a threat, which is a potential waste of energy. Here we examine the similarities and differences in how two species of algae respond to two different sources of damage: herbivores and wave action. Based on palatability assays, we provide evidence that *Ascophyllum nodosum* is able to respond differently to different sources of damage while *Fucus vesiculosus* is not, demonstrating that this ability is variable within an algal family. Although we found no difference tensile resilience and toughness between sites, phlorotannin concentrations were higher at the exposed/low herbivory site. Despite phlorotannins being a frequently documented anti-herbivore compound, herbivores significantly preferred algae with higher phlorotannin concentrations. This finding should draw attention to the importance of taking care when making assumptions regarding the relationship between chemistry and herbivore preference.

Andrews, K.S.^{1*}, Moriarty, P.², Harvey, C.J.¹

JELLIES ON THE MOVE: VERTICAL AND HORIZONTAL PATTERNS OF MOVEMENT OF JELLYFISH IN PUGET SOUND.

1 - Northwest Fisheries Science Center 2 - Kenyon College

Jellyfish populations are increasing in coastal marine habitats throughout the world, and they are generally considered indicators of poor environmental quality, in part because of their tolerance for warm, hypoxic or eutrophic conditions. However, their role in the ecosystem has largely been overlooked. We lack much basic information on their ecology, including abundance, distribution, behavior and diets. Such information is crucial to estimate their impacts on other species and on ecosystem services. In this study, we monitor the movement patterns of two species of jellyfish (*Phacellophora camtschatica* and *Cyanea capillata*) in Puget Sound, WA using active and passive acoustic technology. During 24-hour active tracking sessions of tagged jellyfish, we found a wide range of vertical movement behavior – some remained at constant depths, while others made many large dives, while others were continuously oscillating up and down. Overall, jellyfish moved up in the water column at night and tended to stay within or below the thermocline/halocline. Horizontally, jellyfish also showed individual variation, but overall, jellyfish did not simply move at the same rate as the tide. In fact, individuals moved fastest during slack tides. Movements at larger scales and over the entire summer are also being monitored with passive acoustic receivers. Eventually, our findings will be used to parameterize models that couple jellyfish movement and habitat use with jellyfish dispersal rates, consumption rates and diets; the models will provide system-scale estimates of the predatory impact of jellies as a whole and of distinct jellyfish source regions in particular.

† **Aryafar, H.^{*}, Dickson, K.A.**

HOW DOES DELAYED HATCHING IN THE CALIFORNIA GRUNION, *LEURESTHES TENUIS*, AFFECT LARVAL SWIMMING, DEVELOPMENT, AND SURVIVAL?

California State University Fullerton

Leuresthes tenuis spawns terrestrially and can extend embryonic incubation beyond the initial incubation period of 9-14 days post-fertilization (dpf), to up to 30 dpf at 20°C. We tested the hypotheses that delayed hatching in *L. tenuis* results in larvae that have less yolk and reduced post-hatching survival when starved (disadvantages), but that are longer and have increased swimming activity (advantages of delayed hatching). We measured notochord length (NL), swimming activity, and yolk area of larvae hatched after initial incubation (10 dpf) and extended incubation (28 dpf) at 20°C from nine batches of fertilized eggs, each from one female and one male. In one batch, we compared the time to 50% mortality in 10-dpf and 28-dpf larvae when starved versus fed. NL was significantly greater in 28-dpf larvae than in 10-dpf larvae from four batches, significantly lower in two, and did not differ significantly in the other three. Routine swimming activity did not differ significantly between 28-dpf larvae and 10-dpf larvae in all but one batch. Yolk content was significantly lower in 28-dpf larvae from all batches studied. Survival time was reduced in 28-dpf larvae compared with 10-dpf larvae, reflecting the decrease in yolk content. The effect of delayed hatching varied among batches for both NL and yolk area, suggesting parental effects. Reduced energy reserves that cause increased mortality when starved, and no compensatory increase in swimming activity suggest that larvae that must delay hatching are at a disadvantage when competing with those that do not.

† **Ashander, J.^{1*}, Krkosek, M.², Lewis, M. A.³**

AQUACULTURE-INDUCED CHANGES TO DYNAMICS OF A MIGRATORY HOST AND SPECIALIST PARASITE: A CASE STUDY OF PINK SALMON AND SEA LICE

1 - University of California Davis 2 - University of Washington 3 - University of Alberta

Exchange of diseases between domestic and wild animals is a rising concern for conservation. In the ocean, many species display life histories that separate juveniles from adults. For pink salmon (*Oncorhynchus gorbuscha*) and parasitic sea lice (*Lepeophtheirus salmonis*) infection of juvenile salmon in early marine life occurs near salmon sea-cage aquaculture sites and is associated with declining abundance of wild salmon. Here, we develop a theoretical model for the pink salmon/sea lice host-parasite system and use it to explore the effects of aquaculture hosts, acting as reservoirs, on dynamics. Because pink salmon have a two-year lifespan, even- and odd-year lineages breed in alternate years in a given river. These lineages can have consistently different relative abundances, a phenomenon termed "line dominance." These dominance relationships between host lineages serve as a useful probe for the dynamical effects of introducing aquaculture hosts into this host-parasite system. We demonstrate that parasite spill-over and spill-back with aquaculture hosts can either increase or decrease the line dominance in an affected wild population. The direction of the effect depends on the response of farms to wild-origin infection. If aquaculture parasites are managed to a constant infection level, independent of the intensity of wild infections, then line dominance increases. On the other hand, if wild-origin infections on aquaculture hosts are controlled proportional to their intensity then line dominance decreases.

† Augyte, S.* , Shaughnessy, F. J.

A PRELIMINARY FLORISTIC ANALYSIS OF MARINE INTERTIDAL ALGAE FROM CAPE MENDOCINO, CA TO CAPE BLANCO, OR

Humboldt State University

Baseline floristic data is critical to managers of complex ecosystems as it is useful in detecting changes in communities over time as well as for implementing conservation and management strategies. The aim of this study is to compare patterns of intertidal algal species diversity spanning over 200 miles of poorly described coastline at three locations in northern California and one in southern Oregon. The two Capes are the westernmost points of the states of California and Oregon, respectively and therefore the second objective of this work is to determine if the flora around the Capes is distinct from what is found in between the Capes. Similarities in composition of macroalgal assemblages is investigated using presence/absence data for each taxon. Basic habitat attributes for each species as well as results from multivariate analysis used to describe the similarities among the four sites will be presented.

Barnas, K.^{1*}, Issacson, M.², Sanderson, B.¹, Carey, M.¹

MORE THAN JUST A FISH IN A BUCKET: EXAMINING SPORTFISH STOCKING IN THE PACIFIC NORTHWEST

1 - NOAA Fisheries, NWFSC 2 - University of Wisconsin Stevens Point

Over the past 40 years at least 25 species of non-indigenous fish have been stocked into WA, OR, ID. We obtained fish stocking records from state agencies across the Pacific Northwest to ask whether fish stocking trends have changed since the 1990s Endangered Species Act (ESA) listings of Pacific Salmon. Historically fish stocking in the Pacific Northwest was characterized by introductions of warm water species such as bass, walleye, catfish, and northern pike – all documented salmon predators. We looked at current (since the first ESA salmon listing, 1992) and historical stocking records with respect to the species, biomass, and locations stocked. In general, the numbers of non-indigenous species, overall biomass, and number of locations stocked have remained stable or increased since 1992. This suggests that state fisheries programs have yet to fully incorporate concerns about non-indigenous species into stocking decisions.

Bartlett, J.N.* , Loke, K.L., Young, K., Lowe, C., Rourke, B.C.

CHANGING SEXES IN A COMPLEX ENVIRONMENT - SHIFTS IN SKELETAL MYOSIN ISOFORMS IN COASTAL POPULATIONS OF CALIFORNIA SHEEPHEAD

California State University Long Beach

Myosin heavy chain (MyHC) isoform expression was investigated in California sheephead, *Semicossyphus pulcher*, a protogynous hermaphroditic fish found in coastal Southern California and Northern Mexico. This species was collected from nine capture sites near the Channel Islands where both overall size, and size of individuals at the transitional sexual stage, varies considerably. We therefore cloned MyHC isoforms and analyzed proteins by SDS-PAGE to determine if gender, size, water temperature, or geographic location influenced contractile protein expression. The relative percentage of slow MyHC isoform increased as sheephead transitioned from female to male with the highest expression of slow MyHC isoform observed in male sheephead. Northern and off-shore island populations were exposed to significantly colder average monthly water temperatures than Southern and near-shore island populations. The lowest expression of slow MyHC was seen in the cold water female populations, when compared to the warm water female populations. Relative percentage of slow MyHC isoform positively correlated with standard length in populations where mass increased significantly with sex change. No significant differences were observed between red mid-line and white body wall MyHC expression. Swimming fins had the highest expression of slow MyHC overall. Thus, in this interesting system where muscle mass undergoes dramatic growth through maturation and gender transition, MyHC isoforms are likely influenced by both sexual development and environment.

Basch, L.V.* , Eble, J., Leemhuis, A., White, J., Walsh, W.

REEF-BUILDING CORAL RECRUITMENT IN NATIONAL PARKS AND MARINE PROTECTED AREAS ALONG THE KONA COAST, HAWAII ISLAND.

National Park Service

Coral recruitment is a key measure of reef condition. Data collected over four years indicate that recruitment rates of reef building corals along the Kona or West Hawai'i Island coast are extremely low when compared with rates elsewhere in Hawai'i, and globally. Rates are slightly higher on the northern, Kohala coast within the Kona region, and decrease to the south. Data for other benthic invertebrates support this pattern. There is high spatial and temporal variability in the coral recruitment time series; variance among sites appears greater than within sites. While variability in marine recruitment datasets is expected and known – for corals and many other sessile benthic

invertebrates - low coral recruitment rates in the Kona region may indicate the prolonged failure of a key process(es) within the Kona reef ecosystem, suggesting limited replacement of coral populations by newly settled coral larvae or juveniles. If coral populations do not replace themselves over time by continued recruitment, what may appear to be a beautiful, healthy reef may already be dead. Low coral recruitment rates may reflect a temporal "low" in the recruitment cycle for the Kona ecosystem, or, if coral recruitment is limited this may signal a "red flag" concerning the condition of this extensive reef tract. Either way, a regional scale perspective is necessary to provide a clear picture of recruitment patterns and underlying processes.

† **Baughman, C.S.^{1*}, Webb, L.A.², Gulland, F.M.D.³, Greig, D.J.³**

NUTRIENT SUCKING FIENDS: DOES THE DE-WORMING MEDICATION PROFENDER® REDUCE GASTROINTESTINAL PARASITES IN CALIFORNIA SEA LIONS?

1 - California State University Monterey Bay 2 - Moss Landing Marine Laboratories 3 - The Marine Mammal Center
California sea lions (*Zalophus californianus*) acquire gastrointestinal parasites from their mother's milk, the ground at haul-out sites, and their prey. Parasites attach to the gastrointestinal lining and reduce nutrients available to the host. Large numbers of parasites result in reduced body condition and may cause mortality, especially in juveniles. Stranded yearling California sea lions admitted to The Marine Mammal Center during summer 2010 were screened to identify animals without confounding health conditions. Of these, ten were randomly selected to receive 11 mg/kg Profender® topical solution on the back of their neck where it absorbed through the skin, traveled to the gastrointestinal lining via the bloodstream, and potentially inhibited parasite attachment. To test effect of increased drug absorption time, study subjects were divided into two water exposure categories: immediate access to water (n=5) and dry for 24 hours (n=5). Decreased adult parasites yields decreased numbers of parasite eggs shed in feces. Egg counts are highly variable; therefore, three fecal samples were collected before drug application and again approximately two weeks later. Nematode, cestode, and trematode eggs were counted in each sample and the difference between mean two week and mean initial egg counts were calculated for each parasite type for each animal. Water exposure had no significant effect (nested two-way ANOVA: nematodes p=0.646, cestodes p=0.212, trematodes p=0.411). Therefore, wet and dry samples were pooled. Profender® did not significantly reduce parasite egg counts, however low power indicated increased sample sizes are needed (paired t-test: nematodes p=0.891, cestodes p=0.319, trematodes p=0.602).

Beaudreau, A.H.^{1*}, Levin, P.S.², Norman, K.C.²

IN THE EYE OF THE BEHOLDER: FOLK BIOLOGICAL CLASSIFICATION SYSTEMS AND PERCEPTIONS OF SPECIES ABUNDANCE TRENDS IN PUGET SOUND

1 - University of Washington 2 - NOAA Fisheries, NWFSC

The species concept is central to characterizing biological diversity and inherently affects the conservation and management of natural systems; yet, people may name and classify organisms in ways that can differ enormously from scientific classification schemes. Furthermore, the way in which individuals organize species or species groupings into taxonomies can guide their inductions about the structure and dynamics of animal populations. In this study, interviews with 95 fishers, divers, and researchers were used to develop folk taxonomies for marine organisms in Puget Sound. As a component of the interviews, subjects were given color photos of 46 marine mammals, fishes, and invertebrates and asked to group the organisms according to their own criteria. We then used these taxonomies to determine the extent to which respondents' perceptions of how biological diversity is organized influence the ways in which they interpret changes in the abundance of marine organisms. Our analyses revealed striking differences in folk taxonomies related to stakeholders' primary types of experience in the marine environment (e.g., fishing, diving, research). Because species are lumped or split differently across folk taxonomies, how individuals perceive changes in species abundance will also vary. Ultimately, understanding how people perceive biological diversity is central in effectively engaging stakeholders in the recovery of depleted species and the ecosystems on which they depend.

† **Ben-Horin, T.^{*}, Lenihan, H.S.**

ENVIRONMENTAL VARIANCE AND THE TRANSMISSION OF WITHERING SYNDROME IN BLACK ABALONE
University of California Santa Barbara

Withering syndrome is a chronic wasting disease of California abalones. Since this disease was first observed at the northern Channel Islands in the mid-1980s, populations of black abalone (*Haliotis cracherodii*) have experienced catastrophic declines in southern California. Controlled laboratory studies have shown that elevated water temperatures play a key role in both the transmission and development of disease. In the wild, the onset of disease-induced mortalities among populations of black abalone is universally associated with periods of elevated water temperature. The absolute rate of disease-induced mortality however is decoupled from patterns in water temperature. Temporal patterns in the body temperatures of intertidal poikilotherms are often decoupled from patterns in water temperature. During aerial exposure, the flux of heat into and out of intertidal organisms is driven

by complex and interacting climatic factors such as solar radiation, air temperature, and relative humidity. As a result, temperature extremes at low tide can far exceed those experienced during submersion, significantly increasing the range of body temperatures experienced by intertidal organisms. We tested the effect of regularly fluctuating temperatures on the transmission of withering syndrome by independently manipulating incoming radiation, tidal height, and water temperature in controlled laboratory microcosms. Our results reveal clearly that transmission of the etiological agent increases significantly with regular fluctuations in the thermal environment, regardless of the mean temperature experienced by hosts. This finding highlights an urgent need to develop a better mechanistic understanding of the scale-dependent sensitivities of parasites and hosts to dynamic biological and environmental parameters.

† **Best, R.J.^{*}, Stachowicz, J.J.**

TROPHIC CASCADES IN SEAGRASS MEADOWS DEPEND ON MESOGRAZER VARIATION IN BOTH FEEDING RATES AND PREDATION SUSCEPTIBILITY.

Bodega Marine Laboratory, University of California Davis

Seagrasses provide important habitat for fishes and invertebrates but are declining around the globe, often due to overgrowth by algae. One hypothesis for increased algal overgrowth is that overfishing of top consumers has led to greater numbers of small predatory fishes that reduce the abundance of algae-eating mesograzers. This trophic cascade hypothesis requires that the same mesograzers that control algal biomass are also susceptible to fish predation. While mesograzers are known to vary in their effects on algae and seagrasses, it is not known how their susceptibility to predators varies or how it is related to grazing abilities. Using six common mesograzers from Bodega Harbor, CA, we assessed species-specific feeding rates on *Ulva* macroalgae, epiphytic microalgae, and eelgrass. We then assessed species-specific predation susceptibility using juvenile Cabezon fish in tanks of eelgrass habitat with and without *Ulva*. We found that when *Ulva* was present, the fastest consumers of *Ulva* were the least susceptible to predation. This appeared partly due to an associational refuge, as these grazers were consumed as frequently as others when the algae was absent. Such a refuge for the major consumers of algae should reduce the potential for trophic cascades leading to algal overgrowth. Also, when *Ulva* was absent the grazers that feed most heavily on eelgrass itself were the least susceptible to predation. Thus variation in predatory fish abundance in seagrass meadows may reduce the abundance of some grazer species, but because those that graze most intensely are least affected, the impact on primary producer biomass may be limited.

Bird, C.E.^{1*}, Franklin, E.¹, Toonen, R.J.¹, Smith, C.M.²

BETWEEN TIDE AND WAVE MARKS: A UNIFYING MODEL OF PHYSICAL ZONATION ON LITTORAL SHORES
1 - Hawaii Institute of Marine Biology, University of Hawaii at Manoa 2 - Department of Botany, University of Hawaii at Manoa

The effects of tides on littoral marine habitats are so ubiquitous that shorelines are commonly described as 'intertidal', whereas waves are considered a secondary factor that simply modifies the intertidal habitat. However mean significant wave height exceeds tidal range at many locations worldwide. Here we construct a sinusoidal model of coastal water level based on both tidal range and wave height. From the patterns of emergence and submergence predicted by the model, we derive four vertical shoreline benchmarks which bracket up to three novel, spatially distinct, physically defined zones. The (1) emergent tidal zone is characterized by tidally driven emergence in air; the (2) wave zone is characterized by constant wave wash; and the (3) submergent tidal zone is characterized by tidally driven submergence. The decoupling of tidally driven emergence and submergence made possible by wave action is a critical prediction of the model. On wave-dominated shores (wave height \gg tidal range), all three zones are predicted to exist separately, but on tide-dominated shores (tidal range \gg wave height) the wave zone is absent and the emergent and submergent tidal zones overlap substantially, forming the traditional "intertidal zone". We conclude by incorporating time and space in the model to provide deeper insight into physical conditions and zonation on littoral shores. The wave:tide physical zonation model is a unifying framework that can facilitate our understanding of physical conditions on littoral shores whether tropical or temperate, marine or lentic.

† **Blake, R.^{*}, Duffy, J.E.**

DIFFERENCES IN THE CHESAPEAKE BAY, VA EELGRASS (*ZOSTERA MARINA*) COMMUNITY AS A FUNCTION OF LOCAL SHORELINE DEVELOPMENT.

Virginia Institute of Marine Science, College of William and Mary

Shoreline development may impact adjacent submerged habitats by increasing runoff which can carry nutrients, sediments, and synthetic chemicals. Shoreline armoring may also change the physical environment of these habitats by increasing wave reflectance and sediment suspension. These changes may detrimentally affect eelgrass habitats adjacent to developed shorelines. To examine this, we assessed 20 eelgrass beds in lower Chesapeake Bay next to shorelines ranging from developed to undeveloped. We quantified the local shoreline

and riparian area 150 m along the shore by 30 m landward from the shore. We also measured water quality (temperature, dissolved oxygen, salinity) and quantified eelgrass community production (eelgrass biomass, algal biomass, animal abundance and diversity). We found that eelgrass biomass varied neither between eastern bay and western bay sites nor with development, at the scale of this study. Epiphytic algal biomass (as chl *a*) was higher at western than eastern sites, and eelgrass leaf nitrogen followed the same pattern. But, algal biomass was lowest at the most developed sites. At sites with the highest algal biomass, mesograzer biomass was higher. When epiphytic algal biomass was lower, eelgrass percent cover was higher. When eelgrass was dense, small epifaunal predators were more abundant but nekton did not differ. Sediment grain size showed no pattern with development, but the most developed sites had >95% sand. These highly variable results indicate that shoreline development may have less of a direct influence on eelgrass communities at the local scale of 100s of meters than it does at a regional or watershed scale.

† **Block, H.E.^{*}, Steele, M.A.**

SPATIAL AND TEMPORAL VARIATION IN LARVAL TRAITS IN AN ABUNDANT KELP FOREST FISH, *OXYJULIS CALIFORNICA*

California State University Northridge

In marine organisms with complex life histories there is the possibility that events that occur in earlier life stages can affect an individual's subsequent survival. In fish it has been proposed that settlement, the transition from a pelagic habitat to a benthic one, is a critical period in determining survivorship. It is thought that there may be selection on specific larval traits, which could influence an individual's probability of survival after settlement. This study examines variation of larval traits and potential selection on these traits in the common kelp forest fish *Oxyjulis californica* at three sites at Santa Catalina Island, CA. Individuals for this study were collected during the summer of 2009. New settlers, as well as approximately one-month-old juveniles, were collected in order to examine how larval traits persist in the population and determine if selection is acting on a particular trait. The larval traits examined included, planktonic larval duration (PLD), size at settlement, and pre-settlement growth rates. Collections were made at two times and at three sites to look at variation in larval traits, as well as variation in selection for these traits between time periods and locations. Fish settling early in the summer were found to have slower larval growth rates and longer PLDs than those settling later in the summer. We found no evidence of selection on larval traits at any site or time.

† **Borras Chavez, R.^{1*}, Edwards, M.S¹, Rodriguez Montesinos, E², Arvizu Higuera, D.L.², Hernandez Carmona, G.²**

ALGINIC AND BROMATOLOGIC ANALYSIS OF MACROCYSTIS PYRIFERA UNDER SHORT AND LONG TERM HARVESTING

1 - Coastal and Marine Institute Laboratory, San Diego State University 2 - Chemical Laboratory of Marine Algae, CICIMAR, La Paz, Mexico

Harvesting of *Macrocystis* spp. is still a strong business in several countries and a prospective economical source for others. Extraction of alginates and its direct use as food for abalone aquaculture are the two main reasons for harvesting. Alginate yield/viscosity and composition of major macromolecules were evaluated in populations from Northern Chile, ones that have never been harvested (un-manipulated), and populations that have been harvested for more than 10 years (long-term). In addition, these biochemical characters were measured under repetitive harvesting in the Point Loma kelp forest, San Diego every two weeks for three and a half months to evaluate short-term responses. Protein, lipid, fiber, and ash (carbohydrates and minerals) showed no significant difference under repetitive harvesting or long-term harvesting conditions. Our work suggests that for abalone aquaculture, nutrient acquisition may not be affected when populations have been severely harvested after a long period of time, or when they are harvested several times in one season. Alginate yield showed slight variation after several harvesting seasons, but alginate viscosity did not. Therefore, depending on the use given to the alginate extracted, the resulting product may present a reduced quality after a long period of time.

Britton-Simmons, K.^{1*}, Okamoto, D.², Pister, B.³, Sanchez, I.⁴, Klinger, T.¹

DENSITY-DEPENDENT AND DENSITY-INDEPENDENT RESPONSES OF A NATIVE HERBIVORE TO A NON-NATIVE SEAWEED

1 - Friday Harbor Labs, University of Washington 2 - University of California Santa Barbara 3 - National Park Service 4 - Universidad de Oviedo

Native consumers are potentially important for regulating invasion by non-native species, but the effect of native consumers will be mediated by their responses to spatial variability in densities of both prey and conspecifics. We studied the response of the native, herbivorous gastropod *Lacuna vincta* to the non-native seaweed *Sargassum muticum* in the San Juan Islands, WA to better understand how this native consumer may affect invasion by *Sargassum*. Field and laboratory studies revealed that *Lacuna* is more abundant and prefers to feed on

Sargassum over the two most common native kelps (*Saccharina subsimplex* and *Agarum fimbriatum*). Although *Lacuna* reaches high density on *Sargassum* (max number recorded = 2967 snails per thallus) a field experiment suggested there was not a spillover effect onto adjacent kelps (i.e. no apparent competition). We measured the aggregational (numerical) response of *Lacuna* to *Sargassum* by quantifying the abundance of *Lacuna* on *Sargassum* across a range of *Sargassum* patches that varied in density. At low patch density snail abundance was highly variable, with some patches having high snail densities. In contrast, dense patches of *Sargassum* never contained high abundances of *Lacuna*. Possible explanations for this pattern include a dilution effect and predation. Finally, a laboratory feeding trial indicated that *Lacuna* feeding rate on *Sargassum* was independent of conspecific snail density. Our results suggest that the effect of *Lacuna* on *Sargassum* is modulated by food preferences and host density. Overall, this work suggests that *Lacuna* may be most effective at reducing the performance of *Sargassum* in early invasion stages.

† **Brown, A.L.***, **Carpenter, R.C.**

FLOW-DRIVEN OUTCOMES OF CORAL-ALGAL COMPETITION

UC Berkeley Gump Field Station, California State University Northridge

In this study the flow-driven outcomes of interactions between *Porites* sp and three types of algae (algal turfs, *Turbinaria ornata*, *Amansia rhodantha*) were evaluated. Coral-algal interactions help shape coral reef communities. Negative interactions (i.e. competition) between coral and algae occur due to a suite of physical and/or chemical mechanisms. The efficacy of these mechanisms and the outcome of interactions may change based on flow-driven changes in microenvironments where interactions between coral and algae occur. Water flow was measured on three spatial scales using an Acoustic Doppler Profiler for overall flow, clod cards on the surface of a bommie, and fluorescein dye within interactions (algal turf, *Turbinaria*, *Amansia*). Overall water flow decreases from the upstream to the downstream side of a bommie (63% lower). At the level of an algal turf-coral interaction, water is retained for longer periods of time on the downstream sides of bommies (48% longer). Algal winners and neutral interactions were categorized on the upstream and downstream sides of bommies. These outcomes correlate with overall flow speeds and are dependent on morphological type and the hypothesized mechanism of competition (chemical for algal turf and *Amansia*, physical for *Turbinaria*). In lower flows (on the downstream side of a bommie) there are more algal turf winners. In higher flows (upstream side of a bommie) *Turbinaria* won more often. *Amansia* outcompeted coral, regardless of flow environment. This research provides insights for continued studies on how the flow environment influences not only outcomes of coral-algal interactions, but also the mechanisms underlying these interactions.

† **Bryson, S.***, **Fong, P. M.**

FACILITATION BECOMES INHIBITION UNDER EXTREMELY STRESSFUL CONDITIONS

University of California Los Angeles

The direction of ecological interactions depends on stress. While studies have documented shifts towards positive interactions when stressed, little research has addressed how interactions change under extremely stressful conditions. The upper Mediterranean-climate salt marsh is a patchwork of two alternative stable states, the hypersaline vegetated marsh and the barely habitable ultrahypersaline salt pannes. *Batis maritima* is an early-colonizing plants shown to ameliorate soil salinities. We hypothesized: **1.** *Batis* facilitates revegetation in the vegetated marsh, and **2.** the *Batis* facilitation is diminished in the salt pannes. We predicted that, even with soil amelioration, salinities are too high in the pannes to promote growth. We conducted two experiments to examine effects of *Batis* on vegetation colonizing rates at Mugu Lagoon in Southern California. Marsh plots were cleared into 3 treatments: *Batis* naturally present, *Batis* naturally absent, and *Batis* removed (n=5). Along panne margins we created plots with *Batis* naturally present, *Batis* naturally absent, *Batis* removed, and *Batis* mimic (nylon rope) (n = 10). Vegetation growth rates and soil salinity were monitored for two years. In the marsh, *Batis* present treatments had the highest revegetation rates, indicating facilitation. In the pannes *Batis* present and *Batis* mimic treatments had the lowest vegetation growth rates, suggesting inhibition. These experiments provide an example of how interactions change under extremely stressful regimes- documenting a loss of an important facilitation. For successful conservation efforts shifting interactions will have to be considered as some may be altered by increased stress.

Burnaford, J.L.*

LONG-TERM CHANGES IN ABUNDANCE OF THE INTERTIDAL CANOPY-FORMING KELP *SACCHARINA SESSILE*: COMMUNITY EFFECTS AND POSSIBLE CAUSES

California State University Fullerton

Saccharina sessile is a stipeless canopy-forming kelp that forms extensive beds in the low rocky intertidal zone of the Pacific Northwest. In 1998, to evaluate the effects of the *S. sessile* canopy on community structure, I established 25 permanent plots (1m x 1m) at Pile Point, San Juan Island, WA. All 25 plots had at least 70%

canopy cover of *S. sessile*, with an average cover of 73%. In 2008 I re-surveyed these plots to evaluate changes in kelp canopy cover and community structure after a 10 year period. In 2008, *S. sessile* cover was substantially lower than in 1998 (2008 average = 35%; cover only exceeded 70% in three plots). I also observed changes in the structure of the understory community over the 10 year period. Most notably, in 2008, the assemblage of algae and sessile invertebrates differed between plots at the high edge of the *S. sessile* zone and plots at the low edge of the zone, a pattern that was not present in 1998. Surveys of *S. sessile* canopy cover from 1998 – 2000 and 2007 – 2010 show substantial year-to-year changes that appear to be related to changes in environmental conditions such as the duration of low tide exposure. Future studies will focus on the identification of the specific causes and consequences of changes in abundance of this important low intertidal kelp.

Byrnes, J.E.* , Reed, D.C., Cardinale, B.J., Cavanaugh, K.C., Holbrook, S.J., Schmitt, R.J.
CLIMATE CHANGE, STORM FREQUENCY, AND THE FUTURE OF KELP FOREST FOOD WEBS
University of California Santa Barbara

Climate models predict a dramatic increase in the annual frequency of severity weather events during the next century. These storms can remove large quantities of the giant kelp, *Macrocystis pyrifera*, a foundation species that provides the habitat and energy for subtidal food webs in Southern California. Here we show that increases in the annual frequency of severe storms lead to a decrease in the diversity and complexity of food webs of giant kelp forests. We demonstrate this by linking natural variation in storms with measured changes in kelp forest food web network structure in the Santa Barbara Channel using Structural Equations Modeling (SEM). We then match predictions from statistical models to results from a multi-year kelp removal experiment designed to simulate frequent large storms. Both SEM models and experiments agree: if large storms remain at their current annual frequency, periodic storms help maintain the complexity of kelp forest food webs. However, if large storms increase in annual frequency and begin to occur year after year, kelp forest food webs become less diverse and complex. The loss of complexity occurs primarily due to decreases in the diversity and complexity of higher trophic levels. Our findings demonstrate that shifts in climate-driven disturbances that affect foundation species are likely to have impacts that cascade through entire ecosystems.

† **Cameron, C.M.* , Edmunds, P.J.**
THE EFFECTS OF DAMAGE VARYING IN EXTENT AND ORIGIN ON THE GROWTH OF SMALL CORALS
California State University Northridge

In this study, we explored the effects of multiple types of damage and differing lesion densities on the growth of small corals using two sets of experiments. First in 2009, we simulated fish predation on reef corals to test the hypothesis that artificial damage designed to mimic three corallivorous fish feeding groups did not affect the growth and healing of corals. Second in 2010, we evaluated the extent to which the growth response to damage reflected new growth versus healing (repair at the site of lesion), by testing the hypothesis that linear extension (skeletal growth) is not affected by lesion density (1, 2, or 3 scars) and that lesion density had no effect on colony shape through compensatory growth outside of the lesion. Corals damaged through excavations mimicking corallivorous fishes grew 27-37% slower than corals damaged through simulated browsing, and 11-16% slower than corals damaged by simulated scraping. The analysis of linear extension suggested that lesion density had no effect on apical growth, although there was more new growth within lesions versus outside lesions on the top of damaged corals. Together, these results show that corals are more severely affected by excavation damage when compared to browsing and scraping damage, and that the response to excavation damage appears to be more directly associated with calcification within the site of damage (i.e. healing) than compensatory growth.

Campanale, J.P.* , Hamdoun, A.
DEVELOPMENT AT THE EXPENSE OF DEFENSE; SEA URCHIN SMALL MICROMERES LOSE MULTIDRUG EFFLUX ACTIVITY AT THEIR FORMATION

Scripps Institute of Oceanography, Scripps Institution of Oceanography
Embryos employ cellular defenses to combat a variety of environmental stressors, including toxicants, ultraviolet radiation, heat and pathogens. Less understood is whether tradeoffs exist between the activity of these defenses and the operation of developmental programs controlling cell fate and morphogenesis. One such defense, efflux transport, is important for keeping toxic chemicals from gaining access into cells. Using confocal microscopy, we measured the intracellular fluorescence of different cells in embryos of the purple sea urchin, *Strongylocentrotus purpuratus*, after treatment with calcein-AM, a proxy of ATP binding cassette transporter efflux activity. Additionally, we performed calcein assays in combination with several efflux inhibitors. We found small micromeres, the presumptive germline of the adult sea urchin, have reduced chemical defense at their formation. Specifically, small micromeres accumulate calcein-AM at a rate 3.2 (+/- 0.30 sem) times higher than other cells in the embryo. The increased permeability in this critical cell type is not limited to calcein-AM, but an array of structurally diverse compounds, including CellTrace RedOrange, BoDipy-verapamil and BoDipy-vinblastine,

suggesting that this phenomenon could render these cells more vulnerable to toxic compounds. The loss of key chemical defenses in the small micromeres represents a paradox: embryonic cells contributing significantly to the adult life stage are the least defended. Our goal will be to understand the physiological context in which increased permeability, although a risk, may be essential for development.

Carney, L.T.^{1*}, Bohonak, A. J.², Edwards, M. S.², Alberto, F.³

GENETIC AND EXPERIMENTAL EVIDENCE FOR A GAMETOPHYTE BANK OF MIXED-AGE AND MIXED-ORIGIN IN A SOUTHERN CALIFORNIA KELP FOREST

1 - Scripps Institution of Oceanography 2 - San Diego State University 3 - Center of Marine Sciences, University of the Algarve, Campus de Gambelas, Faro, 8005-139, Portugal

Recent laboratory studies have demonstrated that the microscopic gametophytes of several kelp species can rapidly resume development and produce sporophytes from a delayed state. Like terrestrial seeds or aquatic resting eggs, banks of delayed kelp stages may supplement population recovery after periods of stress, playing an important role for kelp populations that experience adult sporophyte absences due to seasonal or inter-annual disturbances. We found that removing the microscopic stages from natural rock substratum prevented the recruitment of new kelp sporophytes for more than two months within a southern California kelp forest. Recruitment occurred within one month in plots where microscopic stages were left intact, which may confer an advantage for the resulting sporophytes as they attain larger sizes before later recruiting neighbors. Using a microsatellite-based parentage analysis for the dominant kelp, *Macrocystis pyrifera*, we estimated that a portion of the new *M. pyrifera* sporophyte recruits had originated from zoospores that dispersed between 3 m and 112 m from their parents. Recruitment of some sporophytes from a "gametophyte bank" took place at least seven months after the parents had disappeared. Microsatellite diversity was high ($H_E \approx 0.9$) for both adults and juveniles that arose from delayed stages. Thus, mixed age and mixed origin banks of *M. pyrifera* gametophytes may promote maximal genetic diversity in recovering populations. Gametophyte banks may also reduce population genetic subdivision and self-fertilization rates for intact populations by promoting survival of zoospores dispersed >10 m, and those dispersed during inhospitable environmental conditions.

Carpenter, R.C.^{*}, Johnson, M.D., Moriarity, V.

ORIGIN-SPECIFIC RESPONSES BY THE TROPICAL CORALLINE ALGA, *HYDROLITHON ONKODES* TO AMBIENT, ELEVATED, AND VARIABLE pCO_2

Richard B. Gump South Pacific Research Station, California State University Northridge

A growing body of evidence suggests that continued acidification of surface waters of the ocean will have significant negative impacts on the ability of calcifying organisms to secrete calcium carbonate structures. These predictions are particularly critical for coral reefs where calcified taxa are foundation species and have several important ecological roles. Calcified crustose coralline algae are important primary producers that bind the reef framework together and often serve as settlement cues for coral larvae. Organisms living in different reef habitats may experience diel variation in pCO_2 as a result of reef metabolism and water residence time over the reef. This study investigated the responses of the common coralline alga *Hydrolithon onkodes* from upstream and downstream habitats to ambient, elevated, and variable pCO_2 . Corallines collected from each habitat in Moorea, French Polynesia were placed in mesocosms where pCO_2 was manipulated using gas-mixing technology. After 2 weeks, differences in buoyant weights indicated that corallines from both reef habitats calcified most rapidly in the ambient treatment, calcified significantly less (70% reduction) in the elevated pCO_2 treatment, and calcified at intermediate rates in the variable pCO_2 treatment. However, corallines from downstream habitats calcified at significantly greater rates than upstream corallines in variable pCO_2 conditions, suggesting some degree of acclimatization response by organisms that regularly experience variable pCO_2 . These results have important implications for measuring responses of calcifying organisms to ocean acidification and indicate that organismal responses can be habitat-specific, suggesting the potential for adaptation to a future ocean with elevated pCO_2 .

† Carrillo, A.^{*}, Bansuan, H., Miranda, A., Treybig, T.A., Dickson, K.A.

THE EFFECTS OF EXTENDED INCUBATION ON MORPHOLOGY AND FEEDING ACTIVITY OF THE CALIFORNIA GRUNION, *LEURESTHES TENUIS*

California State University Fullerton

The California grunion, *Leuresthes tenuis*, spawns from March to August on sandy beaches on nights following the spring high tides. Fertilized eggs develop within the sand for 8-14 days until they are stimulated to hatch by wave action during the next spring high tide. If that does not happen, embryos may extend incubation for up to 30 days post-fertilization (dpf) and hatch during a subsequent spring high tide. We investigated the effects of extended incubation on development and feeding activity in California grunion larvae. It was hypothesized that 28-dpf larvae (extended incubation) would have more developed skeletal structures and greater feeding rates than 10-dpf larvae (normal incubation). Fertilized eggs, from paired males and females, were incubated at 20°C until stimulated to

hatch at 10 and 28 dpf. Larvae (10 and 28 dpf) were cleared and stained to count the number of skeletal elements in the caudal fin and the number of dentary and pharyngeal teeth for three batches of eggs. Feeding rates of 10- and 28-dpf larvae were measured as the change in rotifer (*Branchionus* sp.) density over a 4-h period for seven batches of eggs. In all batches studied, the 28-dpf larvae had significantly more dentary and pharyngeal teeth, more skeletal elements within the caudal fin, and significantly greater feeding rates than 10-dpf larvae. These results of extended incubation in *L. tenuis* may improve larval survival and compensate for known negative effects of delayed hatching, including decreased hatching rates and decreased energy reserves.

† **Cavanaugh, K.C.***, **Siegel, D.A.**, **Reed, D.C.**

SEASONAL TO DECADEAL DYNAMICS OF GIANT KELP BIOMASS IN THE SANTA BARBARA CHANNEL
University of California Santa Barbara

Synthesizing long-term observations at multiple scales is vital to understanding and predicting ecosystem responses to a changing climate. Recent increases in the availability of time-series satellite data allow regional variability in producer biomass and productivity to be evaluated on seasonal to decadal scales. Here, we combined LANDSAT satellite imagery with diver sampling to assess local and regional changes in the biomass of giant kelp (*Macrocystis pyrifera*) at unprecedented temporal resolution. Our goals were to determine (1) the relative importance of resource availability and wave disturbance in driving both seasonal and interannual cycles in regional kelp populations and (2) the level of sub-regional variability in the roles of these forcing processes. Correlative analyses involving a range of oceanographic and climatic variables (e.g., swell height, sea surface temperature, nutrients, ENSO, PDO, and NPGO indices) provided insight into the potential drivers of seasonal to interannual dynamics in giant kelp biomass and possible responses of the giant kelp system to changes in these drivers. The spatial coverage of LANDSAT allowed us to investigate how the roles of these drivers varied in space due to wave exposure, local temperature and nutrient conditions, etc. We found that region-wide seasonal dynamics were negatively correlated with maximum wave height and sea surface temperature. Sub-regions with similar temporal dynamics were separated by wave exposure gradients. Linking remotely acquired data with long-term ecological field measurements can facilitate a better understanding of the patterns and drivers of biomass and primary production for a multitude of terrestrial and aquatic ecosystems.

Chang, A.L.^{1*}, **Malm, P.D.²**, **Deck, A.K.¹**, **Willits, K.¹**, **Attoe, S.³**, **Fisher, J.L.³**, **Morgan, S.G.¹**

GOING WITH THE FLOW OR STAYING CLOSE TO HOME? POPULATION DYNAMICS AND CONNECTIVITY OF BIVALVES IN SAN FRANCISCO BAY

1 - Bodega Marine Laboratory, University of California Davis 2 - Sonoma State University 3 - Oregon State University

Population connectivity is a key factor in the causes and consequences of fluctuations in abundance and geographic distribution of estuarine and marine invertebrates and helps modulate metapopulation responses to floods, droughts, and many other disturbances. We investigated population dynamics and larval dispersal patterns of *Ostrea lurida* and *Mytilus galloprovincialis* in San Francisco Bay using a combination of population surveys, recruitment monitoring, and trace elemental fingerprinting methods. We examined oyster and mussel populations during the low flow season at the end of a three-year drought (Fall 2009) and during higher flow conditions (Spring 2010). In the fall of 2009, oyster and mussel abundance and size distributions differed significantly along the salinity gradient from upstream sites toward the mouth of the Golden Gate. Maximum oyster density occurred in brackish waters near China Camp State Park with over 1000 oysters / m², while intertidal mussel density was highest at sites closer to the mouth of the estuary. Significant regional variation in temperature and salinity conditions appear to be correlated with differences in timing of spawning and settlement throughout the year. Juvenile oyster recruitment varied significantly around the Bay, with greatest settlement in moderately-to-high salinity areas, especially during warmer periods. Oyster and mussel larvae from different sites around the Bay contained sufficiently distinct trace elemental fingerprints to be discriminated from each other at fairly small spatial scales. Natal origins of collected juvenile oysters from Fall 2009 matched several sites in northern San Francisco Bay.

Clark, G.F.*, **Johnston, E.L.**

TEMPORAL DEPENDENCE OF THE DIVERSITY-INVASIBILITY RELATIONSHIP IN SESSILE MARINE INVERTEBRATES

Subtidal Ecology and Ecotoxicology Lab, University of New South Wales (Australia)

Disturbance can affect both the diversity and invasibility of communities. Many field studies have found correlations between diversity and invasion, but if both factors independently respond to disturbance then spurious non-causal relationships may be observed. Here, we show that disturbance can cause a temporal shift in the diversity-invasibility relationship. In a field experiment using sessile marine communities, disturbance strongly affected both diversity and invasion such that they were highly correlated. Disturbance facilitated initial invasion, creating a

negative diversity-invasibility relationship when the invader first arrived. Over time, disturbance hindered the invaders' persistence, creating a positive diversity-invasibility relationship. We suggest that temporal changes in the diversity-invasibility relationship may contribute to the "invasion paradox", a term for the contrasting patterns of experimental and observational studies of the diversity-invasibility relationship.

† **Clarke Murray, C.^{1*}, Martone, P.T.¹, Therriault, T.W.²**

BIOMECHANICS OF INVASION: INTERSPECIFIC ADAPTATIONS FOR TRANSPORT IN HULL FOULING COMMUNITIES

1 - University of British Columbia 2 - Fisheries and Oceans Canada

Marine invaders transported by commercial and recreational vessels must undergo journeys of considerable time and distance, while enduring extreme conditions. Successful transportation of hull fouling species depends on the ability to avoid hydrodynamic dislodgement from the vessel. We would expect that highly successful hull fouling invaders would have adaptations to reduce the probability of dislodgement. Possible adaptations include behavioural modifications in flow, strong attachment, low-drag body forms and larval settlement preferences. In this study we asked the question: Are invasive species better adapted for transport than natives? Probability of dislodgement was investigated using measurements of attachment strength and drag for a variety of common native and nonindigenous fouling species. Attachment was much greater in nonindigenous species, though this trend was mediated by dispersal strategy. This suggests that nonindigenous species are selected for adaptations that increase their probability of transport outside the native range. Results can be integrated into a transport model for predicting future invasions based on morphological characteristics, thereby improving vector management strategies.

† **Coates, J.H.^{*}, Hovel, K.A., Butler, J.L.**

PINK ABALONE (*HALIOTIS CORRUGATA*) MOVEMENT FOLLOWING ARTIFICIAL AGGREGATION: TESTING A POTENTIAL RESTORATION TECHNIQUE

San Diego State University

Pink abalone (*Haliotis corrugata*) are broadcast spawners and fertilization rates therefore are dependent upon the spatial proximity of adults. Allee effects, defined as a decrease in fitness as population size declines, may be acting on abalone and similar species through low fertilization success rates when population densities are reduced. To better understand the role of Allee effects in the failed population recovery and potential restoration of pink abalone, I conducted a field experiment to examine pink abalone movement behavior in a simulated restoration situation. I created an aggregation of acoustically tagged abalone in a small area of the Point Loma kelp forest near San Diego, CA, and tracked individual abalone movements for 57 days using a Vemco Radio Acoustic Positioning (VRAP) system, which provided positions accurate to within ± 2 m in the x and y directions. During periods of successful data collection, animals were positioned on average 4 times per day. The distance from the first to last positions in a track averaged 12.1 m and ranged from <1 to 70 m. Home range, represented by minimum convex polygons (MCP) containing all positions, averaged 492 m². Twenty-seven percent of abalone MCPs were equal to or smaller than the spatial resolution of the equipment, suggesting that these abalone moved little or not at all. The remaining 73% of the abalone MCPs were larger than that of a stationary tag. While a few abalone moved surprisingly large distances, the moderate movements of most could have an important impact on fertilization rates.

† **Compton, V.M.^{1*}, Anderson, T.W.², Morgan, S.G.³, Cherr, G.N.³**

UNDERSTANDING THE ROLE OF HABITAT IN MEDIATING PREDATION RISK OF LARVAL FISH EXPOSED TO A PYRETHROID INSECTICIDE

1 - Bodega Marine Laboratory, San Diego State University 2 - San Diego State University 3 - Bodega Marine Laboratory, University of California Davis

Habitat structure is important in providing prey a refuge from predators, yet its importance relative to other factors in mediating predation risk is often unclear. The importance of habitat structure may be even greater in ecosystems with higher contaminant loads such as estuaries where fish may suffer from impaired swimming ability and lower predator vigilance. We explored the role of habitat structural complexity on predation risk of larval topsmelt, *Atherinops affinis*, exposed to sublethal concentrations of the pyrethroid insecticide esfenvalerate. Observations were made on prey swimming behavior during predation trials with juvenile stickleback, *Gasterosteus aculeatus*, as predators. The distribution and density of artificial seagrass was manipulated to simulate differential habitat structural complexity. Observations of predator behavior were quantified by successful and unsuccessful attempts at capturing prey. Topsmelt larvae exposed to high concentrations of insecticide were more likely to display erratic swimming behavior, and suffered the greatest mortality of all prey. Contrary to our prediction, increasing habitat structural complexity resulted in the greater proportion of successful strikes, suggesting that predator efficiency is positively related to habitat structure. These results provide an avenue for

future studies to explore whether the potentially interactive effects of habitat structure and exposure of prey and predators to insecticides may influence predation risk. Understanding these complex interactions is critical for implementing the management and restoration of habitats in urban estuarine ecosystems.

† **Conner, S.L.***, **Bauer, R.T.**

INFECTION OF ADULT MIGRATORY RIVER SHRIMPS, *MACROBRACHIUM OHIONE*, BY A BRANCHIAL BOPYRID ISOPOD, *PROBOPYRUS PANDALICOLA*

University of Louisiana at Lafayette

Macrobrachium ohione is a migratory (amphidromous) river shrimp (Decapoda, Caridea) that may be parasitized by the branchial parasite, *Probopyrus pandalicola* (Isopoda, Bopyridae). Shrimps are usually infected by bopyrid parasites during the late zoeal or early postlarval stages; in this study, we investigated the apparent parasite infection of adult shrimps. We analyzed the relationships between parasite body size and host shrimp body size to test the hypothesis that parasite infection of adult shrimps occurs during the shrimps' reproductive migrations. Results presented here indicate that infection of adult shrimps is common in *M. ohione* in the Atchafalaya and Mississippi Rivers, Louisiana, USA. In the two upriver sites sampled parasite size was not associated with host size. In these locations, many parasitized adult *M. ohione* were infected with immature *P. pandalicola* (40.3%-51.2%), indicating that the shrimps were adults at the time of infection. A possible explanation is that when female shrimps enter the estuary to hatch larvae, they molt and spawn another brood. The smaller male shrimps which accompany the females downstream are also assumed to molt and continue growth. The intermediate host of the parasite is an estuarine copepod, and thus the parasite cryptoniscus larva which infects the host shrimp is primarily estuarine as well. Newly molted shrimps have soft cuticles which may facilitate their infection by parasite cryptoniscus. Our conclusion is that most infections of adult shrimps occurs during their migration into estuarine waters, the primary habitat of infective parasite larvae, and that host vulnerability is probably increased following host ecdysis.

Conway-Cranos, L.L.*

AN INVESTIGATION OF THE RELATIVE IMPORTANCE OF MECHANISMS DRIVING VARIATION IN THE RECOVERY OF MUSSEL BEDS

University of Washington

Recovery rates and trajectories profoundly influence the way disturbance determines community structure and as such it is important to understand the factors that contribute to variation in them. Recent interest in incorporating ecological resilience into management plans has further highlighted the importance understanding the likelihood of recovery after a disturbance as well as the mechanisms that drive it. I experimentally initiated the recovery process in an intertidal mussel assemblage at three sites spanning a major biogeographic break in California. To investigate the relative importance of the mechanisms driving observed variation in recovery rates, I calculated a recovery index and related fluctuations in this index to changes in recruitment, consumer density and cover of potential facilitator species and conspecifics. I found that the geographic pattern of recruitment closely resembled the geographic pattern of observed recovery rates such that sites with higher recovery rates also showed higher levels of recruitment. Despite this, recruitment was only identified to be important in driving temporal variation in recovery at single site, indicating that there may be an indirect relationship between recruitment and recovery, mediated by the effects of recruitment into the intact mussel bed on rates of mussel encroachment into disturbed patches. I found evidence for a strong per capita effect of predators on recovery since the site where predators negatively affected recovery in both small and large disturbances was also the site with the lowest predator levels. Thus, site-specific variation in the mechanisms driving recovery provide the context that determines their relative importance.

Craig, M.T.^{1*}, **Chartier, L.²**, **Fodrie, F.³**, **Allen, L.⁴**, **Toonen, R.²**

BOUNDLESS BOUNDARIES: THE ENIGMA OF DISCORDANT PHYLOGEOGRAPHIC AND BIOGEOGRAPHIC BREAKS IN COASTAL CALIFORNIA

1 - *Isla Magueyes Marine Laboratory, University of Puerto Rico* 2 - *Hawaii Institute of Marine Biology, University of Hawaii at Manoa* 3 - *University of North Carolina* 4 - *California State University Northridge*

The range of the California Halibut, *Paralichthys californicus*, spans three biogeographic provinces along the coastline of Alto (United States) and Baja (Mexico) California. To assess population genetic structure of the California Halibut, we analyzed mitochondrial cytochrome b sequences from 375 individuals across a large portion of its native range. Nucleotide diversity was consistently low among sampling sites ($\pi = 0.002576 \pm 0.001650$), while haplotype diversity was consistently high ($h = 0.7653 \pm 0.0238$). We found that California Halibut were genetically homogeneous across sampled sites with an overall Φ_{st} . We found no evidence of genetic discontinuities at two previously recognized marine phylogeographic breaks (Monterey Bay and the Los Angeles region), or across the California Transition Zone at Point Conception. We conclude that California Halibut are

genetically homogeneous and experience substantial geneflow, at least over evolutionary time scales.

† **Crowther, D.A.^{*}, Tissot, B.N.**

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

Washington State University Vancouver

Marine conservation efforts, specifically marine protected areas (MPAs), are important recourses for balancing the often opposing values inherent in economic growth and conservation of biodiversity. The state of Oregon has recently deliberated on and approved several proposals for MPAs within the state's territorial sea. Two pilot sites were selected and four additional sites were recommended for further study with the goal of balancing the biodiversity of the state's nearshore marine ecosystem without adversely affecting the socioeconomics of coastal communities. However, from the pool of proposals the state selected, none quantitatively assessed how fishing effort varies in relation to the biodiversity benefits of the proposed sites. Given the lack of data in the state's selection process, we examined quantitative and spatially explicit data on fisheries, physical and ecological characteristics to the originally proposed sites. Using these metrics, we compared the network of six sites the state selected to a network of eight that were proposed by a coalition of conservation groups. In comparing these two MPA networks, we hope to identify the tradeoffs made by the state to remain within the guiding sideboards of ecological significance relative to adverse social and economic impacts. Understanding the balance between fisheries and conservation of these two networks sheds light on the efficacy of the proposal process, the importance of data gaps in such a process, and provides feedback to the state on future site selection.

Cumbo, V.R.^{1*}, Fan, T.Y.², Edmunds, P.J.¹

TEMPERATURE AND PCO₂ AFFECTS ON THE PHYSIOLOGY OF THE EARLY LIFE STAGE OF POCILLOPORIA DAMICORNIS

1 - California State University Northridge 2 - National Museum of Marine Biology and Aquarium, Taiwan, Republic of China

Coral reefs are threatened by global climate change (GCC), with increased temperature destabilizing the association between coral and their endosymbiotic algae, and increased CO₂ depressing coral calcification. Sexual reproduction and larval recruitment offer the primary means of recovery for coral populations on reefs negatively impacted by GCC, but it is unknown whether these processes will continue to operate as they have in the past. To determine the effects of GCC on coral larvae, *Pocillopora damicornis* larvae from Taiwan were exposed to 442 and 604 μatm pCO₂ at 25°C (ambient) and 29°C (high) to mimic current and future climate predictions. Incubations lasted 24 hr and were repeated over 4 days of peak larval release; at the end of the treatments, aerobic dark respiration, dark-adapted yield and mortality were measured. The only significant interaction between temperature and pCO₂ occurred with larvae respiring at a higher rate under stress environmental conditions (p=0.042), yet the day of release significantly affected all variables. Day 1 and 2 larvae responded positively to treatment conditions, with increased respiration at high temperature, increased photosynthetic efficiency at high temperature and pCO₂, and decreased mortality at high pCO₂. In contrast, larvae from day 3 and 4 of release responded negatively to treatments. These results demonstrate that while GCC can negatively impact coral larvae, the consequences are strongly affected by larval development. Evidence that coral larvae are resistant to GCC, at least at some point in their development, suggests that constitutive mechanism may be available to resist GCC effects later in life.

† **Darling, E.S.^{1*}, McClanahan, T.R.², Cote, I.M.¹**

ALL STRESSED OUT? SYNERGIES, RESILIENCE AND COTOLERANCE ON EAST AFRICAN CORAL REEFS

1 - Simon Fraser University 2 - Wildlife Conservation Society

A challenge for conservation science is predicting the impacts of co-occurring human activities on ecological systems and the goods and services they provide. Multiple anthropogenic stressors impact global marine ecosystems and are expected to jeopardize their ecological functions and resilience. The possibility that two or more stressors interact synergistically is of particular concern, but such non-additive effects remain largely unidentified in nature. We use a long-term dataset of hard coral cover from Kenyan reefs to examine the independent and interactive effects of two stressors: fishing and a temperature anomaly in 1998 that caused mass coral bleaching and mortality. While both stressors decreased coral cover, fishing by 51% and bleaching by 74%, they did not interact synergistically. Instead, their combined effect was antagonistic or weakly additive. The observed non-synergistic response may be associated with the cotolerance of coral species to both fishing and thermal stress; corals that are tolerant to fishing impacts are also tolerant to bleaching stress. The finding that the impacts of fishing and bleaching are not synergistic is hopeful news given future predictions for coral reefs. However, our results also suggest that marine reserves may not provide corals with a refuge from climate change

and that resilience-based management to reduce the impacts of local stressors may actually increase the vulnerability of coral communities to global climate impacts.

Day, J.L.*

SAVING A LIVING DINOSAUR: AN INTEGRATIVE APPROACH TO GREEN STURGEON RECOVERY

National Marine Fisheries Service

The North American green sturgeon, *Acipenser medirostris*, is an anadromous fish that occurs in the nearshore Eastern Pacific Ocean from Alaska to Mexico. They are long lived, late maturing, spawn infrequently in natal streams, and spend substantial portions of their lives in marine waters. Using molecular analyses and evidence of spawning site fidelity, NMFS designated two distinct population segments (DPS) of green sturgeon. Northern DPS (nDPS) green sturgeon spawn in the Klamath River, California and Rogue River, Oregon. Southern DPS (sDPS) green sturgeon are currently thought to spawn only in a short stretch of the upper mainstem Sacramento River, below Keswick Dam. In 2006, NMFS determined that the sDPS warranted listing as a threatened species under the Endangered Species Act (ESA). Like other species of sturgeon, green sturgeon have experienced population declines over the past century, primarily due to the effects of impoundments (e.g., barriers and altered flow regimes), water quality degradation, competing water uses, and overutilization. Since listing, NMFS has initiated the process of developing a recovery plan, or a roadmap to direct efforts to rebuild DPS greens sturgeon populations to where they are self-sustaining and no longer need the protections afforded by the ESA. Here I present an overview of the recovery process, describe the types of criteria used to gauge progress, and solicit further collaboration to aid in the task of saving this living dinosaur.

† **Demes, K.W.^{1*}, Carrington, E.², Martone, P.T.¹**

VARIATION IN ANATOMICAL AND MATERIAL PROPERTIES EXPLAINS DIFFERENCES IN HYDRODYNAMIC PERFORMANCES OF FOLIOSE RED MACROALGAE (RHODOPHYTA)

1 - University of British Columbia 2 - Friday Harbor Labs, University of Washington

Over the last two decades, many studies on functional morphology have suggested that material properties of seaweed tissues may influence their fitness. Because hydrodynamic forces are likely the largest source of mortality for seaweeds in high wave energy environments, tissues with material properties that behave favorably in these environments are likely to be selected for. However, it is very difficult to disentangle the effects of materials properties on seaweed performance because size, shape, and habitat also influence mechanical and hydrodynamic performance. In this study, anatomical and material properties of 16 species of foliose red macroalgae were determined and their effects on hydrodynamic performance were measured in laboratory experiments holding size and shape constant. Results suggest that increased blade thickness (primarily caused by thickening of medullary tissue) results in higher flexural stiffness which inhibits the seaweeds' ability to reconfigure in flowing water, and thereby increases drag. However, this increase is concurrent with an increase in the force required to break tissue, possibly offsetting any risk of failure. Additionally, while increased non-pigmented medullary cells may pose a higher metabolic cost to the seaweed, decreased reconfiguration causes thicker tissues to expose more photosynthetic surface area incident to ambient light in flowing water, potentially ameliorating the metabolic cost of producing these cells.

Denny, M.W.* , Dowd, W. Wesley, Bilir, Lisa, Mach, Katherine

SPREADING THE RISK: SMALL-SCALE BODY TEMPERATURE VARIATION AMONG INTERTIDAL ORGANISMS: IMPLICATIONS FOR SPECIES PERSISTENCE

Hopkins Marine Station, Stanford University

The intertidal zone of wave-swept rocky shores is a potentially useful system in which to detect, experimentally manipulate, and possibly understand the ecological consequences of impending changes in environmental temperature. However, the spatial and temporal complexity of the shoreline's thermal environment challenges ecologists' ability to progress from site-specific measurements to general predictions. In this study, we conducted intensive field experiments to quantify inter-individual variation in body temperature among organisms at a typical intertidal site, and we used these measurements to characterize micro-scale variation in potential thermal stress. Within the 336-m extent of our site, local variation was substantial in several metrics of extreme and cumulative thermal exposure. The within-site variation in extreme temperatures rivaled variation among sites along 14° of latitude. Application of our within-site data to a simple theory of risk suggests that small-scale spatial variation in temperature can reduce the chance of local extirpation that otherwise would accompany an increase in average habitat temperature or an increase in the frequency of extreme thermal events. The magnitude of this "buffering" effect also depends heavily on inter-individual variation in thermal tolerance, a factor that has received little attention from physiologists.

Donovan, M.K.^{1*}, Williams, I.D.², Friedlander, A.M.¹

DEMOGRAPHIC VARIABILITY IN AN INTRODUCED HAWAIIAN REEF FISH

1 - University of Hawaii at Manoa 2 - Pacific Islands Fishery Science Center, National Oceanographic and Atmospheric Association

The grouper, peacock hind (*Cephalopholis argus*), were introduced to the Hawaiian Islands in the 1950s as part of a program attempting to enhance nearshore fisheries by introducing fishes from the South Pacific to supplement Hawaii's depauperate native grouper and snapper fauna. *C. argus* populations have proliferated in many parts of the Main Hawaiian Islands, becoming a dominant shallow reef predator. In Hawaii and elsewhere, *C. argus* is known to prey on small fishes, including the recruits and juveniles of many species, and consequently there are concerns that the current abundance of *C. argus* has had detrimental impacts on local reef fish communities. To investigate variability in the population dynamics of the species throughout the majority of its invasive range, samples were collected throughout the Main Hawaiian Islands. Standard techniques involving otolith ageing were employed to describe age and growth, and that information combined with length frequency distributions from underwater visual surveys was used to estimate population size structure by location. These factors, measured at different locations, were then compared to assess the individual effects of fishing pressure, protected area status, benthic habitat, prey abundance and location on demographic responses of *C. argus*. This study highlights the importance of considering variability in demographic parameters in a coral reef fish for stock assessments. Further, this is a step towards understanding the variation of demographic parameters that occurs on multiple spatial scales and how this relates to the ecological role of a predatory fish species.

† Driscoll, R.M.^{1*}, Reiss, C.S.², Hentschel, B.T.³

DETERMINING POPULATION STRUCTURE OF THE ANTARCTIC EUPHAUSIID *THYSANOESSA*

MACRURA (G.O. SARS 1885)

1 - Southwest Fisheries Science Center, San Diego State University 2 - Southwest Fisheries Science Center, National Oceanographic and Atmospheric Association 3 - Coastal and Marine Institute Laboratory, San Diego State University

Climate change may have important consequences for pelagic ecosystems, driving shifts in phenology, production and community composition. Of the many pelagic systems, the Antarctic Peninsular ecosystem is experiencing some of the planet's most rapid climate change. Euphausiids, principally Antarctic krill (*Euphausia superba* Dana), are the region's major trophic link between primary production and upper trophic levels (seabirds, marine mammals, and fish) and also support an important fishery. Given the stenothermic nature of *E. superba*, its future in this region is uncertain as Southern Ocean temperatures warm. Other smaller species of Euphausiids are abundant in the region, notably *Thysanoessa macrura*. Whether species like *T. macrura* might replace *E. superba* and how the functioning of the ecosystem might change as a result are unknown. Resolving these questions requires information on the growth, productivity, and dynamics of these potential replacement species. Knowing the population's age structure is a critical first step. As part of a larger re-analysis of a 20 year time series of preserved samples from the US Antarctic Marine Living Resources Program, I examine the utility of using length frequency analysis as a proxy for age in the first year of life to discern recruitment success of *T. macrura* cohorts.

† Dufault, A.M.^{1*}, Cumbo, V.R.¹, Fan, TY², Edmunds, P.J.¹

EFFECTS OF DIURNALLY OSCILLATING SEAWATER DIC CHEMISTRY ON THE GROWTH AND SURVIVAL OF CORAL RECRUITS

1 - California State University Northridge 2 - National Museum of Marine Biology and Aquarium, Taiwan

To date, the studies that have explored ocean acidification (OA) effects on early life history stages of corals have employed steady pCO₂ conditions rather than diurnally variable pCO₂, which is a common feature of shallow reefs. In this study, we tested the response of recruits of the brooding coral *Seriatopora hystrix* from Nanwan Bay, Taiwan, to oscillating seawater DIC chemistry. Newly settled recruits were exposed to ambient (440 µatm), high (663 µatm) and oscillating pCO₂ for 3 days at 25°C in spring, and the experiment was repeated in the summer for 6 days with slightly different pCO₂ conditions (456 µatm and 837 µatm). As occurs naturally, corals in the oscillatory treatment were placed in ambient pCO₂ during the day and in high pCO₂ at night; growth was measured using the planar area of corallites and weight of deposited CaCO₃. Growth did not differ between ambient and high pCO₂, however, diurnally oscillating conditions increased growth by 6-10% for area, and 17-19% for weight, and elevated growth coincided with 10-14% increased survivorship during the summer. The stimulatory effect of oscillatory DIC on growth was dependent on when high pCO₂ was administered, with the effect decreasing when high pCO₂ was administered during the day; this outcome implies the mechanistic response to CO₂ may differ between day and night. The results of this short-term experiment suggest some coral species may be resistant to the negative effects of OA and could benefit from diurnally variable pCO₂ on a time scale of hours-days.

Eberl, R.*

PHYLOGEOGRAPHY OF THE HIGH INTERTIDAL ISOPOD *LIGIA PALLASII*: ALEUTIAN ISLANDS TO MONTEREY BAY

Bodega Marine Laboratory, University of California Davis

Ligia pallasii (Ligiidae, Oniscidea, Isopoda) is an important detritivore of rocky shores and feeds mostly on algal wrack. *Ligia pallasii* has a current range from the Aleutian islands to Central California that spans several biogeographic provinces. *Ligia pallasii* distribution is restricted to rocky shorelines and to semiprotected areas with rocky cliffs in the southern range where it is sympatric with the congener *Ligia occidentalis*. The suspected limited dispersal capability of *Ligia pallasii* leads to the prediction that substantial genetic differentiation should occur throughout the range of this species with the possibility of cryptic speciation as has been found in other Ligiidae. Mitochondrial cytochrome oxidase I sequence data from populations throughout its range were used to determine genetic diversity, population structure and gene flow in *Ligia pallasii*.

Edmunds, P.J., Brown, D.B.*, Moriarty, V.

COMPARATIVE INTERACTIVE EFFECTS OF OCEAN ACIDIFICATION AND TEMPERATURE ON TWO TROPICAL SCLERACTINIAN CORALS

California State University Northridge

This study tests the hypothesis that the response of corals to combinations of temperature and pCO₂ is consistent among species, and it was motivated by the possibility that scleractinians may cease to exist as a calcified taxon due to the effects of ocean acidification (OA). Pieces of massive *Porites* spp. and *P. rus* from the back reef of Moorea, were incubated for 1 month under orthogonal combinations of temperature (29.3°C and 25.7°C) and pCO₂ (423 versus 832 µatm) at 580 µmol photons m⁻² s⁻¹. Using an 8-tank mesocosm and CO₂ mixing technology, treatments were created in a partly nested design (tanks) with two between-plot factors (temperature and pCO₂) and one within-plot factor (species); calcification and photophysiology were used as dependent variables. pCO₂ and temperature independently affected calcification, but the response to pCO₂ and temperature differed between species; massive *Porites* spp. was virtually unaffected by treatments, but *P. rus* grew 50% faster at 29.3°C versus 25.7°C, and 28% slower at 832 versus 423 µatm CO₂. Photochemical efficiency of PSII was relatively unaffected by treatments, but the maximal (F_m) and steady state (F_o) fluorescence were depressed by high pCO₂ at 29.3°C (but not 25.7°C), particularly for *P. rus*. Our results demonstrate that corals do not respond in identical ways to the effects of OA, with calcification strongly depressed in one species, but unaffected in another. The effects of OA on PSII fluorescence in *P. rus* suggests that photophysiological performance might be related to low calcification under high pCO₂ for this species.

Edmunds, P.J.*

INTERACTIVE EFFECTS OF HIGH PCO₂, HETEROTROPHY, AND TEMPERATURE ON THE CALCIFICATION AND PHOTOPHYSIOLOGY OF MASSIVE *PORITIES* SPP.

California State University Northridge

Rising atmospheric pCO₂ and its dissolution in seawater pose a hazard to scleractinian corals by impeding calcification and, potentially, threatening their existence as a calcified taxon. The objective of this study was to explore the effects of pCO₂ and temperature on massive *Porites* spp. (Scleractinia) and test the hypothesis that the effects are modified by zooplanktivory. Small colonies of massive *Porites* spp. from the lagoon of Moorea, French Polynesia, were incubated for 1 month under orthogonal combinations of temperature (29.3 versus 25.7°C), pCO₂ (423 versus 832 µatm), and heterotrophic feeding (none versus live *Artemia* spp.). An 8-tank mesocosm with CO₂ gas mixing technology was used to create treatments in a partly nested design (tanks) with two between-plot factors (temperature and pCO₂) and one within-plot factor (heterotrophy); the response was assessed using calcification and photophysiological performance. Calcification of massive *Porites* spp. was unaffected by pCO₂ and temperature, as well as the interaction between the two, although it increased 40% with heterotrophy. Temperature and high pCO₂ affected photochemical efficiency of PSII, although the effects biologically were small, and heterotrophy strongly stimulated PSII fluorescence. These results demonstrate that massive *Porites* spp. can resist the effects of high pCO₂ on calcification, and moreover suggest that heterotrophy could counteract the negative effects of high pCO₂ on the calcification of other corals.

Edmunds, P.J.¹, Ross, C.L.M.^{1*}, Didden, C.²

UNUSUALLY HIGH LOCALIZED RECRUITMENT OF MONTASTRAEA ANNULARIS COMPLEX ON THE FRINGING REEFS OF ST. JOHN, U.S. VIRGIN ISLANDS

1 - California State University Northridge 2 - Viewpoint School

Montastraea annularis complex (MAC) is one of the most important hermatypic corals in the Caribbean where it has experienced severe decline in cover since the 1980's. These corals have been censused on the shallow reefs

(≤ 9 m depth) along 4 km of St. John's southern coast for the past 16 years. Prior to 2008, the density of MAC along this stretch of coast was <0.068 colonies m^{-2} , but it more than doubled in 2008 to 0.152 colonies m^{-2} and remained relatively high at 0.116 m^{-2} in 2009. These densities were driven by only 7-9 colonies $year^{-1}$, but against the long-term context of weak recruitment and declining cover of this complex, these densities are notable. In 2009, the spatial context of the surveys was expanded to 47 km, along the north, south and east coasts of St. John, to determine the extent of this putative recruitment pulse. Results of these surveys indicated that MAC recruitment was localized to the initial 4 km surveyed in the Great Lameshur Bay area; outside this area, the mean density was 0.010 juvenile colonies m^{-2} . The results demonstrate that MAC is still capable of recruitment at rates similar to those of the 1970's when densities as high as 0.15 colonies m^{-2} were recorded in Curaçoa and Bonaire. However, the limited spatio-temporal extent of the relatively high recruitment event in St. John is unlikely to appreciably alter the declining population trajectories of this taxon.

Edwards, M.S.^{1*}, Kim, K.Y.²

CLIMATE CHANGE AND KELP FORESTS: BALANCING PHOTOSYNTHESIS AND RESPIRATION

1 - Coastal and Marine Institute Laboratory, San Diego State University 2 - Department of Oceanography, Chonnam National University

The global climate is changing and the long-term impacts to our coastal ecosystems are largely unknown. We investigated the role kelp forests play in moderating seawater pCO_2 within their boundaries in California and Alaska. Using potentiometric titration of seawater samples collected at different depths, locations, and times of day, we observed that kelp forests can reduce surface seawater pCO_2 by as much as 50% relative to adjacent waters, but at the same time increase bottom water pCO_2 . This pattern varies considerable among different forests and among different microhabitat types within each forest. Further, using incubation experiments we show that carbon reduction in the surface waters is due largely to photosynthesis while carbon increases near the benthos is due to respiration. Finally, sampling different forests in California, mainland Alaska and the Aleutian Islands, we show that kelp forests play an important role in moderating coastal seawater carbon, but this varies considerable among different forests and with ambient meteorological conditions.

Eernisse, D.J.^{1*}, Brooker, L.R.²

A CLADE OF CHITONS WITH EYES IS SPLIT UNCONVENTIONALLY INTO NEW WORLD VERSUS OLD WORLD LINEAGES

1 - California State University Fullerton 2 - University of the Sunshine Coast, Queensland

A monophyletic chiton lineage whose members characteristically have hundreds of ocelli embedded in their upper valve surfaces are presently assigned to either Toniciinae or Acanthopleurinae. This subdivision is partly based on whether the adult girdle is nude (Toniciinae) or is covered with calcareous armor such as spines or scales (Acanthopleurinae). Their fossils date only to the Miocene so improved phylogenetic resolution would provide enhanced opportunities for investigating recent eye evolution. These chitons also include some of the most conspicuous and ecologically important chitons living in tropical intertidal habitats, especially *Acanthopleura* spp., and also some species in cooler waters including *Tonicia* spp. in southern Chile. DNA sequence comparisons strongly corroborate the ocellus clade but not its internal subdivision into conventional Toniciinae and Acanthopleurinae groupings. Instead, our results support separate New World and Old World radiations. For example, the large-bodied "*Acanthopleura*" *echinata* with its stout girdle spines and the scale-bearing *Enoplochiton niger* are normally classified as Acanthopleurinae. These species co-occur in Chile and are supported as sister species despite their girdle differences. Even more surprising, their close phylogenetic relationship to the nude-girdle *Tonicia* spp. (Toniciinae) in Chile suggests that Acanthopleurinae is presently an artificial grouping. Our success in deciphering this global biogeographic pattern has been accelerated by our recent addition of chiton samples from the Central Indo-Pacific region, representing additional (including new) species to our comparison. Our results indicate that phylogeny correlates with geography, not with the apparently labile girdle ornamentation.

† Elahi, R.^{*}, Sebens, K.P.

URCHINS MEDIATE NATURAL VARIATION BETWEEN BIODIVERSITY AND RESOURCE USE

Friday Harbor Labs, University of Washington

Ecologists are beginning to consider the effects of diversity on ecosystem properties within a trophic context. In this study, we ask whether urchins mediate variation in the relationship between species richness and resource availability on rock walls in the San Juan Islands, Washington. Space is the limiting resource for sessile organisms on marine rocky substrata, and the availability of space is limited by recruitment and growth but increased through senescence, disturbance and consumption. We observed a negative, triangular relationship between richness and available space, such that quadrats with many (> 20) taxa had very little space. However, the amount of space was not necessarily high at low richness, because some quadrats were fully occupied by one or two clonal ascidians. We tested the hypothesis that urchins alter richness-space relationships using a before-after, control-impact

manipulation of urchin density. The number of urchins mediated richness-space relationships; transects with more urchins displayed steeper negative correlations between richness and available space. Interpreting the results of the field experiment in the context of urchin diet, we conclude that urchins mediate patterns of species richness and space availability on these rock walls by consuming spatially dominant clonal ascidians. In natural communities, patterns of species richness and resource use cannot be understood fully without considering the role of consumers in replacing limiting resources.

† **Espasandin, C.L.***, **Fox, E.**, **Lowe, C. G.**

EVALUATING ECOSYSTEM RECOVERY IN A RESTORED SOUTHERN CALIFORNIA ESTUARY BY ACOUSTIC MONITORING OF THE CALIFORNIA HALIBUT

California State University Long Beach

California has lost over 90% of its coastal wetlands through development, which has had a dramatic influence on coastal fishes in southern California, such as the California halibut, *Paralichthys californicus*. To quantify functionality of restored estuarine habitat, acoustic telemetry was used to identify patterns of residency, fine-scale habitat use, and seasonal movements of subadult California halibut (mean TL 40 ± 11.6 cm) within the Huntington Beach Wetlands (HBW). No tagged fish ($n = 9$) were found to leave the HBW during the 10-day active tracking observation period, which were spread across seasons. Halibut showed a mean home range size of $11,833 \text{ m}^2$ (range = $1712 - 28667 \text{ m}^2$); however, there is no correlation between home range size and fish size. Halibut showed a high degree of site fidelity indicated by high overlap in activity space over time. Halibut used channel habitat 100% of the time although it constitutes only 54% of the total available habitat. While in the channels, individuals utilized ecotone habitat (mud/eelgrass (*Zostera marina*)) disproportionately more than its availability within the HBW. Halibut translocated to marsh habitat ($n=2$) returned to channel habitat within 12 hours of release. Findings suggest restored estuaries/marshes containing channel-like habitat with eelgrass may support more juvenile and sub-adult halibut over at least short periods of time (~ 1 month). Ongoing passive tracking of tagged halibut in the HBW will provide information on long-term site fidelity.

† **Fanslow, C.***, **Mackie, J. A.**, **Parr, L.**

POPULATION CHARACTERIZATION OF THE DUNGENESS CRAB, *CANCER MAGISTER*: CONSIDERATION OF EFFECTS OF CURRENTS ON LARVAL DISPERSAL

San Jose State University

The recruitment of marine invertebrates with a long larval stage is expected to be dynamic as a result of major currents and other factors. Off the California coastline in the early spring, larval recruitment is likely to be strongly influenced by north to south moving Davidson Current, while later in the year, following the so-named spring transition, the major current moves from south to north. We examined phylogeographic variation and temporal genetic variability in larval recruits (megalopae), of the Dungeness Crab. Adult crabs were collected from the Western US seaboard. Megalopae were sampled in light traps placed in Coos Bay, Oregon over 2008 and 2009. Mitochondrial cytochrome c oxidase subunit I (COI) nucleotide sequences were used for analyses. The larval data were compared with the adult genetic variation using population structure (F_{ST}) and nested clade analysis. These results were consistent with long-range larval dispersal, however localized genetic structure was detected in the adult populations suggesting genetic patchiness possibly derived from factors post recruitment.

Ferrier, G.A.*, **Kim, S.J.**, **Loo, J.A.**, **Zimmer, C.A.**, **Zimmer, R.K.**

SENSORY BIOLOGY AND THE ROCKY INTERTIDAL: A MULTIFUNCTIONAL BARNACLE PROTEIN DRIVES ECOLOGICAL INTERACTIONS

University of California Los Angeles

Sensory systems provide critical filters that enable organisms to detect and recognize valuable resources. Trophic cascades structuring populations and communities are established to a large degree by behavioral-mediated interactions that rely on sensory inputs. Here, we investigated the contributions of surface-associated proteins as signal molecules within wave-swept, rocky intertidal habitats. Using electrospray ionization coupled with gas-phase electrophoretic mobility molecular analysis (ESI-GEMMA), barnacles (*Balanus glandula*) were found to produce a high molecular weight (~390 kDa), insoluble, glycoprotein complex (called MULTIFUNCin) for cuticle/shell formation. A primary subunit (~199 kDa) of this complex evoked habitat selection and settlement of conspecific larvae, thereby operating as a seminal recruitment cue. The same subunit also triggered predation by numerically dominant whelk species (*Acanthinucella spirata*, *Nucella emarginata*, *N. ostrina*, *N. canaliculata*, and *N. lamellosa*) on barnacle juveniles and adults in lab and in field. Complete nucleotide translation from a sequenced 5.1 kb mRNA transcript identified the glycoprotein as consisting of 1,550 amino acids (mw = 171 kDa). Structural elucidations further revealed significant homology (72%) among amino acid sequences of glycoprotein settlement cues between barnacle species (*B. glandula* and *B. amphitrite*), inhabiting different biogeographical provinces. As dominant competitors for space, the relative balance between barnacle recruitment and predation mortality would

have strong, cascading direct and indirect effects on community dynamics. Contact protein cues thus could play critical roles over a near-global scale and act as critical factors structuring species assemblages within natural habitats.

Flegel, R. L.^{1*}, Robles, C. D.¹, Halpin, P.², Aleman-Zometa, J.¹

LANDSCAPE PATTERN AND PROCESSES IN THE DISTURBANCE PARADIGM: AN ALTERNATIVE VIEW OF MUSSEL BEDS

1 - *Bamfield Marine Sciences Centre, California State University Los Angeles* 2 - *University of California Los Angeles*

Disturbance in natural communities holds the interest of ecologists as a mechanism promoting diversity. An archetypal disturbance process is wave-generated gap formation in beds of the sea mussel, *Mytilus californianus*. Influential conceptual papers developed the view of mussel beds as spatially random mosaics of succession states. We examined gap formation in seven mussel beds in Barkley Sound, British Columbia. Panoramic photos taken annually for seven years indicated that disturbances recurred in specific areas within the beds. A spatial analysis of a GIS database integrating small-scale measurements of topography, wave force, and the 3-D structure of the mussel aggregation indicated that the gaps form only in the multi-layered cover in the middle of the beds. Peripheral regions of the bed, which were invariably mono-layers, did not form gaps. The regions of large chronic disturbance occurred where flow conditions favor thickened mussel aggregations, which self-organize into layers, as superficial mussels suppress interior mussels, weakening their attachment. Our findings indicate that mussel bed succession states do not occur in random mosaics generated solely through externally imposed wave forcing. Instead, different steady-state structures develop in specific sub-regions of the beds, and they are susceptible to disturbance to different degrees. These spatially ordered disturbance regimes arise from community interactions, including self-organization of the mussel aggregation, that interact with external forcing of waves in a stochastic but predictable landscape process. Because self-organization and propagating disturbances occur in natural assemblages over a range of spatial scales (e.g. forests, mussel beds, biofilms), our findings may have broad implications.

† Fontana, R.E.^{1*}, Jahncke, J.², Largier, J.L.¹

COASTAL OCEANOGRAPHIC FRONTS OFF NORTH-CENTRAL CALIFORNIA: PATTERNS, PREDICTABILITY, AND BIOLOGICAL IMPORTANCE

1 - *Bodega Marine Laboratory, University of California Davis* 2 - *PRBO Conservation Science*

Coastal upwelling regions are among the most productive ocean ecosystems known. Productivity within these areas is spatially and temporally heterogeneous. Production is enhanced and concentrated by small-scale, coastal physical oceanographic features. Fronts are one such feature that forms at boundaries between water masses. These features are defined by sharp gradients in physical oceanographic properties, such as temperature, salinity, and/or density. Front dynamics lead to an accumulation of surface-associated plankton and buoyant debris within the frontal zone. This accumulation attracts predators, including seabirds and marine mammals. Here, we examine the presence, patterns, and underlying causes of fronts over the north-central California shelf from Bodega Bay south to San Francisco Bay. We analyzed ten years of underway thermosalinograph data. We found front patterns to be predictable both spatially and temporally. Fronts are more common during spring and summer, at which time they exhibit sharp temperature gradients characteristic of strong upwelling. During the rainy winters, however, salinity fronts develop due to freshwater outflow. We have identified six frontal regions within this area. The San Francisco Bay plume front is associated with freshwater outflow meeting coastal waters. However, the five remaining frontal zones are defined by sharp thermal gradients and associated with flow structures due to upwelling and its interaction with topography. Changes in fluorescence (a proxy for surface phytoplankton concentration) are associated with all six frontal regions. An improved understanding of the patterns and processes associated with these fronts promises new insights in understanding higher trophic level productivity and biomass distribution.

† Forrest, M.J.^{1*}, Schlaepfer, M.A.²

NOTHING A HOT BATH WON'T CURE: GEOTHERMAL ECOSYSTEMS AS REFUGES FOR AMPHIBIANS FROM CHYTRIDIOMYCOSIS

1 - *Scripps Institution of Oceanography* 2 - *State University of New York, College of Environmental Science and Forestry, Syracuse, NY*

Dramatic declines and extinctions of amphibian populations throughout the world have been associated with chytridiomycosis, an infectious disease caused by the pathogenic fungus *Batrachochytrium dendrobatidis* (Bd). Laboratory experiments have demonstrated that temperature plays an important role in chytridiomycosis disease-host dynamics, and that Bd ceases growth at temperatures above 28°C. Here we describe natural micro-climatic conditions that correlate with a significant reduction in Bd prevalence in amphibian hosts. We sampled 221

amphibians, including 201 Lowland Leopard frogs (*Rana yavapaiensis*), from twelve sites in Arizona, USA, seven of which were influenced by geothermal water sources. There was a strong inverse correlation between the water temperature at which each Lowland Leopard frog was captured and Bd prevalence. In locations where the disease is known to be present, estimated prevalence of Bd dropped from 70-90% at 15°C, to 0-20% in water > 30°C. A strong inverse correlation between a frog's Bd status and the water temperature was also observed within sites. Our findings indicate that geothermal ecosystems provide amphibians with significant protection from Bd and chytridiomycosis, which could have local and regional implications for disease dynamics and the evolution of resistance to this pathogen.

† **Froman, L.D.***, **Eernisse, D.J.**

ARE BROODING CHITONS ON SANTA CATALINA ISLAND GONOCHORIC, UNLIKE THEIR HERMAPHRODITIC AND SELF-FERTILIZING NORTHERN RELATIVES.

California State University Fullerton

We discovered populations of a small brooding chiton living under intertidal rockweeds on Santa Catalina Island, and tentatively identified them as a brooder previously known only from central California, *Cyanoplax caverna* (Eernisse, 1986). However, we also noted some intriguing differences including a greater range of intra-population color variation that is typical for *C. caverna*. In Monterey Bay, *C. caverna* was previously shown to be highly unusual for chitons because all individuals are self-fertile hermaphrodites that brood; strict males are absent or very rare. In contrast, we found males when we dissected chitons from the Catalina population. Although females somewhat outnumbered males, the presence of any males implies they reproduce via cross-fertilization. We also investigated the gonads of another recently discovered population of putative *C. caverna* brooders from a sea cave near Pismo Beach. All 10 Pismo Beach animals dissected had eggs, consistent with them being self-fertile hermaphrodites as in Monterey Bay. We also sequenced mitochondrial 16S ribosomal RNA sequences from all three populations. Our molecular and reproductive results support the hypothesis that the Catalina chitons are a genetically distinct and still undescribed species of gonochoric brooders that cross-fertilize their embryos. Compared with outgroups, the Catalina chitons are supported as closely related to the hermaphroditic *C. caverna*, but there is also robust bootstrap support for them being distinct from either Monterey Bay or Pismo Beach populations of *C. caverna*. Our results help support hypotheses linking the rare occurrence of lineages that self-fertilize to the inbreeding associated with brooding.

Galleher, S.N.*, **D'Andrea, T**, **Adkisson, K**, **Amoroso, N**, **Boyer, J**, **Hutmacher, A**

DIG OR SUCK? A FIELD COMPARISON OF METHODS USED TO QUANTIFY INTERTIDAL BIVALVE POPULATIONS IN OREGON ESTUARIES

Oregon Department of Fish and Wildlife

Four decades ago, the Oregon Department of Fish and Wildlife (ODFW) conducted habitat and clam population surveys in Oregon's 15 major estuaries to document the ecological status of these important natural resources. Since that time, recreational harvesting has intensified but bay clam stock assessment data are still deficient for resource management purposes. In large scale sampling strategies time is always one of the major limiting factors especially in intertidal areas due to the daily and seasonal inundation regime. A previous pilot study conducted in Coos Bay found that burrow hole counts, popular for their rapid sample time and ease for covering large areas systematically, were not a good predictor of bivalve abundance relative to more detailed sampling. We have further tested detailed sampling methods in paired samples across two estuaries. We present a comparison of the rapid burrow hole count method against two detailed methods of hand digging and venturi suction dredge to "suck" out a defined area of sediment in determining the most time efficient and accurate sampling method. Specifically, we estimated abundance, biomass, and size for the four main recreational bay clam species (*Tresus capax*, *Saxidomus gigantea*, *Protothaca staminea*, and *Clinocardium nuttallii*) and other common species (*Macoma nasuta* and *Macoma inquinata*). Our methods and findings will aid ODFW in future strategies for surveying other Oregon estuaries in the upcoming years and with management plans for ensuring that studies between estuaries and years are comparable.

† **Gherard, K.E.^{1*}**, **Erisman, B.²**

AGE, GROWTH, AND BATCH FECUNDITY OF THE GULF CORVINA, *CYNOSCION OTHONOPTERUS*, FROM THE NORTHERN GULF OF CALIFORNIA, MEXICO

1 - California State University Northridge 2 - SIO, Scripps Institution of Oceanography

The Gulf Corvina, *Cynoscion othonopterus*, is a vital component of commercial fisheries in the northern Gulf of California, yet little is known about its life history. 445 specimens were collected from the commercial gillnet fishery at the Gulf of Santa Clara in Sonora, Mexico from March 2009 to May 2010 to determine the age structure, growth rate, and batch fecundity of adults. Fish ranged from 145 mm to 1013 mm in total length and from 1 to 8 years of age. Von Bertalanffy growth model parameters were: $L=1173$ mm, $k=0.1635/\text{yr}$, and $t_0=0.0851$ years, and

$R^2=0.95$. Mean oocyte diameter differed significantly among development stages. Spawning females produced up to 1,219,342 oocytes per batch, and batch fecundity was correlated to both total length and gonad-free body weight. The growth rate of *C. othonopterus* differed between sexes with males having a higher growth rate earlier in life and females reaching a larger size. The distribution of oocyte diameters and oocyte stages indicate that *C. othonopterus* are synchronous, multiple batch spawners with indeterminate annual fecundity. The high degree of synchronization in gonadal development among females reflects the semi-lunar spawning cycle of adults, which migrate to spawn in the estuaries of the Colorado River Delta over four day periods during six consecutive spring tides.

† **Gil, M.A.***

THE RESPONSE OF CORALS TO EUTROPHICATION: THE GOOD, THE BAD, AND THE UNCLEAR
UC Berkeley Gump Field Station, University of Florida

Declines in coral cover and associated increases in the abundance of algae on tropical coral reefs have been widely linked to coastal eutrophication. These shifts in reef community structure may occur because eutrophication: 1) enhances growth of turf/macroalgae that compete with coral; and/or 2) directly affects the coral holobiont. The latter mechanism has been explored in laboratory and field experiments largely limited to two enrichment levels, indicating negative, neutral and even positive direct effects of eutrophication on coral growth. I propose that these diverse results arise from differential effects of eutrophication that are concentration specific, with low-levels benefitting corals by increasing productivity of nutrient-limited endosymbiotic algae, and with high-levels becoming toxic for corals. To test this hypothesis, I used a randomized-block design (n=8) to examine the effects of seven eutrophication levels on *Porites massive* juvenile colonies at an oligotrophic site off the northern coast of Moorea, French Polynesia. Using garden fertilizer (N:P:K=19:6:12), I implemented a treatment gradient (0, 5, 10, 25, 50, 85, 125 g) and measured coral growth over one month. Water column nutrient and fertilizer mass loss data exhibited positive, linear relationships with treatment level ($p < 0.0001$ for both). Coral growth exhibited a unimodal relationship across treatments, with average growth initially increasing 19.27% (0g to 50g treatment), followed by a 36.40% decrease (50g to 125g treatment). These results suggest that eutrophication may have concentration-specific effects on corals that could explain the heterogeneity in responses previously observed.

Goddard, J.H.^{1*}, Gosliner, T.M.², Pearse, J.S.³

DECLINE IN NUDIBRANCH GASTROPODS FOLLOWING A CLIMATE-RELATED RANGE SHIFT OF A LARGE PREDATORY AEOLID IN THE NE PACIFIC OCEAN

1 - Marine Science Institute, University of California Santa Barbara 2 - California Academy of Sciences 3 - University of California Santa Cruz

Although climate-related range shifts have now been documented for many marine species, the ecological impacts of these shifts remain little known. In 1977, *Phidiana hiltoni* (O'Donoghue, 1927) began spreading northward from Monterey, California. By 1992 it had reached Duxbury Reef (37° 53' 23", 122° 41' 59"), where other nudibranchs subsequently appeared to decline. We investigated the role of *P. hiltoni* in this decline through diet analysis, feeding trials, and comparison of historical and recent abundance data. In the wild, *P. hiltoni* preyed largely on hydroids, especially *Plumularia laginifera* and unbranched campanulariids, but also showed evidence of predation on nudibranchs. In the laboratory, *P. hiltoni* attacked most of the dendronotid and aeolid nudibranchs presented to it, ingesting small individuals whole. The pooled abundance of nudibranchs vulnerable to attack by *P. hiltoni* has declined an average of two-thirds at Duxbury Reef since its arrival, compared to no change in the non-vulnerable species. At Scott Creek and Pillar Point, two sites in *P. hiltoni*'s new range where it has been one and two orders of magnitude less abundant, respectively, than at Duxbury Reef, there was no difference in the before/after abundance of either group of nudibranchs. Therefore, we conclude that *P. hiltoni* likely caused the decline at Duxbury Reef, through competition for prey and direct predation. A brief larval period, combined with cyclonic recirculation in the lee of Point Reyes, may be driving self-recruitment of *P. hiltoni* at Duxbury Reef, as well as preventing its continued northward spread.

† **Goldstein, M.C.***

ABUNDANCE AND DISTRIBUTION OF PLASTIC MICRODEBRIS IN THE NORTH PACIFIC CENTRAL GYRE
Scripps Institution of Oceanography, UCSD

The North Pacific Central Gyre (NPCG) is among the oldest and largest biomes on Earth. Reports of increasing plastic debris in the NPCG, particularly microdebris less than 5 mm in diameter, have caused significant public concern. The Scripps Environmental Accumulation of Plastics Expedition (SEAPLEX), in collaboration with the nonprofit group Project Kaisei, documented the abundance and distribution of plastic debris over a 5,000 km cruise track. Neustonic plastic was found in 100 consecutive manta tows performed over 2,700 km of the NPCG and transitional region on the western boundary of the California Current. Plastic abundance and size was further quantified using a digital scanner (Zooscan) combined with image analysis software. Results indicate that plastic

microdebris in the NPCG and nearby regions is widespread and abundant, reaching densities of 4.1 particles per m². Microdebris less than 1 cm² in diameter accounts for 93% of the available surface area, and is colonized by a subset of the North Pacific subtropical rafting community. These results are a first step to understanding the ecological implications of plastic microdebris in the NPCG.

† **Gooding, R.A.***, **Harley, C.D.G.**

THERMAL COPING BEHAVIOR OF THREE LITTORINE SNAILS WITH SALINITY AND PH.

University of British Columbia

Acute thermal events, such as heat waves, are predicted to increase in frequency and severity as climate change progresses. Marine organisms in the high intertidal are especially prone to lethal and sublethal consequences of these events. Littorine snails inhabiting the uppermost fringe of the rocky intertidal exhibit various behaviors, such as aggregation and microhabitat use, to mitigate thermal stress. However, concurrent abiotic stressors may not only reduce their physiological thermal tolerance but may also alter their thermal coping behaviors. We tested the salinity and pH tolerances of *Littorina sitkana*, *L. plena*, and *L. scutulata*, and found no difference between species. We then investigated the effects of salinity and pH stress on thermal coping behaviors during a simulated summer low tide, and whether these effects differed by species. If concurrent stressors associated with climate change alter the thermal coping behaviors of intertidal littorines, this would make acute thermal events (i.e. hot summer days) an even greater threat to littorina performance and survival.

† **Goulding, T.***, **Cohen, C.S.**

THORNY-HEADED WORMS INFECTING MOLE CRABS: A COSMOPOLITAN MARINE PARASITE OR CRYPTIC SPECIES COMPLEX?

Romberg Tiburon Center for Environmental Studies, San Francisco State University

Despite the ecological importance of parasites there is a lack of information on basic issues such as parasite species identity and specificity, especially in marine systems. Acanthocephalans, or thorny-headed worms, are obligate endoparasites that unlike many parasitic helminthes, are not known to engage in any form of asexual reproduction. This difference in reproductive strategy and life history makes thorny-headed worms an interesting comparison to marine trematodes; we expected that the lack of clonal reproduction would result in increased genetic diversity and less spatial partitioning. Mole crabs (*Emerita* spp.) are an ideal host for studying marine acanthocephalans because they are abundant in sandy beach ecosystems and frequently parasitized by thorny-headed worms. We used molecular techniques to examine cryptic diversity, population structure and phylogeography of the marine acanthocephalan, *Profilicollis altmani*. Genetic divergence between acanthocephalan populations in the Pacific Ocean, Atlantic Ocean, and Gulf of Mexico was very low, suggesting that there is significant dispersal of this parasite by seabirds that serve as final hosts. The low genetic divergence in COI (0-1.8%) and ITS (0%) sequences also suggests that this acanthocephalan is not a cryptic species complex. This is an interesting contrast to several studies in freshwater acanthocephalans in which several cryptic species were discovered, often with narrow host specificity. The longevity of acanthocephalan eggs and the mobility of seabird hosts compared to freshwater fish hosts previously studied could contribute to the generalist strategy of this parasite; it would be intriguing to see if other marine acanthocephalans display similar specificity and distribution patterns.

† **Gowan, J.C.***, **Carpenter, R.C.**

CORAL-ALGAL INTERACTION FREQUENCIES AND OUTCOMES ALONG FLOW AND SEDIMENTATION GRADIENTS

Richard B. Gump South Pacific Research Station, California State University Northridge

Competition between scleractinian corals and benthic algae has been implicated as one of the major mechanisms by which coral reefs degrade. The effects of algae on corals and vice versa are inconsistent and may be influenced by abiotic factors such as flow and sedimentation. This study determined the frequency and outcome of various coral-algal interactions between taxa and along gradients of flow and sedimentation. We first quantified flow and sedimentation regimes at three sites within two habitat types using a combination of current profilers and clod cards to estimate flow and sediment traps to measure sedimentation rate. Results indicate that defined gradients exist along the habitat types. Sediments were then collected from *Porites* spp. – algal turf interaction sites as well as from areas adjacent to the corals and algae that were not in direct competition. Sediments were retained more on interaction boundaries compared to the adjacent coral and algal surfaces. Similarly, there is significantly less sediment on the surface of corals than in the sediment trap, on algal surfaces, or on interactions. Estimates of benthic composition and interaction frequency and outcomes were also recorded along the experimental gradients. Results indicate that for both *Porites* spp. - algal turf and *Porites* spp. - CCA, there is a significant difference in interaction frequency and outcome along both gradients. The results indicate that interaction frequency and outcome are influenced by the prevailing flow and sedimentation regimes and raise questions about the

importance of flow and sedimentation in structuring communities by influencing the outcomes of coral-algal competition.

† **Granneman, J.E.***, **Steele, M.A.**

AN ASSESSMENT OF FISH COMMUNITIES AND PRODUCTION ON ARTIFICIAL AND NATURAL REEFS IN THE SOUTHERN CALIFORNIA BIGHT

California State University Northridge

Despite the extensive use of artificial reefs worldwide, it is still not clear how well these manmade structures mimic natural reefs or whether they succeed in increasing the net production of fishes in an area. To address this issue, we studied five pairs of artificial and natural reefs in the Southern California Bight. Underwater visual transects were used to quantify fish assemblages and physical characteristics of the reefs. Additionally, four target fish species were collected at each of the reefs to quantitatively compare fish production between artificial and natural reefs. Production was measured as somatic growth and production of reproductive products of the fish species collected. The artificial reefs studied were generally much smaller than the natural reefs. Artificial reefs had significantly greater fish densities and fish biomass densities, although standing stock was significantly greater on natural reefs. Artificial reefs were found to be more rugose and had greater vertical relief than natural reefs; whereas macroalgae was more abundant on natural reefs. Overall there was no consistent difference in somatic, gonadal, and total production density of all species combined between artificial and natural reefs. Fish density, biomass density, and production density were positively correlated with more rugose substrate type and negatively correlated with increasing reef size. Additionally, fish density and fish biomass density were positively correlated with increasing invertebrate density. Overall, these results imply that these artificial reefs are valuable in producing fish biomass because fishes on the artificial reefs fared as well as fishes on natural reefs.

† **Gravem, S.A.^{1*}**, **Ardisana, R.²**, **Morgan, S.G.¹**

MICROCLIMATE CHANGES THE STRENGTH OF THE PREDATOR-PREY INTERACTIONS IN ROCKY SHORE COMMUNITIES

1 - Bodega Marine Laboratory, University of California Davis 2 - University of Illinois at Urbana-Champaign

The changing climate will not only affect the distribution of species, it will change how species in a community interact with one another in unpredictable ways. The rocky intertidal boulder field system we examine is ideal for studying the synergistic effects of changing climate factors on species interactions because of the strong stress gradients spanning small spatial scales. We examined how changing temperature and wave exposure around large boulders altered the distributions of species and altered interactions between two top predators, the keystone seastar *Pisaster ochraceus* and the dog whelk *Nucella ostrina*, and their prey species. Surprisingly, *Nucella* had a stronger effect on barnacle densities (*Chthamalus stellatus* and *Balanus glandula*) in thermally stressful environments; the impact of waves on *Nucella* or competition among barnacles and algae may have contributed to this pattern. Changing microclimate also altered the ability of *Pisaster* to control the distribution of habitat-forming and competitively dominant mussels (*Mytilus californianus*). If continued climate change results in higher thermal stress or increased storm events, the distributions and strength of the interactions among key species in various intertidal communities may be altered.

Greenley, A.P.^{1*}, **Micheli, F.¹**, **Saenz-Arroyo, A.²**, **Vazquez, L.²**, **Rossetto, M.³**, **Haupt, A.J.¹**, **Hernandez, A.²**
MARINE RESERVES AS BUFFERS AGAINST NATURAL MORTALITY FOR PINK (*H. CORRUGATA*) AND GREEN (*H. FULGENS*) ABALONE IN BAJA, CA.

1 - Hopkins Marine Station, Stanford University 2 - Comunidad y Biodiversidad 3 - University of Parma

Fisheries management plans incorporate marine reserves, but empirical evidence of fisheries enhancement via larval spillover is still sparse. In 2006, the fishing cooperative Buzos y Pescadores on Isla Natividad, Baja California Sur, Mexico established two marine reserves in collaboration with biologists and managers to conserve and restore fished populations of pink (*Haliotis corrugata*) and green (*H. fulgens*) abalone. Monitoring initiated after reserve establishment revealed a significant decline over time in abalone densities for both species within and outside of the reserves. Mortality and declines in abundances of abalones were less pronounced inside reserves, with pink and green abalone densities approximately double inside reserves compared to fished blocks in 2009. Greater abundances and larger sizes of abalone inside the reserves resulted in higher estimated reproductive output from reserves compared to fished blocks, as based on size-fecundity relationships. Recruitment rates of abalone post-larvae on collectors were significantly greater within the reserves. This effect of increased recruitment was observed no further than 150 m outside one of the reserves. These results suggest that while abalone recruitment is highly localized, with minimal spillover occurring beyond reserve boundaries, marine reserves may still benefit abalone fisheries by maintaining greater densities and sizes of abalone and therefore effectively acting as insurance against natural mortality events.

Groesbeck, A.S.^{1*}, Salomon, A.K.¹, Lepofsky, D.S.¹, Rowell, K.², Davis, B.M.¹

ANCIENT CLAM MARICULTURE ON BRITISH COLUMBIA'S COASTLINE: AN EMPIRICAL ANALYSIS OF SECONDARY PRODUCTIVITY

1 - Simon Fraser University 2 - University of Washington

In this study, we bring together archaeological, ecological, and traditional ecological knowledge to provide evidence for the past ecological and cultural role of clam gardens that may inform contemporary conservation strategies. The relatively recent discovery and documentation of several hundred ancient clam gardens in British Columbia has prompted many questions about this ancient mariculture technique. It is widely assumed that clam gardens served to increase secondary production of clam beaches managed by First Nations. Until now, this question of clam garden productivity has mostly been investigated by archeologists, anthropologists and geomorphologists. In this study we empirically test these questions from an experimental ecology standpoint. Around Quadra Island, BC there are many comparable replicates of "classic" clam gardens that have been built and maintained by First Nations. Preliminary surveys of these clam gardens suggest that clam productivity could have been enhanced in a number of ways. We plan to test these alternative hypotheses experimentally by quantifying the growth rates of butter clams (*Saxidomus giganteus*) transplanted at various densities, with and without predators (sunflower stars) and competitors (barnacles and sea lettuce). We ground truth our data with the use of oxygen stable isotopes, which validate seasonal temperatures during time of growth. Total station site mapping will determine the original slope of altered beaches, and we will calculate the gains in clam habitat. Our experimental design will be informed by local traditional knowledge of clam garden history and will data will be paired with archeological data from adjacent village sites.

† Grupe, B.M.^{*}, Levin, L.A., Jellison, B., Thurber, A.R.

COMMUNITY STRUCTURE AND TROPHIC PATTERNS ON ROCKS, WOOD, AND BIOTIC SUBSTRATES AT A DEEP-SEA METHANE SEEP OFF COSTA RICA

Scripps Institution of Oceanography

Deep-sea methane seeps are chemosynthetic environments in which microbial primary production fuels the food web. Seeps typically occur in soft-sedimented areas, but authigenic carbonates, sunken wood, and animal shells can provide a diversity of additional microhabitats. The implications of substrate heterogeneity for biodiversity, community structure, and food webs at seeps are unknown. We asked whether substrate identity influences community structure by comparing macrofauna on replicate one-year deployments of carbonate rocks, wood, worm tubes, and bivalve shells to one another and to natural hard substrates at a 1000m methane seep off Costa Rica. We hypothesized that faunal composition and dietary patterns on experimental substrates would most closely resemble those of similar natural substrates. Community differences, however, were most evident between natural carbonates and experimental substrates. Multi-dimensional scaling did not distinguish among experimental substrates, but it found differences in assemblages on natural and experimental substrates. The data suggest that the influence of substrate type might become more evident as succession progresses. Gastropods dominated all types of substrate, with provannid snails and seep-endemic limpets being especially common. The presence of these bacterial grazers, physicochemical environment, and spatial effects may be more important than substrate type during early community development. Stable isotopes were used as diet indicators and suggest a relationship between food webs and substrate. The mean $\delta^{13}\text{C}$ of macrofauna on carbonate (-35‰) and mussel shells (-35‰) was lighter than macrofauna associated with worm tubes (-27‰) or wood (-25‰). Organisms were widespread in isotopic space, suggesting multiple energy pathways support the macrofaunal community on all substrates.

† Gyory, J.^{*}, Pineda, J.

TURBIDITY AS A CUE FOR SYNCHRONOUS LARVAL RELEASE IN THE BARNACLE *SEMIBALANUS BALANOIDES*

Woods Hole Oceanographic Institution

Many marine invertebrates release larvae synchronously under conditions that maximize their survival probability. The acorn barnacle, *Semibalanus balanoides*, is thought to release larvae in response to phytoplankton blooms, which provide a high-food environment for the larvae. Our high-frequency observations revealed that early-stage nearshore larval abundance was related to winter storms. We hypothesized that the barnacles might be using turbidity, not phytoplankton abundance specifically, as a cue for release. We conducted field observations and experiments to study the effect of turbidity and phytoplankton abundance on the larval release response of gravid *Semibalanus balanoides* adults. Larval release coincided with increased turbidity at three sites along the northeast coast of the United States. A three-year time series of weekly phytoplankton and zooplankton samples from Rhode Island showed that there was no species of phytoplankton that bloomed consistently prior to larval release. Larval release was not consistently related to total phytoplankton abundance or changes in phytoplankton size classes. We exposed gravid barnacles to phytoplankton or inert synthetic beads and found that they responded to both, suggesting that the presence of particles is more important than the identity of particles. Feeding experiments

showed that adult cannibalism on newly released larvae is lower in high-turbidity than in low-turbidity conditions. We suggest that *Semibalanus balanoides* times its reproduction to coincide roughly with the onset of winter-spring phytoplankton blooms, but high turbidity could be the cue that fine-tunes the timing of larval release, since turbid waters might provide a predation refuge for the nauplii.

† **Hall, A.M.***

THE RELATIONSHIP OF TIDAL SCOUR AND THE DISTRIBUTION AND ABUNDANCE OF EXOTIC EPIFAUNA
University of Alaska Fairbanks

Elkhorn Slough is one of the most ecologically productive coastal wetlands remaining in California; however, previous studies have revealed erosion of valuable estuarine habitat attributed to the opening of Moss Landing channel in 1947. Several volumes of soft sediment are exported out of the Slough every year, which changes the soft sediment bottom to a hard substrate. The impact on benthic invertebrates is unknown. The relationship of tidal erosion on epifaunal species distribution and abundance was analyzed at Elkhorn Slough. Tidal erosion was examined using geospatial analyses of change over time of the depth of the main channel. Surveys from 1993 through 2007 were compared with a 2009 survey collected using multibeam sonar and vessel-mounted topographic LIDAR. Changes in the spatial distribution and abundance of five exotic epifauna species have been previously related to this erosion gradient, and were assessed for recent changes by analyzing tidal scour rate, substrate, depth, and distance from the mouth using video surveys conducted in 2003 and 2009. A high distribution and abundance of epifaunal species show possible relationship to a low erosion gradient, specifically with *Didemnum vexillum*, an exotic colonial species commonly found on hard substrates. As tidal erosion increased, soft-sediment was exported and harder substrates, such as shells, were exposed, which provided a habitat suited for exotic species. The spatial distribution of epifauna species shows implications for invasions of exotic species at areas of low erosion. The results from this research provide important information regarding management alternatives for restoration of Elkhorn Slough.

† **Han, X.***

EFFECTS OF VARIATIONS IN MORTALITY AND RECRUITMENT RATES ON THE SPATIAL PATTERNS OF
DIADEMA SAVIGNYI

UC Berkeley Gump Field Station, University of California Santa Barbara

Herbivory plays a crucial role in structuring coral reef communities. A decrease in abundance of herbivores increases the probability of state shift from coral to algae domination. Although both fish and sea urchins are important herbivores, many tropical reef systems have suffered from over-harvesting of fishes and therefore, a more thorough understanding the effect of urchins on community structure is essential. This study examines if variations in recruitment and mortality rates can account for the differences in spatial distribution of the sea urchin *Diadema savignyi* in Moorea, French Polynesia. *D. savignyi* occur either in high density aggregations or as cryptic solitary individuals. I am exploring both potential causes and effects of this spatial variation in density. To test whether variation in recruitment contributes to the observed spatial pattern, newly settled urchins were counted in meter quadrat surveys at 10 locations around the island. There was significant spatial variation in recruitment rates among locations; however, recruitment density does not match onto adult density. My results suggest that mechanisms other than variation in recruitment rates, such as differences in predation intensity, accounts for the differences in abundance distribution of *D. savignyi* in Moorea.

† **Harrer, S.L.*, Miller, R.J., Reed, D.C.**

NON-DESTRUCTIVE METHODS FOR PREDICTING BENTHIC UNDERSTORY MACROALGAL BIOMASS AND
PRODUCTIVITY

University of California Santa Barbara

Understory assemblages comprise a significant and under-represented portion of benthic macroalgal biomass and productivity. Methods for measuring these parameters in situ have proven laborious and destructive and have led to a poor understanding of understory biomass and productivity dynamics over long temporal and large spatial scales. We explored the ability of a simple physiologically-based model to estimate net primary production (NPP) by mixed species assemblages of understory macroalgae using three parameters: bottom irradiance, taxon-specific macroalgal photosynthesis versus irradiance (P vs. E) parameters, and taxon-specific foliar standing biomass. We compared model output to in situ measurements of understory NPP to demonstrate the accuracy of our model. In addition, we developed non-destructive methods for converting measures of taxon-specific abundance (i.e., density and percent cover) to biomass. We applied this method to a long term data set of macroalgal abundance and used derived estimates of foliar standing biomass with our physiologically-based model to estimate NPP of the algal understory at 8 locations over the course of 2.5 years. Finally, we explored the ability of these derived estimates of biomass to predict seasonal and annual NPP.

Hechinger, R.F.* , Wood, A.C., Kuris, A.M.

EUSOCIALITY IN A FLATWORM: TREMATODE PARASITES FORM SOLDIER AND REPRODUCTIVE CASTES

University of California Santa Barbara

In some of the most complex animal societies, individuals exhibit a cooperative division of labor to form castes. The most pronounced types of caste formation involve reproductive and non-reproductive forms that are morphologically distinct. Here, we document physical and behavioral caste formation in a flatworm. Trematode flatworm parasites undergo repeated clonal reproduction of 'parthenitae' within their molluscan hosts, forming colonies. We present experimental and observational data demonstrating specialization among trematode parthenitae to form distinct soldier and reproductive castes. Soldiers do not reproduce, have relatively large mouthparts, and are much smaller and thinner than reproductives. Soldiers are also more active, and are disproportionately common in areas of the host where invasions occur. Further, only soldiers readily and consistently attack heterospecifics and conspecifics from other colonies. The division of labor described here for trematodes is strongly analogous to that characterizing other social systems with a soldier caste. The parallel caste formation in these systems, despite varying reproductive mode and taxonomic affiliation, indicates the general importance of ecological factors in influencing the evolution of social behavior. Further, the "recognition of self" and the defense of the infected host body from invading parasites are comparable to aspects of immune defense. A division of labor is likely widespread among trematodes, and trematode species encompass a considerable taxonomic, life history and environmental diversity. Trematodes should therefore provide new, fruitful systems to investigate the ecology and evolution of sociality.

† Hedge, L.H.* , Johnston, E.L.

MANIPULATING THE INTRINSIC ELEMENTS OF INVASIVE PROPAGULE PRESSURE: ARRIVAL FREQUENCY MORE IMPORTANT THAN INTENSITY

Evolution and Ecology Research Centre, UNSW, University of New South Wales, Sydney, Australia

Invasive propagule pressure is a measure of the number of individuals released into an area to which they are not indigenous. Recent models incorporating propagule pressure have had some success at explaining invader distributions but there remain relatively few experimental studies that have manipulated propagule pressure directly and quantified its effects. As such, although the basic positive relationship between propagule pressure and invasion success is well supported, the shape of this relationship is unknown. It might be linear or more complex, containing irregularities such as thresholds. Propagule pressure can be amplified through either an increased number of arrival events or an increased intensity of exposure during any one event. If the system is supply-driven or recruitment-limited then both the intensity and frequency of propagule arrival are likely to be important. Using a novel experimental technique, we provide empirical evidence of propagule pressure effects on invasion success of the Pacific Oyster, *Crassostrea gigas* (Thunberg) in the marine sub-tidal. While total invader populations were strongly regulated by predatory pressure, we show that smaller, less dense introductions result in greater proportional settlement into sub-tidal temperate reef invertebrate communities. We complement this finding by showing that frequent small inoculations dramatically increase invader success relative to infrequent large introductions. Frequency of introduction may therefore be a better predictor of invasion success than total propagule pressure. Our findings may help explain patterns of ballast water and hull-fouling introductions, as ports and harbours that receive frequent exposure to larvae from the same source are at greater risk of invasion.

† Hensgen, G.M.^{1*}, Holt, G.J.¹, Stunz, G.W.², Holt, S.A.¹, Williams, J.A.², Mungia, P.¹, Ojanguren, A.F.¹

THE EFFECTS OF HABITAT FRAGMENTATION ON THE ABUNDANCE AND DIVERSITY OF SMALL NEKTON IN SUBTROPICAL SEAGRASS MEADOWS

1 - University of Texas Marine Science Institute, University of Texas 2 - Harte Research Institute, Texas A&M Corpus Christi

This project investigated how diversity and abundance of small fish and shrimps vary as a function of habitat fragmentation in shallow subtropical seagrass beds. During summer and fall of 2009 we used high precision GPS mapping technology and GIS-based analysis methods to map, quantify, and sample fragmented seagrass meadows in the Mission-Aransas National Estuarine Research Reserve (MANERR) and Corpus Christi Bay, Texas. Relationships between different seagrass habitats and their fauna were analyzed at several spatial scales, encompassing the qualities of both large landscapes and individual patches. We used independent quantitative fragmentation indices to distinguish between habitats from three categories (continuous cover, intermediate and high fragmentation) of naturally occurring seagrass habitat and we investigated the relative importance of individual patch size, shape, isolation, and local edge amount in predicting observed assemblage characteristics. Significant differences in community structure were observed between habitats representing each fragmentation category. Animal diversity was highest in continuous seagrass habitats, however animal densities were greatest in highly fragmented seagrass patches. Results will be helpful in determining how fragmentation impacts the

ecological function of nursery and adult habitats containing marine species of conservation concern, as well as for assessing how habitat change affects species with different reproductive and dispersal strategies. We also demonstrate the potential for using advances in mapping and analysis technologies to monitor habitats with precision at low cost. Combining high resolution data collection and spatial analysis techniques in estuarine-associated research shows promise for monitoring impacts from the habitat change on episodic, seasonal, and inter-annual time scales.

Heras, J., †Aguilar, A.*

A GENOMIC SCAN FOR POSITIVELY SELECTED GENES IN TWO CLOSELY RELATED MARINE FISHES: *SEBASTES CAURINUS* AND *S. RASTRELLIGER* University of California, Merced

The genus *Sebastes* is known to be a highly diverse group of marine fishes comprised of a species flock, a group of closely related species that rapidly diverged from a recent monophyletic origin. Rockfishes inhabit temperate waters of the Pacific and Atlantic Oceans, but the focal point of diversity is located in the North Pacific. Few studies on these fishes have emphasized the use of genomic information to identify natural selection within this genus. In this study comparative genomic methods were used to identify putative functional genes under positive Darwinian selection between two closely related marine fishes. Expressed Sequence Tags (ESTs) from two species of rockfishes, *Sebastes caurinus* and *S. rastrelliger*, were used to characterize patterns of positive selection by identifying ortholog pairs between the two species via a Reciprocal Best Hit BLAST (RBHB), and estimating Ka/Ks to measure selection between each ortholog pair. In order to gain a better understanding of the functional categories of these ESTs, both datasets were annotated to the Swissprot database to identify putative gene function and gene ontologies. Our results show that a number of genes under positive selection are involved in metabolism and immune function, which are common in other studies in the field of comparative genomics. These ortholog pairs under positive selection between the two species will be used as candidate genes to assess selection within the subgenus *Pteropodus* for future studies.

† Hitchman, S.M.^{1*}, Reynolds, N.B.¹, Thompson, A.R.²

IDENTIFYING SOURCE HABITAT FOR AN EXPLOITED ROCKFISH SPECIES WITH IMPLICATIONS FOR MARINE PROTECTED AREA DESIGN

1 - University of San Diego 2 - Southwest Fisheries Science Center

The unprecedented strain on both the structure and function of marine ecosystems has led to calls for new management approaches to counter the anthropogenic impacts in coastal oceans; one spatial management option, marine protected areas (MPAs), have been proposed as a means for both maintaining biodiversity and managing fisheries. Bocaccio, *Sebastes paucispinis*, are a major component of both commercial and recreational fisheries in Southern California. However, recent declines in bocaccio have been so severe that stocks have been formally designated as "overfished". Since bocaccio spawn from demersal habitat, distributions of young larvae (<2 days) may give the best estimate of rockfish natal habitat. The goal of the study was to identify source habitats within the Cowcod Conservation Area (Southern California Bight) by ageing the sagittal otoliths of larval bocaccio collected during February of 2002-2004 and mapping larval distributions. Results show a significant association of young larvae with benthic habitats along the 300-m depth contour for all three years of study, suggesting that young larvae can be used to identify bocaccio natal habitat. Using larvae to identify source habitats may be easier and more cost-effective than sampling deep and patchily distributed adults, and may be particularly useful in no-take MPAs where fishery-dependent data are no longer available.

† Hondolero, D.E.^{1*}, Edwards, M.S.²

PHYSICAL AND BIOLOGICAL CHARACTERISTICS OF KELP FORESTS IN KACHEMAK BAY, ALASKA

1 - Kasitsna Bay Laboratory, San Diego State University 2 - Coastal and Marine Institute Laboratory, San Diego State University

In hard-bottom temperate ecosystems kelp forests can support diverse communities of organisms. Their biogenic structure can modify both longshore currents and modulate internal waves that propagate through the kelp forests. Along the southern coasts of Alaska, two species of canopy-forming kelps, *Nereocystis leutkeana* and *Eualaria fistulosa*, co-occur and have dissimilar morphologies. Their differences in morphology may affect patterns of water movement through the forests, which may have strong impacts to patterns of larval delivery and biodiversity, particularly in Kachemak Bay, Alaska which experiences large tidal fluctuations and longshore currents. The goal of our research was to determine how currents are affected by canopy type and to determine if larval delivery of invertebrates and benthic biodiversity differ between canopy types. Differences in current modulation were found between kelp forest types and both larval and benthic biodiversity differed among sites and between kelp forest types. Our results suggest that ongoing monitoring programs of kelp forest distribution in the Kachemak Bay Research Reserve should include data on kelp forest type as well as extent.

† **Hooton-Kaufman, B.S.***

HABITAT ASSOCIATIONS OF NATIVE FISHES WITH THE INVASIVE KELP *UNDARIA PINNATIFIDA* IN MONTEREY HARBOR

Moss Landing Marine Laboratories

The invasion of Monterey Harbor by the kelp *Undaria pinnatifida* provides a unique opportunity to study habitat associations formed with novel habitat created by kelp. Monterey Harbor is a taxonomically simple environment, and provides a less complex backdrop in which to study habitat associations with kelp in comparison to the dynamic kelp forests nearby. Fish assemblages associated with *Undaria* were compared with fish assemblages in other benthic habitats in Monterey Harbor to determine if *Undaria* influenced assemblage structure and microhabitat use by fishes. In monthly sampling from November 2009 to August 2010, a total of 143 quadrats of *Undaria* and 224 of other benthic habitats were collected. A total of 155 fishes of 6 genera were identified, with *Gibbonsia* spp. accounting for 54% of all fishes and juvenile KGB rockfish accounting for 35% of all fishes collected. Although fish density and composition varied during the study, in all months in which fishes were caught in *Undaria* habitat, fish density was significantly higher in *Undaria* as compared to other benthic habitats. These results suggest that the invasive kelp *Undaria* may be a preferred source of habitat for native fishes in the simple environment of Monterey Harbor. The mutualistic nature of these associations is being further investigated in laboratory and field experiments.

† **Hunter-Thomson, K.I.***, **Starr, R.M.**

DO TERRESTRIAL PARADIGMS APPLY TO SUBTIDAL REEFS? FISH COMMUNITY STRUCTURE IN LANDSCAPE-SCALE HABITATS

Moss Landing Marine Laboratories

In most ecosystems, the distribution and density of species across a landscape are greatly influenced by the type, amount, and spatial configuration of existing habitat patches. Studies in terrestrial environments have shown that species diversity and density often positively correlate with proximity to a habitat edge and with other habitat parameters such as the perimeter-to-area ratio of a habitat patch. These patterns, however, have not been shown to occur in marine temperate sub-tidal rocky habitats, perhaps because most fish-habitat studies have focused on fine-scale habitat associations. We examined the density and diversity of nearshore fish populations near Point Lobos, California, with respect to two landscape-scale habitat characteristics: 1) proximity to habitat edge and 2) perimeter-to-area ratio. We used data from visual strip-transects collected from the *Delta* submersible in 2004, 2007, and 2008 to quantify densities and diversity of fishes within a landscape patch (defined as discrete areas of isolated hard substrate in similar depth zones, as determined from side-scan sonar images). Species diversity positively correlated to proximity to habitat edges in shallow habitats (30-60 m, $p = 0.002$) and richness negatively correlated with perimeter-to-area ratio ($p = 0.008$). However, the mean density of all fishes did not vary significantly ($p > 0.05$) with respect to proximity to habitat edge or with perimeter-to-area ratio. These results suggest that ecological paradigms learned in terrestrial environments may not transfer to marine ecosystems.

† **Hutto, S.V.***

DIFFERENTIAL RECRUITMENT OF *POSTELSIA PALMAEFORMIS* ACROSS SUBSTRATE TYPES AND THE POTENTIAL FACILITATIVE EFFECTS OF TURFING ALGAE

Moss Landing Marine Laboratories

Kelp recruitment success can be influenced by the microhabitat within which the kelp microscopic stages settle and develop. Previous work in Washington state suggests preferential recruitment and survival of *Postelsia palmaeformis* to bare rock, whereas in central California this intertidal kelp grows to maturity more abundantly on algal turf, though bare rock is available and accessible. This study quantified the degree of the potential enhancement of *Postelsia* recruitment to algal turfs, determined geographic and temporal trends of this phenomenon, and investigated the potential mechanism of facilitation. *Postelsia* preferentially recruited to coralline algae, or functionally similar turfing algae, across its range (British Columbia, Oregon and California) and throughout the year in central California from November 2009 to October 2010. Algal turfs were consistently cooler and more humid throughout the geographic range compared to ambient conditions, and provided more stable conditions as ambient conditions fluctuated due to environmental variation. These results suggest that algal turf may facilitate *Postelsia* recruitment, possibly by providing more tolerable conditions for survival of microscopic stages. The particular mechanism for this facilitation is currently being investigated in field and laboratory studies.

Idjadi, J.A.^{1*}, **Caruso, C.C.²**, **Lagueux, K.³**, **Mandelman, J.W.³**

NO EVIDENCE OF A FISH AGGREGATION (FAD) EFFECT FOR SUBMERGED LIQUID NATURAL GAS STRUCTURES IN MASSACHUSETTS BAY

1 - New England Aquarium, Eastern Connecticut State University 2 - Woods Hole Marine Biological Laboratory 3 - New England Aquarium

Changes in the global demand for natural gas and port security concerns about Liquid Natural Gas (LNG) vessels have led to an increase in offshore ports for the re-gasification and delivery of natural gas. These ports consist of large subsurface buoys and arrays of chain, cable, and pipe that substantially increase the amount of submerged hard structure where they are placed. LNG ports also have a “zone of exclusion” where commercial and recreational boat traffic is prohibited. We hypothesized that increased structure and reduced fishing pressure due to exclusion zones might combine to increase fish densities in the vicinity of the ports due to a fish aggregation device (FAD) effect and a small reserve effect. In order to address this hypothesis, we conducted 120kHz split-beam sonar surveys around two Northeast Gateway submerged turret loading buoys and two control sites of similar benthic composition and bathymetry. We made CTD casts on each sampling day to consider the influence of oceanographic patterns on fish distributions. Divers also made qualitative observations on fish species that were closely associated with the structure. When comparing LNG to control sites, there appeared to be no FAD or reserve effect. However, we did see that one LNG site had significantly higher fish densities than the others. In future work we will continue to conduct acoustic and CTD surveys to see if a FAD effect is present at smaller scales and if among-site density differences are attributable to differences in temperature and salinity strata.

Ingram, T.* , Kraft, N.J.B., Kratina, P., Schluter, D.

FOOD WEB CONSEQUENCES OF STICKLEBACK ADAPTATION TO AN INTRAGUILD PREDATOR

University of British Columbia

Intraguild predation (competition and predation by the same antagonist) is a common and ecologically important interaction, but we know little about its effect on the evolution of intraguild prey. Threespine stickleback appear to evolve more limnetic and antipredator phenotypes in the presence of a benthic intraguild predator (prickly sculpin), a response that may modify both the stickleback-sculpin interaction and the impacts of stickleback on the rest of the food web. We introduced sculpin to experimental pond mesocosms containing ‘unexposed’ stickleback from sculpin-free lakes and ‘exposed’ stickleback that have an evolutionary history with sculpin. Unexposed stickleback had low survival due to predation in tanks with sculpin, whereas sculpin decreased the growth rates of exposed stickleback but did not affect their survival. Exposed stickleback had more limnetic diets, and caused a corresponding shift toward more benthic and less pelagic prey biomass in the mesocosms. Stickleback evolution in response to intraguild predation thus has effects that reverberate throughout aquatic food webs.

† **Jacobson, L.M.* , Edmunds, P.J.**

THE ALLOCATION PRIORITIES FOR TISSUE ENERGY RESERVES IN SCLERACTINIANS EXPOSED TO TOTAL NUTRIENT LIMITATION

California State University Northridge

This study addressed the nutrition of a tropical reef coral under starvation conditions to explore the role of tissue reserves in sustaining viability, and to better understand allocation priorities under severe nutrient limitation. Starvation experiments simplify studies of organismic nutrition by eliminating factors such as assimilation, thus facilitating the examination of how reserves are utilized. Juvenile, massive *Porites* spp. were starved for up to 20 d in darkened, filtered water (0.2 μ m pore size) with DOM depleted using activated carbon. Every 2-4 d, the corals were sampled for calcification, respiration rate, and tissue biomass. Starving corals continued to calcify for the first 8 d, but their respiration rates declined dramatically (up to 60%) and biomass was reduced (up to 12%); thereafter, calcification, respiration, and biomass remained unchanged. These results show that starved corals catabolize tissue reserves to support their first priority of maintaining tissue structure and sustaining calcification, processes that are likely limited by the amount of tissue reserves. This period of continued calcification indicates that skeletogenesis is either prioritized instead of conserving tissue reserves, or is coupled to respiration through the production of metabolic CO₂. In this experiment, reserve tissue was depleted in about 8 d; subsequently the corals appeared to enter metabolic stasis, in which they can survive without further tissue loss for at least 12 d. These outcomes are predictable from Dynamic Energy Budget theory, thereby supporting the notion that calcification is prioritized highly relative to the maintenance of tissue structure and the size of reserves.

Johnson, D.W.* , Hixon, M.A.

WHY AREN'T DAMSELFISH HUGE?

National Center for Ecological Analysis and Synthesis

Preliminary field estimates of natural and sexual selection suggest that bicolor damselfish (*Stegastes partitus*) should be much bigger than they are. Larger adult males produce much more offspring than their smaller counterparts, apparently resulting in very strong selection for larger body size. These patterns, combined with evidence for ample genetic variation in body size, prompt the question of why damselfish are as small as they are. To examine this question, we conducted a detailed examination of lifetime fitness (as opposed to reproductive success of adults), using data from an 8-year, multi-generation field study of damselfish demography. These

analyses revealed important life-history trade-offs that balance the observed pattern of strong reproductive selection favoring large size. Results suggest that the observed mean value for adult male size is actually very close to the value expected to optimize fitness, and that selection is in fact strongly stabilizing, rather than directional.

† **Johnson, M.D.***, **Carpenter, R.C.**

THE EFFECT OF ELEVATED pCO_2 ON CALCIFICATION OF THE CRUSTOSE CORALLINE ALGA *HYDROLITHON ONKODES* IN MOOREA, FRENCH POLYNESIA.

Richard B. Gump South Pacific Research Station, California State University Northridge

Increasing concentration of carbon dioxide (pCO_2) in the atmosphere has raised wide-spread concern over the cascading effects of ocean acidification for marine ecosystems. The effects of elevated pCO_2 on rates of calcification in coral reef habitats have focused primarily on scleractinian corals with few studies addressing the impacts on crustose coralline algae (CCA). *Hydrolithon onkodes* is an important reef building species of CCA that constitutes up to 11% of the open substrata in the shallow back reef of Moorea, French Polynesia. This study investigated the potential effects of elevated pCO_2 on calcification of *H. onkodes*. Cores of *H. onkodes* were exposed to either ambient seawater or seawater bubbled directly with CO_2 enriched air (average pCO_2 of 835 μatm). Calcification rates were estimated by measuring differences between the initial and final buoyant weights after 18 days and 31 days in treatment conditions. After 18 days the calcification rate of *H. onkodes* was significantly reduced in the elevated pCO_2 treatment, and reduced calcification rates continued in the elevated pCO_2 treatment until the conclusion of the experiment at 31 days. These results provide evidence that an elevated pCO_2 of 835 μatm impairs calcification of *H. onkodes*. In business-as-usual predictions, oceanic pCO_2 is projected to reach 800 μatm by the end of the century. These results suggest that this rapid change in the carbonate system will likely depress growth rates and increase dissolution of tropical CCA with unknown cascading effects on the coral reef community.

† **Jones, C.L.***, **Anderson, T.W.**

EVALUATING EELGRASS HABITAT QUALITY BY FISH SETTLEMENT, PERFORMANCE, AND SURVIVAL.

San Diego State University

Although the quantity of suitable habitat is important to the distribution and abundance of organisms, the quality of habitat may have more direct demographic consequences. In evaluating habitat quality, previous studies have emphasized the importance of one or two variables (e.g. organism density) that might reflect more suitable habitat. The quality of habitat, however, should also be based on the performance of the organisms living within it. In this study, we used both demographic rates (settlement and survival) and individual performance (growth rate and condition) of the giant kelpfish (*Heterostichus rostratus*) to assess habitat quality among eelgrass beds in San Diego Bay, California. Seven sites were used to estimate settlement of giant kelpfish in Spring and Summer 2009. Higher rates of settlement were observed closer to the mouth of the bay. Juvenile giant kelpfish were collected approximately 2 months after the settlement period to determine site-specific post-settlement growth rates and individual condition. Otolith microstructure image analysis provided growth rates, and total lipids were used as an indicator of condition. Survival of kelpfish was assessed by exposing recruits to predators under three treatments of habitat that reflected eelgrass structural complexity among sites. We then employed multivariate techniques to evaluate whether our measures of habitat quality collectively differed among sites within the bay. Estimating demographic rates and the performance of organisms will provide a better understanding of habitat quality and importantly, how quality may vary spatially.

† **Jones, E.***, **Long, J.D.**

HABITAT CHOICE BY A MARINE ISOPOD IS RELATED TO THE PRESENCE OF A PREFERRED EPIPHYTE

San Diego State University

Variation in food and habitat quality can shape interactions among mesograzers, algal epiphytes, and host algae. Although studies have highlighted the importance of epiphyte palatability and habitat structure, little work has focused on how mesograzer preferences change over time. We examined feeding preferences of the isopod *Idotea baltica* when offered a choice between *Ascophyllum nodosum* experimentally epiphytized by *Elachista fucicola*, loose *Elachista*, and non-epiphytized *Ascophyllum*. *Idotea* consumed over 2.5 times more *Elachista* attached to *Ascophyllum* than other food choices. Additionally, to test whether the host alga *Ascophyllum* serves as a food source or simply habitat structure, we conducted a paired-choice assay with *Elachista* experimentally attached to *Ascophyllum* versus *Elachista* attached to a mimic. Equal consumption of *Elachista* on the two hosts, and lack of feeding on *Ascophyllum*, suggests that isopods colonize *Ascophyllum* because it provides a structure for attachment. Finally, we examined temporal variation in isopod habitat preference when offered a choice between *Ascophyllum* epiphytized by *Elachista* and non-epiphytized *Ascophyllum*. Seventy-three percent of *Idotea* initially preferred to settle on epiphytized hosts, however, this habitat preference declined over time and

disappeared after 34 hours. The declining preference for epiphytized hosts was correlated with a decrease in epiphyte abundance from isopod consumption. Thus, isopod feeding and habitat choice were influenced by epiphyte presence, but habitat preferences changed over time as epiphytes were consumed. These temporal changes in isopod behaviors may provide insight into foraging patterns and predation risk as isopods move among hosts.

† **Jorve, J.P.***, **Demes, K.W.**, **Kordas, R.L.**

SITES EXPOSED TO FERRY TRAFFIC EXHIBIT HIGHER INTERTIDAL SEAWEED ABUNDANCE AND SPECIES RICHNESS

University of British Columbia

Effects of ferry traffic within the Gulf Islands of British Columbia on marine communities have not been explored, despite their prevalence and more than 50 years of operation. Artificially-created waves and flow have the potential to alter coastal communities in this region. Ferries operate on up to hourly frequencies along coastlines of the Southern Gulf Islands in close proximity to shore, creating substantial waves. We examined changes in community structure in sites exposed to ferry traffic relative to geographically similar control sites. Abiotic conditions were comparable among all sites with the exception of mass transfer (flow) being higher at exposed sites. Although there were no differences in animal communities, abundance and richness of seaweeds were significantly higher in sites exposed to ferry traffic. We conclude that increased wave action (mass transfer) from frequent and proximate ferry traffic stimulates primary production in intertidal seaweeds.

† **Kane, T.L.***, **Fong, P.**

TIDAL CYCLES AND NITROGEN INPUTS INFLUENCE NITROGEN FIXATION AND DENITRIFICATION IN SOUTHERN CALIFORNIA ESTUARIES

University of California Los Angeles

Nitrogen cycling is at the foundation of maintaining ecosystem function of estuaries. Throughout Mediterranean-type systems, especially highly impacted southern California estuaries, nitrogen (N) cycling, and in particular, biogeochemical processes that can add or remove nitrogen, are not well studied. We measured sediment nitrogen fixation and denitrification rates in two San Diego County estuaries in 2008. Sampling encompassed wet and dry seasons, and subtidal and intertidal mudflat habitats. Rates were measured for bare sediment cores and sediments slurried with ambient site water to represent low tide and high tide conditions, respectively. To model a system with further N enrichment, we also measured rates for sediments slurried with N-amended site water (+300uM NO_3^-). Results indicated N-fixation occurs throughout the tidal cycle, even in the presence of increased water column and pore water N. Nitrogen fixation activity was similar across sites for both subtidal and intertidal sediments at high and low tide conditions. Nitrogen enrichment inhibited N-fixation activity at most sites. Denitrification rates were higher in ambient slurry treatments compared to bare cores where rates were barely detectable, indicating overall sediment denitrification is greatest during high tide. Denitrification in N enriched sediments was variable across sites and dates, though all showed the potential for denitrification, and rates in subtidal and intertidal sediments increased greater than 30-fold at some sites. Understanding these processes provides a more complete picture of how N cycles through these estuaries and is important to consider when determining nutrient impacts and how best to manage anthropogenic N input.

Kaplan, I.*

SCREENING FISHERY MANAGEMENT SCENARIOS FOR THE CALIFORNIA CURRENT INTEGRATED ECOSYSTEM ASSESSMENT

NOAA Fisheries, NWFSC

We have worked collaboratively with fishery managers at NOAA's regional offices and staff at the National Marine Sanctuaries (NMS) to identify six broad options for managing human impacts on the marine system, both coast wide and in Central California. These management options include shifts in fishing gear, closed areas, and changes in levels of fishing effort per fleet. We applied an Atlantis ecosystem model to screen these policy options. The model is spatially explicit and includes the full food web, fisheries, and oceanography. In this talk we describe the motivation for the project, the Atlantis ecosystem model used to test the management scenarios, and the approach to incorporating and scoring these scenarios based on ecological indicators and management objectives. We found that no single scenario maximized all performance objectives. Any policy choice would involve tradeoffs between stakeholder groups and policy goals. Of the scenarios most relevant to management, the coast wide 25% gear shift from trawl to longline or pots appeared to be one possible compromise. A coast wide closure of some fishing areas to bottom contact gear sacrificed revenue, and scenarios such as one consolidating bottom impacts to >550m did not perform substantially differently from Status Quo. However, stakeholders who place more weight on biogenic habitat (e.g. corals and sponges) might prefer the closure of fishing area to bottom contact. This methodology is one of the modeling approaches within the California Current Integrated Ecosystem Assessment

(IEA) framework.

Karl, S.A.* , Gorospe, K.D.

MICRO-SPATIAL GENETIC AND THERMAL ARCHITECTURE OF HAWAIIAN CORAL REEFS

Hawaii Institute of Marine Biology, University of Hawaii at Manoa

Thermal stress can cause geographically widespread bleaching events, during which corals become decoupled from their symbiotic algae. Bleaching, however, also can occur on smaller, spatially-patchy scales, with corals on the same reef exhibiting varying responses. We investigated small-scale (i.e., 4-meter) differences in temperature on three Hawaiian patch reefs. All colonies of the coral, *Pocillopora damicornis* on the reef were mapped and DNA fingerprinted. Genetic diversities on the reefs were very low with a few genotypes (e.g., 6) comprising most of the individuals (~2,800) on the reefs. Results show that stable, biologically significant temperature variation exists at small scales and that depth, relative water flow, and substrate cover and type were not significant drivers of this variation. Instead, finer spatial and temporal scale advection processes at the benthic boundary layer are likely responsible. Overall, these reefs were not as genetically diverse as we expected but are highly, spatially heterogeneous in temperature. Micro-spatial habitat heterogeneity may help structure reefs in ways that increase their ability to respond to climate change.

† **Kay, M.C.^{1*}, Lenihan, H.L.¹, Kotchen, M.², Miller, C.J.³**

FISHING, HABITAT, AND DISTANCE FROM MPA BORDERS INFLUENCE SPINY LOBSTER ABUNDANCE ON REEFS AT THE SANTA BARBARA CHANNEL ISLANDS

1 - University of California Santa Barbara 2 - Yale University 3 - CA Lobster and Trap Fishermen's Assn

Spatially explicit strategies for managing marine fisheries have received increased attention in recent years. The most common among these is the implementation of no-take marine reserves in which removal of organisms is prohibited. Empirical studies that demonstrate the effects of marine reserves typically compare conditions (e.g., target organism abundance, mean size, or biomass) categorically inside and outside of reserves. However, a more comprehensive understanding of how fishing and marine reserves influence the abundance and distribution of target organisms should consider factors that change across space and vary among sampling sites. Here, we explore the influence of fine-scale habitat features and distance from reserve borders (both inside and outside reserves) in determining the local abundance of California spiny lobster (*Panulirus interruptus*) on reefs at the Santa Barbara Channel Islands.

† **Kelly, MW*, Sanford, E, Grosberg, RK**

LIMITED POTENTIAL FOR ADAPTATION TO CLIMATE CHANGE IN THE TIDEPPOOL COPEPOD *TIGRIOPUS CALIFORNICUS*

Bodega Marine Laboratory, University of California Davis

Risk of extinction imposed by climate change is typically assessed using climate envelope models that assume a species environmental tolerance is static in both time and space. We test this assumption in the tidepool copepod *Tigriopus californicus* using laboratory-rearing and selection experiments to quantify thermal tolerance and scope for adaptation in 8 populations spanning >17° of latitude. *T. californicus* exhibits striking local adaptation to temperature, but heat tolerant phenotypes found in southern populations cannot be achieved in northern populations, either through acclimation or 10 generations of strong selection. Thus, physiological plasticity and evolutionary change appear to have limited capacity to buffer these isolated populations against increasing temperatures. Moreover, our results suggest that models that assume a constant climatic envelope across a species range may greatly underestimate extinction risk in species with strong local adaptation.

Kim, T.* , Micheli, F

BOTH GLOBAL DIMMING AND WARMING MAY ACCELERATE INVASION OF MARINE NON-INDIGENOUS SPECIES

Hopkins Marine Station, Stanford University

Most studies of the effects of climate change on biological invasions have focused on the effects of temperature increase. However, decreased level of solar radiation, or global dimming, could be another driving factor that can facilitate invasion of non-indigenous species (NIS). Here we tested if combination of decrease in light radiation and increased temperature can influence the establishment or dominance of marine invasive fouling species in estuaries. We manipulated light radiation by deploying different shading devices (black, white, or transparent screens, and no treatment) over recruitment tiles placed in the intertidal zone of a central California estuary containing over 50 marine NIS. Non-indigenous fouling species had greater recruitment and growth under the shading treatments (black and white screens) than under the transparent plates, indicating that low radiation facilitates species invasion in the intertidal region. Interestingly, the abundance of NIS was greater under white

screens where solar radiation and temperature are higher than under black screens. In contrast, the result of an additional experiment showed that the coverage of NIS on underside of black plates (with lower radiation and higher temperature) was higher than on underside of white plates. The results suggest that both lower radiation and higher temperature can facilitate invasion of marine NIS.

† **Kolupski, M.L.^{1*}, Fox, M.D.², Gray, S.C.¹**

CONNECTING THE LAND TO THE SEA: SEDIMENTATION AND RESUSPENSION ON CORAL REEFS, ST. JOHN, US VIRGIN ISLANDS

1 - University of San Diego 2 - Moss Landing Marine Laboratories

Increased sedimentation from watershed development into coastal bays is one of the greatest threats to near-shore coral reefs. Sediment can be harmful to corals because it can smother, abrade, or block light necessary for photosynthesis. In order to evaluate the effects of development on sedimentation, sediment trap accumulation rates and composition (organic, carbonate, terrigenous) were compared between bays below developed and an undeveloped watershed. Twenty-four sediment traps were placed in mangrove, shore, bay and reef environments in three bays on St. John, USVI: Great Lameshur Bay (undeveloped), Fish Bay (developed), and Coral Bay (developed with sediment mitigation structures). Sediment traps were collected and processed every three weeks from August 2008-March 2009, and sediment composition was determined by Loss on Ignition. Current meters were placed in two reef locations. Sediment trap accumulation rates were 3-162 times higher below developed watersheds (range: 0.6-705 mg cm⁻² d⁻¹). Compositional trap accumulation rates ranged from (0.1-41, 0.2-270, 0.1-387) mg cm⁻² d⁻¹ for organic, carbonate, and terrigenous components respectively. On the Fish Bay reefs, sediment trap accumulation rates were high enough (2-548 mg cm⁻² d⁻¹) to potentially cause severe to catastrophic stress to corals for almost all of the sampling periods. Resuspension studies indicated that bottom sediment resuspension did contribute to total sediment trap accumulation. Resuspension was greatest at the reef in Fish Bay and at the shore in Coral Bay. These data will be used as baseline data for ongoing sediment, water quality, and ecological monitoring to evaluate the effectiveness of sediment mitigation projects being constructed in the watershed.

† **Kroeker, K.J.^{1*}, Kordas, R.L.², Crim, R.N.², Singh, G.G.²**

QUANTIFYING THE VARIATION IN BIOLOGICAL RESPONSES TO OCEAN ACIDIFICATION

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

Ocean acidification could affect many marine organisms and cause profound ecological shifts. The biological responses to ocean acidification have been measured across a range of taxa, but this information exists as case studies and has not been synthesized into meaningful comparisons among functional groups. We used meta-analytic techniques to explore the variation in biological responses to ocean acidification, and found significant variation in the sensitivity of marine organisms. Calcifying organisms generally exhibited larger negative responses than non-calcifying organisms across numerous response variables, with the exception of crustaceans, which calcify but were not negatively affected. Calcification responses varied significantly among organisms using different mineral forms of calcium carbonate. Organisms using one of the more soluble forms of calcium carbonate (high-magnesium calcite) can be more resilient to ocean acidification than less soluble forms (calcite and aragonite). Additionally, there was variation in the sensitivities of different developmental stages, but this variation was dependent on the taxonomic group. Our analyses suggest the biological effects of ocean acidification are generally large and negative, but the variation in sensitivity among organisms has important implications for ecosystem responses.

Krug, P.J.*

REDUCED GENE FLOW AND REPRODUCTIVE ISOLATION FOLLOW POPULATION-LEVEL SHIFTS TO NON-DISPERSING LARVAE IN A CARIBBEAN SEA SLUG

California State University Los Angeles

Theory predicts evolutionary transitions from planktotrophic larvae to less dispersive lecithotrophic larvae should reduce gene flow and genetic diversity, but testing such hypotheses is challenging; inter-specific comparisons are confounded by factors other than larval type that also differ between species. Work in echinoids further suggests that differences in development mode may confer reproductive isolation between related species, but this has not been tested for protostomes. The Caribbean sea slug *Costasiella ocellifera* is a rare case of poecilogony; some populations in Florida and the Bahamas are lecithotrophic with crawl-away juveniles, while most populations express planktotrophy. I used this species to identify consequences of population-level shifts to non-dispersive larvae on gene flow and reproductive isolation within a species. As predicted, mitochondrial diversity was lower, and mean pairwise *F*_{st} higher, for lecithotrophic populations. Breeding crosses were performed between four populations from Florida and the Bahamas, two of each development mode. Slugs from both lecithotrophic populations showed pre-zygotic isolation when paired with partners from planktotrophic populations. All crosses involving lecithotrophic slugs from the Bahamas showed pronounced post-zygotic isolation, with up to a third of

embryos failing to develop, and post-zygotic isolation was also measured between Florida populations differing in development. Shifts to lecithotrophy increase self-recruitment and may accelerate the fixation of alleles governing reproductive compatibility, which in turn prevents immigrant planktotrophs from interbreeding with lecithotrophic mothers. This feedback loop can produce rapid evolution of reproductive isolation and may explain why in diverse taxa, lecithotrophic species often have planktotrophic sister species.

† **Kuo, E.S.L.^{1*}, Lenz, E.A.¹, Sanford, E.¹, Gaylord, B.¹, Hill, T.M.¹, Russell, A.D.², Jacobs, L.A.¹**

NO CHANCE TO REFUEL: EFFECTS OF OCEAN ACIDIFICATION AND ELEVATED TEMPERATURE ON LECITHOTROPHIC LIMPET LARVAE

1 - Bodega Marine Laboratory, University of California Davis 2 - Department of Geology, University of California Davis

Increases in atmospheric carbon dioxide (CO₂) concentrations have resulted in increasing global temperatures and decreasing ocean pH and carbonate saturation (ocean acidification). It has been suggested that species with lecithotrophic (non-feeding) larvae may be less sensitive to these changes than species with planktotrophic larvae, but there are few studies of lecithotrophic species to address this hypothesis. We examined the combined effects of elevated CO₂ levels and temperature on the time to settlement, survivorship and growth of the lecithotrophic larvae and juveniles of the seaweed limpet *Lottia insessa*. Larvae were reared under factorial combinations of three CO₂ levels (380, 540 and 970 ppm) and two temperatures (11 and 16C) until they settled, and the settlers were then raised in a common garden environment. CO₂ level, temperature, and their interaction had significant effects on larval shell size. The percentage of larvae that survived to settlement was affected by temperature and the interaction, but not by CO₂ level. There were no significant differences in the time to settlement among any of the treatments. Despite the negative effects of elevated CO₂ and temperature on the larvae, there was little evidence that these impacts persisted into the juvenile phase after several weeks of grazing in a common garden. Our results suggest that (1) lecithotrophic larvae that lack the capacity to compensate for increased environmental stress via compensatory larval feeding may be sensitive to climate change, but (2) carry-over effects may be ameliorated in herbivorous juveniles that have settled in high food environments.

† **Lee, L.C.^{*}, Salomon, A.K.**

ASSESSING RECOVERY OF NORTHERN ABALONE: ECOLOGY AND PLACE MATTER

Coastal Marine Ecology and Conservation Lab, Simon Fraser University

Northern abalone, *Haliotis kamtschatkana*, had the dubious honor of being the first marine mollusk to be listed as threatened in Canada. Twenty years later, stock assessment surveys suggest that northern abalone are not recovering and that the species should be uplisted to endangered. However, recovery targets are often driven by reference points that ignore the history of human alteration of ecosystems. While continued poaching remains a threat, our reconstruction of historical ecological baselines and contemporary spatial variation in kelp forest dynamics challenges the view that northern abalone in British Columbia are facing imminent extirpation or extinction. We show that local and regional scale biotic and abiotic factors can have significant effects on abalone population structure, and therefore, have important consequences for assessment of population status.

† **Lee, W.^{1*}, Byers, J.E.²**

RELATIONSHIP BETWEEN PREDATION AND PREY ABUNDANCE IN AN ESTUARY: IMPLICATIONS FOR PREY PERSISTENCE ACROSS A LANDSCAPE

1 - University of New Hampshire 2 - University of Georgia

The importance of predation on prey communities has been demonstrated usually on a small spatial scale. On the other hand, heterogeneity of predation over a large spatial scale can significantly influence its impacts on prey populations. The Atlantic Horseshoe Crab, *Limulus polyphemus* exerts intense and frequent predation pressure on infauna on certain mudflats of the Great Bay estuary, New Hampshire. Two five-month predator exclusion experiments conducted at one site in 2009 and 2010 found abundance of the infaunal clam, *Macoma balthica*, to be significantly greater in exclusion areas than in control plots experiencing natural predation. To investigate the importance of *L. polyphemus* predation across the estuary, clam abundance and *L. polyphemus* foraging activity was quantified at ten sites separated by kilometers. Clam abundance was found to vary significantly among sites. The correlation between the predator foraging activity and prey abundance across a large spatial scale will be presented, and its implications on the persistence of prey populations and predator foraging behavior will be discussed.

Lees, D.C.^{*}

THE RELATIONSHIP BETWEEN MOVEMENT AND AVAILABLE FOOD IN THE SEA URCHINS

STRONGYLOCENTROTUS FRANCISCANUS AND *S. PURPURATUS*

Littoral Ecological & Environmental Services

The relationship between food available to subtidal populations of the sea urchins *Strongylocentrotus franciscanus* and *S. purpuratus* and movement patterns of individuals was investigated to provide basic knowledge on the ecology of these species and to contribute information useful in managing kelp beds off the west coast of North America. These studies were conducted on populations in two areas of outer Mission Bay that differed primarily in algal standing stocks and species composition (i.e., algae available to the sea urchins as food). Movement in both areas was studied by monitoring the positions of uniquely tagged individuals of both species for a one-year period. In long-range movement studies, the amount and qualitative aspects of observed movement differed markedly. The sea urchins in the area with low amounts of algae available to them exhibited: (i) far greater movement; and (ii) in a more directed manner; or (iii) both, than the animals in the area with high algal availability. Sea urchins in the latter area were relatively sedentary. Controlled feeding (manipulation) experiments support the hypothesis that the relationship between the amount of food available and the differences in movement displayed by sea urchin populations is causal. When I provided abundant food to caged animals in the area with sparse algae, observed movement decreased markedly. In contrast, when I restricted food availability for caged animals in the area with abundant algae, observed movement increased markedly.

Lindstrom, S.C.^{1*}, Hughey, J.R.², Martone, P.T.¹

NEW, RESURRECTED AND REDEFINED SPECIES OF *MASTOCARPUS* (PHYLLOPHORACEAE, RHODOPHYTA) FROM THE NORTHEAST PACIFIC

1 - University of British Columbia 2 - Hartnell College

Recent molecular phylogenetic investigations of the red algal genus *Mastocarpus* Kützinger from the northeast Pacific resolved numerous cryptic species. Although species were clearly defined through genetic analyses, the correct names to apply to the species remained unclear due to the morphological variability exhibited by the thallus. To determine the appropriate name for each entity, we analyzed the DNA from type material of taxa previously ascribed to *Mastocarpus*. Matching partial ITS sequences of type specimens to modern collections, we are able to apply the currently used names *Mastocarpus papillatus*, *M. pacificus* and *M. jordinii* to the appropriate species. We also resurrect the following names and propose new combinations in *Mastocarpus* for *Gigartina cristata*, *G. latissima*, and *G. agardhii* and create new names for species for which we were unable to verify an existing name. The name *M. jordinii* applies to a species thus far collected only from Moss Beach, San Mateo Co. and the Monterey Peninsula, California. Specimens previously assigned to *M. jordinii* are now separated into three species: two new to science and one previously described. An updated phylogeny using a broad range of geographical and morphological collections is presented that includes data from three genomes: nuclear ribosomal ITS, chloroplast *rbcL* and mitochondrial *COI*. Morphological and anatomical diagnoses, along with vertical distributions and geographic ranges, are provided for each species.

† Linnenbrink, J.M.^{*}, Radecki, J.R. , Wilson, R.R. Jr.

GENETIC DIVERSITY IS RECOVERED QUICKLY IN NEWLY FOUNDED GOBY POPULATIONS: A PARADIGM FOR BIOLOGICAL INVASION?

California State University Long Beach

Populations founded by few individuals (low effective size) are expected to lose genetic diversity from inbreeding and genetic drift. On decadal or even shorter time scales this lost genetic diversity may be restored by ongoing immigration into the new population. It has been suggested that for biological invasions quick recovery of genetic diversity might aid establishment and further spread. Whereas biological invasions have been occurring for decades, availability of methods for quantitatively assessing genetic diversity is comparatively recent. One approach in assessing temporal changes among invasive populations is to evaluate a "time series" of successive invasions by a single species, or a suitable combination. Of the many species that have invaded the estuaries of California and Australia between 1960 and 1996, we used a series of six invasions by four Asiatic gobies (three *Tridentiger* and one *Acanthogobius* species) to assess temporal change in mtDNA haplotype diversity as a function of years since the first record. Using control region sequences of at least 28 specimens per invasion, we measured singletons per haplotype, and haplotype (*h*) and nucleotide diversities. A linear regression of haplotype diversity on years was significant ($P = 0.001$; $R^2 = 0.94$). Treating the combination of species as representative of a time line for any single species, recovery from $h = 0$ (youngest) to $h = 0.998$ (oldest) invasion was about 45 yr, or about 20-25 generations. We believe this quick recovery is best explained by ongoing immigration into invasive populations from one or more source populations.

Long, J.D.^{1*}, Dolecal, R.E.¹, Cochrane, E.²

TRAMPLING EFFECTS ON BARNACLE ABUNDANCE AND COVERAGE VARY WITH ONTOGENY

1 - Coastal Marine Laboratory, San Diego State University 2 - Maine Maritime Academy

Although trampling disturbs rocky shores, previous studies disagree about the nature of this disturbance. This

controversy may arise because trampling primarily reduces juvenile survivorship and manipulating trampling in ecologically realistic ways may be difficult. We compared the impact of trampling at two sites (Ship Harbor and Bass Harbor) in a national park separated by only 300 m. Ship Harbor receives heavy foot traffic whereas Bass Harbor remains nearly unvisited. At both sites, we monitored barnacle density and coverage within cleared plots and established barnacle communities. We also manipulated natural trampling of barnacle recruits using human-exclusion cages. Prior to the summer when visitation peaked, barnacle recruitment into cleared plots was high at both sites. However, survival of these recruits across the summer was lower at Ship Harbor (12%) than Bass Harbor (23%). Similarly, changes in barnacle coverage in established communities differed between these sites – decreasing at Ship Harbor (5%) and increasing at Bass Harbor (6%). In the exclusion experiment, coverage of barnacle recruits increased by 23-36% in all plots except the uncaged plots at Ship Harbor (i.e. the most likely to be trampled) where coverage decreased by 5%. Factors other than trampling including predators, flow, rock type, aspect, slope, and temperature do not account for these differences. Thus, trampling reduced the abundance and cover of barnacles, but primarily of new recruits at the more visited site. Although new recruitment should replace trampled barnacles, long-term declines may arise if regional trampling intensity dramatically increases or if the established barnacle community also declines.

Longo, C.^{1*}, Tserpes, G.², Peristeraki, N.², Kapantagakis, G.², Pierce, G. J.³

THE ROLE OF INDIVIDUAL BODY SIZE IN FISH DIVERSITY PATTERNS - A MEDITERRANEAN CASE-STUDY
1 - National Center for Ecological Analysis and Synthesis 2 - Fisheries Department, Hellenic Centre for Marine Research, Crete, Greece 3 - School of Biological Sciences (Zoology), University of Aberdeen, Aberdeen, UK
Protecting and restoring marine biodiversity has been set as a key objective in several international agreements, including the EU common fisheries policy (CFP, 2002). In the Mediterranean basin in addition to biodiversity loss due to a long history of exploitation, habitat destruction and pollution, the recent temperature rise is reducing the habitat of local fish while allowing alien species entering through the artificial Suez Canal, to expand their range.

In this rapidly changing ecosystem, however, an understanding of present fish diversity patterns to be used as a reference, is yet lacking. In addition, the mechanisms through which fishing affects fish communities are still poorly understood even in more studied regions (e.g. the North Sea). Since fish feed at increasingly higher trophic levels as they grow in size, and fishing effects are often size-related, we suggest here that different ecological constraints can be expected to determine the number of species coexisting (species richness) and their relative abundances (species evenness) within different body sizes. Therefore, using the South Aegean Sea as a case-study, we compared here the diversity across individual body size classes (i.e. diversity size-spectra) between regions with contrasting diversity and productivity patterns. While the spatial distribution of large fish biomass and diversity had high correlation with primary productivity, fishing effort explained small fish spatial patterns. Overall these results indicate that a size-based approach to measuring species diversity can highlight patterns, otherwise hidden by analysing the community as a whole, thus offering a more ecologically meaningful measure of fish community diversity.

Lonhart, S.I.^{1*}, Traiger, S.²

SMALL-SCALE, SHORT-TERM GROWTH AND DISTRIBUTION OF AN INVASIVE BRYOZOAN IN MONTEREY HARBOR

1 - NOAA's Monterey Bay National Marine Sanctuary 2 - University of California Santa Cruz

Invasive species are common inhabitants of harbors along the coast of California. Tunicates, sponges, and bryozoans are among the more common invertebrates found in fouling communities on floating docks and pilings. An invasive bryozoan, tentatively identified as *Watersipora subtorquata*, has been in Monterey Harbor since the early 1990s, but only recently has it been detected outside of the harbor. Since relatively little is known about *Watersipora* and its interactions with other sessile species in California, we studied the growth and distribution of *Watersipora* in Monterey Harbor. Using fixed photo quadrats, we collected percent cover data from cement pilings, comparing the four sides of replicate pilings at two depths. Colony growth was rapid, with turnover on the order of weeks, with no effect of depth. Percent cover of several species was correlated with the presence/absence of *Watersipora*, and the invader has the potential to form monocultures, smothering all other species.

Lorda, J.^{1*}, Hechinger, R. F.², Lafferty, K.D.³

PERFORMANCE AND ABUNDANCE DISTRIBUTION OF THE INTERTIDAL HORN SNAIL, CERITHIDEA CALIFORNICA, THROUGHOUT ITS NORTHERN DISTRIBUTION

1 - Dept of Ecology, Evolution and Marine Biology, University of California Santa Barbara 2 - Marine Science Institute, University of California Santa Barbara 3 - Western Ecological Research Center, US Geological Survey
Estuaries are great systems to examine the relationship between factors influencing local performance and broad-

scale distribution and abundance. Estuaries are discrete, semi-closed systems. Many taxa experience high local recruitment. Local variables can therefore both strongly affect the performance of individuals and determine local abundance. The intertidal California horn snail is perhaps one of the most abundant and important species in California and Baja California estuaries. In this study, we present the abundance of the California horn snail for almost every existing population (40 estuaries) of its northern range from Drakes Estero, California to Laguna Ojo de Liebre, Baja California, spanning 10° (~1110 km) of latitude. Additionally, at 14 of these estuaries spread through this range, we quantified two measures of performance (growth and gonad-somatic index) throughout a year. We examined how biotic (predation and parasitism) and abiotic factors (temperature and light) influence performance and abundance. Results provide insight into the distribution and abundance of this important species and the potential effect of climate change on its distribution. These results also increase our empirical understanding of the importance of local environmental and biological variables on the performance and distribution of species.

† **Loury, E.K.^{*}, Cailliet, G.M., Ebert, D.A.**

DIET OF THE GOPHER ROCKFISH (*SEBASTES CARNATUS*) INSIDE AND OUTSIDE OF THE POINT LOBOS STATE MARINE RESERVE

Moss Landing Marine Laboratories

No-take marine reserves are predicted to increase the density of fishes within their boundaries, which may in turn affect the feeding habits of those fishes through changes in feeding ecology or food availability. Point Lobos State Marine Reserve is the oldest marine reserve in the United States, being closed to fishing since 1973. The reserve boundary was expanded under the Marine Life Protection Act Initiative in 2007. During the summers of 2007-2009, the California Collaborative Fisheries Research Program collected a total of 462 gopher rockfish (*Sebastes carnatus*) for stomach content analysis at three Point Lobos sites: inside the original 1973 boundary, inside the extended area of the 2007 boundary, and at a nearby reference site outside the reserve. *S. carnatus* exhibited a highly diverse diet of mostly invertebrate species. Prey types with the highest Index of Relative Importance values included brittle stars, and crabs of the family Pisidae and the genus *Cancer*. Diet composition was highly similar between the old and new reserve sites (82.5 percent similarity index (PSI)), as well as between these sites and the reference site (74.5 PSI and 72.0 PSI for the old and new reserve sites respectively). Although fish inside the reserve appeared to have more specialized diets than outside, the high extent of overlap suggests similar feeding habits in the protected and unprotected sites. Similar analyses are currently underway for three other marine reserves in central California.

Lowe, A.T.^{1*}, Quetin, L.B.², Ross, R.M.², Oakes, S.A.², Vernet, M.³, Kozlowski, W.³, Yarmey, L.³, Fritsen, C.H.⁴

SIMULATED GROWTH AND CONDITION OF LARVAL ANTARCTIC KRILL IN RESPONSE TO ENVIRONMENTAL VARIABILITY DURING WINTER

1 - Friday Harbor Labs, University of Washington 2 - University of California Santa Barbara 3 - Scripps Institution of Oceanography 4 - Desert Research Institute

The first fall and winter in the life cycle of Antarctic krill is a critical period that determines larval recruitment to the adult population. However, larval krill energetics during this period are poorly understood. An individual-based model (IBM) was developed to investigate the effects of environmental variability on the physiological condition and survival of larval krill during fall and winter, west of the Antarctic Peninsula. Historical field and experimental observations from the Palmer Long-Term Ecological Research (LTER) and Southern Ocean Global Ocean Ecosystems Dynamics (SO GLOBEC) programs were used to parameterize the model. The carbon-based IBM, coupled to output from models of sea ice and phytoplankton dynamics, incorporated historical measurements of temperature-dependent ingestion and respiration rates to model the growth and condition factor of larval krill. Growth rate and condition factor were closely related to the timing and magnitude of seasonal food availability. Simulations highlighted three critical processes controlling the timing and magnitude of food availability: the fall phytoplankton decline, sea ice advance and development of sea ice microbial communities (SIMCOs), and the late winter SIMCO bloom. This study is the first to identify fall phytoplankton dynamics as a major determinant of larval krill survival and recruitment. A delay or decrease in food availability led to diminished physiological condition during this critical period. Physiological condition was maintained and survival highest when the time between food sources was minimized. This model illuminates the relationship among changing sea ice and phytoplankton dynamics and changes in krill populations along the West Antarctic Peninsula.

† **Marhaver, K.L.^{*}, Sandin, S.A.**

DISTANCE-DEPENDENT MORTALITY OF JUVENILE CORALS IS MICROBE-MEDIATED, SPECIES-SPECIFIC

AND MAY DRIVE BEHAVIORAL EVOLUTION OF LARVAE

CARMABI, Scripps Institution of Oceanography, UCSD

Reef corals host species-specific microbial communities containing ubiquitous potential pathogens, and juvenile corals are particularly susceptible to microbial attack. We tested whether microbial communities from adult corals cause distance-dependent mortality of juveniles, and whether this effect is species-specific, two predictions of the Janzen-Connell hypothesis. To do this, we reared juveniles of the common Caribbean coral *Montastraea faveolata* over five spawning periods in Curacao. To measure survivorship, we conducted field experiments with settled coral recruits and laboratory experiments with swimming larvae. To examine microbial effects, we manipulated the microbial environment in the lab with antibiotics and water filters. Together, six field and lab experiments provide evidence for distance-dependent, microbe-mediated Janzen-Connell survivorship effects in this coral species. Behavioral data from these experiments suggest this mechanism is strong enough to drive the habitat selection behavior of dispersing larvae. The population dynamics of a coral species are therefore governed not only by larval supply on a very large scale, but also by microbial and behavioral ecology on a very small scale.

Markel, R.W.*

INDIRECT EFFECTS OF SEA OTTERS ON ROCKFISH RECRUITMENT, CARBON SUPPLY, TROPHIC POSITION, AND GROWTH

Bamfield Marine Sciences Centre, University of British Columbia

Trophic cascades involving habitat-forming primary producers like kelp may have strong effects on food web dynamics and productivity. I investigated trophic and non-trophic consequences of sea otter (*Enhydra lutris*) predation on shallow rocky-reef communities on the west coast of Vancouver Island, British Columbia, by comparing sea urchin density, *Macrocystis* forest size, and black rockfish (*Sebastes melanops*) recruitment, growth and isotopic signatures between regions with and without otters. High urchin densities and small *Macrocystis* forests were found in the absence of otters, and juvenile black rockfish recruitment was higher in the otter-present region. In both regions kelp-derived carbon content increased and trophic position decreased post-settlement as juvenile black rockfish grew larger. Where otters were absent, larger juvenile rockfish increased in body condition and trophic position, and decreased in kelp-derived carbon content with the onset of piscivory. Growth rates were highest for individuals from the otter-absent region known to have consumed juvenile herring. These results suggest that sea otters indirectly enhance rockfish recruitment by increasing the available area of kelp forest habitat. Transitions in growth trajectories and the contribution of benthic production to rockfish nutrition were similar between the two regions, with the exception that in the absence of otters, rockfish were more likely to make the transition to piscivory, which resulted in greater growth and trophic position. Otters therefore play an important role in rockfish population dynamics at regional scales by mediating recruitment and trophic dynamics via regulation of grazer abundance and kelp forest size.

Marshall, D.J.* , Aguirre, D, Blows, MW

THE GENETICS OF STRESS RESISTANCE IN MARINE INVERTEBRATE LARVAE - IMPLICATIONS FOR STUDIES OF CLIMATE CHANGE

University of Queensland

Pollution is a common stress in the marine environment and one of today's most powerful agents of selection, yet we have little understanding of how anthropogenic stresses influence mechanisms of adaptation in marine populations. Due to their life history strategies, marine invertebrates are unable to avoid stress and must adapt to variable environments. We examined the genetic basis of stress resistance across multiple environments using the marine invertebrate, *Galeolaria caespitosa*. Gametes were crossed in a quantitative genetic breeding design to enable partitioning of additive genetic variance across a concentration gradient of a common marine pollutant, copper and a natural stress, decreased salinity. We use a range of quantitative genetics analyses to ask: Is there genetic variation in stress resistance? Do genotypes that cope well with one stress, cope well with stronger or different stresses? Finally, are genetic correlations likely to constrain the evolution of stress resistance in a marine organisms?

Marshman, B.C.* , Moore, J.D.

PREVENTING EXTINCTION: MAINTENANCE OF CAPTIVE POPULATIONS OF THE ENDANGERED WHITE ABALONE (*HALIOTIS SORENSENI*)

Bodega Marine Laboratory, University of California Davis

In the 1970s, white abalone (*Haliotis sorenseni*) abundance significantly declined as a result of commercial and recreational overfishing. In 2001, they were the first marine invertebrate to be federally listed as an endangered species; since their listing, the population has continued to decline. Individuals remaining in the wild are mostly isolated and, with variable recruitment rates, the probability that the species could recover without human intervention is increasingly small. Previous attempts at captive breeding programs have been hindered by

mortalities resulting from withering syndrome, caused by a Rickettsiales-like prokaryote (WS-RLP). Shell-boring organisms, such as bivalves, sponges, and polychaetes, exert additional stress on their abalone hosts and may facilitate opportunistic microbes that cause shell lesions. Recent efforts undertaken by our lab have focused on attempting to eradicate and prevent new occurrences of these pathogens and pests from our captive wild white abalone and their progeny. We developed an oxytetracycline antibiotic bath treatment to eradicate WS-RLP in captive abalone populations. We have also employed a protocol to eradicate boring organisms, which involves coating the dorsal surface of the shell with paraffin. We are using filtration and ultraviolet sterilization methods to treat incoming seawater to prevent further exposure to WS-RLP and boring organisms and perform regular PCR tests on feces samples to detect any latent or emerging WS-RLP infections. Continued efforts will hopefully sustain long-term health of our abalone population and allow for their use in a captive rearing program.

† **Martinez-Takeshita, N.^{1*}, Allen, L.G.², Franklin, M.P.¹**

THE GLOBAL GENETIC DIVERSITY OF *SERIOLA LALANDI* (YELLOWTAIL)

1 - Nearshore Marine Fish Research Program, California State University Northridge 2 - Southern California Marine Institute, California State University Northridge

The Yellowtail (*Seriola lalandi*), one of the most important sport and commercial species off southern California, is the largest member of the Jack family (Carangidae). These cosmopolitan fish can be found in subtropical and temperate waters. *Seriola lalandi* are commercially fished, recreationally fished, and farm raised in the regions they occupy, thus providing an important food source and a sizeable economic impact for the people in these countries. DNA samples were collected from California (Channel Islands, Catalina Island & San Clemente Island), the Pacific Coast of Baja California, the Gulf of California, New Zealand, Japan, South Africa and Chile. A mitochondrial DNA analysis using the d-loop was used to determine the population structure and genetic variation between distinct sites. It may also be possible to identify subspecies and changes in population structure due to fishing pressures, as well as, migratory patterns of this global species. The genetic analysis will provide valuable information to help properly manage and sustain these fish populations in the future.

Matterson, K.O.* , Gleason, D.F.

THE EFFECT OF SETTLEMENT ANGLE ON JUVENILE GROWTH OF THE TEMPERATE SCLERACTINIAN, *OCULINA ARBUSCULA*.

Georgia Southern University

Light intensity varies over small spatial scales (e.g. substrate angles) in marine communities, which could affect photosynthetic efficiency and growth in juvenile corals. In this study, we examined the effects of settlement angle on juvenile growth in the temperate scleractinian, *Oculina arbuscula*, on the hard-bottom reefs off coastal Georgia. Working within and outside the Grays Reef National Marine Sanctuary, we determined the relationship among settlement angle, chlorophyll concentration and algal density of juvenile *O. arbuscula*. A chlorophyll density proxy was derived using multivariate analysis of red, green and blue color data from field images and extracted chlorophyll concentrations. The light environment was quantified at three different substrate slopes (0°, 45°, 90°) with respect to the surface of the water column and replicated in a laboratory experiment to measure juvenile growth rates over time. Heterotrophy was added as a second treatment variable to determine if juveniles could compensate for reduced light levels by increasing feeding. Light intensity and settlement angle were positively correlated to chlorophyll concentrations with no significant relationship to algal density. This indicates that juveniles oriented on more perpendicular surfaces retain less chlorophyll than those on horizontal surfaces and may require heterotrophy to meet their daily energy requirements. We observed positive growth in all treatments with an additive food source regardless of light intensity, and significant reductions of pigment concentration under low light treatments. These results suggest that juveniles may compensate for substrate orientation by increasing or decreasing pigment concentrations and feeding rates to maintain growth.

† **Matthews, J.A.* , Hentschel, B.T.**

THE EFFECTS OF SIMULATED SUBLETHAL PREDATION ON THE IN-SITU GROWTH AND PALP REGENERATION RATES OF *POLYDORA CORNUTA*

Coastal and Marine Institute Laboratory, San Diego State University

Spionid polychaetes are vulnerable to sublethal predation as worms extend their two feeding palps above the sediment-water interface while suspension feeding. To measure effects of palp loss on the rates of body growth and palp regeneration, we performed a field experiment in which 2, 1, or 0 palps were removed from *Polydora cornuta* juveniles. After palp manipulation, individuals established tubes within labeled vials that were transplanted into intertidal sediments in the Tijuana Estuary. Subsets of vials and worms were recovered 3 and 6 days later.

After 3 days, individuals that had both palps removed lost body volume and grew significantly slower than worms with 1 or 0 palps removed. After 6 days, worms with 2 palps removed had grown to their initial body volume, but continued to have significantly slower growth rates than worms with 0 palps removed. Worms with 2 palps removed had regenerated the lost palp tissue within 3 days. Curiously, worms that had one damaged and one intact palp regenerated the single damaged palp significantly slower than the palp-regeneration rate of worms that had both palps removed. After 6 days, all damaged palps had regenerated to their pre-removal length. The rapid in-situ regeneration rates of removed palps suggests that sublethal predation may be common in nature and may impact the growth rates of juvenile spionids for several days.

† **McKinzie, M.K.^{*}, Lowe, C.G.**

FINE-SCALE HORIZONTAL AND VERTICAL MOVEMENT OF BARRED SAND BASS, *PARALABRAX NEBULIFER*, WITHIN A KNOWN SPAWNING AGGREGATION
California State University Long Beach

Active acoustic telemetry was used to analyze fine-scale horizontal and vertical movement patterns of barred sand bass, *Paralabrax nebulifer*, within a known spawning aggregation, the Huntington Beach Flats, California. Sand bass used soft, sand habitats in 15-30 m of water; several individuals showed strong associations with natural and artificial reef habitats located randomly throughout the spawning grounds. They display distinct diel patterns of activity. Activity spaces averaged $39,298 \pm 94,241 \text{ m}^2$ (\pm SD), using larger areas during the day than night. Individuals showed high degrees of overlap in core areas of use among tracks, averaging $5,218 \pm 13,143 \text{ m}^2$. Fish were detected for a period of 2 d up to 4 mo, depending on transmitter battery life. Several individuals left the spawning site and were relocated 0.5-3.0 km from last known detection several weeks later. Tracked individuals remained < 3m off the seafloor at night and moved up into the mid-water column (~ 10 m depth) during the day remaining primarily within the thermocline (~ 16 °C). During the day, they continually made directed dives towards the seafloor lasting 15-30 sec. Data suggests that both transient and resident individuals are using the Huntington Flats spawning ground, with some fish potentially going back and forth between their home range site and their spawning habitat or utilizing more than one spawning ground throughout the summer breeding season. Understanding barred sand bass unique spawning behaviors can lead to more effective management strategies for this species and protect the long-term sustainability of its fishery.

Miller, E.F.^{1*}, McGowan, J.A.²

CLIMATE-DRIVEN CHANGES IN SOUTHERN CALIFORNIA COASTAL FISHES, 1972-2009
1 - MBC Applied Environmental Sciences 2 - Scripps Institution of Oceanography

Global, oceanic fisheries are declining, but little information is available on the status of coastal, minimally-harvested species. We used a 38 year (1972-2009) time-series of coastal fish abundances recorded during entrapment monitoring at five coastal power plants to study variations in species-specific trends. This period coincided with coastal physical oceanographic variations including a long-term warming trend. Twenty-one species make up 98% of the 13 million fish recorded. These data document a marked decline in abundances and a faunal shift in close association with ocean warming. The ensemble mean, annual entrapment rate declined 97% between 1972 ($8774/10^6 \text{ m}^3 \pm 7436$, SE) and 2009 ($235/10^6 \text{ m}^3 \pm 172$). The limited fishery importance suggests these patterns of change are due to effects of environmental dynamics rather than harvesting.

† **Miller, S.H.^{*}, Morgan, S.G.**

INTERANNUAL VARIABILITY IN TRACE ELEMENT SIGNATURES ALONG THE NORTHERN CALIFORNIA COAST

Bodega Marine Laboratory, University of California Davis

Population connectivity is a crucial and often poorly understood component of marine benthic invertebrate population dynamics. Understanding the connectivity among populations has important implications for such practical applications as fishery management, invasive species control, and marine protected area establishment. Unique signatures of trace elements found in calcified structures or soft tissues have been used to investigate population connectivity in a range of species in environments throughout the world. The temporal stability of those signatures, however, is poorly studied. In this study, we used trace element signatures retained in the soft tissues of the porcelain crab *Petrolisthes cinctipes* to investigate the temporal stability of trace element signatures along the open coast of northern California. Embryos were collected each spring from up to 23 locations along the coast from 2006 through 2010. Trace element signatures of embryos were then grouped to provide the best classification success and investigate the spatial resolution of the signature. Comparing the stability of the trace element signatures among years will help ecologists and resource managers determine the best frequency of sampling when using trace elements to investigate population connectivity.

Morgan, S.G.^{1*}, Fisher, J.L.², McAfee, S.T.³, Largier, J.L.¹, Halle, C.M.¹

EVENT PROFILING REVEALS LARVAL ADVECTION AND CONTROL IN A RECRUITMENT-LIMITED UPWELLING SYSTEM

1 - Bodega Marine Laboratory, University of California Davis 2 - Hatfield Marine Science Center 3 - California Ocean Science Trust

The effectiveness of larval behavior in regulating dispersal and recruitment in a dynamic ocean is of central importance to marine population and community ecology and for conserving and managing resources. A long history of surveying larvae in the plankton and new recruits from the shore indicates that larvae exert considerable control over their movements during prevailing ocean conditions. The advent of ocean observing systems enables complementary targeting of oceanographic events to determine how changes in ocean conditions affect larval transport and recruitment. We capitalized on a long-term record of larval recruitment and a distinctive oceanographic signature to provide a rare glimpse of how changes in ocean conditions affect larval advection, control and recruitment in a region of strong upwelling and recruitment limitation. We repeatedly profiled the vertical and horizontal distribution of a larval assemblage and ocean conditions during infrequent relaxations of prevailing equatorward winds near Bodega Bay, California, USA. Water flowing from San Francisco Bay into the ocean was advected poleward by a buoyant coastal boundary current that arrived devoid of larvae, whereupon the resident larval assemblage was restricted to cold saline bottom waters, pushed offshore and diel vertical migrations were suppressed. This revealed the strong effect of changes in oceanographic conditions can have on behaviorally mediated larval distributions and why few species recruit during relaxation events. Targeted profiling of larval assemblages complements widespread monitoring of recruitment from shore and is necessary to determine how changing ocean conditions affect larval distributions, recruitment dynamics and the connectivity of populations.

† **Morton, D.N.^{*}, Anderson, T.W.**

SPATIAL PATTERNS OF INVERTEBRATE SETTLEMENT IN A GIANT KELP FOREST

San Diego State University

Macroalgal stands of giant kelp (*Macrocystis pyrifera*) can greatly reduce current velocity and direction around and through rocky reefs, potentially altering the delivery and settlement of kelp forest fauna. My primary research objective was to determine whether patterns of invertebrate settlement differed spatially within forests of *Macrocystis pyrifera*. Eighteen sites, distributed across six random transects perpendicular to shore, were established in the Point Loma kelp forest near San Diego, California. At each site, invertebrate settlement was quantified using S.O.S. Tuffy brand dish-scrubbers. Two Tuffys were placed at 6-7 m depth on separate buoyed lines at each site for 2-week periods from July – October 2009. After biweekly collection, invertebrates from each sample were sorted into the following taxonomic groups (in order of decreasing abundance): Crustacea, Gastropoda, Polychaeta, Bivalvia, Anthozoa, Acari (mites), Nematoda, Platyhelminthes, and Echinodermata. The mean number of individuals settling over a 14-day period revealed significant differences within some taxa by location along the edge or within the kelp forest. With all taxa combined, there was a difference in the number of individuals settling in different areas of the kelp forest, with more individuals settling within the outer edge and interior of the kelp forest than within the inner edge. Patterns of settlement also differed among taxa, potentially indicating differential patterns of larval delivery.

† **Moulton, O.M.^{1*}, Hacker, S.D.²**

FOUNDATION SPECIES SURFGRASS MORPHOLOGY AND COASTAL GRADIENTS INFLUENCE INVERTEBRATE COMMUNITIES ON THE OREGON COAST

1 - University of Chicago 2 - Oregon State University

Foundation species are important components of ecosystems because they provide habitat and ameliorate stressful conditions for residents. Comparisons of congeneric foundation species have mostly been limited to comparisons of native and invasive species, with less attention paid to multiple native species. Surfgrasses (*Phyllospadix* spp.) are ubiquitous foundation species on the coast of Oregon, USA, protecting resident invertebrates from waves and providing them access to sandy substrate in an otherwise rocky habitat. Two native species, *P. scouleri* and *P. serrulatus*, have superficially similar morphological characteristics and co-occur within the same rocky intertidal zones. We investigated whether these native congeneric species function similarly as foundation species by comparing the two species' morphology, sediment accretion, and associated resident macroinvertebrates at three capes that vary in oceanographic conditions. The results show that while the macroinvertebrate abundance was the same between surfgrass species, macroinvertebrate species richness, composition, and functional groups varied considerably, with more infauna and deposit feeders found within *P. serrulatus*. *P. serrulatus* also had fewer tillers, rhizomes, and lower biomass per given area but greater sediment accretion than its congener *P. scouleri*. One notably strong result was the difference in macroinvertebrate abundance among capes, with Cape Perpetua having 2.5-3 times more animals per given area than Cape

Foulweather or Cape Blanco. Overall, we found that while the two co-occurring surfgrass congeners provided functionally different habitat for resident macroinvertebrate species, regional oceanographic processes (upwelling, productivity) were more influential in determining the overall abundance and productivity of these highly diverse animal communities.

† **Muthukrishnan, R.^{*}, Fong, P.**

BENTHIC COMMUNITY STRUCTURE AND STABILIZING MECHANISMS PROVIDE SUPPORT FOR ALTERNATE STABLE STATES IN A TROPICAL REEF ECOSYSTEM

University of California Los Angeles

Coral populations are declining globally, often resulting in a shift to an algal dominated community which many hypothesize represents an alternate stable state (ASS) for tropical reefs. We explicitly tested the hypothesis that coral dominated and algal dominated reefs represent ASS on two reefs around Isla Contadora, Panama. Theory predicts that ASS systems will be pushed by some processes towards either of the alternate states, producing a bimodal distribution of community states. Surveys of benthic community structure showed that community states on the study reefs were either heavily dominated by coral or by algae and intermediate conditions were rare. We also identified herbivory and algal growth as mechanisms stabilizing the alternate states. Herbivory rates were higher in the coral dominated state, maintaining a low algae environment, and lower in the algal dominated state providing less top-down control. In contrast, algal growth rates were higher in the algal compared to the coral dominated state, helping maintain higher algal biomass. Because the rates of these processes affect community composition and have feedbacks with the current community state, they push the community away from intermediate conditions toward one of the two alternate states. As such these processes provide a mechanism to produce the observed distribution of community states. The presence of ASS in tropical reef systems means that they are initially resilient to stresses, but resistant to recovery after a transition to an alternate state. Therefore recognition of ASS is critical for the development of successful conservation and management strategies for these systems.

† **Nickols, K.J.^{*}, Gaylord, B., Largier, J.L.**

NEARSHORE VELOCITY GRADIENTS LOWER THE SPEED LIMIT FOR COASTAL DISPERSERS

Bodega Marine Laboratory, University of California Davis

For many nearshore marine organisms, the larval phase is the primary dispersive phase that establishes connections among populations. Relatively little is known about transport over the inner shelf where larvae originate and where currents are heavily influenced by the presence of the shore. Previously, we have shown a robust pattern at 5 sites along the California coast where alongshore velocity decreases logarithmically toward shore, similar to the hydrodynamic "law of the wall". Further investigation indicates that this region of attenuated flow most likely derives from bottom friction and horizontal shear, which implies that eddy diffusivity, a parameter that describes mixing, increases linearly with distance from shore. We use a 2-D particle tracking model to explore the effects of nearshore velocity and diffusivity gradients on dispersal kernels of short-dispersing species. We parameterize the model from field measurements of velocity and associated estimates of diffusivity. Including this level of resolution of the nearshore flow field substantially changes dispersal kernels and dramatically increases predicted self-recruitment. The tendency for these background flow features to reduce alongshore larval movement may be further enhanced by localized 'speed bumps' such as recirculation zones associated with topography and biologically induced flow retardation in kelp forests.

Nielsen, K.J.^{1*}, McPhee-Shaw, E², Largier, J.³, Menge, B.A.⁴

WIND-DRIVEN DYNAMICS, WAVE TRANSPORT AND PHYTOPLANKTON 'BLOOMS' IN THE ROCKY INTERTIDAL

1 - Sonoma State University 2 - Moss Landing Marine Laboratories 3 - Bodega Marine Laboratory 4 - Oregon State University

Analysis of physical oceanographic conditions and continuous, rapidly sampled chl-a fluorescence (calibrated to in situ chl-a) at two shallow, intertidal stations on rocky shores in northern California demonstrate the event-dominated nature of near-coast variability in phytoplankton abundance. A novel and previously unrecognized mechanism, unique to the nearshore zone, may be responsible for the elevated chl-a levels observed here and by others. Bloom events, characterized by episodic peaks typically persisting about 1.5 to five days, often coincided between two sites separated by ~ 150 km and downstream from two different, upwelling centers (Cape Mendocino and Point Arena). We compared the timing of bloom events to possible oceanographic forcings. We saw evidence for a stronger relationship between bloom events and high wave energy than with cold temperatures (indicative of upwelling and high nutrients) or with warm temperatures (indicative of relaxation and offshore blooms). The association between peak wave energy and bloom events was most apparent from approximately May through late June, but did not continue into late summer, suggesting a seasonal pattern of variation in phytoplankton

species which might respond differentially to wave transport. We suggest the novel interpretation that bloom events in the shallowest segment of the coast might often be the signature of accumulation of phytoplankton caused by convergence of wave-driven surface Stokes transport at the impermeable shore boundary. This novel interpretation may have implications for understanding coastal productivity and near-coast aggregations of toxic blooms and some pollutants.

† **Nishizaki, M.T.^{*}, Carrington, E**

PHYSIOLOGICAL AND BEHAVIORAL RESPONSES OF THE BARNACLE (*BALANUS GLANDULA*) TO TEMPERATURE AND FLOW.

Friday Harbor Labs, University of Washington

It is generally understood that physical factors such as temperature and flow may play a role in constraining the distribution and abundance of many marine invertebrates. Although correlations that link species distributions to detailed environmental data exist, their efficacy in making predictions under changing environmental conditions is limited. Alternatively, mechanistic explanations for such correlations can provide a strong basis for predicting the consequences of environmental shifts (i.e., climate change, species introductions). In this study, experiments were conducted on barnacles, *Balanus glandula* to quantify both behavioral and physiological responses over a wide range of water temperatures (5 to 25 °C) and flow velocities (0.7 to 150 cm s⁻¹) simultaneously. Results revealed that cirral beating and respiration rate increased in response to both temperature and water flow. Whereas respiration rates increased steadily up to 25 °C, cirral beating rates peaked at 20 °C. In contrast, respiration rates generally plateaued above velocities of 20 cm s⁻¹, whereas beating rates increased steadily up to 150 cm s⁻¹. These data suggest that barnacle physiology may serve as a mechanism limiting barnacle distribution and will serve as a basis for biophysical models that make explicit predictions about species ranges.

Nydam, M.L.^{1*}, Harrison, R.G.²

INTROGRESSION DESPITE SUBSTANTIAL DIVERGENCE IN A BROADCAST SPAWNING MARINE INVERTEBRATE

1 - University of California Santa Barbara 2 - Cornell University

Understanding the relationship between reproductive isolation and time since divergence is critical to our understanding of speciation. One group for which we know little about the relationship between hybridization/introgression and time since divergence is the marine broadcast spawners. Here, we investigate the distribution of closely related cryptic species of marine broadcast spawners (Type A and B *Ciona intestinalis*) in areas of potential sympatry to determine whether these two types occur together and if so, whether they show evidence of hybridization and introgression. Then we combine our data with other studies to investigate general patterns of reproductive isolation vs. divergence in marine broadcast spawners. We found that Type A and B *C. intestinalis* occurred sympatrically in 2007, and that 21 individuals show evidence of introgression in sympatry (out of ~500). Type A and B *C. intestinalis* are 12.4% divergent at mitochondrial COI (mtCOI), and in comparison with other marine broadcast spawning species at mtCOI, these two types may be near the upper limit of the range of divergence values where introgression is still possible. However, introgression at divergence levels similar to those found in *Ciona* does occur, prompting questions about the strength of postmating prezygotic reproductive barriers in marine broadcast spawners.

† **Olivier, T.J.^{*}, Bauer, R.T.**

DOWNSTREAM HATCHING MIGRATION OF THE RIVER SHRIMP *MACROBRACHIUM OHIONE* IN THE LOWER MISSISSIPPI RIVER SYSTEM

University of Louisiana at Lafayette

Adult *Macrobrachium ohione* live and breed in fresh water, but larval development occurs at sea, a life history pattern termed amphidromy. Although still abundant in the lower Mississippi River System (MRS), *M. ohione* were once numerous far north in the upper MRS, bringing into question the mechanism of larval delivery to coastal waters. A female "hatching" migration may ensure that the larvae reach the required salinity in time for the critical molt to the second (first feeding) stage. This study tested the hypothesis that embryo-bearing females deliver larvae to the estuaries of the Mississippi and Atchafalaya Rivers (Louisiana). Shrimps were collected by trapping at upstream and downstream locations within the Mississippi and Atchafalaya Rivers, respectively. The abundance of reproductive-sized females was greater at the downstream sites in both rivers during the breeding season. At the delta sites, an increase in female body size was observed from non-reproductive to reproductive seasons. During the reproductive season, significantly larger proportions of females incubating embryos at any stage of development were observed downstream in the Atchafalaya River, but not in the Mississippi River. The proportions of females incubating near-hatching embryos and females with near-spawning ovaries were both associated with the downstream sample sites. Females within the lower MRS were observed with near-spawning ovaries while subsequently incubating near-hatching embryos which suggest that females have the potential to

produce multiple broods during the reproductive season. Results from this study support the hypothesis of a downstream hatching migration by females in both the AR and MR.

Olson, E.L.^{1*}, Salomon, A.K.¹, Wirsing, A.J.², Heithaus, M.R.³

QUANTIFYING LARGE-SCALE MOVEMENT PATTERNS OF MALE LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN THE EASTERN INDIAN OCEAN

1 - *Simon Fraser University* 2 - *University of Washington* 3 - *Florida International University*

Understanding the distribution and movement patterns of endangered species is vital for developing effective conservation strategies. Loggerhead sea turtles are listed 'Endangered' by The World Conservation Union. The Shark Bay World Heritage Property is home to the largest breeding population of loggerhead turtles in Australia and the third largest in the world. With little known about the movements of males in this population, our objective is to monitor and quantify the large-scale movement patterns of adult male loggerhead turtles to inform conservation strategies. In February 2009, we tagged 9 male loggerhead turtles with SPOT5 satellite tags. Data collection to date has revealed all 9 individuals have stayed within the World Heritage Property, exhibiting home ranges considerably smaller than previously thought. To complement the quantitative tracking data, we interviewed 6 locals and recorded their traditional ecological knowledge concerning loggerhead turtle movement, habitat use and species interactions. The unique combination of natural science and social science in this research will result in the most comprehensive investigation of male loggerhead sea turtle movement behavior and habitat use to date. Furthermore, it is cultivating relationships between North American researchers, local fishermen, and local Aborigines, forming a basis for collaborative conservation management.

Orr, D.^{1*}, Raimondi, P.¹, Bell, C.¹, Conway-Cranos, T.², George, M.¹, Lohse, D.¹, Worden, S.¹

ASSESSMENT OF EFFECT AND PREDICTIONS OF RECOVERY DYNAMICS WHEN BASELINE DATA ARE SCARCE: A CASE STUDY OF THE COSCO BUSAN OIL SPILL

1 - *Long Marine Laboratory, University of California Santa Cruz* 2 - *University of Washington*

A persistent problem in assessing impacts to biological communities resulting from oil spills is the general scarcity of baseline information that can be used to address natural temporal (and spatial) variation in measured parameters. Equally vexing is the prediction of recovery dynamics following disturbances given the typical absence of local data on such attributes of biological communities. The Cosco Busan oil spill (that occurred in the San Francisco Bay, California, in 2007) provides a case study for both issues. Here we describe the approaches taken to (1) estimate impacts to rocky shore biological communities resulting from the oil spill and subsequent cleanup and (2) make predictions of the integration of recovery over time. We conclude that such estimates and predictions must rely on use of existing data sets (here, primarily baseline data collected under the Multi-Agency Rocky Intertidal Network or MARINE program) and flexible approaches to analyses. Without flexibility in approach, assessments will often not have sufficient power to account for natural variability, which will lead to the inability to make strong conclusions concerning impact or potential for recovery.

Paddack, M.J.^{1*}, Crane, Nicole²

SEEKING RESILIENCE & MONITORING FOR SOLUTIONS ON CORAL REEFS OF A CARIBBEAN ATOLL

1 - *Santa Barbara City College* 2 - *Cabrillo College*

Coral reefs worldwide are exhibiting signs of distress and degradation. This is particularly so in the Caribbean, where live coral cover across the region has declined by 80% in the past 30 years, and recent findings indicate fish abundances have begun to fall as well. These declines, along with a recent threat of an introduced predator is likely restructuring coral reef communities and is raising concern about widespread ecological collapse of these critical ecosystems. Initial surveys of the Mesoamerican Barrier Reef system suggest that reefs along Turneffe Atoll (Belize) may be more resilient than other reefs in this region. Oceanic Society has begun to survey forereef and backreefs on several reefs along the Atoll in order to a) examine how reef community structure varies relative to factors such as proximity to development and lagoonal influence, and b) determine candidate sites for implementation of Marine Protected Areas. These surveys are being conducted by both trained scientists and trained citizen scientists. Citizen scientists allow more frequent and widespread surveys and have the shared benefit of educating the public about environmental issues that impact ecosystems they depend upon. We present initial findings of the newly implement forereef surveys along with multi-year data from backreef surveys on Turneffe Atoll.

† Painter, S.M. and Fong, P. *

THE INFLUENCE OF POPULATION DENSITY AND SEX RATIO ON INDIVIDUAL SEX CHANGE IN A TEMPERATE REEF FISH, *LYTHRYPNUS DALLI*

University of California Los Angeles

It is widely accepted that sex change in fish is largely controlled by relative size, but little is known about how

differences in population density or sex ratio may influence sex change patterns of individuals. Sex change in *Lythrypnus dalli* is predictable and well understood in small, stable social groups in laboratory settings; however, it is not known if these same patterns hold in dense field populations. To test this, we held size structure constant and manipulated the sex ratio and density of populations of *L. dalli* on artificial reefs in the field and in small laboratory aquaria and monitored sex change behavior. Sex ratio and density had different effects on the sex change behavior of initial males versus initial females and sex change from female to male was significantly more common than sex change from male to female. The percent of initial females who changed sex increased when the sex ratio became more female biased, but was not significantly affected by density. Sex change of males was rare, only occurring in the moderate and high density treatments, and was not affected by sex ratio. Both population density and sex ratio significantly affected sex change behavior suggesting that individuals may be responding to cues at the scale of populations as well as cues from smaller social groups. Also, results differed between the laboratory and field experiments which demonstrate that a complete understanding of sex change behavior cannot be achieved solely through examination of this behavior in small scale laboratory experiments.

Parnell, E.* , Miller, E.F., Lennert-Cody, C.E., Dayton, P.K., Carter, M.L., Stebbins, T.D.

LOW FREQUENCY CLIMATE FORCING OF GIANT KELP IN SOUTHERN CALIFORNIA

Scripps Institute of Oceanography, Scripps Institution of Oceanography

The nutrient climate on the inner shelf off southern California decreased dramatically across the 1976-1977 North Pacific climate regime shift. This shift in nutrient climate appears to have caused giant kelp (*Macrocystis pyrifera*) canopies off southern California to respond differently to the interannual variability of the nutrient climate across the regime shift, a pattern that persists presently. Based on a time series of aerial kelp canopy that began in the mid 1960s, the response of regional giant kelp forests off San Diego and Orange Counties to nutrient replete years prior to the 1976-1977 regime shift was dampened relative to that afterward. Since the regime shift, kelp canopies appear more sensitive to interannual nutrient climate fluctuation. This intensification of physical control of kelp forests off southern California is further supported by the correlation of seawater density and *M. pyrifera* density quantified in situ. The linear fit of the percent of the time the 25.1 sigma-t isopycnal bathes the inner shelf each year accounts for >70% of the variability of giant kelp density off Pt. Loma. Importantly, the depth of the 25.1 sigma-t isopycnal deepened ~5 m across the regime shift. Our results suggest that (1) the response of kelp canopies to El Niño Southern Oscillation (ENSO) events is mediated by lower frequency climate modes which appear to modulate the regulatory importance of biological and physical processes on giant kelp, and (2) further deepening of the density structure off southern California could have dramatic effects on the southern distribution of *M. pyrifera*.

† **Passarelli, B.* , Pernet, B.**

THE MARINE LIVE BAIT TRADE IN CALIFORNIA: A PATHWAY FOR THE INTRODUCTION OF NON-INDIGENOUS SPECIES?

California State University Long Beach

Members of several species of marine invertebrates are regularly imported into California for use as live bait in recreational fishing. We studied the marine live bait trade in California as a potential introduction pathway for non-indigenous species. We estimated the number of individuals of five of the most commonly sold species of marine live bait in California using data from telephone and mail surveys of bait shops. We also investigated seasonality in the marine live bait trade, and how bait shops dispose of packing materials, sea water, and unsold live bait. Our estimates show that approximately 570,000 bloodworms (*Glycera dibranchiata*), 600,000 pileworms (*Nereis virens*), 370,000 lugworms (*Perinereis* sp.), and almost 1,900,000 ghost shrimp (*Neotrypaea californiensis*) are imported annually into California. *Glycera dibranchiata*, *Nereis virens*, and *Perinereis* sp. are non-indigenous to California. The ghost shrimp *Neotrypaea californiensis* is native to California but bait shrimp are imported from out of state and may have non-indigenous species of parasites or hitchhikers. Our results show that these species are imported year-round. Hitchhiker species are also commonly observed in live bait shipments. These results will help managers to determine the approaches that should be taken to make the live bait trade in California as environmentally safe as possible.

Pinsky, M.L.^{1*}, Jensen, O.P.², Ricard, D.³, Palumbi, S.R.¹

BEWARE OF ASSUMPTIONS: GLOBAL METAANALYSIS REVEALS THAT FISHERIES COLLAPSES ARE NOT MORE COMMON AMONG LARGE, TOP PREDATORS

1 - Hopkins Marine Station, Stanford University 2 - Rutgers University 3 - Dalhousie University

Surveys of terrestrial species have identified traits such as large body size and high trophic level associated with vulnerability to population declines. However, similar analyses for the ocean have focused on relatively few species. We analyzed two global fisheries datasets (stock assessments and landings) to determine the life history traits of species that have suffered dramatic population collapses. Contrary to expectations, our data suggest that

up to twice as many fisheries for small, low trophic level species have collapsed as compared to those for large, top predators. These patterns contrast with those on land, suggesting substantial differences in the processes driving vulnerability. Even temporary collapses of small, low trophic level fishes can have ecosystem-wide effects by reducing food supply to larger fish, seabirds, and marine mammals.

† **Pirtle, J.L.^{1*}, Eckert, G.L.¹, Stoner, A.W.²**

HABITAT STRUCTURE INFLUENCES SURVIVAL AND PREDATOR-PREY INTERACTIONS OF EARLY JUVENILE RED KING CRAB, *PARALITHODES CAMTSCHATICUS*

1 - School of Fisheries and Ocean Sciences, Juneau Center, University of Alaska Fairbanks 2 - Alaska Fisheries Science Center, National Marine Fisheries Service

Highly structured nursery habitats promote survival for juvenile stages of many species by providing refuge from predators and foraging opportunities. We demonstrate that nursery habitat structure affects survival and predator-prey interactions of red king crab through integrated laboratory and field experiments. Crabs preferred complex biogenic habitats formed by structural invertebrates and macroalgae over structural mimics and sand in the absence of predators, yet they associated with any available structural habitat when fish predators were present. Unsheltered juvenile crab (age 0 and 1 yr) survival was higher in the presence of complex habitat with Pacific cod (*Gadus macrocephalus*) predators in the laboratory and with fish and invertebrate predators in the field. Remote video captured predator behavior and predation events of crabs in the laboratory and field experiments. Fish predator foraging efficiency decreased with increased structural habitat complexity, and crab activity and refuge response behavior varied with crab stage and habitat. Age-0 crabs were cryptic and avoided predators by associating with habitat structure or remaining motionless in the absence of structure and were less likely to respond to an attack. In contrast, age-1 crabs were likely to flee or directly fight an attacking predator and less likely to remain motionless in the absence of structural refuge. Complex habitats, cryptic behavior, and direct defense improve juvenile red king crab survival against certain predators. Understanding conditions that contribute to early life stage success will advance understanding of population fluctuation for this depressed fishery resource species.

Pister, Benjamin^{1*}, Philippi, Tom²

TWENTY YEARS OF ROCKY INTERTIDAL MONITORING AT CABRILLO NATIONAL MONUMENT: DETECTION AND ANALYSIS OF LONG-TERM TRENDS

1 - Cabrillo National Monument, National Park Service 2 - Inventory and Monitoring Program, National Park Service

A rocky intertidal monitoring program was initiated at Cabrillo National Monument (CNM) in 1990 after anecdotal observations suggested many intertidal organisms were declining. Monitoring plots were replicated in three areas along shore, or “zones”, corresponding to a steep visitation gradient. This design helps CNM to understand empirical limits of variation in the rocky intertidal environment, diagnose abnormal conditions, and to potentially identify agents of abnormal change (e.g. visitation). A docent program ensures poaching and take are kept very low. Several core taxa are targeted by monitoring techniques including *Mytilus californianus*, *Silvetia compressa*, *Chthamalus* spp., *Balanus glandula*, *Tetraclita rubescens*, *Pollicipes polymerus*, *Phyllospadix torreyi*, *Egregia menziesii*, a red algal turf complex, *Pisaster ochraceus*, *Haliotis cracherodii*, and *Lottia gigantea*. Results vary by species. Changes of note include a sudden crash of *Mytilus* spp. across all zones in the early 1990s, followed by a moderate recovery in Zone 1 – the zone with highest visitation. A slow but steady and significant decline in *Lottia gigantea* size has also been observed across all zones. This decline is the result of the loss of the very largest individuals from the population. Although we can't always discern the causes of these changes, they would not have been detected without a long term monitoring approach. A report on the past 20 years of monitoring at CNM will be published later this year. However, these data are in the public domain, and the National Park Service encourages research within its borders that would aid in understanding ecological processes, human disturbance, climate change, and ocean stewardship.

Pruitt, J.N.^{*}, Stachowicz, J.J.

DIVERSITY BEGETS DIVERSITY: INDIVIDUAL VARIATION IN ONE TROPHIC LEVEL FACILITATES VARIATION IN OTHERS

Bodega Marine Lab, University of California Davis

Identifying and preserving the mechanisms maintaining biodiversity is one of the core goals of ecology and evolutionary biology. One potentially pervasive route to variation is that diversity is itself self-promoting, and variation of one type (e.g., intraspecific variation) facilitates variation in others (e.g., species richness). Using the Ochre Sea Star (*Pisaster ochraceus*) I ask whether the behavioral phenotype of sea stars affect the selection gradients they impose on their prey (*Chlorostoma funebris*).

† Puritz, J.B.^{*}, Toonen, R.J.

COASTAL POLLUTION LIMITS PELAGIC LARVAL DISPERSAL

Hawaii Institute of Marine Biology, University of Hawaii at Manoa

We examined the population structure of *Patiria miniata*, the common bat star, using two mitochondrial DNA sequence and seven microsatellite loci, and correlate that with a simple model based on flow rates and proximity to *P. miniata* populations for the four major stormwater runoff and wastewater effluent sources of the Sothern California Bight. Here, we show that overall genetic connectivity is high ($F_{ST} \sim 0.005$); however, multivariate analyses show that genetic structure is highly correlated anthropogenic inputs. The best models included both stormwater and wastewater variables and explained between 26.55% and 93.69% of the observed structure. Our results indicate that anthropogenic runoff and effluent are acting as barriers to larval dispersal, effectively isolating a high gene flow species that is virtually free of direct human impacts.

† Pusack, T.J.^{1*}, Christie, M.R.², Johnson, D.W.³, Stallings, C.D.⁴, Hixon, M.A.²

GENE FLOW AND LARVAL DISPERSAL IN A METAPOPULATION OF A CORAL-REEF FISH

1 - Dr. Mark Hixon Lab, Oregon State University 2 - Department of Zoology, Oregon State University 3 - National Center for Ecological Analysis and Synthesis 4 - Florida State Univeristy Coastal and Marine Lab, Florida State University

Marine metapopulations consist of separate local populations connected by larval dispersal. Understanding marine metapopulation dynamics is critical to inform fisheries management, guide marine reserve design, and establish effective conservation efforts. Because larval dispersal patterns characterize metapopulations, we examined the genetic structure of multiple cohorts of a common coral-reef fish over 5 years. We used neutral genetic markers (10 microsatellite loci) to identify dispersal patterns in bicolor damselfish (Pomacentridae: *Stegastes partitus*). We genotyped samples from 3647 fish (1601 adults and 2046 recruits) collected from 5 sites surrounding the Exuma Sound, Bahamas, from 2004 through 2008. Bayesian parentage analysis indentified several parent-offspring pairs and directly documented self-recruitment at 3 of the 5 sites. Principal coordinates analysis revealed that recruits from each site clustered in the same multivariate space as the adults from the same site, and did not cluster with individuals from other sites. This indirect evidence indicated that self-recruitment likely occurred at all sites. Nevertheless, measures of genetic differentiation (e.g., F_{st} , G_{ST}) and results from assignment methods suggested high levels of gene flow among populations over longer time periods. Additionally, we compared heterozygosity and relatedness among adult and recruits, which indicated spatially and temporally independent sweepstakes recruitment events. Our findings suggest that connectivity among subpopulations explained metapopulation structure on evolutionary time scales. However, since we found evidence of self-recruitment and locally independent sweepstakes events over multiple years, local larval production is probably important to structuring metapopulations on ecological time scales.

Putnam, H.M.^{1*}, Edmunds, P.J.², Fan, T.Y.³, Gates, R.D.¹

PHYSIOLOGICAL RESPONSE OF *POCILLOPORA DAMICORNIS* TO INTERACTIVE CLIMATE CHANGE STRESSORS

1 - Hawaii Institute of Marine Biology, University of Hawaii at Manoa 2 - California State University Northridge 3 - National Museum of Marine Biology and Aquarium

Coral reefs are under assault from a variety of anthropogenic stressors, most profound of which are the warmer, more acidic oceans predicted to result from increasing global temperatures and atmospheric CO₂ levels. The goals of this study were to examine the physiological and molecular response of *Pocillopora damicornis* from Nanwan Bay, Taiwan, under the separate and interactive effects of increased temperature and pCO₂. Experiments were completed in a 16-tank facility, with four replicate tanks for each of four combinations, at the following levels: 25 °C, 460 ppm; 25 °C, 850 ppm; 29 °C, 460 ppm; 29 °C, 850 ppm. CO₂ treatments were created by bubbling pre-mixed concentrations of CO₂ into each tank, and the stability was evaluated using current “best practices” recommendations. The biological responses to treatments were assessed via measurements of photophysiology over the course of the experiment, and of calcification, *Symbiodinium* density, and chlorophyll-a content upon completion of the 15-day exposure. No effect of pCO₂ was present in either the photophysiological or physiological parameters. Higher temperatures resulted in higher *Symbiodinium* densities, with a decline in photochemical efficiency in the light, and corresponding increases in non-photochemical quenching as assessed by excitation pressure. The results of this study suggest a dominant brooding coral on the fringing reefs of Taiwan is more strongly affected by changes in temperature than pCO₂, and reinforces the need for CO₂ research on a wide range of species, and large spatial and temporal scales for future predictions of coral reef resilience to global stressors.

Radecki, J.R.^{*}, R.R. Wilson Jr.

GENETIC DIVERSITY OF THE INVASIVE CHAMELEON GOBY (*TRIDENTIGER TRIGONOCEPHALUS*) REVEALS MULTIPLE SOURCE POPULATION ADMIXTURE

California State University Long Beach

The chameleon goby *Tridentiger trigonocephalus* became prevalent in harbors of California and Australia after invasion from Asia (e.g., Tokyo Bay) dated to the 1960s and 1970s, respectively. We tested the hypothesis that *T. trigonocephalus* in San Francisco Bay (SFB) and Sydney Harbor (SH) have spread throughout those and surrounding estuaries principally by an *in situ* rise in abundance after founding, rather than from continuing immigration. An *in situ* rise would be evidenced by persistence of reduced genetic diversity indices for mtDNA, such as too few singleton haplotypes and low haplotype and nucleotide diversities relative to equilibrium populations. mtDNA control regions (698 bp) were sequenced and analyzed at the above indices for 32 specimens each from one potential source (Tokyo Bay), and two invasive, populations; none showed significant loss of singleton haplotypes relative to an equilibrium population. Interestingly, haplotype diversity ($h=0.998 \pm 0.0085$) for chameleon of SFB was significantly ($p < 0.01$) higher than h of the populations at Tokyo Bay (TB) and SH, which did not differ significantly. The elevated h in SFB over one potential Asian source suggests multiple source populations admixing within the SFB population, leading to rejection of the above hypothesis. The result contrasts with that for yellowfin goby of SFB where h of the invasive population was not significantly different from the TB population, but had a significantly lower singleton count. TB's haplotype "fingerprint" (signature haplotypes attributed to that population) suggested few to no individual in SFB or SH was descended from TB chameleons.

† **Raith, M.R.^{*}, Zacherl, D.C., Eernisse, D.J.**

PHYLOGENETIC RELATIONSHIPS OF OSTREIDAE FROM THE GULF OF CALIFORNIA AND OUTER BAJA CALIFORNIA

California State University Fullerton

The Olympia oyster, *Ostrea lurida*, is the only native oyster on the west coast of the United States and has been the focus of current restoration efforts. Although the Olympia oyster was recently demonstrated as distinct from its southern congener, *O. conchaphila*, some uncertainty remained because there was no overlap between localities sampled. Also, demonstration of their hypothesized sister species relationship was confounded by other unsampled nominal species of Ostreidae whose ranges were reported to overlap with *O. lurida* and *O. conchaphila*. In order to further confirm the status of the Olympia oyster as a distinct northern species and to better resolve relationships within the family Ostreidae, we collected and sequenced partial 16S mitochondrial DNA for all the oyster morphotypes we could find from 11 sites along the western coast of Baja California, Mexico and within the Gulf of California. Valuable field assistance was provided by investigators from both the Centro de Investigaciones Biológicas del Noroeste and the Universidad Nacional Autónoma de México. Preliminary results confirm that *O. lurida* is distinct from *O. conchaphila*, even in the newly sampled transition zone. Our results also support an unresolved polytomy consisting of *O. lurida*, *O. conchaphila* and a grouping of two species, one of which is likely *Myrakeena angelica*. Among our outgroups, individuals morphologically identified as *O. tubulifera* grouped consistently within what is likely a single highly variable species, *Saccostrea palmula*. Further data analysis and the incorporation of morphological characters into the phylogeny will be used to refine current findings.

Reed, D.^{1*}, Rassweiler, A¹, Carr, M², Malone², Cavanaugh, K¹, Siegel, D¹

WAVE DISTURBANCE OVERWHELMS BOTTOM-UP AND TOP-DOWN CONTROL IN CALIFORNIA KELP FORESTS

1 - Marine Science Institute, University of California Santa Barbara 2 - University of California Santa Cruz

There has been much discussion and debate over the relative importance of resource availability (bottom-up) and consumer pressure (top-down) in controlling the structure and dynamics of natural communities. Perhaps no where has this debate been more ardent than in discussions of shallow benthic marine systems dominated by large kelps. We took advantage of regional differences in environmental forcing and consumer abundance to examine the relative importance of nutrient availability (bottom-up), grazing pressure (top-down), and storm waves (disturbance) in controlling the standing biomass and net primary production of the giant kelp *Macrocystis pyrifera* in central and southern California. Proponents of bottom-up control would expect the cold, nutrient rich waters of central California to support more kelp biomass and production than the more oligotrophic waters of southern California. Those who favor top-down control would also expect central California to have more kelp, although they would attribute this pattern to the near absence of sea urchin grazers in this region due to intense predation by sea otters. Surprisingly, we found that patterns of kelp biomass and production did not match either of these predictions. Data from a 9-year times series at long-term study sites in southern and central California showed that biomass and production of giant kelp were substantially lower in central California, which is consistent with the hypothesis that more intense wave disturbance on the central coast overwhelmed bottom-up and top-down forces.

Robles, C.D.^{*}, Alvarez, L., Martinez, C.A.

A KEYSTONE PREDATOR'S SOMATIC RESPONSE TO CHANGING PREY AVAILABILITY: INDETERMINATE

GROWTH IN *PISASTER OCHRACEUS*.

California State University Los Angeles

Pisaster rapidly aggregate on swaths of juvenile mussels (*Mytilus* spp.) and disperse once they deplete these preferred prey. This numerical response is a crucial mechanism of a complex equilibrium that maintains stationary lower boundaries of mussel beds, despite huge inter-annual variation in the input of juvenile mussels. To test the hypothesis that the energetics of fitness drive the numerical response, we first altered zonation patterns, and hence prey availability, by manipulating *Pisaster* densities. We then transplanted PIT-tagged sea stars from sites with massive mussel recruitment into the different experimental sites, and after 1 month recorded their energy storage (dry weights of pyloric caeca and gonads) and somatic growth (changes in live mass and arm length). Sea stars transplanted to sites with experimentally lowered prey zones (high accessibility of preferred prey) sustained substantial energy storage and growth; sea stars transplanted to sites with raised zones (depleted prey), or to sites without altered zonation (controls without massive recruitment), showed decreases in energy storage, live body mass, and arm length. Shrinkage was far greater for relatively large sea stars, which require greater total maintenance energies. Larger arms accommodate larger pyloric caeca, allowing greater reproductive output. Thus, experimentally blocking the numerical response through repeated density manipulations revealed the potential fitness consequences of remaining in scarcity. Our conclusion implies that energetic constraints underlie the spatially structured equilibria maintaining stationary boundaries, and hence, the stability of local prey populations.

Rodriguez, G.E.* , Rassweiler, A., Reed, D.C., Holbrook, S.

PATTERNS OF BIRTH AND LOSS: WHAT EXPLAINS THE BIOMASS DYNAMICS OF THE WORLD'S MOST PRODUCTIVE MARINE ORGANISM?

University of California Santa Barbara

Macrocystis forests around world exhibit strong seasonal variation in biomass. Data collected by the Santa Barbara Coastal Long Term Ecological Research (SBC LTER) project show that variations in biomass of *Macrocystis* in the Santa Barbara Channel are much better predicted by the abundance of fronds than the abundance of whole plants. Despite extensive studies on this iconic species, little is known about the role of progressive senescence and other factors that may affect the deaths of individual fronds. We examined frond lifetimes over 36 months and measured possible factors affecting variation in those lifetimes, such as wave height, temperature and nutrients. We found that age was the best predictor of frond death, accounting for the majority (~65%) of the variance in frond loss, and all other factors combined explain only ~10 % of the total variance in frond loss. This suggests that *Macrocystis* frond senescence in the Santa Barbara Channel may be more important than previously thought, and fronds age and die in a predictable fashion, despite a variable environment.

Sagarin, R.*

THE PUBLIC TRUST DOCTRINE AND THE BP GULF DISASTER: TIME TO UNIFY NATURAL HISTORY AND ENVIRONMENTAL POLICY

University of Arizona

The Public Trust Doctrine is a powerful, but largely forgotten foundation of American law. It states that public resources exist for the benefit of current and future generations of citizens and are only held in trust by the government. As trustee, the government has the obligation to protect, repair and grow the trust. The abdication of this trust was clearly seen in the lead up to the BP/Deepwater horizon disaster in the Gulf. Case law throughout the last century has increasingly expanded the scope of the Doctrine to include a wide range of natural services, and some recent environmental statutes contain trust language but conservationists have not yet fully embraced the power of the Doctrine to unify conservation law in the U.S. The Obama administration also shied away from a strong recognition of the Doctrine in its recent formation of a National Ocean Policy. The Doctrine is firmly rooted in a basic, natural history based understanding of the social and ecological goods and services that make up our public trust portfolio. Managing this portfolio well will require learning the interrelated lessons of the BP disaster, the recent financial crisis, and the failure by 20th century ecologists to properly monitor ecological systems.

Salomon, A.K.*

BEYOND THE OUTER SHORES; COMPARING KELP FOREST DYNAMICS FROM HAIDA GWAI, BRITISH COLUMBIA TO THE CHANNEL ISLANDS, CALIFORNIA

Simon Fraser University

Coastal people of the Pleistocene, 18th century explorers and Ed Ricketts may have had a broader spatial understanding of the variation in north-eastern Pacific kelp forests than most modern day marine ecologists. Archaeological evidence and historical place names link kelp forest ecosystems from Alaska, through British Columbia, to southern California. To broaden our understanding of the variation in factors governing kelp forest dynamics, I compared key trophic rates (predation and grazing) in Haida Gwaii, British Columbia and the Channel

Islands, California. Predator assemblage, prey density and abiotic context predictably drove variation in these rates. Given the range expansion of two strongly interacting marine predators (sea otters and fishermen) and the growing network of marine reserves along this coastline, it behooves us to understand the factors driving variation in these rates. This research emphasizes that knowledge is often tied to place, suggesting a pressing need for a trans-regional perspective and a leisurely journey of travel and research from Baja to the Bering Sea to truly understand the factors governing kelp forest dynamics.

Samhuri, J.F.* , Tolimieri, N., Levin, P.S.

SURROGATES, INDICATORS, AND ASSESSMENTS, OH MY! EMPIRICAL TESTS OF THE INDICATOR SPECIES CONCEPT FOR U.S. PACIFIC GROUND FISH

Northwest Fisheries Science Center, National Oceanic and Atmospheric Administration (NOAA)

Can the abundance of one species act as a surrogate for that of another? The concept of indicator species is not new to conservation biology, though tests of indicator performance are surprisingly rare. In the marine environment, the rise of ecosystem-based management has led to calls for a broader understanding of changes in the status of both harvested and unharvested species. Yet, along the US West Coast, for example, only 30 of the 90 species within the Pacific Coast Groundfish Fishery Management Plan are subject to formal stock assessments. We tested the hypothesis that trends in the abundance and biomass of assessed species can provide insight into those of unassessed species using a fishery-independent data set, the West Coast Groundfish Trawl Survey (WCGTS). The WCGTS data set consists of triennial data collected during the period 1977-2004, and annual data from 1998 until the present, and includes total counts and aggregate weights of species collected from trawlable habitats from the U.S./Canadian border to the U.S./Mexico border, in depths 50–1280 m. We tested for covariation in the patterns of numerical and biomass densities of assessed and unassessed species across two spatial gradients (depth and latitude) and in two different time periods (pre- and post-2003). Our results provide guidance for fisheries managers charged with inferring the status of species not subject to regular stock assessments, and underscore the need to demonstrate rather than assume the reliability of indicator species.

† **Santschi, C.A.^{1*}, Page, H.M.¹, Culver, C.S.², Dugan, J.E.¹, Johnson, L.¹**

INFLUENCE OF ENVIRONMENTAL VARIABLES ON THE RECRUITMENT AND DEVELOPMENT OF FOULING ASSEMBLAGES IN HARBORS

1 - Marine Science Institute, University of California Santa Barbara 2 - California Sea Grant Extension/Marine Science Institute, University of California Santa Barbara

Non-native marine invertebrates colonize boat hulls and harbors world-wide. Although these species are widely distributed in harbors, often occurring in higher abundance than native species, their distribution and abundance varies over time and space. As part of a larger study, we explored relationships between the recruitment and persistence of native, non-native, and cryptogenic harbor fouling organisms and select physical and biological variables thought to influence the distribution and abundance of these taxa. We deployed and retrieved experimental tiles at intervals of 1, 3, and 12 months at 16 stations in Santa Barbara Harbor. Concurrently, we measured salinity, water temperature, flow and depth, as well as the sessile invertebrate assemblage on the dock at each station. The non-natives *Watersipora subtorquata* and *Ciona* spp. (*C. savignyi* and *C. intestinalis*) and cryptogenic spirorbid worms showed strong spatial patterns of recruitment on tiles deployed for one month. These patterns correlated with existing cover on the dock for *Watersipora* and water flow for *Ciona*. To explore the influence of water flow on recruitment, we manipulated flow *in situ*. Species recruitment differed between treatments (Manova), with recruitment of *Ciona* significantly lower on tiles receiving elevated flow. Overall, the percent cover of both non-native and native species was lower with elevated flow. Our results suggest water flow influences the recruitment and persistence of fouling species, and that considering circulation in harbors may improve our ability to predict their distribution and inform control strategies.

Schiel, D.R.* , Lilley, S. A

MANAGING DIVERSITY ON ROCKY SHORES: WHAT DO WE MEAN, HOW IS IT PARTITIONED IN SPACE AND TIME?

Canterbury University, New Zealand

Diversity is a broad term used to define the richness and relative abundance of species in a community. However, the term diversity incorporates a variety of quantitative and qualitative measures. Many of these are fundamental descriptive variables in ecology and conservation management, but their quantitative definition has been contentious. Preserving and restoring diversity are common managerial goals, but there is considerable variation in

how diversity is apportioned and quantified within (alpha diversity) and among (beta diversity) samples at multiple spatial and temporal scales, and between habitats. On rocky shores, habitat-forming algal species can exert strong influences, spatially and temporally, on understory communities through an increase in habitat complexity and heterogeneity. Habitat complexity leads often to a change in local species richness (alpha diversity) and is frequently positively correlated with species turnover both spatially and temporally (beta diversity). These lead to greater overall diversity. Here, we examine a variety of aspects of diversity (the rate of species accumulation, the relative proportions of alpha and beta diversity (spatially and temporally), the relative proportions of common and rare species, and the overall community assemblage) associated with habitat-forming algae in two intertidal habitat types over four years. We quantify the effects of habitat variability on the various components of diversity, quantify spatial and temporal rarity and examine correlations between spatial variability of common and rare taxa.

† **Schoenrock, K.M.^{1,*}, Amsler, C.D.¹, McClintock, J.B.¹, Baker, B.J.²**

THE EFFECT OF ENDOPHYTE INFECTION ON GROWTH AND SURVIVORSHIP OF ANTARCTIC MACROALGAE (RHODOPHYCEAE).

1 - Palmer Station, Antarctica, University of Alabama, Birmingham 2 - University of South Florida

Filamentous Algal endophytes are common in many species of chemically defended macroalgae along the Western Antarctic Peninsula. Effects of endophytism in these hosts are unknown, but may be detrimental to host due to competition for light and nutrients or pathogenic effects. To test the effect on host growth and survivorship, individuals representing three degrees of endophyte infection from three species of red macroalgae (Rhodophyceae) were out-planted and monitored for growth. The experiment occurred at the end of the Austral summer and lasted approximately 6 to 9 weeks until population senescence was imminent. Growth rate was measured by weight change of individuals every three weeks. Any fragmentation of individuals during the experiment was accounted for using surface area measurements. A negative relationship between endophyte infection level and host growth rate was found in one species, *Gymnogongrus turquetti*. Survivorship individuals was greatest among those with low levels of endophyte infection. Further inquiry into endophyte effects on host senescence and reproduction warranted.

† **Schuster, M.D.^{*}, Konar, B.**

PHLOROTANNINS AND URCHIN (*STRONGYLOCENTROTUS POLYACANTHUS*) FEEDING PREFERENCES IN THE ALEUTIAN KELP *EUALARIA FISTULOSA*

Institute of Marine Science, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks

Kelps (Order *Laminariales*) can produce secondary metabolites that have been shown to deter grazing in some marine herbivores. The benthic nearshore environment of the central Aleutian Islands generally exists in two states of grazing pressure. When grazing pressure is low, the nearshore is dominated by kelps. Alternatively, when grazing pressure is high (due to an abundance of the green sea urchin, *Strongylocentrotus polyacanthus*), the nearshore is dominated by barrens that contain very few kelps. The objectives of this study were to determine if the canopy forming kelp *Eualaria fistulosa* produces phlorotannins in response to *S. polyacanthus* grazing and to determine if *S. polyacanthus* prefer *E. fistulosa* tissue from barrens or kelp forests. Reproductive tissue of *E. fistulosa* was collected from barrens and kelp forests at five islands along the central Aleutian Archipelago and their phlorotannin concentrations were quantified in the lab using the DMBA method. The following summer, reproductive tissue was collected from barrens and kelp forests and used for *in situ* feeding experiments. At most sites *E. fistulosa* had higher phlorotannin concentrations in areas of high grazing pressure. *In situ* feeding experiments showed that urchins had no preference when offered *E. fistulosa* tissue collected from areas of high and low urchin density. Greater phlorotannin concentrations in barren grounds than in kelp forests indicate that *E. fistulosa* may increase phlorotannin production in response to urchin grazing, though the relationship between phlorotannin concentration and *S. polyacanthus* grazing preference remains unclear.

† **Segui, L.M.^{*}, Hovel, K.A.**

URCHIN POPULATION REGULATION IN CALIFORNIA KELP FORESTS: USING AN INDIVIDUAL-BASED MODEL TO EXAMINE THE ROLE OF PREDATOR BEHAVIOR

San Diego State University

Understanding predator behavior is necessary to elucidate the mechanisms that drive prey population regulation. In southern California kelp forests, spiny lobsters (*Panulirus interruptus*) and sheephead (*Semicossiphus pulcher*) are widely cited as top predators that strongly influence kelp persistence and community structure via regulation of herbivorous sea urchin populations. To date, most of the evidence for this is correlative, and the underlying mechanisms of urchin population regulation are unclear. We combined data from literature and our own field experiments on urchin mortality to develop an individual-based model (IBM) designed to test the effects of spiny lobsters and sheephead on urchin mortality. In our model, we varied lobster and sheephead foraging behaviors, including handling time (functional responses) and tendency to aggregate (aggregative responses) to determine

the conditions under which predators can control urchin density when urchins form feeding aggregations that may lead to kelp barrens. We found that proportional mortality of urchins was insensitive to sheephead handling time but was sensitive to variations in lobster handling time at high urchin densities. Sheephead and lobsters independently displayed type II functional responses resulting in inverse density-dependent mortality of urchins, and when both predators were active in the model, we did not observe an additive effect on urchin mortality. Our results suggest that predator behaviors are important to evaluate when investigating urchin population regulation in kelp forests.

† **Selden, R.L.***

FISHING-INDUCED CHANGES IN CALIFORNIA SHEEPHEAD SIZE ALTER PREDATION RATES AND KELP FOREST ECOSYSTEMS

Dept of Ecology, Evolution and Marine Biology, University of California Santa Barbara

Fisheries managed using minimum size limits skew the size distribution of targeted species towards smaller sizes by removing large individuals. Since many species interactions are driven by relative body sizes, a reduction in size can impact entire food webs. This is especially true for fish where mouth size constrains prey size, resulting in shifts in diet as fish grow. Fishing has reduced the average size of one such predator, the California sheephead, *Semicossyphus pulcher*, an important consumer of urchins in California kelp forests. Previous gut content analyses show urchins comprise a larger proportion of the diet as sheephead grow. Since increased urchin densities have been linked to kelp deforestation, reductions in sheephead size may decrease urchin predation rates and lead to declines in kelp cover. This study is the first to examine empirically how predation rates vary with sheephead and urchin size, and whether different sizes of urchins are vulnerable to predation inside and outside of reserves where larger size classes of sheephead have recovered. The size and sex of sheephead preying upon fifteen red and purple urchins in three size classes (15-30mm, 35-50mm, and 55-75mm) were recorded for 30 minutes at three sites inside and outside of the marine reserve. Only sheephead that met or exceeded the minimum size limit (30cm) were able to successfully consume urchins, and only the largest sheephead could attack the largest urchins. These results suggest increasing the minimum size limit or establishing marine reserves may increase the role sheephead play in mediating urchin densities.

Selkoe, K.A.^{1*}, Toonen, R.J.², White, C.³, Watson, J.R.³, Ben Horin, T.³, Iacchei, M.², Mitarai, S.³, Gaines, S.D.³, Siegel, D.³

HOW WELL DOES POPULATION GENETICS INFORM MARINE LARVAL CONNECTIVITY?

1 - Hawaii Institute of Marine Biology, University of California Santa Barbara 2 - Hawaii Institute of Marine Biology, University of Hawaii at Manoa 3 - University of California Santa Barbara

Studies of marine population genetic patterns often make inferences about the scale of population connectivity. For many marine species population connectivity is mediated through a larval phase, and the pelagic larval duration (PLD) is assumed to influence the spatial scale of population connectivity. Testing whether PLD correlates with genetic estimates of population structure is critical to understanding how these different approaches to estimating connectivity compare. Previous studies examining this question report conflicting results. With a new database of recent marine genetic studies, we clarify the root of this conflict and identify key covariates that help explain when PLD and genetic estimates of connectivity should be strong and when they likely won't be. We illustrate the latter scenario with results on the genetic patterns of 3 kelp-associated species in the Southern California Bight – California spiny lobster, kelp bass and Kellet's whelk. These species showed concordant genetic patterns despite major differences in PLD and life history. High resolution oceanographic modeling of larval dispersal for each species demonstrates how PLD has limited effect on population genetic patterns for an oceanographically complex region like the Southern California Bight. Instead, the size of kelp beds was a good predictor of genetic structure and diversity for these species, highlighting the importance of landscape and ecology mediating connectivity. Furthermore, the relationship of kelp bed size to genetics suggested a hypothesis for future testing: turnover of a kelp bed via size fluctuation enhances genetic diversity of resident species, perhaps due to density dependence and age structure effects.

† **Singh, G.G.^{1*}, Markel, R.M.², Harley, C.D.², Chan, K.M.A.¹**

COMMUNITY CONSEQUENCES OF A KEYSTONE PREDATOR INTERACTING WITH AN ECOSYSTEM ENGINEER

1 - Institute for Resources, Environment and Sustainability, University of British Columbia 2 - Department of Zoology, University of British Columbia

Temperate nearshore ecosystems contain certain strongly interacting species that control community structure, including mussels (*Mytilus californianus*) and sea otters (*Enhydra lutris*). Mussels outcompete other sessile organisms for primary substrate, and can modify microhabitat by forming complex networks to facilitate the coexistence of other invertebrate species. Sea otters are important keystone predators that have important

population and community level impacts. Otters can regulate the size and abundance of many invertebrate species, including mussels, and in some cases this can have cascading impacts through top down processes. We ask how otter predation in mussel beds affect intertidal community structure. Taking advantage of naturally expanding sea otter populations on the Pacific coast of North America (specifically the outer coast of British Columbia and northern Washington), we show how the structure of mussel beds change along a gradient of otter influence. Standardized plots were dug out of mussel beds in different regions chosen based on the amount of time otters have been resident in an area. Average mussel size, mussel bed depth and mussel bed biomass decreases in regions where otters have been resident for comparatively longer periods of time. As a consequence, the biomass of species associated with the mussel beds decrease as well. Community composition and species specific biomasses also change with changes in mussel bed structure. This study demonstrates important community level consequences of top down predation as a large mobile keystone predator interacts with an ecosystem engineer, affecting the ecosystem function of habitat provision.

† **Skilling, D.J.***, **Bird, C.E.**, **Toonen, R.J.**

GATEWAYS TO HAWAII – GENETIC POPULATION STRUCTURE OF THE TROPICAL SEA CUCUMBER
HOLOTHURIA ATRA

Hawaii Institute of Marine Biology, University of Hawaii at Manoa

Holothuria atra is one of the most common and widest ranging tropical, coral reef sea cucumbers in the world, and here we examine population genetic structure based on mitochondrial COI to aid in determining the appropriate scale for coral reef management. Based on SAMOVA, AMOVA and BARRIER analyses, we show that despite its large range, *H. atra* has hierarchical, fine-scale population structure driven primarily by between-archipelago barriers, but with significant differences between sites within an archipelago as well. Phylogenetic and coalescent analyses along with haplotype networks and patterns of haplotype diversity suggest that Hawai'i and Kingman reef are important centers of the genetic diversity in the region rather than an evolutionary dead-end for migrants from the Indo-Pacific. Finally we show that for *H. atra* Kingman Reef is the most likely stepping stone between Hawai'i and the rest of the Pacific, not Japan or Johnston Atoll as previously presumed. Based on our data, Johnston Atoll can instead be seen as an outpost of the Northwestern Hawaiian Islands rather than a gateway to the Hawaiian Archipelago.

Steele, M.A.^{1*}, **Schroeter, S.C.²**, **Reed, D.C.²**

GROWTH, REPRODUCTION, AND TISSUE PRODUCTION OF TEMPERATE REEF FISHES ON ARTIFICIAL VERSUS NATURAL REEFS

1 - California State University Northridge 2 - Marine Science Institute, University of California Santa Barbara

Artificial reefs are commonly used to mitigate damage to natural reefs, yet how well these artificial reefs function is still widely debated. One major question yet to be resolved is whether artificial reefs produce fishes at rates equivalent to those on natural reefs. We tested whether rates of reef fish growth, reproduction, and total tissue production on a large artificial reef (Wheeler North Reef) were comparable to those on two nearby natural reefs. Adults from five of the most common rocky reef fishes in the Southern California Bight (California sheephead, kelp bass, barred sand bass, señorita, and blacksmith) were collected during the spawning season in 2009. Rates of growth, reproduction, and tissue production of each species were generally similar on the artificial and natural reefs, with rates on the artificial reef being most like those on the natural reef nearest to it. These generally similar rates of tissue production (somatic and reproductive) are congruent with similar foraging success (based on gut fullness) of fishes on the three reefs. The similar performance of fishes living on the artificial and natural reefs implies that well-designed artificial reefs can mitigate damage to natural reefs by enhancing production of reef fishes.

Stevens K.J., **Wall, C.B.***, **Janssen, J.A.**

THE ROLE OF ARBUSCULAR MYCORRHIZAL FUNGI IN MODULATING WETLAND COMMUNITY STRUCTURE

University of North Texas

The affect of arbuscular mycorrhizal fungi (AMF) on plant performance is well documented. However, the importance of these symbionts in modulating community structure in wetland ecosystems has yet to be determined. To identify the roles of AMF in the establishment of wetland-seedlings following flooding, we assessed the effects of AMF on seedlings of two herbaceous pioneer species, *Bidens frondosa* and *Eclipta prostrata*, under three levels of water availability. Three questions were addressed within this design: (1) Does inoculation affect seedling growth and development? (2) Are the effects and degree of colonization dependent upon water availability? (3) Does plant response to inoculation differ between closely related species? We found that inoculation had no detectable effects on shoot height, or plant biomass, but did affect biomass partitioning and root morphology in a species-specific manner, with the total fresh weight and root morphology of *E. prostrata* being

more responsive to AMF colonization than for *B. frondosa*. Shoot/root ratios were lower in non-inoculated *E. prostrata* compared to inoculated plants, while root length and surface area were greater in non-inoculated *E. prostrata*; inoculation had no detectable effect on *B. frondosa* root morphology. AMF associations formed at all levels of water availability, but were more abundant in dry versus intermediate and inundated water treatments. As AMF affect the growth and development of wetland plants in a species-specific manner, they have the potential to alter community structure in a predictable pattern. These results suggest that AMF may play integral roles in modulating community structure in wetland ecosystems.

Stewart, H.^{1*}, Price, N.², Holbrook, S.³, Schmitt, R.³, Brooks, A.³

THE ROLE OF ONTOGENY AND ENVIRONMENTAL STRESS IN DEFINING A MUTUALISM

1 - UC Berkeley Gump Field Station, Fisheries and Oceans Canada 2 - SIO 3 - University of California Santa Barbara

In a mutualistic species interaction, the reliance of a host upon a symbiotic resident is not necessarily constant over time or space. We used manipulative field experiments and surveys to examine the onset of a mutualism between recently settled reef-building corals, which are undergoing recruitment limitation, and their resident crabs. Trapeziid crabs have been reported to clear sediments from interstitial spaces of a colony, to ward off predators, and to protect colonies from overgrowth by competitive benthic macroalgae for adult corals. In return, the crabs are thought to receive refuge from their predators and to acquire resources from mucous released by the colony. On a tropical reef, we found that the relative ability for a coral host to acquire a resident crab depended on the host size and morphological complexity, which may be related to the ability of a host to provide adequate micro-refugia for trapeziid crabs. Newly settled resident crabs are capable of clearing harmful sediments that otherwise smother young coral colonies and the presence of a crab in a coral recruit increased host growth and survival. At another host ontogenetic stage, crab presence also resulted in increased performance, although the effect was relatively less substantial. However, the ability for a coral recruit to retain the services of a resident crab was limited by exceedingly high sedimentation rates and exposure to invertivores. Thus, the nature of this important mutualism between a host coral and symbiont crab is a function of ontogeny and environmental stressors.

† Stier, A.C.^{1*}, Leray, M.²

MULTIPLE PREDATOR EFFECTS IN INVERTEBRATE CORAL REEF COMMUNITIES

1 - Richard B. Gump South Pacific Research Station, University of Florida 2 - CRIOBE, University of Paris 6 Pierre & Marie Curie

The importance of interactions between predators (e.g. intraguild predation, competition, or cooperation) in modifying predator-prey dynamics has classically been studied in short-term experiments with a single species of prey. However the degree to which predator-predator interactions permeate entire prey communities and modify the diversity and relative abundance of species remains poorly understood. Here, we examined the independent and combined effects of two predatory fishes on coral dwelling decapods in Moorea, French Polynesia. Predators substantially reduced prey abundance, and the magnitude of these negative effects increased with predator density. While predators did not affect within patch diversity (richness or rarefied richness), they did increase variation in diversity between patches (beta) and modify community composition. There was, however little evidence for emergent effects of multiple predator species on abundance or diversity. Preliminary analysis results suggests that predator-predator dynamics may have a reduced or absent effect over longer time scales and in diverse prey community.

† Swanson, S.A.^{*}, Carpenter, R.C.

THE UNIQUE BIOLOGY AND ECOLOGY OF THE ECHINOID ECHINOSTREPHUS ACICULATUS IN MOOREA, FRENCH POLYNESIA

Richard B. Gump South Pacific Research Station, California State University Northridge

This study examined the distribution and unique feeding behavior of *Echinostrephus aciculatus* in Moorea, French Polynesia in order to understand the different roles echinoids play on contemporary coral reefs. Most echinoids function as grazers on the benthos and occasionally capture macroalgae from the water column. *E. aciculatus* however, appears to be an obligate suspension feeder and unlike many reef echinoids, does not influence benthic community structure adjacent to their burrows. Thirty-one percent of the 436 *E. aciculatus* surveyed over 585 meters of reef exploited this feeding behavior and maintained a thin mucus sheet draped over the tips of their spines. Observations suggest this mucus was obtained from adjacent dendropomid gastropods, and its acquisition was significantly faster when they were located within 25 cm of mucus producing *Dendropoma maximum*. Feeding experiments in a laboratory flume demonstrated *E. aciculatus* captured pieces of the macroalga *Sargassum pacificum* without mucus nets and were more successful at capturing algae in low (12 cm/s) versus high (26 cm/s) flow. In the field, *E. aciculatus* were 2.25-times more abundant in high flow environments compared to low flow environments but were three times more likely to maintain mucus in their spines. We hypothesize that the

inconsistency between low feeding success at high flow, versus their greater distribution in these habitats might be explained by their utilization of mucus nets in high flow. In the future, if the trend towards macroalgal dominance on coral reefs continues, species such as *E. aciculatus* may benefit from increased available particulate algal drift.

† **Tait, K.J.***, **Hovel, K.A.**

RELATIVE EFFECTS OF STRUCTURAL COMPLEXITY, PREDATION RISK, AND FOOD AVAILABILITY ON HABITAT SELECTION OF SEAGRASS FAUNA

San Diego State University

Within seagrass habitats, structural complexity strongly influences the abundance, survival, and diversity of organisms. Structural complexity varies within and among seagrass patches, creating a mosaic of microhabitats in which predator and prey organisms interact. Though tethering experiments have revealed a great deal about the effects of structural complexity on relative survival and foraging success, we know little about how these organisms select and move among microhabitats. Moreover, many predators of seagrass epifauna are juvenile fishes and invertebrates that use seagrass habitats to search for food and to seek refuge from higher-order predators. Our goal was to determine whether seagrass epifauna (prey) and juvenile fishes (predators) select habitat based on structural complexity, and if patch selectivity is modified by predation risk and food levels. Working in mesocosms, we found that epifaunal prey (the grass shrimp *Hippolyte californiensis*) and juvenile fish predators (the giant kelpfish *Heterostichus rostratus*) preferred areas of high complexity artificial seagrass over areas of low complexity artificial seagrass. However, grass shrimp switched their preference to low complexity seagrass when a predatory threat was introduced to the high complexity treatment. In contrast, juvenile giant kelpfish exhibited a strong preference for high complexity seagrass even in the presence of a predatory threat. In a separate experiment, both *H. californiensis* and *H. rostratus* preferred higher complexity seagrass with no food to less complex seagrass containing food. Our research provides novel information that can be used in seagrass conservation and restoration when considering how habitat structure influences the abundance and distribution of organisms.

† **Thomas, K.N.***

THE DISTRIBUTION OF TWO MARINE CLADOCERANS DURING UPWELLING AND DOWNWELLING EVENTS OFF THE OREGON COAST.

Oregon Institute of Marine Biology, University of Oregon

During the summer of 2007, zooplankton samples were taken from a transect 0.5 to 27 km offshore near Coos Bay, Oregon. The transect consisted of 7 vertically stratified stations, and sampling occurred on 4 dates. Two sample dates (27 June and 14 August) were characterized by upwelling conditions and two (3 and 18 July) were characterized by downwelling or relaxation events. Two marine cladocerans, *Evadne nordmanni* and *Podon leuckarti*, were identified. Individuals from each sample were counted, measured in two body axes, sexed, identified as gamogenic or parthenogenic, and assigned a reproductive stage. Embryos were counted in mothers of both species, and in *Evadne* the percentage of the valve space filled by the brood pouch was approximated for each female. *P. leuckarti* was found primarily in nearshore surface waters and was rare farther offshore. *E. nordmanni* was most abundant nearshore but was also found in low densities farther offshore and deeper in the water column. The effects of size, reproductive stage, sex, number of embryos, and oceanographic conditions on cladoceran vertical and horizontal distribution will be discussed.

Thompson, A.R.*, **Watson, W.**, **McClatchie, S.**, **Weber, E.D.**

INFLUENCE OF SCALE ON THE DYNAMICS OF THE LARVAL FISH ASSEMBLAGE IN THE SOUTHERN CALIFORNIA BIGHT

NOAA Fisheries, SWFSC

Elucidating forces that affect the distribution and abundance of multiple species is a central goal of community ecology and is important for ecosystem management. Within the Southern California Bight (SCB), the CalCOFI program has augmented understanding of how marine fish assemblages are spatially and temporally organized. The relatively coarse sampling design of CalCOFI surveys in the SCB (74 stations separated by ~40-100 km covering 226,500 km²), however, may fail to resolve fine-scale assemblage structure in biologically important sections of the SCB. We examined the larval fish assemblage in relation to environmental and purely spatial (spatial eigenvectors) covariates over three years within 2 regions: 1) the Cowcod Conservation Area, a relatively small (~15,000 km²), finely-sampled (64 stations separated by ~10 km) marine protected region within the SCB and 2) the whole SCB as sampled by CalCOFI. Multivariate analysis of CalCOFI samples in each year separated oceanic fishes from a group containing both coastal pelagic and coastal demersal fishes. Environmental factors (depth and temperature) significantly affected CalCOFI assemblage structure and explained more variation than spatial covariates. Within the CCA, rockfish species separated from a suite of pelagic species in each year. Depth and temperature also were significant within the CCA but here more variation was explained by spatial than environmental covariates. The significance of purely spatial covariates within the CCA suggests that unmeasured

factors have a large effect on the larval assemblage in this region. Results highlight the importance of multi-scale sampling for providing a more complete understanding of fish assemblages.

† **Thurber, A.R.^{1*}, Jones, W.J.², Schnabel, K.³**

DANCING FOR FOOD IN THE DEEP SEA: A UNIQUE SYMBIOSIS BY A NOVEL SPECIES OF YETI CRAB
1 - *Scripps Institution of Oceanography* 2 - *University of South Carolina* 3 - *NIWA Wellington*

The deep sea remains largely unexplored and hosts a diversity of unknown species. During exploration of a methane seep off Costa Rica, we discovered the second species of Yeti Crab, a member of the newly described family Kiwaidae. Video footage showed these crabs conducting a unique behavior of waving their chelipeds (first walking legs) in areas of active seepage. Subsequent microscopic and molecular analyses demonstrated that these chelipeds were covered with filamentous bacteria. Phylogenetic analysis of the bacteria indicated that the epibionts were most closely related to hydrothermal vent inhabiting decapod symbionts. Stable isotopic and fatty acid biomarker analyses found that chemosynthetic production was the main source of nutrition for this crab species. Also, similar biomarkers between the tissue and the bacteria-dominated spines suggested that the epibiotic bacteria on the chelipeds are farmed by this novel crab species for nutrition. Modified setae on the 3rd maxilliped (mouth appendage) provided evidence for a potential mechanism for bacteria harvesting, and both in situ and laboratory observations showed the crabs using these appendages to scrape their bacteria-laden setae. We hypothesize that the crab's arm waving behavior is a mechanism to increase the availability of hydrogen sulfide and oxygen to its symbionts and increase the crab's epibionts chemoautotrophic production. As the closest relatives of this new species and its epibionts are from hydrothermal systems, this discovery of a methane seep Kiwa provides an example of the close relationship among the deep-sea reducing ecosystems.

† **Tingco, L.F.***

IMPACT OF DISTURBANCE ON *CHARADRIUS ALEXANDRINUS NIVOSUS* ROOSTING AND FORAGING BEHAVIOR

California State University Los Angeles

Charadrius alexandrinus nivosus (Western Snowy Plover) is federally listed as a threatened species and considered a 'species of special concern' by the state of California. It last nested in Los Angeles County in 1945 but continues to winter roost on Los Angeles County beaches. Since 1945, disturbances (activities that caused birds to flush from foraging or resting) from pedestrian traffic, beach grooming, lifeguard vehicles, and introduced predators, have prevented them from nesting on Los Angeles County beaches and has also led to a significant decline in roosting habitat. The objective of this project is to better understand the relationship between the time individuals spend foraging and resting, enclosure type (i.e. enclosed and unenclosed), and disturbances. Observational studies will be conducted at six beach sites. Three of the sites have enclosures in place to protect roosting habitat and three do not. Two types of data will be collected: site level and individual level. Site level data includes information about disturbances near enclosed and unenclosed winter roosting sites. Individual level data includes information about transit time (time spent resting, foraging, and flushing) for individuals in a roost at each site. The collected data and findings of this project will be used to assist California Fish and Game and United States Fish and Wildlife with their *C. alexandrinus nivosus* recovery goals and to re-evaluate existing conservation efforts on Los Angeles County beaches for protecting wintering *C. alexandrinus nivosus*. In this talk I will present preliminary findings of this long-term project.

Tolimieri, N.*, Williams, G., Andrews, K., Levin, P.

STATUS OF WEST COAST GROUND FISHES: PRELIMINARY RESULTS FROM THE CALIFORNIA CURRENT INTEGRATED ECOSYSTEM ASSESSMENT

NOAA Fisheries, NWFSC

Groundfishes are an important component of the California Current ecosystem because of their ecological importance and their high value as recreational and commercial fisheries. We examined trends in groundfish abundance (# km⁻²) and community structure (diversity and top predator biomass) as indicators of groundfish status. For abundance analyses, we chose a subset of species from 17 functional groups. Thus, the 17 groundfish that we cover represent groups of fish from different habitats and trophic guilds. These 17 species make up about 80% of the total number of individuals captured. Diversity analyses used all taxa identified to species. Top predators had trophic levels of 4.0 or higher. Ten out of 17 species showed declines from 2005-2009: Pacific hake, stripetail rockfish (small shallow rockfishes), Dover sole, rex sole (small flatfishes), chilipepper (midwater rockfishes), spiny dogfish (small demersal sharks), shortbelly rockfish, white croaker (miscellaneous nearshore demersal fishes), canary rockfish, and longnose skate (skates and rays). Five species had stable population trends: sablefish, redstripe rockfish (shallow large rockfishes), splitnose rockfishes (deep small rockfishes), darkblotched rockfishes (deep large rockfish), and yelloweye rockfish. Only lingcod (large demersal predators) and arrowtooth flounder (large flat fishes) increased. Shannon diversity and the biomass of top

predators also declined during this period indicating continued changes in the community structure of west coast groundfishes. Area for improvement of indicators include: (1) integration of multiple data sources, (2) development of more species-specific statistical models, and (3) the development of composite indicator(s).

Tomas, F.* , Stachowicz, J.J.

DOES THE ENEMY RELEASE HYPOTHESIS APPLY TO MARINE INVASIONS? AN EXPERIMENTAL TEST WITH FOULING COMMUNITIES

Institut Mediterrani d' Estudis Avançats, Illes Balears, Spain

Understanding the mechanisms that limit species invasions is a major concern for conservation. The Enemy Release Hypothesis (ERH) predicts that introduced species will successfully spread in a new environment where it lacks its natural predators, while the Biotic Resistance Hypothesis suggests that introduced species are constrained by competence with native species and predation from native predators. Numerous studies confirm both hypotheses in terrestrial and freshwater systems, while the role of native enemies in regulating marine invasions is still poorly understood. In addition, some authors have argued that the phylogenetic relationship between invasive and native species can be a predictive tool to forecast invasions, and that exotic plants that are closely related to native species are more vulnerable to native herbivores since they are more likely to be functionally similar to their native "pairs". In this work we used a series of paired-choice feeding experiments with native predators to ask 1) Does ERH apply in fouling communities (i.e. do native predators prefer native to introduced ascidians)? and 2) Is feeding behaviour of native predators on introduced species influenced by the phylogenetic relationship between native and introduced species? We did not find support for ERH, but different behaviours between predators. While sea stars often preferred the exotic species to the native one, sea urchins did not exhibit strong preferences. In addition, no clear relationship was observed between degree of relatedness and susceptibility to native enemies. Predation can strongly determine the structure and composition of fouling communities, and our results suggest it could also contribute to limiting tunicate invasions.

Tompkins, P.A.* , Steller, D.S.

RHODOLITHS AT CATALINA ISLAND: DISTRIBUTION, GROWTH, AND CONSEQUENCES OF DISTURBANCE
Moss Landing Marine Laboratories

Rhodoliths are free-living coralline algae (Rhodophyta) which form large beds on the seafloor. Globally, these beds serve as a benthic habitat, and support diverse communities. Slow growing, rhodoliths are sensitive to disturbance and threatened by a range of human impacts. While rhodoliths were known in California waters, no prior literature exists on their distribution or biological characteristics. This investigation was designed to (1) estimate the distribution and characterize the rhodolith beds around Catalina Island, (2) determine rhodolith growth and internal banding rates, and (3) examine the sensitivity of rhodolith habitat to common sources of disturbance. A systematic search of shallow subtidal (0-30 meters) areas around the island revealed the presence of seven distinct beds. Coverage of rhodoliths was mapped by divers using SCUBA, and live rhodolith characteristics (density, size frequency, sphericity, branch density) were determined by collecting and analyzing core material. Living rhodoliths at Catalina range from 5-25 mm in axis length (mean=10.0 ±3.6mm), and can occur in densities above 12,500 individuals per square meter. Growth and internal banding periodicity was determined by outplanting stained thalli and retrieving after two six month periods. Samples were then sectioned, imaged, and measured. Average growth rates are consistent with global averages: 1.56±0.42mm/yr for Fall 2008, and 0.80±0.14 mm/yr for Spring 2010. To examine the effect of mooring chain disturbance, rhodolith characteristics were compared between disturbed and undisturbed areas, and the results of a manipulative experiment showed a significant ($p=0.004$) negative effect of mooring chains on the three-dimensional structure of the habitat.

Trbovich, S.M.* , Wilson, R.R. Jr.

QUANTIFYING GENETIC DIFFERENTIATION AMONG KELP BASS (*PARALABRAX CLATHRATUS*)
SUBPOPULATIONS IN THE SOUTHERN CALIFORNIA BIGHT

California State University Long Beach

Whereas studies of genetic differentiation in marine ecosystems are common, satisfactory quantification and explanation of such differentiation is less so. We genetically compared 159 kelp bass (*Paralabrax clathratus*) from 4 collection sites among the San Pedro Shelf, Santa Catalina Island, Santa Barbara Island, and San Nicolas Island in the Southern California Bight. Average microsatellite differentiation value among all sites and across all loci was 0.172 (Jost's D_{est}), partially driven by a loss of allelic richness in the two outer Southern California Bight subpopulations. Microsatellite and mtDNA analyses support a nearly threefold net inshore to offshore bias in gene flow, as well as an estimated 40% reduction in effective population size at San Nicolas Island as compared to Santa Catalina Island and the San Pedro Shelf. Observations supporting infrequent recruitment success at San Nicolas Island and prior estimates of low reproductive success at that site may indicate that these genetic

differences result from infrequent (episodic) fluxes of *P. clathratus* recruits from outside the area, possibly caused by pulses of warm water from the eastern Southern California Bight.

† **Tyburczy, W.R.***, **Wootton, J.T.**

TIMING IS EVERYTHING: THE EFFECTS OF SPECIES DENSITIES AND SEASONAL PREY RECRUITMENT ON PREDATORS IN A WHELK-BARNACLE SYSTEM

University of Chicago

Predation, mortality, and reproduction occur on vastly different temporal scales, yet this is rarely taken into account in research on multi-species systems. In part, this is due to the difficulty in manipulating reproductive timing of most organisms. By exploiting regional differences in the seasonal recruitment patterns of the barnacle, *Balanus glandula*, I was able to test the effects of prey recruitment timing on the predatory whelk, *Nucella ostrina*. Results from this “natural experiment” were supplemented by caged experimental manipulations of barnacle availability. Whelks had higher summer growth rates under pulsed barnacle recruitment than under sustained recruitment ($P=0.0488$). In a separate experiment, whelk and barnacle density manipulations on isolated rocks showed that higher whelk density significantly reduced growth rates in the first year ($P=0.0101$), but not the second. Initial densities of whelks and barnacles were not good predictors of whelk population size in the following year, but initial whelk population size was positively correlated with per capita egg production of whelks in the following year ($P=0.0392$). Data from these experiments will be used to elucidate the effects of seasonal reproduction on predator-prey systems using Bayesian model-selection techniques.

White, C.¹, **Valencia, S.R.^{2*}**, **Costello, C.²**

DO WE HAVE TO CHOOSE? BALANCING HARVEST AND CONSERVATION GOALS IN REBUILDING A COLLAPSED STOCK

1 - Marine Science Institute, University of California Santa Barbara 2 - Bren School of Environmental Science and Management, University of California Santa Barbara

Public pressure to rebuild collapsed fish stocks, even in the face of rising food demand, necessitates a fresh look at the tradeoffs between conservation and fishing. We examined the question “Is harvest compatible with stock rebuilding?” in relation to the collapsed red abalone (*Haliotis rufescens*) fishery in the Channel Islands. Using data recently collected during collaborative surveys at San Miguel Island we constructed a spatially explicit age-structured bio-economic model that incorporates stochastic recruitment dynamics. We identified optimal management strategies in relation to a multi-criteria objective function that weights both economic (fishery) and conservation (stock rebuilding) interests. We outline how the allocation of harvest effort over time and space affects both the net present value of the stock and population growth, and present the efficiency frontiers for the strategies examined. Our results demonstrate that joint economic-conservation benefit increases with increasing complexity in management (employing multiple strategies in concert). While this level of strategic management may be impractical in an open access fishery, it could be achieved through a cooperative management structure such as the one currently proposed for an experimental red abalone fishery at San Miguel Island.

† **Vogt, S.C.***, **Smith, J.R.**, **Murray, S.N.**

THE CONSUMER'S DILEMMA, NATIVE OR NON-NATIVE SEAWEEDES?

California State University Fullerton

Although non-indigenous species (NIS) of seaweeds are established in coastal habitats worldwide, the ecological effects of only 6.5% of seaweed introductions have been studied. In particular, little is known about the feeding responses of native consumers when they encounter new additions to the flora. Yet, native consumers can feed on non-native seaweeds at rates that may determine their success in a recipient community. Both the selective consumption (Biotic Resistance Hypothesis; BRH) and avoidance (Enemy Release Hypothesis; ERH) of NIS of seaweeds by native consumers have been reported. To investigate feeding interactions between native macro-invertebrates and native and non-native seaweeds in southern California coastal waters, we performed a series of two-choice laboratory experiments. Feeding choices of the sea hare *Aplysia californica*, the snail *Chlorostoma aureotincta*, the crab *Pachygrapsus crassipes*, and the urchin *Strongylocentrotus purpuratus* were determined for four morphologically and/or taxonomically similar pairs of native (*Chondracanthus canaliculatus*; *Macrocystis pyrifera*; *Sargassum agardhianum*) and non-native (*Caulacanthus ustulatus*; *Undaria pinnatifida*; *Sargassum horneri* and *Sargassum muticum*) seaweeds. Native macro-invertebrates tended to consume native over non-native seaweeds (nine of 16 assays). However, this pattern was not consistent; consumers showed at least a trend towards non-native seaweed choices in four assays (particularly *P. crassipes*), with no choice being observed in the remaining three assays. The feeding responses of southern California consumers appear to be inconsistent with either predictions of the ERH or BRH, indicating that the impact of native consumers on the success of a seaweed introduction must be evaluated on a case-by-case basis.

Weitzman, B.P.^{1*}, Bodkin, J.L.², Esslinger, G.G.², Kloecker, K.A.², Tinker, M.T.³, Estes, J.A.¹
THE EFFECTS OF SEA OTTER RECOLONIZATION ON BENTHIC INTERTIDAL INVERTEBRATE COMMUNITIES IN GLACIER BAY, ALASKA.

1 - Long Marine Laboratory, University of California Santa Cruz 2 - Alaska Science Center, US Geological Survey

3 - Long Marine Laboratory, US Geological Survey

The influence of sea otters (*Enhydra lutris*) on nearshore marine communities has been widely studied in rocky-bottomed ecosystems, however less is known about their impacts on soft-sediment communities. The re-colonization of sea otters in Southeast Alaska to areas they have been long absent (~100 years) provides a natural experiment with which to examine the response of intertidal communities to the return of a top predator. We report on a long-term (12+years), comparative study of intertidal invertebrate communities in Glacier Bay, utilizing the uneven spatiotemporal pattern of sea otter re-colonization to disentangle and quantify direct and indirect effects of predation. We randomly sampled roughly 45 intertidal sites throughout Glacier Bay, measuring the size and abundance of urchins and bivalves. We compared sites before and after their re-occupation by sea otters (treatment), while conducting simultaneous before-after comparisons at sites not occupied (control). We used a "BACI" experimental design to examine the effects of predation on the relative abundance, size distribution, biomass density, species composition and diversity of invertebrate fauna. Concurrently, we conducted foraging observations of sea otters to measure temporal variation in diet composition and biomass recovery and used these to estimate the direct effects of predation on invertebrate species. We found significant changes in both the size distribution and abundance of clam species that were preferentially consumed by sea otters. The removal of many large bivalves and resorting of benthic strata likely has implications for the intertidal community that can alter available biomass in the system, provide space for recruitment, and indirectly increase species diversity.

† **Wells, E.H.^{*}, Grosholz, E.D.**

RAPID AND DIFFERENTIAL LEARNING FOR AN INVASIVE CRAB PREDATOR ON TWO NON-NATIVE SNAILS
Romberg Tiburon Center for Environmental Studies, University of California Davis

The ability of invasive predators to learn rapidly how to handle novel prey is often proposed as a key to invasion success, however few studies have examined this experimentally. The invasive green crab (*Carcinus maenas*) is a generalist predator capable of learning to handle new prey items in its introduced range. We present lab experiments demonstrating how *Carcinus* differentially handles two novel species, the Eastern mudsnail *Ilyanassa obsoleta* and the Japanese hornsnail *Batillaria attramentaria*. We gave naïve *Carcinus* three weeks of experience with large and small sizes of both snail species, and at initial and final time points we observed 1) consumption rates of each size*species and 2) diet preferences. *Batillaria* consumption rates did not change through time. Crabs learned to handle both sizes of thick-shelled *Ilyanassa*, winking rather than cracking shells as with thin-shelled *Batillaria*. However, in multi-prey choice experiments an initial preference for small *Batillaria* switched to preference for large *Batillaria*, and *Ilyanassa* was never preferred. Field tethering and caging experiments that exposed *Ilyanassa* and *Batillaria* to ambient levels of predation in San Francisco Bay showed very low levels of predation on snails of either size or species in the field, despite the presence of birds, fish, and mammals in addition to crabs. This work demonstrates two difficulties in predicting predatory interactions in food webs that include invasive species: 1) learning may occur and preferences may change over a period of post-invasion exposure, and 2) predation in the lab may not scale to predation in the field.

† **Westphal, M.J.^{1*}, Eckert, G.L.¹, Tamone, S.L.²**

GROWTH OF JUVENILE RED KING CRAB *PARALITHODES CAMTSCHATICUS* IN THE LAB AND FIELD
1 - School of Fisheries and Ocean Sciences, Juneau Center, University of Alaska Fairbanks 2 - University of Alaska Southeast

Red king crab (RKC) once supported the most valuable crustacean fishery in Alaska until collapse in the early 1980s, resulting in large-scale fishery closures with little population recovery. Uncovering the early life history of small juvenile RKC is important for current restoration and conservation efforts. We are investigating the growth of small juvenile wild-caught RKC, held individually in the lab, and of cohorts in the wild, surveyed monthly in the intertidal. In the lab, crab molts are measured to quantify molt increment and construct a predictive model of crab growth. Crabs are held at ambient (~3.5 – 12°C) water temperatures, ambient photoperiod and fed a highly diverse, calcium-enhanced diet to excess. In the field, we measure monthly the size frequency of juvenile red king crabs in the intertidal. These measurements are necessary in order to better understand growth in the wild and discern potential artifacts of juvenile crab growth in the laboratory. On average, juvenile RKC in the laboratory require ~1700 degree-days to reach the sixth instar (C6) measuring ~5.5mm carapace length (CL). Average percent growth per molt for the first five instars is 22.5% for laboratory-raised crabs. Juvenile red king crabs from the field were 6.39 ± 1.37 mm CL (mean \pm SD) in January 2010 and 12.19 ± 2.57 mm CL in August 2010. Understanding growth in the early stages of benthic existence is needed to better understand recruitment and potential bottlenecks in the early life history that may be limiting population recovery.

White, C.^{1*}, Halpern, B.S.², Kappel, C.V.², Selkoe, K.A.²

NEW GRIDS ON THE BLOCK: USING MARINE SPATIAL PLANNING TO ASSESS TRADEOFFS AMONG OFFSHORE WIND FARMS, FISHING, AND CONSERVATION

1 - Marine Science Institute, University of California Santa Barbara 2 - National Center for Ecological Analysis and Synthesis

Coastal marine ecosystems are now crowded by varied sectors (user groups) interested in myriad ecosystem services. Conflicts among sectors in their ability to procure different services from shared, interacting ecosystem resources has prompted a U.S. Federal call for a comprehensive, integrated and transparent marine spatial planning (MSP) process for reducing conflicts. Offshore renewable energy (e.g., ocean wind farms) represents a new and potentially high-value sector in coastal marine ecosystems. Large economic gains and generation of 'green' energy are its purported benefits; concerns about impacts on marine mammals and the displacement of fisheries are potential costs. The State of Massachusetts sits at the epicenter of this debate; one energy development zone was recently approved after a decade of controversy and two more zones are under consideration. To inform this debate we performed a spatially-explicit bioeconomic tradeoff analysis among wind energy, fishery and whale watching ecosystem services in Massachusetts Bay. This new methodology enabled us to identify optimal MSP solutions for wind energy development that minimized spatial conflicts among sectors and maximized their values. Solutions were markedly superior to single-sector management outcomes, and strongly dependent on the spatial design of the wind farms, and on the habitat type associated with the fishery under consideration. Our study quantifies service tradeoffs in an ecosystem crowded with sectors, demonstrates the value of MSP for mediating tradeoffs and minimizing sector conflicts, and highlights when and how offshore renewable energy may be developed optimally in coastal ecosystems.

Williams, G.D.^{*}, Andrews, K.S., Tolmieir, N., Samhuri, J., Kaplan, I., Levin, P.S.

A SYSTEMATIC FRAMEWORK FOR EVALUATING AND RANKING ECOSYSTEM INDICATORS FOR THE CALIFORNIA CURRENT LARGE MARINE ECOSYSTEM (CCLME)

Northwest Fisheries Science Center, National Oceanographic and Atmospheric Association

NOAA is leading the development of integrated ecosystem assessments (IEAs) throughout the United States as part of an ongoing move toward ecosystem-based management of marine and coastal resources. One aspect of the IEA process emphasizes the development of ecosystem indicators - quantitative biological, chemical, physical, social, or economic measurements that serve as proxies of natural and socio-economic system conditions. As such, they provide a means to judge change in ecosystem attributes relative to management objectives and ecosystem risk. We use an established framework (Levin et al. in press) to systematically evaluate and organize potential indicators of ecosystem health for the CCLME, for this presentation focusing on indicators associated with two attributes of ecosystem "health": community composition (e.g., species diversity, functional group biomass) and energetics/material flow (e.g., carbon cycling, primary production). We identified 79 potential indicators from the peer-reviewed science literature and evaluated their potential to fulfill three categories of criteria: primary (essential information for providing scientifically useful guidance), data (measurement and availability of this information), and other (important non-scientific information). We outline the evaluation steps, scoring, and considerations used to select the final suite of 6 proposed indicators: Zooplankton species biomass anomalies, Taxonomic distinctness (average and variation), Top predator biomass, Seabird annual reproductive output, Chlorophyll a, and Inorganic nutrient levels. We emphasize that this indicator suite is preliminary and will likely evolve as 1. more data becomes available and 2. other formal criteria are instituted to quantify the quality of the science supporting each indicator during the evaluation process.

† Wilson, J.R.^{*}, Kay, M.C., Lenihan, H.S.

SPATIAL VARIABILITY IN FISHING PRESSURE AND DEMOGRAPHY AND THE IMPLICATIONS FOR MANAGEMENT OF A NEARSHORE FISH

Bren School of Environmental Science and Management, University of California Santa Barbara

Many nearshore marine species demonstrate spatial variability in growth rates, reproductive schedules and natural mortality. Fishing pressure is also spatially variable and is intensified by the growing implementation of no-take Marine Protected Areas (MPAs). Spatial variation poses significant challenges for conventional fisheries management. Stock assessments often assume homogeneous life histories and fishing pressure across coast wide scales and set management regulations accordingly. Moreover, stock assessments do not incorporate biomass within MPAs into calculations of current stock biomass. Here we address these issues by analyzing data from a collaborative research program at the northern Channel Islands focused on exploring grass rockfish (*Sebastes rastrelliger*) population dynamics inside and outside of four MPAs and across a biogeographic gradient. We determine significant spatial variability in demography and fishing pressure and use these estimates to parameterize spawning potential ratio (SPR) and yield per recruit (YPR) models across the islands. Our results suggest that area-based management and the inclusion of biomass protected within MPAs can help achieve target

objectives of fisheries management such as improving yields while meeting SPR goals. This research supports a growing movement towards area-based management in nearshore fisheries.

† **Withy-Allen, K.R.***, **Hovel, K.A.**

CALIFORNIA SPINY LOBSTER MOVEMENT BEHAVIOR AND HABITAT USE: IMPLICATIONS FOR MARINE RESERVES IN SOUTHERN CALIFORNIA

Coastal and Marine Institute Laboratory, San Diego State University

Marine protected areas (MPAs) are widely used to rebuild depleted populations, but their effectiveness hinges on adequate knowledge of the factors dictating population dynamics for target organisms. Movement patterns, habitat associations, and habitat-specific survival rates of juveniles and adults, which often are unknown, will strongly influence MPA effectiveness. California spiny lobsters (*Panulirus interruptus*) are the target of intense commercial and recreational fishing in southern California, but we lack basic information to determine if MPAs planned for the region will enhance abundance. Working within and outside of the La Jolla Ecological Reserve (LJER), we (i) quantified lobster movement patterns and home ranges over short (nightly – weekly) and long (1 – 14 months) time scales using acoustic telemetry, (ii) surveyed lobsters to determine day and night habitat associations, and (iii) tethered lobsters to assess habitat-specific predation risk. Lobsters exhibited high site fidelity and small home ranges (geometric mean of 651 m² and 5,912 m² per week based on 50% and 95% Kernel Utilization Distributions (KUDs), respectively). Lobsters were strongly associated with rocky habitat during the day but were associated with the red algae *Plocamium cartilagineum* while feeding at night. Lobster relative survival rates were high across vegetated and unvegetated habitats at night, and were highest in surfgrass (*Phyllospadix torreyi*) habitat during the day. Our results highlight the need to consider how movement patterns vary over short and long time scales, and how patterns of habitat use may vary from day to night for nocturnally active species such as spiny lobsters when planning MPAs.

POSTERS

† **Aalto, E.A.***

EFFECTS OF BYCATCH MORTALITY ON POPULATION DYNAMICS IN MODEL FOOD WEBS

University of California Davis

Ensuring the sustainability of California fisheries is a complex and pressing issue. Equally challenging is the protection and restoration of threatened marine species. Effective multi-species management for harvested and protected species must incorporate both ecological and economic interactions, such as competition and bycatch mortality. Models were constructed to examine the effects of harvest and bycatch mortality on the dynamics of small food webs. Model ecosystems were composed of two to four species, and included competition, predation, age structure, harvest pressure, and bycatch. Both discrete- and continuous-time growth models were used and population dynamics were evaluated deterministically and via stochastic simulation. Results suggest that even low to moderate bycatch rates can counteract the positive population growth expected from reduced competition or predation. Under some theoretical scenarios, increased harvest of a competitor can even lead to lower populations of the species of interest.

Alioto-Jurado, D.*

OCCURRENCE, TAXONOMY, AND PHENOTYPIC VARIATION IN ANGEL SHARKS OF THE EASTERN PACIFIC OCEAN

University of California Los Angeles

Angel sharks are a primarily benthic dwelling group comprising the monotypic genus *Squatina*. Distinguishing the numerous individual species within this genus proves very difficult due to the general morphological homogeneity they exhibit. In the Eastern Pacific region the *Squatina* genus appears to have an anti-tropical distribution. In the North Eastern Pacific (NEP) described species *Squatina californica* occurs from off the coasts of southern Alaska to Mexico. In the South Eastern Pacific (SEP) described species *Squatina armata* occurs off the coasts of Ecuador down to southern Chile. It is not currently known if more distinct species occur and remain yet described throughout both these areas, particularly the understudied SEP. Even in the more studied NEP, previous studies suggest that a sub-population in the partially isolated Gulf of California may constitute a third distinct species. Throughout the entire range the degree of phenotypic variation exhibited by sub-populations has not been previously noted. Here the morphology of multiple sharks from across the Eastern Pacific region were measured and compared across varying degrees of geographic distances. Samples specimens were measured using a newly refined morphometric protocol specifically designed for angel sharks unique body plan. Groups of samples from the NEP and SEP were subsequently compared with the corresponding original species description for each area. Results are presented with up to the date results of corresponding ongoing genetic analysis.

Bailey, D.M.*, Steele, M.A., Allen, L.G.

EFFECTS OF LARGE PREDATOR ACCUMULATION ON YOY MORTALITY IN MARINE PROTECTED AREAS.

Nearshore Marine Fish Research Program, California State University Northridge

Understanding how Marine Protected Areas (MPAs) affect the structure and function of populations within them is essential for their effective planning and use. There is widespread evidence that MPAs enhance the abundance of large exploited species, many of which are predatory fishes. Increased predation pressure from large piscivores may increase mortality of smaller fishes, including juveniles of large species, potentially altering community structure. This study compared young of year (YOY) survivorship for six abundant fish species inside and outside of the MPA at Santa Catalina Island, located off the coast of southern California. Unexpectedly, results indicated no evidence of increased predation on YOY fishes within the MPA: YOY mortality rates did not differ significantly between MPA and unprotected reefs. These findings suggest that, at least within MPAs in southern California, the accumulation of large predators is unlikely to have major impacts on the structure of the community of kelp forest fishes. These findings provide a basis for more realistic predictions of how MPAs may be expected to affect marine fish communities.

† **Basilio, A. J.^{1*}, Perlman, B.², Ferry, L.A.²**

EFFECTS OF BODY SIZE ON PECTORAL FIN GROWTH OF BLACK SURFPERCH (*EMBLOTUCA JACKSONI*) FROM CENTRAL CALIFORNIA

1 - Moss Landing Marine Laboratories, California State University Monterey Bay 2 - Moss Landing Marine Laboratories

Black surfperch (*Embiotoca jacksoni*) are labriform swimmers that primarily use their pectoral fins for propulsion. We examined how certain characteristics of the pectoral fin changed with body size. We hypothesized that these

characteristics of the pectoral fin would scale isometrically with body size. Specimens were photographed while lying flat with their left side exposed and their fin rays fully splayed. Digital images were analyzed using ImageJ software. The following measurements were obtained: the length of the pectoral fin along its top and bottom margins, the height of the fin at its insertion and along the distal edge, pectoral fin surface area, aspect ratio, and fineness ratio. Total body length and height of each specimen were also measured. Both fin length measurements revealed a positive slope when plotted against total body length and were consistent with isometric growth. Fin height and surface area of the pectoral fin also had positive slopes. Aspect ratio and fineness ratio, however, revealed different trends with total body length. Aspect ratio of the pectoral fin was highly variable with increasing body size. Fineness ratio had a negative slope, suggesting the fish became more deep-bodied with increasing body size.

† **Beas, R.^{1*}, Beck, M.², Carr, M.H.¹**

MONITORING BAJA CALIFORNIA: AN INTERNET BASED APPROACH

1 - Long Marine Laboratory, University of California Santa Cruz 2 - Long Marine Laboratory, The Nature Conservancy

The Baja California Peninsula has been a focal location for protection and management of terrestrial and marine ecosystems and resources for various reasons. Lately, a diverse group of scientist, governmental agencies, fishermen and public organizations have invested energy and resources on setting aside conservation areas for protection. Monitoring and evaluation programs are needed to assess the effectiveness of these conservation efforts. The costs of monitoring and evaluating protected areas can require substantial investments and these investments escalate with the increasing number of protected areas. A fundamental goal is the development of monitoring programs that are highly informative, affordable and coordinated among managed areas. Thus, we have constructed a database of past and present monitoring and evaluation studies in the Baja California Peninsula to help coordinate and inform the design of monitoring programs. Habitat type, locations, type of monitoring or evaluations, focal species, collaborations and funding resources are some basic information we have obtained from the organizations and institutions we have identified to date. With this information, we have created a GIS database that shows what type of monitoring-related studies have been performed as well as to identify information gaps. However, such data bases quickly become outdated and incomplete. Therefore, we have created an online database, where scientists can report their research online and update the database in real time. This in turn, will promote collaboration among those research groups that monitor or evaluate the natural resources in Baja California. Visit the site at: <http://www.gawana.com/baja>

Bell, C.A.^{*}, Ammann, K.N., George, M.K., Raimondi, P.T.

ASSESSING SUITABLE HABITAT AND THE POPULATION SIZE OF BLACK ABALONE (*HALIOTIS CRACHERODII*) FOR CRITICAL HABITAT DESIGNATION

Long Marine Laboratory, University of California Santa Cruz

Black abalone (*Haliotis cracherodii*) have experienced mass mortalities along the coast of California since the mid-1980s and are now protected under the USA Endangered Species Act. Mortality is due to poaching and a fatal wasting disease called "withering syndrome". Working with MARINe (Multi-Agency Rocky Intertidal Network) and PISCO (Partnership for Interdisciplinary Studies of Coastal Oceans) monitoring groups we have documented their decline along the California coast. We currently sample abalone populations at 27 sites from Half Moon Bay to Point Conception. The last extant large and healthy populations exist in the Monterey Bay National Marine Sanctuary- *their area of ecological viability*. To assess change in abundance and size structure we initially established sites where abalone occurred in relatively high densities. However, this design may be unsuitable for estimating population size. To rectify this we designed a study to estimate the population size and to determine the amount of suitable habitat available to black abalone along the California mainland from Point Reyes to Point Conception. We sampled areas for black abalone and also characterized the quality of habitat suitable for abalone occupation. Additionally, we used a gradient of sample areas away from an area of known suitable habitat and found that suitable habitat is not spatially clustered. We also found strong correlation between the quality of habitat and the density of abalone. Our data are being used by the National Marine Fisheries Service to designate critical habitat and to aid in the recovery of black abalone.

Blanchard, A.L., Feder, H.M., Parris, C.L., Rucker, T.L.^{*}

TEMPORAL VARIABILITY OF BENTHIC COMMUNITIES IN THE DEEP BASIN OF AN ALASKAN FJORD, 1971-2009.

Institute of Marine Science, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks

Temporal trends of deep-subtidal macrofauna in Port Valdez, Alaska, were assessed with respect to multiple environmental stressors. Deep-basin stations were sampled using a van Veen grab (0.1m²), sediments washed over a 1.0 mm screen, and fauna preserved in 10% buffered formalin. Effects from a magnitude 9.2 earthquake in

Prince William Sound, Alaska, 1964, were reflected in recolonization of the basin of the fjord, increased abundance and number of taxa over time, and moderately increased variability in abundance through 1990, stabilizing 26 years after the earthquake. Long-term climatic variability and local physical processes were important sources of spatial and temporal variability. Correlative evidence suggests that indirect effects of juvenile salmon from a shoreline hatchery and deposition of adult salmon carcasses moderately enhanced deep-basin benthic communities. Overall, faunal trends deviated from the stability expected for benthic communities in other fjords. Physical characteristics of the fjord were important in mediating the effects of stressors and in delaying the readjustment process.

Blanchette, C.A.^{1*}, Alderman, Eric², Argyropoulos, Nicole², Boggs, Cathy³, Caron, Bruce⁴, Gaines, Steve⁵, Melack, John⁶, Miller, Steve⁵, Penley, Constance³, Rice, Ron³, Toole, Dave²

DIGITALOCEAN: A SOCIAL MEDIA PLATFORM CONNECTING OCEAN SCIENTISTS

1 - Marine Science Institute, University of California Santa Barbara 2 - Outthink Media 3 - Carsey-Wolf Center for Television, Film and New Media, University of California Santa Barbara 4 - New Media Research Institute 5 - Bren School of Environmental Science and Management, University of California Santa Barbara 6 - Dept of Ecology, Evolution and Marine Biology, University of California Santa Barbara

DigitalOcean (DO) is using the power of collaborative digital media to open new windows into the sea that bring to light images, data, and stories of sea life and ocean processes. DO is combining technological and social networking solutions to enable multi-disciplinary, multi-generational communities—a network of networks—to simultaneously advance ocean science research and inspire public engagement with the search for solutions to the crises threatening the world's ocean. When fully realized, participants will include scientists, educators, students, policy makers, media specialists, and ocean enthusiasts, people who make their living from the sea, and the general public. The DigitalOcean platform will provide a robust suite of open-source tools and interfaces combined with software hooks to leading Web 2.0 service application programmer interfaces (APIs). A wide range of scientific, educational, and resource management projects will leverage the capabilities of this system once the community is engaged. The DigitalOcean Network connects a reusable collection of high-value ocean media through photographs, videos, data displays and also through ocean science by means of research preprints, reviews, citations, critiques, comments, tags, and quality ratings. Over time, this DO collection should become the single best source for freely reusable ocean science/media. DO will be built from user-provided content, with community-added value, and licensed for free to the public.

† **Blaser, S.B.***

EFFECT OF DIURON AND IMAZAPYR HERBICIDES ON NATURAL PHYTOPLANKTON COMMUNITIES: IMPLICATIONS FOR THE SAN FRANCISCO ESTUARY/DELTA

Romberg Tiburon Center for Environmental Studies, San Francisco State University

Herbicides have the potential to negatively affect marine and aquatic ecosystems as they are mobilized through precipitation and irrigation from the land into the watershed. Diuron is an herbicide of concern in the northern San Francisco Estuary (SFE) because it is heavily used for both agricultural and urban land, is toxic, and persistent in the environment. Despite its known presence in the SFE, little is known about its impact on phytoplankton communities. Imazapyr is another herbicide in use in the SFE and is applied to manage invasive plants throughout the estuary. Imazapyr is not currently monitored in the SFE, nor is much understood about potential unintended consequences of it to phytoplankton. Experiments were conducted to empirically determine the impact of increasing concentrations of diuron or imazapyr on primary production and community composition of natural phytoplankton assemblages collected in the SFE. Results show that primary production was reduced with diuron concentrations as low as 1 µg/L; these concentrations fall within the range of diuron concentrations that have been previously reported for the northern SFE and Delta. Increasing concentrations of imazapyr resulted in decreased production during long-term (48 hour) exposure with limited impact in immediate tests. Reduced primary production was observed at high imazapyr concentrations (5 mg/L). These findings provide evidence that herbicides may reduce primary production and shape phytoplankton communities in the food-limited SFE.

Blaser, S.B.*

EFFECT OF DIURON AND IMAZAPYR HERBICIDES ON NATURAL PHYTOPLANKTON COMMUNITIES: IMPLICATIONS FOR THE SAN FRANCISCO ESTUARY/DELTA

Romberg Tiburon Center for Environmental Studies, San Francisco State University

Herbicides have the potential to negatively affect marine and aquatic ecosystems as they are mobilized through precipitation and irrigation from the land into the watershed. Diuron is an herbicide of concern in the northern San Francisco Estuary (SFE) because it is heavily used for both agricultural and urban land, is toxic, and persistent in the environment. Despite its known presence in the SFE, little is known about its impact on phytoplankton communities. Imazapyr is another herbicide in use in the SFE and is applied to manage invasive plants throughout

the estuary. Imazapyr is not currently monitored in the SFE, nor is much understood about potential unintended consequences of it to phytoplankton. Experiments were conducted to empirically determine the impact of increasing concentrations of diuron or imazapyr on primary production and community composition of natural phytoplankton assemblages collected in the SFE. Results show that primary production was reduced with diuron concentrations as low as 1 µg/L; these concentrations fall within the range of diuron concentrations that have been previously reported for the northern SFE and Delta. Increasing concentrations of imazapyr resulted in decreased production during long-term (48 hour) exposure with limited impact in immediate tests. Reduced primary production was observed at high imazapyr concentrations (5 mg/L). These findings provide evidence that herbicides may reduce primary production and shape phytoplankton communities in the food-limited SFE.

† **Blum, J.C.***, **Sanford, E.**

TEMPERATURE SENSITIVITY OF RIGHTING RESPONSE IN NATIVE AND INTRODUCED RANGE POPULATIONS OF *UROSALPINX CINEREA*

Bodega Marine Laboratory, University of California Davis

Anticipating the ecological consequences of anthropogenic climate change and biological invasions for marine ecosystems requires understanding how changing climate regimes affect ecologically relevant behaviors in introduced species. We compared the temperature sensitivity of righting response speed, a behavior related to overall movement and important to surviving dislodgment and evading predators, between native and introduced populations of the predatory muricid gastropod, *Urosalpinx cinerea* (Say). Winter minimum temperatures, which set the boundaries of many ecologically important activities, are likely to increase due to climate change. Righting speed of *U. cinerea* was tested under four temperature treatments spanning winter conditions across much of its range (5°C, 10°C, 15°C, and 20°C) using snails from two native range bays (in Connecticut and Delaware) and from three introduced range bays (in Washington and California). Snails took significantly longer to right themselves as temperatures dropped from 20°C to 5°C, with the greatest temperature sensitivity in the interval from 10°C to 5°C. However, this response was broadly similar across source bays, and there was no difference in response between introduced and native range *U. cinerea*. Since the interval of greatest temperature sensitivity coincides with winter minimum temperatures in the introduced range bays, warmer winters brought on by global climate change could extend *U. cinerea*'s active feeding and reproductive periods over a greater proportion of the year, with potential concomitant impacts on native oysters and other prey species in the introduced range.

† **Brodfehrer, J.M.***

DETERMINING ISOTOPIC FRACTIONATION AND TURNOVER RATES OF *FUNDULUS PARVIPINNIS* TISSUES TO CALIBRATE WETLANDS FOOD WEBS

University of San Diego, University of San Diego

Landscape complexity can be analyzed through its food web, which contains numerous connections between consumers and the resources on which they feed. Wetlands are ideal for analyzing these connections as they contain various habitats. Urban development has devastated many wetland areas, reducing their size and leading to species endangerment. The study of food web relationships in wetlands can aid preservation efforts. Analyzing stable isotopic shifts of carbon, sulfur and nitrogen between resources and consumers allows for a calibration of the food web, and information about how that food web and ecosystem work and interacts with adjacent ecosystems. The purpose of this study is to determine the isotopic fractionation rates and turnover rates in the species *Fundulus parvipinnis*, an abundant, keystone species in the wetlands of the Kendall-Frost Reserve located in San Diego, California. *Fundulus parvipinnis* were sampled from one creek in the Kendall-Frost Reserve and kept in seawater tanks with a fixed diet of brine shrimp, for which the isotopic signature was analyzed. Liver and muscle tissues from the fish were analyzed by weekly samplings. The change in isotopic signature of the *F. parvipinnis* was determined and also the rate at which the isotopic shift occurred. The data from this study will yield more accurate details of the fractionation and turnover rates of *F. parvipinnis*, allowing the trophic role of this species in the wetland food web to be more accurately determined, providing integral information about habitat connectivity. This will greatly aid the process of wetland and species preservation.

† **Buck, C.M.***, **Wilkerson, F.P.**, **Parker, A.**, **Marchi, A.**

SEASONAL FLUCTUATIONS IN PHYTOPLANKTON COMMUNITIES AND NUTRIENT LEVELS WITHIN DRAKES ESTERO MARINE CONSERVATION AREA, CA

Romberg Tiburon Center for Environmental Studies, San Francisco State University

Drakes Estero Marine Conservation Area, Point Reyes National Seashore, CA is the only designated marine coastal wilderness on the West Coast of the United States. The shallow low-inflow estuary is surrounded by designated wilderness and historic cattle farms, and is the site of an oyster aquaculture facility. The interplay between local physics and variation in the supply of different forms of nitrogen, both from natural and anthropogenic sources, are hypothesized to lead to shifts in primary production and phytoplankton community

composition (including the promotion of harmful algal bloom species) seasonally. A study was initiated in May 2010 to compare seasonal and spatial variations in the concentrations of nitrate, ammonium, phosphate, silicate, and chlorophyll, phytoplankton species, and rates of primary production in Drakes Estero. The objectives are to characterize phytoplankton species within Drakes Estero and determine how phytoplankton respond to the variable nutrient regimes (with an emphasis on primary productivity and nutrient uptake) within Drakes Estero and to determine if there is a community shift towards Harmful Algal Bloom Species (HABs), and if so under what chemical, biological, and seasonal conditions. The hypothesis is that phytoplankton primary productivity and nutrient uptake rate may be dominated by different species under different seasonal nutrient regimes and with location within Drakes Estero. This study will give an in-depth look at the species supporting primary productivity or negatively impacting the ecology of Drakes Estero, as well as the Farallones Islands by promoting HABs.

† **Burgess, A.***

VECTORIZING ALGAL TOXIN IN MARINE PLANKTONIC FOOD WEBS: SORTING OUT NUTRITIONAL DEFICIENCY FROM TOXICITY EFFECTS

Shannon Point Marine Center, Western Washington University

Harmful algal blooms (HAB) can be detrimental to finfish in fish pens and can close down shellfish beds due to paralytic shellfish poisoning. HAB may also play a role in affecting coastal system productivity. This can only be determined if we can develop a better understanding of the dynamics of algal toxin transfer among components of the food web. Larval crabs can be an important component of the plankton in coastal systems and can ingest toxic algae directly or indirectly by ingesting smaller zooplankton that themselves feed on the toxic algae. This research determined whether the reduction in larval crab survival and delay in development reported on the rotifer-fed toxic algal diet is a function of algal toxin transfer or a consequence of reduced nutritional value of the rotifer. Two rotifer diets were created, one fed *Alexandrium andersoni* (toxic alga); the other *Isochrysis galbana* (non-toxic alga). Feeding rates of larval crabs on these different prey types and selective feeding between the two prey types were determined. To distinguish between toxic and nutritional effects, groups of larvae were fed on various combinations (proportions) of the two prey. Treatments were applied to larvae of *Lophopanopeus bellus* through at least the third zoeal stage. Effects of treatments were compared for stage mortality and duration. Trends in the data show that survival on the different proportions of rotifers are able to support survival through zoeal stages but the molt duration seems to be delayed with the increase of proportion of toxic-algae fed rotifers.

† **Cadwallader, J.A.***, **Long, J.D.**

HERBIVORE EXCLUSION DOES NOT INFLUENCE PRIMARY PRODUCTION IN A SOUTHERN CALIFORNIA SALT MARSH

Coastal and Marine Institute Laboratory, San Diego State University

Although salt marshes are structured by several abiotic and biotic factors, recent work in Atlantic Ocean marshes suggests top-down forces like herbivory can critically shape salt marsh communities. However, the role of large herbivores in Southern California salt marshes is unknown. Such information may be particularly important given that management of these habitats often includes removal that may impact plants via predator release of herbivores. Thus, we investigated the effects of herbivore grazing of salt marsh plants within Sweetwater Marsh (San Diego, CA). To assess feeding preferences of nearby herbivores, we transplanted six marsh plant species to upland sites in choice arrays. To identify herbivores, we deployed infrared cameras within upland habitats. Additionally, we conducted an herbivore exclusion experiment to examine the consequences of vertebrate herbivory in the marsh. Cages were installed in February 2010 and each block contained a control cage, partial cage, and full enclosure cage. Within each replicate, we measured *Spartina foliosa* density, grazing damage, length of marked *Spartina* individuals, and percent cover of plants in May and September 2010. We only observed rabbits and squirrels were observed feeding on transplanted plants with strong preferences for *Spartina*. Surprisingly, we have not observed any treatment effects in the exclusion experiment suggesting large herbivores did not influence marsh plants in Sweetwater during our study. If a lack of grazing persists into 2011, this may suggest that our Pacific Ocean marsh contrasts with Atlantic Ocean marshes, perhaps because of differences in plant defense or herbivore pressure.

† **Callaghan, M. E.**¹, **Philips, T.K.**²

PHYLOGENETIC ANALYSIS OF THE BEETLE GENUS *TRICHIOTINUS* (COLEOPTERA: SCARABAEIDAE) USING MORPHOLOGICAL AND MOLECULAR DATA

1 - California State University Monterey Bay 2 - Western Kentucky University

An evolutionary history of the North American beetle genus *Trichiotinus* was created including all eight species and three outgroup taxa. We combined 11 morphological traits and molecular analyses of CO1 and 28S genes (nearly 150 informative characters) to construct a phylogeny of the genus *Trichiotinus*. Combining molecular and morphological data produced a robust phylogeny describing the evolutionary history of these beetles. Results

show that *Trichiotinus* is monophyletic and composed of two main clades, one with two species (*T. bidens* and *T. lunulatus*: clade 1) and the other with the remaining six species that form two additional clades (clades 2 and 3). North-south and east-west geographic partitioning of lineages may have resulted in speciation events within the genus. The limited distribution of *T. rufobrunneus* within Florida and the presence of *T. viridans* within the Midwest agricultural corn and soybean belt (Fig 8) make these two species of potential conservation concern. Conservation issues may need to be further studied as well as dating speciation events.

† **Castorani, M.C.N.^{1*}, Hovel, K.A.², Williams, S.L.³, Baskett, M.L.⁴, Morgan, S.G.³**

ANTAGONISTIC ECOSYSTEM ENGINEERS AND ALTERNATIVE COMMUNITY STATES IN INTERTIDAL MUDFLATS: AN EMPIRICAL TEST OF SCALE-DEPENDENCE

1 - Bodega Marine Laboratory, University of California, Davis, Coastal and Marine Institute Laboratory, San Diego State University 2 - Coastal and Marine Institute Laboratory, San Diego State University 3 - Bodega Marine Laboratory, University of California Davis 4 - Department of Environmental Science and Policy, University of California Davis

Despite recent attention to the concept of ecosystem engineering, there have been few investigations into the interactions between multiple engineers. We examined the interaction between two groups of engineers as a potential mechanism for generating alternative community states. Intertidal mudflats at Tomales Bay, CA alternate between dense patches of eelgrass (*Zostera marina*) and bioturbated sediments dominated by burrowing thalassinid shrimps (*Neotrypaea californiensis* and *Upogebia pugettensis*). Surveys revealed a negative, nonlinear correlation between eelgrass and shrimp burrows, with sharp transitions across ecotones. We hypothesized that engineering of the sediments determines patterns of spatial heterogeneity and that these patterns represent alternative states. We removed eelgrass at several spatial scales, predicting that large disturbances would be more likely to result in a state switch. To examine patch persistence, we transplanted eelgrass into bioturbated mudflats at several spatial scales, predicting that large transplantations would outperform small transplantations and that changes to sediment conditions would depend upon transplantation size. Preliminary results from manipulations suggest that eelgrass performance depends on patch size. The spatial scale of eelgrass transplantation had a significant nonlinear effect on sediment grain size, indicating the potential for a negative feedback. Additional sampling will reveal whether engineering of sediments will generate unique assemblages and whether the resultant communities persist, with the eventual goal of quantifying the ecological function of these distinct states and modeling the interaction between engineers in an analytic framework. This study represents a novel contribution as one of the few empirical investigations of alternative states in seagrass and soft-sediment ecosystems.

Champieux, T.M.^{*}, Whitcraft, C. R., Allen, B.J.

IF YOU RESTORE IT, WILL THEY COME? RESTORATION OF THE HUNTINGTON BEACH WETLANDS

California State University Long Beach

In an effort to reclaim degraded wetland habitat, the Huntington Beach Wetlands Conservancy restored tidal influence to three marshes (Talbert, Brookhurst, and Magnolia) isolated from tides for almost 100 years. Talbert Marsh was restored in 1989; Brookhurst Marsh in 2009, and Magnolia Marsh in 2010. One portion of our research in these systems evaluates whether the benthic macroinvertebrate communities will return to a pre-disturbance state (as compared to a reference marsh). Twenty years post-restoration, Talbert Marsh resembles other natural marshes in southern California. One commonly accepted theory of marsh community succession is a trajectory from an unvegetated, microalgae and insect-dominated system to a vegetated system with a diverse invertebrate community of detritivores and insects. Given that Brookhurst and Magnolia were restored as a vegetated marsh while Talbert was largely unvegetated pre-restoration, will Brookhurst and Magnolia develop in similar ways and over similar time-scales to Talbert? Within two months of tidal reintroduction, there was increased microalgal biomass and a similar invertebrate community in Brookhurst relative to Talbert, our reference marsh. Our study demonstrates the potential effectiveness of tidal restoration for California wetlands and provides information about efficient and effective methods by which to evaluate the restoration of important marsh ecosystem functions, such as trophic support.

† **Claytor, S.C.^{*}, Muchlinski, A, Torres, E**

GENETIC VARIATION OF THE EASTERN FOX SQUIRREL (*SCIURUS NIGER*) IN CALIFORNIA

California State University Los Angeles

The fox squirrel (*Sciurus niger*) is native to the central and eastern United States and the southern prairie provinces of Canada. It was introduced by humans into many cities within California in the late 1800s and early 1900s. It is likely that each of the introductions was composed of a small number of fox squirrels, however, it remains unknown whether the introduced animals came from one or several regions within the natural geographic range of the species. Information about the genetic diversity, population structure, and potential sources of

northern and southern California fox squirrels is investigated by sequencing the D-loop region of the mitochondrial DNA because of its small genome size and conserved arrangement of genes. As the introductions of fox squirrels to California are very recent, it is expected that the mtDNA haplotypes present in California represent the effective minimum number of founders from each introduction. The source of the introductions of *S. niger* into California has been speculated for some time, yet conclusive evidence is lacking regarding the historical source of these introductions. Some researchers are concerned that range expansion by the non-native fox squirrel may displace the native western gray squirrel (*Sciurus griseus*). This study was conducted to better understand the population genetic structure of the introduced fox squirrel.

Connor, J.L.*

EXTRACTING RESEARCH VALUE FROM VISUAL IMAGES

Monterey Bay Aquarium Research Institute

The ability to quickly and accurately categorize visual images is useful for scientific analysis and documentation of species biodiversity and changes that occur over time. The Monterey Bay Aquarium Research Institute (MBARI) has recorded and archived video and still images from remotely operated vehicles (ROVs) over the past 22 years. In addition, imaging systems are now being developed for autonomous undersea vehicles (AUVs) to allow for more cost-effective collection of data. The ROV videos have been systematically annotated and archived as an institutional asset and the database currently holds over 3 million geo-referenced annotation records. These include identification of organisms and geologic features, as well as notes on morphology, animal behavior, habitat, environment, and human impacts. MBARI's Video Annotation and Reference System (VARS) is used for the creation, storage, and retrieval of the video annotation records. The resulting data archive has proven a valuable scientific resource for publications as well as for exploratory studies, education and outreach. Challenges to be addressed in coming years include: improving scientific analysis processes, e.g., changing depth distributions of individual species; the transition of existing video archives to more accessible digital formats; and increasing access to this wealth of images and information.

† Coyle, T.A.*, Kordas, R.L., Harley, C.D.

CLIMATE CHANGE, SALINITY, AND VARIATION IN COMMUNITY STRUCTURE ON ROCKY SHORES

University of British Columbia

Rising temperatures and changes in precipitation are affecting the spatial and temporal patterns of salinity within the Strait of Georgia, British Columbia. Variations in salinity may directly affect species based on their physiological tolerance or indirectly affect species via changes in inter-specific interactions. Field based herbivore exclusion experiments were performed to explore the relationship between variations in oceanic salinity, herbivore abundance and percent cover of invertebrate and algal species. We found that salinity has a direct effect on the abundance of *Cthamalus spp.*, *Lottia spp.* and *Littorina spp.* The effect of salinity on algal abundance is indirect and driven by herbivory, with treatment effects beginning to emerge in the late summer. The effect on the abundance of *Balanus spp.* is weak and variable. Our results emphasize the importance of community level interactions in determining spatial and temporal patterns of distribution and abundance which may vary with climate change.

† Crossen, SR^{1*}, Zacherl, DC¹, Whitcraft, CR², ¹

RESTORATION OF OLYMPIA OYSTERS: OYSTER SETTLEMENT, SURVIVAL, GROWTH, AND COMMUNITY BIODIVERSITY ON CONSTRUCTED OYSTER BEDS

1 - California State University Fullerton 2 - California State University Long Beach

The Olympia oyster has experienced substantial population declines throughout its range (from Sitka, AK to Baja California, Mexico) since the early 1900's. Our study will test the effectiveness of different restoration techniques for this species in southern California. We hypothesize that Olympia oyster larvae will settle, survive more and will grow faster, and that epifaunal community diversity will be higher on an oyster bed compared to a mudflat and that infaunal diversity will be lower under an oyster bed than a mudflat. To test our hypotheses, we augmented intertidal mudflat with the dead *Crassostrea gigas* shell into 5 replicate experimental 2mX2m plots of two thicknesses, 4cm and 12cm, and two types, bagged/consolidated shell vs. loose shell, plus 5 control plots without shell added (total=25plots). We compared larval settlement among treatment and control plots using settlement arrays deployed onto each plot for two-week periods over summer 2010 following construction of reefs in June 2010. We will also measure oyster survival and growth rates, bed degradation, and will monitor community biodiversity before and after (at 0, 6, 12, 18, and 24 months) construction of experimental plots. The results of this study will contribute to the design of future restoration efforts in southern California.

Cuetos-Bueno, J.¹, Houk, P.², Zgliczynski, B.¹, Sandin, S. A.¹, Smith, J. E.¹

REEF FISHERIES AND THEIR EFFECTS ON REEF FISH ASSEMBLAGES ACROSS THE COMMONWEALTH

OF THE NORTHERN MARIANA ISLANDS

1 - Center for Marine Biodiversity and Conservation, Scripps Institution of Oceanography, UCSD 2 - Pacific Marine Resources Institute

Coral reef fish communities are susceptible to anthropogenic pressure due to habitat degradation and direct extraction through fishing, and understanding the relative importance of each stressor is fundamental for the development of effective management strategies. The present study examines the effects of the near shore fisheries on the coral reef fish assemblages across a clear gradient of fishing intensity in the Mariana archipelago, Western Pacific. We assess these effects using catch-based data collected by PMRI at Saipan's markets, and fish count data collected by NOAA's Coral Reef Ecosystem Division using standard belt transects from 52 sites in 12 islands, ranging from rarely to heavily fished. While far from pristine, the remote northern islands had 3 times the fish biomass of the southern populated islands. Total fish biomass in the southern islands follows a negative gradient associated with distance to Saipan, where 90% of CNMI residents live. Very susceptible to fishing pressure due to their life history, higher trophic level fishes show 40 times less biomass in the southern islands, while herbivores, currently the most harvested trophic level had two times less biomass. Five preferred species that account for 45% of market catch show 4-12 times less biomass in the heavily fished southern islands. Our results suggest that fishing pressure is the main driver of the fish biomass patterns that we founded. By combining socioeconomic surveys with quantitative reef fish surveys we are able to examine how fisheries may be affecting fish populations in these tropical Pacific Islands.

† Davis, S.L.*

EFFECTS OF COLONY SIZE, HABITAT AND HERBIVORY ON THE GROWTH AND SURVIVAL OF JUVENILE CORALS IN MOOREA, FRENCH POLYNESIA

Richard B. Gump South Pacific Research Station, University of California Santa Barbara

Though it is generally agreed that grazing by herbivores can have a positive effect on coral reef communities, incidental removal of corals by herbivores may comprise a significant component of mortality among young corals, influencing coral population and community structure. This study tests the hypothesis that less preferred algal assemblages can act as habitat refuges for juvenile corals, such that an association with a less preferred algal assemblage may reduce incidences of grazer-induced damage and/or mortality, and that the benefits of this association may depend on coral size. To examine the effects of algal associations, colony size, and herbivores on the growth and survival of juvenile corals (genus *Pocillopora*), I placed juveniles from two size classes in treatments with either "preferred" or "avoided" algal assemblages, and used herbivore exclusion cages to examine grazer-induced mortality and damage. After 21 days in the field, I compared initial and final buoyant weights and bite scars to evaluate the original hypothesis. I also used belt transects to estimate local densities of common herbivorous fish and behavioral observations and examine grazing among treatments. Though observations of herbivores revealed differential preferences among algal assemblages, there was little effect of algal assemblage on growth or incidental grazing damage. There was, however, a significant effect of coral size on growth. Recent evidence suggests that incidental mortality and damage may be most influential at very early life stages, thus future studies will examine the potential for herbivory refuges in smaller corals.

Davis, B.M.^{1*}, Salomon, A.K.¹, Watson, J.C.², Lee, L.C.¹, Carpenter, J.³, Drake, M.¹

EFFECTS OF SEA OTTER RECOLONIZATION ON ROCKY INTERTIDAL GRAZER-KELP COMMUNITIES ON BRITISH COLUMBIA'S CENTRAL COAST

1 - Simon Fraser University 2 - Vancouver Island University 3 - Heiltsuk Integrated Resource Management Department

Sea otters are recognized as having dramatic effects on subtidal benthic community structure, however, their impacts on intertidal communities are less well documented. Sea otters were extirpated from British Columbia's coast by 1929, and were re-introduced to Vancouver Island in the 1970's. The first raft to recolonize the central coast of British Columbia was sighted in the Goose Group Islands in 1989. By exerting strong top-down control on benthic communities, the sea otter range expansion in BC has important repercussions ecologically, socio-economically and culturally. In the central coast specifically, the ecosystem effects of sea otter foraging have major implications for the Heiltsuk First Nation who depend on this area's marine resources. In partnership with the Heiltsuk Integrated Resource Management Department (HIRMD), we initiated a preliminary investigation on British Columbia's central coast to determine if sea otters have detectable direct impacts on the density, biomass and behavior of intertidal macroinvertebrate grazers and indirect effects on intertidal kelp density and biomass. Intertidal surveys of macroinvertebrates and kelp (n=10-15 quadrats per site) were conducted at three sites at varying stages of sea otter colonization; not colonized, recently colonized (<10 years), and a site near the first raft documented in 1989. Results of this preliminary survey and future studies may be used to inform the marine use plan for this area.

Deck, A.K.* , Grosholz, E.D.

COMPETITIVE EFFECTS OF SESSILE SPECIES ON OLYMPIA OYSTER DEMOGRAPHY ALONG GRADIENTS IN A CENTRAL CALIFORNIA ESTUARY

Bodega Marine Laboratory, University of California Davis

Competitive interactions are widely studied in ecological communities, and their importance may vary along stress gradients as well as with life history stage. In this study, we investigated competitive effects of the sessile community on the native Olympia oyster, *Ostrea lurida*, in Tomales Bay, California. We explored the cumulative effects of presence of potential competitors on multiple aspects of oyster life history: total recruitment, post-recruitment growth, and juvenile and adult growth and mortality. We investigate these demographic variables, as well as the makeup of the sessile community, along estuarine and tidal height gradients where both physical and biological factors vary. Despite finding variation in oyster demography and the sessile community along these gradients, there were no competitive effects on total recruitment or juvenile and adult growth and mortality. However, presence of competitors did significantly affected post-recruitment growth of oysters. These competitive effects varied along the tidal height gradient but not the estuarine gradient. These results better shape our understanding of how variation in habitat characteristics may influence competitive effects on a target species throughout its life history. As the Olympia oyster is currently a species of interest for estuarine restoration, these results may aid restoration practitioners in planning and designing future projects.

† Degrassi, A.L.* , Smith, J. R., Murray, S.N.

POTENTIAL DRIVERS OF MACROALGAL PREFERENCE IN SOUTHERN CALIFORNIA MARINE CONSUMERS

California State University Fullerton

Marine macroalgal consumers are known to preferentially feed on certain seaweeds. Several factors, including consumers' ability to effectively handle, eat, assimilate, and allocate consumed energy, may drive food choices. Previous research revealed that two southern California consumers, crabs (*Pachygrapsus crassipes*) and urchins (*Strongylocentrotus purpuratus*), fed upon both native (*Macrocystis pyrifera*) and non-native (*Undaria pinnatifida*) kelps; however, when given a choice, crabs chose to feed on *Undaria* while urchins chose *Macrocystis*. The goal of this study was to elucidate potential drivers for these contrasting choices. We hypothesized that observed choices are a function of the specific consumers ability to assimilate and allocate energy from the macrophyte. After a 30-day diet of either kelp, crabs and urchins did not assimilate either kelp differently and only crabs increased growth on its preferred diet. We also expected that consumer choice was partially driven by algal characteristics, such as chemical defense concentrations, organic and caloric content, and tissue toughness. Nutritional quality was relatively similar in both seaweeds but, the thinner *Undaria* blades were easier to tear and puncture. Our results suggest that crabs may prefer *Undaria* as it resulted in higher growth and may be easier to manipulate and consume. No clear drivers were discerned for urchins but, speculatively, may be attributed to the co-evolutionary relationship with the *Macrocystis* in which it associates with. Our results suggest that mechanisms behind food choices likely differ among taxa.

† DeGroot, A.M.^{1*}, Kolupski, M.L.¹, Fox, M.D.², Gray, S.C.¹

TEMPORAL AND SPATIAL VARIATION IN SEDIMENT TEXTURE ON CORAL REEFS, US VIRGIN ISLANDS

1 - University of San Diego 2 - Moss Landing Marine Laboratories

Previous studies have shown that sedimentation can negatively impact corals. However, the degree of sediment stress may be affected by sediment texture (grain size). For example, finer grains may be more detrimental because corals expend more energy removing them from their tissues, but coarse grains can be extremely abrasive. This study is part of a larger ongoing research project that monitors the impact of watershed development and mitigation of land-derived sedimentation on coral reefs in St. John, US Virgin Islands. We examined the factors affecting the spatial and temporal variability in sediment texture and the rate of fine (<63 microns) and coarse (63-1000 microns) sediment accumulation on coral reefs. The textural parameters (grain size distribution, % clay, silt, and sand) of sediment samples collected every three weeks between 8/08-3/09 were determined using a Beckman-Coulter LS200 Laser Particle Sorter. On reefs below developed watersheds, the bulk sediment accumulation in the sediment traps was significantly higher, and the sediments were finer and contained a greater proportion of clay compared to those below undeveloped watersheds. Though the mean bulk sediment trap accumulation rates in one reef below a developed watershed (Fish Bay) were high enough to cause "significant sediment stress" (109 ± 30 SE mg/cm²/day), the rates of fine (<63 microns) sediment accumulation at all reefs were less than 7 mg/cm²/day, which is below the rate shown by Weber et al. (2006) to cause photosynthetic stress. However, corals in Fish Bay may have been exposed to potentially damaging rates of coarse sedimentation.

† Domingos, A.M.* , Anderson, S.

EFFECTS OF TIDAL RESTRICTIONS UPON TIDAL PRISM AND WATER QUALITY WITHIN A REMNANT

SOUTHERN CALIFORNIA ESTUARY: MUGU LAGOON

California State University Channel Islands

Mugu Lagoon is one of the largest remaining wetlands within Southern California and suffers from varying degrees of tidal restriction. The vast majority of the world's lagoons have been severely altered or destroyed via an array of anthropogenic forces. Lagoon destruction and alteration degrade habitats for many species of marine mammals, fish, and birds. Southern Californian lagoons suffer anthropogenic alteration throughout their watersheds. Urban and agriculture runoff, dams and channelization along the tributaries, and fragmentation restricting tidal flow within the lagoon act collectively to produce complex hydrology's difficult to model. Despite this degradation, these lagoons serve a vital role improving water quality as it flows into the ocean. Southern California has had some of the greatest challenges protecting and preserving its coastal lagoons due to its increasing population, urbanization, and agriculture practices. The effects of increasing restrictive tidal fluctuation upon volume exchange, tidal height, and water quality have drastically altered coastal lagoons throughout the Southern California Bight. This study examined the drainage ditch that flows toward the Ormond Wetland, which is an exceptionally important site. Restoration efforts are being proposed to restore tidal flow from Mugu Lagoon to Ormond Wetland, which currently does not have a tidal flow associated with it. The tidal flow is severely restricted within the far reaches of Mugu Lagoon. Restoration efforts of Ormond Wetland will need to focus on restoring tidal flow throughout Mugu Lagoon in order to restore tidal flow to Ormond Wetland.

Eckert, G.L.*

INTERDISCIPLINARY GRADUATE EDUCATION IN MARINE SCIENCE & THE MARINE ECOSYSTEM
SUSTAINABILITY IGERT IN ALASKA

University of Alaska Fairbanks

The National Science Foundation's Integrative Graduate Education and Research Training (IGERT <http://www.igert.org>) program provides an excellent opportunity for funding graduate programs in marine science. Because ocean sciences are inherently interdisciplinary, they are well suited to this NSF program, although relatively few marine-related IGERTs exist. IGERTs offer \$30K per year fellowships plus a cost of education allowance to PhD students. Many IGERTs observe that the quality of their applicants and interest in graduate programs increase. At the University of Alaska Fairbanks IGERT in marine ecosystem sustainability, trainees gain a broad background in fishery science, ecology, marine science, marine policy, economics, and anthropology to complement their own specialized expertise acquired through dissertation research and study. Training and research addresses ecosystem-based solutions to critical research and stewardship questions in the sustainable use of living marine resources, skills that are critically needed in today's society. * Students collaborate on research that transcends traditional disciplinary boundaries. * They learn to address the unique challenges of ecosystem-based management and to understand its implications for society.* The program challenges students to develop innovative approaches to pressing real-world problems. * Course work includes marine ecosystem science, traditional ecological knowledge, fisheries management, and resilience theory. * Students have opportunities to mentor Alaska Native and rural Alaskan undergraduates. The UAF IGERT is actively recruiting PhD and MS students through 2012. <http://www.uaf.edu/mesas>.

Edwards, C.B.^{1*}, Friedlander, A.F.², Sandin, S.A.¹, Williams, I.D³, Smith, J.E.¹

A GLOBAL ASSESSMENT OF CORAL REEF HERBIVORES: EVIDENCE OF FISHING EFFECTS ON THE BIOMASS OF TAXONOMIC AND FUNCTIONAL GROUPS

1 - Scripps Institute of Oceanography, Scripps Institution of Oceanography, UCSD 2 - Coral Reef Ecosystem Division, National Oceanic and Atmospheric Administration (NOAA) 3 - Hawaii Cooperative Fishery Research Unit, Dept Zoology, University of Hawaii

Resilience and restoration strategies for threatened and degraded coral reefs will be most useful if realistic management targets are accurately determined. Evidence suggests herbivores may be a useful mechanism for maintaining or rebuilding reef resilience. However, little is known about how fishing alters herbivore biomass or community structure. We conducted a global meta-analysis on the variability in biomass of key taxonomic and functional groups and examined variation between fished and unfished locations at global and regional scales. An exhaustive search of peer reviewed literature and collaboration between SIO and US governmental monitoring programs was used to create a dataset including over 700 estimates of biomass from 107 locations around the globe. Herbivore biomass at unfished and fished sites was 46.2 ± 6.3 and 16.1 ± 1.1 g/m², respectively, and independent of regional effects. Functional group analysis shows significantly greater biomass of the scraper/excavator sub-guild at unfished sites relative to fished sites (25.51 ± 5.7 and 4.43 ± 0.4 g/m², respectively), also independent of regional effects. Results suggest over-exploitation of fish resources has large impacts on herbivorous fish assemblages and disproportionately effects the scraper/excavator sub-guild. Evidence suggests scraping and excavating species are especially important in maintaining low fleshy algal abundance and promoting crustose coralline algae and coral recruitment, supporting the view that restoration strategies must maintain

subgroups in proper ratios. Given the important role that herbivores play in maintaining the balance between algal and coral cover these results have significant implications for the development of management strategies to improve the resilience and restoration of the world's coral reefs.

† **Efird, T.P.***, **Konar, B**

BIOGEOGRAPHY OF KELP FOREST FISH COMMUNITIES ALONG THE ALEUTIAN ARCHIPELAGO, ALASKA.
University of Alaska Fairbanks

Kelp forests fish communities of the Aleutian Islands have had to cope with great changes to their habitat over the last two decades. The majority of scientific effort in this system has been focused on the algae, urchin, and otter paradigm. Biogeographic breaks in marine fauna along the island chain have also been described based on deep, offshore surveys and attributed to the surrounding oceanography. Kelp forest fish communities are the missing feature in both of these system wide examinations. The objectives of this study were to assess the current state of kelp forest fish community structure along the Aleutian Archipelago, determine what habitat characteristics might be important to these fishes, and see if the observed communities corroborate published biogeographic breaks. To address these objectives diver based visual transect surveys were performed at 30 sites from Unalaska Island to Attu Island, Alaska. Two 100m² transects were run at each site, recording fish biodiversity and abundance as well as physical and biological habitat characteristics. Principle component analysis shows a distinct break in habitat type and fish communities at Samalga Pass. Abundances of Gadids, Hexagrammids, Sebastids and Cottids differed on either side of the pass, as did the abundances of algae and sessile invertebrates, as well as water temperature and salinity. The location of this break agrees with published biogeographical breaks of offshore fauna; however the analysis suggests that the current urchin or kelp regime status affects resident fish communities in addition to oceanographic forces.

† **Elsberry, L.A.***, **Burnaford, J.L.**

THE EFFECTS OF LOW-TIDE EXPOSURE ON THE HIGH INTERTIDAL ALGA *ENDOCLADIA MURICATA* IN TWO GEOGRAPHIC REGIONS

California State University Fullerton

The abundance and distribution of an alga within its geographic and tidal range is partially determined by the abiotic conditions it experiences during low tide. For example, the ability of an alga to photosynthesize when re-immersed after experiencing heat and desiccation stress during low tide can affect the alga's growth and survival. The alga *Endocladia muricata* occupies high rocky benches along the US West Coast, and populations in different regions can experience very different environmental conditions due in part to the timing of exposure during summertime low tides. We compared the distribution and abundance of *E. muricata* at sites in southern California and Washington and examined the effects of low-tide exposure on the photosynthetic recovery of individuals from each region. We conducted field surveys at four sites in each region in which we quantified the percent cover and reproductive status of *E. muricata*. In the lab, we measured the photosynthetic recovery of *E. muricata* from each region after exposure to simulated low tide conditions at three temperatures (20, 30, and 40°C). In the field, overall cover of *E. muricata* was higher at sites in Washington than at sites in southern California. Individuals from the different regions showed differences in their ability to recover from simulated low tides. Overall, both temperature and level of thallus hydration affected photosynthetic rates. Global climate change is predicted to cause increased temperatures which may cause high mortality in intertidal algae, such as *E. muricata*.

† **Evans, L.***

THE BIOACCUMULATION OF COPPER AND ZINC IN GIANT KELP AND THE SUBSEQUENT TROPHIC TRANSFER TO GRAZERS

Coastal Waters Marine Lab, San Diego State University

Heavy metal pollution from anthropogenic activities is a major threat to the health of marine ecosystems worldwide. Many negative impacts from heavy metal pollution on marine organisms have been observed as organisms absorb metals from their environment. When algae acquire heavy metals through bioaccumulation these metals can move up the food chain and become bioavailable to invertebrates by consumption (i.e. biomagnification). This is known as trophic transfer and its effects are still being debated. In this study we observed the accumulation of copper (Cu) and zinc (Zn) by giant kelp, *Macrocystis pyrifera*, and purple urchins, *Strongylocentrotus purpuratus* directly from the water, and the trophic transfer of these metals from *M. pyrifera* to *S. purpuratus*. Accumulation in urchins was tested in two different tissue types: gonad (G) and vascular system (VS) tissue. Accumulation for both Copper and Zinc, in urchin tissues, was higher in the VS than in G.

† **Fisher, K.C.***, **Martone, P.T**

GROWTH AND CALCIFICATION RATES OF THE INTERTIDAL CORALLINE ALGA *BOSSIELLA PLUMOSA*
University of British Columbia

Calcified red algae are major components of rocky intertidal zones along the outer coast of British Columbia, dominating wave-swept areas, providing habitat for intertidal fauna, and playing host to many intertidal epiphytes. Known for their ability to precipitate CaCO_3 from seawater and incorporate it into their cell walls, the contribution of coralline algae to limestone deposits is well documented throughout the fossil record. As atmospheric CO_2 increases and ocean pH decreases, corallines may be unable to precipitate CaCO_3 and incorporate it into their tissues, raising concerns that growth rates and abundance of coralline algae will decline in the future. In order to establish baseline data on current growth and calcification rates, I vitally stained coralline fronds in the field with Calcofluor White and monitored them for one month. Here I report growth and calcification rates of the intertidal articulated coralline *Bossiella plumosa* at Botanical beach on Vancouver Island. By quantifying new tissue generated since stain application, I determined the growth rate of randomly selected fronds of different size classes. From this data I calculated a minimum age of plants of various sizes, an important factor in determining the rate of turnover along the shore. In addition, I calculated calcification rates to estimate the effect of *Bossiella plumosa* on carbon cycling and storage at the site. By providing baseline data on growth and calcification rates of this common coralline alga, this study will help us anticipate the potential impact of ocean acidification on intertidal communities and nearshore carbon budgets.

Fletcher, N.C.^{*}, Raimondi, P.T., DaCosta, C.M., Redfield, M.A., Worden, S.E.

AN OVERVIEW OF ROCKY INTERTIDAL MONITORING FOR THE NORTH CENTRAL COAST MPA BASELINE PROGRAM

Long Marine Laboratory, University of California Santa Cruz

The Marine Life Protection Act mandates the establishment of a network of Marine Protected Areas (MPAs) along the California coast. The most recent addition to this network are 25 MPAs spanning the north central coast from Pigeon Point to Point Arena. This follows the 2007 implementation of MPAs within the Central Coast MPA Study Region. The collection of baseline data is an important part of evaluating their effectiveness and informing adaptive management. These data are being collected by the North Central Coast MPA Baseline Program, a collaboration of 11 monitoring groups working in diverse marine habitats and on socioeconomic issues. The rocky intertidal is among these diverse habitats being assessed and is arguably the most sensitive area to land-based and human activities. The intertidal monitoring group collecting baseline data for the north central coast MPAs is based out of UC Santa Cruz and operates in collaboration with two existing large-scale monitoring groups, PISCO (Partnership for Interdisciplinary Study of Coastal Oceans) and MARINE (Multi-agency Rocky Intertidal Network). PISCO and MARINE monitor over 100 intertidal sites along the west coast of North America from Alaska to Baja California, including baseline monitoring sites within the Central Coast MPA Study Region established in 2007. Approximately 15 new intertidal monitoring sites are being established within the North Central Coast MPA Study Region. These new sites will be monitored using existing MARINE and PISCO long-term monitoring protocols. Key elements of this intertidal monitoring program include assessment of biodiversity, community structure, and species of special interest.

Flores, V.R.^{1*}, Glazier, A.², Jennings, R.², Etter, R.²

POPULATION STRUCTURE OF THE ABYSSAL PROTOBRANCH BIVALVE *LEDELLA ULTIMA* IN THE WESTERN NORTH ATLANTIC

1 - Humboldt State University 2 - University of Massachusetts Boston

The deep-sea (below 200 m) is the most common environment on Earth, yet only recently have studies addressed evolutionary processes responsible for the highly diverse, endemic fauna found in this region. This issue was addressed in the past by analyzing geographic patterns of haplotype diversity using formalin fixed museum specimens that were sampled in the 1960s. Although high diversity was found throughout all regions, population structure was only evident in the upper bathyal region, but not in the lower bathyal or abyssal regions. To further investigate population divergence plus analyze temporal population variation, we amplified and sequenced a fragment of the 16S rRNA gene from samples of the lower bathyal/abyssal protobranch bivalve *Ledella ultima*. These were collected in 2008 from the same sites as the 1960s and preserved in ethanol. As in the past, high haplotype diversity was found throughout all regions. AMOVAs revealed no significant differences among any of the sampled populations. There was no evidence for divergence in current populations of *L. ultima*, nor for changes in the populations since the 1960s. Our results suggests that there is little opportunity for divergence at abyssal depths, and this region may play only a minor role in the evolution of the highly diverse deep-sea fauna.

Flores, D.C.^{*}, Loke-Smith, K.A., Lowe, C.G., Young, K.A.

APOPTOSIS MEDIATES GONADAL RECONSTRUCTION DURING SEX TRANSITION IN CALIFORNIA SHEEPHEAD (*SEMICOSSYPHUS PULCHER*)

California State University Long Beach

California sheephead are commercially and recreationally important monandric labrids. While it is well understood

that these protogynous fish can undergo a female-to-male sex change, little is known about cellular processes that mediate the transformation of ovarian into testicular tissue. We hypothesized that programmed cell death, or apoptosis, mediates this process. Sheephead gonads were examined from individuals caught during the breeding season and an in situ terminal transferase-mediated end labeling (TUNEL) assay was used to determine the degree of apoptosis across transitional stages. Sheephead were classified based on gonadal morphology into female, early, mid, and late transitionals, and males. Gonad mass, GSI, and plasma estradiol concentrations were significantly higher in females than all other groups ($p < 0.05$); whereas, plasma 11-keto testosterone concentrations were lower in females as compared to mid and late transitionals and males ($p < 0.05$). The number of TUNEL-positive cells normalized to gonadal area was low in females, but increased significantly in early and mid transitionals ($p < 0.05$) before returning to lower levels in late transitionals and males that did not differ from female counts ($p > 0.05$). While early and mid transitional fish exhibit structures characteristic of both male and female gonads, TUNEL-positive cells were noted most prominently in degrading follicles, with developing spermatocysts displaying low to no indicators of apoptosis. The increase in TUNEL-positive cells during early and mid transition stages suggests that apoptosis mediates removal of follicular tissue during transition from ovary to testis in California Sheephead, and may be a critical step in gonadal remodeling.

† **Fox, E.J.^{*}, Espasandin, C.L., Whitcraft, C., Lowe, C.G., Allen, B.J.**

QUANTIFYING TROPHIC SUPPORT FOR CALIFORNIA HALIBUT IN A RESTORED COASTAL WETLAND AS A METRIC FOR RESTORATION SUCCESS

California State University Long Beach

Loss of coastal wetlands and their associated services during the past century has been extensive. To offset such habitat loss, restoration and mitigation are increasingly used as potential solutions. Post-restoration monitoring and assessments typically focus on structural attributes of the restored habitats, but recent research has emphasized the importance of evaluations that also include ecosystem function. In this study, the recovery trajectory of a recently restored salt marsh in Southern California was assessed with respect to a reference marsh in the same wetland system that was restored 20 years ago. In addition to measuring structural attributes that include fish and benthic macroinvertebrate community structure and seagrass cover, we used stable isotope and gut content analyses of juvenile California halibut (*Paralichthys californicus*) to quantify the development of trophic support for this key focal species. Protected embayments along the California coast are believed to function as critical nursery habitats that promote increased survival and growth of juvenile halibut. Developing effective tools for assessing restoration performance in coastal wetland habitats will be instrumental in ensuring the sustainability of this commercially and recreationally exploited species. The generality of our methods suggests that they may be applicable in a variety of restored systems and habitat types thus providing valuable information about restoration success to land managers and ecologists.

† **Frolli, E.E.^{1*}, Benson, S.², Webb, L.³, Carroll, D.³**

DEVELOPING A METHOD TO ESTIMATE ABUNDANCE OF *AURELIA AURELIA* IN SURFACE WATERS OFF CENTRAL CALIFORNIA

1 - *California State University Monterey Bay* 2 - *NOAA's Monterey Bay National Marine Sanctuary* 3 - *Moss Landing Marine Laboratories*

We tested the efficacy of an automated method to quantify aggregations of moon jellyfishes, *Aurelia aurelia*, from the surface to 2m depth from aerial photographs taken during fall line transect surveys. These surveys were conducted to assess distribution and abundance of leatherback turtles, *Dermochelys coriacea*, that migrate long distances to forage on jellyfishes. Photographs with known scale were taken with a belly-mounted, high resolution, digital still camera. The color range of moon jellyfishes was determined in a test photograph and a Matlab program was used to quantify the number of pixels within the designated color range. Prior mean bell diameter data for moon jellyfishes captured off central California were used to calculate number of pixels per jellyfish at the scale of the photograph, assuming horizontal orientation. Dividing the number of pixels containing jellyfish by pixels per jellyfish provided an estimate of the total number of jellyfishes in the photograph. Jellyfishes were manually marked with a point feature in ArcGIS to obtain a proxy total number of jellyfishes of 8884 where as the Matlab program produced an estimate of 5926, underestimating the count by 33.3%. Size distribution of jellyfishes is likely to vary from year to year and the automated method results may improve if annual jellyfish bell diameter data are available. We conclude that the automated method has potential to provide a repeatable, unbiased, and efficient method to track significant changes in the abundance of moon jellyfishes in future years, thus allowing critical leatherback habitat to be refined.

† **Gatza, B.^{*}, Muchlinski, A.**

THE EASTERN FOX SQUIRREL AS AN INVASIVE SPECIES: APPEARANCE AT RANCHO SANTA ANA BOTANIC GARDEN, CLAREMONT, CA

California State University Los Angeles

A population of western gray squirrels (*Sciurus griseus*) existed on the campus of California State Polytechnic University in Pomona, CA for over 40 yrs. Although this population was replaced by introduced eastern fox squirrels (*Sciurus niger*) over a period of less than 4 years, detailed information on population sizes over time was not obtained. This current study follows the appearance of *S. niger* at Rancho Santa Ana Botanic Garden in Claremont, CA, where a population of *S. griseus* has existed for many decades. We are conducting a monthly census of both species of tree squirrels using three transect lines within the Botanic Garden. We report on the change in the population size of *S. griseus* and *S. niger* over a period of 14 months. The number of *S. niger* has gradually increased over time with juvenile animals first observed in November of 2009. The number of *S. griseus* has gradually decreased while the total number of squirrels on the study site has remained fairly constant over time. This study is a test of a Habitat Suitability Model to determine if the Botanic Garden will be a coexistence site for the species or whether *S. niger* will replace *S. griseus* at the location.

Gilman, S.E.^{1*}, Johnson, M. W.², Nakayama, S.², Carrington, E.³

THE EFFECT OF TEMPERATURE ON THE FEEDING BEHAVIOR OF THE INTERTIDAL SNAILS NUCELLA OSTRINA AND NUCELLA LAMELLOSA

1 - Friday Harbor Labs, The Claremont Colleges 2 - Scripps College 3 - Friday Harbor Labs, University of Washington

Climate change is expected to have broad consequences for intertidal communities, however few studies have examined the effect of temperature on interactions between species. On the Washington coast, the snails *Nucella lamellosa* and *N. ostrina* play a fundamental role in determining the spatial distribution of the barnacle *Balanus glandula*. We hypothesized that temperature changes could alter the feeding rates of these snails and thus the predation experienced by *B. glandula*. We separately tested the effect of water temperature, low tide exposure, and air temperature during low tide, on the time for a snail to feed on a barnacle. We found that the ratio of snail aperture size to barnacle operculum size was positively correlated with feeding duration. Increasing water temperature from 8C to 11C reduced feeding duration for *N. lamellosa* but had no effect on *N. ostrina*. Increasing air temperature during low tide from 11C to 21C increased *N. lamellosa*'s feeding duration, but decreased it for *N. ostrina*. Our results suggest feeding behavior show markedly different responses to air and water temperature changes, with little consistency between species.

† **Gosnell, J.S.^{*}, DiPrima, J.B.**

THE IMPACT OF HABITAT COMPLEXITY ON CONSUMPTION AND DISTRIBUTION OF THE EMARGINATED DOGWHELK, NUCELLA EMARGINATA

University of California Santa Barbara

Habitat complexity is an element of ecological systems that can influence available resources, niche spaces, and species interactions. However, the impact of complexity on predators in intertidal sites has not been evaluated. Predation is an important process in these communities, and large natural gradients in complexity exist and may influence consumption rates. Habitat complexity may also alter the impact of other factors, such as top predators and wave action, on the survival and distribution of mesopredators. We examined how mussel bed complexity influenced whelk (*Nucella emarginata*) growth, survival, and consumption of mussels (*Mytilus californianus*) and their relationship to a keystone intertidal predator (*Pisaster ochraceus*). Results indicated that whelks prefer a greater degree of habitat complexity because it can provide an abundant, accessible food source, refuge from predation, and shelter from wave action. These results suggest habitat complexity may be an overlooked factor influencing the community dynamics of intertidal sites.

† **Gruman, C.A.^{*}, Salomon, A.K.**

INVASIVE PREDATORS AND CROSS-SYSTEM TROPHIC CASCADES

Simon Fraser University

Normal 0 false false false MicrosoftInternetExplorer4

In some island systems, invasive Norway rats (*Rattus norvegicus*) have been shown to directly reduce seabird densities, which indirectly causes proliferation of intertidal invertebrate grazers (snails and limpets) and intertidal macroalgae to decline. This cross-system trophic cascade has been shown to cause intertidal community structure to switch regimes from algal dominated- to invertebrate-dominated. We quantify the magnitude of these indirect effects in Gwaii Haanas National Park Reserve and Haida Heritage Site, where invasive Norway rats have proliferated on some islands and have significantly impacted marine avifauna. We present data from intertidal transect surveys that compare abundance of dominant algal species, sessile invertebrates and conspicuous grazers between islands with and without rats. Information about how depletion of avian predators is affecting key trophic interactions within this particular system, will help inform upcoming management program for Norway rats in Gwaii Haanas National Park Reserve and Haida Heritage Site, British Columbia.

† Hameed, S.O.^{1*}, Baty, J.H.², Doerr, A.N.², Holzer, K.A.²

ASSESSING COMMUNITY-LEVEL VULNERABILITY TO CLIMATE CHANGE FOR MANAGEMENT AT POINT REYES NATIONAL SEASHORE

1 - Bodega Marine Laboratory, University of California Davis 2 - University of California Davis

Global climate change and its unknown consequences for natural communities in specific locations pose major challenges to conservation management. Assessing the vulnerability of natural communities to climate change involves predicting the degree to which natural communities will be exposed to environmental changes as well as identifying communities' sensitivity to those environmental changes they will experience. Point Reyes National Seashore is taking a proactive approach to the challenge of managing natural communities in the face of climate change by pursuing a site-specific climate change vulnerability assessment. The assessment will provide the basis for prioritizing management decisions in the park. In order to capture the vulnerability of the park's natural communities to future climate scenarios, we have partnered with scientists and managers at Point Reyes National Seashore to take a multi-faceted approach: 1) We are surveying scientific experts regarding how climate changes pose a threat to 14 communities in the park. 2) We are quantitatively comparing vegetation community distribution predictions of niche models and dynamic vegetation models. 3) We are mapping predicted sea level rise onto vegetation communities at the park and analyzing the potential impacts to the park's communities. 4) We are assessing the vulnerabilities of some individual species to climate changes using NatureServe's Climate Change Vulnerability Index. With this four step approach we are developing an important management tool for the park and simultaneously creating a road map for other conservation managers to effectively consider the implications of climate change when prioritizing management decisions.

† Hessing-Lewis, M.L.^{*}, Hacker, S.

A BLOOMIN' GOOD TIME ON THE OREGON COAST; *ULVOID* SPP. MACROALGAE PATTERNS ALONG AN UPWELLING GRADIENT

Hatfield Marine Science Center, Oregon State University

Blooms of *Ulvoid* spp. macroalgae in coastal waters have been increasing globally as a result of land-based eutrophication. Such "nuisance" algae blooms are often associated with changes in community structure, such as declines in seagrass beds. Along the exposed coasts of Washington and Oregon we assessed patterns of macroalgae and their potential relationship to a coast-wide gradient of upwelling intensity. We found that macroalgae biomass was highest in the Southern Oregon estuaries (Coos Bay, Yaquina Bay), where upwelling is strongest. In Northern Oregon (Netarts Bay) and Southern Washington (Willapa Bay) we found that macroalgae biomass was very low. From 2008 to 2009 annual ranges of mean macroalgae volume varied from 300-1200 mL 0.25m⁻² in Coos Bay, 1100-2100 mL 0.25m⁻² in Yaquina Bay, 15-19 mL 0.25m⁻² in Netarts Bay, and 15-160 mL in Willapa Bay. Across this spatiotemporal gradient in macroalgae productivity we found no correlation with eelgrass density or percent cover. A 10-year time series also shows that eelgrass demography in Coos Bay is uncorrelated with marine nutrient inputs and macroalgae blooms. These trends demonstrate that eelgrass is not responding negatively to upwelling-influenced macroalgae blooms, as has been observed in other eutrophied estuaries.

† Hidalgo, G., Thomas, E.J.^{*}, Shaner-Thompson, S., Anderson, S.

COMPARING AERIAL INSECT PRODUCTIVITY ACROSS SOUTHERN CALIFORNIA WETLANDS

California State University Channel Islands

California's wetlands have been greatly reduced over the past 200 years, with less than 9% of historic wetland area remaining. Most remaining marshes are degraded due to human influences such as invasive species, landscape fragmentation, etc. In the past three decades, wetland restoration has gained in popularity, but issues such as rigorously defined performance metrics used to evaluate that restoration effort and basic data collection still need to be resolved. Insect productivity is a promising indicator of the ecological functioning of marshes, with aerial arthropods recognized as key components of both terrestrial and aquatic ecosystems. To this end, we measured insect productivity by deploying sticky traps along 30m transect tape at 10m intervals across various sites. By monitoring productivity we can monitor food chain health how it compares to overall wetland health. Insect sticky traps were placed across various wetlands in three southern California counties: Mugu Lagoon and Ormond Beach (Ventura), Malibu and Biona (Los Angeles), and Carpinteria (Santa Barbara). Results were collected as biomass per m² produced per day, and operationally defined according to insect size, species, and morphology. Results show that biodiversity and biomass depend on plant composition of the surroundings, with species richness and individual count positively corresponding with increased wetland health. These efforts are also among the first in rigorously measuring insect populations through various time points and across a wide range of wetlands in Southern California in a way that is inexpensive, efficient, and provides a proficient ecological indicator for wetland productivity.

† **Hiebert, T.C.***, **Bingham, B.L.**

HETEROTROPHIC FEEDING IN SYMBIOTIC AND APOSYMBIOTIC *ANTHOPLEURA ELEGANTISSIMA*
Shannon Point Marine Center, Western Washington University

The temperate anemone, *Anthopleura elegantissima* is facultatively symbiotic with two distinct types of algae: zooxanthellae (*Symbiodinium muscatinei*) and zoochlorellae (*Elliptochloris marina*). Symbiotic *A. elegantissima* potentially benefit from this relationship by receiving excess photosynthate from their algal partners. Nonsymbiotic (aposymbiotic) individuals host neither algae and must rely solely on external food sources. Given their complete dependence on heterotrophic feeding, we predicted that aposymbiotic *A. elegantissima* would be more effective at capturing and consuming prey. Symbiotic and aposymbiotic *A. elegantissima* were exposed to high or low light treatments. We then fed them and measured ingestion time, digestion time, and assimilation efficiency. Preliminary results suggest, contrary to our expectations, that aposymbiotic anemones are less efficient predators with longer ingestion times than symbiotic anemones. Digestion times were longer for all individuals in low light treatments regardless of symbiotic state. Symbiotic anemones overall had slightly higher assimilation efficiencies than aposymbiotic anemones, but light levels appear to have little effect. Our results suggest symbiotic algae hosted by *A. elegantissima* may not only provide carbon to the host anemone, but may also boost heterotrophic feeding efficiency.

Iacchei, M.*, **Bird, C.E.**, **Conklin, K.Y.**, **Toonen, R.J.**

DOES SIZE MATTER, OR IS MORE ALWAYS BETTER?: EFFECTS OF 'OPIHI (*CELLANA SANDWICENSIS*)
SIZE AND DENSITY ON INTERTIDAL COMMUNITIES

Hawaii Institute of Marine Biology

Despite debates regarding the exact extent and severity of species declines, there is an overwhelming consensus that human impacts on marine ecosystems have decreased individual abundance and altered the size structure of harvested species worldwide. However, few studies have examined the effects that these changes have on the ecological community in which these fisheries species reside. Here, we experimentally simulated two commonly used fisheries management strategies (size limits and total allowable catch or bag limits) to investigate how they affect ecological community structure when applied in a controlled setting. We manipulated size (15mm, 45mm) and density (20/m², 40/m²) of yellowfoot 'opihi (*Cellana sandwicensis*) in a fully factorial manner using 36 field enclosures (0.25m²) located along the North Kona coastline of Hawai'i Island. Yellowfoot 'opihi are the most prized of three endemic limpet species found in the main Hawaiian Islands, and are harvested commercially, recreationally, and for subsistence. These species have been a unique part of the culinary culture of Hawai'i for over a century, but their populations have been steadily declining, despite short generation times, rapid growth rates, and harvest regulations. We evaluated algal community changes using photo quadrats, and also tracked growth rates within each treatment. Our preliminary results after 2 months suggest differences in community composition among treatments that may be influencing growth and survival in this species. These data will directly inform current management decisions in Hawai'i for this species.

Jacinto, D.M.*, **Lee, K.H.**, **Torres, E.**

PHYLOGEOGRAPHY OF THE BIOLUMINESCENT OSTRACOD *VARGULA TSUJII* (MYODOCOPIDA:
CYPRIDINIDAE) IN CALIFORNIA.

California State University Los Angeles

Vargula tsujii is a bioluminescent cypridinid ostracod crustacean with a reported range from Baja California to Monterey Bay (Kornicker & Baker 1977). This species nests within a large and diverse clade of bioluminescent signaling species from the Caribbean; no other bioluminescent cypridinids are known from the Pacific Coast of the Americas. *Vargula tsujii* diverged from its Caribbean relatives prior to the emergence of the Isthmus of Panama (2-5 mya). We have collected *V. tsujii* in kelp beds at Santa Catalina Island, the Port of Los Angeles Harbor in San Pedro, and in Mission Bay at San Diego; our attempts to collect it north of Los Angeles have been unsuccessful. We have been unable to locate any published reports of its occurrence between Los Angeles and Monterey Bay. In Southern California, haplotype diversity in mtDNA cytochrome oxidase I is moderate, with maximum sequence divergence of 2.86% between samples from San Diego and Los Angeles. There appears to be some genetic structure in the Southern California populations. More intense sampling, especially from deeper waters, might improve our chances of collecting *V. tsujii*. The distribution of the plainfin midshipman fish *Porichthys notatus* (Batrachoideidae) that consumes *V. tsujii* for its bioluminescence suggests that *V. tsujii* should still be present north of the Los Angeles region.

Kacev, D.^{1*}, **O'Malley, R.¹**, **Bear, M.²**, **Lewison, R.¹**

PHOTOGRAPHIC-BASED POPULATION ASSESSMENT FOR SEVENGILL SHARKS IN SAN DIEGO

1 - San Diego State University 2 - Sevengill Shark Sightings

Since 2008, sevengill sharks have been more commonly sighted by SCUBA divers in near-shore San Diego

County waters. The reasons for increased sighting frequency are unknown, but it has attracted the interest of local media and dive communities. For the past two years, divers have been asked to report and record sevengill sightings and photographs in a central database. Using a spot recognition pattern originally developed by NOAA and commonly employed with other large marine species, we are working to individually identify sharks based on recognizable spotting patterns. The photographs collected in the first year will be used to make minimum population size estimates. As we continue to collect data and pictures, we will use the photos as mark and recapture events and will make additional population estimates based on established mark-recapture equations including the Peterson method as well as Cormack-Jolly-Seber models. This project capitalizes on an opportunity to engage the local community as “citizen scientists”, providing valuable data and educating local divers.

† **Kehrier, C.L.***, **Dickson, K.A.**

EXTRA-OCULAR MUSCLES AS A POSSIBLE SOURCE OF HEAT FOR CRANIAL ENDOTHERMY IN LAMNID SHARKS

California State University Fullerton

In lamnid sharks, orbital *retia mirabilia* conserve metabolic heat, allowing elevation of eye and brain temperatures above ambient water. Warm blood transported from the locomotor red muscle to the orbital *retia* contributes some heat, but an additional source of heat is needed to maintain cranial temperatures at levels previously reported in these sharks. We hypothesized that one or more of the extra-ocular muscles would serve as a heat source for cranial endothermy in the shortfin mako shark (*Isurus oxyrinchus*). To test this hypothesis, total activity of the enzyme citrate synthase (CS activity g^{-1} of muscle * mass of each muscle) was measured for all six extra-ocular muscles as an index of heat production capacity. The metabolic heat production potential of individual extra-ocular muscles in the shortfin mako shark were compared to that of the ectothermic blue shark (*Prionace glauca*). In the shortfin mako, the six extra-ocular muscles did not differ significantly from one another in CS specific activity, but CS specific activity of the inferior rectus muscle was significantly greater in the shortfin mako than in the blue shark. As a percentage of total eye mass, the masses of all six extra-ocular muscles in the shortfin mako were greater than those of the blue shark. Thus, muscle mass contributes more than CS specific activity to differences in heat production capacity between the two species. These results suggest that all six extra-ocular muscles may contribute heat for cranial endothermy in the mako shark.

† **Kelly, J.A.***, **Craig, S. F.**

GEOGRAPHIC VARIATION IN SPOTTING PATTERN AND BACKGROUND COLOR IN THE NUDIBRANCH *DIAULULA SANDIEGENSIS*

Humboldt State University

The nudibranch, *Diaulula sandiegensis* (Gastropoda: Opisthobranchia) displays phenotypic variation in spotting pattern and background color, and the spots are thought to resemble the oscula of *Haliclona permollis*, one of its principle sponge prey. To investigate this phenotypic variation, *D. sandiegensis* were located and photographed in their intertidal and subtidal habitats along the Pacific coast from San Diego, CA to Bamfield, British Columbia. The software program ImageJ was used to count and measure spots from photographs collected in the field as well as photographs found on the Internet. Latitudinal variation in spot number was found, with individuals from northern California, Washington, and British Columbia exhibiting many more spots on their dorsum than individuals in southern California. Variation in spot number was almost twice as great between versus within beaches. Preliminary data suggests that there is significant latitudinal variation in background color and significant variation in spotting pattern and background color with depth. To determine whether the spotting pattern or the background color would change due to environmental factors, I held *D. sandiegensis* with differing spotting pattern and background coloration, from two different sites, in a common laboratory environment at the Telonicher Marine Laboratory for two months. The spotting pattern and the background color did not change. These data suggest that spotting pattern and background color have a genetic basis.

Kelly, E.L.A.*, **Smith, J.E.**

CAN HERBIVORES REVERSE CORAL REEF DECLINE? ASSESSMENT OF IMPACTS AND FUTURE IMPLICATIONS FOR CORAL RECOVERY ON MAUI

Center for Marine Biodiversity and Conservation, Scripps Institution of Oceanography, UCSD

Phase shifts from coral to algal-dominated reef ecosystems have occurred on coral reefs around the world as a result of human impacts. Coral cover at Kahekili Reef, Maui has declined from 55% to 33% over the past 15 years while algal abundance has increased, likely due to two local stressors: land-based nutrient loading and overfishing. In July 2009, the Hawaii Division of Aquatic Resources designated Kahekili an Herbivore Fisheries Management Area (HFMA), which banned the removal of herbivorous fishes and urchins in an effort to reverse the decline in coral cover on this reef. Algal growth rates, herbivore grazing rates, and algal production were assessed upon the designation of the HFMA and one year after designation. Current data on herbivorous fish and urchin grazing rates

and preferences for algae species show that the most significant blooming algal species were grazed an order of magnitude faster than non-blooming algae, suggesting the ban could be effective in reducing algal cover. Individual fish species also show clear preferences for macroalgal species, though the majority of grazing by all fishes occurs on turf algae. Algal production on the reef currently exceeds the grazing capability of the fish and urchin population on Kahekili. Therefore, future increase in herbivore biomass on the reef will be essential to return the reef to a coral-dominated ecosystem and to increase the resilience of this reef system to global stressors like climate change. The success of the HFMA could provide a model for coral reef area management.

† Koetke, S.A.^{1*}, Grosholz, E.D.²

TOP-DOWN EFFECTS OF *CARCINUS MAENAS* IN BODEGA BAY, CA: IS THERE EVIDENCE OF PREFERENCE IN FEEDING TOWARDS NATIVE SPECIES?

1 - Bodega Marine Laboratory, California State University Monterey Bay 2 - Bodega Marine Laboratory, University of California Davis

Invasive species are a leading problem in conservation because they often compete with or prey on native species. However predation by exotics may be based on optimal foraging, not specifically targeting natives. We hypothesized that invasive species target native species. For example the European green crab (*Carcinus maenas*) was introduced to Bodega Bay, CA in the early 1990's and has had significant top down effects especially on small clams. This has caused a dramatic decline in populations of the native clam species, *Nutricola tantilla*; followed by an increase in populations of the invasive gem clam, *Gemma gemma*. This resulted in green crabs facilitating and accelerating the invasion of the gem clam. We tested whether this feeding preferences was based on size selection or species selection. Using *in situ* containers conducted over 24 hours in mudflats, we controlled for differences in size between native and invasive clams to determine if there was a difference in predation among species. Results showed *C. maenas* fed randomly on clams of both species when they were approximately the same size ($P = 0.613$), which suggests that feeding preference is not linked to species selection. This suggests that future introduction of invasive species will not necessarily target natives, as feeding preference is based largely on size selection rather than a focus on native species.

Kushner, D. J. , Richards, D. V., Moore, K. J. *, Sprague, J. L. , Mooney, E. A. , Ibarra, S. N. , Scheer, G. ALIEN SPECIES AND A CHANGING WORLD; WILL KELP FORESTS AT THE CHANNEL ISLANDS EVER BE THE SAME?

Channel Islands National Park and Marine Sanctuary

Invasive species are increasingly affecting marine ecosystems on a global scale and the impacts of these invasions are now recognized as a significant aspect of global change. Several species have been introduced to kelp forests along the California coast and although little baseline information is available, most of these species have had relatively small ecological impacts. The present establishment of the invasive alga *Sargassum horneri* appears to be unlike previous invasions and is expected to soon dominate areas along California including the Channel Islands. Channel Island National Park's long-term kelp forest monitoring (KFM) program has nearly 30 years of baseline data prior to the first observation of *S. horneri* that will assist with monitoring this invasion and its ecological impacts. The alga was first discovered in Long Beach in 2003, Catalina Island in 2006, and Anacapa Island in April 2009. By October 2009, *S. horneri* was well established in the areas where it was first discovered with notably higher densities of both small and large plants, some at or near reproductive maturity. In addition, *S. horneri* was found at eight of fifteen survey locations including two KFM sites. In 2010, the alga was observed at six KFM sites at Santa Barbara, Anacapa and Santa Cruz Islands -- indicating rapid and widespread expansion in the park. Though it is likely that little can be done to control this alga in open coast ecosystems, the KFM program will continue to monitor its spread and ecological impacts at the Channel Islands National Park.

† Lee, W.^{1*}, Idjadi, J.A.²

THINKING OUTSIDE THE QUADRAT: EXAMING SPATIAL PATTERNS USING LOW-LEVEL AERIAL PHOTOGRAPHY FROM RADIO CONTROL AIRPLANES

1 - University of New Hampshire 2 - Eastern Connecticut State University

'You haven't seen a tree until you've seen its shadow from the sky.' - Amelia Earhart

Aerial photography has been utilized for a wide range of ecological and environmental studies. Though aerial photographs are invaluable to understanding landscape patterns, the cost of conventional aerial photography from manned aircraft prohibits its widespread use. Moreover, due to limitations of aircraft and aeronautical regulations, conventional aerial photography is limited to higher altitudes which compromises image resolution. Over the past decade, there appears to be an increase in use of unmanned aerial platforms such as kites, balloons and remote-control aircrafts to conduct low-altitude aerial photography. This is likely the result of decreasing cost and miniaturizing of sophisticated flight, georeferencing and photographic equipment. Radio control (RC) airplanes, in particular, represent a relatively inexpensive, versatile and controlled way to conduct low altitude photography.

Studies of shallow and intertidal habitats would particularly benefit from large scale, high resolution surveys using RC planes because small physical and biological features are integral to the marine landscape, but are often too small to detect from altitudes of conventional aircrafts. However, to the best of our knowledge, RC planes have not been used in marine studies. We used RC plane equipped with a consumer grade digital camera to conduct aerial surveys of horseshoe crab foraging pits on the mudflats of Great Bay, New Hampshire in the summer 2010. We will present findings and images from these surveys and discuss the utility and potential development of this method.

† **Lewis, J.T.^{*}, Boyer, K.E.**

EFFECTS OF EPIFAUNAL GRAZER SPECIES ON EELGRASS (*ZOSTERA MARINA*) IN SAN FRANCISCO BAY
Romberg Tiburon Center for Environmental Studies, San Francisco State University

Studies in various parts of the world have found that different epifaunal grazer species may vary from one another in their effects on seagrass growth. However, the impacts of the suite of grazer species found in San Francisco Bay eelgrass (*Zostera marina*) beds have not yet been compared. We investigated the effects of five common San Francisco Bay eelgrass epifauna species, *Idotea ressecata*, a native isopod, *Phyllaplysia taylori*, a native opisthobranch, *Ampithoe valida*, an introduced gammarid amphipod, *Ilyanassa obsoleta*, an introduced prosobranch, and *Corophium alienense*, an introduced corophid amphipod. We set up a series of flow-through mesocosms, each containing three shoots of eelgrass and one of the aforementioned species. Eelgrass shoots were trimmed to a uniform starting length and some tanks were left without animals as controls. After fifteen days, one eelgrass shoot was removed from each tank and length and dry weight of this shoot were measured. Differences in the length and dry weight of eelgrass shoots among the grazer species were observed, indicating that these species do vary in their effects on eelgrass. Positive effects of several species, as found in many other studies, likely resulted from removal of competing epiphytes, but negative effects through direct consumption of eelgrass were pronounced for one of the three invasive species. These data are being used to guide further study of invertebrate assemblage effects with implications for restoration of eelgrass habitats in San Francisco Bay.

Litvin, S.Y.^{1*}, Micheli, F.¹, Lee, S.C.¹, Woodson, C.B.², Monismith, S.G.²

QUANTIFICATION OF TEMPORAL CHANGES IN INTERACTIONS STRENGTHS WITHIN A KELP FOREST COMMUNITY

1 - Hopkins Marine Station, Stanford University 2 - Environmental Fluid Mechanics Laboratory, Stanford University

Our goal is to elucidate how environmental conditions mediate proximate ecological responses of species and communities that reside in rocky-reef kelp forests within the Lovers Point State Marine Reserve. First, we are utilizing a first-order multivariate autoregressive (MAR) approach, a multiple regression technique for interacting species that may both affect and respond to other groups (e.g. abundances of other taxa, abiotic variables) and responses that account for autocorrelations. For this approach, we have selected the invertebrate mesograzer community which resides on the kelp canopy and developed and implemented survey protocols to monitor population sizes, their primary predators, alternate prey sources for their predators and the extent and state of physical habitat. This data will be combined with data from the Kelp Observatory (a moored set of oceanographic equipment) and analyzed using the MAR technique to determine how physical forcing, environmental conditions, changes in the relative availability of food resources and changes in trophic interaction strengths affect kelp forest community structure and dynamics over time. In addition, we are using stable isotope analysis to further understand temporal variability in the strengths of trophic linkages and the importance of in-situ (i.e. kelp derived) primary productivity. This work centers on juveniles of two species of rockfish, blue (*Sebastes mystinus*) and kelp (*Sebastes atrovirens*). By analyzing in-situ and off shore primary producers and food resources and juvenile rockfish for carbon and nitrogen stable isotope ratios we will gain a better understanding of the relative importance of the resources supporting these species over time.

† **Lopez, E.K.^{1*}, Henkel, S.K.²**

BASELINE SURVEY OF MACROINFAUNAL INVERTEBRATE COMMUNITY AT POTENTIAL WAVE ENERGY SITE OFF THE OREGON COAST

1 - Marine Landscape and Ecology Lab, California State University Monterey Bay 2 - Hatfield Marine Science Center, Oregon State University

The Northwest National Marine Renewable Energy Center (NNMREC) plans to deploy a wave energy device testing facility called the Mobile Ocean Test Berth (MOTB) in an area off Yaquina Head, near Newport, Oregon. Wave energy capture devices can potentially alter the physical conditions and in turn impact the macroinfaunal invertebrate community. Alteration of the patterns in these communities could have major implications because the invertebrates act as a major food source for commercially important species. The samples that were taken are meant to act as a pre-assessment of the benthic community before device installation. This data will be compared to results of studies after the devices have been installed in order to assess the environmental impacts of wave

energy. The sampling stations were located in and around the MOTB area. A total of 12 stations were sampled for macroinfaunal invertebrates, and two replicates were taken at each station. Sediment samples were taken with a 0.1 m² box core and sieved on a 1 mm mesh screen. Several major taxa were identified to species, and densities of polychaetes, crustaceans, molluscs, echinoderms were estimated and compared to historical surveys in a similar area. It was found that the number of taxa is lower in areas with larger median grain sizes; this information is valuable for selecting locations for future wave energy development.

Luecke, N.C.^{1*}, Wasson, K², Preisler, R²

OYSTERS ON A CLAM SHELL: OLYMPIA OYSTER RESTORATION SCIENCE AT ELKHORN SLOUGH, CA
1 - Elkhorn Slough National Estuary, California State University Monterey Bay 2 - Elkhorn Slough National Estuary
Olympia oysters (*Ostrea lurida*) have been present in Elkhorn slough for over 10,000 years. However our surveys show that only about 5000 individuals remain in this central California estuary, and for the last several years recruitment has been very low. Such a small population is in danger of local extinction, which would eliminate a key intermediary between northern and southern California populations. Elkhorn Slough's anthropogenically increased sedimentation has created an environment largely unsuitable for oysters. To enhance Elkhorn Slough oyster populations, we are testing different methods of providing hard substrates for oyster settlement and survival without burial. We have tested various prototypes of artificial oyster reef. In all cases, the dominant substrate used was large native clam shells that are abundant in the lower estuary, but not in the upper estuary where conditions are optimal for oysters. Prototypes included cage constructed of lattice, a cage made of wood and fencing as well as biodegradable mesh tubing. The most durable reef type created to date though consists of clam shells embedded in a concrete matrix. We designed these reefs to be mobile and modular so their location could be adjusted in response to monitoring data, thus conducting adaptive management of oyster restoration. Field surveys have supported our restoration effort by determining the optimal tidal height for reef placement. Low intertidal elevations have higher oyster recruitment, but also higher overgrowth by fouling species than the high intertidal elevations, suggesting that some intermediate elevation appears to be optimal.

† Mach, M.E.^{*}, Chan, K.M.A.

TRADING GREEN BACKS FOR GREEN CRABS: POTENTIAL IMPACT OF EUROPEAN GREEN CRAB
INVASION ON SHELLFISH HARVEST IN PUGET SOUND
University of British Columbia

Non-native species represent a threat to native biodiversity and can have immense impacts on biological communities, altering ecosystem function and services. Theoretical studies on high-impact invasive species are important for predicting changes in community structure and function, especially when economically important species and services are at risk. The European green crab, *Carcinus maenas*, is regarded as a future threat to nearshore ecosystems of Puget Sound, WA with populations already established along the outer coasts of Washington and Vancouver Island. We used a predation model to predict the effects of this key marine invader, *C. maenas*, on commercially important shellfish in Puget Sound. *C. maenas* causes a loss of hardshell clams, Pacific oysters, mussels and Dungeness crab, which will reduce the total revenue from these fisheries and likely the number of jobs associated with harvesting and processing. These shellfish also act as important filters, reducing the high concentrations of nutrients and toxins released from urbanized areas into Puget Sound. Estimates of revenue loss due to reductions in commercial shellfish harvest by green crab predation range from \$9 to \$26.8 million USD. This translates to a loss of up to 826 jobs associated with these shellfisheries if green crabs invade at high densities. Additionally, this invasion will likely exacerbate the loss of biodiversity already occurring, and alter important habitats within Puget Sound.

Maltese, M.M.^{*}, Fouts, S.M., Troyer, S.M., Behrens, M.D.

EFFECTS OF DIET AND TEMPERATURE ON THE PERFORMANCE AND GUT MORPHOLOGY OF
PRICKLEBACK FISHES
Pacific Lutheran University

Marine herbivorous fishes are more abundant and diverse in tropical waters than temperate waters. These latitudinal patterns may be mediated by a temperature constraint affecting digestive processes. Such a physiological constraint was assessed by investigating the effects of diet and temperature on the performance and gut morphology of sister species of prickleback fishes (*Xiphister atropurpureus* and *Xiphister mucosus*) found on the Olympic Peninsula, WA. Fish were held at various temperatures (6°C and 16°C) and fed either an herbivorous or omnivorous diet for eight weeks. Growth was independent of temperature on an algal diet, while growth generally increased with temperature on a diet supplemented with animal material. These data fail to confirm past findings supporting a physiological constraint that drives the latitudinal diversity patterns in herbivorous fishes.

Relative gut lengths of both species decreased with an increase in temperature. Assimilation efficiency of squid did not vary with temperature for either species while assimilation efficiency of algae increased for *X. mucosus* and decreased for *X. atropurpureus* with an increase in temperature. The efficiency of food assimilation and differences in consumption rates can explain the growth patterns seen at low and high temperatures. Our findings present a better understanding of how temperature and diet can affect the growth rates of two *Xiphister* species, with a shared evolutionary history, but differing dietary modes.

† **Mitch, M*, Garza, C**

RELATIONSHIP BETWEEN HABITAT COMPLEXITY AND OCHRE SEA STAR (*PISASTER OCHRACEUS*) ABUNDANCE

California State University Monterey Bay

The Ochre sea star (*Pisaster ochraceus*) is a well-studied invertebrate of the rocky intertidal due to its direct influence on the zonation of benthic invertebrates in this community. Predation by *Pisaster* regulates the distributional boundaries of the competitively dominant mussel, *Mytilus californianus*, which can in turn help provide space, a critical resource in the intertidal, for other organisms. In this study it was examined whether regional variation in the complexity of intertidal habitat and availability of *M. californianus* around the Monterey Peninsula could be used to explain variation in the abundance and distribution of *Pisaster*. A Topcon total station laser surveyor was used to record the position of *Pisaster* within the intertidal, the lower boundary of the mussel beds, and the habitat complexity, a measurement incorporating the complexity of geological and biological habitat, at each site. Percent cover of the mussel beds was also measured in the corresponding photo surveys taken at three shore levels: 0.61, 1.22, and 1.83 m above Mean Lower Low Water (MLLW). The local variation in intertidal complexity and abundance of *Pisaster* at each site suggests that there are environmental factors contributing to the difference in distribution of mussel beds and sea stars. In addition to the large scale marine factors influencing *Pisaster* abundance, local variation in the complexity and mussel bed cover could influence *Pisaster* foraging in the rocky intertidal, resulting in change in its current structure and function.

† **Monaco, C.J.***

SIZE-DEPENDENT INTERTIDAL DISTRIBUTION AND FORAGING BEHAVIOR IN *PISASTER OCHRACEUS*

University of South Carolina

The ecological implications of body size transcend the individual, and have long been identified as a major feature of natural systems. Size is especially relevant when considering species that regulate community dynamics, such as keystones and bioengineers. Within a predator-prey context, theory predicts that their relative sizes have strong influence on the outcome of their interactions. Since Dr. Paine recognized the disproportionate effect that intertidal keystone *Pisaster ochraceus* could have over *Mytilus californianus* populations, this interaction has been intensively studied. Literature offers field and laboratory evidence supporting the importance of size in this system; however, both approaches have not been combined, precluding a description of the preying mechanism of *Pisaster*. I present preliminary data collected from an exposed rocky-shore at Bodega Marine Reserve (Spring 2010), combining field and laboratory methods for exploring the size relationships between this predator and its main prey. Feeding activity, intertidal height and microhabitat use were recorded for both species. Data showed an interesting size-dependent distribution on *Pisaster*: large individuals preferentially occupied lower heights than smaller ones. Additionally, as described elsewhere, there is a positive relationship between the size of *Pisaster* and the mussels it consumes. Following Optimal Foraging Theory, I hypothesized that differences in handling-time and profitability, measured in the laboratory, determine *Pisaster* foraging behavior and height. Though results are not conclusive, they support the hypothesis, suggesting that *Pisaster* size-dependent distribution is explained by energetic constraints. Thus, smaller *Pisaster* forage higher, where more profitable mussels are found. Potential ecophysiological consequences of this behavior are discussed.

Mooney, E.A.^{1*}, Ibarra, S.N.¹, Scheer, G.¹, Santschi, L.A.², Imondi, R.L.²

DNA BARCODING: A GENETICS-BASED SPECIES IDENTIFICATION TOOL FOR MARINE ECOSYSTEM MANAGEMENT

1 - Channel Islands National Park 2 - Coastal Marine Biolabs

As ecologically based management strategies become more prevalent, a greater level of resolution in monitoring techniques is required to elucidate trophic cascade effects throughout food webs. This approach requires precise identification of taxa throughout all life stages, a task that cannot be achieved using morphological criteria alone. DNA barcoding is a genetics-based species identification tool that can be utilized to address such deficiencies thereby advancing our understanding of community ecology. A DNA barcode is a sequence of nucleotides from a reference mitochondrial gene that is capable of distinguishing species groups from all others. Scientists within a global network are participating in a landmark biodiversity genomics initiative (the International Barcode of Life

project) that seeks to build a genetic registry of DNA barcodes from all eukaryotes. Once this reference database is complete, a barcode generated from a specimen that cannot be identified based upon its physical attributes may be queried against all known reference barcodes. Once a match is identified, a species name will be assigned to the unknown specimen. Of the estimated 10M eukaryotic species, 79K are currently represented in the database. Collaborations among many different interest groups are therefore required to achieve the ambitious goals of the initiative. The Channel Islands National Park and Coastal Marine Biolabs are currently collaborating on the assembly of a reference barcode library for marine indicator species found within the Channel Islands kelp forests. Together with the development of new technologies, this DNA-based inventory is expected to provide new tools for marine ecosystem management.

Moore, E.* , Latker, A., Kasuya, M., Stebbins, T.

TEMPORAL AND SPATIAL VARIATION IN GRAIN SIZE COMPOSITION IN SOFT-BOTTOM HABITATS OFFSHORE OF SAN DIEGO, CA

City of San Diego

The City of San Diego typically conducts annual regional benthic surveys to characterize habitat conditions and to provide context for more localized fixed-site monitoring surrounding the Point Loma and South Bay ocean outfalls. For this study we analyzed sediment data collected over a 10-year period (1994-2003) from 319 randomly selected stations (9–461 m depths) to explore temporal and spatial variability in soft-bottom habitats off San Diego. Grain size distributions were determined using a Horiba laser analyzer for particles <2 mm in diameter following sieving of coarser particles. Several parameters, including mean and median particle size, sorting coefficient, and percent composition of the sand, silt, clay and coarse fractions were summarized based on depth and location within four main zones, including the Oceanside, Mission Bay, and Silver Strand littoral cells, and along the Coronado Bank. Preliminary results indicate that sediments vary across the continental shelf and upper slope off San Diego, with a general decrease in particle size and increase in fine sediments with increasing depth. Overall patterns in particle size distributions were similar within the three littoral cells although differences in the magnitude of decrease were apparent. Sediments ranged from sand to sandy mud (containing a substantial silt and clay fraction) at most sites, while several stations were characterized by coarser sands or gravel. Additionally, sediments were coarser than expected at the Coronado Bank sites. Finally, although temporal variability in particle size distributions was high, there were no clear trends or patterns over these sample years.

† Munday, E.S.^{1*}, Kaufman, L.², Shank, B.²

ANALYSIS OF FISH SIZE AND ABUNDANCE IN RELATION TO BENTHIC COVER IN AND OUT OF A NO TAKE AREA AT HALF MOON CAYE, BELIZE

1 - Washington State University Vancouver 2 - Boston University

In a prior study, benthic cover was not a clear indicator of protection effects at the Half Moon Caye (HMC) no take area (NTA) where fishing is not allowed. I continued searching for significant indicators of protection effects by examining not only benthic cover, but also four species of herbivorous fish (*Scarus iserti*, *Sparisoma aurofrenatum*, *Stegastes partitus*, and *Stegastes adustus*) and a commercial fish and predator, the Nassau grouper (*Epinephelus striatus*). Each species' abundance, length range, and mean length were compared across NTA boundaries. Additionally, I examined correlations between benthic cover and fish abundance and size. Because there would theoretically be more predator pressure on parrotfish in the NTA, differences in parrotfish size were predicted. However, sizes did not significantly differ between NTA and non-NTA fish. This either indicates that *E. striatus* and other predators are not abundant enough at HMC to cause size selection, or that a recently proposed trophic cascade theory is not applicable to the HMC NTA and possibly other NTAs. Reasons why the theory may not apply to different protected reefs must be examined because it could have grand implications for herbivore grazing efficiency in NTAs. Non-significant differences between benthic cover in and out of the HMC NTA could also indicate that herbivore importance to macroalgae reduction is relatively minor and so would be unaffected by a potential trophic cascade. Of additional interest is that adult groupers of different sizes seemed to exhibit habitat preference, which could shape coral reef predator-prey interactions.

Nickels, C.F.^{1*}, McKenna, M.F.¹, Sala, L.¹, Goldbogen, J.¹, Katz, S.L.², Calambokidis, J.³, Ohman, M.D.¹
DO BLUE WHALES (*BALAENOPTERA MUSCULUS*) FEED IN A SIZE-SELECTIVE MANNER ON EUPHAUSIIDS?

1 - Scripps Institution of Oceanography 2 - Channel Islands National Marine Sanctuary 3 - Cascadia Research Collective

Blue whales (*Balaenoptera musculus*) were observed lunge feeding on euphausiid aggregations by researchers in the Northern Channel Islands in September 2009 and August 2010. To determine whether the whales were feeding selectively within the krill patches, euphausiid size composition from net tows was compared to the size composition in Blue Whale fecal samples obtained from the same site. Whole euphausiids were measured from

the tip of the rostrum to the end of the telson and identified by species, sex, and life history phase (i.e. furcilia, juvenile, adult). The aggregations during both years were dominated by *Thysanoessa spinifera*. The total length of the euphausiids from the fecal samples was calculated from measurements of right mandibles, based on a linear regression of total body length to right mandible length developed from the net tow samples. Whole *T. spinifera* furcilia, juvenile, and adults were dissolved in a solution which approximated the pH of a whale stomach. This allowed us to determine whether smaller mandibles are not found in fecal samples because they break down during digestion or because Blue Whales are selectively feeding on larger euphausiids.

† **Okamoto, D.K.***, **Holbrook, S.J.**, **Schmitt, R.J.**, **Reed, D.C.**

DECADAL-SCALE CHANGES IN FISH POPULATIONS, FORAGING HABITAT COMPOSITION, AND FOOD AVAILABILITY ON SANTA CRUZ ISLAND, CA.

University of California Santa Barbara

Many fish populations worldwide have undergone large fluctuations during recent decades as a result of natural (e.g., climate variation) or anthropogenic (e.g., fishing) impacts. Our long-term data show that surfperch (Embiotocidae) populations on Santa Cruz Island in Southern California have exhibited similar dynamics. Populations declined tremendously from high levels during the late 1980s and they have rebounded during the past decade. Surfperches are an ideal system for investigating the role of natural processes in controlling reef fish population dynamics because they are largely unexploited, sedentary and produce live young that are locally retained. Since 1982, we have conducted annual surveys of adult and young of the year surfperch abundances, the composition of their foraging habitat (benthic algae and sessile invertebrates) and the abundance of their prey (i.e., small, mobile invertebrates) at 11 reefs on Santa Cruz Island. The time series reveals that large temporal shifts in striped (*Embiotoca lateralis*) and black surfperch (*Embiotoca jacksoni*) populations coincided with dramatic shifts in the composition of their foraging habitat and in the biomass density of prey (specifically taxa such as Caprellid and Gammarid amphipods) that live within it. We hypothesize that regional shifts in oceanographic climate may alter the biomass density of fish food that, when combined with local changes in habitat composition, may strongly impact the dynamics of reef fish populations.

† **Parissenti, L.***, **Pam, M.**, **Pearse, V.**

AGGRESSION IN THE CLONAL INTERTIDAL SEA ANEMONE *ANTHOPLEURA DOWII*

Hopkins Marine Station, Stanford University

The clonal intertidal sea anemone *Anthopleura dowii* possesses acrorhagi on marginal columnar projections, a defining character of the genus. Although anemones with acrorhagi are presumed capable of aggression, such behavior had not previously been documented in this species. Clonal aggregations of *A. dowii* on rocky shores in the Gulf of California (Sea of Cortez) were tested for aggressive inter- and intra-clonal behavior and compared to *A. elegantissima*, a similarly clonal, rocky-shore species whose aggression has been well described from populations on the central coast of California. Tests involved bringing into contact the tentacles of polyps of *A. dowii* from the same and different clones (each clone marked by distinctive color patterns), to observe any reactions by the anemones, especially tentacle retraction and acrorhagial expansion and extension. Polyps of *A. dowii* demonstrated aggression only to non-clonemates. The behavior was consistent with the five steps of aggression described for *A. elegantissima*. This behavior is presumably important in defense of habitable space, facilitating survival and growth of the clone. The disproportionately large size of the acrorhagial projections in the small polyps of *A. dowii*, compared to those of other *Anthopleura* species, may reflect the particular scarcity of suitable habitat available in the Gulf of California, given exposure to intense sunlight and extremes of temperature and salinity measured in the shallow intertidal pools that *A. dowii* inhabits. The pattern of aggression in anemones coinciding with small polyp size, clonal growth mode, and high rocky-shore habitat is especially well exemplified by *A. dowii*.

† **Pfremmer, S. J.***, **Zacherl, D. C.**

SETTLING PREFERENCES OF THE NATIVE AND NON-NATIVE OYSTERS OF NEWPORT BAY

California State University Fullerton

The native oyster of the west coast of the United States, *Ostrea lurida*, had population declines since the early 1900's due to pollution and over-harvesting. A Japanese oyster species, or the non-native oyster, *Crassostrea gigas*, has since then replaced much of the oyster population. Many commercial shellfish farms produce *C. gigas* for consumer consumption, but many farms do not raise the native oyster. To see preferences of settlement among these two species, field and lab experiments were performed. Twenty tees with native and non-native shell were deployed in Newport Bay, California to determine settlement preferences in the field. Tees were retrieved after two weeks and brought to the lab to count spat per shell. Both native and non-native larvae were put into five different water treatments to determine settlement preferences in the lab. Settlement was counted by how many spat had attached themselves to the substrate. Expected results in the field are that native larvae will prefer to settle onto native shell. Expected results in the lab are that native larvae will prefer to settle in the water treated

with native shell and that the non-native larvae will prefer to settle in the water treated with non-native shell.

† **Plank, C.A.^{1*}, Best, R.J.², Stachowicz, J.J.²**

HABITAT AND FEEDING PREFERENCE OF *AMPITHOE LACERTOSA* AND *IDOTEA RESECATA* IN BODEGA HARBOR, CA

1 - Bodega Marine Laboratory, Aquinas College, Grand Rapids, MI 2 - Bodega Marine Laboratory, University of California Davis

Small crustacean grazers can have a positive effect on seagrass biomass by consuming algae, which reduces shading. Different grazer species may have unique effects on seagrass biomass. In this study we examined the extent to which feeding choice and/or habitat preference influence the distribution of the amphipod *Ampithoe lacertosa* and the isopod *Idotea resecata* in the eelgrass (*Zostera marina*) beds of Bodega Harbor, California. Based on their field distribution, we hypothesized that *Ampithoe* would prefer to live on *Ulva* and that *Idotea* would prefer to live on *Zostera*. Additionally, we hypothesized that both grazer species would prefer to feed on their respective host plants. When offered food treatments of *Ulva* sp., *Zostera marina*, or both, *Ampithoe* preferred to feed on *Ulva* and *Idotea* consumed some of each food type. Over the course of a 33 day growth trial with food treatments of *Ulva*, *Zostera*, both, or none (control), both species grew more on diets containing *Ulva*. In a 2 day habitat trial using mimics, both species preferred the *Zostera* mimic over the *Ulva* mimic. We concluded that *Ampithoe* host plant choice may be determined by both refuge value and nutritional value, whereas habitat value may be a more important factor than food value in determining host plant choice for *Idotea*.

† **Quilley, R.G.^{1*}, Przyuski, N.W.², Gray, S.C.¹**

A COMPARISON OF SEDIMENTATION AND TURBIDITY IN MANGROVE ENVIRONMENTS AMONG AREAS OF VARIABLE HUMAN IMPACT, ST. JOHN, USVI

1 - University of San Diego 2 - University of California Santa Barbara

Corals growing on mangrove prop roots have recently been discovered in Hurricane Hole (HH) in the VI Coral Reef National Monument, St. John, USVI. This study a) examined the spatial variability of benthic sediments within HH, and b) compared the quantity and composition of suspended, settling and benthic sediments within HH and two other coastal mangrove sites, one of which is below a developed watershed. The sediment accumulation rate and TSS (total suspended solids) were determined by filtering and weighing sediments that accumulated in sediment traps and water samples. The sediment composition (% organic, % terrigenous, % carbonate) and the suspended organic matter (SOM) was determined using Loss on Ignition (LOI). In HH, the proportion of terrigenous and organic matter in the sediments decreased with distance from the mangroves. Among the three mangrove study sites, the mean TSS was lowest at HH [7.6 ± 3.8 mg/L] and the SOM was highest [3.8 ± 1.7 mg/L], comprising up to 50% by weight of the TSS. Additionally, mean sediment accumulation rates [0.9 ± 0.2 mg/cm²/d] were more than 3 times lower in HH than the other two mangrove sites [3.9 ± 0.6 mg/cm²/d (Lameshur Bay) and 5.2 ± 0.2 mg/cm²/d (Coral Bay)]. The TSS and mean sediment accumulation rates measured at HH were less than values previous researchers have shown to cause stress to corals, suggesting that sedimentation and turbidity in the HH mangrove are not high enough to negatively impact the recruitment or growth of corals.

† **Ramshaw, B.C.^{1*}, Pakhomov, E.A.¹, Kaehler, S.²**

THE DISTRIBUTION, ABUNDANCE AND DIETARY IMPORTANCE OF KELP-DERIVED DETRITUS OFF THE WEST COAST OF VANCOUVER ISLAND, CANADA

1 - University of British Columbia 2 - Rhodes University, Grahamstown, South Africa

The extirpation of sea otters from the B.C. coast led to cascading effects on the near-shore ecosystem structure, function and productivity. By feeding on herbivorous invertebrates, sea otters facilitate the return of kelp beds which act as refuge for fish and invertebrates. Such communities may also be two to three fold more productive than areas without sea otters due to the elevated contribution of the kelp-derived carbon. Kelp may either be directly consumed by invertebrates or incorporated in the food web indirectly via particulate detritus after kelp breaks away and sink to the bottom of the shelf. Due to currents, the kelp-derived detritus may spread over large areas subsidizing diets of both pelagic and bottom dwelling species thus increasing spatial effects of coastal kelp forests on local productivity. We sampled particulate organic matter, zooplankton and various benthic organisms along six transects run perpendicular from the shore to 30 km offshore at three main areas (two transects per area): (a) the north end of Vancouver Island with well established (>25 years) sea otter populations and dense kelp beds; (b) the south end of Vancouver Island that lacks sea otters and has small kelp beds; and (c) point in the middle with recently established (~10 years) sea otter populations and recovering kelp beds. Stable isotope signatures of carbon and nitrogen were used to measure relative contribution of the kelp-derived detritus off Vancouver Island to pelagic environments as well as its dietary dynamics in zooplankton and benthic invertebrates in relation to kelp forest biomass.

† **Ramírez-Valdez, A.^{1*}, Ruiz-Campos, G.², Correa-Sandoval, F.³, Carpizo-Ituarte, E.³**

ECOLOGY AND BIOGEOGRAPHY OF THE ROCKY INTERTIDAL FISH COMMUNITY IN THE WESTERN COAST OF THE BAJA CALIFORNIA PENINSULA

1 - Facultad de Ciencias Marinas, Universidad Autónoma de Baja California 2 - Facultad de Ciencias, Universidad Autónoma de Baja California 3 - Instituto de Investigaciones Oceanológicas, Universidad Autónoma de Baja California

The taxonomical composition, ecological attributes and biogeographical aspects of the rocky intertidal fishes of the western coast of the Baja California peninsula, Mexico, were studied along 16 sites between Medio Camino (32° 10' N) and Los Cerritos (23° 20' N), during June 2006 to February 2010. The rocky intertidal fish assemblage was composed by 42 species, 33 genera and 19 families. A discontinuous pattern in the ecological attributes of the fish community was recognized along the geographic gradient, which was mainly composed by those assemblages located within the Sebastian Vizcaino and Todos Santos bays. Woolly sculpin (*Clinocottus analis*) and opalaye (*Girella nigricans*) were the most abundant species both in the northern and central sub-areas, while the notchfin blenny (*Entomacrodus chiostictus*), Mexican night sergeant (*Abudefduf declivifrons*) and porehead blenny (*Labrisomus multiporosus*) dominated in the southern sub-area. Based on distribution and density of permanent species, the area encompassed between Punta Abreojos and San Juanico represents the distributional boundary for northern (warm-temperate) and tropical fish elements. Most of species (85%) have distributional ranges that include the California marine faunal region and its Californian province, followed by those species with distributions into the Mexican province (58%) of the Tropical Eastern Pacific Region and the province of Cortez (56%). The known northernmost geographical ranges are extended for *Muraena lentiginosa*, *Sargocentron suborbitalis* and *L. multiporosus*, *Bathygobius ramosus*; while the southernmost ranges extended for *C. analis*, *Oligocottus rubellio* and *Amphistichus koelzi*. The latitudinal gradient showed a significant correlation with the fish species diversity.

Rawling, D.W.^{1*}, Fox, M.D.², Gray, S.C.¹

CAN SEDIMENT TEXTURE BE USED AS A PROXY TO MEASURE TERRIGENOUS (LAND-DERIVED) SEDIMENT FLUX ON CORAL REEFS?

1 - University of San Diego 2 - Moss Landing Marine Laboratories

In the US Virgin Islands, one of the primary threats to coral reef ecosystems is land-derived (terrigenous) sedimentation. Previous studies on St. John, US Virgin Islands have demonstrated that watershed development, especially the building of dirt roads on steep slopes, increases sediment delivery to coastal bays with coral reefs. Some researchers have used the proportion (%) of fine grained (< 75 microns) sediments sieved from sediment traps as a proxy for terrigenous sediment based on the assumption that terrigenous sediment is predominantly fine grained (< 75 microns) and that coarser grained sediments are primarily carbonate. We tested this assumption by comparing the grain size distribution to the composition (% organic, % terrigenous and % carbonate) of sediments collected in mangrove, shore, and coral reef sites below developed and undeveloped watersheds on St. John, USVI. The composition of the sieved grain-size fractions was determined by the Loss on Ignition (LOI) method. Both terrigenous and carbonate grains were found in all locations and in all grain size fractions. However, the relationship between sediment composition and texture varied between environments. At shore and mangrove sites the terrigenous proportion of sediment was generally consistent between grain-size fractions. At reef sites the terrigenous proportion generally decreased with increasing grain size, but the fine (<75 microns) grain-size fraction contained abundant carbonate grains. These data demonstrate that sieving is not an accurate or appropriate method to use to quantify terrigenous sedimentation on coral reefs and that sediment texture is not proxy for sediment composition.

Redfield, M.A.[†], Raimondi, P.T., Fletcher, N.C., Worden, S.E.

AN OVERVIEW OF THE NORTH CENTRAL COAST MARINE PROTECTED AREAS BASELINE PROGRAM MONITORING

Long Marine Laboratory, University of California Santa Cruz

In May 2010, a network of 25 Marine Protected Areas (MPAs) was established under the Marine Life Protection Act. This network spans the north central coast of California ranging from Pigeon Point to Point Arena. These 25 MPA's include 12 State Marine Conservation Areas (SMCA) which limit commercial and recreational take, 10 State Marine Reserves (SMR) which prohibit commercial and recreational take, and three State Marine Recreational Management Areas (SMRMA) which provide, limit, or restrict recreational opportunities. These areas account for 153 square miles (20.1%) of state waters in this region. Baseline data must be collected in order to evaluate their effectiveness and inform adaptive management. These baseline data are vital for characterization of initial ecological and socioeconomic changes, and to inform long-term monitoring programs and implementation. The North Central Coast MPA Baseline Program is a collaboration of 11 groups that will monitor and characterize eight ecosystem features. These features include diverse marine habitats as well as consumptive and non-consumptive uses. For some of these features, long term monitoring programs are well established throughout the west coast

of North America. These programs can provide baseline data, increasing cost-effectiveness, providing a more clear picture of the pre-MPA baseline, and allowing for widespread spatial comparison.

Renck, C.L.^{1*}, Burfeind, D.D.², Tibbetts, I.R.³, Udy, J.W.⁴

HABITAT PREFERENCE OF JUVENILE BLUE SWIMMER CRABS (*PORTUNUS PELAGICUS*) FOR SEAGRASS, *CAULERPA TAXIFOLIA* AND UNVEGETATED SUBSTRATE

1 - University of San Diego 2 - Australian Rivers Institute and Griffith School of Environment, Griffith University 3 - Centre for Marine Studies, University of Queensland 4 - Water Studies, School of Engineering, University of Queensland

Near-shore habitats have been degraded from a variety of anthropogenic impacts. In Moreton Bay, Australia seagrass coverage has declined a result of decreasing water quality, resulting in increased available space for the opportunistic, habitat-forming alga *Caulerpa taxifolia*. This decline in seagrass coverage has resulted in a habitat mosaic of seagrass, *C. taxifolia*, and unvegetated substrate, in areas once colonized solely by seagrasses. Fish communities have differential selection of habitats within this mosaic; however, it is unknown how this habitat configuration may impact benthic invertebrates. In the current study we examined diurnal patterns of habitat selection of an important fishery species, the blue swimmer crab (*Portunus pelagicus*) by using laboratory-based experimental mesocosms. Juvenile *P. pelagicus* were given a choice of three habitat types: (1) seagrass, *Zostera muelleri* (2) *C. taxifolia* and (3) unvegetated sand substrate. Trials were conducted for 24 h and the location of each crab was recorded every 4 h. *P. pelagicus* used seagrass significantly more than other habitat types during the day; however, at night there was no difference between seagrass and unvegetated substrate use. *C. taxifolia* use was similar between day and night and was used significantly less than seagrass at all times. This indicates that *C. taxifolia* is unlikely to be an important habitat type for juvenile *P. pelagicus*. Furthermore, our results suggest a diurnal movement pattern between seagrass and unvegetated substrate whereby crabs use seagrass during the day to avoid predation and move to the sand at night to forage for food.

Reynolds, A.M.^{1*}, Halasz, A.², Benayahu, Y.², Janes, M.P.³, McFadden, C.S.¹

PHYLOGENY OF THE SOFT CORAL FAMILY XENIIDAE

1 - Harvey Mudd College 2 - Tel Aviv University 3 - AquaTouch

Xeniidae is one of the most abundant families of soft coral in the tropical Indian Ocean, Pacific Ocean, and the Red Sea. They are often opportunistic species that colonize degraded reefs. Sixteen genera have been defined morphologically; however, some of the genus distinctions are unclear and their phylogenetic relationships remain unknown. Understanding these relationships may be critical for understanding the reef systems where Xeniidae are located. To test the phylogenetic relationships among genera, we sequenced the COI, msh1, and ND2 regions of the mitochondrial genome from individuals of different common genera within Xeniidae. These sequences were then used to construct a phylogenetic tree. Species were distributed among four well-supported clades, which were distinguished by the presence and length of an insertion in the 16S region upstream of ND2. The genus *Anthelia* formed one monophyletic clade. A second clade consisted of *Xenia* only, and another was a mix of *Ovabunda* and *Xenia*. A final clade included a mix of *Xenia*, *Heteroxenia*, and several other xeniid genera (*Asterospicularia*, *Sansibia*, *Sarcothelia*). These results suggest that *Xenia* is not monophyletic, and that distinctions between *Xenia* and *Heteroxenia* need to be re-evaluated. Once the phylogenetic relationships among genera and species have been resolved, we hope it will also be possible to identify concordant morphological characters that will allow genera, and even species, to be identified in the field.

Reyns, N.B.^{*}, Patnode, C.H.

ACIDIFICATION EFFECTS ON LARVAL DEVELOPMENT AND SWIMMING BEHAVIORS OF THE SHORE CRAB, *PACHYGRAPSUS CRASSIPES*

University of San Diego

While a growing number of studies have documented negative impacts of anthropogenic ocean acidification on the growth and survival of marine organisms, most research has focused on calcifying species. The sensitivity of larval crustaceans to decreases in pH, however, has been poorly documented. We examined the effects of decreased pH on larval development and swimming behaviors of the striped shore crab, *Pachygrapsus crassipes*. Ovigerous females were collected in the intertidal and maintained in CO₂-acidified water (pH between 7.25-8.1) in the laboratory until spawning. We quantified larval survival (in control vs. low pH water) and measured six morphological characteristics to determine if acidification impacts larval development. Larval swimming behaviors were examined using a larval tracking video system. Preliminary data suggest that decreased pH impacts larval development of intertidal crabs. Larval swimming trajectories will be analyzed to determine if pH-driven morphological differences result in changes in swimming behavior.

Richards, D.V.* , Whitaker, S.G.

MONITORING BLACK ABALONE MOVEMENT AND AGGREGATING BEHAVIOR.

Channel Islands National Park, National Park Service

Once abundant, *Haliotis cracherodii* (black abalone) populations crashed between 1986 and 1992 as a bacterial infection raced through the southern California population. The decline was documented through monitoring data collected by the National Park Service at the Channel Islands. These data played an important role in designating the species as Federally Endangered in 2009 and defining Critical Habitat. Recently, recruitment of juvenile black abalone has been observed at Santa Cruz Island and a remnant population of older individuals persists at San Miguel Island. All other populations at surrounding islands remain depressed or have disappeared. At present, monitoring efforts involve gathering information on nearest neighbor distance and group size, tagging individuals, and fine-scale mapping of the microhabitats utilized by black abalone. This information will help us to better understand the movement patterns and habitat preferences of this endangered species.

Rock, M.O.* , Elahi, R., Sebens, K.P.

WHAT ARE CHITONS BITING? A QUANTITATIVE DIET ANALYSIS OF FIVE SPECIES FROM SUBTIDAL ROCK WALLS IN THE SALISH SEA

Friday Harbor Labs, University of Washington

Chitons are a diverse and ecologically important clade of primary consumers in marine ecosystems, but quantitative data on the diets of chitons are limited to a handful of species. This study explores the potential for niche partitioning among an assemblage of chitons on subtidal rock walls in the San Juan Islands, Washington, using gut content analysis. We collected *Tonicella undocaerulea*, *T. lineata*, *T. insignis*, *Mopalia swanii* and *M. spectabilis* from rock walls between 12 and 18 m depth at three sites. Preliminary results suggest strong species-specific variation in diet that is consistent across sites. In support of previous literature, *T. lineata* appears to consume crustose coralline algae. However, *T. undocaerulea* and *T. insignis* consume far more microalgae and diatoms. Similarly, the diets of *M. swanii* and *M. spectabilis* lacked coralline algae but were comprised of notably more invertebrates. The major differences in diet within the genus *Tonicella* and between the genera *Tonicella* and *Mopalia* suggest that these chitons are not functionally redundant and may have species-specific impacts on epilithic communities.

Rosenberg, M.F.^{1*} , Goldstein, M.C.² , Cheng, L.²

THE EFFECT OF NEUSTONIC MICROPLASTIC DEBRIS ON THE PELAGIC INSECT *HALOBATES SERICEUS*
1 - *Torrey Pines High School*, 2 - *Scripps Institution of Oceanography, University of California San Diego*

The North Pacific Central Gyre (NPCG) is a key area of interest for investigating the effects of plastic debris on the lives of marine organisms because much of this debris is concentrated in gyres throughout the world's oceans. This study provides the first assessment of the impact of plastic on marine invertebrates, targeting the neustonic marine insect *Halobates sericeus*. This species was chosen because it utilizes floating material, including plastic, as a substrate to lay eggs. We sorted and analyzed 45 recent (2009) and 32 historical (1972/1973) samples from the NPCG. We found that the abundance of plastic in the NPCG has significantly increased over the last forty years, but did not detect a similar increase in the abundance of *H. sericeus*. Data from 1972/1973 indicated that there was no correlation between the densities of *H. sericeus* and plastic. However, the 2009 samples showed a significant positive correlation ($p < .0001$, $R^2 = 0.3353$). Further research is necessary to determine the specific nature of the interaction between plastic debris and *H. sericeus* in the NPCG.

† Ruiz-Vallejo, T.^{1*} , Montaña-Moctezuma, G.² , Seminoff, J.A.³

APPLICATION OF LOOP ANALYSIS TO EXAMINE FISHING EFFECTS ON THE COMMUNITY STRUCTURE OF THE BLACK TURTLE IN BAHIA DE LOS ANGELES

1 - *Facultad de Ciencias, Universidad Autonoma de Baja California* 2 - *Instituto de Investigaciones Oceanológicas, Universidad Autonoma de Baja California* 3 - *Southwest Fisheries Science Center, National Marine Fisheries Service*

Bahia de Los Angeles (BLA) in the Gulf of California was declared a Biosphere Reserve in 2007 and it is one of the most important regions for the feeding of marine turtles in México. The objectives of this project were to: a) characterize the marine community structure in BLA as it pertains to the black turtle (*Chelonia mydas agassizii*), and b) determine the direct and indirect effects of artisanal fisheries on this community. A qualitative means of modelling was used called "Loop Analysis"; which allows the construction of ecological models to analyze the direct and indirect effects of a disturbance on community structure. Models were built with published dietary and ecological information about the primary marine taxa within BLA. Alternative models were used to represent system variability. Model-derived prediction tables were then used to understand the population effects of fishing on black turtles and other species targeted by local fisheries. Results suggest that community structure is important, revealing the competition between the turtles and the fishery for similar resources. Model predictions

indicate that black turtles may decrease, increase or remain the same if fishing increases. This variable response depends on the resources targeted by the fishery. The harvest on elasmobranchs and carnivorous fishes caused a decrease in black turtles; however, the commercial exploitation of herbivorous fishes and brown algae, but not green algae, causes black turtles to either increase or remain constant in population size. We present scenarios that could allow the coexistence of fishing and the turtle conservation in BLA

† **Salois, S.L.***, **Idjadi, J.A.**

DAIRY BULL THEN AND NOW: TRAJECTORIES OF JAMAICAN REEFS PROVIDE EVIDENCE FOR PHASE SHIFTS

Eastern Connecticut State University

Jamaican reefs are considered a quintessential example of a degraded and macroalgal-dominated reef system. There is debate over whether macroalgal-domination is an alternate stable state of reefs or a phase shift from a coral dominated condition. There are some reefs in Jamaica, like Dairy Bull, that are well-studied examples of high coral cover reef communities which can shed light on this debate. We tested the hypothesis that Dairy Bull reef is returning to recent levels of coral cover following a bleaching event. The density of herbivorous fish and urchins was also examined to infer their role in determining coral versus macroalgal cover. After evaluating the data for benthic cover among three sites on the north coast of Jamaica we compared it against data from 1995 and 2003, finding that Dairy Bull's coral cover is reminiscent of pre-bleaching levels although the abundance of *Acropora cervicornis* has declined. That said, *A. cervicornis* continues to grow from remnant populations. Urchin densities are comparable as well. Preliminary data on these three north coast sites show a great deal of variation in fish densities on <2-kilometer scales with more fish in areas of high cover of macroalgae. This may suggest that fish have a limited role in driving the coral-dominated state of Dairy Bull and controlling macroalgae at other forereef sites. The bounce-back of Dairy Bull following bleaching and the lack of an apparent herbivorous agent for this recovery provide additional evidence that Dairy Bull reef is experiencing a phase shift-reversal.

† **Sanchez, B.D.***, **Steele, M.A.**

A COMPARISON OF GROWTH AND CONDITION OF *PARALABRAX NEBULIFER* FROM POLLUTED AND UNPOLLUTED SITES IN SOUTHERN CALIFORNIA.

California State University Northridge

Environmental stressors can have detrimental effects on fish populations by limiting the abilities of individuals to acquire resources for growth, reproduction and survival. Pollutants such as PAH's, PCB's and heavy metals can cause physiological stress in fishes, especially in areas of high pollutant concentrations, such as is commonly found in harbors. This study evaluated the impacts of pollutants on growth and condition of a common coastal marine fish in Southern California. *Paralabrax nebulifer* (barred sand bass) is one of the most frequently caught fishes in the recreational fishery in Southern California. This demersal species occupies a variety of habitats, including kelp beds, sand flats, inland harbors, and bays. This study was conducted at four sites: two polluted sites within harbors (Los Angeles/ Long Beach and San Diego Harbor) and two relatively unpolluted sites located outside of harbors (Huntington Flats and Barn Kelp). Fish were collected from May to September 2010 and the length, body weight, liver weight, gonad weight and sexual maturity were recorded. We compared growth (size at age from otoliths), condition factors (K), hepatosomatic index (HSI), and gonadosomatic index (GSI).

† **Sawyer, K.M.***

SETTLEMENT PREFERENCE OF THE OLYMPIA OYSTER (*OSTREA LURIDA*) IN COOS BAY, OREGON

Oregon Institute of Marine Biology, University of Oregon

The Olympia oyster (*Ostrea lurida*) is the only native oyster on the west coast of the United States. The population was decimated in the early 20th century by overharvesting, but recent restoration efforts are in progress to re-establish this ecologically important species. Oyster beds provide excellent habitat for many other species as well as improving water quality. A common restoration technique is the addition of Pacific oyster (*Crassostrea gigas*) shell as a hard substrate for *O. lurida* larvae to settle on with the goal of creating a self-sustaining population. However, no studies have looked at the potential benefits of using conspecific shell or live oysters. I looked at settlement of *O. lurida* larvae in Coos Bay, OR throughout the spawning season beginning in July 2010 on four different substrates: live *O. lurida*, shell of *O. lurida*, live *C. gigas* and shell of *C. gigas*. I will look at trends in settlement on live oysters compared to oyster shell and on *O. lurida* compared to *C. gigas*.

Schwartz, R.F.^{1*}, **Kay, I.S.²**

TEMPORAL VARIATION IN THE EFFECTS OF AN INTRODUCED MANGROVE (*AVICENNIA MARINA*) ON SOIL CHARACTERISTICS OF A SAN DIEGO WETLAND

1 - University of San Diego 2 - University of California San Diego

Exotic plant invasions and introductions represent some of the greatest threats to coastal wetlands, potentially

altering food web structure, availability of resources, and environmental factors. The gray mangrove (*Avicennia marina*) was introduced to the *Spartina foliosa* wetlands of the Kendall Frost Marsh Reserve in San Diego, California in 1968. Since that time, *A. marina* has re-emerged on six occasions, despite repeated eradication attempts, most recently in April 2006. *A. marina* functions as an "ecosystem engineer" by replacing existing *S. foliosa* and creating novel three-dimensional habitat. *S. foliosa* salt marshes are an important focus for conservation efforts, providing habitat for commercially important fish and other rare/endangered species. To assess the impact of *A. marina* on salt marsh soil, we compared soil characteristics in replicate plots of *A. marina* and *S. foliosa* to assess levels of soil organic matter (SOM) and particle size. Our collections represented two time points: May 2006 and January 2007. We found that soil characteristics exhibited temporal variation: *A. marina*-dominated plots had less SOM and larger particle size than *S. foliosa*-dominated plots in May 2006. However, no difference was found in January 2007. The positive correlation between SOM and faunal abundance is well established, as is the shift from nematode-dominated communities to harpacticoid-dominated communities in coarser sediments. These findings suggest that mangroves could have cascading effects on ecosystem processes, potentially impacting epi- and infaunal assemblages, and overall habitat utilization. Further investigation is required to understand patterns over longer time scales and with a focus on seasonal variation.

Shevalier, Y.R.^{1*}, Becker, Bonnie J.¹, Behrens, Michael D.², Lemay, Brenda¹, Eccles, Jolene¹, Staggers, Shayla¹, Baird, Kendra¹, Troyer, Stena², Maltese, Melina², Henzler, Christine M.³, Hoaglund, Elizabeth³
DETERMINING GEODUCK LARVAL DISTRIBUTION IN QUARTERMASTER HARBOR USING ADAPTIVE TRAPPING AND A NOVEL MOLECULAR TOOL

1 - University of Washington, Tacoma 2 - Pacific Lutheran University 3 - University of California Santa Barbara

Despite a century of study, larval transport of marine invertebrates remains a "black box" of ecology. Larval sampling, sorting and identification to species can be difficult or impossible. Our group is integrating a new molecular identification tool, fluorescent in situ hybridization with cell sorting (FISH-CS) with a trapping approach to target geoduck larvae, dramatically increasing the efficiency of larval sampling and allowing for studies with larger spatial and temporal sampling scales. We deployed and retrieved passive tube traps, to take time-integrated plankton samples in Quatermaster Harbor, WA weekly from March through June of 2010. Concurrently, we collected oceanographic data and monitored geoduck settlement. During the early spring, the water column was well-mixed; if geoduck larvae were present we expect to find them in traps at various depths. Later in the season, the water column becomes more stratified and large blooms of phytoplankton were documented; we expect that larvae will peak at this time and will be found near the chlorophyll maximum. In addition, we predict water velocity will be directly proportional to the number of larvae captured. Sample analysis is ongoing. Upon completion, we will be able to map the distribution of geoduck larvae in Quatermaster Harbor. Resulting data can be used to build a model of regional geoduck populations, both natural and farmed, for management purposes. Some broader applications of this technique include monitoring ballast tanks for target invasive species, and creating a large-scale, multi-species larval distribution atlas.

† **Speckmann, S.A.^{1*}, Talley, T.S.^{1,2}**

THE EFFECTS OF PLANT DIVERSITY AND LITTER ON PLANT-SOIL PROCESSES IN A SOUTHERN CALIFORNIA COASTAL SCRUB SYSTEM.

1 - University of San Diego 2 - Scripps Institution of Oceanography, University of California San Diego

Ecosystem functions may be influenced by species diversity and productivity in systems. The extent and direction of relationships depends upon the ecosystem and focal function. Plant productivity is a common focal function with less attention paid to plant-soil processes even though many coastal systems are detritally-driven. Using a large field experiment, we tested the effects of plant diversity and presence of plant litter on decomposition rates and soil fertility in a young coastal scrub system in Southern California. Decomposition rates increased with plant diversity and litter presence, but this decomposition did not yet translate to higher soil fertility (e.g., organic matter accumulation) in this young system. The processes underlying these relationships (e.g., changes to the physical environment) will be presented. This research reveals that both plant diversity and productivity influence plant-soil processes in this system and, therefore, has implications for better understanding drivers of community succession and for improving how we restore coastal ecosystems.

† **Tang, X.^{*}, Cohen, S.**

ASPECTS OF ASEYUAL AND SEXUAL REPRODUCTION PATTERNS OF EELGRASS (*ZOSTERA MARINA*) IN SAN FRANCISCO BAY

Romberg Tiburon Center for Environmental Studies, San Francisco State University

Eelgrass (*Zostera marina*), a highly clonal flowering marine angiosperm, has high productivity in marine ecosystems. However, eelgrasses have been threatened by rapid environmental changes. Although sexual reproduction is important to maintain genetically diverse populations that are resistant or resilient to environmental

stress, little is known about the bottleneck problems of eelgrass reproduction. The goal of this research was to identify the reproduction patterns of eelgrass in San Francisco Bay. Annual population was expected to perform better than perennial population due to previous studies involving the phenotypic and genotypic variation between them. However, our greenhouse mesocosm results show no significant difference in germination success or early growth eelgrass seeds from annual and perennial populations. Moreover, to examine genetic diversity in the field, we set up a fine-scale 10m*10m clone map experiment at Point Molate, a perennial bed in east San Francisco Bay that experienced an extreme population constriction in 2006. 34 eelgrass plants were sampled and genotyped for 9 highly polymorphic microsatellite loci. We expected the population bottleneck to have reduced genetic diversity in this population, and high numbers of eelgrass plants produced by clonal reproduction. However, our clone map showed that only 2 of the ramets revealed the same 9 – loci genotype, showing that this population has retained high genetic diversity after a bottleneck event and is not characterized by high levels of asexual reproduction.

Tang, C.M.*

CLIMATE CHANGE AND THE OCEANS: BALANCING THE USE OF LOCAL, REGIONAL, AND GLOBAL ECOSYSTEM EXAMPLES FOR ENGAGING PUBLIC AUDIENCES

California Academy of Sciences

Many studies indicate that Americans are still confused and ambivalent about climate change. The general public does not understand the scientific consensus surrounding the causes and impacts of climate change. Perhaps as a consequence of this confusion, there have not been major, significant societal changes regarding climate change solutions, mitigations, or adaptations. By effectively communicating the actual and predicted consequences of climate change on ecosystems, biologists may be able to contribute to behavioral and attitudinal changes by non-scientists. For example, studies suggest that people do not understand the connection between climate change and the oceans. Thus, biologists could contribute to public understanding of climate change by highlighting studies of threatened marine ecosystems which citizens are familiar with and care about. For example, at the California Academy of Sciences in San Francisco, exhibits in both the aquarium and the natural history museum tell stories about how climate change may impact ecosystems and fisheries of the San Francisco Bay, the Farallon Islands, and the Northern California coast. The use of local examples is designed to bring the threat of climate change home in our visitors' minds. At the same time however, because biodiversity loss due to climate change may be greater in the far-away tropics, the Academy also features climate change impacts to coral reefs to complement the local stories. By displaying the beauty of the coral reefs, we highlight the global impacts of climate change as well as engage visitors emotionally and hopefully, inspire them to act.

Tissot, B.N.*

A POLICY AND PROCEDURAL ANALYSIS OF THE MARINE RESERVE PROCESS IN OREGON

Washington State University Vancouver

The State of Oregon is currently in the process of establishing a network of marine reserves. The marine reserve process was initiated by the Governor in 2007 and is being developed in cooperation with the Ocean Policy Advisory Council, a legislatively mandated marine policy advisory body, the Oregon Department of Fish and Wildlife, and multiple Community Action Teams. This paper will discuss the public process used to propose and evaluate marine reserves in Oregon including the role of science, socio-economic data, involvement of stakeholders in Community Action Teams, and public dynamics. I will also examine the process from a policy perspective, including the role of conflicting goals, interagency congruence, and the development of advocacy coalitions. My analysis provides an illustration of both the strengths and weaknesses of the current process and provides recommendations that can be used in the establishment of future marine reserve networks.

† Treibergs, K. A.*

THE EFFECTS OF LARVAL SIZE AND ADULT MORPHOLOGY ON SETTLEMENT AND GROWTH OF AN ENCRUSTING BRYOZOAN, IN CHARLESTON, OR

Oregon Institute of Marine Biology, University of Oregon

Bryozoans serve as a unique model system to study settlement success and polymorphism in colonial organisms. I study aspects of the biology of the invasive cheilostome bryozoan *Schizoporella japonica* in the fouling communities of Charleston, OR. I removed colonies attached to mussels and induced the release of larvae. I measured sizes of individual larvae and induced them to settle on a scored biofilmed substrate. About 50% of larvae settled within four hours, and all remaining larvae failed to settle successfully after 48 hours. I then raised colonies in the laboratory and in the field measuring growth and survival rates, and am monitoring the formation of polymorphic zooids such as adventitious avicularia and ovicells. Growth rates and colony success will be analyzed with respect to initial larval size. In addition, I am studying the function of the avicularia in *S. japonica*. Preliminary studies and observations suggest that avicularia do not prevent settlement of other organisms on colonies, but may serve as defensive structures, preventing small polychaetes and flatworms from feeding on embryos within

ovicells. The results of this study will test the hypothesis that offspring size affects successful recruitment, further the understanding of bryozoan polymorphism, and document the life cycle of an invasive fouling organism.

Troyer, S.M.^{*}, Maltese, M.M., Behrens, M.D.

EXAMINING DISEASE PREVALENCE IN THE SEA URCHIN, *STRONGYLOCENTROTUS PURPURATUS* ALONG THE OLYMPIC PENINSULA

Pacific Lutheran University

Diseases are widely considered to be increasing and often have major community consequences. Therefore, understanding the mechanisms driving disease dynamics in marine systems is of increasing importance. This study investigated the prevalence of two disease pathologies in the sea urchin, *Strongylocentrotus purpuratus*, along the Olympic Peninsula of Washington. Since 2007, we have sampled urchin disease prevalence and population parameters (density and size) every six months at five different sites located either on the coast or in the Strait of Juan de Fuca. Through the repeated monitoring of these sites, we have detected distinct spatial and temporal patterns in disease prevalence. These data show that sites within the Strait of Juan de Fuca have a significantly higher prevalence of disease compared with the near absence of disease at coastal sites. Seasonally warmer temperatures also correlate with increased disease prevalence whereas cooler temperatures associate with an increase in disease recovery. Population parameters such as size and density are also associated with disease prevalence as there are increased levels of disease at sites with higher population densities, as well as larger mean size of urchins. The spatial and temporal patterns of disease prevalence and associations with various population parameters allow us to generate predictions regarding the factors underlying variation in sea urchin disease. Understanding the mechanisms driving the patterns observed through this study is important to gaining knowledge about disease dynamics in marine systems.

† Turner, K.R.^{*}, Sebens, K.P.

PREDATORY FISHES' IMPACTS ON BENTHIC COMMUNITY STRUCTURE IN THE SAN JUAN ISLANDS, WA
Friday Harbor Labs, University of Washington

Predators can play important roles in structuring communities. In marine systems predators may act as keystone species or as the species responsible for triggering trophic cascades. In the temperate marine subtidal many of the interesting examples of community-wide impacts of predators involve predation on sea urchins. Where urchins are present in abundance, due to the absence of their predators, they are able to graze standing kelp biomass to very low levels. This can change the physical environment and reduce the structure and food sources available to other species. However, in the San Juan Islands, WA, urchin abundance does not appear to strongly influence kelp abundance, and urchin predators are naturally rare or have been locally extinct for at least a century. Therefore the region provides an opportunity to study temperate marine food webs and the effects of large predators on a benthic community that does not depend on strong urchin-kelp interactions. We are studying the effects of large carnivorous fishes (lingcod, *Ophiodon elongatus*, and rockfishes, *Sebastes* spp.) on the rocky subtidal communities of San Juan Channel. Predatory fish abundance is variable within San Juan Channel, which allows us to study community structure across a range of predator abundance. We use surveys of all trophic levels involved in this natural experiment combined with exclusion cages designed to restrict fish access from large swaths of the benthos to determine the community-wide impacts of predatory bottomfishes. We will discuss results from the first year of these studies.

Vargas, R.^{1*}, Carter, D.¹, Castro, C.¹, Goodwin, L.¹, Razon, L.¹, Rivera, J.¹, Sillas, M.¹, Talley, D.²

NO ECOSYSTEM IS AN ISLAND: HABITAT CONNECTIVITY IN THE SEA OF CORTEZ

1 - Ocean Discovery Institute 2 - University of San Diego

This study both collected current and examined long term data to examine the connectivity between the arid islands of Bahía de los Angeles, Mexico and the adjacent highly productive Sea of Cortez. Specifically, we looked at the effect that rainfall has on the abundance and diversity of tenebrionid beetles on both bird and non-bird islands. Although both island types show inter-annual variability, this variability tends to be much higher on bird islands. Further, beetle abundance tends to be higher on guano islands, particularly during rainy years. Our research is important because it allows us to better understand the connectivity of these two ecosystems, improving our abilities to conserve them.

Walker, A.M.^{1*}, Foley, M.M.²

IMPACTS OF A LARGE-SCALE WILDFIRE ON LINKED WATERSHED, STREAM, AND NEARSHORE MARINE HABITATS IN BIG SUR, CALIFORNIA

1 - Long Marine Laboratory, University of California Santa Cruz 2 - Center for Ocean Solutions, Stanford University
Allochthonous subsidies, such as sediment, nutrients, and particulate organic matter (POM), can be transported to nearshore marine habitats via river inputs. The magnitude and timing of subsidy delivery depends on numerous

factors including watershed topography, rainfall patterns, land-use, and man-made or natural disturbances such as wildfire. The Big Sur coast in central California is characterized by a Mediterranean climate, steep landscape, and nearly pristine terrestrial and marine habitats. In the summer of 2008, the Basin Complex Fire (BCF) severely burned over 180,000 acres of this pristine wilderness area. The BCF provided a unique opportunity to investigate the effects of wildfire on linked watershed, stream, and coastal marine habitats due to the availability of pre-fire water quality data (2005-2008) that were collected from two rivers and adjacent nearshore areas of Big Sur: the Big Sur River (watershed ~90% burned) and Big Creek (watershed 0% burned). Following the BCF, water samples were continually collected (2008-2010) and analyzed for the same suite of constituents as pre-fire samples including chlorophyll-a, POM, nitrate, and phosphate. Our data show that there were significant increases in the concentration of chlorophyll-a, POM, nitrate, and phosphate at the Big Sur River sites following the fire across all years, while there was no statistically significant change in concentrations at Big Creek sites. This study highlights the importance of understanding how connectivity and subsidy delivery across the land-sea interface is altered by terrestrial disturbances and how long the impacts can persist in the system.

Wang, M.^{*}, Nguyen, K.C., Talley, T.S., Dayton, P.K.

HOW DOES PLANT DIVERSITY INFLUENCE THE FUNCTION OF A YOUNG COASTAL ECOSYSTEM AS ARTHROPOD HABITAT?

Scripps Institution of Oceanography, UCSD

While there is general agreement that species diversity influences ecosystem function, the mechanisms behind observed patterns and the relative importance of these relationships has been debated. Diversity-function relationships may change with ecosystem successional stage and focal function. Here, we determine the effects of plant diversity on the arthropod habitat function of a young coastal scrub ecosystem by testing several diversity-function theories, including sampling effect, facilitation and complementarity effect. We sampled the canopy arthropods from each individual plant within each treatment plot, where treatment is plant species diversity level. Along with plant abundance, complexity and quality data, we explored whether arthropods were responding to one particular species in the mix (e.g., sampling effect), to physical attributes of one or more species (e.g., facilitation), and/or to a mix of trophic and physical attributes contributed by the various species (e.g., complementarity effect). Arthropod diversity and total abundance were driven primarily by sampling effects (the presence of one or two species with large individuals) and, to a lesser degree, as-yet unexplained effects of plant diversity. Predator abundances had stronger associations with plant diversity levels and plant complexity than herbivores and detritivores, which correlated with plant biomass, food quality and possible interspecific relationships. Our findings reveal that biodiversity-function relationships are not as pronounced in this young, low-productivity system as plant biomass-function relationships. Besides providing a better understanding of drivers of community assembly, our work informs current efforts to restore native plant and arthropod communities.

Warneke, A.M.^{1*}, Virtue, S.¹, Sanchez, A.², Hovel, K.A.¹

SEAGRASS NURSERY HABITAT FUNCTION: RELATIVE EFFECTS OF HABITAT STRUCTURE AND PREY DENSITY ON MESOPREDATOR FORAGING EFFICIENCY

1 - Coastal and Marine Institute Laboratory, San Diego State University 2 - Coastal and Marine Institute Laboratory, Grossmont College

Seagrass structural complexity (e.g., shoot density or shoot biomass per unit area) may strongly influence prey survival and predator foraging success. Laboratory experiments and field tethering experiments suggest that increasing structural complexity limits the ability of predators to find and capture their prey. However, these experiments typically hold prey density levels constant as habitat structure increases, or prevent prey from fleeing from predators, which are not realistic conditions in seagrass habitat. We conducted laboratory-based mesocosm experiments to determine the relative effects of artificial seagrass shoot density and prey (grass shrimp *Hippolyte californiensis*) density on juvenile giant kelpfish (*Heterostichus rostratus*) foraging behavior. In a fully-crossed experimental design with three shoot density treatments (150, 400, 600 shoots m⁻²) and two prey density treatments (75 and 300 shrimp per mesocosm), we recorded (1) kelpfish activity (i.e. time spent in motion), (2) kelpfish predation (strike) attempts, (3) the proportion of strikes that were successful, and (4) the proportion of times that kelpfish pursued fleeing grass shrimp. Kelpfish activity levels were influenced by structural complexity, but not by prey density; kelpfish swam significantly less in high complexity seagrass than in moderate and low complexity seagrass. Surprisingly, the number of kelpfish strikes, proportional strike success and decisions to pursue fleeing prey did not vary with either structural complexity or prey density. Our results suggest that it is important to evaluate how seagrass habitat structure influences the behavior of predator and prey organisms, and that researchers should not presume strong linkages between habitat structure and foraging ability.

Weisman, D.^{*}, Reed, D.C., Schroeter, S.C., Huang, D.Y., Deza, A.A., Bentley, E.L.

INDEPENDENT ASSESSMENT OF MITIGATION PERFORMANCE: A CASE STUDY FOR WHEELER NORTH REEF, THE WORLD'S LARGEST ARTIFICIAL KELP REEF

Marine Science Institute, University of California Santa Barbara

The Wheeler North Reef is a 176 acre artificial reef located off San Clemente CA. It was constructed by Southern California Edison as partial mitigation for the loss of giant kelp forest habitat and associated biota caused by the operation of the San Onofre Nuclear Generating Station. An important element of the mitigation is the inclusion of physical and biological standards by which the performance of the artificial reef is judged. Data obtained from independent long-term monitoring done by UCSB scientists working under the direction of the California Coastal Commission (CCC) are being used to determine: (1) whether the performance standards are met; (2) the causes for any failures to meet the standards; and (3) the most appropriate methods for remediation if the standards are not achieved. As part of this monitoring data, the abundance (density or percent cover) and sizes of over 300 species of kelp forest algae, invertebrates and fish are collected once per year in summer at 256 transects distributed equally at Wheeler North Reef and two nearby reference reefs (San Mateo and Barn). Data on age, size-specific fecundity and somatic production for several indicator species of kelp forest fish are also collected at all three reef sites. While the primary purpose of these data are to provide the CCC with information needed to make regulatory decisions pertaining to the operation of a large coastal power plant, they also provide much insight into short and long-term processes affecting the biological structure and ecological function of kelp forest communities.

Wheeler, S.G.^{1*}, Anderson, T.W.², Morgan, S.G.³, Hobbs, J.A.³

THE INFLUENCE OF PARTURITION DATE, LARVAL CONDITION AND UPWELLING ON RECRUITMENT SUCCESS OF COPPER ROCKFISH

1 - Bodega Marine Laboratory, San Diego State University 2 - San Diego State University 3 - Bodega Marine Laboratory, University of California Davis

Variation in larval condition may affect settlement success of rockfishes (*Sebastes spp.*), and thus realized recruitment and patterns of population connectivity. Recent evidence suggests that older individuals represent a significant larval source as they disproportionately invest more energy into offspring and release larvae earlier in the reproductive season. If so, temporal variation in larval condition may reflect the combined effect of maternal investment and ocean productivity. Variation in wind forcing over upwelling-relaxation cycles may also affect larval settlement. We are evaluating patterns of larval growth, settlement and recruitment patterns of copper rockfish (*Sebastes caurinus*) to determine the relative importance of parturition date, condition and upwelling on settlement and recruitment of copper rockfish. Recently settled rockfishes were collected weekly from Apr-Sep 2010 in Bodega Harbor and Tomales Bay. Otolith microstructure analysis is being used to assess the condition (growth rate) and parturition date of fish. Parturition dates of older juveniles were collected in mid-September as an estimate of recruitment success and are being compared to parturition dates and condition patterns of recent settlers to determine (1) if condition at settlement predicts survivorship and (2) if individual parturition dates from peak settlement events match those of juveniles. To determine the effect of upwelling on settlement, we correlated changes in wind conditions and otolith microchemistry (Mg, Sr, Ba using LA-ICPMS) with settlement. Preliminary results suggest that parturition date and offspring condition both affect survivorship potential but upwelling-relaxation cycles may not.

Whitaker, S.G.^{*}, Richards, D.V.

WIDESPREAD DECLINES IN ABUNDANCES OF ROCKY INTERTIDAL ECOSYSTEM MODIFIERS AND ASSOCIATED MOTILE INVERTEBRATE SPECIES

Channel Islands National Park

Rocky intertidal rockweeds and mussels are ecosystem engineers that modify the physical environment and provide canopy for a suite of motile invertebrate taxa. Monitoring of 21 northern Channel Island sites over the last 30 years by the National Park Services has documented recent declines in abundances of such habitat modifiers and their associated motile species. Historically, the abundances of California mussels, *Mytilus californianus*, have oscillated, with short periods of declines followed by relatively rapid recovery. The rockweed, *Silvetia compressa*, has also undergone large population decreases temporally, though recovery has typically been slower. In 2008, *M. californianus* abundances began precipitously decreasing at most sites beyond declines observed in previous decades; mussels disappeared completely in permanent plots at six sites by fall 2009. Standing stocks of *S. compressa* have also exhibited larger than average declines starting in spring 2005. By 2009, below average rockweed cover was measured at all but one site with the alga nearly absent from seven sites. Concurrent monitoring of the abundances of grazing and predatory molluscs commonly inhabiting rockweed and mussel communities suggests that motile invertebrate declines are likely associated with loss of biotic habitat. Our data

suggest that widespread changes are occurring in rocky intertidal community structure at the Channel Islands. Future studies are needed to elucidate the factors causing these observed declines.

† **Whitlow, L.M.^{*}, Eernisse, D.J.**

TEST OF PHENOTYPIC PLASTICITY IN THE SURFGRASS LIMPET, '*LOTTIA*' PALEACEA: SHELL GEOMETRY, VOLUME AND LIFE HISTORY TRAITS

California State University Fullerton

Limpet shells exhibit amazing phenotypic plasticity in coloration, geometry, and sculpturing, reflecting differences between intertidal microhabitats. The shell of the surfgrass limpet, "*Lottia*" *paleacea*, is highly plastic, either narrow or wide depending on which of two surfgrass species it inhabits. We hypothesized that limpets living on a narrower blade of *Phyllospadix torreyi* would have on average a lower total volume than those on the wider *P. scouleri*. If so it follows that shell plasticity could have additional effects on life history traits, including gonad volume, age (volume) at first reproduction, and seasonality. We demonstrated that the volume of the limpets could be effectively modeled as a pyramid, $(LWH)/3$, and this allowed us to estimate each surfgrass limpet's internal volume. We estimated the volume of 232 limpets found on *P. torreyi* and 237 limpets found on *P. scouleri* from Cambria, San Luis Obispo Co., California. Our results suggest that limpets on *P. torreyi* have a significantly lower mean volume and maximum size than those on *P. scouleri*. We counted the number of eggs, where detectable, in each female limpet. Although the limpets on *P. torreyi* did not get as large, their narrower shape did not lead to a disproportionate reduction in the volume devoted to eggs. Likewise, it did not significantly modify their age at first reproduction, or correspond to any detectable difference in reproductive seasonality, relative to the wider morph. We have thus concluded that reproductive traits are largely decoupled and independent of phenotypic plasticity in shell geometry.

† **Wrubel, K.R.^{1*}, Groth, S.²**

CHANGES IN RED SEA URCHIN (*STRONGYLOCENTROTUS FRANCISCANUS*) TEST SIZE DURING THE OREGON URCHIN FISHERY (1986-2009)

1 - Washington State University Vancouver 2 - Oregon Department of Fish and Wildlife

Red sea urchins, *Strongylocentrotus franciscanus*, are the target of an important commercial fishery along the West coast. Oregon's fishery peaked in the early 1990's when it ranked as one of the state's largest. Since that time, there has been a decline in fishery landings, effort and average size, as well as significant changes to the size distribution of market urchins. Conversely, there have been minimum changes to the management of the fishery since its peak, resulting in current management not reflecting the current status of the fishery. Harvested urchin tests were measured from Orford reef, the state's most productive single area, since 1988 providing a long-term dataset allowing us to monitor changes in urchin size distribution. During the initial years of the fishing on this area, market sampling showed large average size combined with a proportionately high percentage of large (old) animals. Subsequent to the fishing down of the virgin stock, size distribution of market samples showed a modal signal increasingly close to the minimum size limit (89 mm) indicating a move to "recruitment fishing" and fishery productivity decreased. As fishing pressure has receded, average urchin sizes have increased, though, given their long life history, the ratio of very large urchins has not responded proportionally. Evaluating changes in urchin test size throughout the fishery assists management agencies to coarsely infer changes to population structures. These results will be used to write a fishery report and to update the management of this fishery.

† **Zamudio, S.¹, Cumbo, V.¹, Fan, T.Y.², Edmunds, P.J.¹**

THE INTERACTIVE EFFECTS OF PCO₂ AND AMMONIUM ON LARVAE OF THE CORAL *POCILLOPORA DAMICORNIS*

1 - California State University Northridge 2 - National Museum of Marine Biology and Aquarium, Taiwan

Scleractinian corals thrive in oligotrophic seawater, and their Symbiodinium symbionts are typically highly sensitive to nutrient concentrations, including NH₄⁺, which is taken up and used directly by the algae. Ocean acidification (OA) poses a serious threat to adult corals by impairing their ability to deposit calcified skeletons, but the impacts of OA on planula larvae and their Symbiodinium symbionts is uncertain. The goal of this study was to test the hypothesis that nutrients modulate the response of coral larvae to increased pCO₂. Brooded larvae from the coral *Pocillopora damicornis* were used as a model system, and were collected from colonies in shallow water (10 m) in Taiwan. Larvae were subjected to combinations of ambient (434 μ atm) and high pCO₂ (743 μ atm) crossed with ammonium concentrations of 2.6 μ M (ambient) and 10.8 μ M (elevated) for 5 days at 29°C. Larval size, maximum dark-adapted quantum yield of PSII (Fv/Fm), protein content and survivorship were measured as response variables throughout the experiment. A significant CO₂ × nutrient interaction was found, in which Symbiodinium subjected to high pCO₂ and high nutrients experienced an increase in Fv/Fm, while those subjected to elevated nutrients and ambient pCO₂ experienced a decrease in Fv/Fm. Although all other measured variables were unaffected by the treatment conditions, these results suggest that symbiotic coral larvae might benefit from NH₄⁺

through its effects on their Symbiodinium, and indirectly these effects might facilitate tolerance of elevated pCO₂ levels.

† Ziccarelli, L.M.^{*}, Shanks, A., Morgan, S., Kudela, R.

PSEUDO-NITZSCHIA AND DOMOIC ACID PRODUCTION IN THE SURF ZONE

Oregon Institute of Marine Biology, University of Oregon

From 15 June to 15 July 2010, we collected water samples from within and just seaward of the surf zone at Sand City, Monterey Bay, CA. Surf zone samples were collected by filling a 1 Liter jar with water from in the rip current. Offshore samples were collected with a 20 µm net towed vertically from 10 m. Particulate domoic acid (pDA) and phytoplankton cell concentrations were obtained using standard techniques. *Pseudo-nitzschia* was very abundant in both the surf zone and offshore. Concentrations in the surf zone were generally about 10X higher than offshore (mean=10.4, SE=2.4) with cell concentrations ranging from 375,000 to 3,216,000 /L in the surf zone and 51,600 to 253,000 /L offshore. Particulate domoic acid was present in the surf zone and offshore. Concentrations of pDA in the surf zone ranged from 138.52 to 4509.66 ng/L and offshore from 45.58 to 2078.66 ng/L. By dividing the pDA concentration by the cell concentration we can estimate the pDA production per cell. pDA per cell ranged from 48 to 11 ng/10,000 cells in the surf zone and averaged 24 (SD=12). In the offshore waters it ranged from 324 to 2 ng/10,000 cells and averaged 110 (SD=121). *Pseudo-nitzschia* were frequently highly concentrated in the surf zone and were a source of high concentrations of pDA in that habitat. The generally higher per cell concentration of pDA in the *Pseudo-nitzschia* cells offshore suggests that they may have been in a more stressed physiological state than cells within the surf zone.

Local Restaurants (all within 0.5 miles of the hotel)

1. Tender Greens
2400 Historic Decatur Road, San Diego, CA (619) 226-6254
tendergreensfood.com
 2. Da Kine's Plate Lunches
2400 Historic Decatur Rd, San Diego, CA 92106-6158 (619) 269-3688
dakines.com
 3. Sammy's Woodfired Pizza
2401 Truxtun Rd # 102, San Diego, CA (619) 222-3111
sammypizza.com
 4. Cafe San Diego
2468 Historic Decatur Road Ste 100 San Diego, CA 92106 (858) 427-0594
cafesandiego.com
 5. Panera Bread
2445 Truxtun Rd, San Diego, CA 92106-6153 (619) 222-2122
panerabread.com
 6. Ekiru Sushi
2850 Womble Rd, San Diego, CA (619) 221-1228
 7. Sushiya
2558 Laning Rd, San Diego, CA (619) 224-0100
sushiya-sd.com
 8. Spices Bay Thai Kitchen
2558 Laning Rd # 102, San Diego, CA (619) 224-8424
spicesbaythai.com
 9. Oggi's Pizza and Brewing Company
2562 Laning Road, San Diego, CA (619) 876-5000
oggis.com
 10. Harbor Greek Cafe restaurant
2556 Laning Road, San Diego, CA 92106 (619) 224-3900
harborigreekcafe.com
- Los Primos Mexican Food
2556 Laning Rd # B101, San Diego, CA (619) 224-8226
losprimosmexicanfood.com
- 2560 Laning Rd # A-101, San Diego, CA (619) 221-4362