



Western Society  
of Naturalists  
Program and Abstracts

89<sup>th</sup> Annual Meeting  
Vancouver, British Columbia, Canada  
November 6-9, 2008

Thursday, Nov 6	Friday, Nov 7	Saturday, Nov 8	Sunday, Nov 9
Welcome	Registration  SYMPOSIUM 1 (BALLROOM) Ecological perspectives through stable isotope analysis 0800-1135	Registration  SYMPOSIUM 2 (BALLROOM) Women in marine biology: personal perspectives from the field 0800 - 1115 <i>followed by Lifetime Achievement award and Naturalist of the Year award</i>	Registration  PLENARY SPEAKER (BALLROOM) Andrew Trites The decline of Steller sea lions: riding out a sea of ecological change in the North Pacific 0830 - 0930
	Sessions 1 & 2 (PINNACLE I) Invertebrate biology I Dispersal and recruitment I  Sessions 3 & 4 (PINNACLE III) Plant/algal biology I Intertidal ecology I	Sessions 9 & 10 (PINNACLE I) Fisheries ecology I Fisheries ecology II  Sessions 11 & 12 (PINNACLE III) Invertebrate biology II Intertidal ecology II	Sessions 17 & 18 Species-habitat associations (PINNACLE I) Plant/algal biology II (PINNACLE III)  Sessions 19 & 20 Community ecology III (SHAUGHNESSY I) Population biology & ecology (SHAUGHNESSY II)
Registration	Sessions 5 & 6 (SHAUGHNESSY I) Community ecology I Behavior and evolution  Sessions 7 & 8 (SHAUGHNESSY II) Applied ecology Invasive species	Sessions 13 & 14 (SHAUGHNESSY I) Community ecology II Physiological ecology  Sessions 15 & 16 (SHAUGHNESSY II) Conservation and restoration ecology Dispersal and recruitment II	Have a safe trip home!
Student workshop Pinnacle I 1800-2000	WSN Poster session (BALLROOM) 1900 - 2200	WSN business meeting (PINNACLE III) 1815 - 1915	
Student mixer The Lions Pub 2000-2400	WSN Attitude Adjustment Hour (name badge required)  BALLROOM 1930	Presidential Banquet (tickets required) Auction for student travel  PINNACLE I 1930 (banquet) & 2130 (auction)	

# Western Society of Naturalists

## ~ 2008 ~

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## 89<sup>TH</sup> ANNUAL MEETING

### VANCOUVER MARRIOTT PINNACLE

### VANCOUVER, BRITISH COLUMBIA, CANADA

## General Information

### **Registration and Information**

Welcome! Registration packets will be available at the registration table for those members that have pre-registered. Those that have not pre-registered but wishing to attend the meeting can pay for membership and registration (with an added \$20 late fee). **Unfortunately, banquet tickets cannot be sold at the meeting because the hotel requires final counts of attendees well in advance.** The Attitude Adjustment Hour (AAH) now is included in the registration price, so you will only need to show your badge for admittance. WSN t-shirts and other paraphernalia must be purchased or picked up at the WSN Student Committee table.

A list of recommended restaurants near the Marriott Pinnacle can be found at the end of the program.

### **Special Event Information**

On Thursday, November 6, there will be a student workshop entitled "Ocean Acidification and climate change: Dis-solving the mystery" held in Pinnacle 1. Immediately following will be the student mixer, held at **The Lions Pub**, 2 blocks from the hotel at 1128 W. Hasting Street. On Friday, November 7, the WSN poster session will begin at 7 PM in the ballroom and the Attitude Adjustment Hour (AAH) will begin at 7:30 PM in the ballroom. The Presidential Banquet will be held on Saturday, November 8 at 7:30 PM in Pinnacle I, immediately followed by the Auction for the Student Travel Fund at ~ 9:30 PM.

## SPECIAL EVENTS

### Thursday, November 6

1800 – 2000 WSN Student Workshop (Pinnacle 1)  
2000 – 2400 WSN Student Mixer (The Lions Pub)

### Friday, November 7

1900 – 2230 WSN Poster Session (Pinnacle Ballroom)  
1930 – 2230 AAH: Attitude Adjustment Hour (Pinnacle Ballroom)

### Saturday, November 8

1815 – 1900 WSN Annual Business Meeting (Pinnacle III)  
1930 – 2130 WSN Presidential Banquet (Pinnacle I)  
2130 – 2330 WSN Auction (Pinnacle I)

## PROGRAM OF EVENTS

\* Indicates person presenting

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

### THURSDAY, NOVEMBER 6, 2008

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1600 – 2000 **Registration**

1800 **WSN student workshop: “Ocean acidification and climate change: Dissolving the mystery”** (Pinnacle I)

*Speakers to include:*

Gretchen Hofmann, UC Santa Barbara

James Barry, Monterey Bay Aquarium Research Institute

Terrie Klinger, University of Washington

2000 **WSN Student Mixer** (The Lions Pub, 1128 W. Hasting Street)  
Open to all graduate and undergraduate students; no ticket required.

See the student desk for directions.

FRIDAY, NOVEMBER 7, 2008

STUDENT SYMPOSIUM

PINNACLE BALLROOM

ECOLOGICAL PERSPECTIVES THROUGH STABLE ISOTOPE ANALYSIS

0800 INTRODUCTION AND ANNOUNCEMENTS

0815 **Newsome, S.D.** *Geophysical Laboratory, Carnegie Institution for Science* USING ISOTOPIC PROXIES TO ASSESS DIETARY SPECIALIZATION AND NICHE VARIATION ACROSS SPACE AND TIME: SEA OTTERS (*ENHYDRA LUTRIS*) IN THE NORTH PACIFIC OCEAN

0845 **Salomon, A.K.** *Marine Science Institute, University of California Santa Barbara* USING STABLE ISOTOPES TO INFER TROPHIC RELATIONSHIPS IN KELP FOREST FOOD WEBS: PERKS, PITFALLS AND SOLUTIONS

0915 **Pakhomov, E. & S Kaehler** *Department of Earth and Ocean Sciences, University of British Columbia* IMPORTANCE OF KELP-DERIVED MATTER IN THE OPEN-OCEAN ISLAND ECOSYSTEM: SPATIAL AND TEMPORAL DYNAMICS INFERRED THROUGH THE IMPLICATION OF STABLE ISOTOPES

0945 BREAK

1005 **Page, H.M.** *Marine Science Institute, University of California Santa Barbara* TRANSPORT OF LAND-DERIVED MATERIALS ACROSS ECOSYSTEM BOUNDARIES: EVALUATION USING STABLE ISOTOPES

1035 **Finney, B.** *Department of Biological Sciences, Idaho State University* A LONG-TERM PERSPECTIVE ON NORTH PACIFIC CLIMATE AND ECOSYSTEM CHANGE: INSIGHTS FROM STABLE ISOTOPE ANALYSIS

1105 PANEL DISCUSSION

1135 LUNCH

FRIDAY, NOVEMBER 7, 2008

SESSION 1

PINNACLE 1

INVERTEBRATE BIOLOGY I

Chair: Richard Emlet, University of Oregon

- 1300 **Emlet, R.B.** \* *University of Oregon* REPRODUCTION AND DEVELOPMENT OF A BROODING, AUSTRALIA SEA URCHIN *PACHYCENTROTUS BAJULUS*
- 1315 †**Gehman, A.M.** \* *Western Washington University, Shannon Point Marine Center* MATERNAL DIET AND JUVENILE QUALITY IN THE SEA STAR *LEPTASTERIAS AEQUALIS*
- 1330 **Van Alstyne, K.L.** \*, **Dominique, V.J. III,** and **G. Muller-Parker** *Western Washington University* DO THE SYMBIONTS OR HOSTS IN AN ANEMONE-ZOOXANTHELLA SYMBIOSIS PRODUCE DIMETHYLSULFONIOPROPIONATE (DMSP)?
- 1345 †**Chomiczewski, L.A.** \*, and **S.D. Sulkin** *Western Washington University* MANIPULATING THE NUTRITIONAL VALUE OF PLANKTOTROPHIC LARVAE AS PREY FOR LARVAL CRABS
- 1400 †**Neufeld, C.J.** \* *University of Alberta and Bamfield Marine Sciences Centre* THE LONG AND SHORT OF SEX IN THE SEA: A NOVEL REPRODUCTIVE STRATEGY IN THE GOOSENECK BARNACLE *POLLICIPES POLYMERUS*?
- 1415 †**Dodge, C.A.** \*, and **M.S. Edwards** *San Diego State University* THE EFFECTS OF FOOD AVAILABILITY ON CONSUMPTION RATES AND SPAWNING COMPETENCE IN THE PURPLE URCHIN (*STRONGYLOCENTROTUS PURPURATUS*)
- 1430 †**Hall, K., Patrick, J. W. A.** \*, and **K. Romanin** KILLERS IN THE SURF: A LOOK AT THE VORACIOUS FEEDING BEHAVIOR OF THE ANKLE BITING ISOPODS OF PACHENA BEACH
- 1445 †**Matthews, J. A.** \*, and **B. T. Hentschel** *San Diego State University* EFFECTS OF IN-SITU CURRENT MANIPULATIONS ON GROWTH RATES OF THE INTERFACE-FEEDING POLYCHAETE, *POLYDORA CORNUTA*
- 1500 BREAK

## DISPERSAL AND RECRUITMENT 1

Chair: Alan Shanks, University of Oregon

- 1530 **Shanks, A.L.**<sup>\*1</sup>, and **R.K. Shearman**<sup>2</sup> *1 - University of Oregon, Oregon Institute of Marine Biology 2 - Oregon State University, College of Oceanic and Atmospheric Sciences* CROSS-SHELF DISTRIBUTIONS OF INTERTIDAL INVERTEBRATE LARVAE ARE UNAFFECTED BY UPWELLING- OR DOWNWELLING- FAVORABLE WINDS
- 1545 **Johnson, D.W.**<sup>\*</sup> *Oregon State University* A SMALL FRY'S PERSPECTIVE ON FISHERIES-INDUCED EVOLUTION: THE IMPORTANCE OF LARVAL QUALITY AND POPULATION REPLENISHMENT
- 1600 †**Miller, S.H.**<sup>1\*</sup>, **Morgan, S.G.**<sup>1</sup>, and **H.S. Carson**<sup>2</sup> *1 - Bodega Marine Lab, UC Davis 2 - San Diego State and UC Davis* TRACKING CRAB POPULATION CONNECTIVITY USING TRACE ELEMENT ANALYSIS OF SOFT TISSUES: A NEW APPROACH
- 1615 †**Nickols, K.J.**<sup>\*</sup>, **Gaylord, B.**, and **J.L. Largier** *University of California, Davis, Bodega Marine Laboratory* THE COASTAL BOUNDARY LAYER: LOWERING THE SPEED LIMIT FOR NEARSHORE DISPERSERS
- 1630 **White, J. W.**<sup>1\*</sup>, **Botsford, L. W.**<sup>1</sup>, **Coffroth, M. A.**<sup>2</sup>, **Paris, C. P.**<sup>3</sup>, **Planes, S.**<sup>4</sup>, **Shearer, T. L.**<sup>5</sup>, **Thorrold, S. R.**<sup>6</sup>, and **G. P. Jones**<sup>7</sup> *1 - UC Davis 2 - University of Buffalo 3 - University of Miami 4 - Universite de Perpignan 5 - Georgia Tech 6 - Woods Hole 7 - James Cook University* CONNECTIVITY AND RESILIENCE OF MARINE METAPOPOPULATIONS: MATCHING EMPIRICAL EFFORTS TO PREDICTIVE NEEDS
- 1645 **Lafferriere, A.M.**<sup>\*</sup>, and A.L. Shanks *Oregon Institute of Marine Biology, University of Oregon* DISTRIBUTION OF ZOOPLANKTON WITHIN LANGMUIR CIRCULATION CELLS
- 1700 †**Carson, H.S.**<sup>\*</sup> *San Diego State and UC Davis* THE POPULATION CONNECTIVITY OF THE OLYMPIA OYSTER (*OSTREA CONCHAPHILA*) AMONG SOUTHERN CALIFORNIA ESTUARIES
- 1715 †**Romero, R.**<sup>\*</sup> *Moss Landing Marine Labs, SJSU* RECRUITMENT STRATEGIES OF THE EPHEMERAL, OPPORTUNISTIC MACROALGA *ULVA* (LINNAEUS) IN CENTRAL CALIFORNIA
- 1730 †**Christie, M.R.**<sup>1\*</sup>, **Albins, M.A.**<sup>1</sup>, **Beets, J.**<sup>2</sup>, **Tissot, B.N.**<sup>3</sup>, **Thompson, S.**<sup>4</sup>, and **M.A. Hixon**<sup>1</sup> *1 - Department of Zoology, Oregon State University 2 - Department of Marine Science, University of Hawaii at Hilo 3 - Washington State University, Vancouver 4 - Cascadia Conservation Trust, OR* PATTERNS OF POPULATION CONNECTIVITY IN A CORAL-REEF FISH

FRIDAY, NOVEMBER 7, 2008

SESSION 3

PINNACLE III

PLANT/ALGAL BIOLOGY I

Chair: Mike Graham, Moss Landing Marine Labs

- 1300 †**Fink, L. A.**\*, and **S. L. Manley** *California State University Long Beach* METAL POLLUTION REFLECTED IN KELP SAP: A NEW TOOL TO ASSESS THE HEALTH OF THE KELP FOREST ECOSYSTEM
- 1315 †**Mothokakobo, Rochelle K**\*, and Matt Edwards *San Diego State University* VARIATION IN PHLOROTANNIN CONCENTRATIONS IN UNDERSTORY KELPS IN POINT LOMA, SAN DIEGO, CA
- 1330 †**Hessing-Lewis, M.L.**<sup>1\*</sup>, **Hacker, S.**<sup>1</sup>, **Rumrill, S.**<sup>2</sup>, and **B. Menge**<sup>1</sup> *1 - Oregon State University 2 - South Slough Estuarine Research Reserve* SEAGRASS-MACROALGAE INTERACTIONS UNDER A MARINE-DERIVED NUTRIENT CONTEXT
- 1345 †**Carney, L.T.**\*, and **M.S. Edwards** *San Diego State University* EFFECT OF NUTRIENTS ON DEVELOPING GAMETOPHYTES OF THE GIANT KELP *MACROCYSTIS PYRIFERA*
- 1400 **Boller, M.**<sup>1</sup>, **Kost, L.**<sup>2</sup>, and **P. T. Martone**<sup>3\*</sup> *1 - Saint John Fisher College, Rochester, NY 2 - Hopkins Marine Station of Stanford University, Pacific Grove, CA 3 - University of British Columbia, Vancouver, BC* RESOLVING RECONFIGURATION: MECHANICAL IMPLICATIONS OF MORPHOLOGICAL DIVERSITY IN WAVE-SWEPT MACROALGAE
- 1415 **Graham, M.H.**<sup>1\*</sup>, **Kinlan, B.P.**<sup>2</sup>, and **L.D. Druehl**<sup>3</sup> *1 - Moss Landing Marine Labs 2 - University of California Santa Barbara 3 - Bamfield Marine Sciences Centre* ECOLOGY OF KELP FORESTS IN DEEP TROPICAL WATERS
- 1430 †**Spitler, M. I.**\*, and **R.C. Carpenter** *California State University, Northridge* FACTORS INFLUENCING THE DISTRIBUTION AND ABUNDANCE OF TWO DOMINANT MACROALGAL SPECIES ON CORAL REEFS IN MOOREA, FRENCH POLYNESIA
- 1445 †**Nishizaki, M.T.**\*, **Grunbaum, D.**, and **R.A. Cattolico** *Department of Biology and School of Oceanography, University of Washington* PREDICTING BLOOM-FORMATION FROM SWIMMING BEHAVIOR IN A MARINE ALGA
- 1500 BREAK



FRIDAY, NOVEMBER 7, 2008

SESSION 4

INTERTIDAL ECOLOGY I

PINNACLE III

Chair: Brian Bingham, Western Washington University

- 1530 **Dutton, J.M.\***, and **G.E. Hofmann** *University of California, Santa Barbara* SPATIAL AND TEMPORAL PATTERNS IN DISTRIBUTION AND PROTEIN DEGRADATION FOR *MYTILUS* CONGENERS IN BODEGA BAY, CA
- 1545 **Fletcher, A.\***, **Bingham, B.L.**, **Muller-Parker, G.**, and **L. Francis** *Western Washington University* DOES ALGAL SYMBIONT COMPLEMENT AFFECT GONAD DEVELOPMENT IN *ANTHOPLEURA ELEGANTISSIMA*?
- 1600 †**Cooper, E.E.\*** *Oregon Institute of Marine Biology* *CHLOROSTOMA (TEGULA) FUNEBRALIS* AGE STRUCTURE AND EFFECTS ON REPRODUCTIVE POTENTIAL OF POPULATIONS
- 1615 **Lees, D. C.\***, and **W. B. Driskell** *Littoral Ecological & Environmental Services* DELAYED RECOVERY IN INTERTIDAL CLAM ASSEMBLAGES IN PRINCE WILLIAM SOUND FOLLOWING THE *EXXON VALDEZ* OIL SPILL CLEANUP
- 1630 †**Wood, M.E.\***, **Nielsen, K.J.**, and **M.J. Donahue** *Sonoma State University* REPRODUCTIVE OUTPUT OF A KEYSTONE PREDATOR AND ITS PREFERRED PREY: THE DIFFERENTIAL INFLUENCE OF OCEANOGRAPHIC REGIME AND LOCAL HABITAT
- 1645 **Shanks, A.L.<sup>1\*</sup>**, and **S.G. Morgan<sup>2</sup>** *1 - University of Oregon, Oregon Institute of Marine Biology 2 - U. of California Davis, Bodega Marine Laboratory* SURF ZONE DYNAMICS AND THE SETTLEMENT AND RECRUITMENT OF BARNACLES
- 1700 †**Fong, L.S.\***, and **C.D. Robles** *California State University, Los Angeles* EXPERIMENTAL CONFIRMATION OF FACILITATIVE INTERACTIONS OF CALIFORNIA MUSSELS (*MYTILUS CALIFORNIANUS*) ON ROCKY SHORES, BARKLEY SOUND, BRITISH COLUMBIA
- 1715 †**Jorve, J.P.\*** *Moss Landing Marine Laboratories, University of British Columbia* CASCADING EFFECTS OF *MASTOCARPUS* MORPHOLOGICAL VARIABILITY ON SUB-CANOPY IRRADIANCE AND *LOTTIA* SPP.
- 1730 †**Gooding, R. A.\***, **Tang, E.**, and **C.D.G. Harley** *University of British Columbia* MULTIPLE CLIMATE VARIABLES INCREASE THE GROWTH OF A KEYSTONE PREDATOR, THE SEASTAR *PISASTER OCHRACEUS*
- 1745 **Alifano, A. R.\*** *Moss Landing Marine Labs* THE ROLE OF DRIFT ALGAE ON TROPHIC ECOLOGY OF INTERTIDAL PURPLE SEA URCHINS *STRONGYLOCENTROTUS PURPURATUS* IN CENTRAL CALIFORNIA

FRIDAY, NOVEMBER 7, 2008

SESSION 5

SHAUGHNESSY I

COMMUNITY ECOLOGY I

Chair: Jarrett Byrnes, Marine Science Institute, UC Santa Barbara

- 1300 **McMillan, S.M.**\* *Moss Landing Marine Laboratories* EFFECTS OF *CHLOROSTOMA* GRAZING ON THE PRODUCTIVITY AND REPRODUCTIVE POTENTIAL OF THE GIANT KELP, *MACROCYSTIS PYRIFERA*, IN CENTRAL CALIFORNIA
- 1315 †**White, J.S.**\*, **Boyer, S.E.**, and **A. Delval** *Department of Zoology, University of Florida* EFFECTS OF FARMED ALGAL TURF ON GROWTH AND SURVIVAL OF MASSIVE *PORITES*
- 1330 †**Nichols, K.D.**\*, and **K.A. Hovel** *San Diego State University* THE EFFECTS OF PREDATORS AND HABITAT ON SEA URCHIN DENSITY IN SOUTHERN CALIFORNIA KELP FORESTS
- 1345 **Maloney, E.R.**<sup>1\*</sup>, **Fairey, W.R.**<sup>1</sup>, **Lyman, A.A.**<sup>1</sup>, **Walton, Z.A.**<sup>1</sup>, **Foss, S.F.**<sup>2</sup>, and **S.N. Shiba**<sup>2</sup> *1 - Moss Landing Marine Labs 2 - California Dept. Fish and Game, Office of Spill Prevention and Response* SURVEYS FOR INTRODUCED MARINE SPECIES ON THE OUTER COAST OF CALIFORNIA: WHO'S ON OUR TURF?
- 1400 †**McLaughlin, John P.**<sup>1\*</sup>, **Marcogliese, David J.**<sup>2</sup>, **Kuris, Armand M.**<sup>1</sup>, and **Kevin D. Lafferty**<sup>3</sup> *1 - Department of Ecology, Evolution and Marine Biology, University of California Santa Barbara 2 - Environment Canada, Montreal, Quebec 3 - Western Ecological Research Center, United States Geological Survey* ADDING PARASITES TO THE NW ATLANTIC SHELF FOOD WEB DOUBLES SPECIES RICHNESS AND ALTERS NETWORK STRUCTURE
- 1415 **Sebens, K.P.**\* *Friday Harbor Labs and Dept. of Biology, University of Washington* COMPETITION AND COEXISTENCE IN THE ROCKY SUBTIDAL ZONE
- 1430 **Pochon, Xavier**<sup>1</sup>, **Stat, Michael**<sup>1</sup>, **Takabayashi, Misaki**<sup>2</sup>, **Chasqui, Luis**<sup>3</sup>, **Jones, Leonard**<sup>4</sup>, **Logan, Dan D. K.**<sup>5</sup>, and **Ruth D. Gates**<sup>1\*</sup> *1 - Hawaii Institute of Marine Biology, SOEST, University of Hawaii 2 - Department of Marine Science, University of Hawaii at Hilo 3 - Departamento del Biologia, Universidad del Valle, Colombia 4 - Institute of Marine Sciences, University of Dar es Salaam, Tanzania 5 - School of Biological Sciences, Victoria University of Wellington, New Zealand* COMPARISON OF ENDOSYMBIOTIC AND FREE-LIVING *SYMBIODINIUM* DIVERSITY IN A HAWAIIAN REEF ENVIRONMENT
- 1445 **Byrnes, J.E.**<sup>1\*</sup>, and **K.E. Edwards**<sup>2</sup> *1 - Marine Science Institute, University of California Santa Barbara 2 - Bodega Marine Lab, University of California Davis* PREDATOR DIVERSITY INFLUENCES SHORT AND LONG-TERM WATER FILTRATION IN FOULING COMMUNITIES
- 1500 BREAK

FRIDAY, NOVEMBER 7, 2008

SESSION 6

SHAUGHNESSY I

BEHAVIOR AND EVOLUTION

Chair: Luke Miller, Hopkins Marine Station, Stanford University

- 1530 †**Sala, LM\***, **Kitaguchi, BD**, and **BT Hentschel** *San Diego State University* BEHAVIOR AND GROWTH OF ECHINOPLUTEUS LARVAE, *DENDRASTER EXCENTRICUS*, IN RELATION TO PHYTOPLANKTON THIN LAYERS
- 1545 †**Bell, T.M.\***, and **J.P. Wares** *University of Georgia* THE PHYLOGEOGRAPHIC STRUCTURE AND EVOLUTIONARY ECOLOGY OF THE NORTH ATLANTIC ISOPOD, *IDOTEA BALTHICA*
- 1600 **Miller, L.P.\*** *Hopkins Marine Station, Stanford University* THE QUANDARY OF COLOR AND THE SIGNIFICANCE OF SHAPE: TEMPERATURE RELATIONS IN LITTORINE SNAILS
- 1615 **Marshall, D. J.\*** and **N. E. McKenzie** *School of Integrative Biology, The University of Queensland, Australia* CUSTOM-MADE GAMETES: TRANSGENERATIONAL STRESS RESISTANCE IN A MARINE INVERTEBRATE
- 1630 **Levin, Phillip S.\***, **Andrews, Kelly**, **Horne, Peter**, and **G. Williams** *NOAA Fisheries* SCALING UP BEHAVIOR IN SIXGILL SHARKS: AN APPROACH FOR EXPLORING THE KNOWN UNKNOWN
- 1645 †**Crean, A.J.\***, and **D.J. Marshall** *University of Queensland* PHENOTYPIC PLASTICITY IN MULTIPLE TRAITS OF THE EGGS OF A BROADCAST SPawner
- 1700 **Curtis, D.L.\***, and **I.J. McGaw** *University of Nevada, Las Vegas and Bamfield Marine Science Centre* THE EFFECTS OF NUTRITIONAL STATUS AND FOOD AVAILABILITY ON THE SALINITY AND THERMAL PREFERENCE OF ADULT DUNGENESS CRABS IN THE LAB AND IN THE FIELD
- 1715 †**Withy-Allen, K.R.\***, and **K.A. Hovel** *San Diego State University* MOVEMENT OF CALIFORNIA SPINY LOBSTER, *PANULIRUS INTERRUPTUS*, IN SOUTHERN CALIFORNIA KELP FOREST HABITAT
- 1730 **Frid, A\***, and **J Marliave** *Vancouver Aquarium* APPLYING PREDATION RISK THEORY TO THE RECOVERY OF DEPLETED POPULATIONS OF ROCKFISH AND LINGCOD
- 1745 †**Marshall, W.M.\***, and **M.L. Berbee** *Department of Botany, University of British Columbia. Bamfield Marine Sciences Centre* DIVERSITY AND LIFECYCLES OF ICHTHYOSPOREANS, NEW PROTISTS FROM THE ANIMAL/FUNGAL LINEAGE, COLLECTED FROM MARINE INVERTEBRATES OF BRITISH COLUMBIA

FRIDAY, NOVEMBER 7, 2008

SESSION 7

SHAUGHNESSY II

APPLIED ECOLOGY

Chair: Sean Anderson, California State University Channel Islands

- 1300 **Coleman, H.M.**,<sup>1\*</sup> **Hamdoun A.M.**,<sup>2</sup> and **H.S. Lenihan**<sup>1</sup> *1 - Bren School of Environmental Science and Management, University of California, Santa Barbara, CA. 2 - Hopkins Marine Station, Stanford University* ECOLOGICAL CONSEQUENCES OF EXPOSURE TO NATURAL OIL CONTAMINATION
- 1315 **Samhuri, J.F.**\*, and **P.S. Levin** *NOAA Fisheries, Northwest Fisheries Science Center* TOOLS OF THE TRADE: IDENTIFYING VITAL SIGNS AND ECOLOGICAL THRESHOLDS FOR MARINE ECOSYSTEM-BASED MANAGEMENT
- 1330 †**Ortiz, DM**<sup>1\*</sup>, **Tissot, BN**<sup>1</sup>, and **WJ Walsh**<sup>2</sup> *1 - Washington State University Vancouver 2 - Hawaii Division of Aquatic Resources* EVALUATING HABITAT-RELATED EFFECTIVENESS OF AN MPA NETWORK IN WEST HAWAII
- 1345 **Williams, G.D.**\*, **Harvey, C. J.**, **Andrews, K. S.**, and **P. S. Levin** *NOAA - Northwest Fisheries Science Center* TROPHIC RELATIONSHIPS AND MOVEMENT PATTERNS OF SIXGILL SHARKS (*HEXANCHUS GRISEUS*) IN PUGET SOUND: INFERENCES ABOUT THEIR ECOSYSTEM ROLE FROM STABLE ISOTOPE ANALYSIS
- 1400 †**Komoroske, L.M.**<sup>1\*</sup>, **Lewison, R.L.**<sup>1</sup>, and **P.H. Dutton**<sup>2</sup> *1 - San Diego State University 2 - NOAA-Southwest Fisheries Sciences Center* CONTAMINANT LEVELS, BIOACCUMULATION AND HEALTH EFFECTS IN *CHELONIA MYDAS* IN SAN DIEGO BAY, CA
- 1415 **Anderson, SS**\* *California State University Channel Islands* SUSTAINABLY HARVESTED SEAFOOD OPTIONS IN COASTAL CALIFORNIA
- 1430 **Ruttenberg, Benjamin I**\*, **Miller, Jeff**, **Waara, Rob**, and **Matt Patterson** *National Park Service* MONITORING CORAL REEF ECOSYSTEMS IN U.S. NATIONAL PARKS IN FLORIDA AND THE CARIBBEAN TO IMPROVE SCIENCE AND MANAGEMENT
- 1445 **Wormald, C. L.**\* *California State University, Northridge* REEF FORECLOSURE: IMPLICATIONS OF CORAL DECLINE FOR EXPLOITED CORAL REEF FISHES
- 1500 BREAK

FRIDAY, NOVEMBER 7, 2008

SESSION 8

INVASIVE SPECIES

SHAUGHNESSY II

Chair: Andrew Brooks, Marine Science Institute, UC Santa Barbara

- 1530 †**Albins, M. A. \***, **Pusack, T.P.**, and **M.A. Hixon** *Dept. of Zoology, Oregon State University* EFFECTS OF THE INVASIVE INDO-PACIFIC LIONFISH (*PTEROIS VOLITANS*) ON BAHAMIAN CORAL-REEF FISHES: PREDATION AND COMPETITION
- 1545 †**Cheng, B.S.<sup>1\*</sup>**, and **K.A. Hovel<sup>2</sup>** *1 - University of California, Davis 2 - San Diego State University* BIOTIC RESISTANCE BY AN EXPLOITED NATIVE SPECIES: CONSEQUENCES FOR PREDATOR LOSS
- 1600 **Allee, R. M. \***, and **D.A. Donovan** *Western Washington University* THE EFFECTS OF ANOXIC CONDITIONS ON THERMAL TOLERANCE AND STRESS PROTEIN LEVELS IN FOUR LOCAL BIVALVES
- 1615 †**Siegrist, Z.C. \***, and **D.A. Donovan** *Western Washington University* TEMPERATURE AND SALINITY TOLERANCES OF THE CLAMS *NUTTALLIA OBSCURATA*, *PROTOHACA STAMINEA* AND *VENERUPIS PHILIPPINARUM*
- 1630 † **Brenneis, V.E. \*** *University of California, Davis* INTEGRATION OF AN INTRODUCED CONSUMER INTO AN ESTUARINE FOOD WEB: DIRECT AND INDIRECT EFFECTS OF THE NEW ZEALAND MUDSNAIL IN THE COLUMBIA RIVER ESTUARY
- 1645 †**Radecki, J.R. \***, and **R.R. Wilson, Jr.** *California State University, Long Beach* MTDNA GENETIC DIVERSITY ANALYSIS OF THE INVASIVE CHAMELEON GOBY (*TRIDENTIGER TRIGONOCEPHALUS*)
- 1700 **Carr, L.A.<sup>1\*</sup>**, **Boyer, K.E.<sup>1</sup>**, and **A.J. Brooks<sup>2</sup>** *1 - Romberg Tiburon Center, San Francisco State University 2 - Marine Science Institute, UC Santa Barbara* SEAGRASS HABITAT COMPLEXITY MEDIATES FISH PREDATION ON AN INVASIVE HERBIVORE IN SAN FRANCISCO BAY
- 1715 †**Green, S.J. \***, and **I.M. Côté** *Dept. of Biological Sciences, Simon Fraser University* PREDICTING THE IMPACT OF INVASIVE LIONFISH (*PTEROIS VOLITANS* AND *P. MILES*) ON NATIVE REEF FISH POPULATIONS IN THE CARIBBEAN
- 1730 †**Sorte, C.J.B. \***, and **S.L. Williams** *Bodega Marine Lab, UC Davis* PREDICTING IMPACTS OF CLIMATE CHANGE ON MARINE COMMUNITY COMPOSITION
- 1745 **Larson, A.A. \***, **de Rivera, C.E**, **Ruiz G.M**, **Grosholz, E.D.**, and **Sytsma** *MD Aquatic Bioinvasions Research and Policy Institute at Portland State University* CAN WE ATTRIBUTE THE REBOUND OF NATIVE SPECIES TO THE REMOVAL OF AN INVASIVE CRAB, *CARCINUS MAENAS*?

**FRIDAY, NOVEMBER 7, 2008**

1900 **WSN POSTER SESSION** **PINNACLE BALLROOM**

1930 **WSN ATTITUDE ADJUSTMENT HOUR** **PINNACLE BALLROOM**

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

**SATURDAY, NOVEMBER 8, 2008**

**PRESIDENTIAL SYMPOSIUM**

**BALLROOM**

**WOMEN IN MARINE BIOLOGY: PERSONAL PERSPECTIVES FROM THE FIELD**

- 0800 INTRODUCTION (Kathy Ann Miller)
- 0815 **Mach, K.** *Stanford University* WHAT IS GOING ON WITH WOMEN IN SCIENCE?: A GRADUATE STUDENT GETS CURIOUS
- 0845 **Nielsen, K.** *Sonoma State University* LOW RECRUITMENT SUCCESS FROM A LARGE, COMPETENT LARVAL POOL: IS NEGATIVE SELECTION OR HABITAT CHOICE TO BLAME?
- 0915 **Dethier, M.** *University of Washington* "IT'S 2008, HOW COME WE'RE NOT THERE YET?" OR "WE SHOULDN'T HAVE TO HAVE THIS SYMPOSIUM"
- 0945 BREAK
- 1015 **Pearse, V.B.** *University of California Santa Cruz* ALTERNATIVE LIFESTYLES AND CLIMATE CHANGE: VIEWS FROM A 20TH CENTURY FOX
- 1045 PANEL DISCUSSION

- 
- 1115 WSN LIFETIME ACHIEVEMENT AWARD (Vicki and John Pearse)
- 1125 INTRODUCTION OF THE NATURALIST OF THE YEAR (by Kathy Ann Miller)
- 1130 WSN NATURALIST OF THE YEAR (Terrie Klinger)
- 1200 LUNCH

SATURDAY, NOVEMBER 8, 2008

SESSION 9

PINNACLE 1

FISHERIES ECOLOGY I

Chair: Chris Stallings, Florida State University Coastal and Marine Laboratory

- 1300 **Hamilton, S.L.<sup>1\*</sup>, Caselle, J.E.<sup>1</sup>, Egloff, T.<sup>1</sup>, Kondo, E.<sup>1</sup>, Loke, K.<sup>2</sup>, and C. Lowe<sup>2</sup>** 1 - *University of California Santa Barbara* 2 - *California State University Long Beach*  
SPATIAL DIFFERENCES IN THE TROPHIC ECOLOGY AND LIFE HISTORIES OF CALIFORNIA SHEEPHEAD HAVE FISHERIES MANAGEMENT IMPLICATIONS
- 1315 †**Bond, M.H.<sup>1\*</sup>, and A.L. Collins<sup>2</sup>** 1 - *School of Aquatic and Fishery Sciences, University of Washington, Seattle* 2 - *University of California, Santa Cruz*  
STABLE ISOTOPES INDICATE MARINE NUTRIENTS ARE IMPORTANT TO STEELHEAD (*ONCORHYNCHUS MYKISS*) REARING IN FRESHWATER LAGOONS
- 1330 **Allen, L.G.\*** *Southern California Marine Institute and California State University Northridge*  
FISHERIES INDEPENDENT ASSESSMENT OF A RETURNING FISHERY? AN UPDATE ON THE ABUNDANCE OF JUVENILE WHITE SEABASS (*TRACTOSCION NOBILIS*) IN THE SHALLOW NEARSHORE WATERS OF THE NORTHERN PORTION OF THE SOUTHERN CALIFORNIA BIGHT, 1995-2008.
- 1345 **Focht, R.C.<sup>1\*</sup> and Brooks, A.J.<sup>2</sup>** 1 - *Northeastern University* 2 - *University of California Santa Barbara*  
RESIDENT FISHES INFLUENCE THE RECRUITMENT SUCCESS OF NEWLY SETTLED INDIVIDUALS IN TWO SPECIES OF DAMSELFISHES
- 1400 †**Sweeney, Joelle M.\***, and **James T. Harvey** *Moss Landing Marine Laboratories*  
ASSESSING FOUR CONSUMPTION MODELS FOR ESTIMATING DIET OF CALIFORNIA SEA LION, *ZALOPHUS CALIFORNIANUS*
- 1415 **Stallings, C. D.\***, **Koenig, C. C.**, and **F. C. Coleman** *Florida State University Coastal & Marine Laboratory*  
BYCATCH OF AN ECONOMICALLY-IMPORTANT GROUPER AND ITS PREY IN A SUB-TROPICAL TRAWL FISHERY
- 1430 **Marliave, J.B.\***, and **K.W. Conway** *Vancouver Aquarium*  
CLOUD SPONGES AS ROCKFISH HABITAT: WHAT IS ROCKFISH NURSERY HABITAT?
- 1445 **Markel, R.W.<sup>1\*</sup>, and C.L.K. Robinson<sup>2</sup>** 1 - *Department of Zoology, University of British Columbia* 2 - *Western and Northern Service Centre, Parks Canada Agency*  
DIFFERENTIAL ROCKFISH RECRUITMENT ACROSS KELP AND EELGRASS HABITATS IN BRITISH COLUMBIA: IMPLICATIONS FOR MARINE PROTECTED AREA DESIGN
- 1500 BREAK



SATURDAY, NOVEMBER 8, 2008

SESSION 10

PINNACLE I

FISHERIES ECOLOGY II

Chair: Ginny Eckert, University of Alaska Fairbanks

- 1530 †**Pirtle, J.L.\***, and **G.L. Eckert** *University of Alaska Fairbanks, Juneau School of Fisheries and Ocean Sciences* OPTIMAL NURSERY HABITATS FOR ALASKAN RED KING CRAB (*PARALITHODES CAMTSCHATICUS*)
- 1545 **Eckert, G.L.\*** *University of Alaska Fairbanks* MARINE ECOSYSTEM SUSTAINABILITY IN ALASKA - A NEW INTERDISCIPLINARY GRADUATE STUDY PROGRAM
- 1600 †**Haupt, AJ\***, **Micheli, F**, and **SR Palumbi** *Hopkins Marine Station* USING MOLECULAR MARKERS TO ASSESS CONNECTIVITY OF A COMMERCIALY IMPORTANT MARINE INVERTEBRATE
- 1615 †**Martin, C.J.B.\***, and **C.G. Lowe** *California State University, Long Beach* MIDWATER FISH COMMUNITY STRUCTURE AT OFFSHORE PETROLEUM PLATFORMS ON THE SAN PEDRO SHELF, SOUTHERN CALIFORNIA
- 1630 **Fields, A.T.\***, and **R.R. Wilson, Jr.** *California State University at Long Beach* DOES GENETIC DIVERSITY VARY WITH LATITUDE IN A MID-SHELF FLATFISH (*CITHARICHTHYS SORDIDUS*) OF THE EASTERN NORTH PACIFIC OCEAN?
- 1645 †**Lotterhos, K.E.\*** *Florida State University* IS UPWELLING CORRELATED WITH RECRUITMENT TIME-SERIES OF BLACK ROCKFISH, *SEBASTES MELANOPS*, IN BARKLEY SOUND, BC?
- 1700 **Mireles, C\***, **Martin, C**, and **C.G. Lowe** *California State Univeristy Long Beach* DEPTH PREFERENCE AND VERTICAL MOVEMENT OF NEARSHORE REEF FISHES ON SAN PEDRO SHELF OFFSHORE PETROLEUM PLATFORMS
- 1715 †**Webber, J.D.<sup>1\*</sup>**, and **T.W. Anderson<sup>2</sup>** *1 - San Diego State University and University of California, Davis 2 - San Diego State University* LARVAL TRAITS AND SWIMMING PERFORMANCE OF THREE TEMPERATE REEF FISHES: ALTERNATE STRATEGIES AND A COMMON THREAD?

SATURDAY, NOVEMBER 8, 2008

SESSION 11

PINNACLE III

INVERTEBRATE BIOLOGY II

Chair: Doug Eernisse, California State University Fullerton

- 1300 †**Vasquez, Maria C. \***, and **Steve R. Dudgeon** *California State University Northridge*  
PROBING FOR OXYGEN: INVESTIGATING HOW THE AVAILABILITY OF  
DISSOLVED OXYGEN MAY LEAD TO MORPHOLOGICAL PLASTICITY IN THE  
HYDROZOAN *HYDRACTINIA SYMBIOLONGICARPUS*
- 1315 †**Stevens-McGeever, S.J. \*** *University of California, Santa Barbara* EFFECT OF A  
CYMOTHOID TONGUE REPLACEMENT ISOPOD ON THE BLOOD OF THE  
HOST FISH *LUTJANUS PERU*
- 1330 †**Winans, A.K. <sup>1\*</sup>**, and **J.E. Purcell<sup>2</sup>** *1 - Western Washington University 2 - Shannon  
Point Marine Center* EFFECTS OF LOW PH ON ASEXUAL REPRODUCTION AND  
STATOLITH FORMATION OF THE SCYPHOZOAN, *AURELIA LABIATA*
- 1345 †**Geierman, Christina \***, and **Richard B. Emlet** *Oregon Institute of Marine Biology*  
TRENDS IN FEEDING OF THE ACORN BARNACLE *BALANUS GLANDULA* OVER  
GROWTH
- 1400 **Romanin, K.D.F. \*** *University of Victoria* A LOOK AT SOME EFFECTS OF FEEDING  
PLASTIC PARTICLES TO MARINE ZOOPLANKTON
- 1415 **Eernisse, D. J. \***, and **M. F. Strathmann** *Calif. State Univ. Fullerton* SURPRISING  
SPECIES DIVERSITY WITHIN THE SEASTAR GENUS *HENRICIA* ALONG  
WESTERN NORTH AMERICA
- 1430 †**Wolf, M. \***, and **C.M. Young** *Oregon Institute of Marine Biology, University of Oregon*  
CASTRATOR OR CONSTRAINT? IMPACTS OF THE PARASITIC COPEPOD  
*ISMAILA BELCIKI* ON THE REPRODUCTIVE OUTPUT OF ITS NUDIBRANCH  
HOST, *JANOLUS FUSCUS*
- 1445 **Bennett, K.C. \***, **Emlet, R.E.**, **Smart, T.I.**, and **C.M. Young** *Oregon Institute of Marine  
Biology* LARVAL DEVELOPMENT AND ONTOGENETIC DIFFERENCES OF TWO  
DEEP-SEA URCHINS: *CIDARIS BLAKEI* AND *STYLOCIDARIS LINEATA*  
(ECHINODERMATA: ECHINOIDEA: CIDAROIDA)
- 1500 BREAK

SATURDAY, NOVEMBER 8, 2008

SESSION 12

PINNACLE III

INTERTIDAL ECOLOGY II

Chair: Emily Carrington, Friday Harbor Labs, University of Washington

- 1530 **Carrington, E.\*** *Friday Harbor Laboratories and Department of Biology, University of Washington* A COUPLED BIOPHYSICAL/METABOLIC MODEL FOR GROWTH AND PERSISTENCE OF AN INTERTIDAL MACROALGA
- 1545 **Hart, A.<sup>1\*</sup>, Britton-Simmons, K.H.<sup>1</sup>, and K.L. Van Alstyne<sup>2</sup>** *1 - University of Washington 2 - Western Washington University* CHEMICAL AND MORPHOLOGICAL RESPONSES OF AN INTERTIDAL ROCKWEED TO WATERBORNE CUES FROM A LITTORINE SNAIL
- 1600 **Edmunds, P.J.<sup>1\*</sup>, Lenihan, H.<sup>2</sup>, and M Kotchen<sup>2</sup>** *1 - California State University, Northridge 2 - University of California at Santa Barbara* THE EFFECT OF SIMULATED FISH PREDATION ON JUVENILE MASSIVE *PORITES* EXPOSED TO CONTRASTING REGIMES OF WATER FLOW AND TEMPERATURE
- 1615 **Lees, D. C.\* , and W. B. Driskell** *Littoral Ecological & Environmental Services* ARMORED MIXED-SOFT SEDIMENTS - A DISTINCTIVELY DIFFERENT SEDIMENT PARADIGM?
- 1630 †**Smith, K. A.\*** *University of South Carolina* SPLASH, SURGE, SUBMERGE: A BIOPHYSICAL ANALYSIS OF OCEAN INFLUX IN THE ROCKY INTERTIDAL
- 1645 **Young, A. N.\* , and S. F. Craig** *Humboldt State University* EFFECTS OF TEMPERATURE ON THE ASSOCIATED COMMUNITIES OF MUSSEL BEDS: ARE THEY BLACK AND WHITE?
- 1700 †**Conway-Cranos, L.L.\*** *University of California at Santa Cruz* FACILITATIVE INTERACTIONS AS A POTENTIAL DRIVER FOR SPATIAL VARIATION IN RECOVERY PATTERNS IN THE CALIFORNIA ROCKY INTERTIDAL
- 1715 †**Horwith, M.H.\* , and J.L. Ruesink** *University of Washington* LOCAL EFFECTS OF GEODUCK (*PANOPEA ABRUPTA*) AQUACULTURE ON A MEADOW OF INTERTIDAL EELGRASS (*ZOSTERA MARINA*)
- 1730 †**Wheat E.\*** *University of Washington* DRIVERS OF LOCAL VARIATION IN OYSTER *CRASSOSTREA GIGAS* GROWTH: FOOD LIMITATION OR TIDAL CIRCULATION?
- 1745 **Braby, C.E.\* , Laferriere, A.M., Galleher, S.N., Massaua, M.J., Venturi, E.A., and D.M. Westerman** *Oregon Department of Fish and Wildlife* AN ASSESSMENT OF BAY CLAM SPATIAL DISTRIBUTION AND ASSOCIATED HABITAT CHARACTERISTICS IN COOS BAY, OREGON

SATURDAY, NOVEMBER 8, 2008

SESSION 13

SHAUGHNESSY I

COMMUNITY ECOLOGY II

Chair: Eric Sanford, Bodega Marine Laboratory, UC Davis

- 1300 †**Nelson, M.L.**<sup>1\*</sup>, **Craig, S.F.**<sup>1</sup>, and **J. Adams**<sup>2</sup> *1 - Humboldt State University 2 - Fort Valley State University* ON THE IMPORTANCE OF SPECIES: THE ROLE OF THE SEA ANEMONE *METRIDIUM SENILE* IN ALTERING EARLY SUCCESSION WITHIN MARINE FOULING COMMUNITIES
- 1315 †**Bowles, C M**<sup>\*</sup> and **E. Grosholz** *University of California at Davis; Bodega Marine Laboratory* STABILITY, DISTURBANCE AND RESILIENCE IN TWO ALTERNATE SOFT-SEDIMENT COMMUNITIES
- 1330 **Sanford, E.**<sup>\*</sup> and **D.J. Worth** *Bodega Marine Laboratory, UC Davis* DRILL, BABY, DRILL: GEOGRAPHIC VARIATION IN AN INTERTIDAL PREDATOR-PREY INTERACTION
- 1345 †**Krug, J. M.**<sup>\*</sup> and **M. A. Steele** *California State University, Northridge* A TEST FOR CORRELATED RECRUITMENT OF PREDATOR AND PREY SPECIES OF KELP FOREST FISHES
- 1400 †**Okamoto, D. K.**<sup>\*</sup>, **Stekoll, M. S.**, and **G. E. Eckert** *Juneau Center, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks* RECRUITMENT INHIBITION, REPRODUCTIVE INUNDATION AND COEXISTENCE BETWEEN DOMINANT SUBTIDAL ALGAL CRUSTS AND KELPS
- 1415 **Bracken, M.E.S.**<sup>1\*</sup>, **Williams, S. L.**<sup>2</sup>, **Jones, E.M.**<sup>2</sup>, **Carranza, A.**<sup>2</sup>, and **R.C. Rockwood**<sup>2</sup> *1 - Marine Science Center, Northeastern University 2 - Bodega Marine Laboratory, University of California at Davis* HERBIVORES, THERMAL STRESS, AND NUTRIENTS COMBINE TO DETERMINE INTERTIDAL ALGAL DIVERSITY
- 1430 **Lenihan, H.S.**<sup>1\*</sup>, **Edmunds, P.J.**<sup>2</sup>, and **M.J. Kotchen**<sup>1</sup> *1 - Bren School of Environmental Science and Management, UC Santa Barbara 2 - Department of Biology, California State University, Northridge* THE RESPONSE OF *POCILLOPORA VERRUCOSA* TO SIMULATED FISH PREDATION UNDER DIFFERING REGIMES OF FLOW AND TEMPERATURE
- 1445 **Martone, R.G.**<sup>1\*</sup>, **Micheli, F.**<sup>1</sup>, **Gonzalez, L.I.**<sup>2</sup>, **Guzman-del-Proo, S.A.**<sup>3</sup>, **Haupt, A.J.**<sup>1</sup>, and **E. Serviere-Zaragoza**<sup>4</sup> *1 - Hopkins Marine Station, Stanford University 2 - Section of Integrative Biology, University of Texas, Austin 3 - Escuela Nacional de Ciencias Biologicas, Instituto Politecnico Nacional, Mexico D.F. 4 - Centro de Investigaciones Biologicas del Noroeste, La Paz, Mexico* SPATIAL PATTERNS OF SUBTIDAL COMMUNITY STRUCTURE ACROSS DIFFERENTIAL UPWELLING CONDITIONS IN BAJA CALIFORNIA
- 1500 BREAK

SATURDAY, NOVEMBER 8, 2008

SESSION 14

PHYSIOLOGICAL ECOLOGY

SHAUGHNESSY I

Chair: Anne Todgham, UC Santa Barbara

- 1530 †**Goldenheim, W.M.\***, and **P.J. Edmunds** *California State University, Northridge* VARIABILITY IN THE EFFECTS OF TEMPERATURE AND FLOW ON THE GROWTH AND PHOTOPHYSIOLOGY OF A REEF BUILDING CORAL IN MOOREA, FRENCH POLYNESIA
- 1545 †**Hammond, L.M.\***, and **G.E. Hofmann** *UC Santa Barbara* IMPLICATIONS OF OCEAN ACIDIFICATION ON BIOMINERALIZATION GENE EXPRESSION AND SPICULE FORMATION IN *STRONGYLOCENTROTUS PURPURATUS* EMBRYOS AND LARVAE
- 1600 **Andrews, K.S.<sup>1\*</sup>**, **Boudreau, A.<sup>2</sup>**, **Williams, G.D.<sup>1</sup>**, **Beckman, B.<sup>1</sup>**, **Larsen, D.A.<sup>1</sup>**, and **P.S. Levin<sup>1</sup>** *1 - NOAA Fisheries, NWFSC, Seattle, WA 2 - University of Washington, School of Aquatic and Fishery Sciences* ASSESSING BIOLOGICAL RESPONSE TO MANAGEMENT EFFORTS: DEVELOPING AN INDEX OF GROWTH FOR LINGCOD
- 1615 †**Hettinger, A.<sup>1\*</sup>**, **Hoey, J.<sup>2</sup>**, **Sanford, E.<sup>1</sup>**, **Gaylord, B.<sup>1</sup>**, **Hill, T.M.<sup>3</sup>**, and **A. Russell<sup>4</sup>** *1 - Department of Evolution and Ecology and Bodega Marine Laboratory, University of California Davis 2 - Department of Integrative Biology, University of California Berkeley 3 - Department of Geology and Bodega Marine Laboratory, University of California Davis 4 - Department of Geology, University of California Davis* OCEAN ACIDIFICATION IMPACTS LARVAL AND JUVENILE GROWTH IN THE NATIVE OYSTER *OSTREA LURIDA*
- 1630 **Evans, Tyler G.\***, and **George N. Somero** *Hopkins Marine Station, Stanford University* A TRANSCRIPTOMIC TIME COURSE OF HYPER- AND HYPOOSMOTIC SIGNALING EVENTS IN A EURYHALINE FISH: OSMOSENSORS TO EFFECTORS
- 1645 **Fangue, N.A.\***, and **G.E. Hofmann** *University of California Santa Barbara* PHYSIOLOGICAL PERFORMANCE IN THE FACE OF CLIMATE CHANGE: BIOLOGICAL CONSEQUENCES OF MULTIPLE STRESSORS
- 1700 †**Matson, P.G.\***, and **G.E. Hofmann** *UC Santa Barbara* MICROARRAY-BASED LARVAL GENE EXPRESSION PATTERNS OF THE GREEN SEA URCHIN, *STRONGYLOCENTROTUS DROEBACHIENSIS*, IN RESPONSE TO TEMPERATURE
- 1715 †**Waterson, TP<sup>1\*</sup>**, **Barshis, D.<sup>2</sup>**, and **JH Stillman<sup>1</sup>** *1 - San Francisco State University 2 - University of Hawaii, Manoa* PLASTIC GROWTH RESPONSE TO DIEL TEMPERATURE FLUCTUATIONS VARIES BETWEEN COLONIES OF THE REEF-BUILDING CORAL *PORITES LOBATA*
- 1730 **Todgham, A.E.\***, and **G.E. Hofmann** *Ecology, Evolution and Marine Biology, UC Santa Barbara* PREDICTING THE IMPACTS OF OCEAN ACIDIFICATION: USING GENOMICS TO IDENTIFY PHYSIOLOGICAL “TIPPING POINTS”
- 1745 †**Green, D.H.\***, and **P.J. Edmunds** *California State University, Northridge* SUBSTRATUM EFFECTS ON THE EARLY POST-SETTLEMENT SUCCESS OF JUVENILE CORALS ON SHALLOW FRINGING REEFS IN ST. JOHN, US VIRGIN ISLANDS

SATURDAY, NOVEMBER 8, 2008

SESSION 15

SHAUGHNESSY II

CONSERVATION AND RESTORATION ECOLOGY

Chair: Bonnie Becker, University of Washington, Tacoma

- 1300 †**Olmata, Felicia**\* *University of Rhode Island, Department of Marine Affairs* THE MEDITERRANEAN SEA CETACEAN SANCTUARY: PROSPECTS FOR AN EFFECTIVE SANCTUARY AGREEMENT
- 1315 **Kiffney, P. M.**\*, **Pess, G.**, and **J. Anderson** *Northwest Fisheries Science Center* RECOLONIZATION OF THE CEDAR RIVER BY PACIFIC SALMON
- 1330 †**McCully, K.M.**\*, and **D.C. Potts** *Ecology and Evolutionary Biology, University of California, Santa Cruz* DISTRIBUTION AND RECRUITMENT OF THE BLACK-LIPPED PEARL OYSTER, *PINCTADA MARGARITIFERA*, AT MIDWAY ATOLL, NORTHWESTERN HAWAIIAN ISLANDS
- 1345 **Sandin, S.A.**<sup>1\*</sup>, and **McNamara, D.**<sup>2</sup> *1 - Scripps Institute of Oceanography 2 - University of N. Carolina, Wilmington* SPATIAL DYNAMICS OF HERBIVORY AND CORAL GROWTH: IMPLICATIONS FOR REEF CONSERVATION AND RECOVERY
- 1400 **Becker, B.J.**\*, and **P.A. Selkin** *Interdisciplinary Arts and Sciences, University of Washington, Tacoma* THE UDUBIA DEBATE: AN EDUCATIONAL EXERCISE SIMULATING MARINE RESERVE DESIGN
- 1415 **Shears, N.T.**\* *Marine Science Institute, UCSB* CAN MARINE RESERVES PROTECT HARVESTED PREY SPECIES?
- 1430 **Tissot, B. N.**\* *Washington State University Vancouver* ESTABLISHING AN MPA NETWORK IN OREGON: AN INTEGRAL ECOLOGY ANALYSIS
- 1445 **Sagarin, R. D.**\* *Duke University* SIZE MATTERS: LOSS OF LARGE COASTAL INVERTEBRATES AND IMPLICATIONS FOR ECOLOGY AND MANAGEMENT
- 1500 BREAK

SATURDAY, NOVEMBER 8, 2008

SESSION 16

SHAUGHNESSY II

DISPERSAL AND RECRUITMENT II

Chair: Sylvia Behrens Yamada, Oregon State University

- 1530 †**Johansson, ML<sup>1\*</sup>, Banks, MA<sup>1</sup>, Glunt, KD<sup>2</sup>, Hassel-Finnegan, HM<sup>2</sup>, and VP Buonaccorsi<sup>2</sup>** 1 - Coastal Oregon Marine Experiment Station, Hatfield Marine Science Center, Oregon State University 2 - Department of Biology, Juniata College  
INFLUENCE OF HABITAT DISCONTINUITY, GEOGRAPHICAL DISTANCE, AND OCEANOGRAPHY ON FINE-SCALE POPULATION GENETIC STRUCTURE OF COPPER ROCKFISH (*SEBASTES CAURINUS*)
- 1545 †**Burgess, S.C. \***, and **D.J. Marshall** School of Integrative Biology, University of Queensland, Brisbane, Australia EFFECTIVE LARVAL DISPERSAL: DO THE COSTS OF DISPERSAL REDUCE POPULATION CONNECTIVITY?
- 1600 **Trbovich, S.M. \***, and **R.R. Wilson, Jr.** California State University, Long Beach ARE SOUTHERN CALIFORNIA BIGHT FISH POPULATIONS GENETICALLY DIVIDED? MICROSATELLITE DATA FROM KELP BASS (*PARALABRAX CLATHRATUS*)
- 1615 **Keever, C.C.<sup>1</sup>, Sunday, J.<sup>1</sup>, Puritz, J.B.<sup>2</sup>, Addison, J.A.<sup>3</sup>, McGovern, T.M.<sup>4</sup>, Marko, P.B.<sup>4</sup>, Toonen, R.J.<sup>2</sup>, Grosberg, R.K.<sup>5</sup>, and M.W. Hart<sup>1\*</sup>** 1 - Simon Fraser University 2 - Hawaii Institute of Marine Biology 3 - University of New Brunswick 4 - Clemson University 5 - University of California, Davis THE WRONG PLACE AT THE RIGHT TIME: POPULATION GENETIC STRUCTURE IN *PATIRIA MINIATA*
- 1630 **Page-Albins, K.N. \***, **Frenock, M.**, and **F. Chan** Oregon State University, Department of Zoology, PISCO NEARSHORE TEMPERATURE CLIMATOLOGY FOR CAPE PERPETUA OREGON
- 1645 †**Sunday, J. \***, and **M.W. Hart** Simon Fraser University LOCAL ADAPTATION IN A LONG-DISTANCE DISPERSER
- 1700 **Behrens Yamada, S\* , and P. Mike Kosro** Oregon State University CAN OCEAN CONDITONS PREDICT THE COHORT STRENGTH OF THE INVASIVE EUREOPEAN GREEN CRAB, *CARCINUS MAENAS*
- 1715 **Henzler, C.M. \***, **Hoaglund, E.A.**, and **S.D. Gaines** UC Santa Barbara SHINING A LIGHT ON MARINE LARVAE: A NEW METHOD FOR RAPID PLANKTON SORTING
- 1730 †**Hoaglund, EA<sup>1\*</sup>, Henzler, CM<sup>2</sup>, Hofmann, GE<sup>1</sup>, and SD Gaines<sup>2</sup>** 1 - Dept. Ecology, Evolution and Marine Biology, UC Santa Barbara 2 - Marine Science Institute, UC Santa Barbara ILLUMINATING PATHWAYS: WHAT FLUORESCENT LARVAE CAN TELL US ABOUT THE DISPERSAL OF COASTAL MARINE SPECIES

**SATURDAY, NOVEMBER 8, 2008**

1815 **WSN Annual Business Meeting** **PINNACLE III**

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

1930 **Presidential Banquet** **PINNACLE I**

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

2130 **WSN Auction for student travel** **PINNACLE I**

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



**SUNDAY, NOVEMBER 9, 2008**

**PLENARY ADDRESS**

**PINNACLE BALLROOM**

**DR. ANDREW TRITES, UNIVERSITY OF BRITISH COLUMBIA**

0830 INTRODUCTION by local chair Chris Harley

0835 **Trites, A.** *Marine Mammal Research Unit, University of British Columbia* THE DECLINE OF STELLAR SEA LIONS: RIDING OUT A SEA OF ECOLOGICAL CHANGE IN THE NORTH PACIFIC

0930 BREAK

SUNDAY, NOVEMBER 9, 2008

SESSION 17

PINNACLE I

SPECIES-HABITAT ASSOCIATIONS

Chair: Steve Lonhart, Monterey Bay National Marine Sanctuary

- 1000 †**Moore, E.C. \***, and **K.A. Hovel** *San Diego State University* RELATIVE INFLUENCE OF HABITAT COMPLEXITY AND EDGES ON SEAGRASS EPIFAUNAL COMMUNITIES
- 1015 †**Lannin, R.K. \***, **Hembrough, B.M.**, and **K.A. Hovel** *San Diego State University* EFFECTS OF SEAGRASS STRUCTURE ON THE PREDATOR-PREY INTERACTIONS BETWEEN JUVENILE GIANT KELPFISH (*HETEROSTICHUS ROSTRATUS*) AND GRASS SHRIMP (*HIPPOLYTE* SPP.)
- 1030 †**Walsh, Sheila M. \*** *Scripps Institution of Oceanography, University of California, San Diego* SPECIES RICHNESS IS AN AMBIGUOUS INDICATOR OF ECOSYSTEM HEALTH
- 1045 **Lonhart, S.I.<sup>1\*</sup>**, **Ritter, A.F.<sup>2</sup>**, and **K. Wasson<sup>3</sup>** *1 - Monterey Bay National Marine Sanctuary, NOAA 2 - Ecology and Evolutionary Biology, University of California, Santa Cruz, CA 3 - Elkhorn Slough National Estuarine Research Reserve* RESPONSE OF ESTUARINE COMMUNITIES TO ALTERED TIDAL EXCHANGE IN ELKHORN SLOUGH
- 1100 **Meux, BM\***, **Fejtek, SM**, and **TK Ford** *Santa Monica Baykeeper, Marina del Rey, CA 90292* GIANT KELP RESTORATION IN SANTA MONICA BAY
- 1115 †**Grant, N. E. \*** *Moss Landing Marine Lab* USE OF EELGRASS (*ZOSTERA MARINA*) BY FISHES AND INVERTEBRATES IN ELKHORN SLOUGH, CA
- 1130 †**Perlman, B. M. \***, and **L. A. Ferry-Graham** *Moss Landing Marine Laboratories* INTERSPECIFIC VARIATION OF PECTORAL FIN MORPHOLOGY OF SURFPERCHES (EMBIOTOCIDAE) ALONG CENTRAL CALIFORNIA

SUNDAY, NOVEMBER 9, 2008

SESSION 18

PINNACLE III

PLANT/ALGAL BIOLOGY II

Chair: Matt Edwards, San Diego State University

- 1000 **Carpenter, R.C.** \* *Department of Biology, California State University, Northridge* SCALE-DEPENDENT EFFECTS OF WATER FLOW ON CORAL REEF PRIMARY PRODUCTION
- 1015 †**Alyono, M.C.** <sup>1\*</sup>, **Stites, S.** <sup>1</sup>, and **P.T. Martone** <sup>2</sup> *1 - Hopkins Marine Station of Stanford University, Pacific Grove, CA 2 - Department of Botany, University of British Columbia, Vancouver, BC* BLEACHING IN INTERTIDAL CORALLINE ALGAE: INTERACTIONS OF ENVIRONMENTAL FACTORS
- 1030 †**Wehrenberg, M.L.** \* *Moss Landing Marine Labs* MECHANISMS FOR POPULATION PERSISTENCE OF *GRACILARIOPSIS* SP. (RHODOPHYTA) IN A CENTRAL CALIFORNIAN ESTUARY
- 1045 †**Fejtek, S.M.** <sup>1\*</sup>, **Edwards, M.S.** <sup>1</sup>, and **Kim, K.** <sup>2</sup> *1 - Department of Biology, San Diego State University, San Diego, California, USA 2 - Department of Oceanography, Chonnam National University, Gwangju, Korea* THE EFFECTS OF IRRADIANCE IN DETERMINING THE VERTICAL DISTRIBUTION OF ELK KELP, *PELAGOPHYCUS PORRA*
- 1100 **Poray, A.P.** \* , and **R.C. Carpenter** *California State University Northridge* SPATIAL ESCAPE AT A PHYSIOLOGICAL COST: CONSEQUENCES FOR CORAL REEF MACROALGAE INHABITING REFUGIA FROM HERBIVORES
- 1115 †**Miklasz, K.A.** \* *Hopkins Marine Station* SIZE-BASED PATTERNS IN THE REPRODUCTION OF CORALLINE ALGAE
- 1130 †**Suskiewicz, T.S.** \* *Moss Landing Marine Laboratories* EFFECT OF CANOPY AND UNDERSTORY ALGAE ON RECRUITMENT OF THE ANNUAL KELP *NEREOCYSTIS LUETKEANA* IN CENTRAL CALIFORNIA
- 1145 **Kinlan, B.P.** \* *Marine Science Institute, UC Santa Barbara* QUANTIFYING THE LOCAL INFLUENCE OF UPWELLING ALONG COASTLINES

SUNDAY, NOVEMBER 9, 2008

SESSION 19

SHAUGHNESSY I

COMMUNITY ECOLOGY III

Chair: Chris Harley, University of British Columbia

- 1000 †**Harrison, L.R.**\*, and **I.M. Cote** *Department of Biological Sciences, Simon Fraser University* ECOLOGICAL EFFECTS OF POLLUTION ON LAGOONAL CORAL REEFS
- 1015 †**Rochman, Chelsea M.**\*, **Levin, Lisa L.**, and **Guillermo F. Mendoza** *Scripps Institution of Oceanography; UCSD* CHANGES IN MACROFAUNAL COMMUNITY STRUCTURE ACROSS THE OREGON MARGIN OXYGEN MINIMUM ZONE
- 1030 **Harley, C.D.G.**\*, **Lee, K.**, **Tang, E.**, and **T. Healy** *University of British Columbia* THE POTENTIAL IMPACTS OF CLIMATE-DRIVEN SALINITY CHANGE ON COMMUNITY STRUCTURE IN THE STRAIT OF GEORGIA
- 1045 **Heinlein, J.M.**<sup>1\*</sup>, **Stier, A.C.**<sup>2</sup>, and **M.A. Steele**<sup>3</sup> *1-Northeastern University 2-University of Florida 3-CSU Northridge* PREDATORS REDUCE RECRUITMENT OF CORAL REEF FISHES IN MOOREA, FRENCH POLYNESIA
- 1100 †**Arkema, K.K.**\* *Natural Capital Project, Stanford University* LICHEN OF THE SEA: SPATIAL PATTERNS IN THE ABUNDANCE, DEMOGRAPHY AND ECOSYSTEM FUNCTION OF A KELP FOREST EPIPHYTE
- 1115 †**Cover, W.A.**\* *University of California, Santa Cruz* DIRECT, SPECIES-SPECIFIC IMPACTS OF SEA URCHINS ON LIVE CORALS
- 1130 **Edwards, K.F.**\*, and **S. J. Schreiber** *Department of Evolution and Ecology and Center for Population Biology, University of California, Davis* PREEMPTION OF SPACE ENHANCES COEXISTENCE BY CREATING COMPETITIVE INTRANSITIVITIES
- 1145 **Shurin, J.B.**\*, **Matthews, B.**, **Markel, R.W.**, and **S. Dick** *UBC* COMPARING TROPHIC STRUCTURE IN MARINE AND FRESHWATER PLANKTON AND BENTHOS
- 1200 †**Boeckner, M J**<sup>1\*</sup>, **Pawluk, K A**<sup>1</sup>, and **H C Proctor**<sup>2</sup> *1 - University of Alberta: BMSC 2 - University of Alberta* EFFECTS OF A DEPTH GRADIENT ON COLONIZATION OF SEDIMENT IN SHALLOW COASTAL WATERS

SUNDAY, NOVEMBER 9, 2008

SESSION 20

SHAUGHNESSY III

POPULATION BIOLOGY AND ECOLOGY

Chair: Mark Steele, California State University Northridge

- 1000 †**Colvard, N B\***, and **P J Edmunds** *California State University, Northridge* DECADAL-SCALE CHANGES IN THE ABUNDANCE OF BENTHIC REEF INVERTEBRATES ON THE SOUTH COAST OF ST. JOHN, USVI
- 1015 †**Bailey, D.M\***, and **M.A. Steele** *CSU Northridge* EFFECTS OF MARINE PROTECTED AREAS ON COMMUNITY STRUCTURE OF KELP FOREST FISHES
- 1030 †**Staaf, D.J.\*** *Hopkins Marine Station* DIVERGING COUSINS: TWO DIFFERENT PATTERNS OF POPULATION STRUCTURE IN TWO SIMILAR SPECIES OF OCEANIC SQUID
- 1045 †**Nguyen, A.T.\***, **Hechinger, R.**, **Hofmann, G.**, and **A. Kuris** *UC Santa Barbara* POPULATION GENETICS OF THE PARASITE, *ACANTHOPARYPHIUM SPINULOSUM*, FROM SNAILS IN NORTHERN PACIFIC COAST ESTUARIES
- 1100 †**Shelton, A. O.\*** *University of Chicago* DO MALES MATTER? POPULATION EFFECTS OF MALE RARITY IN SURFGRASS (*PHYLLOSPADIX*)
- 1115 **Moffitt, E.A.\***, **White, J.W.**, and **L.W. Botsford** *Department of Wildlife, Fish, and Conservation Biology, University of California, Davis* SIZE AND SPACING GUIDELINES: VALUABLE BUT INSUFFICIENT METRICS FOR MARINE PROTECTED AREA NETWORK DESIGN
- 1130 †**Grey, E.K.\*** *Department of Ecology & Evolution, University of Chicago* ENVIRONMENT HAS A LARGER EFFECT THAN INTERFERENCE COMPETITION ON THE POPULATION GROWTH RATE OF THE EXOTIC ASCIDIAN, *BOTRYLLOIDES VIOLACEUS*, IN WASHINGTON, USA
- 1145 **Yang, S.\*** *University of Washington, Department of Biology* EMPIRICAL THRESHOLDS IN EELGRASS ABUNDANCE AND HABITAT MODIFICATION: DOES POSITIVE FEEDBACK AFFECT RESILIENCE? EXPANSION FROM A SINGLE INTRODUCED SOURCE POPULATION
- 1200 **Britton-Simmons, K.H.\***, and **H.L. Stewart** *University of Washington* DRIFT MACROPHYTE CAPTURE BY *STRONGYLOCENTROTUS FRANCISCANUS*: THE EFFECTS OF PHYSICAL HABITAT AND URCHIN MORPHOLOGY

## ABSTRACTS

### STUDENT SYMPOSIUM: ECOLOGICAL PERSPECTIVES THROUGH STABLE ISOTOPE ANALYSIS

**Finney, B.\*** *Department of Biological Sciences, Idaho State University, Pocatello, ID* A LONG-TERM PERSPECTIVE ON NORTH PACIFIC CLIMATE AND ECOSYSTEM CHANGE: INSIGHTS FROM STABLE ISOTOPE ANALYSIS

Climatic changes affecting the North Pacific Ocean vary over a wide range of timescales, including interannual, decadal and millennial. While a basic understanding of the climatic history of this region since the last ice age ended is emerging, much less is known regarding variability in corresponding marine ecosystems. Recently, paleoecologic studies utilizing sediment cores and archeological deposits, often integrated with stable isotope analysis, have begun to unravel information on past ecosystem change. High-resolution paleoproductivity reconstructions based on multiproxy analysis of sediment cores from the Gulf of Alaska suggest persistent variability over multidecadal scales, punctuated by abrupt state changes in overall productivity level. Such "mega-regime shifts" are of a different nature and larger amplitude than historical regime-shifts, and suggest response to major times of reorganization of atmospheric-ocean circulation. One such shift occurred at the transition to warmer climates at the end of the Little Ice Age (ca. 1850 AD). Recent paleoclimatic studies suggest this reflects a change in atmospheric circulation from more zonal to meridional in nature. This shift in climate and productivity can be tracked into higher trophic levels. Such data is available for pelagic fish in some regions, where changes in their abundance are recorded in fossil or geochemical records in sediments. Records of Alaskan salmon and Southern California sardine and anchovy abundance reveal differing interspecies relationships during the Little Ice Age relative to historical observations. Data is also available through stable isotope analysis of marine mammal remains in coastal archeological middens. Isotope values from specimens dating from the Little Ice Age are distinct from historical values, suggesting differences in diet and/or oceanographic conditions. Similar major shifts in climate, productivity and higher trophic levels occurred at several other times during the Holocene. It is envisioned that this long-term data can assist in developing climate and ecosystem models to better understand future ecosystem trajectories.

**Newsome, SD\*** *Geophysical Laboratory, Carnegie Institution for Science, Washington, DC, USA* USING ISOTOPIC PROXIES TO ASSESS DIETARY SPECIALIZATION AND NICHE VARIATION ACROSS SPACE AND TIME: SEA OTTERS (*ENHYDRA LUTRIS*) IN THE NORTH PACIFIC OCEAN

A central problem in ecology, and indeed of all of biology, is to quantify the flow of energy and materials within and among ecosystems. Tracking these flows helps unravel the functional structure of these systems and allows us to diagnose the factors that control change and stasis. For example, differences in diet composition among con-specifics (dietary specialization) have been documented across a broad range of taxonomic groups and habitats, and such variation at the individual level is increasingly recognized as an important component of diversity in trophic interactions. Identification of individual dietary specialization, however, requires longitudinal dietary records that are labor-intensive to obtain for many species. We have been developing isotopic proxies to efficiently quantify this phenomenon in sea otter (*Enhydra lutris*) populations from across the North Pacific Ocean. Comparison of our results with observational data on diet provides a unique opportunity to validate individual- and population-level foraging characteristics gathered from isotopic proxies. Our group is also analyzing material from historic and archaeological archives to (1) assess changes in population dietary breadth in response to known anthropogenic perturbations and (2) compare dietary preferences among modern and prehistoric populations in the same location and generate a pre-exploitation baseline of foraging information for a consumer that plays a keystone role in kelp forest ecosystems. We suspect that the isotopic approach applied to sea otters could be used to characterize the degree of dietary variation among and within

individuals for many species that are much more difficult to observe in their natural habitats.

**Page, HM\*** *Marine Science Institute, University of California Santa Barbara, Santa Barbara, CA, USA*  
TRANSPORT OF LAND-DERIVED MATERIALS ACROSS ECOSYSTEM BOUNDARIES:  
EVALUATION USING STABLE ISOTOPES

Understanding transport, processing and incorporation of land-derived materials across coastal landscapes is necessary to evaluate the effects of land use and freshwater runoff on the functioning of nearshore ecosystems. Linkages between material inputs from land and a salt marsh and nearshore reef ecosystem in southern California have been explored using stable isotope analyses. In the highly developed watersheds of southern California, dissolved and particulate nutrients can be delivered to the coastal ocean via groundwater and surface runoff. Water chemistry and isotope analyses revealed the upland-marsh boundary plays an important role in transforming and retaining groundwater nitrogen, with the incorporation of anthropogenic nitrogen into marsh consumers. Low dry weather surface runoff with intermittent high flows associated with winter rainfall events are typical of urbanized watersheds in a Mediterranean climate. Water chemistry and isotope analyses of algae and consumers within unchanneled tidal creeks receiving runoff suggested that nutrients in dry weather flows are largely retained and diluted within the creeks. Storm runoff, however, can deliver large volumes of particulate organic matter (POM) to nearshore reefs. Carbon isotope data indicate little direct use of land-derived POM by marsh or reef consumers. However, N isotope values suggest land-derived nitrogen from storm runoff may enter the reef food web indirectly through a trophic intermediate (e.g. microbes, algae). Collectively, isotope data support the importance of small salt marshes in intercepting materials in groundwater and dry weather surface runoff, and suggest a pathway by which nutrients in storm runoff could enter nearshore reef food webs.

**Pakhomov, E<sup>1\*</sup>, and S Kaehler<sup>2</sup>** *1 - Department of Earth and Ocean Sciences, University of British Columbia, Vancouver, BC, Canada 2 - Department of Botany, Rhodes University, Grahamstown, South Africa*  
IMPORTANCE OF KELP-DERIVED MATTER IN THE OPEN-OCEAN ISLAND  
ECOSYSTEM: SPATIAL AND TEMPORAL DYNAMICS INFERRED THROUGH THE  
IMPLICATION OF STABLE ISOTOPES

The ecosystem of the Prince Edwards Islands (PEI) is unique as it is situated in generally unproductive sub-Antarctic waters. However, it is known to support millions of land-based top predators. Applications of stable isotopes in the food web studies in the vicinity of the archipelago in the past 10 years provide new data on the potential importance of the kelp-derived detritus as a trophic subsidy to that of the phytoplankton. Stable isotope signatures of organisms from four major assemblages, comprising zooplankton, kelp-associated species, inter-island and near-shore benthos, were investigated in the vicinity of the PEI and related to stable isotopes of offshore and inshore producers. Both pelagic and benthic inter-island communities ultimately derived most of their energy from pelagic production. However, while zooplankton fed primarily on allochthonous open ocean phytoplankton, the inter-island benthos seemed to rely mostly on autochthonous inter-island diatom blooms. In contrast, both kelp-associated animals and near-shore communities derived a high proportion of their energy from kelp-originated matter. There is now mounting evidence, that the importance and spatial extent of macroalgal- and especially kelp-derived matter in coastal and island ecosystems has been considerably underestimated worldwide. It was estimated that between the PEI on average 40-45% of suspension feeders' diet originated from kelp-derived matter. This strongly suggested that the dietary subsidy of both kelp-derived carbon and nitrogen appears to be far more widespread than previously anticipated and not limited to the vicinity of kelp beds. The most recent findings postulate that due to the suspended nature of the macroalgal matter and the strong unidirectional nature of the circumpolar current, dispersal of detritus may be greatly enhanced. It is also possible that this suspended detrital matter contributes to the diet of downstream plankton and benthic communities. Combination of bulk and compound specific stable isotope measurements of the bottom-dwelling shrimp *Nauticaris marionis* tissues provided the first

evidence of significant changes in the overall productivity of the sub-Antarctic PEI system over the past several decades. Such changes may imply substantial structural changes in the physical oceanography in the vicinity of the islands, which could be linked to global climate change.

**Salomon, AK\*** *Marine Science Institute, University of California Santa Barbara, Santa Barbara, CA, USA and School of Resource and Environmental Management, Simon Fraser University, Burnaby, BC, Canada* USING STABLE ISOTOPES TO INFER TROPHIC RELATIONSHIPS IN KELP FOREST FOOD WEBS: PERKS, PITFALLS AND SOLUTIONS

Analysis of naturally occurring stable isotopes has become a powerful tool to elucidate trophic relationships because organisms “are what they eat, isotrophically”. That is, food web interactions are recorded in a consumer’s isotopic signature. However, isotopic inference of trophic interactions has its challenges; *uncertainty* and *variation* in the isotopic signatures of food sources (i.e. prey) are rarely accounted for and isolating source signatures on temperate reefs can be difficult. In this talk, I will illustrate the perks and pitfalls of isotopic inference with a case study from New Zealand where we used the large-scale experimental framework of four marine reserves, transplanted filter feeders, and naturally occurring stable isotopes to test the extent to which the exploitation of reef predators can alter kelp carbon flux and secondary production. We provide evidence that the exploitation of predatory snapper (*Pagrus auratus*) and lobster (*Jasus edwardsii*) can indirectly reduce kelp biomass and kelp carbon flux to secondary producers. We also show that the ecosystem-level effects of fishing on nearshore carbon flux are context-dependent and hinge on large-scale, regional oceanographic factors. Estimates of kelp contribution to the diet of transplanted consumers averaged  $56.9 \pm 6.2\%$  SE for transplanted mussels and  $33.8 \pm 7.3\%$  SE for transplanted oysters, suggesting that organic carbon fixed by kelp is an important food source fueling northeastern New Zealand’s nearshore food webs. These estimates however ignore the *uncertainty* and *variability* in source isotopic signatures. Luckily, several new mixing models that employ Bayesian approaches will vastly improve our ability to incorporate *uncertainty*, *variability* and prior information into the isotopic inference of trophic interactions. These new quantitative innovations will allow food web researchers to better understand and estimate the human alteration of a diversity of ecosystems, including kelp forests.

### **PRESIDENTIAL SYMPOSIUM: WOMEN IN MARINE BIOLOGY: PERSONAL PERSPECTIVES FROM THE FIELD**

**Dethier, M.\*** *University of Washington* "IT'S 2008, HOW COME WE'RE NOT THERE YET?" OR "WE SHOULDN'T HAVE TO HAVE THIS SYMPOSIUM"

In my career I have encountered little blatant sex discrimination, and have never felt that being female prevented me from doing what I wanted. But our academic departments and professional committees are still unbalanced. I have no answers, but do have some general advice and encouragement.

**Mach, K.\*** *Stanford University* WHAT IS GOING ON WITH WOMEN IN SCIENCE?: A GRADUATE STUDENT GETS CURIOUS

A few years ago, I noticed that, in the middle of their doctoral studies, female marine-biology students at my institution seemed to be losing interest in academic careers. This observation prompted a journey through the literature on women in science. I will share a few of the things I learned.

**Nielsen, K.\*** *Sonoma State University* LOW RECRUITMENT SUCCESS FROM A LARGE, COMPETENT LARVAL POOL: IS NEGATIVE SELECTION OR HABITAT CHOICE TO BLAME?

During my young adult years and early professional training I thought accusations of gender bias were largely whining. Through much of my formal and informal pre-college education, I had been thoroughly



inculcated with the notion that women were capable of earning the same professional status as men, given equivalent, objective measures of effort and achievement. However, experience has shown me that examples of gender bias, albeit often subtle and largely inadvertent (but occasionally bizarrely overt), are not as hard to find as I had imagined. And the pipeline from eager undergraduate to a tenured position in marine biology is still disproportionately leaky to women. Are qualified women experiencing greater negative selection along the career pipeline relative to equally qualified men? Or are intelligent women simply choosing to opt out of an ill-balanced life-style imposed by our possibly outdated and often ritualistic professional norms? Through a combination of personal and professional anecdotes and (an attempt to gather) some hard evidence, I will explore the answers to these questions. I will also argue that effective, engaged mentoring, combined with active cultivation of healthier professional norms and work environments is probably the best way to attain equal opportunity for productive careers and balanced lives, for all.

**Pearse, V.B.** \* *University of California Santa Cruz* ALTERNATIVE LIFESTYLES AND CLIMATE CHANGE: VIEWS FROM A 20TH CENTURY FOX

Choosing the lifestyle of a free-lance scientist has meant, for me, being at once fully engaged and perpetually unemployed, simultaneously a mate, mother, and marine biologist. With the shifting baselines of cultural climate change, is the work environment for women in marine biology warming or cooling? Are we entering a dead zone? Or on the brink of expanding opportunities? Investing alternative energy can create more rewarding careers for women -- and for men too. This is not a time for reducing our footprint!

### **STUDENT WORKSHOP: OCEAN ACIDIFICATION AND CLIMATE CHANGE: DIS-SOLVING THE MYSTERY**

**Hofmann, G.E.** *UC Santa Barbara* Coastal marine ecosystems, from the intertidal to the continental shelves, are particularly vulnerable to global climate change (IPCC 2007) and the physical factors that are changing in these systems are more than just temperature. Due to the interaction of oceans with the atmosphere and the role of the ocean in carbon dioxide (CO<sub>2</sub>) sequestration, marine ecosystems will experience temperature changes combined with changes in ocean pH (aka ocean acidification). Thus, as a consequence of future elevated levels of the greenhouse gas, CO<sub>2</sub>, the different seawater chemistry that is predicted will most likely be a novel environmental experience for most marine organisms. Notably, processes such as biomineralization (the production of calcium carbonate shells and skeletons) will be impacted, but other basic metabolic activity may also be challenged. The three presentations in this WSN workshop will address different aspects of ocean acidification with emphases on what we need to know to make sound decisions about management of marine resources and where this emerging field of research is headed. In addition to providing a basic overview of ocean acidification, this presentation will focus on the use of technologies in molecular biology to assess climate-change related impacts on marine invertebrates such as sea urchins and mollusks, important members of marine ecosystems. Data presented in will show how ‘gene chips’ and other approaches can assist us in understanding how marine invertebrates are responding to the climate-change related “multistressors” in the future high CO<sub>2</sub> world. In addition, the importance of taking an ecological development approach in ocean acidification research, i.e., studying development and larval forms, will be emphasized.

**Barry, J.** *Monterey Bay Aquarium Research Institute* Although much research on ocean acidification has focused on its effects on calcification in marine organisms, other physiological stresses such as acidosis, respiratory stress, and metabolic depression also affect the survival, growth, and reproduction of animals. Even if tolerable, these stresses increase the ‘cost of living’ for animals, with consequences that include reduced allocation to growth and reproduction. Changes in the performance of individuals scale-up to changes in the demographic rates of populations (including potential extinction), shifts in the dynamics of marine food webs, and the reorganization of marine ecosystems. Ocean acidification research at MBARI

has expanded from studies of the chemistry and biology of ocean carbon sequestration by direct deep-sea carbon dioxide injection to the broader effects of anthropogenic climate and environmental change. Jim Barry's lab studies the effects of environmental hypercapnia and hypoxia on the performance and survival of marine animals. Because deep-sea animals are generally less resilient to environmental perturbations than upper ocean taxa, our lab at MBARI uses a comparative approach to evaluate the effects of changing ocean chemistry on deep- and shallow-living species. These studies also combine field and laboratory studies to expand our understanding of the consequences of ongoing changes in ocean chemistry for marine ecosystems.

**Klinger, T.** *University of Washington* The problem of ocean acidification and associated stressors is large and complex—what social scientists might refer to as a ‘wicked problem’. Given that we can’t easily mitigate for the amount of carbon now in the atmosphere and oceans, the most promising lines of scientific investigation will contribute to our understanding of the likely responses of populations, species, and whole ecosystems to the combined effects of acidification, warming, and other stressors. Research and monitoring that allow parameterization of models, forecasting, and identification of lag-times, non-linearities, and tipping points will have value to managers, policy-makers, and the public as we attempt to adapt to unforeseen changes in the world’s oceans. Coordinated efforts are required to provide the necessary science in a useful time-frame. We’ll discuss how graduate students can frame tractable research questions to best address aspects of this ‘wicked problem’.

### PLENARY ADDRESS – ANDREW TRITES

**Trites, A.W.** Marine Mammal Research Unit, Fisheries Centre, University of British Columbia, Room 247, AERL, 2202 Main Mall, Vancouver, B.C. Canada V6T 1Z4 THE DECLINE OF STELLER SEA LIONS: RIDING OUT A SEA OF ECOLOGICAL CHANGE IN THE NORTH PACIFIC

The decline of Steller sea lions in the Gulf of Alaska and Bering Sea has stimulated a wide range of field studies, captive studies, and mathematical models that are yielding insights into the sea lion’s ecosystem. They suggest that a shift in oceanographic conditions in the mid-1970s positively affected some species (e.g., pollock and flatfish), and negatively affected others (e.g., crabs, shrimp, herring and sandlance). These in turn negatively affected the abundance of predators at higher trophic levels such as Steller sea lions, northern fur seals and harbor seals. Steller sea lions that once ate a diverse diet that included fatty forage fishes now consume a low diversity diet dominated by pollock and Atka mackerel. Captive studies indicate there are negative health consequences for young Steller sea lions that depend heavily on pollock. Behavioral observations, and at-sea-tracking of sea lions further support the hypothesis that there is a high abundance of prey (primarily pollock or Atka mackerel) available to Steller sea lions in the Gulf and Aleutian Islands, but that diversity and quality of prey is lacking. Archeological data and mathematical ecosystem models further suggest that the magnitude of changes that occurred in the biomass of the major species in the Bering Sea was not the result of fishing or whaling. Instead the most likely explanation for the decline of Steller sea lions and other species is a change in ocean climate (popularly referred to as a regime shift), which should revert to earlier conditions (based on historic patterns) and return the Bering Sea to its previous state.

### CONTRIBUTED PAPER ABSTRACTS

†**Albins, M. A. \***, **Pusack, T.P.**, and **M.A. Hixon** *Department of Zoology, Oregon State University* EFFECTS OF THE INVASIVE INDO-PACIFIC LIONFISH (*PTEROIS VOLITANS*) ON BAHAMIAN CORAL-REEF FISHES: PREDATION AND COMPETITION

The Indo-Pacific lionfish (*Pterois volitans*), introduced to Florida waters in the early 1990s, is currently spreading rapidly throughout the Caribbean region. This invasive carnivore may directly and indirectly

affect coral-reef ecosystems via predation on native fishes and invertebrates, as well as competition with native predators. We conducted a series of field experiments on a matrix of small patch reefs in the Bahamas to examine the short-term effects of lionfish on native reef fishes. Single lionfish transplanted to individual reefs caused significant reductions in the recruitment of native fishes by an average of 79% over a five-week period. Twenty-three of thirty-eight species recruiting to both lionfish-absent (control) reefs and lionfish-present reefs -- including four of five parrotfishes -- were negatively affected by lionfish. This strong effect on a key life stage of a broad variety of coral-reef fishes suggests that invasive lionfish are already having substantial negative impacts on Atlantic coral reefs. While short-term 8-week competition experiments did not indicate that lionfish cause significant reductions in the growth of native piscivores (coney and Nassau grouper), lionfish grew at far higher rates, in terms of both length and mass, than similarly sized native piscivores experiencing the same field conditions. Fast growth rates combined with large impacts on prey resources suggest that lionfish may compete strongly with native piscivores over longer time periods.

**Alifano, A. R.** \* *Moss Landing Marine Labs* THE ROLE OF DRIFT ALGAE ON TROPHIC ECOLOGY OF INTERTIDAL PURPLE SEA URCHINS *STRONGYLOCENTROTUS PURPURATUS* IN CENTRAL CALIFORNIA

Allochthonous (externally produced) energy inputs can provide a trophic link from one system to another, allowing consumers to be more abundant than if supported solely by in situ resources. Central California subtidal kelp forests are significant sources of primary production that potentially support intertidal sea urchins via onshore transport of algal fragments. In Stillwater Cove, Carmel, natural drift abundance increased during summer and decreased in winter. A 7 month caging experiment manipulated drift algae arrival to intertidal *Strongylocentrotus purpuratus* to test whether individuals denied drift algae would exhibit decreased reproductive capabilities, tissue enrichment, or survivorship compared with individuals supplied natural or excessive drift algae. Sea urchins in drift-exclusion treatments had significantly smaller gonad indices and depleted  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values compared to treatments with drift. Algal community composition did not differ among treatments, indicating that drift-deprived sea urchins persisted without forming grazing fronts as previously described in subtidal forests. Although the presence of detached macroalgae enhanced gonad production and nutrient uptake for intertidal sea urchins, a short-term absence of drift larger than  $1\text{ cm}^2$  did not negatively impact survivorship, growth, or community composition. Tiny algal fragments and particulate matter may provide adequate nutrition for survival and growth of *S. purpuratus* existing in burrows, indicating that intertidal sea urchins are potentially regulated by different trophic mechanisms than in the subtidal.

**Allee, R. M.** \*, and **D.A. Donovan** *Western Washington University* THE EFFECTS OF ANOXIC CONDITIONS ON THERMAL TOLERANCE AND STRESS PROTEIN LEVELS IN FOUR LOCAL BIVALVES

Invasive species found in marine environments have garnered increasing attention as their numbers and impact on ecosystems have become more apparent. Coastal marine areas, such as estuaries, are some of the more impacted ecosystems that have begun to get attention. This project focuses on the effects of anoxia and the interactions it has with thermal tolerance in four local intertidal bivalves. *Nuttallia obscurata* is a recent invader on whom little physiological research has been conducted. Two other commercially important clams, *Venerupis philippinarum* and *Prototheca staminea*, were also tested. Finally, the surface-dwelling mussel *Mytilus trossulus* was used as a comparison to the burrowing clams. The bivalves had anoxic conditions induced by using rubber bands to hold their valves shut. After a period of four days, they were tested for thermal tolerance by placing gill strips from individual organisms into one of three temperature treatments that varied per species. The gill tissue was evaluated for time to death. Gill tissue was also collected before thermal tolerance experiment, but after anoxia, to examine levels of stress protein levels by way of Western Blot Method. There were no significant differences in temperature tolerance between the anoxic and control bivalves. Levels of Hsp70 were

found in all species, but only quantifiable levels in *Mytilus trossulus*. Follow up experiments include anoxia induction for longer time periods, as well as a more in-depth look at stress protein patterns in *Mytilus trossulus*.

**Allen, L.G.\*** *Southern California Marine Institute and California State University Northridge*  
FISHERIES INDEPENDENT ASSESSMENT OF A RETURNING FISHERY? AN UPDATE ON THE ABUNDANCE OF JUVENILE WHITE SEABASS (*TRACTOSCION NOBILIS*) IN THE SHALLOW NEARSHORE WATERS OF THE NORTHERN PORTION OF THE SOUTHERN CALIFORNIA BIGHT, 1995-2008

Nearshore, coastal and embayment areas off the northern two-thirds of the Southern California Bight were sampled for 14 years to determine the spatial and temporal patterns abundance and size distributions of young white seabass in the shallow (5-14 m) waters from Santa Barbara south to Newport Beach. A total of 10 stations, eight in nearshore coastal waters and two in embayments, dispersed along the northern portion of the Southern California Bight were surveyed in each sampling month using 45.7 m variable mesh, monofilament gill nets. In the period of sampling (April 1995 – June 2008), a total of 8,042 juvenile white seabass was captured in 51 sampling months. The mean catch-per-unit-effort (CPUE: 2.6 fish/net + 0.5) for juvenile white seabass varied significantly among stations. Stations located near large rocky headlands, such as Palos Verdes, Santa Barbara, and Newport yielded the highest catches. Although CPUE peaked in August 1999 as a result of strong year classes in 1996-97, overall, catches tripled over the first eleven-year sampling period at seven coastal sites increasing significantly at a rate equivalent to 0.22 fish/net/year. These relatively high catches of wild, juvenile fish in the first eleven years of the study, along with significant increases in commercial CPUE and increased recreational catches overall, led to the conclusion that the natural population of white seabass is in the process of recovery. Therefore, we (Allen et al, 2007) proposed that the white seabass represented one of the first documented cases of a recovering, demersal species of commercial importance. We further concluded that the ban of nearshore commercial gill net fishing by Proposition 132 probably contributed greatly to the increase in the population size that led to this recovery. However, I will now present three additional years (2005-2008) of data on juvenile white seabass abundance and this story seems far from over.

†**Alyono, M.C.<sup>1\*</sup>, Stites, S.<sup>1</sup>, and P.T. Martone<sup>2</sup>** *1 - Hopkins Marine Station of Stanford University, Pacific Grove, CA 2 - Department of Botany, University of British Columbia, Vancouver, BC*  
BLEACHING IN INTERTIDAL CORALLINE ALGAE: INTERACTIONS OF ENVIRONMENTAL FACTORS

Environmental conditions along the intertidal zone vary greatly from one hour to the next. Many intertidal organisms are adapted to tolerate these large fluctuations in environmental stresses. However, the coincidence of multiple stressors may prove lethal. For example, when a very low tide occurs during the middle of a hot and sunny day, organisms are simultaneously exposed to high light, temperature, and desiccation stresses. Under these conditions, emersed intertidal seaweeds often lose their photosynthetic pigments and become “bleached.” While it can be surmised that light, temperature, and desiccation stresses may each contribute to the bleaching of intertidal algae, the precise cause of such bleaching events has not been fully explored. To differentiate the possible effects, we manipulated light, temperature, and humidity in a fully-factorial experiment in order to induce bleaching in the coralline alga *Calliarthron tuberculosum*. All factors individually induced bleaching of *Calliarthron*; however the combination of all three stressors was the most detrimental, increasing both the rate and extent of bleaching. These data can be used in conjunction with climatic models to predict the reoccurrence of bleaching events at various locations along the shore.

**Anderson, S S\*** *California State University Channel Islands* SUSTAINABLY HARVESTED SEAFOOD OPTIONS IN COASTAL CALIFORNIA

When faced with evidence that a particular fish stock is overharvested, we most commonly tell consumers or concessioners to avoid such problematic stocks and “buy sustainably harvested” fish instead. While this sounds great, it often has little bearing upon reality. To begin to gauge the practical seafood options available to local consumers of seafood, my students and I have begun surveying purveyors of seafood across the southern California counties of Santa Barbara, Ventura, and Los Angeles. Data collected to date show few sustainable seafood options exist for purchase. Those that are available cost more than the average conventionally harvested item, but the magnitude of this price difference was typically small. Lack of detailed seafood information appears to currently be the biggest barrier to wider purchasing of sustainable seafood in southern California. Educational campaigns directed at institutional purchasers may be the most efficacious way to increase the proportion of sustainable seafood purchased in southern California.

**Andrews, K.S.<sup>1\*</sup>, Boudreau, A.<sup>2</sup>, Williams, G.D.<sup>1</sup>, Beckman, B.<sup>1</sup>, Larsen, D.A.<sup>1</sup>, and P.S. Levin<sup>1</sup>** 1 - NOAA Fisheries, NWFSC, Seattle, WA 2 - University of Washington, School of Aquatic and Fishery Sciences ASSESSING BIOLOGICAL RESPONSE TO MANAGEMENT EFFORTS: DEVELOPING AN INDEX OF GROWTH FOR LINGCOD

For most fish species, it is difficult to measure growth or feeding rates non-lethally in situ. In this project, we use the endocrine system, which plays an integral role in regulating cell division and growth in all vertebrates, to develop an index of nutritional status for lingcod *Ophiodon elongatus*. One of the principal hormones regulating growth is insulin-like growth factor-I (IGF-I). Levels of blood plasma IGF-I are related to feeding and growth rates of Pacific salmon (Beckman et al 1998) and several other marine teleosts (e.g. Negatu & Meier 1995, Perez-Sanchez et al. 1995). First, we characterize the relationship between levels of IGF-I and growth rates in a controlled laboratory experiment. Growth rates of lingcod in the lab varied from -0.96 – 1.56 g/day over two feeding periods lasting a total of 62 days. After characterizing the relationship between IGF and growth in the laboratory, we use this index to quantify relative differences in the nutritional status or growth of lingcod in the field by collecting blood samples at different fishing sites. The differences in this index among lingcod are compared with densities of lingcod and other groundfish species at each fishing site to investigate whether nutritional status or growth is density-dependent among sites. Understanding whether processes, such as density-dependent growth, occur will have considerable impacts on the overall success of specific management strategies.

**Arkema, K.K.\*** Natural Capital Project, Stanford University LICHEN OF THE SEA: SPATIAL PATTERNS IN THE ABUNDANCE, DEMOGRAPHY AND ECOSYSTEM FUNCTION OF A KELP FOREST EPIPHYTE

Epiphyte colonization and lifespan are intimately related to the dynamics of the species on which they reside. However, the distribution of an epiphyte within aggregations of its host may also depend on microclimate variation generated by the physical structure of the host itself. Thus a host may inhibit as well as facilitate an epiphyte. I explored relationships between giant kelp, *Macrocystis pyrifera*, and one of its most abundant epiphytes, the encrusting bryozoan, *Membranipora serrilamella*. Using observational studies and field experiments, I evaluated whether spatial variation in substrate longevity, colony mortality, larval recruitment, and clonal reproduction explained differences in the abundance of *Membranipora* within kelp forests, of varying size, off the coast of Santa Barbara, California. Abundance (measured as percent cover) was 2 to 5 times higher along forest edges than interiors, a pattern only partially explained by variation in larval recruitment. *Membranipora* coverage appeared to be largely driven by differences in the clonal reproduction of colonies located along the forest edge compared to interior. Clonal reproduction was significantly reduced inside forests, and the results of *in situ* feeding assays suggest that kelp-dampened currents resulted in a lower flux of food to interior colonies. I found no differences between forest edges and interiors in substrate longevity and colony mortality. A synthesis of field measurements and predictions of ingestion rates suggests that *Membranipora* filtering capacity may be largely driven by the size and density of the kelp forest. Collectively, these findings demonstrate

how two ecosystem engineering attributes of giant kelp (substrate provisioning and microclimate generation) interact to influence the distribution, demography and ecosystem function of its epiphyte.

†**Bailey, D.M\***, and **M.A. Steele** *CSU Northridge* EFFECTS OF MARINE PROTECTED AREAS ON COMMUNITY STRUCTURE OF KELP FOREST FISHES

Understanding how Marine Protected Areas (MPAs) affect community structure of the organisms within them is essential for their effective planning and use. There is widespread evidence that MPAs enhance the abundance of large individuals, many of which are predatory species targeted by fisheries. Whether intensified predation by these large predators in MPAs affects prey species has seldom been evaluated. This study investigates how the community structure of kelp forest fishes in two long-term MPAs differs from nearby reference sites outside of MPAs. Replicated underwater visual transects were used to quantify the size structure and composition of the entire fish assemblage inside and outside of the MPA at Anacapa Island and another MPA at Santa Catalina Island, California. Whereas total density and species richness of fishes did not differ inside versus outside of the two MPAs, the expected pattern of more large individuals of predatory species (mainly kelp bass and California sheephead) within MPAs was evident. Higher densities of large predators, however, did not appear to have cascading effects: small prey were not consistently less abundant in MPAs. These findings suggest that, at least within MPAs in southern California, build up of large predators is unlikely to have major impacts on the entire assemblage of kelp forest fishes.

**Becker, B.J.\***, and **P.A. Selkin** *Interdisciplinary Arts and Sciences, University of Washington, Tacoma* THE UDUBIA DEBATE: AN EDUCATIONAL EXERCISE SIMULATING MARINE RESERVE DESIGN

In this simulation, students work in groups to design a marine reserve around a hypothetical island state called “Udubia.” The simulation includes spatially-structured data on habitats, diversity, currents, fisheries, endangered species, marine mammals, and social factors. Students choose characters that represent a variety of stakeholders, are placed in like-minded groups, create a reserve design based on provided data sources, and defend it in a presentation and debate. The exercise is intended to teach students: 1. to place the principles of conservation biology, natural history, and marine ecology into an interdisciplinary and applied context, 2. to defend a conservation position using data and research, 3. to interpret geographic data and information, 4. to demonstrate the compromises needed to create a conservation plan given conflicting motivations of different stakeholders, and 5. to orally communicate their ideas in front of an audience. By using a simulated environment, data can be created on an appropriate scale for students to make sophisticated, data-based arguments. This exercise is available online for free through TIEE.

**Behrens Yamada, S\***, and **P. Mike Kosro** *Oregon State University* CAN OCEAN CONDITIONS PREDICT THE COHORT STRENGTH OF THE INVASIVE EUROPEAN GREEN CRAB, *CARCINUS MAENAS*.

Once a non-native species arrives and survives in an area, its persistence depends on its recruitment success. If conditions are not favorable for recruitment it will become extinct. The European green crab (*Carcinus maenas*) has a six-year life span and has persisted at low densities in Oregon and Washington coastal estuaries for the past 11 years. We show here that after the arrival of the strong founding cohort of 1998, significant recruitment occurred only in 2003, 2005 and 2006. Warm winters, late spring transitions and northward shelf currents in March and April are correlated with the arrival of these strong cohorts. Cold winters, early spring transitions and strong southward (and offshore) currents in March and April are linked to cohort failure. The winters of 2002 and 2008 were especially cold with water temperatures never rising above 10°C. Since green crab larvae cannot develop below 10°C, virtually no recruitment occurred in Oregon and Washington in these two years. Green crabs are still too rare to exert a measurable effect

on the native benthic community and on shellfish culture in Oregon and Washington. However, if their numbers were to increase, we may be able to predict the arrival of strong cohorts from ocean conditions and alert managers and shellfish growers of possible increases in predation pressure from this invader.

†**Bell, T.M.\***, and **J.P. Wares** *University of Georgia* THE PHYLOGEOGRAPHIC STRUCTURE AND EVOLUTIONARY ECOLOGY OF THE NORTH ATLANTIC ISOPOD, *IDOTEA BALTHICA*

Organisms experience abiotic and biotic factors that vary in time and space in their presence and Intensity, even over short distances. This spatio-temporal environmental heterogeneity that occurs throughout a species' range can result in different selective pressures between populations, whereby alleles favored in one region of a species range may be disadvantageous in other regions. Thus, variation in natural selection can lead to local adaptation and maintenance of genetic and phenotypic diversity within a species. The marine herbivorous isopod species *Idotea balthica* is distributed throughout the North Atlantic and exhibits deep population genetic divergence among populations along the northeastern coast of North America at the mitochondrial cytochrome oxidase 1 (mtco1) gene and in AFLP markers. The diversity of intertidal marine macroalgae changes quite dramatically along this coastline in a pattern that is similar to the population genetic patterning found in *I. balthica*. Feeding preference and food choice assays were conducted with *I. balthica* using eight different algal species in order to determine if these genetically distinct lineages have specialized on the macroalgal species available to their local population. The stomach content of wild caught individuals was analyzed using universal algal molecular markers in order to determine the accuracy of laboratory feeding assays and the algal species diversity consumed by populations.

**Bennett, K.C.\***, **Emllet, R.E.**, **Smart, T.I.**, and **C.M. Young** *Oregon Institute of Marine Biology* LARVAL DEVELOPMENT AND ONTOGENETIC DIFFERENCES OF TWO DEEP-SEA URCHINS: *CIDARIS BLAKEI* AND *STYLOCIDARIS LINEATA* (ECHINODERMATA: ECHINOIDEA: CIDAROIDA)

Two deep-sea urchins, *Stylocidaris lineata* and *Cidaris blakei* (Echinodermata: Echinoidea: Cidaroida), were collected at depths ranging from 508 m to 681 m in Tongue of the Ocean, Bahamas. Adults were spawned and larvae were reared in culture. Both species exhibited the larval form characteristic of cidaroids. They lacked an amniotic invagination and developed rudiments as described previously for *Eucidaris thouarsi*. Despite the similarity of their adult habitat, the early embryology and larval development of these urchins had some marked differences. Egg diameters were 100 µm and 155 µm for *S. lineata* and *C. blakei* respectively, indicating a ca. three-fold difference in volume. *Stylocidaris lineata* exhibited higher thermal tolerances and was successfully reared at 20°C, whereas *C. blakei* development became abnormal above 15°C. As gastrulae, *C. blakei* had an apical tuft, and *S. lineata* did not. Mouths of *C. blakei* did not develop until well into the two-arm pluteus stage, and sometimes not until the 4-arm pluteus stage, whereas larvae of *S. lineata* developed mouths in the prism stage. These differences in ontogeny could indicate differences in environmental variables encountered during the larval stage and they may represent the evolution of alternative strategies for development in the deep sea.

†**Boeckner, M J<sup>1\*</sup>**, **Pawluk, K A<sup>1</sup>**, and **H C Proctor<sup>2</sup>** *1 - University of Alberta: BMSC 2 - University of Alberta* EFFECTS OF A DEPTH GRADIENT ON COLONIZATION OF SEDIMENT IN SHALLOW COASTAL WATERS

Accounts world-wide have found that the abundance of most benthic fauna declines with increasing depth. Lack of organic matter and distance from land masses are usually cited for these faunal declines. These studies generally sampled established sediment with the shallowest samples taken in excess of 100 m. We determined if faunal colonization was affected by a much shallower depth gradient: 6, 12, 18, 24 and 30 m. The abundance of most taxa, including harpacticoid copepods, declined sharply with increasing depth. The exceptions were nematodes, cumaceans, chironomids, rotifers and oligochaetes which tended

to remain equally abundant across all depths and halacarid mites which were most abundant at deeper sites. Exposure class and weeks in the field were also important factors affecting the colonization of various fauna. Higher faunal abundances were associated with more protected sites. Also, fauna more capable of active dispersal, including harpacticoid copepods, amphipods and polychaetes, colonized more quickly than nematodes, halacarid mites and bivalves. Accumulation of marine snow and temperature had no measurable effects on colonization rates. Thus, we found that effects of depth impacted faunal abundance even in relatively shallow water and that these effects do not seem to be caused by decreased organic material or distance from land masses as indicated for studies conducted in deeper water.

**Boller, M.<sup>1</sup>, Kost, L.<sup>2</sup>, and P. T. Martone<sup>3\*</sup>** 1 - Saint John Fisher College, Rochester, NY 2 - Hopkins Marine Station of Stanford University, Pacific Grove, CA 3 - University of British Columbia, Vancouver, BC  
RESOLVING RECONFIGURATION: MECHANICAL IMPLICATIONS OF MORPHOLOGICAL DIVERSITY IN WAVE-SWEPT MACROALGAE

Despite the relentless and inhospitable pounding of crashing waves, the intertidal zone of wave-swept rocky shores supports a staggering array of morphologically diverse macroalgae. Flexible thalli reorient and reconfigure branches and blades, changing both the size and the shape of thalli exposed to flow, in order to reduce drag. The process of reconfiguration in intertidal macroalgae has not been well-studied in the lab in part because traditional re-circulating water flumes (1 m/s) cannot reproduce flow under breaking waves (10 - 25 m/s). Thus, the extent of reconfiguration in high flow and the accuracy of long-range extrapolations have remained elusive. Here we characterize reconfiguration of several macroalgal species in a high-speed re-circulating flume, documenting changes in size (reduction of projected area) and shape (reduction of drag coefficient) with increasing water velocity (up to 4 m/s). Data were then used to predict drag force at environmentally relevant water velocities. Extrapolation accuracy was evaluated by comparing predictions to drag measured on thalli at 10 m/s in a novel gravity-accelerated water cannon. Results suggest that different morphologies (e.g., bladed algae, branched algae) specialize in changing either size or shape in flow and that these growth strategies may represent two distinct adaptations to limit drag. The influence of thallus morphology on our ability to predict drag in the field will be discussed.

**Bond, M.H.<sup>1\*</sup>, and A.L. Collins<sup>2</sup>** 1 - School of Aquatic and Fishery Sciences, University of Washington, Seattle 2 - University of California, Santa Cruz  
STABLE ISOTOPES INDICATE MARINE NUTRIENTS ARE IMPORTANT TO STEELHEAD (*ONCORHYNCHUS MYKISS*) REARING IN FRESHWATER LAGOONS

Steelhead (*Oncorhynchus mykiss*) populations in coastal central California have recently been in decline. However, the ultimate mechanisms responsible for these population declines are unclear. Recent work in Scott Creek, a small central California stream, indicates that during the spring juvenile steelhead migration, approximately 20% of downstream migrants remain in the lagoon habitat for an additional 6-9 months, while the remainder move directly to sea. Juveniles with additional rearing in the closed lagoon habitat have significantly higher marine survival than those reared in strictly upstream habitats, likely due to differences in growth and a significant size dependent marine mortality. Although the lagoon habitat is generally freshwater, large swell events often deposit significant amounts of seawater and algal detritus over the shoal. Our aim was to determine whether lagoon productivity, and subsequent high steelhead growth rates, was due to nutrient inputs from terrestrial or marine sources. In the fall of 2006 and 2007 we used stable isotopes of carbon and nitrogen to determine the relative importance of the lagoon habitat as compared to complete freshwater or marine rearing habitats. During 2006 (a high marine input year), lagoon steelhead experienced higher growth rates and nearly 50% of their tissue was marine in origin, while in 2007 (a comparatively low input year), both growth rates and marine nutrients in tissue were lower. These results indicate that lagoon morphology and resulting delivery of marine nutrients may be critical to the survival of central coastal California steelhead populations.



†**Bowles, C M\*** and **E. Grosholz** *University of California at Davis; Bodega Marine Laboratory*  
STABILITY, DISTURBANCE AND RESILIENCE IN TWO ALTERNATE SOFT-SEDIMENT  
COMMUNITIES

Ecological systems can be modified by many factors including habitat modification, eutrophication, introduction of species and fishing. Thresholds may exist, allowing a natural system to withstand disturbance or switch to a distinct community. Alternate stable states are distinct communities in similar environments. Alternate stable state theory may be important for understanding dynamics and managing ecological systems, but experimental evidence is limited and controversial. To persist, alternate stable states must have positive feedback mechanisms, mechanisms to promote the community at the expense of outsiders and recover from disturbance (resilience). *Boccardia proboscidea*, a native polychaete worm, has recently formed dense patches in Bodega Harbor mudflats adjacent to habitat dominated by venerid clams and phoronids. Data show *Boccardia* and phoronid communities have discrete biological assemblages and physical characteristics and are alternate states. I experimentally manipulated *Boccardia* and phoronid communities using reciprocal transplants, defaunated plots with coarse or fine sediment, and disturbances to examine multiple aspects of stability, including persistence and resilience. Resilience in defaunated plots differed with community type and physical habitat. The rate of change in all plots was related to the identity of the surrounding community, the type of physical habitat and the community structure of the plot. Plots with animals (transplants) were better able to prevent invasion by the surrounding community than defaunated plots and thus had a smaller rate of change. I simulated natural and anthropogenic disturbances of different sizes. The initial impacts as well as resilience differ depending on community identity and type of disturbance.

**Braby, C.E.\***, **Laferriere, A.M.**, **Galleher, S.N.**, **Massaua, M.J.**, **Venturi, E.A.**, and **D.M. Westerman**  
*Oregon Department of Fish and Wildlife* AN ASSESSMENT OF BAY CLAM SPATIAL  
DISTRIBUTION AND ASSOCIATED HABITAT CHARACTERISTICS IN COOS BAY, OREGON

Oregon's estuaries are legend for intertidal recreational clamming on its broad mudflats. Four decades ago, the Oregon Department of Fish and Wildlife (ODFW) conducted habitat and clam 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 the status of Oregon's clam populations have not been revisited. In spring/summer 2008, we conducted the first comprehensive habitat and biological survey in the greater Coos Bay system since the 1970's. Utilizing modern mapping and surveying techniques we applied both systematic and random sampling strategies to determine current patterns in clam populations and to compare present patterns with historical ones. We present both our sampling strategy and our findings of distribution/abundance/biomass for the 4 main recreational bay clam species (*Tresus capax*, *Saxidomus gigantea*, *Protothaca staminea*, and *Clinocardium nuttallii*) and associated habitat characteristics (based on 10 environmental factors). Regional comparisons using both PRIMER-based multi-dimensional scaling (MDS) analysis and ANOVA-based analysis show that over 6 major tideflats, there are strong regional patterns in clam community structure over a 12-km estuarine gradient. 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 the current recreational allowances are sustainable.

**Bracken, M.E.S.<sup>1\*</sup>**, **Williams, S. L.<sup>2</sup>**, **Jones, E.M.<sup>2</sup>**, **Carranza, A.<sup>2</sup>**, and **R.C. Rockwood<sup>2</sup>** *1 - Marine Science Center, Northeastern University 2 - Bodega Marine Laboratory, University of California at Davis*  
HERBIVORES, THERMAL STRESS, AND NUTRIENTS COMBINE TO DETERMINE  
INTERTIDAL ALGAL DIVERSITY

Given threats to biodiversity, it is essential to understand the factors that determine the number of species at a given location. In marine ecosystems, consumers, temperature stress, and nutrients have all been shown to independently influence diversity, but no studies have examined the combined effects of all

three factors. We factorially manipulated herbivore abundances (H), shade (S), and nutrient availability (N) and evaluated their effects on algal species richness across tide-height and wave-exposure gradients in the Bodega Marine Reserve, California. We cleared 160 plots of algal standing stock and measured algal richness quarterly for 18 months as a function of H, S, and N. Predictably, richness was almost always higher in plots lower on the shore, and richness tended to be slightly higher in wave-exposed habitats. After accounting for these differences in tide height and wave exposure, we observed persistent H effects on richness, though -H plots only contained, on average, one more species than +H plots. S effects were even more subtle: shading only enhanced richness in the summer. We observed no effect of N, by itself, on richness. Stronger effects of H, S, and N became apparent when all three were considered together, but even these effects took a year to become apparent. Over the final six months of the experiment, richness was highest in -H +S +N treatments and lowest in +H -S -N treatments. Our results highlight the importance of considering multiple simultaneous drivers of biodiversity in long-term field experiments.

†**Brenneis, V.E.**\* *University of California, Davis* INTEGRATION OF AN INTRODUCED CONSUMER INTO AN ESTUARINE FOOD WEB: DIRECT AND INDIRECT EFFECTS OF THE NEW ZEALAND MUDSNAIL IN THE COLUMBIA RIVER ESTUARY

Introduced species interact with recipient communities via direct and indirect interactions. The New Zealand mudsnail (*Potamopyrgus antipodarum*) can achieve high densities in invaded systems, potentially causing negative effects on native consumers and their predators. New Zealand mudsnails are increasingly found in bays along the Pacific Coast of North America but there are few studies of the interactions between mudsnails and native species in estuarine systems. I examined interactions between New Zealand mudsnails, the amphipod, *Americorophium salmonis*, and the isopod, *Gnorimosphaeroma insulare*, in the presence of native predators including Pacific staghorn sculpin (*Leptocottus armatus*), threespine stickleback (*Gasterosteus aculeatus*), juvenile starry flounder (*Platichthys stellatus*), and signal crayfish (*Pacifastacus leniusculus*). Results from this laboratory experiment show that while all predator species consume mudsnails, crayfish consume significantly more snails than do fish. In addition to this direct effect, mudsnail presence increases crayfish and sculpin predation on amphipods. The presence of obvious epibenthic prey (mudsnails) may increase foraging by these predators, resulting in increased consumption of cryptic, subsurface prey (amphipods). While crayfish digest mudsnails effectively, a proportion of snails (20-50%) consumed by fish survived gut passage intact, indicating that fish derive little energetic benefit while serving as a potential transport vector for mudsnails. The effects of New Zealand mudsnails in this estuarine system include positive direct and indirect effects on crayfish, mixed direct and indirect effects on fish predators, and negative indirect effects on amphipods.

**Britton-Simmons, K.H.**\*, and **H.L. Stewart** *University of Washington* DRIFT MACROPHYTE CAPTURE BY *STRONGYLOCENTROTUS FRANCISCANUS*: THE EFFECTS OF PHYSICAL HABITAT AND URCHIN MORPHOLOGY

Detrital macrophytes are a potentially valuable food resource in deep subtidal marine habitats. In the San Juan Islands of Washington State the red urchin (*Strongylocentrotus franciscanus*) occurs at depths far below those occupied by the macroalgae on which it feeds. These deep red urchins subsist on drifting macrophyte detritus, which they capture out of the water column. We measured in situ drift macrophyte capture rates of red urchins at two sites in the San Juan Islands to address two questions: (1) Do wind, current, or tides regulate drift macrophyte inputs to deep habitats?, (2) Does red urchin morphology influence drift macrophyte capture? We measured currents and individually tagged 10 urchins at each of two sites in the San Juan Islands (depth = 25 m below MLLW). Drift macrophytes captured by these urchins were collected every 48 hours over a 30 day period during June of 2007 and again in January of 2008. Macrophytes were returned to the lab where we recorded the number, mass, and species identity of all pieces of drift algae collected from each urchin. Drift macrophyte capture by red urchins was positively related to current speed during the summer, but not during the winter when drift was scarce and average capture rates were 85% lower. Drift macrophyte capture was not influenced by urchin size, spine

length or other morphometric characters. Our results suggest that currents and storms play a key role in regulating drift macrophyte inputs, but the influence of these factors varies with season.

†**Burgess, S.C.\***, and **D.J. Marshall** *School of Integrative Biology, University of Queensland, Brisbane, Australia* EFFECTIVE LARVAL DISPERSAL: DO THE COSTS OF DISPERSAL REDUCE POPULATION CONNECTIVITY?

Current models of marine population connectivity largely focus on larval dispersal and propagule arrival. For dispersal to make an effective contribution to population persistence however, settlers must survive and reproduce. For non-feeding larvae, increases in facultative dispersal time are costly because larval condition is likely to decline as finite energy reserves are consumed. Therefore, individuals dispersing for longer should have different establishment success from those spending little time dispersing. Using a combination of laboratory and field experiments, we found that the probability of bryozoan larvae (*Bugula neritina*) surviving the first few weeks after settlement depended on a complex interaction between larval size and pelagic larval duration (PLD). We also found that PLD's in this species vary widely in field, despite individuals being competent to settle once released. We derived a general connectivity model, using parameters estimated from these data, to demonstrate how these PLD - dependent costs of dispersal could favour the recruitment of locally derived larvae. As a result, not all links established during larval dispersal are likely to contribute to actual population connectivity.

**Byrnes, J.E.<sup>1\*</sup>**, and **K.E. Edwards<sup>2</sup>** *1 - Marine Science Institute, University of California Santa Barbara* *2 - Bodega Marine Lab, University of California Davis* PREDATOR DIVERSITY INFLUENCES SHORT AND LONG-TERM WATER FILTRATION IN FOULING COMMUNITIES

In marine ecosystems, primary and secondary predators are more likely to go extinct than species at other trophic levels. These extinctions can directly alter the density and community composition of basal consumers and then indirectly affect primary producers. Here we examine the consequences of predator extinction for water filtration in a sessile marine invertebrate fouling community. We assembled communities of mobile fouling community predators that differed in density and richness using an additive-replacement design. Predators were then placed in cages with settlement panels and deployed at a marina in Bodega Bay, CA for one year. At the end of the year, we placed the panels in closed chambers with raw seawater, and monitored changes in chlorophyll over the course of several hours. We used structural equation modeling in order to tease apart the different pathways of indirect effects of predators on filtration as mediated by the different elements of the resulting sessile community. We found that consumer diversity and abundance both directly reduced total cover, although the two negatively interact due to intraguild interactions. Reduced cover then lead to decreases in short term (i.e. within 1 hour) filtration rates. Changes in cover also resulted in changes in sessile species richness, evenness, and biomass; all three properties then influenced water filtration, but only after several hours. Interestingly, changes in evenness also fed back to influence cover, potentially amplifying the effect of consumer treatment on cover, and therefore, on short-term filtration rates. Our results suggest that predator diversity decline can indirectly change whole-community filtration through multiple causal pathways. As we consider the consequences of predator diversity loss, it is crucial to look at changes to the whole community rather than just a single response.

†**Carney, L.T.\***, and **M.S. Edwards** *San Diego State University* EFFECT OF NUTRIENTS ON DEVELOPING GAMETOPHYTES OF THE GIANT KELP *MACROCYSTIS PYRIFERA*

The ability of kelp gametophytes to delay their development during unfavorable conditions and then reproduce once conditions improve may be important for population persistence in heterogeneous environments. Nutrient-deprived gametophytes of *Macrocystis pyrifera* persist in a delayed 1-2 cell stage for at least 200 days and reproduce once nutrients are added. We investigated which nutrient components were responsible for this development by growing the microscopic stages of *M. pyrifera* in the laboratory

under several enrichment conditions 1) sterilized surface seawater (SW) with concentrations of macronutrients (phosphate and potassium) and micronutrients (trace metals and vitamins) specified by Provisoli (1968) with either 10 or 90  $\mu\text{mol}$  nitrate ( $\text{NO}_3^-$ - L-1) (PES+10 or +90, respectively) 2) SW with full PES but excluding nitrate (PES-N) 3) SW with either 10 or 90  $\mu\text{mol}$   $\text{NO}_3^-$ - L-1 (SW+10 or +90, respectively) and 4) SW with no enrichment. Twenty days after inoculation replicates were switched to either 1) SW+10 2) SW+90 3) PES-N 4) PES+10 or 5) PES+90. Gametophyte length was measured 20 and 34 days after inoculation and sporophyte production was monitored throughout the experiment. The 1-2 cell delayed state was maintained when micro- and macronutrients were absent, regardless of nitrate. However, only recruitment cues that included nitrate resulted in sporophyte production by delayed gametophytes. Sporophyte production occurred within 5 days of the recruitment cue for gametophytes delayed in PES-N, which is 50-70% faster than for all other treatments when calculated from the time nutrients were added.

**Carpenter, R.C.** \* *Department of Biology, California State University, Northridge* SCALE-DEPENDENT EFFECTS OF WATER FLOW ON CORAL REEF PRIMARY PRODUCTION

Hydrodynamics have significant effects on organism morphology, distributions, and rates of growth. Multi-specific algal turf communities are a major primary producer on many coral reefs and contribute substantial energy to higher trophic levels, making the role of flow speed in controlling rates of turf primary production of considerable interest. Effects of flow speed on rates of primary production were estimated at spatial scales from  $10^{-3}$  to  $10^2$  meters. At the 3 smallest scales, experiments were conducted in flumes using natural turf communities. At the  $10^{-3}$  m scale, photosynthetic rates were estimated from oxygen profiles over turf communities using micro-optodes, and applying Fick's first law of diffusion to estimate rates of oxygen evolution at 6 speeds. Measurements at the  $10^{-1}$  and  $10^1$  m scales were made in flumes at 8 speeds using changes in dissolved oxygen. At the largest scale, community-level net primary production was estimated over 200 m of the reef flat at Kaneohe Bay, Hawaii using upstream-downstream sampling. The effects of flow on primary production are positive at all scales examined. The slopes of these relationships are steepest at the smallest scale, and similar for all larger scales. These results suggest that the effects of flow on coral reef metabolism vary from organismal to community scales and may reflect nonlinear effects of flow on mass transfer and/or the inclusion of non-photosynthetic organisms at larger spatial scales. A remaining challenge is the relative importance of variation in light and flow in modulating rates of metabolism across spatial scales.

**Carr, L.A.**<sup>1\*</sup>, **Boyer, K.E.**<sup>1</sup>, and **A.J. Brooks**<sup>2</sup> *1 - Romberg Tiburon Center, San Francisco State University 2 - Marine Science Institute, University of California at Santa Barbara* SEAGRASS HABITAT COMPLEXITY MEDIATES FISH PREDATION ON AN INVASIVE HERBIVORE IN SAN FRANCISCO BAY

Epifaunal species, small herbivorous crustaceans, can have important positive effects on seagrass communities through grazing epiphytes that compete for light, and are also an important link in the food chain from primary producers to higher-order consumers. However, epifaunal species vary in their functions, and the roles of invasive epifauna in driving seagrass ecosystem structural and functional properties in new locations are difficult to predict. We used a mesocosm experiment to investigate how herbivory by an abundant invasive amphipod (*Ampithoe valida*) in San Francisco Bay is influenced by structural complexity in eelgrass (*Zostera marina*) under different scenarios of predation pressure. Shiner surfperch (*Cymatogaster aggregata*) readily consumed *A. valida* on eelgrass but greater habitat complexity conferred by flowering shoots (compared to vegetative shoots) weakened predation success. In the absence of surfperch, amphipods consumed eelgrass, reducing shoot mass and height. Surfperch presence, particularly at higher densities, led to significantly greater biomass and height of eelgrass by reducing amphipod herbivory in a classic trophic cascade. We found little evidence that habitat complexity effects on predation carried through to plant measures; however, amphipod refuge in abundant flowering shoots is likely to enhance eelgrass herbivory throughout the beds, emphasizing the importance

of intact predator populations.

**Carrington, E.\*** *Friday Harbor Laboratories and Department of Biology, University of Washington* A COUPLED BIOPHYSICAL/METABOLIC MODEL FOR GROWTH AND PERSISTENCE OF AN INTERTIDAL MACROALGA

Macroalgae inhabiting rocky intertidal shores are alternately subjected to submersion in seawater and emersion in air. While many species are known to have physiological adaptations to tolerate repeated desiccation, photosynthesis requires tissue hydration and thus desiccation potentially comes at the expense of reduced growth. Furthermore, morphology can influence the rate of mass (water vapor) and heat convection between a thallus and its surrounding environment, thereby influencing thallus desiccation and temperature during emersion. This study evaluates the influence of thallus morphology on the growth and persistence of an intertidal macroalga. An integrative model was developed from previous analyses of the ecophysiology and heat budget of the red alga *M. papillatus*, using local meteorological conditions to provide a continuous estimate of thallus temperature, desiccation, and productivity. Run over an entire year, the simulations suggest that emersed carbon fixation is not an important component of the total carbon budget of a thallus, and that productivity is largely determined by the duration of daytime high tides. Changes in thallus morphology (e.g., thickness, branching) have only subtle effects on productivity, but dramatic effects on whether lethal temperatures are encountered during emersion. This mechanistic approach not only provides a useful tool to evaluate potential trade-offs in performance with morphology, but also allows for prediction of the consequences of climate change on the productivity and persistence of a common intertidal species.

†**Carson, H.S.\*** *San Diego State and UC Davis* THE POPULATION CONNECTIVITY OF THE OLYMPIA OYSTER (*OSTREA CONCHAPHILA*) AMONG SOUTHERN CALIFORNIA ESTUARIES

Measuring the exchange of larvae among populations is fundamental to understanding the population dynamics of marine organisms and designing effective management and restoration strategies for them. The Olympia oyster is a useful model to study the population connectivity of estuarine invertebrates because the larvae incorporate chemical information about their natal site into their shells before dispersal. This information can be accessed in recruits using laser ablation inductively-coupled plasma mass spectrometry and compared to pre-dispersal shells from possible source populations. Shelled *O. conchaphila* larvae were periodically removed from adults at eight sites in four southern California estuaries spanning 75 km of coastline in the summers of 2006 and 2007. The ratios to calcium of copper, barium, lead and uranium in the shells were used to distinguish between sites in linear discriminant function analyses. Jackknifed assignment accuracy by site was increased to 74% and 82% for 2006 and 2007, respectively, by grouping the eight sites into three regions: San Diego Bay, Mission Bay and the North County Lagoons. Settlement plates at each site in 2007 collected recent *O. conchaphila* recruits that were assigned to one of the three regions defined by the broods. San Diego Bay and the North County produced over 80% of the sampled recruits in 2007, while Mission Bay was a sink population by comparison. The majority of recruits to San Diego Bay and the North County were self-recruits. Patterns of connectivity varied between settlement pulses, but significant larval exchange occurred among all regions throughout the season.

†**Cheng, B.S.<sup>1\*</sup>, and K.A. Hovel<sup>2</sup>** *1- UC Davis 2 -San Diego State University* BIOTIC RESISTANCE BY AN EXPLOITED NATIVE SPECIES: CONSEQUENCES FOR PREDATOR LOSS

Biotic resistance is the ability of native communities to repel the establishment of invasive species. Depletion of top predators through overfishing and habitat loss and the subsequent lack of intact native predator communities and the biotic resistance they provide has been suggested as an important factor in the ongoing establishment of invasive species. However, support for this idea is almost entirely lacking in coastal systems. We evaluated the factors that influence the distribution of the invasive Asian mussel

(*Musculista senhousia*) in Mission Bay, a Southern California estuary containing extensive eelgrass (*Zostera marina*) habitat. Mussels exhibit a distinct spatial pattern of invasion with extremely high densities at sites towards the back of Mission Bay (up to 4,000 m<sup>-2</sup>) in contrast to near complete absence at sites towards the front bay. We established that propagules arrive at sites where adult mussels are absent and that eelgrass structure positively influences mussel density. Mussel survival and growth were high in predator-exclusion plots throughout the bay, but mussel survival was low in the front bay when plots were open to predators. Experiments in which large predators were allowed access to plots or were restricted from plots revealed that a commercially and recreationally exploited predator, the spiny lobster (*Panulirus interruptus*), likely is primarily responsible for resistance to Asian mussel invasion. Our findings indicate that biotic resistance in the form of predation may be conferred by higher order predators. Continued loss of species in higher trophic levels may cripple the ability of native communities to resist invasion by non-native species.

†**Chomiczewski, L.A.**\*, and **S.D. Sulkin** *Western Washington University* MANIPULATING THE NUTRITIONAL VALUE OF PLANKTOTROPHIC LARVAE AS PREY FOR LARVAL CRABS

Crab larvae are opportunistic omnivores, whose diet may include other invertebrate larvae such as nauplii. The present study examined whether the diets of such larval prey affect their nutritional value to larval crabs. For example, heterotrophic prey such as holoplanktonic zooplankton can pass along both essential fatty acids and algal toxins depending upon their own diets. The present study manipulated the diet of a common larval prey type, the nauplius, to alter its nutritional constituency or to introduce toxins to larval crabs.

Nauplii of the brine shrimp *Artemia* sp. were fed two algal diets differing in their fatty acid content and two algal diets containing different levels of saxitoxins. Crab zoeae of *Cancer magister* and *Hemigrapsus oregonensis* were fed nauplii cultured on these algal diets, and stage survival and duration were measured. Results indicated that crab larvae fed the less-toxic nauplius had higher mortality than those fed the more-toxic nauplius diet with results of the latter similar to results obtained from the freshly hatched nauplius diet. Results are explained by feeding behavior of the nauplii that continually ingested the low-toxin algae while there was only brief ingestion of the high-toxin algae. Feeding behavior of the prey must be considered when assessing their potential to vector algal toxins. Increased larval crab mortality on the less-toxic nauplius was not due to differences in its fatty acid content, implicating the role of toxin rather than nutritional deficiencies.

†**Christie, M.R.**<sup>1\*</sup>, **Albins, M.A.**<sup>1</sup>, **Beets, J.**<sup>2</sup>, **Tissot, B.N.**<sup>3</sup>, **Thompson, S.**<sup>4</sup>, and **M.A. Hixon**<sup>1</sup> 1 - *Department of Zoology, Oregon State University* 2 - *Department of Marine Science, University of Hawaii at Hilo* 3 - *Washington State University, Vancouver* 4 - *Cascadia Conservation Trust, OR* PATTERNS OF POPULATION CONNECTIVITY IN A CORAL-REEF FISH

Patterns of demographic connectivity among and retention within local populations of marine fish are poorly understood due to the difficulty of directly tracking pelagic larvae. To address this issue, we conducted population genetic analyses of yellow tang (*Zebrasoma flavescens*), a commercially and ecologically important coral-reef fish. In 2006, 500 adult and 500 recruit yellow tang were collected from 9 sites distributed around the Big Island of Hawai'i and subsequently genotyped at 15 microsatellite loci. Overall levels of genetic differentiation (e.g., *F*<sub>st</sub>) were low and there were no significant patterns of isolation by distance when Euclidean or along-shore distances were employed. Levels of genetic differentiation among samples of recruits were more similar than expected by chance, which suggests that the number of source populations is less than the number of sampled populations. Additionally, the high levels of polymorphism found within the genetic markers allowed for the detection of parent-offspring pairs using novel statistical methods. All offspring were found to the north of their parents, suggesting that larval dispersal occurred from the south to the north in 2006. Given that the overall levels of genetic differentiation are low, parentage analysis in marine systems may prove to be a powerful tool for informing population-level genetic analyses as well as for providing insights into gene flow and dispersal

at ecological timescales.

† **Colvard, N B\***, and **P J Edmunds** *California State University, Northridge* DECADAL-SCALE CHANGES IN THE ABUNDANCE OF BENTHIC REEF INVERTEBRATES ON THE SOUTH COAST OF ST. JOHN, USVI

It is likely that the global decline in abundance of scleractinian corals influences the benthic invertebrates that inhabit reefs, yet there is surprisingly little data that addresses this important issue. Monitoring of the shallow reefs of St. John for 22 years has created a unique opportunity to assess the response of non-scleractinian invertebrates to reef degradation. To quantify the abundance of invertebrates, photoquadrats from 8 sites (5-14 m depth) were analyzed in 2-year intervals from 1988-2007. Sampling was restricted to macroscopic taxa ( $\geq 3$  cm diam) that were conspicuous in photographs, and the analyses were designed to test the hypothesis that changes in coral cover are not associated with changes in invertebrate abundance at three depths (5, 9, and 14 m). The research focused on a class-level analysis (Anthozoa, Demospongiae, Echinoidea, and Polychaeta), with selected species contrasts used to evaluate the ecological significance of the changes in invertebrate populations. The results demonstrate that the abundance of non-scleractinian invertebrates in deeper water has changed dramatically since 1988. On reefs at  $\geq 9$  m depth, the class-level analysis revealed relative stasis from 1988-1998, but from 1998-2007, representatives of these four classes exhibited a 2-4 fold increase in abundance, notably for suspension feeding taxa. The abundance of these classes did not vary over time on the shallowest reefs. The results of this study demonstrate that some invertebrates have displayed an inverse relationship to changes in coral cover, and they suggest that suspension feeders have become more common as coral cover has declined.

† **Conway-Cranos, L.L.\*** *University of California at Santa Cruz* FACILITATIVE INTERACTIONS AS A POTENTIAL DRIVER FOR SPATIAL VARIATION IN RECOVERY PATTERNS IN THE CALIFORNIA ROCKY INTERTIDAL

Community dynamics of benthic organisms are often influenced by the processes of disturbance and recovery. Recovery rates and trajectories are most likely not the result of any single factor but rather a combination of multiple processes. The prevailing mechanism of succession (Facilitation, Inhibition or Tolerance), propagule input, and grazing pressure from mobile invertebrates may all be important in determining recovery rates and trajectories, yet the relative importance of each of these factors is not known. It is my goal to evaluate the extent to which each of these factors is important in determining recovery potential for the California rocky intertidal ecosystem. I have calculated recovery rates after an experimental disturbance for the intertidal red alga *Endocladia muricata* across two biogeographic regions in California. My approach is to use transition frequencies between community states to assess the prevailing mechanisms of species interactions throughout the course of succession. Here I highlight the potential for positive interactions (facilitation) to influence the outcome of successional trajectories. Since human presence in an area often leads to removal of biota, the process by which a disturbed area recovers is a key part of understanding the long-term consequences of anthropogenic impacts to ecosystems. This approach to understanding successional dynamics can provide useful information to coastal resource managers regarding recovery potential for intertidal organisms while at the same time deepening and quantitatively refining our understanding of the process of ecological succession.

† **Cooper, E.E.\*** *Oregon Institute of Marine Biology* CHLOROSTOMA (TEGULA) FUNEBRALIS AGE STRUCTURE AND EFFECTS ON REPRODUCTIVE POTENTIAL OF POPULATIONS

Between 2005 and 2008, size-frequency distributions from 22 populations of *Chlorostoma (Tegula) funebris* were studied. Sites were categorized by location, Oregon (15 sites), California (5 sites), Baja California (2 sites), and coastal topography, protected (bays and coves) (10 sites) or exposed to the open ocean (12 sites). Variation in size-frequency distributions did not correlate with latitude in the manner suggested by Frank (1965) or Menge et al. (2004). In Oregon, population structures at protected and

exposed sites were significantly different ( $P=0.001$ ). At protected sites, a large percentage of individuals were pre-reproductive juveniles. At exposed sites, the population was weighted towards large individuals capable of large reproductive output. In California and Baja California all populations were predominately composed of juveniles, regardless of coastal topography ( $P=0.336$ ).

The potential reproductive output of a population was calculated by quantifying the number of eggs produced by snails covering the size range of reproductive individuals. Differences in age-structure of the population create significant differences in relative reproductive potential. Populations in the north at exposed sites produce eggs at a rate up to two orders of magnitude higher than populations in the south ( $P=0.004$ ). Size-frequency distributions may have important impacts on the reproductive ability of populations of *C. funebris*.

† **Cover, W.A.**\* *University of California, Santa Cruz* DIRECT, SPECIES-SPECIFIC IMPACTS OF SEA URCHINS ON LIVE CORALS

Interactions between species can shape major processes that influence coral cover and community structure on coral reefs. Sea urchin grazing on macroalgae is known to have a strong indirect benefit on coral cover and reef resilience. While studies of indirect impacts and bioerosion by urchins are common, direct impacts of urchins on live coral tissue are rarely reported. I conducted two experiments on the backreef of Midway Atoll (NW Hawaiian Islands) that demonstrate direct, species-specific impacts of two urchin species (*Echinometra mathaei* and *Heterocentrotus mammillatus*) on three coral species (*Pocillopora ligulata*, *Montipora* c.f *turgescens*, and *Porites lobata*). I epoxied fragments of each coral species inside the bioeroded channels created by the urchins. In half the plots I removed urchins; they remained in the other half. Most fragments of all three coral species placed in plots with *E. mathaei* were grazed down increasingly over a period of several weeks to months, often ending with complete removal of all coral tissue and skeleton. Fragments in plots without *E. mathaei*, and all fragments in *H. mammillatus* plots were unaffected. These results indicate that *E. mathaei* can have direct negative impacts on live corals, while *H. mammillatus* has little or no effect. This differential grazing has important implications for recruitment success of corals, community structure and reef growth.

† **Crean, A.J.**\* , and **D.J. Marshall** *University of Queensland* PHENOTYPIC PLASTICITY IN MULTIPLE TRAITS OF THE EGGS OF A BROADCAST SPAWNER

When provisioning offspring, mothers face a trade-off between egg size and number – either producing a few large eggs or many small eggs. As offspring size can strongly influence offspring fitness, selection favours females that can adaptively adjust egg size depending on the expected offspring environment. Broadcast-spawning mothers (where both eggs and sperm are released into the water) face a unique challenge as the size of their eggs also represents the target size for searching sperm. Large eggs are larger targets for sperm, and are therefore more likely to be fertilized when sperm are scarce; but are also more likely to be fatally fertilized by multiple sperm when sperm are abundant. Accessory structures (e.g. follicle cells) which surround the ovicell (main energetic investment) provide a cheap way of changing the overall egg size. Therefore, eggs can be optimized for the fertilization and offspring environments via plasticity in the size of accessory structures and the ovicell respectively. We tested whether broadcast spawners show adaptive plasticity in egg size by manipulating the density of *Styela plicata* (a solitary ascidian) for one month in the field, and compared the properties of their eggs. Animals in high density environments produced eggs with smaller follicle cells, and thus a smaller total physical size; but with a larger ovicell than eggs from low density animals. Hence, *S. plicata* shows a remarkable degree of egg size plasticity, with different egg traits changing in opposite directions in response to opposing pre- and post-zygotic selection pressures.

† **Curtis, D.L.**\* , and **I.J. McGaw** *University of Nevada, Las Vegas & Bamfield Marine Science Centre* THE EFFECTS OF NUTRITIONAL STATUS AND FOOD AVAILABILITY ON THE SALINITY AND THERMAL PREFERENCE OF ADULT DUNGENESS CRABS IN THE LAB AND IN THE



## FIELD

Unless competition is strong or resources are limited, it is not advantageous for animals to forage in physiologically challenging environments. Previous studies investigating the habitat conditions experienced by decapod crustaceans living in estuaries have examined broad scale changes in environmental variables recorded at fixed stations. However, these studies may not accurately represent the environmental conditions experienced by individual animals in the field. The microhabitat conditions of free ranging Dungeness crabs fitted with CTD data tags were compared with behavioural responses observed in the laboratory. During summer months, forays into the estuary were associated with moderate decreases in salinity and increases in temperature. In the fall and winter, low salinity exposures were more severe and there was no corresponding increase in temperature. When the salinity and temperature experiences of individual animals were compared to conditions measured at fixed stations within the estuary there was little correspondence, indicating a clear role for behaviour in determining microhabitat conditions. Hyposaline exposure often corresponded to times of high food abundance. In the laboratory, nutritional status effected salinity and thermal preference. This further supports the idea that food abundance or resource limitation may be affecting the behaviour and distribution of adult Dungeness crabs in estuaries.

† **Dodge, C.A. \***, and **M.S. Edwards** *San Diego State University* THE EFFECTS OF FOOD AVAILABILITY ON CONSUMPTION RATES AND SPAWNING COMPETENCE IN THE PURPLE URCHIN (*STRONGYLOCENTROTUS PURPURATUS*)

Variation in food availability can affect reproductive timing and reproductive investment in many species. The annual cycle of gametogenesis in the purple sea urchin (*Strongylocentrotus purpuratus*) can peak at different times and magnitudes between populations. Differences in spawning times are most likely due to environmental variation and food availability. We examined variation in the timing and magnitude of gametogenesis in *S. purpuratus* in relation to food availability over three seasons. During each season urchins were exposed to various feeding treatments ranging from fed once a week to *ad libitum* in order to examine the effect on consumption rate, growth and time to reproductive competence. Season and food availability impacted consumption rates; urchins consumed more food per day when fed less often and when food was critical to reproductive success. These results suggest there is a critical period during the beginning of gametogenesis when environmental conditions affect time to spawning. Past this critical period, reproductive competence was similar between feeding treatments while total reproductive output was still affected.

**Dutton, J.M. \***, and **G.E. Hofmann** *University of California, Santa Barbara* SPATIAL AND TEMPORAL PATTERNS IN DISTRIBUTION AND PROTEIN DEGRADATION FOR *MYTILUS* CONGENERS IN BODEGA BAY, CA

Along the west coast of North America, the invasive mussel *Mytilus galloprovincialis* and a native congener *Mytilus trossulus* overlap in range and compete for habitat in an extensive hybrid zone along central California. The two species have been shown to exhibit differential abiotic tolerances in laboratory studies, yet little is known about how such tolerances affect spatial and temporal patterns of geographic distribution, particularly in areas of competition. We examined distributions of the two congeners and their hybrids in neighboring intertidal and subtidal habitats in Bodega Bay, CA over two years, and compared seasonal levels of ubiquitin-conjugated proteins (proteins labeled for degradation) to assess stress in the species at each site. The two species were spatially segregated, with *M. galloprovincialis* dominating the subtidal habitat, and *M. trossulus* constituting a majority of the intertidal mussel population. Hybrid individuals appeared in low numbers at both sites. In regards to physiological performance, ubiquitin (Ub) conjugate values showed different seasonal cycles for the two species, suggesting different periods of peak environmental stress. The highest Ub-conjugated proteins were observed in summer for *M. galloprovincialis* and in winter for *M. trossulus*, consistent with the respective

range edges for their distributions since Bodega Bay is near the northern range edge of the invader and the southern edge of the native species. These findings suggest that future assessments of *Mytilus* populations along the California coast may need to consider vertical distributions and seasonal cycles as part of monitoring and research activities.

**Eckert, G.L.\*** *University of Alaska Fairbanks* MARINE ECOSYSTEM SUSTAINABILITY IN ALASKA - A NEW INTERDISCIPLINARY GRADUATE STUDY PROGRAM

The University of Alaska Fairbanks introduces a new interdisciplinary graduate training program in marine ecosystem sustainability. This program will prepare professionals to solve problems arising at the interface between dynamic environmental and social systems. Students will 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.

\* Students will collaborate on research that transcends traditional disciplinary boundaries.

\* They will learn to address the unique challenges of ecosystem-based management and to understand its implications for society.

\* The program will challenge 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 will have opportunities to mentor Alaska Native and rural Alaskan undergraduates.

We are actively recruiting PhD and MS students starting in 2009. Prospective PhD students (US citizens) can apply for 2 years guaranteed fellowship of \$30K per year plus tuition, health insurance, and research funding. Graduates will be well-prepared to devise 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. For more information, contact [g.eckert@uaf.edu](mailto:g.eckert@uaf.edu).

**Edmunds, P.J.<sup>1\*</sup>, Lenihan, H<sup>2</sup>, and M Kotchen<sup>2</sup>** *1 - California State University, Northridge 2 - University of California at Santa Barbara* THE EFFECT OF SIMULATED FISH PREDATION ON JUVENILE MASSIVE *PORITES* EXPOSED TO CONTRASTING REGIMES OF WATER FLOW AND TEMPERATURE

In this study, we tested the effects of simulated fish predation on juvenile massive *Porites* exposed to combinations of temperature and flow. Manipulations were completed in microcosms filled with unfiltered seawater, and the effects were assessed as growth, maximum dark-adapted quantum yield (Fv/Fm), and the healing of scars. A multiple regression approach revealed that predation caused growth to decline 25% at 29.6 oC, and to increase 23% at 26.6 oC; for corals in the high flow treatment, predation stimulated growth at 26.6 oC. Fv/Fm was influenced by both predation and flow, with predation depressing Fv/Fm by 10% at 6 cm s<sup>-1</sup>, but causing a 19% increase at 21 cm s<sup>-1</sup>. Overall Fv/Fm was increased 4% by high flow, independent of temperature. Predation scars declined in size at similar rates under all conditions, although the tissue within the scars regained a normal appearance most rapidly at 26.6 oC and 6 cm s<sup>-1</sup>. These results reveal complex interactions between temperature and flow on the response of corals to predation, with the outcome differing between the sites of scarring, which healed rapidly and appeared to be prioritized highly for repair, and the whole colony, for which the effects of predation were dependent on temperature and flow. While some of the changes in Fv/Fm lend support to the importance of photosynthetically fixed carbon in the response of growth to predation, it is likely that temperature- and flow- mediated access to heterotrophic resources also determine how these corals respond to predation.

**Edwards, K.F.\* , and S. J. Schreiber** *Department of Evolution and Ecology and Center for Population Biology, University of California, Davis* PREEMPTION OF SPACE ENHANCES COEXISTENCE BY CREATING COMPETITIVE INTRANSITIVITIES

Intransitive competition has the potential to be a powerful contributor to species coexistence, but there are few proposed biological mechanisms that could create intransitivities in natural communities. Using a general model of competition for space, we demonstrate a novel mechanism for coexistence via intransitive competitive abilities. This mechanism depends on the ability of species to preempt space from competitors, which allows competitors to differentiate in their abilities to colonize, preempt, and overtake space. The combined interaction of these three axes of competitive ability allows the emergence of intransitivities in pairwise outcomes, and these intransitivities greatly increase the range of traits for which whole-community coexistence can occur. In distinction to prior results, this mechanism of intransitivity does not require nonhierarchical interference competition. This mechanism operates in concert with a colonization-competition trade-off and therefore builds on existing knowledge of space-limited communities.

**Eerkes-Medrano, D.<sup>1</sup>, Amstutz, A.<sup>1\*</sup>, Langdon, C.<sup>2</sup>, and B. Menge<sup>1</sup>** *1 - Oregon State University 2 - Hatfield Marine Science Center* EFFECTS OF HYPOXIA ON SURVIVAL AND GROWTH OF BARNACLE LARVAE OFF THE OREGON COAST

In recent years, severe hypoxic events off the west coast of the United States have resulted in areas of mass vertebrate and invertebrate species mortality known as dead zones. Dead zones, altered community species composition, and food chain perturbations in response to inner shelf hypoxic conditions have been observed annually from 2002 to 2007. These near shore hypoxic events have already begun to redefine ecosystems off the Oregon Coast and other areas in the California Current Large Marine Ecosystem (CCLME). Barnacle species are of great importance in rocky intertidal communities of the CCLME. Adult barnacle species play important roles in community succession, are important food sources, and promote species diversity. As part of the barnacle life cycle, successful growth and survival of larval stages is essential to the success of sessile adults. Yet, little is known concerning the effects of hypoxia on larval stages of benthic invertebrates in coastal upwelling ecosystems. We are carrying out experiments at Oregon State University's Hatfield Marine Science Center to determine the rate of larval mortality in the barnacle species *Balanus glandula* at increasingly severe levels of hypoxia. We are also investigating the effects of exposure to hypoxic conditions on larval development. Our research will increase our knowledge on the effects of hypoxia on barnacle population dynamics and allow us to predict changes in species composition of rocky intertidal communities, with implications for management, conservation, and outlook of these ecosystems.

**Eernisse, D. J.\* , and M. F. Strathmann** *Calif. State Univ. Fullerton* SURPRISING SPECIES DIVERSITY WITHIN THE SEASTAR GENUS *HENRICIA* ALONG WESTERN NORTH AMERICA

Specimens of *Henricia* (called blood stars) have long posed problems for seastar taxonomists because of their seemingly endless variety of subtle skeletal variations in otherwise similar appearing seastars. Most authors of general marine life guides refer only to *H. leviuscula* on the West Coast even though more than a dozen nominal northeastern Pacific *Henricia* species, subspecies, or varieties have been described. We have focused on intertidal and shallow subtidal members of *Henricia* between southeastern Alaska and northern Baja California. Through the combined study of external skeletal morphology and partial mitochondrial 16S rDNA sequences, we have separated at least ten species, most of which appear to be new. The phylogenetic relationship between these is only partly resolved and could be improved by the eventual inclusion of additional outgroups and an expanded sampling of genes. There are two broad 'spine groups,' one comprised of *H. aspera*, *H. annectens*, and an unidentified species from southern England, and the other including at least seven other West Coast species. These latter seven include four large-bodied and brightly colored species with largely sympatric distributions in the Pacific Northwest intertidal, and three smaller-bodied species that are wider ranging along the West Coast. Our first contribution (with co-author Richard Strathmann) will restrict *H. leviuscula* to one of the four larger Pacific Northwest intertidal species and will introduce as new a small mottled species that broods its embryos, and is found between Sitka, Alaska and northern Baja California, Mexico. Our molecular study

and the description of other new species will follow.

**Emler, R.B.\*** *University of Oregon* REPRODUCTION AND DEVELOPMENT OF A BROODING, AUSTRALIA SEA URCHIN *PACHYCENTROTUS BAJULUS*

Intertidal populations of the brooding sea urchin *Pachycentrotus bajulus* Dartnall were sampled in 1998, 2006, and 2008 in southeastern Tasmania. Observations were made on numbers and size of juveniles on different females, their impact on mothers that carry them amongst their spines, and how unhatched embryos adhered to mothers. Early development was followed for several eggs artificially fertilized in the laboratory. Later development was followed by examining unhatched embryos taken from the spine canopy of females. Females have a very small allocation to gonad compared to that of other sea urchins that spawn eggs into the water column. Fertilized eggs and unhatched embryos are held near the female aboral surface by small loops of mucus that form in association with 3 or more pedicellariar stalks. Development is direct, but vestigial larval spicules may be present. At hatching juveniles are ca. 400  $\mu\text{m}$  in diameter, have no spines, a poorly developed test skeleton, and long primary podia. They eventually grow all the structures found in free living juvenile sea urchins and adhere to the female via podia. Juveniles stay on the mother until they are 3 or more mm in test diameter. They derive some nutrition from their mother by eating her epidermis and create wounds on her surface where they sit amongst the spine canopy. Brooding individuals were found on all visits to Tasmania (November, January, February) but the species has not been sampled for reproduction in Austral winter.

**Evans, Tyler G.\* , and George N. Somero** *Hopkins Marine Station, Stanford University A* TRANSCRIPTOMIC TIME COURSE OF HYPER- AND HYPOOSMOTIC SIGNALING EVENTS IN A EURYHALINE FISH: OSMOSENSORS TO EFFECTORS

Cells respond to changes in osmolality with compensatory adaptations that re-establish ion homeostasis and repair disturbed aspects of cell structure and function. These physiological processes are highly complex, and require the coordinated activities of osmosensing, signal transducing, and effector molecules. Although the critical role of effector proteins such as  $\text{Na}^+$ ,  $\text{K}^+$ -ATPases and  $\text{Na}^+/\text{K}^+/\text{Cl}^-$  co-transporters during osmotic stress are well established, comparatively little information is available regarding the identity or expression of the osmosensing and signal transduction genes that may govern their activities. To better resolve this issue, a cDNA microarray consisting of 9,207 cDNA clones was used to monitor gene expression changes in the gill of the euryhaline fish *Gillichthys mirabilis* exposed to hyper- and hypoosmotic stress. We successfully annotated 168 transcripts differentially expressed during the first 12 h of osmotic stress exposure. Functional classifications of genes encoding these transcripts reveal that a variety of biological processes are affected. However, genes participating in cell signaling events were the dominant class of genes differentially expressed during both hyper- and hypoosmotic stress. Many of these genes have had no previously reported role in osmotic stress adaptation. Our data indicate multiple major signaling pathways work in concert to modify diverse effectors, and that these molecules operate within a framework of a number of regulatory proteins.

**Fangue, N.A.\* , and G.E. Hofmann** *University of California Santa Barbara* PHYSIOLOGICAL PERFORMANCE IN THE FACE OF CLIMATE CHANGE: BIOLOGICAL CONSEQUENCES OF MULTIPLE STRESSORS

Global climate change has profound implications for coastal marine ecosystems. Current predictions include increased average sea-surface temperatures and ocean acidification due to the increase in atmospheric and dissolved carbon dioxide ( $\text{CO}_2$ ). Sea urchins may be particularly sensitive because they are marine calcifiers reliant on high carbonate concentrations for skeletal formation and maintenance, and have larval dispersal and settlement phases that are heavily influenced by factors such as temperature. We raised several species of sea urchin larvae at 15C and under three partial pressures of  $\text{CO}_2$  (control, 380 ppm) and elevated  $\text{CO}_2$  (540 and 970 ppm) chosen based on current and predicted levels of atmospheric

CO<sub>2</sub> by the year 2100. 4-arm urchin larvae were exposed to 1-hour thermal challenges and mortality was assessed to determine whether there are interacting effects of temperature and ocean acidification on larval performance. Our results show that developing at elevated CO<sub>2</sub> levels, i.e. acidic oceanic pHs, results in increased mortality in the high CO<sub>2</sub> treatment (970 ppm) compared to the control group in both purple and red sea urchins. Our results show that larval development under elevated CO<sub>2</sub> may come at a physiological performance cost, in this case a reduction in thermal tolerance. We are currently using a DNA oligonucleotide microarray to identify changes in gene expression in sea urchins faced with multiple stressors. These results suggest that our ability to make predictions about the effects of global change on sea urchin physiological performance is linked to understanding the interactions between multiple environmental variables.

† **Fejtek, S.M.<sup>1\*</sup>, Edwards, M.S.<sup>1</sup>, and Kim, K.<sup>2</sup>** <sup>1</sup> - Department of Biology, San Diego State University, San Diego, California, USA <sup>2</sup> - Department of Oceanography, Chonnam National University, Gwangju, Korea  
THE EFFECTS OF IRRADIANCE IN DETERMINING THE VERTICAL DISTRIBUTION OF ELK KELP, *PELAGOPHYCUS PORRA*

The Elk Kelp, *Pelagophycus porra*, is commonly observed in deep (20-30m) water on the outer edge of Giant Kelp, *Macrocystis pyrifera*, forests in southern California and northern Baja California, MEX, but rarely occurs in shallower water within the giant kelp beds. *Pelagophycus* exhibits a heteromorphic life history, alternating between a macroscopic sporophyte and a microscopic gametophyte. Consideration of both life history stages allowed us to study the apparent inability of *Pelagophycus* to encroach into the more abundant Giant Kelp beds along the southern California coast. Transplanting juveniles inshore revealed that the onset of reproductive maturity occurred sooner at shallower depths with no depression in growth. Experimental removal of *Macrocystis* and the addition of *Pelagophycus* reproductive spores using sori-filled mesh bags resulted in no recruitment of *Pelagophycus* within the Giant Kelp beds. A methodological control within the *Pelagophycus* beds showed a significant increase in *Pelagophycus* recruitment within 1-2m from sori bags as compared to natural recruitment within the site. Additionally, laboratory culture experiments were carried out to investigate the effects of increasing light levels on the microscopic life history stages of *Pelagophycus*. Both embryonic sporophyte and gametophyte exhibited 100% mortality when moved to higher levels equivalent to those found within the *Macrocystis* beds. Sensitivity of *Pelagophycus* microscopic stages was also observed when grown constantly at higher light levels. This light sensitivity of the microscopic stages is likely the major factor inhibiting *Pelagophycus* from permanently establishing within the *Macrocystis* beds.

**Fields, A.T.<sup>\*</sup>, and R.R. Wilson, Jr.** California State University at Long Beach – DOES GENETIC DIVERSITY VARY WITH LATITUDE IN A MID-SHELF FLATFISH (*CITHARICHTHYS SORDIDUS*) OF THE EASTERN NORTH PACIFIC OCEAN?

Glacial retreat during the Pleistocene revealed newly-usable habitats, allowing species colonization via founder events. This colonization is thought to be responsible for an evident loss in haplotype and nucleotide diversities in some terrestrial and estuarine species with increasing latitude. With the mid-shelf zone near shore along the Pacific coast of North America, due to a narrow and steep continental shelf, we looked to see if the loss of genetic diversity with increasing latitude extended to fish species inhabiting the mid-shelf zone--the Pacific sanddab (*Citharichthys sordidus*). By comparing mtDNA control region sequences of 550 bp from sanddabs sampled near Santa Barbara Island (SBI), off the Palos Verde Peninsula (PVP), and in the Strait of Juan de Fuca (JdF) we found a haplotype (= gene) diversity of 1.0 within each population with little difference in nucleotide diversities, but with JdF the least. The number of variable sites was also least in the JdF sample as was the average number of pair-wise differences. For further analysis we concentrated on transversion differences. The TS/TV ratios were SBI = 1.8; PVP = 2.4; JdF = 3.0. Nucleotide diversity remained least in the JdF sample. The most transversion differences within a sample occurred at PVP while the least were at JdF (3.54 vs 2.31). The high variances about the averages prevent fully conclusive statements on genetic diversities; however,  $D_{\infty}ST$  analysis found JdF

sanddabs significantly different from the California samples. We suspect this is likely due to current effects than directly to post-glaciation colonization.

† **Fink, L. A. \***, and **S. L. Manley** *California State University Long Beach* METAL POLLUTION REFLECTED IN KELP SAP: A NEW TOOL TO ASSESS THE HEALTH OF THE KELP FOREST ECOSYSTEM

Using sentinel species as biomonitors can indicate the potential effects urban runoff and its associated toxins have on coastal ecosystems. In southern California, current methods to indicate the sources and movement of pollutants, and their subsequent accumulation into ecological food webs are generally lacking. In this study, we hypothesized that kelp sieve tube sap (STS) could be used as a biomonitor for metal pollution. Giant Kelp (*Macrocystis pyrifera*) sequesters trace metals into STS from its surrounding environment often magnifying the concentration present in ambient seawater. We extracted STS from *M. pyrifera* fronds collected monthly for one year from 10 coastal southern California locations, including 2 presumed “non-polluted” reference sites off Catalina Island. Using ICP-MS methodology, STS concentrations of 17 different metals were measured. For most pollutant-associated metals (Al, Mn, Zn, Cu, Sr, Pb), the highest STS values and most seasonal variation were measured from populations inside the Port of Los Angeles/ Long Beach. Lowest metal values (and least seasonal variation) were measured at less-impacted areas: Catalina Island and Malibu. For some metals (Zn, Sr, Mn, Ni, and Pb), we found a spatial gradient in metal concentration with increasing distance from the Port, suggesting that kelp STS could be used to show the spatial extent of urban impact on the coastal ecosystem. Our results suggest that this innovative method may 1) be useful in describing metal pollution and 2) provide opportunities to further consider the ecological effects of such contaminants accumulating within this habitat-forming species.

**Fletcher, A. \***, **Bingham, B.L.**, **Muller-Parker, G.**, and **L. Francis** *Western Washington University* DOES ALGAL SYMBIONT COMPLEMENT AFFECT GONAD DEVELOPMENT IN *ANTHOPLEURA ELEGANTISSIMA*?

Endosymbiotic algae may be nutritionally beneficial to the sea anemone *Anthopleura elegantissima*, which hosts two types of algae in different phyla: zooxanthellae (*Symbiodinium muscatinei*, P. Dinophyta) and zoochlorellae (green algae in the Phylum Chlorophyta, Class Trebouxiophyceae) in the Pacific Northwest. Research on these anemones has shown that zoochlorellate individuals may receive less nutrition (photosynthetic carbon) from their symbionts than do zooxanthellate anemones. Since nutrition may influence host reproduction, we hypothesized that hosting a particular symbiont may affect gonad development and reproductive fitness of this intertidal species. To test this, a field study of *A. elegantissima* at Cattle Point, San Juan Island, WA, involved collection of anemones during the summer when anemones were reproductively mature. Symbiont density, biomass, and gonad development were assessed. Anemone biomass, tide height and clone position (on the edge of a clone versus in the center) each affected gonad size. Symbiont density was not associated with gonad size. However, a multi-dimensional scaling (MDS) analysis suggested that the density of zoochlorellae in a host influences gonad condition, with higher densities of zoochlorellae associated with lower reproductive maturity of the host. These results support the suggestion that zooxanthellae are “better” symbionts for this intertidal anemone in terms of reproductive outcome.

**Focht, R.C. <sup>1\*</sup>** and **A.J. Brooks<sup>2</sup>** <sup>1 - Northeastern University</sup> <sup>2 - University of California Santa Barbara</sup> RESIDENT FISHES INFLUENCE THE RECRUITMENT SUCCESS OF NEWLY SETTLED INDIVIDUALS IN TWO SPECIES OF DAMSELFISHES

In coral reef systems, resident species have been shown to exert strong positive and negative effects on newly arriving individuals. Observational data revealed that reefs in Moorea, French Polynesia contained large numbers of either *Dascyllus flavicaudus* or *Chromis viridis*, but rarely contained a mixture of the

two species. This pattern could result from two general mechanisms affecting either the settlement or survivorship rates of newly arriving individuals. Facilitation or inhibition by resident fishes could positively or negatively affect survivorship rates of newly arriving recruits in a species specific manner. To experimentally assess the potential consequences of settlement facilitation/inhibition and/or differing survivorship rates on the recruitment success of newly settled individuals, I conducted a manipulative field study. I first removed all fish from 18 replicate experimental reefs and then established three treatments by re-introducing resident *D. flavicaudus* alone, resident *C. viridis* alone, or leaving reefs unoccupied with no residents as a control. I then monitored recruitment over 65 days and found that significantly more *D. flavicaudus* and *C. viridis* individuals successfully recruited to reefs containing resident conspecifics. This effect does not appear to be due to increased numbers of *D. flavicaudus* and *C. viridis* larvae reaching these corals since the same number of individuals settling across all three treatments was roughly equal, but rather that the presence of resident conspecifics influences where larvae settle and the survivorship of those individuals.

† **Fong, L.S.**\*, and **C.D. Robles** *California State University, Los Angeles* EXPERIMENTAL CONFIRMATION OF FACILITATIVE INTERACTIONS OF CALIFORNIA MUSSELS (*MYTILUS CALIFORNIANUS*) ON ROCKY SHORES, BARKLEY SOUND, BRITISH COLUMBIA

Increases in survival or recruitment that result from aggregated distributions constitute one type of facilitative interaction. Previous studies found that sea stars (*Pisaster ochraceous*) preferentially consume small rather than large mussels (*Mytilus californianus*). Small mussels (juveniles and small adults) nested in dense, protective aggregations of large mussels are more likely to survive browsing by sea stars than exposed small mussels. Surveys of mussel bed layering indicated that a veneer of large adults protects juveniles from browsing sea stars. The strength of this effect depends on the intensity of predation (e.g. shore level differences in sea star access). Experimental manipulation of sea star densities established high, low, and ambient levels of predation. We recovered marked juveniles less frequently from plots with the veneer removed than from plots with it intact. ANOVA confirmed that the protective effect of the veneer depends on the intensity of predator pressure. Our empirical evidence supports recent theory that facilitative interactions are among the mechanisms that propagate and maintain mussel beds, structural foundations which facilitate other intertidal species.

**Frid, A.**\*, and **J Marliave** *Vancouver Aquarium* APPLYING PREDATION RISK THEORY TO THE RECOVERY OF DEPLETED POPULATIONS OF ROCKFISH AND LINGCOD

Our objective is to understand why, from the perspective of trade-offs between finding food and avoiding predation, some habitats are superior to others for the survival and growth of juvenile quillback rockfish (*Sebastes maliger*) in Howe Sound, British Columbia. Preliminary analyses of our SCUBA-based data support the prediction that the relative abundance and activity levels of juvenile quillback rockfish respond, at small spatio-temporal scales, to synergistic interactions between the relative abundance of lingcod (a potential predator), the availability of refuge structures, and the abundance of demersal shrimps known to be major prey items. For instance, the relative abundance and activity levels of juvenile quillback rockfish are highest when demersal shrimps are most abundant, but the strength of this relationship depends on intrinsic risk within a habitat (a function combining refuge availability and the probability of encountering a predatory lingcod); the relationship is strong when intrinsic risk is low, but weakens as intrinsic risk rises. Our research could provide a functional understanding of essential habitat for rockfish, thereby improving policies on habitat restoration and the zoning of rockfish conservation areas. Further, when analyzed in the context of other variables, the activity levels of juvenile rockfish may prove to be a behavioural indicator of other aspects of ecosystem health, including the state of lingcod populations.

† **Gehman, A.M.**\* *Western Washington University, Shannon Point Marine Center* MATERNAL DIET AND JUVENILE QUALITY IN THE SEA STAR

Nutritional provisioning that passes from a mother to her offspring can produce maternal carryover effects. Manipulating the amount of food available to a maternal organism is one way to manipulate maternal investment ability, and thereby test maternal carryover. I collected brooding adult *Leptasterias aequalis* from three beaches with varying prey communities in the northern Puget Sound. When broods were released, I measured size and survival of the juveniles under starvation conditions. I then assigned the maternal sea stars to different feeding treatments and controlled their diets for a full year until they spawned again. I measured size and growth of juveniles released from these second broods. Juvenile *L. aequalis* from the initial broods showed surprising resistance to starvation, with 80% survival after 6 months and some living a full year without food. Juvenile survival over time varied significantly among the beaches, although I did not find a significant difference in time of juvenile death. Juvenile size also varied significantly among mothers from the three study beaches, even when differences in female size by beach were accounted for. Maternal feeding treatments had no effect on the size of juveniles in the second brood; instead, juvenile sizes mirrored those seen in the first year, regardless of feeding treatment. Collection location had a stronger effect on juvenile quality than a year of diet treatment. When looking at multiple generations of carryover in *L. aequalis*, it seems that genetics have a greater effect on juvenile quality than maternal diet.

† **Geierman, Christina\***, and **Richard B. Emlet** *Oregon Institute of Marine Biology* TRENDS IN FEEDING OF THE ACORN BARNACLE *BALANUS GLANDULA* OVER GROWTH

The acorn barnacle *Balanus glandula* can increase its aperture diameter by a factor of twenty as it grows from a recruit to an adult. This study examines how the cirral morphology, feeding behavior at a low current speed, and leakiness of the cirri as calculated by a geometric model differ between three size classes. Barnacles (n=10 per size class) were taped while feeding in a flow tank at a current speed of 4cm/s. Molts were collected and several morphometric and meristic traits were measured. Newly-settled juveniles fed at Reynolds numbers less than one at all locations in their cirral fan. They were the only size class of *B. glandula* observed to passively feed and less than 1% of the water encountered by the cirral fan passed in between their cirri. The leakiness of the cirral fan was low for all size classes, indicating that the cirri of this species work more like paddles than rakes or nets.

† **Goldenheim, W.M.\***, and **P.J. Edmunds** *California State University, Northridge* VARIABILITY IN THE EFFECTS OF TEMPERATURE AND FLOW ON THE GROWTH AND PHOTOPHYSIOLOGY OF A REEF BUILDING CORAL IN MOOREA, FRENCH POLYNESIA

Water motion has wide-ranging effects on scleractinians, particularly during thermal bleaching when increased flow may aid in resistance to high temperature. Increased flow removes photosynthetically-derived oxygen radicals, causing greater efficiency of PSII and conferring resistance to bleaching. However, enhanced flow can have both positive and negative effects on coral photophysiology (light-adapted yield, QY); modest increases benefit QY, while larger increases can have detrimental effects, suggesting that there is a threshold effect in QY along a flow continuum. To reconcile these opposing trends, we first compared the growth of juvenile *Porites* sp. among flow microenvironments to determine whether flow affects growth with a comparable threshold effect, reasoning that this might reflect a fitness consequence of similar influence on QY. Second, with juvenile *Porites* sp., we used a flume to test the hypothesis that an interaction between flow and temperature could explain the contrasting effects of flow on QY. Growth of *Porites* sp. in a lagoon environment responded with the anticipated threshold effect. In the flume, QY at ambient temperature (28.3°C) displayed a threshold effect with a maximum at 23 cm/s, but this effect was absent at high temperature (31.1°C) where QY increased linearly with flow to 43 cm/s. Our results indicate the potential for threshold effects of flow on growth of *Porites* sp. in the field, and demonstrate a threshold effect of flow on photophysiology at ambient temperature in the flume. Thus, our results may provide a means to reconcile previous inconsistencies in the effect of flow on corals.



† **Gooding, R. A.\* , Tang, E., and C.D.G. Harley** *University of British Columbia* MULTIPLE CLIMATE VARIABLES INCREASE THE GROWTH OF A KEYSTONE PREDATOR, THE SEASTAR *PISASTER OCHRACEUS*

Multiple climate variables, including temperature and [CO<sub>2</sub>], will change simultaneously with anthropogenic climate change. The combined effects of these variables on marine organisms are poorly understood, especially the effects of ocean acidification on ecologically important species whose growth is not dependent on heavily calcified shells or skeletons. We manipulated water temperature and [CO<sub>2</sub>] to determine the effects on the seastar *Pisaster ochraceus*, a keystone species. We found that seastar growth and feeding rates increased linearly with water temperature across a wide range of temperatures from 5 – 21°C. A doubling of current [CO<sub>2</sub>] also increased growth rates both with and without a concurrent temperature increase; however, [CO<sub>2</sub>] had no effect on seastar feeding rates, suggesting it may be acting directly at the physiological level to increase growth rates. *P. ochraceus*' positive growth response to elevated [CO<sub>2</sub>] was in contrast to previous studies on more heavily calcified species. However, as in past studies, increased temperature and [CO<sub>2</sub>] reduced the proportion of calcified mass in seastars. The predominantly positive effects of temperature and [CO<sub>2</sub>] on *P. ochraceus* will likely result in changing patterns of diversity on rocky shores due to changes in keystone predation. On a broader scale, our findings show that increased [CO<sub>2</sub>] will not always have negative biological effects on marine organisms, suggesting that predictions of community responses to climate change should consider how different types of organisms will respond to changing climatic variables.

**Graham, M.H.<sup>1\*</sup>, Kinlan, B.P.<sup>2</sup>, and L.D. Druehl<sup>3</sup>** *1 - Moss Landing Marine Labs 2 - University of California Santa Barbara 3 - Bamfield Marine Sciences Centre* ECOLOGY OF KELP FORESTS IN DEEP TROPICAL WATERS

Kelp forests are some of the most diverse, productive, and dynamic ecosystems on this planet, yet most ecologists consider kelp-based systems inherently temperate-boreal phenomena. Kelp forests can dominate eutrophic coastal waters of temperate-boreal regions, due to the presence of high nutrient, low temperature waters. However, we have recently completed a study that refutes the hypothesis that tropical and sub-tropical waters are incapable of supporting kelp-based systems. We used a Geographic Information System (GIS) to predict coastal regions between 30°N and 30°S in which enough light and nutrients are available at the sea floor to support kelp photosynthesis and growth. The results indicated extensive kelp-inhabitable regions throughout the tropics, down to depths exceeding 150 meters. Such regions were ubiquitous along the west coasts of Central America and North-Central Africa, the Philippine and Mediterranean Seas, and the coasts of Brazil and the Arabian Peninsula, totaling tens of 1000's of square kilometers of potential kelp habitat. We recently completed an exploration of the Galapagos Archipelago, predicted to be inhabitable by deep kelps, in which we found extensive new forests of *Eisenia galapagensis*, with associated kelp forest organisms. We suggest that extensive kelp populations likely exist in deep tropical waters worldwide and may provide hotspots of habitat and energy provision in otherwise oligotrophic systems.

**Grant, N. E.\*** *Moss Landing Marine Lab* USE OF EELGRASS (*ZOSTERA MARINA*) BY FISHES AND INVERTEBRATES IN ELKHORN SLOUGH, CA

Seagrasses provide an array of ecosystem services to the marine community. They are able to alter flow conditions within and around beds due to physical morphology of the plant itself, and influence the ecology of the surrounding community by acting as habitat. The goal of this study is to begin to determine the role of the seagrass *Zostera* in habitat provisioning in Elkhorn Slough, CA. The hypotheses investigated within this presentation are: (a) does the presence and abundance of fish and invertebrate species change seasonally; and, (b) does it differ from the non-seagrass habitats. Presence and abundance of fishes and invertebrates were measured using a 1-m<sup>3</sup> throw trap in *Zostera*, algal habitat (predominantly *Ulva sp.*) and unvegetated bare substrate. Sampling is being conducted over 1 year with

the three sampling seasons (winter/spring, summer and fall) defined according to the oceanographic conditions in Elkhorn Slough. Patterns emerging from data collected thus far indicate multiple potential habitat functions for *Zostera*. Species presence and abundance changed seasonally from winter/spring to summer, as did algal habitat availability. Trends in both size and abundance of particular fish species suggest *Zostera* beds specifically provide nursery habitat within the estuary. Future directions include assessing the importance of fish prey availability within *Zostera* by determining the correlation between fish densities and the density of their corresponding potential invertebrate prey species, and a mapping study is being used to describe long-term temporal changes in the availability of *Zostera* as a habitat in Elkhorn Slough.

† **Green, D.H.** \*, and **P.J. Edmunds** *California State University, Northridge* SUBSTRATUM EFFECTS ON THE EARLY POST-SETTLEMENT SUCCESS OF JUVENILE CORALS ON SHALLOW FRINGING REEFS IN ST. JOHN, US VIRGIN ISLANDS

Studies of the influence of temperature on scleractinians have increased over the past decade, yet few have documented the effects on post-settlement success. This study focused on the shallow reefs (5 m depth) of St. John, where anecdotal observations of juvenile corals on igneous and carbonate rock prompted a test of the hypothesis that their physiological performance varied between rock substrata due to differences in temperature. To measure temperature, a logger with external probes was installed on the reef for one year, with one probe inserted into each rock type, and a third suspended in the seawater. To test for variation in coral performance between rock substrata, the growth and mortality of juvenile corals (< 40 mm) were assessed by tagging and measuring colonies, and for *Porites astreoides*, photophysiology was compared using the quantum yield of PSII and electron transport rate (ETR) as a function of irradiance. During the warmest part of the day, igneous rock was up to 0.5 °C warmer than carbonate rock, and it retained this heat for longer periods in the late afternoon. Juvenile corals that settled on igneous rock were physiologically limited compared to those on carbonate rock, with growth depressed by ≈50% for much of the year, and a maximum ETR reduced by ≈70%; these effects did not, however, lead to differences in mortality. The results of this study suggest that substratum composition (i.e., rock type) can alter the early post-settlement success of juvenile corals in shallow water due to differences in substratum temperature.

† **Green, S.J.** \*, and **I.M. Côté** *Department of Biological Sciences, Simon Fraser University* PREDICTING THE IMPACT OF INVASIVE LIONFISH (*PTEROIS VOLITANS* AND *P. MILES*) ON NATIVE REEF FISH POPULATIONS IN THE CARIBBEAN

Indo-Pacific lionfish (*Pterois volitans* and *P. miles*) have recently invaded and rapidly spread throughout temperate and tropical Western Atlantic habitats. Lionfish use an ambush strategy to consume whole prey fish and have few predators in their introduced range.

To understand the impacts of lionfish on native fish communities in the Bahamas and to predict their impacts on the wider Caribbean, the prey and habitat preferences of lionfish on reefs along the southwest coast of New Providence, Bahamas, were studied. Prey-sized fish density, diversity and size distribution, reef complexity and topography, and lionfish density and habitat preference data were collected from 14 sites varying in habitat types, depths and lionfish densities. From January 2007 to July 2008, 500 lionfish (TL = 50 - 424 mm) were collected from these sites. Stomach content analysis revealed that lionfish prey heavily on many species and size classes of native reef fish. Comparisons of diet to prey availability suggest preferential predation on species with behavioural characteristics and morphologies that increase encounter rate and ease of capture. Furthermore, compared to total available biomass, lionfish consume a considerable amount of prey biomass from the reef. Finally, lionfish density was positively correlated with both reef complexity and relief, and prey-sized fish density. Results indicate that lionfish have the ability to significantly impact native reef fish communities. These findings can be used in conjunction with fish community and habitat profiles from elsewhere in the Caribbean to predict the impact of lionfish as they continue to spread throughout the region.

† **Grey, E.K.** \* *Department of Ecology & Evolution, University of Chicago* ENVIRONMENT HAS A LARGER EFFECT THAN INTERFERENCE COMPETITION ON THE POPULATION GROWTH RATE OF THE EXOTIC ASCIDIAN, *BOTRYLLOIDES VIOLACEUS*, IN WASHINGTON, USA

To effectively manage marine exotic species we must understand how different factors influence their population growth. I used Life Table Response Experiments to tease apart the effects of environment and interference competition on the population growth of a ubiquitous exotic ascidian, *Botrylloides violaceus*, at four sites in coastal Washington. For two years I tracked colonies in 4 different environments in two competition treatments: colony perimeter in contact with a competitor or not in contact with a competitor. For each treatment I estimated growth rate, survival rate and fecundity and then used a matrix model to calculate the population growth rate. I found that environment explained more of the variation in population growth rate than did competition, and that populations grew faster at sites with warmer temperatures because of increased growth and survival rates. Competition decreased the survival of colonies but, unexpectedly, increased their growth rate thereby resulting in an overall small and variable effect of interference competition on population growth. These results highlight the need to consider how different factors influence overall population growth of exotic species and suggest that environmental factors, especially temperature, determine the success of exotic ascidians in non-native ranges.

† **Hall, K., Patrick, J. W. A. \***, and **K. Romanin** *Authors* KILLERS IN THE SURF: A LOOK AT THE VORACIOUS FEEDING BEHAVIOR OF THE ANKLE BITING ISOPODS OF PACHENA BEACH

In an effort to expand on the little knowledge of the cirrolanid scavenging isopod *Excirrolana vancouverensis* our study analyses their foraging abilities by manipulating prey concentration cues and measuring consumption rates. The strength of response to ice cubes containing fractional dilutions of prey cues followed an overall trend of decreasing response, quantified as numbers caught, with decreasing dilution concentration. Consumption rate measurements made in the field exhibit the feeding capabilities of swarms occurring in their natural feeding environment. An average of 262.2 mg of *Mytilus edulis* flesh was consumed per minute in these trials. Lab measurements yielded individual consumption rates, from which we calculated that *E. vancouverensis* are capable of consuming an average of 6.6 mg of *M. edulis* flesh per minute. With an average body weight of 12.8 mg per individual, our average estimated rates of consumption imply that *E. vancouverensis* is able to consume a staggering 52% of their body weight within one minute of feeding. Isopod distribution in the absence of a stimulus was tested in order to determine how much counts were being influenced by isopods already present in the sand. Four samples taken along a 10 meter transect through the beach surf wash zone yielded the highest average capture counts in the actual incoming wave. Manipulations of prey concentration cues, measurements of consumption rates as well as results from our attempts to produce a wave table that would effectively mimic and function as the cirrolanids' natural environment suggest that these crustaceans are highly adapted to their environment and survival strategy. Rapid consumption rates, large stomachs, and evidence to support the use of chemoreception method of food detection are among a few attributes that these organisms must possess in order to be the highly successful scavengers that they appear to be.

**Hamilton, S.L.<sup>1\*</sup>, Caselle, J.E.<sup>1</sup>, Egloff, T.<sup>1</sup>, Kondo, E.<sup>1</sup>, Loke, K.<sup>2</sup>, and C. Lowe<sup>2</sup>** *1 - University of California Santa Barbara 2 - California State University Long Beach* SPATIAL DIFFERENCES IN THE TROPHIC ECOLOGY AND LIFE HISTORIES OF CALIFORNIA SHEEPHEAD HAVE FISHERIES MANAGEMENT IMPLICATIONS

Most fisheries stock assessments assume spatial invariance in key life history traits, such as growth and maturation rates. One potential problem of managing fisheries using those methods is that fixed size limits across a species' range may lead to overexploitation of populations that mature at sizes larger than the limit. The sex-changing California sheephead (*Semicossyphus pulcher*) are important benthic carnivores in southern Californian kelp forests and they are targeted by recreational and commercial

fisherman. Sheephead from different populations show dramatic differences in growth rates, the timing of maturation and sex change, and reproductive output. Spatial differences in life histories may be partially explained by the striking differences in trophic ecology observed among populations (reflected in gut contents and stable isotopes) as well as exploitation history. Fisheries management may be improved by incorporating spatial variation into stock assessments and considering more localized regulations.

† **Hammond, L.M.\***, and **G.E. Hofmann** *UC Santa Barbara* IMPLICATIONS OF OCEAN ACIDIFICATION ON BIOMINERALIZATION GENE EXPRESSION AND SPICULE FORMATION IN *STRONGYLOCENTROTUS PURPURATUS* EMBRYOS AND LARVAE

Carbon dioxide sequestration into the ocean plays an important role in calcium carbonate ( $\text{CaCO}_3$ ) uptake by marine calcifiers. One group of marine calcifiers is sea urchins, whose larvae take up  $\text{CaCO}_3$  to form spicules through the process of biomineralization. The seemingly beneficial increase in oceanic  $\text{CO}_2$  is in fact unfavorable for these larvae as the carbonate chemistry results in a decrease in  $\text{CaCO}_3$ . While this has the potential to affect the larval skeleton throughout development, a critical time in the biomineralization process occurs when the spicule first forms. Investigating how key biomineralization genes are regulated during this time in early development will help elucidate how larval spicules are affected by increases in  $\text{CO}_2$  due to climate change. For this experiment *Strongylocentrotus purpuratus* embryos were reared in filtered seawater at  $\text{CO}_2$  concentrations of 380 ppm (the current oceanic  $\text{CO}_2$  concentration), 550 ppm, and 990 ppm (two potential future scenarios predicted by the IPCC). Embryos were sampled at 4 developmental points between blastula and early prism stage, all of which occur early in the biomineralization process. Total RNA was extracted for subsequent transcript analysis via quantitative PCR to determine the expression patterns of the following biomineralization genes: *SM30-b*, *SM50*, *CA* (carbonic anhydrase) and *Col-P 3a* (collagen). The results of this study will help elucidate how the *S. purpuratus* biomineralization process will be affected by  $\text{CO}_2$  in early development and, more broadly, how such larvae are likely to respond to future increases in ocean acidification.

**Harley, C.D.G.\***, **Lee, K.**, **Tang, E.**, and **T. Healy** *University of British Columbia* THE POTENTIAL IMPACTS OF CLIMATE-DRIVEN SALINITY CHANGE ON COMMUNITY STRUCTURE IN THE STRAIT OF GEORGIA

Many climate-related studies in nearshore marine environments focus on the effects of temperature and pH. In semi-enclosed basins such as the Strait of Georgia in British Columbia, climatically forced changes in precipitation and snow-melt can lead to important temporal trends in salinity as well. In the Strait of Georgia, low salinities associated with Fraser River outflow reduce the abundance, feeding rate, and survival of the sea star *Pisaster ochraceus*, but do not impact the performance of the mussel *Mytilus trossulus*. As a result, extensive mussel beds are found in areas impacted by the Fraser plume, while *Pisaster* predation prevents the formation of such beds at higher salinity sites in areas not impacted by the Fraser plume. However, the magnitude of Fraser River outflow is impacted by climate change; the peak flow has been decreasing since 1950, and salinity in the Strait has been rising. Climate models project that this trend will continue over the course of the twenty-first century. We predict that *Pisaster* predation will increase in response to increasing salinities, and that mussel bed habitat will be reduced through time. The limited available evidence suggests that this may already be occurring in the Strait of Georgia.

† **Harrison, L.R.\***, and **I.M. Cote** *Department of Biological Sciences, Simon Fraser University* ECOLOGICAL EFFECTS OF POLLUTION ON LAGOONAL CORAL REEFS

Many coral reefs are becoming degraded as a result of sewage pollution. Reefs in lagoons may be particularly vulnerable because of limited water circulation. Impacts can either be by direct exposure (sewage-derived reduction of water quality on benthic organisms and fish), or by indirect effects (impacts on benthic habitats, and consequently fish). Using a multivariate statistical approach I determined (1) the water quality correlates of differences in benthic community composition and (2) the relationship between

fish community composition, water quality and benthic components on reefs in Tanapag Lagoon, Saipan. Salinity and dissolved oxygen explained most variation in benthic community composition, and benthic components in turn constituted most of the top model in explaining differences in fish community composition. Management of water quality remains essential in lagoonal systems because of its potential to reduce reef resilience.

**Hart, A.<sup>1\*</sup>, Britton-Simmons, K.H.<sup>1</sup>, and K.L. Van Alstyne<sup>2</sup>** <sup>1</sup> - University of Washington <sup>2</sup> - Western Washington University  
CHEMICAL AND MORPHOLOGICAL RESPONSES OF AN INTERTIDAL ROCKWEED TO WATERBORNE CUES FROM A LITTORINE SNAIL

The intertidal rockweed *Fucus distichus* responds chemically and morphologically to mechanical damage from herbivores. Recent evidence suggests that a related species, *Ascophyllum nodosum*, responds chemically to waterborne cues that indicate the presence of herbivores. To determine if waterborne cues from herbivores induce morphological or chemical responses in *F. distichus* we grew juvenile *F. distichus* in outdoor mesocosms for 70 days from August to October in the presence of waterborne cues from: 1) the snail *Littorina sitkana* feeding on adult *F. distichus* (experimental treatment), or 2) adult *F. distichus* (control). We compared these treatments in terms of morphology, growth, tissue carbon and nitrogen, phlorotannin levels, and palatability to *L. sitkana*. There was no significant difference between treatments in morphology, growth, tissue carbon or phlorotannin levels, suggesting that juvenile *F. distichus* either cannot detect or do not respond to waterborne cues from *L. sitkana*. However, tissue from the experimental treatment was significantly preferred by *L. sitkana* in a choice feeding trial and consumption was positively related to tissue nitrogen levels. This suggests that waterborne cues from *L. sitkana* do not induce a defense response in juvenile *F. distichus* but *L. sitkana* can detect small differences in *F. distichus* tissue nitrogen levels. Results suggest the possibility of a feedback loop in which utilization of snail metabolic wastes by *F. distichus* influences subsequent feeding preferences.

† **Haupt, AJ\*, Micheli, F, and SR Palumbi** Hopkins Marine Station USING MOLECULAR MARKERS TO ASSESS CONNECTIVITY OF A COMMERCIALY IMPORTANT MARINE INVERTEBRATE.

Understanding dispersal of marine organisms is critical to managing commercially important species at appropriate scales. The wavy top snail, *Megastraea undosa*, is fished commercially in both California and Baja California, Mexico. However, little is known about the status of the fishery or the existence of independent stocks. In order to assess the number of stocks and connectivity among them, over 600 samples were collected throughout the range of the species (Santa Barbara, CA to Punta Abreojos, Mexico) at 15 sites. Samples were amplified at the COI mtDNA locus and analyzed for genetic structure. Genetic structure throughout the range of this species is striking, with global *F<sub>st</sub>* values up to 29% which may be expected given the short pelagic larval duration of five to ten days. These results may have implications for management of this species especially in the areas of Southern Baja California at the southern range limit. These populations, which are heavily fished by Mexican fishing cooperatives, appear to be more isolated from the northern range of the species.

**Heinlein, J.M.\* , Stier, A.C., and M.A. Steele** Northeastern University PREDATORS REDUCE RECRUITMENT OF CORAL REEF FISHES IN MOOREA, FRENCH POLYNESIA

Predation plays an important role in structuring coral reef fish communities and can have particularly strong impacts on the abundance of new recruits (i.e., new settlers). Here, we experimentally examined the effect of predation on recruitment of fishes in the lagoon of Cook's Bay, Moorea, French Polynesia. We constructed 21 reefs, each composed of a translocated *Pocillipora verrucosa* colony fixed to a concrete block. Using enclosure cages to manipulate predator accessibility, each reef was randomly assigned to one of three treatments: fully caged (- predators), uncaged (+ predators) and partially caged (cage control), each with seven replicates. We conducted weekly surveys of recruit species and abundance on each reef and counted piscivores within 1m of each reef and along a 1 x 100 m transect. We found no

evidence of cage artifacts. After 52 days, overall recruit abundance was 48.3% lower on partially caged and uncaged reefs compared to caged ones, with strong reductions to both damselfishes (Pomacentridae) and triggerfishes (Balistidae). Species richness of recruits was highest in the absence of predators but was not statistically different than reefs exposed to predators. Differential impacts of predators on certain species of reef fishes suggest predators may affect community structure by selective foraging. The results of our study provide further evidence that predation has a strong impact on the structure of coral reef fish communities.

**Henzler, C.M.\* , Hoaglund, E.A., and S.D. Gaines** *UC Santa Barbara* SHINING A LIGHT ON MARINE LARVAE: A NEW METHOD FOR RAPID PLANKTON SORTING

Pelagic larvae play a key role in the life history of marine invertebrates, but are notoriously hard to study in the field. Due to their small size and low densities, larvae must be concentrated by plankton tows or traps, then laboriously sorted and identified in order to investigate even basic questions about larval abundance, diversity and distribution in the water column. Additionally, larvae of closely related species are often very similar, and difficult or impossible to distinguish morphologically. PCR-based genetic techniques can be used to differentiate morphologically similar species, but, while effective, these methods add additional time to an already slow process. Another technique, fluorescence in situ hybridization (FISH), has proven successful as an alternative method for fast identification of marine plankton to species, genus or family level groups. We demonstrate a novel adaptation of FISH in conjunction with sorting by a large-particle cell sorter to quickly identify several species and genera of marine invertebrate larvae. Currently, we have had success identifying and counting urchin and mussel larvae, and sorting them by type for further analyses. The method can be easily extended to other taxa, as well. We demonstrate the potential of this method for decreasing the amount of time required for plankton sample sorting and identification, and for processing larvae for downstream applications, including genetic analyses of individual larvae.

† **Hessing-Lewis, M.L.<sup>1\*</sup>, Hacker, S.<sup>1</sup>, Rumrill, S.<sup>2</sup>, and B. Menge<sup>1</sup>** *1 - Oregon State University 2 - South Slough Estuarine Research Reserve* SEAGRASS-MACROALGAE INTERACTIONS UNDER A MARINE-DERIVED NUTRIENT CONTEXT

In estuaries worldwide, macroalgae blooms have been found to negatively affect seagrass populations. Seasonal monitoring of eelgrass (*Zostera marina*) and ulvoid macroalgae biomass show that biomass of both producers in Coos Bay, Oregon is similar to other estuaries negatively affected by eutrophication. However, interaction strengths measured via a macroalgae addition/removal experiment conducted in Coos Bay do not show consistently negative results. Instead, interaction strength was found to vary as a function of season and location along an upwelling-influenced estuarine nutrient gradient. These initial results suggest that eelgrass in upwelling-influence estuaries may not be negatively affected by naturally occurring blooms of ulvoid macroalgae. In contrast to field-based experiments, the potential for negative interactions was documented in a mesocosm macroalgae addition experiment. In the tank environment, macroalgae additions led to decreased eelgrass survivorship and changes in sediment chemistry. Differences between field and mesocosm experiments are most likely the result of physical differences between experimental venues. Continued research is necessary in order to assess eelgrass and macroalgae parameters as indicators of estuarine health in upwelling-influenced estuaries. Furthermore, research showing linkages between nearshore oceanography and the dynamics of estuarine communities is important for ecosystem-based coastal management initiatives.

† **Hettinger, A.<sup>1\*</sup>, Hoey, J.<sup>2</sup>, Sanford, E.<sup>1</sup>, Gaylord, B.<sup>1</sup>, Hill, T.M.<sup>3</sup>, and A. Russell<sup>4</sup>** *1 - Department of Evolution and Ecology and Bodega Marine Laboratory, University of California Davis 2 - Department of Integrative Biology, University of California Berkeley 3 - Department of Geology and Bodega Marine Laboratory, University of California Davis 4 - Department of Geology, University of California Davis* OCEAN ACIDIFICATION IMPACTS LARVAL AND JUVENILE GROWTH IN THE NATIVE

## OYSTER *OSTREA LURIDA*.

The impacts of ocean acidification have only recently been recognized as a human-induced stressor on marine ecosystems. Ocean acidification can disrupt calcification in organisms that precipitate calcareous structures, including many ecologically and economically important species. We examined how decreased levels of carbonate saturation affected larval and juvenile growth and settlement in the native oyster *Ostrea lurida*. Larvae were cultured at three carbonate saturation levels that represent present day CO<sub>2</sub> concentrations (380 ppm) and two future projected *p*CO<sub>2</sub> scenarios (540 and 970 ppm). These treatments were maintained for 20 days throughout larval duration until settlement occurred. Larval and juvenile growth were determined by calculating change in shell area. Larvae exposed to 970 ppm grew 12% less than larvae held under control conditions (380 ppm). In addition, growth varied among larvae produced by different parents, suggesting that impacts of ocean acidification might vary intraspecifically. Juvenile growth was significantly different among CO<sub>2</sub> treatments, and juveniles exposed to 970 ppm grew 24% less than juveniles held under control conditions (380 ppm). Carry-over effects from the larval stage influence juvenile growth, and because post-settlement mortality is often high for marine invertebrates, ocean acidification may negatively impact the size of native oyster populations.

† **Hoaglund, EA<sup>1\*</sup>, Henzler, CM<sup>2</sup>, Hofmann, GE<sup>1</sup>, and SD Gaines<sup>2</sup>** 1 - Dept. Ecology, Evolution and Marine Biology, University of California, Santa Barbara 2 - Marine Science Institute, University of California, Santa Barbara ILLUMINATING PATHWAYS: WHAT FLUORESCENT LARVAE CAN TELL US ABOUT THE DISPERSAL OF COASTAL MARINE SPECIES

One of the most obvious factors that can limit a species distribution is a physical barrier to dispersal. Some coastal marine species may be constrained by oceanographic features that restrict larval dispersal, as suggested by theoretical work and indirect experimental and observational data. However, empirical evidence of oceanographic features limiting the movement of marine larvae is rare, due to the difficulty of processing larval samples at the necessary spatial and temporal resolutions. Here we present a novel method to identify and count marine larvae that will facilitate my proposed work evaluating the movement of larvae across potential oceanographic barriers. We use whole-organism fluorescent in situ hybridization (FISH) to label specific species of marine larvae with a fluorescent DNA probe, and larvae are then counted and sorted with a recently developed large-format cell sorter. With this method, we provide a means to accurately identify larvae to species, reduce the amount of time required to count larvae, and sort larvae for further work. We have developed DNA probes to identify a suite of barnacle and mussel species, and show preliminary success counting and sorting mussel larvae. I will discuss our plans to extend this method to additional species, and apply this method to determine the impact of ocean gyres and current convergence systems on the movement of marine larvae.

† **Horwith, M.H.<sup>\*</sup>, and J.L. Ruesink** University of Washington LOCAL EFFECTS OF GEODUCK (*PANOPEA ABRUPTA*) AQUACULTURE ON A MEADOW OF INTERTIDAL EELGRASS (*ZOSTERA MARINA*)

Geoduck (*Panopea abrupta*) clams constitute a lucrative fishery in Washington State and British Columbia, but the ecological consequences of geoduck aquaculture remain unknown. In cooperation with farmers from Taylor Shellfish, we selected an atypical intertidal bar where planted geoducks exist within and beside eelgrass (*Zostera marina*), a habitat-forming species important to coastal ecosystems. Over the summer of 2008, we surveyed the bar before and after harvest, outside and inside the area planted with geoducks, to determine the local effects of harvest. We found that rates of seasonal increase and decline in eelgrass density differ between the harvested and unharvested area, as do rates of flowering in eelgrass. The harvested and unharvested areas also differed in the organic content and silt-to-sand ratio of sediment. We found limited evidence for the impact of harvest on biotic or abiotic characteristics outside of the harvest zone. Further work will determine whether and at what pace eelgrass will recolonize the harvested area, informing the coexistence of geoduck aquaculture and local intertidal ecosystems.

†Johansson, ML<sup>1\*</sup>, Banks, MA<sup>1</sup>, Glunt, KD<sup>2</sup>, Hassel-Finnegan, HM<sup>2</sup>, and VP Buonaccorsi<sup>2</sup>

1 - Coastal Oregon Marine Experiment Station, Hatfield Marine Science Center, Oregon State University  
2 - Department of Biology, Juniata College INFLUENCE OF HABITAT DISCONTINUITY, GEOGRAPHICAL DISTANCE, AND OCEANOGRAPHY ON FINE-SCALE POPULATION GENETIC STRUCTURE OF COPPER ROCKFISH (*SEBASTES CAURINUS*)

The copper rockfish is a benthic, nonmigratory, temperate rocky reef marine species with pelagic larvae and juveniles. A previous range-wide study of the population-genetic structure of copper rockfish revealed a pattern consistent with isolation-by-distance. This could arise from an intrinsically limited dispersal capability in the species or from regularly-spaced extrinsic barriers that restrict gene flow (offshore jets that advect larvae offshore and/or habitat patchiness). Tissue samples were collected along the West Coast of the contiguous USA between Neah Bay, WA and San Diego, CA, with dense sampling along Oregon. At the whole-coast scale (~2200 km), significant population subdivision ( $F_{ST} = 0.0042$ ), and a significant correlation between genetic and geographical distance were observed based on 11 microsatellite DNA loci. Population divergence was also significant among Oregon collections (~450 km,  $F_{ST} = 0.001$ ). Hierarchical AMOVA identified a weak but significant 130-km habitat break as a possible barrier to gene flow within Oregon, across which we estimated that dispersal ( $N_m$ ) is half that of the coast-wide average. However, individual-based Bayesian analyses failed to identify more than a single population along the Oregon coast. In addition, no correlation between pairwise population genetic and geographical distances was detected at this scale. The offshore jet at Cape Blanco was not a significant barrier to gene flow in this species. These findings are consistent with low larval dispersal distances calculated in previous studies on this species, support a mesoscale dispersal model, and highlight the importance of continuity of habitat and adult population size in maintaining gene flow.

**Johnson, D.W.\*** Oregon State University A SMALL FRY'S PERSPECTIVE ON FISHERIES-INDUCED EVOLUTION: THE IMPORTANCE OF LARVAL QUALITY AND POPULATION REPLENISHMENT

Size-selective fishing mortality may cause evolutionary responses in exploited populations. Simple predictions of these responses may be made from estimates of selection and heritability of selected traits. However, if selection acts on multiple traits, evolutionary responses will also depend on the degree to which selected traits are genetically linked. Recent evidence suggests that genetic covariance between adult size and larval size may be strong for some marine fish. Moreover, larval size may be subject to natural selection. These results suggest that a combination of direct and correlated responses to both fishery and natural selection may influence fisheries-induced evolution. To examine these effects, I used quantitative genetic models to predict short-term evolution of both adult size and larval size. Evolutionary responses were predicted both separately and as a combined, multivariate response (i.e., including both direct and correlated responses). Selection on adult size was based on estimates of fishery selection that favored survival of smaller fish, whereas selection on larval size was based on estimates of natural selection that favored survival of larger individuals. Simple predictions of trait responses were dramatically different from the combined, multivariate response; inclusion of correlated responses changed the predicted direction and rate of evolution. Results indicated that selection on larval traits may slow the evolutionary response of adult traits to size-selective fishing. At the same time, observed rates of fishery selection can decrease larval quality and reduce the rate of population replenishment, despite natural selection for larger larval size.

† Jorve, J.P.\* Moss Landing Marine Laboratories, University of British Columbia CASCADING EFFECTS OF *MASTOCARPUS* MORPHOLOGICAL VARIABILITY ON SUB-CANOPY IRRADIANCE AND *LOTTIA* SPP.

Habitat-forming species can ameliorate stressful environmental conditions in the rocky intertidal.



Associations between morphologically variable habitat-forming species and invertebrates have been demonstrated, however, the mechanism linking these associations have not been explored. This study addressed the effect of *Mastocarpus* spp. morphology on sub-canopy microclimate and macroinvertebrates, and the extent to which any effects occurred both within and among sites (from local to latitudinal variability). Replicate 10 cm diameter PVC cores of 100% cover of *Mastocarpus* spp. were sampled at 7 locations within central California over a one year period for dry biomass, frond density, average frond length, and cumulative frond surface area. Irradiance was measured above and below the canopy, and *Lottia* spp. were quantified. Analysis of Covariance indicated that *Mastocarpus* morphological size significantly altered sub-canopy irradiance levels consistently within central California, however *Lottia* spp. distribution was affected by this association differently depending on location. Variability in sub-canopy irradiance decreased as morphological size increased, such that after a median size threshold, sub-canopy irradiance fell to nearly zero. Locational differences in the effect of morphology on microclimate on *Lottia* spp. could be explained by increases in microalgae (food source) at the substrate in high light microclimates, and conversely, decreased physical stress in low light microclimates. Although the cascading effects of morphology, microclimate, and invertebrate interactions were influenced by location, environmental amelioration and invertebrate associations occurred throughout central California, and possibly throughout the entirety of the *Mastocarpus* spp. range.

**Keever, C.C.<sup>1</sup>, Sunday, J.<sup>1</sup>, Puritz, J.B.<sup>2</sup>, Addison, J.A.<sup>3</sup>, McGovern, T.M.<sup>4</sup>, Marko, P.B.<sup>4</sup>, Toonen, R.J.<sup>2</sup>, Grosberg, R.K.<sup>5</sup>, and M.W. Hart<sup>1\*</sup>** 1 - Simon Fraser University 2 - Hawaii Institute of Marine Biology 3 - University of New Brunswick 4 - Clemson University 5 - University of California, Davis  
THE WRONG PLACE AT THE RIGHT TIME: POPULATION GENETIC STRUCTURE IN *PATIRIA MINIATA*

We collected multilocus sequence and genotype data from the broadcast-spawning sea star *Patiria miniata* at sites that span the species geographic range in the intertidal zone from Alaska to California. This range includes a large gap in Washington and Oregon that coincides with the southern extent of the last Pleistocene glaciation. We found a single prominent phylogeographic break that was consistent across all marker types. Coalescent analysis of nuclear DNA sequences strongly suggested that this population divergence was ~60,000 years old, in the middle of the last Pleistocene glaciation. However, the location of the phylogeographic break did not coincide with the range disjunction and the last glacial maximum. The results include examples of high gene flow on large spatial scales (across the range disjunction), and strong population differentiation on smaller spatial scales (within British Columbia) that has been surprisingly resistant to larval dispersal.

**Kiffney, P. M.\* , Pess, G. , and J. Anderson** Northwest Fisheries Science Center  
RECOLONIZATION OF THE CEDAR RIVER BY PACIFIC SALMON

Habitat fragmentation is a major cause of biodiversity loss, population declines, and reductions in important resource subsidies. A major reason for fragmentation in river landscapes are artificial barriers, such as dams. As a result, providing a dispersal corridor is a common tool used to restore native fish populations, as it is assumed that these populations will increase with barrier removal. This assumption has rarely been tested, however. Moreover, our understanding of the ecological consequences of species reintroduction on resident fauna or ecosystems is rudimentary. We quantified fish density and composition in multiple sections over ~27 km of river and tributary habitat for two years before and five years after a fish passage facility was installed at Landsburg Diversion on the Cedar River, WA, USA. Since 1905, this structure has blocked upstream migration of Pacific salmon, and number of other native fish species. Before the fish ladder, resident trout density increased from downstream (reach 1, 200 m above the dam) to upstream (reach 10, ~17 km from the dam) ranging from 0.01 fish/m<sup>2</sup> to 0.12 fish/m<sup>2</sup>. This pattern was reversed after the ladder with fish density increasing from reach 1 to reach 9 approximately (~14 km from the dam), with the greatest increases occurring in reaches 1 and 2 (~6 km of linear habitat). The return of salmon to the Cedar River has led to a redistribution of fish largely due to

the addition of juvenile coho salmon and increases in resident trout density.

**Kinlan, B.P.**\* *Marine Science Institute, UC Santa Barbara* QUANTIFYING THE LOCAL INFLUENCE OF UPWELLING ALONG COASTLINES

Coastal upwelling drives fluxes of heat, nutrients, larvae, phytoplankton, and other dissolved and suspended matter to intertidal and shallow subtidal ecosystems on eastern boundaries of ocean basins worldwide. Ecologists working in these systems often wish to characterize upwelling variability at local spatial scales relevant to ecological field sites (<1km). The definition of a local upwelling index is problematic, however, because fundamental physical drivers of coastal upwelling (wind, flow, and planetary motion) operate over scales much larger than the site (10's to 1000's of km). Upwelling-related responses observed at coastal sites are actually the local manifestation of offshore meso- to regional-scale processes, modulated by smaller-scale circulation and biophysical processes often associated with topographic and bathymetric features near the coast. The local expression of upwelling can be damped or amplified and exhibit spatial and temporal lags compared to the offshore phenomenon. To quantify the local influence of upwelling, I combined global 50-km satellite/model blended wind data (QuikScat/NCEP 6-hour wind velocity and wind-stress curl, 1999-2008) with digital coastlines to estimate offshore upwelling transport in the vicinity of coastal sites in Western North America. Then, I computed lagged spatiotemporal correlations between upwelling and site-specific biophysical time series (temperature, nutrients, chlorophyll, and settlement). This approach resulted in site-specific coefficients relating each of the local responses to upwelling with the offshore wind forcing. I show that the topographic and bathymetric structure of the coastline can be used to estimate these coefficients, leading to a predictive framework for alongshore variability in the influence of upwelling.

† **Komoroske, L.M.**<sup>1\*</sup>, **Lewison, R.L.**<sup>1</sup>, and **P.H. Dutton**<sup>2</sup> *1 - San Diego State University 2 - NOAA-Southwest Fisheries Sciences Center* CONTAMINANT LEVELS, BIOACCUMULATION AND HEALTH EFFECTS IN *CHELONIA MYDAS* IN SAN DIEGO BAY, CA

Many trace metals and persistent organic pollutants are known to exceed probable effects levels in the San Diego Bay where a population of East Pacific green turtles (*Chelonia mydas*) are known to forage and reside most of the year. In 2007-2008 non-invasive blood and scute sampling was used to measure these contaminants in 21 individuals in the San Diego Bay population. Food sources from nine sites in the Bay were also analyzed to investigate bioaccumulation and identify specific foraging areas. Finally, complete blood cell counts and blood chemical panels were conducted to investigate correlations of contaminant load and health. Significant levels of several non-essential metals persistent organic pollutants were found in multiple individuals, and patterns of contaminant loads varied by sex and size class. Principle Components Regression and MANOVA were used to assess relationships between toxin levels, health status, and bioaccumulation in the green turtle food web. Results from this study are being used to make recommendations for foraging habitat protection and tighter regulation of chemicals in the San Diego Bay watershed.

† **Krug, J. M.**<sup>\*</sup>, and **M. A. Steele** *California State University, Northridge* A TEST FOR CORRELATED RECRUITMENT OF PREDATOR AND PREY SPECIES OF KELP FOREST FISHES

Many marine fishes have a pelagic larval stage whose transport is driven by oceanographic processes, such as currents. Shared exposure of larvae of predator and prey species seems likely to cause recruitment of demersal fishes to be correlated in space. Correlations in recruitment of predators and prey could significantly affect prey population dynamics. We tested for correlations in recruitment of a predator (*Paralabrax clathratus*) and five prey species of fishes at Santa Catalina Island, California. Recruits were counted six times from June to October along twenty-seven 30-m<sup>3</sup> transects at each of eight sites spread over about 30 km of coastline. Adults were also counted three times along similar transects. Density and canopy cover of giant kelp, *Macrocystis pyrifera*, was also enumerated along transects at each site.

Recruitment of all four fishes with pelagic larval stages was not correlated with that of the predator; however, density of young-of-year *Brachyistius frenatus* (a live-bearing surfperch) was positively correlated to the recruitment of *Paralabrax*. The correlation between recruitment of this live-bearing prey species and its egg-laying predator was likely caused by positive responses of each species to kelp abundance. The lack of correlated recruitment among the five species with larval stages implies that shared exposure to ocean currents does not lead to similar spatial patterns of settlement for different species or that very early-postsettlement losses disrupt any correlated patterns of larval delivery.

**Lafferriere, A.M.\* , and A.L. Shanks** *Oregon Institute of Marine Biology, University of Oregon*  
DISTRIBUTION OF ZOOPLANKTON WITHIN LANGMUIR CIRCULATION CELLS

Langmuir circulation cells are wind generated surface currents, which take the form of alternating clockwise and counter clockwise rotating helical cells. Models suggest that organisms and particles may be retained in the convergence and divergence zones depending on the relative settling and swimming velocity versus circulation velocity. Surface water in convergence and divergence zones of Langmuir circulations were sampled with a neuston net and zooplankton were identified and enumerated. Copepods did not differ significantly between zones. *Balanus glandula* cyprids, competent *Polydora* spp., and an unidentified late stage veliger were often significantly concentrated in convergence zones. These results suggest that late stage larvae may be exploiting Langmuir circulation as a transport mechanism to travel shoreward for settlement.

† **Lannin, R.K.\* , Hembrough, B.M., and K.A. Hovel** *San Diego State University* EFFECTS OF SEAGRASS STRUCTURE ON THE PREDATOR-PREY INTERACTIONS BETWEEN JUVENILE GIANT KELPFISH (*HETEROSTICHUS ROSTRATUS*) AND GRASS SHRIMP (*HIPPOLYTE* SPP.)

Seagrass beds create refuge and foraging habitat for many organisms, including commercially and recreationally important fishes. Though it is well known that seagrass structural complexity influences the outcome of predator-prey interactions, there have been few studies that have looked at how the structure of seagrass habitats influence the behaviors of predator and prey species, which ultimately influence prey survival rates and predator foraging success. We quantified the habitat-survival function (HSF) for grass shrimp (*Hippolyte* spp.) exposed to fish predators (juvenile giant kelpfish (*Heterostichus rostratus*) foraging in eelgrass (*Zostera marina*) habitat and also quantified how behaviors of shrimp and fish varied with seagrass structural complexity. Shrimp were exposed to fish in flow-through seawater tanks in which 6 different eelgrass shoot densities (20, 40, 80, 160, 250, and 320 shoots/m<sup>2</sup>) were established. We observed fish and shrimp for 1 h from behind a blind and the proportion of time fish spent in different behaviors, shrimp escape behavior, and the proportional survival of shrimp were recorded. The HSF was hyperbolic, revealing that at lower shoot densities, the proportional survival of shrimp increased rapidly. Although the reaction of the shrimp to the kelpfish followed no trend with increasing seagrass densities, the total time spent swimming by the fish was positively correlated with eelgrass shoot density. Surprisingly, the proportion of successful strikes did not vary with eelgrass structure. Our study can serve as a launching point for further investigations on the affects of seagrass structure on predator-prey behaviors.

**Larson, A.A.\* , de Rivera, C.E, Ruiz G.M, Grosholz, E.D., and Sytsma MD** *Aquatic Bioinvasions Research and Policy Institute at Portland State University* CAN WE ATTRIBUTE THE REBOUND OF NATIVE SPECIES TO THE REMOVAL OF AN INVASIVE CRAB, *CARCINUS MAENAS*?

A key objective of invasive species management is the rebound of native communities. With multiple factors affecting species how can we assess levels of success linked to invasive species control efforts? We have been conducting a control effort of the European Green Crab, *Carcinus maenas* in Bodega Harbor, California, since 2006. Populations of *C. maenas* have shown a decrease of 73-85% since we have begun our removal effort. To identify the extent to which any recovery of clam and crab populations

can be attributed to the removal *C. maenas*, we have been conducting a series of predation experiments. *Carcinus maenas* were kept in containers placed in situ as individuals and at different densities with prey species. Estimates suggest that had we not removed the 13,770 *C. maenas* from the harbor, these crabs could have consumed, in one day, as much as the equivalent of 1.5 -1.7 million *Nutricola* spp., 14,065-16,524 *H. oregonensis*, or 13,770 *C. magister*. At that rate, given the abundance of *H. oregonensis* and of *C. maenas* present in pitfall traps yearly (15 yrs), it would have taken *C. maenas* from 0.3 d – 86 days to consume all of the *H. oregonensis* represented in the traps. Clearly even if containers yield artificially high levels of predation *C. maenas* consume a large number of prey. These results provide an upper estimate of the amount of prey that would have otherwise been unavailable to shorebirds, or to the Dungeness fishery had these invasive crabs remained in the harbor.

**Lees, D. C. \*, and W. B. Driskell** *Littoral Ecological & Environmental Services* ARMORED MIXED-SOFT SEDIMENTS - A DISTINCTIVELY DIFFERENT SEDIMENT PARADIGM?

Based on our studies from 1989 through 1996 evaluating effects of treatment of beaches oiled by the *Exxon Valdez* oil spill in Prince William Sound (PWS), we hypothesized that bivalve assemblages and sediments on treated beaches were severely injured by high-pressure washing. In 2002, we conducted a follow-up study to determine if these effects persisted and were widespread in PWS and to gain insight into clam recovery rates. During this study, we found that sedimentary components and the biota in the armored mixed-soft sediments in PWS do not respond in accordance with the conventional paradigms described for homogeneous sediments. Relationships between median grain size, fines, organics, and biodiversity in PWS sediments diverge substantially from those commonly used to describe traditionally recognized homogeneous sediments. Although armored sediments apparently are widely distributed, paradigms describing the relationships among grain size, fines, organics, and biodiversity in armored sediments do not appear to have been reported previously. Moreover, the importance of armoring to these sedimentary and infaunal relationships has not been recognized. In this presentation, we will demonstrate the differences in the paradigms between these two sediment regimes and explain the process by which armoring develops.

**Lees, D. C. \*, and W. B. Driskell** *Littoral Ecological & Environmental Services* DELAYED RECOVERY IN INTERTIDAL CLAM ASSEMBLAGES IN PRINCE WILLIAM SOUND FOLLOWING THE *EXXON VALDEZ* OIL SPILL CLEANUP.

Our studies of the effects of shoreline treatment on beaches oiled during the *Exxon Valdez* oil spill in Prince William Sound (PWS) from 1989 through 1996 suggested that bivalve assemblages on the beaches treated with high-pressure washing were severely injured in terms of abundance, species composition, and function. In 2002, we conducted a follow-up study to determine the generality and persistence of this injury in PWS. We found that the initial conclusions were accurate, i.e., a considerable proportion of mixed-soft beaches in treated areas of PWS remained extremely disturbed and were functionally impaired in terms of their ability to support foraging by humans and damaged nearshore vertebrate predators such as sea otters. Large, long-lived hard-shell clams, primarily littleneck and butter clams (*Protothaca staminea* and *Saxidomus gigantea*.) remained 66% less abundant at Treated sites than at Reference sites. We also found that standard sediment properties did not appear implicated in lagging clam recovery. But, based on several lines of evidence, we deduced that a major cause for the delay was the disruption of surface armoring (a stratified organization of mixed-soft sediments common in southcentral Alaska) caused by beach washing. Based on the apparent recovery trajectory, we predict that recovery to pre-spill status will take several more decades.

**Lenihan, H.S.<sup>1\*</sup>, Edmunds, P.J.<sup>2</sup>, and M.J. Kotchen<sup>1</sup>** *1 - Bren School of Environmental Science and Management, UC Santa Barbara 2 - Department of Biology, California State University, Northridge* THE RESPONSE OF *POCILLOPORA VERRUCOSA* TO SIMULATED FISH PREDATION UNDER DIFFERING REGIMES OF FLOW AND TEMPERATURE

Partial predation is a common perturbation to reef-building corals, yet their response under combinations of ecologically relevant conditions is poorly known. Here we tested whether simulated fish predation influenced the performance of small branches of *Pocillopora verrucosa* exposed to combinations of temperature (26.6 deg-C vs 29.6 deg-C) and flow (6 cm s<sup>-1</sup> vs 21 cm s<sup>-1</sup>). Manipulations were conducted in microcosms, and growth (weight), maximum dark-adapted quantum yield (Fv/Fm), and the healing of predation scars were measured over 10 days. Results of multiple regressions revealed that predation caused growth to increase significantly (by 14%) at 6 cm s<sup>-1</sup> but decrease (by 34%) at 21 cm s<sup>-1</sup>. The significant interaction of predation and flow was independent of temperature, which had little effect on growth. In contrast, temperature had important influences on Fv/Fm, as did flow. Yield was 5% greater at 26.6 oC than at 29.6 oC, and increased by 3% with an increase in flow; predation had little direct effect on Fv/Fm. Healing of predation scars occurred across all treatments except for the high flow-high temperature treatment. Our results indicate that *Pocillopora* may have the capacity to prioritize repair over growth when bitten, and that this prioritization is enhanced by flow conditions. Such prioritization may have important consequences for coral population dynamics, especially if a juvenile's probability of survival increases with colony size when exposed to multiple chronic disturbances, including partial predation, sediment deposition, and competition with algae for space and light.

**Levin, P.S.<sup>\*</sup>, Andrews, K., Horne, P., and G. Williams** *NOAA Fisheries* SCALING UP BEHAVIOR IN SIXGILL SHARKS: AN APPROACH FOR EXPLORING THE KNOWN UNKNOWN

We have been examining patterns of movement in sixgill sharks as a means to better predict the consequences of environmental change and/or human perturbation on this species. In 2005-2008, we acoustically tagged >40 sixgill sharks in Puget Sound with pressure sensor transmitters and quantified their movement patterns via passive monitoring and active acoustic tracking. Acoustic monitoring suggests that sharks occupy core areas during late fall-early spring and diffuse away from these core areas in warmer months. Continuous active tracking over 24h revealed limited movement. A model of a bounded correlated random walk suggests that sharks move much less than predicted from acoustic monitoring. We thus conclude that we are missing a critical set of movement behaviors. Using what we know about large- and small-scale movement, we were able to quantitatively describe a suite of behavior that must have occurred, but that we did not observe. Our results suggest that these large predators suggest may have a substantial local ecological impact and that they are at risk of local depletion from fisheries.

**Lonhart, S.I.<sup>1\*</sup>, Ritter, A.F.<sup>2</sup>, and K. Wasson<sup>3</sup>** *1 - Monterey Bay National Marine Sanctuary, NOAA 2 - Ecology and Evolutionary Biology, University of California, Santa Cruz, CA 3 - Elkhorn Slough National Estuarine Research Reserve* RESPONSE OF ESTUARINE COMMUNITIES TO ALTERED TIDAL EXCHANGE IN ELKHORN SLOUGH

Many estuarine habitats exist with tidal and freshwater exchange systems altered through construction of water control structures. However, relatively few studies have focused on how estuarine communities respond to such tidal restriction. Elkhorn Slough in central California is an estuary managed by several agencies, and includes habitats experiencing moderately or severely restricted tidal exchange due to water control structures, as well as habitats with full tidal exchange. We conducted rapid field assessments of algae, plants, invertebrates, fishes, birds, and marine mammals in intertidal and shallow subtidal habitats with each level of tidal exchange. For most taxa, we found little difference between sites with full exchange vs. moderate restriction. In contrast, severely restricted sites were significantly different. These sites had lower total species richness than those with moderate and full tidal exchange, but harbored some rare species not found elsewhere (e.g., Tidewater gobies, *Tryonia* snails). Community-level differences are the result of several factors, including restricted movement due to physical barriers and differences in water quality characteristics and habitat structure. In particular, water quality characteristics strongly varied with tidal restriction and influenced patterns of species presence or absence. The results of this

study suggest that the effects of water control structures have very different impacts depending on the amount of tidal exchange allowed and management agencies must choose water control structures carefully. Total estuary-wide biodiversity may be enhanced with a mosaic of tidal exchange regimes.

† **Lotterhos, K.E.**\* *Florida State University* IS UPWELLING CORRELATED WITH RECRUITMENT TIME-SERIES OF BLACK ROCKFISH, *SEBASTES MELANOPS*, IN BARKLEY SOUND, BC?

An elusive question in fisheries biology is determining which environmental factors affect the strength and timing of recruitment in managed species. Larvae of many fish species, including rockfish, have been found to be associated with upwelling fronts. This observation, combined with the increased productivity associated with upwelling, lends itself to the hypothesis that upwelling can be used as an indicator of year-class strength. However, correlations between recruitment and upwelling are species-dependent and are not always significant. This research examined the correlations between upwelling and recruitment for black rockfish, *Sebastes melanops*, in Barkley Sound, Canada. Recruitment was estimated by the abundance of fish caught in SMURFs over six to twelve sampling dates in 2006-2008, and correlated with lagged upwelling indices. Confidence intervals on correlation coefficients were estimated by bootstrap simulation. Results from this research indicate that significant lags between upwelling and recruitment are weak and may differ between years, indicating that multi-year analyses based on equal lags may not capture the dynamics. An exploratory model indicates that there may be strong relationships, however, between upwelling and settlement.

**Maloney, E.R.**<sup>1\*</sup>, **Fairey, W.R.**<sup>1</sup>, **Lyman, A.A.**<sup>1</sup>, **Walton, Z.A.**<sup>1</sup>, **Foss, S.F.**<sup>2</sup>, and **S.N. Shiba**<sup>2</sup> *1 - Moss Landing Marine Labs 2 - California Dept. Fish and Game, Office of Spill Prevention and Response* SURVEYS FOR INTRODUCED MARINE SPECIES ON THE OUTER COAST OF CALIFORNIA: WHO'S ON OUR TURF?

Although the topic of introduced marine and estuarine species has gained attention, the majority of studies have focused on bays and estuaries where, in some cases, numbers of non-native species are in the hundreds. Relatively few non-native species have been reported from outer coast habitats. Our aim was to determine the presence and general distribution of introduced marine invertebrate and algal species along California's outer coast. We conducted field surveys statewide at 22 sites along California's outer coast in 2004 and 2007, targeting subtidal and intertidal rocky and sandy habitats. Nine introduced species were identified between the two surveys, all from rocky habitat. Only one of the introduced species was identified north of Point Conception. Three introduced species overlapped both the 2004 and 2007 surveys, all of which were algae. In addition, 1161 native species and 191 cryptogenic species were identified in the two surveys. Our results highlight patterns of outer coast introductions in California as well as provide a baseline for future monitoring of outer coast introduced species.

**Markel, R.W.**<sup>1\*</sup>, and **C.L.K. Robinson**<sup>2</sup> *1 - Department of Zoology, University of British Columbia 2 - Western and Northern Service Centre, Parks Canada Agency* DIFFERENTIAL ROCKFISH RECRUITMENT ACROSS KELP AND EELGRASS HABITATS IN BRITISH COLUMBIA: IMPLICATIONS FOR MARINE PROTECTED AREA DESIGN

The ability of marine protected areas (MPAs) to effectively conserve and restore fisheries and ecosystems depends on a host of design criterion specific to MPA location and objectives. In this study, we evaluate patterns of spatially and temporally variable rockfish (Genus *Sebastes*) recruitment with respect to a Rockfish Conservation Area (RCA) located on southwestern Vancouver Island, British Columbia. Between 2002 and 2007 we measured the abundance of juvenile rockfishes at 12 eelgrass meadow (*Zostera marina*) and 37 kelp forest (*Macrocystis integrifolia*) locations using beach seines and SMURFs, respectively. Black (*S. melanops*) and copper (*S. caurinus*) rockfish dominated catches in both eelgrass and kelp forest habitats. Despite large and asynchronous annual fluctuations of juvenile rockfish abundance, site location was positively correlated with recruitment from year to year. Juvenile rockfish

abundance was consistently highest at sites outside the RCA in areas characterized by higher tidal velocity. We argue that the effectiveness of RCAs and other forms of MPAs may be limited if local oceanographic features and the location of key recruitment habitats are not incorporated into MPA design.

**Marliave, J.B.\* , and K.W. Conway** *Vancouver Aquarium* CLOUD SPONGES AS ROCKFISH HABITAT: WHAT IS ROCKFISH NURSERY HABITAT?

Different information sources demonstrate use by rockfishes of various substrates as habitat through different life stages. Newly discovered and extensive bioherms in Howe Sound, BC are constructed by *Aphrocallistes vastus*, the cloud sponge. On Texada Island, colonies of individual cloud sponges, growing on rock (known as sponge gardens) receive resource subsidies from the high biodiversity of epifauna on adjacent rock habitats. From the perspective of recruiting juvenile quillback rockfish (*Sebastes maliger*), this food subsidy appears to be missing on bioherms of cloud sponge, for which biodiversity is relatively narrow. While adult and subadult quillback rockfish were present on bioherms, no evidence for nursery recruitment of quillback rockfish to bioherms was observed, whereas the sponge gardens supported high densities of newly recruited quillbacks, perhaps owing to the combination of both refuge and feeding opportunities. The definition of nursery habitat for rockfishes, the taxonomic identification of serial development stages of rockfishes, and recognition of the propensity for successive habitat shifts in the life history of rockfishes all require close consideration in developing conservation strategies for individual species or guilds of these valuable groundfish. Closer attention to fine-scale boundaries of high relief structures may reveal more about recruitment from the plankton to nursery habitat, as opposed to later recruitment of juveniles to adult habitat.

**Marshall, D. J.\* and N. E. McKenzie** *School of Integrative Biology, The University of Queensland, Australia* CUSTOM-MADE GAMETES: TRANSGENERATIONAL STRESS RESISTANCE IN A MARINE INVERTEBRATE

There is a growing recognition that mothers can adjust the phenotype of their offspring in response to environmental change in order to increase offspring fitness. In many marine invertebrates, both sperm and eggs are shed into the external environment as such gametes from mothers and fathers can experience a range of environmental conditions but it remains unclear as to whether fathers alter the phenotype of their sperm. We exposed mothers and fathers of the polychaete *Hydroides diramphus* to a salinity stress for two weeks in the laboratory and then examined fertilisation and development in a variety of salinity environments. We found that maternal and paternal exposure to salinity stress increased the resistance of both types of gametes to that stress but that there were strong trade-offs among environments. Fathers also altered the size of their sperm in response to the change in local conditions. Our results suggest that both males and females exhibit gamete plasticity in marine broadcast spawners and this has a number of implications for population connectivity, the evolution of stress resistance and the study of pollution in the marine environment.

†**Marshall, W.M.\* , and M.L. Berbee** *Department of Botany, University of British Columbia. Bamfield Marine Sciences Centre.* DIVERSITY AND LIFECYCLES OF ICHTHYOSPOREANS, NEW PROTISTS FROM THE ANIMAL/FUNGAL LINEAGE, COLLECTED FROM MARINE INVERTEBRATES OF BRITISH COLUMBIA

The Ichthyosporea were the first unicellular organisms to branch from the animal lineage after the animal/fungus divide. Known only as parasites or commensals, very few Ichthyosporeans grow in culture and fewer still have been isolated in large numbers. During a culture based survey of marine invertebrate gut contents we isolated over 180 Ichthyosporeans into pure culture. Morphology and SSU rDNA sequencing showed that we had found a minimum of four new species, three of them belonging to two new genera, and two of these are the only captive representatives of a divergent clade formerly populated by environmental sequences. Further molecular analysis and the application of the phylogenetic

species concept have shown that the fourth new species is composed of three cryptic species with overlapping morphological traits. Suggesting that the isolates were haploid, no heterozygotes were evident even though polymorphisms were common. Indicating a lack of host specificity, the same haplotypes were isolated from different hosts. Our data are providing the first opportunity to apply multi-locus population-level analysis to make inferences about Ichthyosporean biology such as ploidy, lifecycles and host specificities.

† **Martin, C.J.B.**<sup>\*</sup>, and **C.G. Lowe** *California State University, Long Beach* MIDWATER FISH COMMUNITY STRUCTURE AT OFFSHORE PETROLEUM PLATFORMS ON THE SAN PEDRO SHELF, SOUTHERN CALIFORNIA

Despite growing evidence of the ecological importance of petroleum platforms in the Santa Barbara Channel as essential rockfish nursery habitat, the platforms further south on the warmer-temperate San Pedro Shelf remain largely undescribed. Two years of fish surveys at the San Pedro Shelf platforms show different species assemblages between the two regions, primarily due to a decrease in the richness and density of *Sebastes species* (rockfish) and an increase of nearshore reef species. Furthermore, the San Pedro Shelf platforms showed higher densities of seasonally abundant schooling pelagic species, including *Sardinops sagax* (Pacific sardine) and *Trachurus symmetricus* (jackmackerel), mostly during the summer and autumn months. This seasonal inundation resulted in significant increases in fish abundance and biomass, but was accompanied by decreased values of species diversity and evenness. Within the San Pedro Shelf platforms, species composition as well as fish density, biomass, diversity, evenness, and richness showed significant differences among the three surveyed depth levels (approximately 10m, 20m, and 30m). Generally, the 10m and 20m depths were similar, but both showed significant differences from the 30m level. An Information Theoretic Approach was used to assess the influence of several environmental parameters, revealing that of the measured variables, depth level and water temperature had the greatest amount of influence over community structure. As California begins to debate options for these long standing artificial structures, fisheries managers will need detailed data in order to make appropriate decisions regarding the potential objectives of different platform decommissioning strategies.

**Martone, R.G.**<sup>1\*</sup>, **Micheli, F.**<sup>1</sup>, **Gonzalez, L.I.**<sup>2</sup>, **Guzman-del-Proo, S.A.**<sup>3</sup>, **Haupt, A.J.**<sup>1</sup>, and **E. Serviere-Zaragoza**<sup>4</sup> *1 - Hopkins Marine Station, Stanford University 2 - Section of Integrative Biology, University of Texas, Austin 3 - Escuela Nacional de Ciencias Biologicas, Instituto Politecnico Nacional, Mexico D.F. 4 - Centro de Investigaciones Biologicas del Noroeste, La Paz, Mexico* SPATIAL PATTERNS OF SUBTIDAL COMMUNITY STRUCTURE ACROSS DIFFERENTIAL UPWELLING CONDITIONS IN BAJA CALIFORNIA

The role of regional variation in bottom up factors such as temperature and primary productivity on community organization has become a focus of ecological research over the past decade. Primary producers and secondary consumers in rocky intertidal systems vary across large-scale gradients in coastal upwelling around the globe. However, high variability in community structure also exists at local scales due to species interactions, habitat structure, and recruitment processes. Despite a growing understanding of the large-scale dynamics of coastal upwelling ecosystems, few studies have examined simultaneously the importance of both local- and regional-scale processes in structuring benthic marine communities. We compared nearshore subtidal community structure across variable upwelling conditions along approximately 200 km of shoreline of the west coast of Baja California, Mexico, using both univariate and multivariate analyses. Similar to earlier intertidal studies, our results indicate that subtidal benthic communities exhibit regional-scale variation in the abundance of dominant benthic functional groups such as grazers and filter feeders. However, species-specific patterns emerge, with some species being driven more by local conditions rather than regional environmental processes. These analyses provide testable hypotheses about community regulation and the processes affecting the biomass of commercially important benthic species. Processes driving spatial scales of variability are particularly relevant for species that are commercially harvested, as mismatches between spatial scales of governance



and spatial scales of population dynamics has been known to lead to fisheries collapse.

† **Matson, P.G.**\*, and **G.E. Hofmann** *UC Santa Barbara* MICROARRAY-BASED LARVAL GENE EXPRESSION PATTERNS OF THE GREEN SEA URCHIN, *STRONGYLOCENTROTUS DROEBACHIENSIS*, IN RESPONSE TO TEMPERATURE

Temperature has long been shown to play an important role in structuring species distributions. Current research suggests that anthropogenic-induced climate change will result in elevated ocean temperature which may potentially alter species ranges, particularly at high latitudes. The goal of this study was to characterize the physiological response of green urchin (*Strongylocentrotus droebachiensis*) larvae to increased temperature using a custom-designed oligonucleotide microarray developed for the congener, *S. purpuratus*. Gastrula-stage larval thermotolerance was assessed across a thermal gradient ranging from 7 - 29C for a period of 1 hr. Larvae demonstrated little to no mortality at environmentally relevant temperatures up to 27C and complete mortality at 29C. Tissue samples from the 7, 16, and 25C treatments were collected for RNA extraction and hybridization on the *S. purpuratus* microarray to profile expression patterns across ~1100 stress-related genes. We successfully hybridized cDNA from *S. droebachiensis* to the *S. purpuratus* microarray, demonstrating the utility of this microarray in heterologous species. The patterns and magnitudes of gene expression in response to high (25C) and low (16C) heat stress differed. Exposure to elevated temperatures resulted in the upregulation of genes involved in the defense, apoptosis, translational control of protein synthesis, and acid-base balance and the downregulation of genes involved in the kinome, cell cycle, and development. Gene expression profiling is a useful tool to investigate environmentally-driven stress responses at the organismal level. This information can be incorporated into models forecasting potential effects of anthropogenic-induced climate change on the distribution and abundance of marine species.

† **Matthews, J. A.**\*, and **B. T. Hentschel** *San Diego State University* EFFECTS OF IN-SITU CURRENT MANIPULATIONS ON GROWTH RATES OF THE INTERFACE-FEEDING POLYCHAETE, *POLYDORA CORNUTA*

Most spionid polychaetes are interface-feeders that switch between suspension feeding in fast flows and deposit feeding in slow flows. Experiments in laboratory flumes show that growth rates of the spionid *Polydora cornuta* increase with increasing current speeds and fluxes of suspended food particles. However, these results have yet to be tested in the field, where hydrodynamic conditions and other environmental variables are more complicated than those in laboratory flumes. To test the effects of tidal currents on the growth rates of *P. cornuta* in-situ, we developed methods to manipulate the ambient current and to deploy and recover pre-measured worms so their growth rates could be calculated after recovering worms from the different flow regimes in the field. We constructed paired flow-manipulation channels that increased or decreased the ambient current of a tidal creek in the Tijuana Estuary. Pre-measured *P. cornuta* individuals were placed within the paired flow-manipulation channels during 4 replicate trials that each lasted 4 – 9 days. In contrast to results from published laboratory experiments, juvenile *P. cornuta* grew significantly faster in flow-manipulation channels that decreased the ambient current relative to worms in flow-manipulation channels that increased flow (paired t-test:  $t = -4.358$ ,  $df = 3$ ,  $P = 0.022$ ). We suspect the slower growth of *P. cornuta* in the faster flow is due to higher current speeds and turbulence reducing particle capture. Prior experiments in laboratory flumes were limited to velocities too slow to erode sediment. Results of our field experiment suggest that *P. cornuta* grows fastest at intermediate flows.

† **McCully, K.M.**\*, and **D.C. Potts** *Ecology and Evolutionary Biology, University of California, Santa Cruz* HAWAIIAN ISLANDS DISTRIBUTION AND RECRUITMENT OF THE BLACK-LIPPED PEARL OYSTER, *PINCTADA MARGARITIFERA*, AT MIDWAY ATOLL, NORTHWESTERN HAWAIIAN ISLANDS

The black-lipped pearl oyster, *Pinctada margaritifera*, is considered a potential indicator of the “health” of reef lagoons. It occurs throughout the Hawaiian Archipelago, including Midway Atoll near the northern end of the chain. This species experienced intense commercial exploitation at neighboring Pearl and Hermes Atoll in 1927-1929 and has not recovered to pre-exploitation levels. Although *P. margaritifera* exists at Midway Atoll, there are no reports of it ever being the subject of a commercial industry. Adults are rare at Midway, but we observed recruitment of juveniles onto a variety of substrates at several locations inside the lagoon in 2007 and 2008. We are continuing studies on adult distribution, growth rate, and temporal and spatial patterns of spawning and recruitment in order to extend knowledge of the biology of *P. margaritifera*, enhance understanding of its use as an indicator of environmental change, and provide a pilot restoration study at Midway that will assist the U.S. Fish and Wildlife Service’s goal of restoring *P. margaritifera* at Pearl and Hermes Atoll.

† **McLaughlin, John P.<sup>1\*</sup>, Marcogliese, David J.<sup>2</sup>, Kuris, Armand M.<sup>1</sup>, and Kevin D. Lafferty<sup>3</sup>** 1 - Department of Ecology, Evolution and Marine Biology, University of California Santa Barbara 2 - Environment Canada, Montreal, Quebec 3 - Western Ecological Research Center, United States Geological Survey  
ADDING PARASITES TO THE NW ATLANTIC SHELF FOOD WEB DOUBLES SPECIES RICHNESS AND ALTERS NETWORK STRUCTURE

Challenging long-held assumptions, recent findings suggest that parasites can strongly influence ecological communities. For example, in the well-studied estuarine systems of Southern California parasites not only dominate food web links, their biomass exceeds that of birds, the system’s top predators. In order to determine if these effects are general or system specific we must examine the role parasites in other systems. For this, we have used the published literature to add parasites to existing well-resolved food webs, such as the NW Atlantic Shelf web. Literature searches for host-parasite records in a hierarchy of relevant geographic regions have allowed us to add 470 infectious species to the NW Shelf web, more than doubling its richness. We are examining the unique potential of parasites to augment metrics of food web stability, such as connectance, chain length and interaction strength, as well as the inverse effects of food web structure on infectious dynamics. We also note that the many assumptions involved in assembling food webs from the literature may affect our interpretations. Ideally, we base food webs on direct observations. To this aim, our hope is to use empirical methods to add parasites to Southern California kelp forest and sandy beach food webs.

**McMillan, S.M.<sup>\*</sup>** Moss Landing Marine Laboratories â€ EFFECTS OF *CHLOROSTOMA* GRAZING ON THE PRODUCTIVITY AND REPRODUCTIVE POTENTIAL OF THE GIANT KELP, *MACROCYSTIS PYRIFERA*, IN CENTRAL CALIFORNIA

The purpose of this study was to evaluate how the most abundant kelp forest herbivore in central California, the turban snail *Chlorostoma*, affects the productivity, reproductive output, and survivorship of *Macrocystis pyrifera* within central Californian giant kelp forests. The effects of the turban snail species, *Chlorostoma brunnea*, were investigated using experimental field manipulations of *M. pyrifera* sporophytes and supplementary laboratory experiments. Twenty *Macrocystis pyrifera* sporophytes were selected in Stillwater Cove, Carmel at approximately 10m depth. Ten sporophytes were randomly chosen as controls (i.e. no manipulation) and artifact controls. Ten were stocked with low to high densities (0-400 per sporophyte) of *C. brunnea*. Cages were secured at the base of each stocked kelp sporophyte to reduce immigration and emigration of *Chlorostoma*. Surveys of the *M. pyrifera* individuals were conducted bi-weekly to determine changes in growth, existence of reproductive sporophylls, and reproductive potential. After six weeks, there were no significant trends in *M. pyrifera* growth rate and reproductive potential of *M. pyrifera* as a function of *Chlorostoma* density. Laboratory feeding experiments identified marine fungi growing on *M. pyrifera* as a potential food source for *Chlorostoma brunnea*. Fungal biomass was significantly lowered by *C. brunnea* grazing at moderate densities. Higher densities of *C. brunnea*, however, grazed directly on *M. pyrifera* fronds and fungal biomass increased as the sporophyte deteriorated. Therefore, *Chlorostoma* may feed mainly on epibionts when associated with *M. pyrifera*, except at high

snail densities. This would explain the paucity of effects on *M. pyrifera* by *C. brunnea* observed during the field experiment and in nature.

**Meux, BM\***, **Fejtek, SM**, and **TK Ford** *Santa Monica Baykeeper, Marina del Rey, CA 90292* GIANT KELP RESTORATION IN SANTA MONICA BAY

The Santa Monica Baykeeper's Kelp Restoration and Monitoring Project attempts to help mitigate the large-scale degradation of giant kelp (*Macrocystis pyrifera*) forests in and around Santa Monica Bay, California. Restoration efforts have been focused at Escondido Beach, Malibu (2001-2006) and Long Point, Palos Verdes Peninsula (since Fall 2005-current). The project's goals are to transform urchin barrens to healthy kelp forests by releasing areas from essentially unchecked herbivory pressure through the use of urchin relocation. After urchins are relocated, sporophyll bags are used to seed areas, and adult kelp transplants are added. Sites are considered restored as *Macrocystis* density reaches 0.1 plants/m<sup>2</sup>. Reference (healthy *Macrocystis* beds) and control sites (urchin barrens) were monitored for comparison at both of the restoration sites. The three restoration areas at Escondido Beach, Malibu are now considered restored and are monitored annually using band transect and quadrat methodology. Project results and observations suggest the need for increased abundance of urchin predators. Results from monitoring of the restoration, reference, and control at both locations are discussed.

† **Miklasz, K.A.\*** *Hopkins Marine Station* SIZE-BASED PATTERNS IN THE REPRODUCTION OF CORALLINE ALGAE

Organisms often have competing tradeoffs that define their life history strategies. Tradeoffs have been well studied in coralline algae ecology, occurring among herbivory resistance, desiccation resistance, faster growth, and overgrowth abilities. This study is looking for competing tradeoffs in the reproductive characteristics of coralline red algae. Corallines reproduce through cavities in their calcified tissue, known as conceptacles. Inside this cavity, spores are produced and released by an unknown mechanism through a pore opening in the roof of the conceptacle. In this study, I will measure several parameters of the reproductive organs of coralline algae at Hopkins Marine Station. This data will be combined with literature data from other parts of the world. I will test the hypothesis that an r vs. K selection tradeoff exists in coralline algae reproduction. Some thin coralline algae display opportunist growth strategies: they grow quickly, are the first to colonize open rock, and lose in competitive overgrowth to thicker algae. I will look for r-selection in the reproductive characters of thin corallines, i.e. numerous small spores enclosed in large conceptacles. I expect to find the reverse pattern in thicker corallines. This study will inform later research on the biomechanical energy involved in release of spores from conceptacles and in the survival fitness of settling spores.

**Miller, L.P.\*** *Hopkins Marine Station, Stanford University* THE QUANDARY OF COLOR AND THE SIGNIFICANCE OF SHAPE: TEMPERATURE RELATIONS IN LITTORINE SNAILS

The functional significance of aspects of shell morphology in molluscs has been the focus of much attention in the evolutionary and ecological realms. Among the intertidal littorine snails, shell shape, size, ornamentation and color have many hypothesized roles. Using a mechanistic heat-budget model, I have explored the roles of shell color and shape in influencing heat flux in and out of four species of *Littorina* during aerial exposure at low tide. Model data are compared with *in situ* measurements of body temperature during a range of field conditions. While there are consistent and measurable effects of shell morphology on body temperature, the absolute temperature differences produced by variations in shell color and shape are small, often less than 1°C. The ecological and evolutionary significance of this morphological variation in the context of temperature stress is questionable, especially when compared with existing physiological data on the thermal tolerance of these snails.

† **Miller, S.H.<sup>1\*</sup>**, **Morgan, S.G.<sup>1</sup>**, and **H.S. Carson<sup>2</sup>** *1 - Bodega Marine Lab, UC Davis 2 - San Diego*

*State and UC Davis* TRACKING CRAB POPULATION CONNECTIVITY USING TRACE ELEMENT ANALYSIS OF SOFT TISSUES: A NEW APPROACH

Population connectivity is one of the most important issues in marine ecology; the success of invasive species monitoring, protected area establishment, and fisheries management rely on knowledge of the connectivity among targeted populations. For most benthic marine invertebrates, one of the only potential sources of connectivity is their pelagic larval stage, which could spend minutes to months in the open water before settling. In this study, we investigated the connectivity of 15 populations of the porcelain crab *Petrolisthes cinctipes* along the northern California coast. Ovigerous females and megalopae were collected at sites from Fort Bragg to Point Reyes in two consecutive years. Embryos and megalopae were then dissolved in NaOH in the lab, and their trace element compositions were analyzed using Inductively Coupled Plasma-Mass Spectrometry. Differences in trace element concentrations among embryos were used to create a “map” of site locations, which were significantly different from each other and could be distinguished using discriminate function analysis (DFA) with 83-86% accuracy, depending on the year. Aggregating sites into two regions using the Russian River in Sonoma County as the dividing line increased DFA accuracy to 87-96%. Megalopae were then assigned to sites based on their trace element concentrations, and their assigned sites were compared to their collection sites to determine the connectivity among populations. This project is the first to use the natural trace element signatures of soft tissues instead of hard parts to determine the natal origins of settling larvae. The approach is currently being validated in laboratory experiments.

† **Mireles, C\*, Martin, C, and C.G. Lowe** *California State Univeristy Long Beach* DEPTH PREFERENCE AND VERTICAL MOVEMENT OF NEARSHORE REEF FISHES ON SAN PEDRO SHELF OFFSHORE PETROLEUM PLATFORMS

Public debate surrounding future offshore drilling in California has been brought to the forefront with recent requests to lift the 39 year old ban on offshore drilling. Further fueling this debate is the uncertainty surrounding the fate of these structures and their associated communities once drilling operations have ceased. In the near future, retention of these structures may be allowed via several reefing options. All but one proposed option (leaving entirely in place) would remove or alter important vertical characteristics of the habitat utilized by resident fish communities. Therefore, a thorough understanding of fish depth preference is required to assess the effectiveness of the reefing options. We used acoustic telemetry to monitor the depth utilization of four economically important fish species inhabiting one shallow (50 m) and one deep (225 m) platform located 12 km off the coast of Long Beach. Cabezon (*Scorpaenichthys marmoratus*), California sheephead (*Semicossyphus pulcher*), grass rockfish (*Sebastes rastrelliger*), and kelp rockfish (*Sebastes atrovirens*) were monitored for one year. Grass and kelp rockfish prefer the shallower portions of the platforms (15-20 m) with cabezon preferring the deeper regions (30-40 m). Sheephead generally utilize the shallower portions of the platforms, but are also displaying diurnal depth preferences, with females residing deeper (30-40 m) during night hours. Based on the depth preferences of these four species, most reefing options would drive associated fish deeper than their currently used depths or induce emigration.

**Moffitt, E.A.\* , White, J.W., and L.W. Botsford** *Department of Wildlife, Fish, and Conservation Biology, University of California, Davis* SIZE AND SPACING GUIDELINES: VALUABLE BUT INSUFFICIENT METRICS FOR MARINE PROTECTED AREA NETWORK DESIGN

California’s Marine Life Protection Act (MLPA) mandates that the State design and manage a network of marine protected areas (MPAs) with the primary objectives of protecting marine life, habitats, and ecosystems. Minimum size and spacing guidelines are used in the MLPA process as initial directives and in evaluation of proposed MPA networks. Because many of the goals of the MLPA rely on the persistence of populations, it is important to evaluate MPA networks in terms of whether populations will persist in the system. We evaluated the size and spacing guidelines using the dispersal per recruit model

for several larval and adult dispersal distances. We found that as reserve size increases and/or spacing decreases, a broader range of species with larger larval and adult dispersal distances are expected to persist in the system. Results depend strongly on the level of fishing mortality outside MPAs, and as reserve coverage increases (due to increased reserve size or decreased spacing) the included range of protected species in a network increases in a continuous manner. Therefore, general quantitative size and spacing criteria are limited in use and not appropriate for all systems and species. Size and spacing guidelines are simple and clear directives to begin the design process. However, a network that meets the guidelines may not lead to persistence for many species. In order to meet MLPA goals, the use of models in evaluating population persistence is necessary for evaluation of MPA network designs.

†**Moore, E.C.**\*, and **K.A. Hovel** *San Diego State University* RELATIVE INFLUENCE OF HABITAT COMPLEXITY AND EDGES ON SEAGRASS EPIFAUNAL COMMUNITIES

Habitat structure at multiple scales can influence faunal communities. In seagrass systems most epifauna increase in abundance with increased habitat structural complexity. Abundances are further modified by larger scale aspects of landscape structure (i.e. relative amount of edge). Although multiple scales of structure may covary, most studies look at a single scale in isolation, controlling the variation of others. This covariation occurs in eelgrass (*Zostera marina*) beds in San Diego Bay, USA, where patch-scale complexity (e.g. shoot density and length) increases from the patch edge to interior. Surveys of epifauna and fish communities showed abundances also vary between bed locations. To evaluate relative effects of habitat structure at the patch scale within different landscape locations we conducted a factorial experiment looking at epifaunal utilization of sparse or dense artificial seagrass habitat at both the edge and interior of a natural seagrass bed. We enclosed a subset of plots in predator exclusion cages to observe how predation interacts with habitat structure to influence the community. Bed location had the greatest influence on the epifaunal community though some taxa responded more strongly to shoot density, depending on the ecology of the particular taxon. Predator exclusion had less effect on epifauna with the notable exception of the grass shrimp *Hippolyte* spp. (an important component of fish diets), which was significantly more abundant when predators were excluded. Our results emphasize the importance of addressing and evaluating habitat structure at multiple scales to better understand the distribution and interactions of organisms in a particular environment.

†**Mothokakobo, Rochelle K.**\*, and **Matt Edwards** *San Diego State University* VARIATION IN PHLOROTANNIN CONCENTRATIONS IN UNDERSTORY KELPS IN POINT LOMA, SAN DIEGO, CA

Secondary metabolites serve various functions in marine algae. Within the Phaeophyceae, a well studied class of secondary metabolites called Phlorotannins function in deterring grazers, storing excess carbon, and aiding in growth and wound healing. Various species of kelps are known to have variable background concentrations of phlorotannins and high intrathallus variation, which can enhance production in certain tissues due to growth or function differences; this production can also be enhanced by both biotic and abiotic factors such as light and nutrient availability. In the Point Loma kelp forest, San Diego, CA we evaluated phlorotannin production in two understory kelps, *Laminaria farlowii* and *Pterygophora californica* under different environmental conditions. These conditions were manipulated in the field by experimentally removing the dominant kelp giant kelp canopy in order to increase irradiance at the benthos and adding organic fertilizer to increase nitrogen near the kelp thalli, and in the laboratory by allowing grazers to feed on kelp recruits in mesocosm experiments. Our results indicate that grazing and nutrient availability have strong influences on phlorotannin production, though the relative importance may vary among species.

† **Nelson, M.L.**<sup>1\*</sup>, **Craig, S.F.**<sup>1</sup>, and **J. Adams**<sup>2</sup> *1 - Humboldt State University 2 - Fort Valley State University* ON THE IMPORTANCE OF SPECIES: THE ROLE OF THE SEA ANEMONE *METRIDIUM SENILE* IN ALTERING EARLY SUCCESSION WITHIN MARINE FOULING

## COMMUNITIES

While many studies have documented the pattern of succession in marine fouling communities, few have examined the role that individual species play in creating pattern. Studies from the rocky intertidal have shown us, however, that by manipulating natural communities to include or exclude desired species, it is possible to elucidate the mechanisms by which individuals structure the community at large. The sea anemone *Metridium senile*, a ubiquitous species in temperate fouling communities, is largely ignored in most fouling studies. By grooming natural fouling communities formed on plastic experimental panels and surveying them photographically, *M. senile* is shown here to maintain more free space through time than on panels groomed to initially contain only compound ascidians or erect bryozoans. Field experiments on recruitment conclude that the presence of *M. senile* in fact generates higher recruitment rates among fouling organisms than on controls, ruling out larval predation as a cause for observed long-term patterns. In laboratory tanks, *M. senile* were placed on panels containing recruits from the field and monitored for 5 days. Despite higher recruitment rates in the field, *M. senile* smothers the majority of new recruits by slowly sliding over them with its pedal disk, essentially “wiping the slate clean” of other potential space occupiers. While we illustrate here the mechanism by which *M. senile* maintains free space within its community, we also show that it initially generates increased recruitment. It is therefore important to consider the multiple successional influences that a single species may exert at different temporal scales.

† **Neufeld, C.J.\*** *University of Alberta and Bamfield Marine Sciences Centre* THE LONG AND SHORT OF SEX IN THE SEA: A NOVEL REPRODUCTIVE STRATEGY IN THE GOOSENECK BARNACLE *POLLICIPES POLYMERUS*?

Constrained by their evolutionary history, most barnacles reproduce by extending their unusually long penises to deposit sperm into the mantle cavity of adjacent individuals. However, sperm transfer may be difficult for species living on wave-exposed shores due to the large forces imposed by breaking waves. The common Pacific gooseneck barnacle *Pollicipes polymerus* thrives in high wave-energy environments where the maximum velocity of breaking waves can exceed 30 m/s. While it has been assumed that *P. polymerus* reproduces via direct sperm transfer, copulation has never been observed. In a field survey in British Columbia I found that isolated individuals (up to 18 cm from their nearest neighbour) were brooding young. Additionally, I observed a declining proportion of fertilized individuals as distance-to-nearest-neighbour increased, suggesting self-fertilization is unlikely to account for this pattern. Finally, artificial penis inflation showed that maximum penis extension is very reduced in this species and, even coupled with peduncle movements, is insufficient to reach neighbours more than 8 cm away. These data, together with anecdotal field and laboratory evidence, suggest that *P. polymerus* may be using an alternate sperm transfer strategy to cope with reproduction on wave-exposed shores. I outline the data needed to confirm this hypothesis and discuss its potential evolutionary implications.

† **Nguyen, A.T.\* , Hechinger, R., Hofmann, G., and A. Kuris** *UC Santa Barbara* POPULATION GENETICS OF THE PARASITE, *ACANTHOPARYPHIUM SPINULOSUM*, FROM SNAILS IN NORTHERN PACIFIC COAST ESTUARIES

Digenetic trematodes are widespread and comprise a large biomass in Pacific estuaries of North America. As such, they can influence the ecosystem at the individual, population, and community levels. Additionally, coevolution may arise from the interactions between hosts and parasites. Coevolution in these systems suggests that there is a relationship between parasite genetic diversity and host-specificity in certain parasite species. *Acanthoparyphium spinulosum* (ACAN) is a trematode which is distributed in many estuaries along the Pacific Coast of North America, and appears to have broad host-specificity at the metacercarial stage. Furthermore, the geographic availability of host changes across Pacific Coast estuaries and ACAN prevalence in a particular host species varies from estuary to estuary. This suggests that there may be genetic differences in ACAN host-specificity, and accordingly, genetic diversity may

vary, depending on which hosts are available. This study examines the structure of genetic diversity of ACAN across several estuaries. I will analyze ACAN - infected *C. californica* from estuaries located between San Francisco Bay and Central Baja. Polymerase chain reaction (PCR) and gene sequencing analysis will be used to examine diversity in a specific 800bp fragment of the mitochondrial cytochrome oxidase subunit 1 (COI) gene. Such an examination can elucidate questions regarding the genetic underpinnings of host specificity, and the factors involved in maintaining diversity of genetic material for parasite evolution.

† **Nichols, K.D.\* and K.A. Hovel** *San Diego State University* THE EFFECTS OF PREDATORS AND HABITAT ON SEA URCHIN DENSITY IN SOUTHERN CALIFORNIA KELP FORESTS

It is well documented that sea urchins can have vast impacts on kelp forest community structure as a result of kelp grazing. Despite the ecological importance of sea urchins, direct field studies on the relative effects urchin predators have on shaping urchin populations are rare for Southern California. We conducted surveys in three kelp forest sites near San Diego, CA, including heavily fished and marine reserve sites, to measure sea urchin size, abundance, and habitat use as well as the abundance of potential sea urchin predators. Transect surveys showed urchin behavioral changes among the three sites with urchins tending to be more cryptic inside the reserve as compared to the outside reserve and heavily fished sites. Predator densities and mean sizes of predators were highest inside the reserve and lowest in the heavily fished site. We examined whether purple sea urchin (*Strongylocentrotus purpuratus*) proportional mortality varied with urchin density, time of day, and habitat cover in the La Jolla Ecological Reserve, where densities of potential predators such as sheephead and spiny lobsters are high. Urchin proportional mortality decreased with increasing urchin density. This trend was stronger in open plots than in plots covered with algae, in which proportional mortality was more variable. Examining whether urchin mortality from predation is density-dependent and how habitat complexity influences this relationship is imperative because behavioral changes and increases in urchin populations can have vast ecological and economic consequences in kelp forest communities.

† **Nichols, K.J.\* , Gaylord, B., and J.L. Largier** *University of California, Davis, Bodega Marine Laboratory* THE COASTAL BOUNDARY LAYER: LOWERING THE SPEED LIMIT FOR NEARSHORE DISPERSERS

The movement of ocean waters near the coast has important implications for larval recruitment, pollutant transport, and other ecological processes. The interaction of the coastline and alongshore water flow creates a nearshore velocity gradient (termed the coastal boundary layer; or CBL) whose properties are poorly defined. Here, we examine the presence of a CBL at multiple sites along the California coast, USA, by means of cross-shore transects of velocity quantified using acoustic Doppler current profilers and current-mapping coastal radar. These transects extend to within tens of meters of the shore, into regions where empirical data are historically sparse. We find the presence of a CBL whose characteristics reflect interactions of flow with the shoreline and the shallow seabed near to the shore. For all sites, velocity is polarized in the alongshore direction. In addition, mean alongshore velocity of stations closer to shore (5-10 m isobath) are an order of magnitude smaller than mean velocity of stations farther offshore (20-25 m isobath). Alongshore velocity profiles at each site follow a logarithmic relationship with distance from shore. We find that the CBLs of multiple sites collapse to a universal relationship analogous to ones characterizing small-scale hydrodynamic boundary layers. Underlying parameters describing the relationship relate explicitly to shoreline slope and topography. Results suggest an improved ability to quantify nearshore flows, facilitating a better understanding of processes underlying local retention of certain waterborne constituents, such as larvae and pollutants.

† **Nishizaki, M.T.\* , Grunbaum, D., and R.A. Cattolico** *Department of Biology and School of Oceanography, University of Washington* PREDICTING BLOOM-FORMATION FROM SWIMMING BEHAVIOR IN A MARINE ALGA

*Heterosigma akashiwo* is an actively motile marine alga that forms localized, dense aggregations known as harmful algal blooms (HABs). *Heterosigma* HABs have significant ecological and economic consequences in the marine environment and their formation is variable in both time and space. These HABs are often characterized by rapid increases in cell density in the surface layer of the ocean that cannot be accounted for by changes in population growth alone. An alternative explanation is that previously-dispersed cells become rapidly concentrated through a combination of swimming and passive physical transport. Empirical data, however, are lacking to assess the degree to which cell swimming behavior may or may not influence large-scale spatial patterns. To measure algal swimming, we used a computerized, video-based particle tracking system that quantifies the location and swimming orientation of large numbers of individual cells with high spatial and temporal resolution. Observations of cells (diameter ~ 10 microns) swimming freely within a 1.5 L water column were used to estimate key swimming parameters (e.g., mean drift, turning rate) for different strains of *Heterosigma* isolated from the waters surrounding Rhode Island, Japan and Washington. These estimates were then used to parameterize an advection-diffusion model that predicts spatial population distributions. By combining these theoretical and empirical approaches, we have demonstrated clear differences in swimming characteristics among strains and explore the consequences of such variation in the context of HAB formation.

†**Okamoto, D. K.**<sup>\*</sup>, **Stekoll, M. S.**, and **G. E. Eckert** *Juneau Center, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks* RECRUITMENT INHIBITION, REPRODUCTIVE INUNDATION AND COEXISTENCE BETWEEN DOMINANT SUBTIDAL ALGAL CRUSTS AND KELPS

Kelps provide the foundation for productive nearshore ecosystems and generate ecologically and economically important services, including fish and shellfish habitat. Beneath the kelp canopy, algal crust taxa dominate, transforming rock into living substrate. While algal crusts tolerate effects of the canopy, the reciprocal influence of crust species on recruitment of native canopy species remains undetermined. We combined surveys, field manipulations, and laboratory experiments to investigate recruitment inhibition by algal crusts on co-occurring kelps. Surveys indicate crusts and kelps consistently co-dominate in at least six locations in Southeast Alaska. Using field plots within a kelp habitat where non-calcified red and brown crusts dominated the benthos, we applied three treatments. Kelp recruitment in treatment 1 plots (crusts and kelps removed) was drastically greater than in treatments 2 and 3 plots (undisturbed and only kelp removed), which generally hosted recruitment only on scarce, crust-free surfaces. We then settled and raised microscopic kelps in controlled laboratory mesocosms with non-calcified red, brown, or calcified crusts along with bare rock. Non-calcified red and brown crusts caused a near 100% reduction in kelp recruitment. Testing for spore avoidance of crusts, we settled fluorescently stained spores in wells containing a crusts or bare rock. Brown crusts allowed spore settlement and germination in significant numbers indicating antifouling occurs post-settlement. Despite the space dominance and recruitment inhibition of algal crusts demonstrated herein, the high reproductive capacity of kelps in communities hosting both crusts and kelps may compensate for this inhibition, explaining why neither group competitively excludes the other in nature.

†**Olmata, Felicia**<sup>\*</sup> *University of Rhode Island, Department of Marine Affairs* THE MEDITERRANEAN SEA CETACEAN SANCTUARY: PROSPECTS FOR AN EFFECTIVE SANCTUARY AGREEMENT

In 2002, the International Mediterranean Sea Cetacean Sanctuary was established. This sanctuary is the world's first high seas marine protected area for cetaceans and resulted from intense cooperative actions among France, Monaco and Italy governments and stakeholders. My research traced the development and implementation of the sanctuary by examining the legal regimes from which it emerged, and cooperation and coordination activities that took place. The analysis of legal instruments related to protection and conservation of resources of coastal areas, oceans and seas showed a strong inclination toward an integrated and ecosystem-based approach for the conservation of the marine environment and of its



biological diversity through the development of marine protected areas. The agreement on the creation of a sanctuary for marine mammals was formulated within the spirit of this legal regime's movement. My research also investigated the impacts of the lack of exclusive economic zones for France, Italy and Monaco on the implementation and management of the high seas section of the Sanctuary. This study examined cooperation and coordination among the national and international actors involved in the sanctuary development and management through the use of semi-structured qualitative interviews. The main challenges to overcome were the problem of sovereignty and jurisdiction, the organization of cooperation and coordination at the national and international levels, and the recognition of the Sanctuary boundaries and protection measures by the international community.

†**Ortiz, DM<sup>1\*</sup>, Tissot, BN<sup>1</sup>, and WJ Walsh<sup>2</sup>** *1 - Washington State University Vancouver 2 - Hawaii Division of Aquatic Resources* EVALUATING HABITAT-RELATED EFFECTIVENESS OF AN MPA NETWORK IN WEST HAWAII

Marine protected areas are increasingly being used in restoring overexploited reef-fish populations. If marine protected areas are to succeed in their conservation goals it is important to understand how the abundance and distribution of habitats influence their effectiveness in replenishing targeted reef-fish populations. Here, we evaluate how the design and function of an existing MPA network in West Hawaii influences their effectiveness to replenish fish collected for the aquarium trade. In Hawaii, designation of fishery management areas to replenish aquarium fish populations was based primarily on those areas of high conflict among aquarium fish collectors and dive tour operators and not on habitat-based criteria. Thus, these MPAs vary in size and function with four of the nine showing significant increases in the most commonly collected fish, the yellow tang *Zebrasoma flavescens*. To evaluate the effectiveness of the West Hawaii MPA network, we completed benthic habitat maps and monitored 195 sites among nine study sites to obtain information on characteristics of each of the MPAs and changes in yellow tang populations after their closure. Multivariate statistics were used to explore the relationship between characteristics of the study sites including the width and length of the reef, total MPA area, and the area of habitat types with changes in yellow tang population after MPA closure, including the total number of adults, juvenile and newly recruited fishes. Results of this study can help improve existing management and the future design of MPA in Hawaii and other regions.

**Page-Albins, K.N.\* , Frenock, M., and F. Chan** *Oregon State University, Department of Zoology, PISCO* NEARSHORE TEMPERATURE CLIMATOLOGY FOR CAPE PERPETUA OREGON

Measuring sea-surface temperature is one way of monitoring both large-scale oceanographic changes such as El Niño events and smaller scale changes such as local upwelling. Due to global climate change, the identification of anomalous climate conditions on both large and small scales has become increasingly important. Anomalous conditions can produce cascading effects that can alter ecosystem processes. For example, in 2005 a shift in the strength and timing of nearshore upwelling was shown to significantly alter onshore recruitment patterns of mussels and barnacles in Oregon. In the current study, we have established a temperature climatology for a nearshore (<1 km offshore) site at Cape Perpetua, Oregon based on 10 years of moored temperature data. Anomalies in temperature at this site will be discussed in relation to productivity and larval recruitment. By identifying and examining these anomalies, we hope to gain insight into how ecosystems processes may be altered due to forecasted climate changes.

†**Perlman, B. M.\* , and L. A. Ferry-Graham** *Moss Landing Marine Laboratories* INTERSPECIFIC VARIATION OF PECTORAL FIN MORPHOLOGY OF SURFPERCHES (EMBIOTOCIDAE) ALONG CENTRAL CALIFORNIA

Embiotocids are a group of near-shore fishes that overlap in their distributions, thus are thought to partition themselves into relatively well-defined habitats. We ask if aspects of swimming ability, inferred by fin morphology, are related to the primary habitat of 19 embiotocid species, determined from a

synopsis of multiple habitat use studies. All embiotocids are labriform swimmers. We measured the following variables from flat fins of preserved specimens: angle of the fin base with the long axis of the body, fin length, fin surface area, and aspect ratio of the pectoral and caudal fins ( $L^2/SA$ ). We conducted a PCA to investigate relationships among these variables. PC1 appeared to describe size. PC2 described an inverse relationship between pectoral fin aspect ratios and caudal fin aspect ratios. PC3 was dominated by the variable fin angle. ANOVA performed on these PCs with species as a fixed factor suggested that there were no significant size effects, but there were significant differences in fin aspect ratios and angles among species. Species tended to cluster by habitat type in a general sense. Closely related species sometimes grouped together, such as *Amphistichus argenteus* and *A. koelzi*, suggesting a possible phylogenetic basis for fin shape; however, other species, such as *Embiotoca jacksoni* and *E. lateralis*, occupied the extreme opposite ends of the PC2 continuum. Kinematic studies are presently being conducted to determine how such relationships might change given that fins are flexible and shape can change during use. Swimming performance studies are also being used to quantify aspects of swimming ability among species.

†**Pirtle, J.L.\***, and **G.L. Eckert** *University of Alaska Fairbanks, Juneau School of Fisheries and Ocean Sciences* OPTIMAL NURSERY HABITATS FOR ALASKAN RED KING CRAB (*PARALITHODES CAMTSCHATICUS*)

Red king crab (*Paralithodes camtschaticus*) was the most economically important crustacean fishery in Alaska until collapse in the 1980s. Populations continue to experience low recruitment with little recovery in the absence of fishing. Successful recruitment for many commercially important crustaceans depends upon post-settlement processes influenced by habitat. Early benthic stage (5-20 mm carapace length) red king crab associate with structurally complex substrates, though little is known about why certain substrates may function as nursery habitats, and which attributes of habitat are most important. To identify optimal nursery habitats for red king crab, we investigate settlement patterns in nearshore habitats, and test the ability of a variety of habitats to maximize survival and growth of early benthic stage crabs with laboratory and field experiments. Settlement timing and relative abundance vary by location. Captive crabs demonstrate significant preference ( $p < 0.001$ ) for biogenic and fouled substrates, consuming preferred substrates in 67% of laboratory habitat trials. We suggest that biology is an important habitat feature beyond structural complexity, and that optimal nursery habitats may be those that not only provide shelter, but local foraging opportunities. The next stage of our study will test survival and growth in the presence of predators in the lab with a variety of habitats during winter 2009. Field experiments in summer 2009 will test predator-prey interactions in Alaskan nearshore habitats with wild crabs. Ecosystem-based management of red king crab in Alaska will be more effective with greater understanding of the habitat ecology of this commercially important species.

**Pochon, Xavier<sup>1</sup>, Stat, Michael<sup>1</sup>, Takabayashi, Misaki<sup>2</sup>, Chasqui, Luis<sup>3</sup>, Jones, Leonard<sup>4</sup>, Logan, Dan D. K.<sup>5</sup>, and Ruth D. Gates<sup>1\*</sup>** 1 - *Hawaii Institute of Marine Biology, SOEST, University of Hawaii* 2 - *Department of Marine Science, University of Hawaii at Hilo* 3 - *Departamento del Biología, Universidad del Valle, Colombia* 4 - *Institute of Marine Sciences, University of Dar es Salaam, Tanzania* 5 - *School of Biological Sciences, Victoria University of Wellington, New Zealand* COMPARISON OF ENDOSYMBIOTIC AND FREE-LIVING *SYMBIODINIUM* DIVERSITY IN A HAWAIIAN REEF ENVIRONMENT

The genus *Symbiodinium* is a diverse group of dinoflagellates that form intimate symbioses with a diversity of invertebrates. In scleractinian corals, these dinoflagellates are found within the coral gastrodermal cells where they drive the high levels of productivity and calcification that characterize coral reef ecosystems. Although some corals pass endosymbionts from generation to generation, larvae of many species must acquire their *Symbiodinium* anew from environmental pools. In addition, exchange between endosymbiotic and environmental pools of *Symbiodinium* (reef waters and sediments) has been proposed as a mechanism by which corals could potentially optimize their physiological performance in

the face of changing environmental conditions. Our current understanding of free-living *Symbiodinium* diversity is poor by comparison to endosymbiotic *Symbiodinium* communities, a scenario that reflects the challenges of visualizing the genus against the backdrop of the complex and diverse micro-eukaryotic communities found free living in the environment. We have developed a new approach to define the molecular diversity of *Symbiodinium* communities free-living in the water column and sediments and tested the methodology in a reef environment near Coconut Island, Oahu, Hawai'i. A comparison of the molecular diversity of *Symbiodinium* recovered from the environment with that in endosymbiosis with corals from the same reef reveals no overlap between these communities. These data are consistent with the high proportion of coral species in this geographic region that transmit endosymbionts from generation to generation and suggest that the potential for exchange or repopulation of corals with *Symbiodinium* derived from the environment is limited at this location.

**Poray, A.P.\* , and R.C. Carpenter** *California State University Northridge* SPATIAL ESCAPE AT A PHYSIOLOGICAL COST: CONSEQUENCES FOR CORAL REEF MACROALGAE INHABITING REFUGIA FROM HERBIVORES

Benthic algae are essential components of coral reef communities, and as key primary producers, their distribution and abundance can greatly influence reef productivity. Yet as dominant competitors, macroalgae can outcompete other important organisms for space. For this study, a series of quantitative assessments and manipulative experiments were used to test the role of herbivory and habitat suitability on the distribution and physiology of macroalgae on the back reef of Moorea, French Polynesia. Initial surveys revealed that the majority of macroalgae are limited to cracks and holes in large coral heads and absent from open surfaces accessible to herbivores. Herbivore assay experiments suggest that microhabitats provide structural refugia from herbivores due to lack of accessibility and create a distributional pattern that likely is determined during the settlement and survivorship of young algal recruits. Survivorship of settled individuals is highest between 2-6 cm into a crevice and likely represents a balance between herbivore access and an altered physical environment. Light measurements indicate substantial decreases in light availability within microhabitats, with an up to 60% reduction in the daily integrated PAR within crevices. Individuals exposed to ambient conditions exhibited two-fold increases in photosynthetic response and growth. Despite the ability of photo acclimation there still appears to be a cost associated with living in crevices. These results suggest a trade off between the advantages of spatial refugia from herbivory and the physiological costs incurred in these microenvironments.

†**Radecki, J.R.\* , and R.R. Wilson, Jr.** *California State University, Long Beach* MT DNA GENETIC DIVERSITY ANALYSIS OF THE INVASIVE CHAMELEON GOBY (*TRIDENTIGER TRIGONOCEPHALUS*)

With ongoing biological invasions, knowledge of self-sustaining versus replenished populations is important when analyzing impacts of invasions on marine ecosystems. The chameleon goby, *Tridentiger trigonocephalus*, became prevalent on the California and Australian coasts following invasion from Asia in the 1960s. This study is testing the hypothesis that invasive populations of *T. trigonocephalus* in San Francisco Bay (SFB), California, and Sydney Harbor (SH), New South Wales, have principally spread by an *in situ* rise in population versus continuing immigration. Evidence for an *in situ* rise can be found in reduced genetic diversity indices for mtDNA such as loss of singleton haplotypes, low haplotype diversity, and low nucleotide diversity, relative to populations at mutation-drift equilibrium (MDE) as demonstrated for another invasive goby, *Acanthogobius flavimanus*. mtDNA control regions of *T. trigonocephalus* were sequenced (698 bp) and analyzed for reductions in the above indices. Data from 55 specimens from SFB and 10 from SH showed no significant loss of singleton haplotypes or reductions in haplotype diversities relative to MDE populations. In comparing those two data sets with each other, nucleotide diversity appeared higher in SH ( $\pi = 0.029$ ) than in SFB ( $\pi = 0.017$ ). SFB *A. flavimanus* had a much lower nucleotide diversity ( $\pi = 0.005$ ) and singleton fraction (0.63 vs 0.96) than SFB *T. trigonocephalus*. Results to date imply ongoing immigration may be an important source of genetic

diversity in SFB chameleon goby, but levels may differ between SFB and SH. Further analysis of 40 SH samples and 9 Tokyo Bay samples is underway.

†**Rochman, Chelsea M. \***, **Levin, Lisa L., and Guillermo F. Mendoza** *Scripps Institution of Oceanography; UCSD* CHANGES IN MACROFAUNAL COMMUNITY STRUCTURE ACROSS THE OREGON MARGIN OXYGEN MINIMUM ZONE

Oxygen Minimum Zones (<0.5 ml/l O<sub>2</sub>; OMZs) are found on continental margins where primary production is high. The relationship between macrobenthic ( $\geq 300\mu\text{m}$ ) zonation and the oxygen minimum zone was studied in Oregon margin sediments (500-1200m depth). Five stations along a depth transect (500-1200 m) were sampled during July-September of 2006 for macrofaunal density and diversity. The density of macrofauna was significantly positively correlated with oxygen ( $p < 0.0004$ ), and negatively correlated with depth ( $p < 0.008$ ). Densities at each station were all significantly different from each other ( $p < 0.0001$ ) and were also significantly lower in OMZ (800-1000m) than non-OMZ sediments (500, 1200m) with  $p < 0.0037$ . The best represented phylum was Annelida at all stations, generally followed by Mollusca, Arthropoda, and Echinodermata. Within the phylum Annelida, the family Cirratulidae was most common where oxygen was lowest (900-1000m) and Paraonidae was highest at stations where oxygen was highest (500-800m and 1200m). Both depth and oxygen were not significant factors affecting diversity of macrobenthos (S, J' and H'). Examination of rarefaction curves show that macrobenthos exhibit reduced species richness with decreasing oxygen and increasing depth. OMZs are becoming increasingly important to study, as climate change is leading to their expansion and greater hypoxia on continental shelves. By understanding regions where oxygen concentration is naturally less than 0.5ml/L we can better understand future changes in the oceans.

**Romanin, K.D.F.\*** *University of Victoria* A LOOK AT SOME EFFECTS OF FEEDING PLASTIC PARTICLES TO MARINE ZOOPLANKTON

The East Pacific Gyre is a circular ocean current that is accumulating plastic and creating a new manufactured environment. The effects of the plastic particles are showing detrimental effects on the marine life that lives in these areas since many plastic particles are being consumed as food particles. Since the fate of this plastic is to be broken down into smaller and smaller pieces, I examined the ingestion of microscopic plastic particles by various larval forms. Four types of plastic were tested to see if they would be ingested by crab zoea larvae, echinoderm larvae, and polychaete larvae, and I found that all forms of plastic were being ingested. The consumption and clearance rates of plastic particles in suspension were compared across variable concentrations of food with constant levels of plastic, and across variable concentrations of plastics with constant levels of food. The effects of plastic concentrations in the suspensions had impacts on the rates of consumption, fecal pellet volume, and clearance rates. Further studies were done on the effects of plastic particles on jellyfish, to determine if their non-visual means of predation would allow them to successfully forage within a plastic polluted suspension. The jellyfish, *Polyorchis sp.* ingested plastic readily upon first exposure to it, but then emptied its gut and refused to consume plastic again. After zooplankton were added to the same *Polyorchis* jellyfish at a ratio of one tenth that of the plastic, it was successfully able to forage in the suspension by ingesting almost only zooplankton.

†**Romero, R.\*** *Moss Landing Marine Labs, SJSU* RECRUITMENT STRATEGIES OF THE EPHEMERAL, OPPORTUNISTIC MACROALGA *ULVA* (LINNAEUS) IN CENTRAL CALIFORNIA

Ephemeral algae are early colonizers of the rocky intertidal after a disturbance, although the mechanism of early colonization (including benthic microscopic stages and waterborne propagules) is poorly known. Recruitment of the ephemeral *Ulva* spp. was studied in two types of disturbance manipulations (partial removal where all macroscopic organisms were removed v. complete removal where all macro-and microscopic organisms were removed) and an un-manipulated control at two tidal heights (high *Porphyra*

zone and low *Mazzaella* zone). Replicate disturbances were created in August 2007, November 2007, January 2008, and May 2008 and were monitored until August 2008 on a rocky bench north of Pigeon Point, CA. *Ulva* recruitment into partial removals resulted from both waterborne propagules and microscopic remnants left on the substrate post-disturbance, while *Ulva* recruitment to complete removals did not result from fragments. *Ulva* recruitment peaked after two months in low intertidal plots cleared in August 2007 and May 2008 but peaks differed among treatments indicating temporal differences in recruitment strategies. Among treatment differences in *Ulva* abundance following August 2007 and May 2008 disturbances indicated that remnants do not contribute a large portion to post-disturbance recruitment. *Ulva* did not recruit to low intertidal plots cleared in November 2007 and January 2008; and never recruited to high intertidal plots. Periodic sand inundation in high intertidal plots created a repeatedly disturbed environment which may have led to recruitment failure. Other than waterborne propagules, this study presented little evidence of contribution by alternative life history stages to post disturbance recruitment.

**Ruttenberg, Benjamin I\*, Miller, Jeff, Waara, Rob, and Matt Patterson** *National Park Service*  
MONITORING CORAL REEF ECOSYSTEMS IN U.S. NATIONAL PARKS IN FLORIDA AND THE  
CARIBBEAN TO IMPROVE SCIENCE AND MANAGEMENT

The Marine Ecology Branch of the South Florida/Caribbean Monitoring Network (SFCN) of the U.S. National Park Service is tasked with long-term monitoring of coral reef ecosystems in 5 National Parks in Florida and the Caribbean, including evaluating the effects of newly created no-take marine reserves inside National Parks. In recent years, SFCN has also detected a number of changes in coral reef ecosystems in these parks. In 2005, an unprecedented coral bleaching event occurred throughout the Caribbean and was particularly severe in the Virgin Islands. Monitoring data demonstrated that high coral mortality resulted not from direct effects of bleaching but instead from coral disease that spread after corals began recovering from bleaching. More recently, SFCN documented a rapid coral disease outbreak on one of the highest coral cover reefs in Dry Tortugas National Park. An emergency response cruise returned to the area a few weeks later to find that the outbreak of active disease had stopped. These examples illustrate the importance of effective long-term monitoring programs in evaluating management actions and detecting the effects of acute but short-term stressors. Unfortunately, these results raise a number of important management questions (e.g. why does a disease outbreak begin and why might it stop) that the Park Service is unable to address. We strongly encourage other researchers to propose and pursue interesting and challenging scientific questions that will also provide critical information to improve the management and the health of coral reef systems.

**Sagarin, R. D.\*** *Duke University* SIZE MATTERS: LOSS OF LARGE COASTAL INVERTEBRATES  
AND IMPLICATIONS FOR ECOLOGY AND MANAGEMENT

Much ecological monitoring is focused on presence/absence data or abundance and density data. While monitoring such attributes is important, those metrics can miss key factors in assessing ecosystem health and evaluating management strategies. In particular, the size structure of a population can be extremely important ecologically, especially for many coastal invertebrates where reproduction increases disproportionately with size. Moreover, observations of size structure can be used to reveal signatures of impacts to populations when these impacts would be difficult to observe directly. In this regard, size structure can reveal management failures and also inform better coastal management decisions. I review several recent studies from California and Mexico where observational studies on invertebrate size structure have been conducted over large spatial scales, against historical baselines and museum records, or in relation to management decisions, to reveal impacts of human foraging and management on coastal ecosystems. I also discuss new work contrasting field and museum records of the dye-producing snail *Placopurpura columellaris*.

†**Sala, LM\***, **Kitaguchi, BD, and BT Hentschel** *San Diego State University* BEHAVIOR AND

## GROWTH OF ECHINOPLUTEUS LARVAE, *DENDRASTER EXCENTRICUS*, IN RELATION TO PHYTOPLANKTON THIN LAYERS.

Food for planktotrophic larvae is often patchy, and the ability to locate food-rich patches might affect their development and growth. Studies of larval nutrition typically rear larvae in well mixed cultures and manipulate food on time scales of no less than 1 day. In nature, however, larvae must detect and respond to patches before they can benefit nutritionally, and imperfect sensory or locomotive abilities might result in diet enhancements that last for only minutes. Recent discoveries of phytoplankton thin layers suggest these patches might be especially important for enhancing larval nutrition. To test this with larvae of the sand dollar *Dendroaster excentricus*, we created phytoplankton thin layers in the laboratory using salinity-stratified water columns containing microalgae in a central layer 2 cm thick. Five replicate columns of four treatments were established: 1)  $1 \times 10^5$  cells/ml in the thin layer, 2)  $1 \times 10^4$  cells/ml in the thin layer, 3) a halocline without phytoplankton in the thin layer, and 4) a continuously mixed column ( $1 \times 10^4$  cells/ml). Each week for 4 wk, these treatments were maintained for 4 consecutive days followed by 3 days when all columns were changed to the continuously mixed treatment. On days 1-4, 8-11, 15-18, and 22-25, we quantified the vertical distribution of larvae in the three thin-layer treatments. Larvae typically did not aggregate in or near phytoplankton thin layers until the third and fourth consecutive day. Growth of larvae was fastest in continuously mixed columns followed by larvae that spent 4 d/wk in columns with a  $1 \times 10^5$  cells/ml thin layer.

## **Samhuri, J.F.\*, and P.S. Levin** NOAA Fisheries, Northwest Fisheries Science Center TOOLS OF THE TRADE: IDENTIFYING VITAL SIGNS AND ECOLOGICAL THRESHOLDS FOR MARINE ECOSYSTEM-BASED MANAGEMENT

One of the great challenges of transforming ecosystem-based management (EBM) from a philosophical approach to a set of executable management actions is the development of an appropriate toolkit. Scientific tools for EBM should be quantitative, flexible, and capable of answering questions like “what should be monitored?” and “what are reasonable ecosystem-level management targets?” In this talk, we outline a quantitative approach to (a) develop a set of proxies, or indicators, for ecosystem attributes in marine food webs, and (b) identify ecological thresholds, useful as benchmarks for EBM, from relationships between ecosystem attributes and human or natural perturbation intensity. We illustrate this approach using a model of the British Columbia marine food web. The model allows us to measure the responses of ecosystem attributes to varying levels of perturbation; distinguish robust indicators, which track changes in attribute values, from those that are less informative; and, locate thresholds based on nonlinear relationships between ecosystem attributes and perturbation intensity. These tools are being applied as part of an ongoing effort to provide scientific support for ecosystem-based management in Puget Sound, Washington, USA.

## **Sandin, S.A.<sup>1\*</sup>, and McNamara, D.<sup>2</sup>** 1 - *Scripps Institute of Oceanography* 2 - *University of N. Carolina, Wilmington* SPATIAL DYNAMICS OF HERBIVORY AND CORAL GROWTH: IMPLICATIONS FOR REEF CONSERVATION AND RECOVERY

Competition for space is a critical dynamic affecting patterns and rates of growth of sedentary organisms both on land and in the sea. Understanding the aggregate impact of spatial dynamics on competitive hierarchies along shared margins is important for gaining insight into large-scale systematic shifts, such as catastrophic phase shifts within coral reefs. Predictive insights are fundamental for both understanding conditions leading to coral loss and, perhaps more importantly, for designing strategies for restoring coral populations. To explore this question, we have constructed a cellular automata model for coral reefs to mimic the dominant dynamics of coral reefs. State transitions are governed by probability-driven rules based on dynamics of growth, death, succession and recruitment. Explicit spatial dynamics are depicted both through size-dependent patterns of growth in corals and autocorrelated patterns of foraging for some herbivores. These assumptions are based on two main field observations: (i) small corals are more

susceptible to overgrowth by macroalgae than larger colonies, and (ii) patterns of herbivory are distinct between fishes and urchins, especially in reference to the level of spatial autocorrelation of foraging. We find that algal dominated reefs are particularly stable because coral recruitment is severely reduced in the presence of macroalgae. Although clonal growth allows adult corals to increase in size even in the presence of high macroalgal cover, only in the presence of significant herbivory is coral recruitment facilitated. Additionally, because urchins open larger contiguous sections of benthos from algal coverage than do fishes, coral recruitment will be particularly facilitated in the presence of herbivorous urchins. The wide-spread mortality of both fast-growing corals (e.g., acroporids) and herbivorous urchins in the Caribbean, the dynamic attractor of macroalgal domination is particularly stable. These model predictions mimic closely a growing number of empirical observations from across the Caribbean.

**Sanford, E. \***, and **D.J. Worth** *Bodega Marine Laboratory, UC Davis* DRILL, BABY, DRILL:  
GEOGRAPHIC VARIATION IN AN INTERTIDAL PREDATOR-PREY INTERACTION

Although pairs of species frequently interact over broad spatial scales, the ecological and evolutionary processes that drive geographic variation in species interactions are poorly understood. We examined striking latitudinal differences in the interaction between a predatory dogwhelk (*Nucella canaliculata*) and intertidal mussel (*Mytilus californianus*). Over a 3 year period, we reared snails from 8 populations in California and Oregon through two laboratory generations and tested whether family lines differed in their ability to drill *M. californianus*. Remarkably, F2 snails from Oregon sources were generally unable to drill mid-sized *M. californianus*, whereas California snails readily drilled this prey. Because snails were raised through two generations on a common diet, these differences among populations likely have a genetic basis. Mussel bed surveys revealed large, regional differences in the abundance and size of drilled *M. californianus* that closely matched the observed differences in the drilling capacity of *N. canaliculata*. Using a reciprocal transplant design, we out-planted lab-reared F2 snails to field enclosures at sites in California and Oregon. Snails from Oregon sources showed almost no growth at sites in California, presumably because blue mussels and acorn barnacles were uncommon. In contrast, snails from California sources appeared to be locally adapted to the prey available at California sites and grew well on *M. californianus*. We suggest that latitudinal differences in prey recruitment have selected for differences among populations in the drilling capacity of this direct developing snail, potentially creating geographic differences in the size structure and dynamics of mussel beds.

**Sebens, K.P. \*** *Friday Harbor Laboratories and Department of Biology, University of Washington*  
COMPETITION AND COEXISTENCE IN THE ROCKY SUBTIDAL ZONE

Subtidal rock surfaces are characterized by assemblages of invertebrates and algae that often comprise dozens of species coexisting for months to years on small patches of relatively homogeneous rock surface. The number of species in a regional species pool determines local diversity in such systems worldwide. However, certain species consistently dominate locally, and can predictably outcompete their neighbors. Research on subtidal communities on the east and west coasts of North America is used to demonstrate at least five distinct mechanisms promoting coexistence among species that commonly occur together on subtidal rock substrata. Long-term (30 year) studies of subtidal communities in Massachusetts demonstrate coexistence on a decadal scale, on both vertical and horizontal rock surfaces. Multiple species coexistence is ubiquitous in this case, and occurs even with large changes in disturbance rate. Effects of predators, disturbance, recruitment, regional diversity, and physical factors are examined as they affect species coexistence on homogeneous rock substrata. Mathematical and spatially explicit simulation models are used to examine the processes that promote coexistence in rocky subtidal habitats.

**Shanks, A.L. \*<sup>1</sup>**, and **R.K. Shearman<sup>2</sup>** *1 -University of Oregon, Oregon Institute of Marine Biology 2 - Oregon State University, College of Oceanic and Atmospheric Sciences* CROSS-SHELF  
DISTRIBUTIONS OF INTERTIDAL INVERTEBRATE LARVAE ARE UNAFFECTED BY  
UPWELLING- OR DOWNWELLING-FAVORABLE WINDS

We tested the hypothesis that larvae of intertidal invertebrates are swept offshore during upwelling and shoreward during downwelling. Vertically stratified zooplankton samples and oceanographic data were collected along a line of seven stations from 0.7 to 27 km from shore near Coos Bay, Oregon. Half the sample dates (27 June and 14 August) were characterized by upwelling conditions (lines of constant temperature and salinity tilted upward and a band of cold surface water against the coast) the other half (3 and 18 July) by downwelling (lines of constant temperature and salinity were flat and warm surface waters were in contact with the shore). We identified and staged larvae of *Neotrypaea californiensis*, *Balanus glandula*, *B. nubilus*, *Chthamalus dalli*, *Pollicipes polymerus*, and *Semibalanus cariosus*/*B. crenatus* and identified to species or taxa *Mytilus californianus*, *M. trossulus*, *Hiatella arctica*, *Dendraster excentricus*, and Pinnotherid and Pagurid zoea. On all sample dates, all taxa and stages were not found in the surface waters (0 to 10 m depth) and, with one exception (*B. nubilus* cyprids), were abundant at the three inshore stations (0.7 to 4.5 km offshore) and very rare or absent at seaward stations. The average distance offshore of all taxa and stages ranged from 0.9 to 4 km from shore and did not vary with upwelling and downwelling. Upwelling and downwelling had no effect on the cross-shelf distribution of the larvae of intertidal invertebrates; the hypothesis that upwelling carries larvae offshore and downwelling carries them back onshore was not supported.

**Shanks, A.L.<sup>1\*</sup>, and S.G. Morgan<sup>2</sup>** *1 - University of Oregon, Oregon Institute of Marine Biology 2 - U. of California Davis, Bodega Marine Laboratory* SURF ZONE DYNAMICS AND THE SETTLEMENT AND RECRUITMENT OF BARNACLES

This work was inspired by the following observations: 1) Larvae of intertidal organisms remain between 4 and 0.5 km of shore during upwelling and downwelling. 2) Each of the authors has followed settlement of barnacles to rocks in sandy beaches, but one has seen very high settlement (ALS) and the other low (SM). Larvae of intertidal invertebrates must cross the surf zone to reach shore and perhaps differences in the surf zone at the sites ALS and SM have worked can explain the observed differences in settlement. Barnacle settlement at two sites was significantly positively correlated with wave height. During period of larger waves the surf zone is flushed more rapidly and flushing may transport larvae from the nearshore through the surf zone to shore. We sampled barnacle populations on rocks at dissipative (wide surf zone) and reflective (narrow surf zone) beaches. Barnacle percent-cover, density and larval recruitment were all significantly higher at dissipative than reflective beaches. Circulation in the wide surf zone at dissipative beaches may draw more water into the surf zone leading to higher barnacle settlement and recruitment. Dissipative beaches are due to stronger wave environments than is present at reflective beaches. There is a latitudinal gradient in wave energy (more northward), which may translate into a gradient in beach type and, hence, recruitment. In addition, surf zones associated with rocky shores are generally narrow like reflective beaches, which may lead to lower recruitment there.

**Shears, N.T.\*** *Marine Science Institute, UCSB* CAN MARINE RESERVES PROTECT HARVESTED PREY SPECIES?

The recovery of exploited predatory species in no-take reserves can have cascading effects on lower trophic levels. Subsequently marine reserves may not represent a viable conservation and management tool for lower trophic level species that support fisheries such as sea urchins. I used long-term monitoring data from reserve and non-reserve sites at California's Channel Islands to investigate whether human harvesting or predators had greater regulatory effects on density, size, biomass and reproductive potential of the harvested red sea urchin (*Strongylocentrotus franciscanus*) and the smaller unfished purple sea urchin (*S. purpuratus*). The density of *S. purpuratus* was 6.4 times lower at reserve sites and there was no difference in biomass of reproductive potential between reserve and non-reserve sites. In contrast, there was no difference in the density of *S. franciscanus* between reserve and non-reserve sites, but the two reserve sites consistently supported populations of larger urchins with 3.5 times higher biomass and 5.8 times higher reproductive potential compared to the non-reserve sites. These differences are likely due to



differences in size-selectivity of harvesting (removes large urchins) and predators (prefer smaller urchins) as well as other compensatory effects of predators in reserves. These results suggest that reserves can also have net benefits on harvested prey species by promoting populations with larger and more fecund individuals through a variety of direct and indirect mechanisms.

† **Shelton, A. O.\*** *University of Chicago* DO MALES MATTER? POPULATION EFFECTS OF MALE RARITY IN SURFGRASS (*PHYLLOSPADIX*)

Many ecologically important, habitat-forming species maintain both sexual and asexual reproductive modes. However, we have little understanding of how allocation to and success of each mode affect the persistence of natural populations. The surfgrasses are habitat-forming species with that can reproduce through rhizome fragmentation as well as sexually via seeds. In addition, most populations of surfgrass have extreme, female-biased sex ratios. To understand the effect of skewed sex ratios and asexual reproduction on population persistence, I constructed matrix projection models with four years of demographic data for two species of surfgrass (*Phyllospadix scouleri* and *P. serrulatus*). My results show that population growth rates were near replacement levels in both species ( $\lambda \approx 1$ ). Elasticity analyses showed that asexual reproduction contributed substantially more to population growth than sexual reproduction for *P. serrulatus* but sexual and asexual elasticities were comparable for *P. scouleri*. Using a two-sex matrix model, I asked if small differences in survivorship between the sexes could generate observed sex ratio bias, and how sex differences impacted population growth rate. Model results show that very small sex differences in survivorship (~1-2%) can generate very large sex ratio differences. Population growth rates were largely insensitive to changes in male abundance until they reached a threshold of male abundance, at which point  $\lambda$  declined rapidly. In most cases, surfgrass populations appear to be close this critical male abundance threshold. However, the mechanism underlying male rarity remains unknown.

**Shurin, J.B.\***, **Matthews, B.**, **Markel, R.W.**, and **S. Dick** *UBC* COMPARING TROPHIC STRUCTURE IN MARINE AND FRESHWATER PLANKTON AND BENTHOS

Two lines of evidence indicate that food chains grow longer with more trophic linkages as aquatic habitats become larger. First, top predatory fishes have higher trophic position in large lakes, as indicated by isotopic signatures. Second, oceanic food webs have more species at very high trophic positions than those in lakes, which in turn have more than streams. We evaluated two possible explanations for these patterns: (1) that increased species richness gives rise to more potential pathways from bottom to top, and (2) that benthic pathways are shorter than pelagic. Empirical evidence strongly supports (2) over (1). A comparison of isotopic signatures across BC lakes found that benthic food webs are less size structured, with weaker associations between body size and trophic position than seen in plankton. We find no differences in trophic complexity among lower trophic levels between large and small lakes, or between lake and marine plankton. The latter result indicates that changes in fish abundance may have similar chances of cascading to the phytoplankton in freshwater and marine ecosystems. We discuss selective pressures of pelagic and benthic organisms and their implications for the size structure of food webs and associations with habitat size.

†**Siegrist, Z.C.\***, and **D.A. Donovan** *Western Washington University* TEMPERATURE AND SALINITY TOLERANCES OF THE CLAMS *NUTTALLIA OBSCURATA*, *PROTOTHACA STAMINEA* AND *VENERUPIS PHILIPPINARUM*

We are studying temperature and salinity tolerances of three Pacific Northwest clams: *Nuttallia obscurata*, *Venerupis philippinarum* and *Protothaca staminea*. *N. obscurata*, or the purple varnish clam, is a non-native species that has spread recently and rapidly in the coastal Pacific Northwest. Attempts at commercial marketing have largely failed. This is in contrast to *V. philippinarum*, the Manila clam, which was accidentally introduced to the region in the 1930s but is now very important to commercial shellfish

industry. Finally, *P. staminea* is our local littleneck clam, and is also commercially and ecologically important. To study the physiological tolerances of these three species, we are collecting wild samples from multiple sites and conducting controlled experiments while altering temperature and salinity levels. Examining gill ciliary tolerance acts as an effective correlate to whole organism tolerance; time to ciliary death is evaluated for each species under different conditions. Our results indicate significant differences in temperature tolerance between *N. obscurata* (60 minute survival at 41.4C), *V. philippinarum* (60 min. at 40.8C) and *P. staminea* (60 min. at 36.3C), with *N. obscurata* having the highest overall tolerances. Preliminary salinity results suggest that *N. obscurata* can tolerate lower salinities than the other two clams. We have also observed that *N. obscurata* can survive in low salinities far longer than can *V. philippinarum* and *P. staminea*. These results may offer valuable insight as to why the purple varnish clam is so successful as an invasive species.

†**Smith, K. A.** \* *University of South Carolina* SPLASH, SURGE, SUBMERGE: A BIOPHYSICAL ANALYSIS OF OCEAN INFLUX IN THE ROCKY INTERTIDAL

Intertidal organisms alternate physiological states as tides oscillate between high and low levels. Life sustaining activities including feeding and gas exchange occur when intertidal organisms are submerged during high tide. Then, as the tide recedes, these activities temporarily cease, and intertidal organisms are exposed to temperature and desiccation stress. The relative influence of high and low tide conditions on intertidal organisms is difficult to determine at wave-exposed sites because waves blur tidal movement. Typically, shore level is defined as a category (lower, middle, upper) or with a numerical still tide height, but these measurements are only approximate. In situ pressure loggers may provide a better way to quantify submergence and emergence time, and thus provide better estimates of time spent feeding versus enduring stress. I deployed pressure loggers at 12 wave-exposed, rocky intertidal sites from Washington to Southern California. A logger was deployed at each site for one month, sampling at two-minute intervals. Results indicate that shore level can be quantified into splash, surge, and submerge stages during the tidal cycle. It was also possible to analyze the impact of wave size on measurement of shore level. In situ pressure loggers are a promising new method for dissecting tides from the perspective of rocky intertidal organisms.

†**Sorte, C.J.B.** \*, and **S.L. Williams** *Bodega Marine Lab, University of California - Davis* PREDICTING IMPACTS OF CLIMATE CHANGE ON MARINE COMMUNITY COMPOSITION

While climate models forecast global temperature shifts with increasing levels of confidence, less progress has been made in evaluating effects of global climate change on entire communities. Because species differ in environmental optima and tolerance ranges, their responses to climate change vary, and predicting overall community responses is complex. We used controlled laboratory mesocosm experiments to assess impacts of increased seawater temperatures on species in a subtidal epibenthic ‘fouling’ community. We hypothesized that changes in the dominant fouling spaceholders will arise *via* species-specific differences in processes that influence acquisition and maintenance of space, the primary limiting resource in this system. We assessed survival and growth rates by exposing juveniles to 3 temperature treatments: a low baseline temperature, +3 degrees Celsius (mean increase predicted by global climate change models), and +4.5 degrees Celsius (high predicted increase). Survival was unrelated to temperature except for the single native species considered (*Distaplia occidentalis*) which experienced decreased survival at high *versus* low temperatures. For 5 of 6 species, including *Distaplia*, growth rates increased at the high relative to the low temperature but did not change between low and mid temperatures. As temperature increase approaches 4.5 degrees Celsius, the single native species would be expected to decline whereas 4 of 5 introduced species would be expected to increase in abundance. These data suggest a potential shift in the fouling community of Bodega Harbor (California) towards even greater dominance of introduced species.

†**Spitler, M. I.** \*, and **R.C. Carpenter** *California State University, Northridge* FACTORS

## INFLUENCING THE DISTRIBUTION AND ABUNDANCE OF TWO DOMINANT MACROALGAL SPECIES ON CORAL REEFS IN MOOREA, FRENCH POLYNESIA

Within the backreef habitat of Moorea there are disjunct distributions of two dominant macroalgal species, where a more palatable species, *Sargassum mangarevense*, is found predominantly on the reefcrest and a less palatable species, *Turbinaria ornata*, dominates habitats in the backreef. This project tests the hypothesis that these distributions are a function of herbivore pressure. Herbivory plays an important role in the distribution and abundance of macroalgae. The impact of herbivores is reduced in spatial refugia, where herbivore access is limited, and when preferred species are associated with those less palatable. Spatial refugia vary across this habitat but are most apparent on the reefcrest and tops of coral bommies. *Sargassum* attains nearly one hundred percent cover on the reefcrest, where it is inaccessible to herbivores. In addition, macroalgae are abundant on top of bommies where feeding assays indicate that both species were consumed significantly less compared to individuals placed on the adjacent substratum. In the backreef, *Sargassum* often is found in close association with the highly unpalatable *Turbinaria*. Field experiments compared the loss of *Sargassum* individuals alone to treatments where *Sargassum* was associated with two densities of *Turbinaria*. Results indicate that significantly less mass of *Sargassum* is lost when associated with *Turbinaria*. This association may come at a physiological cost to *Sargassum* which experiences lower rates of photosynthesis and growth when found within *Turbinaria*. Results suggest that the distribution of even a less palatable alga is a function of herbivore access, having important consequences for species coexistence in reef environments.

## †**Staaf, D.J.**\* Hopkins Marine Station DIVERGING COUSINS: TWO DIFFERENT PATTERNS OF POPULATION STRUCTURE IN TWO SIMILAR SPECIES OF OCEANIC SQUID

*Sthenoteuthis oualaniensis* and *Dosidicus gigas* are closely related species of oceanic squids in the family Ommastrephidae, both of which support large fisheries. Their ranges overlap in the Eastern Tropical Pacific. The range of *D. gigas* stretches north and south from this area, while the range of *S. oualaniensis* reaches west across the Pacific and Indian oceans. The latitudinally restricted, transoceanic range of *S. oualaniensis* is typical of ommastrephids, while the restriction of *D. gigas*' range to the Eastern Pacific, and its latitudinal breadth, are unusual. Both species have strong swimming abilities, and *D. gigas* adults reach larger sizes, so why hasn't *D. gigas* crossed the Pacific? Given the overall similarity in morphology and life history of these two species, a comparative analysis of their genetic diversity and population structure may provide insight into their very different species ranges. I have found that *S. oualaniensis* contains deeply divergent, geographically segregated clades, while *D. gigas* shows much less genetic variation, although there is a notable genetic break between populations north and south of the equator. The ranges of these two species must be put in a context of speculation about incipient speciation.

## **Stallings, C. D.**\*, **Koenig, C. C.**, and **F. C. Coleman** Florida State University Coastal & Marine Laboratory BYCATCH OF AN ECONOMICALLY-IMPORTANT GROUPER AND ITS PREY IN A SUB-TROPICAL TRAWL FISHERY

The unintentional capture of non-targeted species (i.e., bycatch) can be extremely high in trawl fisheries and understanding its ecological impacts on food-web dynamics is important to management from an ecosystem-based approach. In Florida, a bottom trawl fishery operates in shallow seagrass beds and primarily targets juvenile penaeid shrimps (especially pink shrimp, *Farfantepenaeus duorarum*) which are sold to bait houses that supply recreational fishermen. Juvenile gag grouper (*Mycteroperca microlepis*) settle to and inhabit the same seagrass habitats in which the bait-shrimp fishery occurs, and survival of gag during this life stage is crucial for the long-term sustainability of their populations. Using the same rollerframe trawling equipment and techniques employed by the fishery, I measured bycatch of both juvenile gag and their prey across the northeastern Gulf of Mexico. Bycatch of gag (measured as capture efficiency, hereafter  $E$ ) was high shortly after they settled to seagrass ( $E_{JUNE} = 0.65$ ), but was negatively correlated with gag size ( $r = -0.89$ ), and decreased through the summer months ( $E_{JULY} = 0.19$ ,  $E_{AUG} =$

0.05,  $ESEPT=0.02$ ). On average, the number of non-targeted animals (including important prey species for juvenile gag) captured per sampling event was 4.65 times greater than the number of bait-shrimp landed. Changes to the structure of these prey communities may have important indirect effects on the growth of juvenile gag, thereby extending the period of time gag are most susceptible to capture by rollerframe gear. These results suggest that the bait-shrimp fishery may require different spatial and temporal restrictions than are currently practiced.

†**Stevens-McGeever, S.J.**\* *University of California, Santa Barbara* EFFECT OF A CYMOTHOID TONGUE REPLACEMENT ISOPOD ON THE BLOOD OF THE HOST FISH *LUTJANUS PERU*

Red Snapper, *Lutjanus peru*, are parasitized by a protandrous hermaphroditic isopod, *Cymothoa exigua*, that removes and functionally replaces the host's tongue. This study examines the effect that this parasite has on the host's blood physiology. Blood samples were analyzed for hematocrit, hemoglobin absorbency, and leucocyte count from unparasitized fish, and those infected with one, or two parasites, and fish without a parasite, but also lacking a tongue signifying that they were previously parasitized. Unparasitized fish had a significantly higher hematocrit than did fish with one or two parasites and fish that were previously parasitized. The data show an even greater drop in hematocrit levels when the female parasite was gravid. These differences indicate that these parasites have a substantial impact on the health of their hosts. In general a host responds to a blood feeding parasite by increasing production of red blood cells. This homeostatic response can compensate for blood losses up to the level exceeding the erythropoietic capacity of the host. The significant decrease in the hematocrit of parasitized red snapper indicates that the cymothoids have exceeded the homeostatic capabilities of the host. The analysis of met hemoglobin shows a statistically insignificant decreasing trend with parasitism. The leucocyte data showed significantly lower levels of white blood cells in parasitized fish. This surprising finding suggests that these parasites could compromise the immune response of infected snappers. Here too the most dramatic effects were seen in fish with a gravid female parasite.

†**Sunday, J. , and M.W. Hart** *Simon Fraser University* LOCAL ADAPTATION IN A LONG-DISTANCE DISPERSER

Local adaptation is infrequently observed among marine taxa, particularly those with prolonged planktonic dispersal. However, if local selection is strong, selection may counteract the homogenizing effects of gene flow. In marine broadcast spawners, fertilization traits are thought to be under strong, population-level coevolution. Here I present data from within-species fertilization experiments using the bat star, *Patiria miniata*, which indicate local evolution of fertilization traits. Results are considered in the context of neutral genetic structure of the species, and probable dispersal patterns based on an oceanographic circulation model.

†**Suskiewicz, T.S.**\* *Moss Landing Marine Laboratories* EFFECT OF CANOPY AND UNDERSTORY ALGAE ON RECRUITMENT OF THE ANNUAL KELP *NEREOCYSTIS LUETKEANA* IN CENTRAL CALIFORNIA

Much of Coastal central California is characterized by two canopy forming subtidal kelps, the perennial *Macrocystis pyrifera* and *Nereocystis luetkeana*, which often form monospecific beds in close proximity to one another. It has been hypothesized that *Nereocystis* exists on the fringes of *Macrocystis* beds because it is competitively inferior and can only persist in environments less hospitable to *Macrocystis*. To test this hypothesis, I manipulated kelp canopy cover and benthic algal cover inside a *Macrocystis* bed at Stillwater Cove and a *Nereocystis* bed at Big Creek Marine Reserve and tracked *Nereocystis* recruitment. Unmanipulated controls and three clearing treatments were created at each site (-canopy/+understory, +canopy/-understory & -canopy/-understory). Results indicated that canopy removal alone significantly increased *Nereocystis* recruitment, however removal of understory kelps and turf algae also yielded a significant and stronger increase in *Nereocystis* recruitment. The complete absence of

recruits in several cleared plots and the high variance between plots also suggested that small-scale variability in the settlement and survival of microscopic stages is important in determining *Nereocystis* recruitment success. Interestingly, both *Nereocystis* and *Desmarestia sp.* recruits continued to appear well into the summer, indicating that these populations may not be entirely limited to a spring recruitment window. As hypothesized, the recruitment of *Nereocystis* is reduced in the presence of a dense *Macrocystis* canopy, however the role of understory algal assemblages are also important and therefore may influence the distribution of *Nereocystis* beds along our coastline.

†**Sweeney, Joelle M. \***, and **James T. Harvey** *Moss Landing Marine Laboratories* ASSESSING FOUR CONSUMPTION MODELS FOR ESTIMATING DIET OF CALIFORNIA SEA LION, *ZALOPHUS CALIFORNIANUS*

The California sea lion, *Zalophus californianus*, occurs along the western coast of North America, and understanding their food habits will better determine their role as top-level predators in the marine ecosystem. Four models are commonly used to determine the proportions of prey species consumed by a sea lion population: modified frequency of occurrence (mFO), split-sample frequency of occurrence (SSFO), fixed biomass reconstruction (FBR), and variable biomass reconstruction (VBR). To assess which model could best estimate diet, captive sea lions (5 male, 4 female) were fed meals of fish and squid and scats recovered. One hundred scats were randomly sampled 15 times, and scat hard parts (otoliths, cephalopod beaks, and bones) were quantified. Two methods were implemented separately to compare which method better estimated prey species: otoliths and beaks (the otolith method) and the all-structure method (otoliths, beaks, and diagnostic bones). Numerical and graded correction factors (NCF and gLCF) were used in conjunction with the FBR and VBR models. The all-structure method and VBR model most accurately estimated species proportions of prey consumed.

**Tissot, B. N. \*** *Washington State University Vancouver* ESTABLISHING AN MPA NETWORK IN OREGON: AN INTEGRAL ECOLOGY ANALYSIS

The State of Oregon is currently in the process of establishing a network of MPAs. The MPA process was initiated by Governor Kulongosi 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 the public. This paper will discuss the procedure used to develop MPAs in Oregon including the role of science, involvement of stakeholders, and public dynamics. I will examine these interactions using Ken Wilber's Integral Ecology framework which provides a multidisciplinary lens through which to view the dynamics of public involvement. 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 MPA networks using an integral definition of sustainability.

**Todgham, A.E. \***, and **G.E. Hofmann** *Ecology, Evolution and Marine Biology, UC Santa Barbara* PREDICTING THE IMPACTS OF OCEAN ACIDIFICATION: USING GENOMICS TO IDENTIFY PHYSIOLOGICAL "TIPPING POINTS"

As the research community explores the impact of ocean acidification (OA) on marine ecosystems, a key link to forecasting the effects of this altered seawater chemistry is understanding the response at the organismal level. Studies have begun to show us that individual species will likely vary in their response to low pH and low carbonate waters depending on their capacity to withstand or compensate for the effects of OA. At present we know little about the mechanistic underpinnings defining these differences in physiological resilience and it is this gap in knowledge that will lead to a better understanding of an organism's physiological "tipping point" with respect to climate change.

In order to begin to understand compensatory mechanisms as they relate to impacts of OA, we have leveraged genomics techniques to examine the response of developing sea urchin larvae in high CO<sub>2</sub> experiments. Here, we have used a custom designed DNA oligonucleotide microarray to assess changes

in gene expression in developing larvae of *Strongylocentrotus purpuratus* and *Lytechinus pictus*. We have targeted a suite of genes that are known to be involved in calcification, energy metabolism, the cellular stress response and development. These data underscore how a genomics/ transcriptomics approach can serve to highlight the plasticity of individual marine calcifiers in a manner that has the potential to tell us a great deal about the physiological “tipping point” of these organisms under future ocean conditions.

**Trbovich, S.M.\***, and **R.R. Wilson, Jr.** *California State University, Long Beach* ARE SOUTHERN CALIFORNIA BIGHT FISH POPULATIONS GENETICALLY DIVIDED? MICROSATELLITE DATA FROM KELP BASS (*PARALABRAX CLATHRATUS*)

Published studies suggest that recruiting kelp bass (*Paralabrax clathratus*) inhabiting the northern Channel Islands are genetically distinguishable between the eastern and western regions of the Santa Barbara Channel. This is potentially due to differing current and thermal regimes between the regions, which extend to eastern and western regions of the overall Southern California Bight (SCB). To evaluate a generalized hypothesis of an east-west (inshore-offshore) genetic gradient for kelp bass across the SCB, we sampled adult kelp bass along an east-west transect line represented principally by 49 samples taken from San Nicolas Island (SNI) and 50 from Santa Catalina Island (SCAI). We genotyped all samples at five polymorphic microsatellite loci reported in an earlier study. Average heterozygosity was lower at SNI than at SCAI for four loci (average difference of  $HO = 0.09$ ) and there was a lower allele richness at the most polymorphic locus (20 alleles at SCAI versus 14 at SNI). An allele-by-allele comparison between the two sample sets revealed a substantial proportion of private alleles at multiple loci and significant overall pairwise frequency differences (Fisher’s Exact Test,  $p = 0.002$ ). Population structuring between the two islands is only marginally significant ( $FST = 0.011$ ,  $p = 0.045$ ), although this is an order of magnitude higher differentiation than recorded for the overall SCB population. Our results support earlier findings, but also indicate that the SNI population is likely recruiting from a smaller, less genetically diverse source population than SCAI.

**Van Alstyne, K.L.\***, **Dominique, V.J. III**, and **G. Muller-Parker** *Western Washington University* DO THE SYMBIONTS OR HOSTS IN AN ANEMONE-ZOOXANTHELLA SYMBIOSIS PRODUCE DIMETHYLSULFONIOPROPIONATE (DMSP)?

Many cnidarians including corals, octocorals, corallimorphs, and anemones contain the sulfonium compound dimethylsulfoniopropionate (DMSP). It is not known if DMSP is synthesized by the animals, their symbionts, or derived through their diet. We determined the source of DMSP in tropical and temperate anemones by: 1) measuring of DMSP in aposymbiotic and zooxanthellate anemones of three anemones that harbor zooxanthellae and one anemone that can harbor zooxanthellae and zoochlorellae, 2) manipulating zooxanthellae numbers by inoculating juvenile aposymbiotic anemones (*Aiptasia pallida*) with their symbiont, *Symbiodinium bermudense*, and 3) manipulating *S. bermudense* numbers by growing aposymbiotic and zooxanthellate *A. pallida* in light and dark conditions. DMSP concentrations in zooxanthellate anemones were 3.4 – 15  $\mu\text{mol g}^{-1}$  fresh mass (FM). In aposymbiotic *Aiptasia* spp. and *Anthopleura elegantissima* that lacked large numbers of zooxanthellae, concentrations were 0 - 0.43  $\mu\text{mol g}^{-1}$  FM. When aposymbiotic *A. pallida* were inoculated with zooxanthellae, average DMSP concentrations were 4.24  $\mu\text{mol g}^{-1}$  FM after five weeks; DMSP not detected in uninoculated control animals. Aposymbiotic anemones maintained in the light or dark for six weeks contained no DMSP or zooxanthellae. Zooxanthellate anemones in the light contained five times as many zooxanthellae and 7.5 times as much DMSP as zooxanthellate anemones maintained in the dark. Taken together, these data show that the zooxanthellae are the sole source of DMSP in *A. pallida*. The trends in DMSP concentrations in other zooxanthellate anemones suggest that this phenomenon is not limited to *A. pallida*, but may be true for other anemones or other cnidarians hosting *Symbiodinium*.

†**Vasquez, Maria C.\***, and **Steve R. Dudgeon** *California State University Northridge* PROBING FOR OXYGEN: INVESTIGATING HOW THE AVAILABILITY OF DISSOLVED OXYGEN MAY LEAD

## TO MORPHOLOGICAL PLASTICITY IN THE HYDROZOAN *HYDRACTINIA SYMBIOLONGICARPUS*

Sedentary organisms are restricted to the environment they settle in; whether it is optimal or poor the organisms may exhibit plasticity to survive. Nonetheless, understanding an organism's environment by quantifying abiotic factors can shed light on the daily stressors experienced by the individual. This study focused on quantifying the environment experienced by the colonial hydrozoan *Hydractinia symbiolongicarpus*, which lives on the back of hermit crab shells, by measuring the amount of dissolved oxygen (DO) at four sediment depths (surface, 1 cm, 3 cm & 5 cm) representative of those in which hermit crabs may be found buried and at two locations along the New England Coast (Barnstable Harbor, MA; Darling Marine Center, ME). In addition, we investigated where the hermit crabs were located during low tide and the sediment composition. DO significantly decreased with increasing sediment depth and was nearly anoxic at 5 cm. A majority of the total hermit crabs counted were found in normoxic pools compared to those buried in the sediment. The sediment at Barnstable Harbor had a higher sand composition compared to that of Maine suggesting a lack of organic material which may result in higher DO availability. This study indicates that *H. symbiolongicarpus* may experience near anoxic levels of DO during low tide due to their symbiosis with hermit crab shells. Current laboratory research on morphological plasticity exhibited by hydrozoans at variable oxygen concentrations may help us understand how hydroids are reacting to the abiotic stressor present in their natural habitat.

†Walsh, Sheila M.\* *Scripps Institution of Oceanography, University of California, San Diego* SPECIES RICHNESS IS AN AMBIGUOUS INDICATOR OF ECOSYSTEM HEALTH

The use of species richness as an indicator of ecosystem health may be an artifact of studying highly degraded systems. On coral reefs, reef fish species richness is generally shown to decline with declines in measures of health, such as coral cover or total fish biomass. A recent study of coral reef health that included nearly pristine coral reefs showed that species richness instead increased with decreases in coral reef health. In order to resolve the conflicting evidence and elucidate mechanisms driving coral reef fish species richness, I surveyed sites across an extreme gradient in coral reef health. I found that coral fish species richness was highest at intermediate levels of coral reef health. The systematic change in the trophic structure, from sites characterized by top predators and corals to sites characterized by small prey fish and algae, appears to drive this pattern in species richness. Nearly pristine sites and highly impacted sites both have low fish density, despite their differences in total fish biomass, making the probability of finding an additional species low. Similarly, pristine and impacted sites are both highly homogeneous in their environment, despite their differences in coral and algal cover, providing fewer niches for fish species. Therefore, fish species richness is an ambiguous indicator of coral reef health. Baselines for ecosystem health are needed to contextualize patterns in species richness and avoid mistaking a trajectory of decline for one of recovery.

†Waterson, TP<sup>1\*</sup>, Barshis, D<sup>2</sup>, and JH Stillman<sup>1</sup> 1 - *San Francisco State University* 2 - *University of Hawaii, Manoa* PLASTIC GROWTH RESPONSE TO DIEL TEMPERATURE FLUCTUATIONS VARIES BETWEEN COLONIES OF THE REEF-BUILDING CORAL *PORITES LOBATA*

In the back reef lagoons of Ofu, American Samoa, corals thrive in temperatures (up to 36C) higher than most corals can tolerate, with daily fluctuations of 2-6C depending on the size and flow of the pool. A reciprocal transplant study showed that massive *Porites* corals from both forereef (constant temperature) and back reef environments grow more quickly in the back reef lagoon, although native back reef corals grow more quickly than forereef conspecifics in all environments. Here we examined whether these growth differences were due to temperature or other environmental factors, and whether growth responses were correlated with genotype. We collected samples of *Porites lobata* from forereef and back reef sites, with n=5 colonies per site and 25-30 replicates per colony. We split the corals between two tanks imitating either the forereef (29C) or back reef (fluctuating 27-32C). Forereef and backreef corals had

significantly higher growth rates in the fluctuating tank than the constant-temperature tank, indicating phenotypic plasticity in growth in response to temperature. As in the field, back reef corals had significantly higher growth rates than forereef corals. However, colony-specific responses varied within each source environment. We hypothesize that this is an effect of host genetic polymorphism since no variation was detected in the genotype of associated symbiodinium. High genetic diversity has been seen in *Porites* species on this reef and we are currently performing phylogenetic reconstruction of host genotypes using DNA sequence data from a 650bp region encompassing ITS1 and ITS2 as well as partial rRNA sequences.

†**Webber, J.D.**<sup>1\*</sup>, and **T.W. Anderson**<sup>2</sup> *1 - San Diego State University and University of California, Davis 2 - San Diego State University* LARVAL TRAITS AND SWIMMING PERFORMANCE OF THREE TEMPERATE REEF FISHES: ALTERNATE STRATEGIES AND A COMMON THREAD?

The “growth-mortality” hypothesis predicts that the fastest-growing and largest larvae within cohorts of marine fishes should have differentially higher survival during their pelagic and early post-settlement stages and, therefore, constitute a greater proportion of recruits in local populations. However, evidence of trade-offs between growth and physiological traits such as swimming performance have been shown in some fishes, and that growth may be optimized, rather than maximized, due to costs associated with rapid growth. We measured swimming performance for three species of recently-settled temperate reef fishes and used their otoliths to hind-cast pre-settlement growth rates and sizes at settlement. We then compared these traits in relation to swimming performance. The three species had significant, but opposite (two similar, one opposing), outcomes with respect to larval growth rate, size at settlement, and swimming performance. All three species had significantly negative relationships between size at settlement and swimming performance and were evident in fishes days to weeks after settlement, indicating that differences in larval traits can have lasting effects on swimming performance. We suggest that the differences observed among these species may be due, in part, to post-settlement behavior and habitat preferences, and that different “strategies” may be employed to enhance survival in early life stages.

†**Wehrenberg, M.L.**<sup>\*</sup> *Moss Landing Marine Labs* MECHANISMS FOR POPULATION PERSISTENCE OF *GRACILARIOPSIS* SP. (RHODOPHYTA) IN A CENTRAL CALIFORNIAN ESTUARY

Gracilaroids are one of the dominant groups of seaweeds found in CA estuaries. Their tolerance of physical stressors such as salinity, desiccation and their psammophytic nature make them well suited to these environments. These algae utilize a broad suite of reproductive strategies in a tri-phasic life-history including: sexual fertilization, release of tetraspores, apogamy, and vegetative fragmentation. The purpose of this project was to examine the mechanisms for growth and reproduction utilized by *Gracilariopsis* sp. in the Elkhorn Slough estuary (Moss Landing, CA). To investigate this, a year-long time series was initiated; whereby, monthly random samples were collected within a 100m x 30m plot to make estimates of biomass and reproductive capacity. In 10 months, the population exhibited little to no utilization of sexual fertilization, and peaked in biomass in the fall and winter months. Surprisingly, the dominant portion of the population was found up to 30cm below the sediment surface during the winter months and sustained for much of the spring. The latter half of the year showed a marked shift to above-ground biomass with a peak in October. This suggests that sediment movement may play an extremely important role in the growth and reproductive cycles of these algae. The capabilities of these thalli to survive underground for extended periods of time may be more consequential to the life-longevity and successful propagation of individuals than any other mechanism.

†**Wheat E.**<sup>\*</sup> *University of Washington* DRIVERS OF LOCAL VARIATION IN OYSTER *CRASSOSTREA GIGAS* GROWTH: FOOD LIMITATION OR TIDAL CIRCULATION?

Filter feeders form an ecologically dynamic link between benthic and pelagic environments. Models suggest that Willapa Bay is at or near carrying capacity for oysters, however questions remain about the



whether a particular location on a tide flat can sustain high densities of suspension feeders. This work explores the local dynamics (ie: at the scale of an oyster bed) of oyster growth and water circulation to address the question: Are the observed patterns of oyster growth a result of long water residence time or local food depletion? Determining how standing oyster density impacts chlorophyll levels and consequently oyster growth is critical information for maximizing oyster yields and quantifying the ecological impacts of the industry. We have found that oyster filtration measurably reduces chlorophyll a concentrations over distances of 100 to 1000m. From studies at multiple locations we have calculated a field filtration rate for Japanese oysters (*Crassostrea gigas*) and applied it to one aquaculture site where we have data on water flow and circulation patterns. Using our field based filtration rate we are able to model food depletion over multiple tidal cycles and compare that with known chlorophyll concentrations. We conclude that filtration activity alone can not account for the patterns of oyster growth and chlorophyll concentrations. We suspect that oysters are additionally impacted by circulation patterns that transcend one tidal cycle. The ultimate goal of this project is to quantify how much food limitation results from the filtration activity of suspension feeders lower in the intertidal zone vs. from tidally driven water circulation patterns.

†**White, J.S.\* , Boyer, S.E. , and A. Delval** *Department of Zoology, University of Florida* EFFECTS OF FARMED ALGAL TURF ON GROWTH AND SURVIVAL OF MASSIVE *PORITES*

The abundant farmerfish, *Stegastes nigricans* , farms dense filamentous algal turf comprised primarily of *Polysiphonia* spp. Farmed turf can trap sediment and previous research suggests turf alone does not increase mortality. Within Moorea, common coral species vary in their sensitivity to the presence of farmed turf: Abundant turf can lead to overgrowth, but only for species commonly colonized by farmerfish (Acroporids and Poritids). Massive *Porites* have lower live coral and altered coral morphology when colonized by *S. nigricans* , likely due to the combination of coral-algal competition and the high abundance of boring invertebrates within territories. One such invertebrate is *Dendropoma maxima* , a tube-dwelling vermetid snail that casts a mucus web to filter feed. Vermetids commonly colonize *Porites* and mucus webs within territories can serve to smother algae and reduce turf-associated sedimentation. The purpose of this study was to quantify the rate of overgrowth at the transition zone between healthy *Porites* and farmed turf within *S. nigricans* territories. Experimental manipulations were used to decouple the effects of turf, sediment, and vermetid snails. Manipulations were repeated in the austral summer and austral winter to characterize seasonal variation in overgrowth rates. Results suggest overgrowth can be intense in the presence of ambient sediment loads. However, vermetid snails can mediate this influence via normal feeding activity.

**White, J. W.<sup>1\*</sup>, Botsford, L. W.<sup>1</sup>, Coffroth, M. A.<sup>2</sup>, Paris, C. P.<sup>3</sup>, Planes, S.<sup>4</sup>, Shearer, T. L.<sup>5</sup>, Thorrold, S. R.<sup>6</sup>, and G. P. Jones<sup>7</sup>** *1 - UC Davis 2 - University of Buffalo 3 - University of Miami 4 - Universite de Perpignan 5 - Georgia Tech 6 - Woods Hole 7 - James Cook University* CONNECTIVITY AND RESILIENCE OF MARINE METAPOPULATIONS: MATCHING EMPIRICAL EFFORTS TO PREDICTIVE NEEDS

Design and decision-making for marine protected areas (MPAs) require prediction of MPA effects using population models. The pattern of demographic connectivity produced by larval dispersal is a key uncertainty in such models. The information required to assess population persistence is a dispersal matrix containing the fraction of larvae traveling to each location from each location, not just the current number of larvae exchanged among locations. Recent modeling research with hypothetical dispersal matrices has shown how the spatial scale of dispersal, degree of advection versus diffusion, total larval output, and temporal and spatial variability in dispersal influence population persistence. Recent empirical studies using population genetics, parentage analysis, and geochemical and artificial marks in calcified structures have improved our understanding of dispersal. However, many such studies report self-recruitment (locally produced settlement/settlement from elsewhere), which is not as directly useful as local recruitment (locally produced settlement/total locally released), which is a component of the

dispersal matrix. Modeling of biophysical circulation with larval particle tracking can provide the required elements of dispersal matrices and assess their sensitivity to flows and larval behavior, but it requires more assumptions than direct empirical methods. To make rapid progress in understanding the scales and patterns of connectivity, greater communication between empiricists and population modelers will be needed.

**Williams, G. D. \***, **Harvey, C. J.**, **Andrews, K. S.**, and **P. S. Levin** *NOAA - Northwest Fisheries Science Center* TROPHIC RELATIONSHIPS AND MOVEMENT PATTERNS OF SIXGILL SHARKS (*HEXANCHUS GRISEUS*) IN PUGET SOUND: INFERENCES ABOUT THEIR ECOSYSTEM ROLE FROM STABLE ISOTOPE ANALYSIS

The sixgill shark (*Hexanchus griseus*) is a large predator and passive scavenger thought to forage across the entire marine food web, making it a good candidate as an indicator species for the overall health of the Puget Sound-Georgia Basin aquatic ecosystem. However, persistent questions remain about sixgill shark diet information that clarifies energy flow and movement patterns of the breeding population within the region. We compared stable isotope ratios ( $\delta^{15}\text{N}$  and  $\delta^{13}\text{C}$ ) of white muscle tissue collected from over 70 sixgill sharks to describe their trophic level within the aquatic food web and to clarify broad movement patterns. Nitrogen stable isotope ratios of sixgill sharks were enriched relative to most other aquatic species, confirming that sixgill sharks represent one of the top trophic levels in the Puget Sound food web. Carbon stable isotope ratios, which are indicators of the sources of food web production, reflect strong spatial patterns of resource use. Subadult sharks from central Sound had highly enriched  $\delta^{13}\text{C}$  ratios, possibly reflecting dependence on benthically-derived nearshore primary production and suggesting little movement outside the Sound. In contrast,  $\delta^{13}\text{C}$  ratios of a mature female and her neonates found stranded in south Sound were highly depleted, reflecting the phytoplankton based food web typical of marine waters on the outer coast and strongly supporting the nursery hypothesis that pregnant females migrate from offshore to protected inshore waters for parturition. Finally,  $\delta^{13}\text{C}$  ratios of subadult sharks from the Juan de Fuca Strait were intermediate between the Puget Sound subadults and the adult female.

†**Winans, A.K.**<sup>1\*</sup>, and **J.E. Purcell**<sup>2</sup> *1 - Western Washington University 2 - Shannon Point Marine Center* EFFECTS OF LOW PH ON ASEXUAL REPRODUCTION AND STATOLITH FORMATION OF THE SCYPHOZOAN, *AURELIA LABIATA*

Although many anthropogenic influences such as global warming, overfishing, and eutrophication may contribute to jellyfish blooms, little is known about the potential effects of ocean acidification on jellyfish. Although jellyfish are “gelatinous”, most form statoliths of calcium sulfate hemihydrate that are components of the balance organs (statocysts). This study was designed to test the effects of decreased pH on moon jellyfish, *Aurelia labiata*, asexual reproduction and statolith formation. Polyps were raised in three pH levels, 8.1 (within average current range), 7.7, and 7.3 at 15°C. Ephyrae (juvenile medusae) produced were counted over 122 days and preserved in EtOH. Ephyra statoliths were counted and measured using image analysis. Neither the numbers of ephyrae produced per polyp or the numbers of statoliths per statocyst differed significantly among pH treatments; however, statolith size decreased significantly in low-pH treatments. Our results indicate that *A. labiata* ephyra production was little affected by low pH, but their statoliths were significantly smaller. Future research on the behavior of ephyrae with small statoliths would further our understanding of the possible effects on jellyfish survival in the wild.

†**Withy-Allen, K.R.**\*, and **K.A. Hovel** *San Diego State University* MOVEMENT OF CALIFORNIA SPINY LOBSTER, *PANULIRUS INTERRUPTUS*, IN SOUTHERN CALIFORNIA KELP FOREST HABITAT

California spiny lobsters (*Panulirus interruptus*) are the target of intense commercial and recreational

fishing in Southern California. Over a century of fishing has significantly decreased lobster abundance and size. It is crucial to protect spiny lobsters, not only to maintain a sustainable fishery, but also because lobsters enhance biodiversity in kelp forest ecosystems as predators of herbivorous urchins. The California Marine Life Protection Act (MLPA) mandates the design and management of new marine protected areas (MPAs), which will commence in Southern California this year. Spiny lobsters are a priority species of the MLPA, but we lack basic information about their behavior and habitat use for efficient design of MPAs. Home range and movement patterns of lobsters are critical pieces of information for making well-informed decisions about appropriate size and location of MPAs. Working within and outside of the La Jolla Ecological Reserve (LJER) near San Diego, we monitored short-term (nightly) and long-term (monthly) lobster movement using both active and passive acoustic tracking techniques. We quantified lobster home range, nightly foraging movements, and rates of spillover from the LJER. Lobsters exhibited minimal movement per night, but moved greater distances over a period of six months from April to October 2008. Although some immigration and emigration from the reserve was detected, lobsters generally maintained home ranges that remained either outside or inside the LJER. This research provides novel information on movement behavior and general ecology of spiny lobsters in San Diego that will be applied to the conservation of this fishery species.

†**Wolf, M.\*, and C.M. Young** *Oregon Institute of Marine Biology, University of Oregon* CASTRATOR OR CONSTRAINT? IMPACTS OF THE PARASITIC COPEPOD *ISMAILA BELCIKI* ON THE REPRODUCTIVE OUTPUT OF ITS NUDIBRANCH HOST, *JANOLUS FUSCUS*

Members of the genus *Ismaila*, endoparasitic copepods of opisthobranch molluscs, inhabit the main body cavity and/or cerata of the host. On the Oregon coast, *Ismaila belciki* can infect over 60% of their obligate hermaphroditic hosts, *Janolus fuscus*, and comprise 3-6% of the host's mass. Infected *J. fuscus* produce viable larvae, suggesting that *I. belciki* is not a complete castrator. We examined the impact of *I. belciki* on the reproductive capabilities of *J. fuscus* to determine if *I. belciki* reduces copulatory ability, sperm production, or female fecundity. Field-collected juvenile *J. fuscus* were reared in isolation to reproductive maturity. These unmated individuals, serving as females, were then mated with another infected or uninfected individual. Resulting egg masses were collected and viability and mass determined for each. Egg masses produced by individuals mated with infected or uninfected partners were similar in mass and abundance, suggesting that sperm availability or copulatory ability is not impacted by infection. To determine if *I. belciki* reduces host female fecundity, infected and uninfected *J. fuscus* were mated with one uninfected individual, then isolated. Egg masses from these isolated individuals were collected, weighed, and the number of capsules and larvae counted in each mass from each individual. Uninfected individuals produced heavier egg masses with more egg capsules and more viable larvae than infected individuals. Thus, *I. belciki* is not a complete castrator but reduces the female reproductive output of its host and may limit the natural population size of *J. fuscus*.

†**Wood, M.E.\*, Nielsen, K.J., and M.J. Donahue** *Sonoma State University* REPRODUCTIVE OUTPUT OF A KEYSTONE PREDATOR AND ITS PREFERRED PREY: THE DIFFERENTIAL INFLUENCE OF OCEANOGRAPHIC REGIME AND LOCAL HABITAT

Coastal communities experience significant variation in delivery and retention of larvae, food resources and growth at meso-spatial scales, creating meta-populations that may contribute differentially to regional larval pools. We investigated the influence of oceanographic conditions and local habitat on reproductive effort of a keystone predator, *Pisaster ochraceus*, and its preferred prey, *Mytilus californianus*, at sites influenced by two upwelling centers: Point Arena (2 sites) and Cape Mendocino (2 sites). Within each region, we focused on two dominant habitat types where both species are common: 1) large, contiguous rocky benches; and 2) sandy shorelines with large boulders and smaller rocky reefs. Oceanographic conditions were described through measurements of water temperature, seston and chlorophyll-a concentrations. We characterized *Pisaster* and *Mytilus* populations by observing: 1) recruitment, 2) abundance and size structure, 3) reproductive effort, 4) mussel growth and 5) sea star diet. *Mytilus* per

capita reproductive effort and recruitment appeared tightly linked to larger-scale, regional oceanographic influences, but reproductive effort at the site level was more strongly influenced by local scale factors such as availability of rocky habitat. In contrast, reproductive effort and population structure of *Pisaster* were more dependent on local factors such as diet quality, and were only indirectly affected by oceanography via prey availability. Thus reproductive effort of these two species in a tightly linked, predator-prey relationship did not co-vary with any of the variables we measured. When protecting ecosystems or communities, a “one size fits all” approach that ignores ecological interactions, and dynamics among meta-populations, may not be successful.

**Wormald, C. L.\*** *California State University, Northridge* REEF FORECLOSURE: IMPLICATIONS OF CORAL DECLINE FOR EXPLOITED CORAL REEF FISHES

Climate change and various anthropogenic impacts are causing the loss of live coral cover and biogenic structure on coral reefs in the Caribbean. Coral reef fish communities are also declining because of habitat loss and overexploitation. In order to effectively manage reef fisheries, we need to understand the importance of biogenic habitat to exploited species, and which species are most vulnerable to reef decline. I examined associations of exploited coral reef fishes with biogenic reef structures in the central Bahamas. A number of species were associated with large reef-building corals, others with soft coral and sponge dominated reefs, and a few species had no discernable association with habitat structure. Species associated with large coral structures accounted for 70% of the total abundance of the assemblage. If coral reefs in this region continue to degrade, these abundant coral-associated species are likely to decline in number, whereas other species may be unaffected, thus altering the composition of the assemblage. This study demonstrates that exploited coral reef fishes are not homogeneous in their habitat associations and, as such, require management approaches that account for specific habitat requirements and the risk of habitat loss.

**†Yang, S.\*** *University of Washington, Department of Biology* EMPIRICAL THRESHOLDS IN EELGRASS ABUNDANCE AND HABITAT MODIFICATION: DOES POSITIVE FEEDBACK AFFECT RESILIENCE?

An organism can modify its abiotic environment in ways that can determine its own distribution across a landscape. Eelgrass (*Zostera marina* L.), a submerged, marine angiosperm, forms patches and meadows, which can ameliorate waves and currents and stabilize sediment. Some studies suggest that these modifications to the abiotic environment can facilitate eelgrass persistence and/or spread by reducing stressful hydrodynamic conditions, but contention remains regarding the exact relationship between eelgrass abundance, spatial arrangement, and habitat modification in the field. Data on the full feedback loop could resolve this issue, but to date, studies have only investigated eelgrass-abiotic or abiotic-eelgrass interactions. Understanding the natural and dynamic process of eelgrass spread and decline may inform management and restoration practices of this declining seagrass. In Summer 2007, I created a range of eelgrass abundances within a meadow in Willapa Bay, WA by thinning/planting eelgrass shoots in 25 sq. m. plots and creating gaps within the meadow. Preliminary results show that plots with less eelgrass were more susceptible to sediment and eelgrass removal during Winter 2007-08 storms, and disturbed plots continue to have low eelgrass abundance through Summer 2008. However, recruitment by seedlings was similar in all plots, despite disturbed plots having fewer flowering shoots. Furthermore, decreasing eelgrass densities monotonically increased water flow and sediment erosion, suggesting habitat modification may play a role. In a recent, separate experiment, I have artificially stabilized sediment under eelgrass patches in high and low wave exposure areas to investigate this potential feedback mechanism.

**Young, A. N.\* , and S. F. Craig** *Humboldt State University* EFFECTS OF TEMPERATURE ON THE ASSOCIATED COMMUNITIES OF MUSSEL BEDS: ARE THEY BLACK AND WHITE?

As climate changes throughout the world, thermal stress on intertidal organisms is of increasing concern. Many studies have focused on the effects of climate change on individual species, however most of the world's rocky coast is dominated by mytilid mussels, a habitat-forming organism: on the Pacific coast beds of *Mytilus californianus* can harbor over 300 associated species. Temperature increases experienced by these ecosystem engineers may also affect their affiliated communities. In this study, plastic mussel beds were created and field temperatures of these beds were manipulated through color of these mussels. Black beds held more radiant heat than white beds and reached higher in-bed temperatures on warm days: on the warmest day of the study the highest temperature inside a black bed was 7°C higher than the warmest white bed; weekly maximum temperatures were also higher in black beds. Beds were monitored in the intertidal for approximately one year, and dynamics of the organisms living on the surface of the beds were recorded monthly. Between the bed types, differences in surface-dwelling organisms were apparent. Most noticeable was limpet abundance, with white beds consistently covered with almost four times as many limpets as black beds. Survivorship of recruited barnacles was also higher on the surface of white beds: white beds saw an average of twice the survivorship rate for barnacles as black beds. While the differences in color and temperature clearly influence the surface of these mussels and the organisms growing and grazing on them, ongoing research will examine whether these changes affect the associated species dwelling down in the beds themselves.

### CONTRIBUTED POSTER ABSTRACTS

**Aguirre, J.D., and D.J. Marshall\*** *School of Integrative Biology, University of Queensland, Brisbane, Australia* GENETIC DIVERSITY ENHANCES PERFORMANCE IN THE FIELD

Empirical and theoretical research has demonstrated that varying levels of diversity can have strong effects on the resilience and dynamics of communities. However the effects of genetic diversity among individuals within a population have received less attention and its effects are not well understood. Genetic diversity can affect a population's response to processes such as disturbance and competition and is likely to have important consequences for the structure of populations in general. Here, we examined the effects of genetic diversity on the post-metamorphic performance of a filter feeding, marine invertebrate (*Bugula neritina*) in the field. Using a manipulative field experiment, we show that in high diversity (10 individuals from 10 different parent colonies) colonies survived better, grew faster and increased size-specific fecundity relative to colonies in low diversity assemblages (10 individuals from the same parent colony). Together these results suggest genetic diversity enhanced the lifetime performance of *B. neritina* in the field. We suggest that genetic diversity can have strong persistent effects on the performance of individuals affecting the recruitment and structure of populations.

**Austin, H.L. \*, and C.M. Young** *Oregon Institute of Marine Biology* THE EFFECT OF HYPO-OSMOTIC STRESS ON VOLUME REGULATION, ION REGULATION AND MORTALITY OF THE SEA ANEMONE *METRIDIUM SENILE* IN SOUTH SLOUGH, COOS BAY, OREGON

The sea anemone *Metridium senile* is found along a salinity gradient in the South Slough Estuary, Coos Bay, Oregon, where it is subjected to frequent and sometimes large decreases in salinity. The purpose of this study is to determine how hypo-osmotic stress contributes to the survival and distribution of *M. senile* within the South Slough Estuary using weekly measurements of body volume, ionic composition and mortality of individuals transplanted to riverine, mesohaline and marine dominated sites within the South Slough Estuary. In July 2008 transplants demonstrated ion and body volume conformation for the first week, and possible ion and body volume regulation for the remaining three weeks of exposure. Mortality was highest at the riverine site. In the laboratory, exposure to 50%, 75% and 100% seawater for twenty-one days resulted in initial conformation of body volume within the first two days. Magnesium ion concentrations showed combined responses of ionoconformation for the first ten days and ionoregulation for the last eleven days of exposure to hypo-osmotic conditions.

**Barr, R.J.<sup>1\*</sup>, and J.E. Caselle<sup>2</sup>** 1 - Dept. of Biology, San Diego State University 2 - Marine Science Institute, University of California, Santa Barbara GOOD SMURF, BAD SMURF: WHAT FACTORS AFFECT A SMURF'S PERFORMANCE?

SMURFs (standard monitoring units for the recruitment of fishes) are effective devices for estimating settlement of kelp-associated fishes. SMURFs were deployed at several locations in the northern Channel Islands and along the adjacent Santa Barbara coast and monitored biweekly during the peak settlement season (March-November) from 2000-2007. Although distinct spatial patterns of settlement were observed, these patterns are potentially confounded by factors that might affect each individual SMURF's ability to attract and retain settling fishes. Such factors include the presence of drift kelp on or around the SMURF, the amount of biofouling on the SMURF, and the distance from the SMURF to the nearest kelp forest canopy. We explore these factors to determine whether they (1) vary significantly from site to site, and (2) alter an individual SMURF's performance, which should be taken into account when interpreting observed patterns of settlement.

**Behrens, M.D.\*** Department of Biology, Pacific Lutheran University SPATIAL AND TEMPORAL VARIATION IN SEA URCHIN DISEASE ON THE OLYMPIC PENINSULA, WASHINGTON

Diseases in marine systems are known to be both ecologically important and increasing over time. Sea urchin diseases have been shown to cause dramatic shifts in the community structure of coral reefs and temperate rocky reefs. However, it has been difficult to determine the factors that drive variation in disease prevalence due likely to the complex processes leading to disease outbreaks. Sea urchins in the genus *Strongylocentrotus* on the west coast of North America suffer from multiple disease pathologies. Surveys of intertidal populations of purple sea urchins (*Strongylocentrotus purpuratus*) along the Olympic Peninsula of Washington show spatial and temporal variation in disease prevalence. This variation in disease prevalence is consistent with temperature driving spatial and temporal patterns of disease, but not consistent with associations between storm damage or urchin density and disease prevalence. Other factors such as pollution may play a role, but cannot be assessed at this time. The potential association with temperature is consistent with past studies of these disease pathologies from central and southern California and Baja California. Disease was also observed in red sea urchins (*Strongylocentrotus franciscanus*) and green sea urchins (*Strongylocentrotus droebachiensis*) indicating potential threats to local fisheries. Future studies should continue to monitor patterns of disease across space and time in addition to environmental parameters likely associated with disease outbreaks.

†**Berriman, J.S.<sup>1</sup>, Mason, M.J.<sup>1</sup>, Denny, M.W.<sup>2</sup> and W.G. Wright<sup>1\*</sup>** 1- Biological Sciences, Chapman University, Orange, CA 2- Hopkins Marine Station, Stanford University WATER CANNON DISCHARGES THAT MIMIC MODERATE WAVES REVEAL ELEVATED RISK OF DISLODGMET DURING TERRITORIAL ENCOUNTERS IN THE INTERTIDAL LIMPET, *LOTTIA GIGANTEA*

Agonistic encounters typically carry with them significant risks, both intrinsic and extrinsic. For the territorial owl limpet, *Lottia gigantea*, a resident of the wave-washed intertidal regions of California, an ever-present extrinsic risk is dislodgement by wave action. This risk is relatively low when a limpet is stationary, but is greater for a foraging limpet. Limpets engaged in agonistic encounters often move 100 times faster than when simply foraging. We hypothesized that high-speed agonistic encounters make limpets even more vulnerable to dislodgement by waves. To mimic the effects of wave action, we exposed these rapidly moving limpets to water-jet discharges from recreational water-guns. We found that small limpets (30-40 mm) were more vulnerable (65%) to dislodgement by water guns than were large limpets (>50 mm; 43% dislodged), and that limpets moving at high speeds (>15 cm/min) were more vulnerable (87% dislodged) than limpets moving at slow speeds (1-5 cm/min, 17% dislodged). Stationary limpets, especially large ones, were rarely dislodged by water guns. Video and force measurements indicated that the water-gun discharge travels at 4-5 m/sec and exerts a shear-force of 4-6 Newtons. We

used linear wave-theory, to calculate the probability of exceeding such water speeds and forces during a one-minute behavioral response in a moderate sea (2 m significant wave height). This probability was 2.0% for speed, and 1.0 % for force. Such high probabilities would be expected to exert strong selection on territorial strategies. We are presently exploring this hypothesis.

†**Blaine, J. M.<sup>1\*</sup>, Tissot, B. N.<sup>1</sup>, Starr, R. M.<sup>2</sup>, and M. M. Yoklavich<sup>3</sup>** 1 - Washington State University Vancouver 2 - Moss Landing Marine Lab 3 - NOAA Fisheries, Santa Cruz DEEP-POPULATION DISTRIBUTION OF TWO COMMERCIAL SPECIES OF SEA CUCUMBERS, *PARASTICHOPUS CALIFORNICUS* AND *PARASTICHOPUS LEUKOTHELE*, IN CENTRAL CALIFORNIA WATERS

Sea cucumbers are fished around the world. Along the west coast of the U.S., *Parastichopus californicus* is the primary species targeted in both a dive and trawl fishery, and *Parastichopus leukothele* is also likely collected in trawls. As most fishery stock assessments target shallow populations of sea cucumbers, the deeper populations often go unmonitored. The purpose of this study is to identify the spatial distribution and dynamics of the deeper (>30m) populations of *P. californicus* and *P. leukothele* in central CA. Using the Delta submersible dive footage from the 2007 central CA marine protected area baseline surveys, individual sea cucumbers of these species were identified and sized. Additional dynamics to be analyzed or described include density, spatial arrangement, macrohabitat, and microhabitat. In preliminary counts, 705 *P. californicus* and 497 *P. leukothele* were identified. Both species have been most abundant in macrohabitats with hard bedrock or ridge substrate, but initial microhabitat data show that *P. leukothele* is more common on mud. Results from this study will provide a fishery-independent analysis of understudied deep sea cucumber populations that may be helpful in the management of these two species.

**Braby, C.E.<sup>1</sup>, Pearse, V.B.<sup>2\*</sup>, Bain, B.A.<sup>3</sup>, and R.C. Vrijenhoek<sup>1</sup>** 1 - Monterey Bay Aquarium Research Inst., Moss Landing, CA 95039, USA 2 - Long Marine Lab., University of California, Santa Cruz, CA 95060, USA 3 - Biology Dept., Southern Utah University, Cedar City, UT 84720, USA PYCNOGONID-CNIDARIAN INTERACTIONS IN THE DEEP MONTEREY SUBMARINE CANYON

Whale carcasses, sunken wood, and cold seeps provide organically enriched oases in the food-limited deep-sea benthos. At 3 such enriched habitats in Monterey Bay, CA, at a depth of nearly 3,000 m, we observed pycnogonids (sea spiders) of at least two species, *Colossendeis gigas* and *C. japonica*, feeding on sea anemones that were commonly found there. Submersible remotely operated vehicles (ROVs) provided direct observations of feeding, as well as high definition video and photographic images. We recorded the co-occurrence of both pycnogonids and prey anemones during 10 of 12 visits during 2002-2006. The sedentary anemone *Anthosactis pearseae* was attached directly to whalebones while the pom-pom anemone, *Liponema brevicornis*, was found resting on soft sediment, rolling in benthic currents, or accumulating where these currents were disrupted by topography, as at whale-falls, wood-falls, and clam fields. Both pycnogonid species were observed feeding on these anemones using multiple feeding strategies. Like the pom-pom anemones, large pycnogonids were conspicuously more abundant at these oases than in the surrounding benthos. This predator-prey pair potentially disperses together, and pycnogonids are a plausible selective force in the evolution of tentacle autotomy by pom-pom anemones.

†**Brown, A.L.<sup>1\*</sup>, Hay, M.E.<sup>2</sup>, and W. Morrison<sup>2</sup>** 1 - Brown University 2 - Georgia Institute of Technology WHO WINS THE FOOD FIGHT? INTER- VERSUS INTRASPECIFIC COMPETITION BETWEEN *POMACEA INSULARUM* AND *POMACEA HAUSTRUM*

Invasive species colonize areas where they are not native and commonly suppress native species. Many negative interactions between native and invasive species have been documented, however, some habitats have numerous invasive species, and potential interactions between invasives are not well studied despite recent suggestions that positive interactions among multiple invasives may cause "invasion meltdowns." Here we examined the inter- and intraspecific competition of two invasive apple snails – *Pomacea insularum*, a new invader in the southeastern United States and *P. haustrum*, an invader present since the

1980s. Their preference and consumption of a native and non-native plant were assessed to evaluate the degree of diet overlap and to suggest how their feeding might impact the environment. Results suggest that the recent invader (*Pomacea insularum*) may competitively suppress *P. haustum* by consuming not only the mutually preferred native plant, but also the less preferred exotic plant. Between the two invaders, the effects of interspecific competition were stronger on *P. haustum*, whereas only intraspecific competition elicited a significant depression of growth on *Pomacea insularum*. This study elucidates some of the patterns occurring presently in the field, and suggests how *Pomacea insularum*, the new invader, may impact the region.

**Budgell, D. \*, Harley, C., and B. Gooding. University of British Columbia** THE ECOLOGICAL IMPLICATIONS OF SHELL COLOR POLYMORPHISM IN THE BLUE MUSSEL, *MYTILUS TROSSULUS*

The blue mussel, *Mytilus trossulus* is an abundant and important component of the intertidal ecology of the west coast of North America, mainly acting as a reliable food source for other animals year round. The focus of this study was to explore the ecological implications of the color polymorphism of the shells which can range from light brown to black. Several field and laboratory studies conducted in Vancouver, British Columbia found no apparent differences in predator prey interactions with *Pisaster ochraceus*, shell strength, or growth rate. However, significant differences in morphometry and thermoregulation were observed. Most importantly, the difference in the rate of heat absorption by the two types of shells may have implications on the survival rate during heat waves.

**Burnaford, J.L.<sup>1\*</sup>, Henderson, S.Y.<sup>1</sup>, Jenkins, K.<sup>2</sup>, and T. Trinidad-Gonzalez<sup>2</sup>** <sup>1</sup> - University of Puget Sound <sup>2</sup> - University of Washington Friday Harbor Laboratories PATTERNS OF ASSOCIATION BETWEEN THE INVASIVE BIVALVE *NUTTALLIA OBSCURATA* AND THREE SPECIES OF NATIVE KLEPTOPARASITIC CRABS IN THE PUGET SOUND

The purple varnish clam, *Nuttallia obscurata*, is an invader in the high intertidal zone of sandy beaches of the Pacific Northwest coast. In the San Juan Islands, WA, (USA), densities of this clam vary greatly among sites, from fewer than 25 clams / m<sup>2</sup> to more than 400 clams / m<sup>2</sup>. After preliminary studies showed that three species of native kleptoparasitic pea crabs (*Pinnixa faba*, *Pinnixa littoralis*, and *Fabia subquadrata*) infected *Nuttallia*, we conducted field surveys to quantify the patterns of association between the species over space (between sites) and time (between years). The proportion of *Nuttallia* infected by pea crabs varied greatly among sites, and the three species of pea crabs were not equally abundant at all locations. Our field observations and laboratory experiments indicated that *Pinnixa faba* and *P. littoralis* move between hosts, and both crabs have multiple mechanisms by which they can infect *Nuttallia*. In areas where *Nuttallia* co-occurred with other bivalves, pea crab infections in the purple varnish clam were higher than we predicted based on the relative abundance of bivalve species. Together these data indicate that the association of these native crabs and this highly abundant invasive bivalve may have important consequences for their respective populations and for community dynamics on Pacific Northwest beaches.

**Byrnes, J.E. \*, Reed, D.C., Holbrook, S.J., and B.C. Cardinale** Marine Science Institute, University of California, Santa Barbara LONG-TERM KELP REMOVAL AT THE SANTA BARBARA COASTAL LTER: A TEMPLATE TO EXAMINE THE CONSEQUENCES OF CLIMATE CHANGE

In a variety of ecosystems around the globe, climate change is projected to cause substantial changes in the abundance of major habitat forming species. Winter storms, a major source of disturbance for the giant kelp, *Macrocystis pyrifera*, and its associated biota are expected to increase in frequency and severity in California. To investigate the ecological consequences of the resulting regular kelp loss for the structure and function of kelp forest communities, the Santa Barbara Coastal Long Term Ecological Research (LTER) site initiated a long-term experiment (LTE) in which kelp is removed annually from



permanent 40m x 40m plots at four different sites. These plots are then compared to paired undisturbed control plots. After one year, high densities of small juvenile kelps established on manipulated sites but not controls. The gradient of community states created by the LTE also presents opportunities for novel explorations of community level processes in the subtidal. For example, During the course of the experiment, we find that algal species richness was positively correlated with understory biomass, a finding that matches manipulative work both in intertidal grassland communities. This occurs despite the fact that changes in algal richness and understory biomass over time appear uncorrelated. Beyond these examinations of changes to community structure, the LTE exists to provide a template for researchers to examine a broad suite of ecosystem processes including primary and secondary productivity, detrital accumulation and decomposition, herbivory, feedbacks between ecosystem structure and function, and more. Using similar long-term manipulations as a setting for ecological experiments may prove to be key in providing insight into changes in ecological dynamics in a changed world.

**Compton, V.M.<sup>1\*</sup>, Turgeon, K.<sup>2</sup>, and F. Guichard<sup>2</sup>** <sup>1</sup> - San Diego State University, McGill University <sup>2</sup> - McGill University, Montreal, QC, Canada  
MODELING EFFECTS OF CORAL REEF COMMUNITY DYNAMICS ON *DIADEMA ANTILLARUM* DISEASE SPREAD AND RECOVERY

The 1984 Caribbean-wide epidemic and mass mortality of the sea urchin *Diadema antillarum* has generated much interest in its ecological impacts, yet only recently have there been attempts to model possible relationships between reef dynamics and pathogen behavior. In this study, we model the epidemic spread of disease in sea urchin populations to better understand dynamics before and after a strong disturbance at different spatio-temporal scales. Using a novel approach to understand pathogen spread of *Diadema*, we modeled the intrinsic community dynamics – competition, facilitation, and density of *Diadema* – instead of extrinsic factors such as oceanic currents. We subsequently focused on these community dynamics to model population recovery. The community was first separated into two isolated modules acting at different spatial and temporal scales, to enable us to understand how these different processes affected the community during the epidemic. Module 1 incorporated competition between herbivorous fishes and *Diadema* with a Susceptible-Infected-Recovered (SIR) model of disease spread, and Module 2 employed a stage-structured competition model in which *Diadema* larvae compete spatially with algae. Results from the first module showed that community dynamics shift to another stable state in equilibrium, or limit cycle oscillations. In Module 2, algae reached a much higher density when an outbreak of disease occurred at a high population density of *Diadema*. This rapid response quickly enabled algae to outcompete *Diadema* larvae for available substratum, which may explain the historically slow recovery of *Diadema* populations.

†**Conahan, G.C. \*, and K.E. Boyer** Romberg Tiburon Center for Environmental Studies and San Francisco State University  
EPIPHYTIC AND BENTHIC MACROALGAE SURVEYS ACROSS FOUR SAN FRANCISCO BAY EELGRASS BEDS; IMPLICATIONS FOR SPECIES INTERACTIONS AND TROPHIC DYNAMICS

Seagrasses are important primary producers worldwide and they harbor myriads of other species of primary producers, including algal epiphytes on seagrass blades and benthic macroalgae. We conducted a survey of these three primary producer groups in San Francisco Bay eelgrass (*Zostera marina*) beds to support mesocosm experiments focused on evaluating the interactions of these groups and their role in trophic dynamics. In July/August 2008, we surveyed four eelgrass beds, estimating eelgrass densities, biomass, and productivity (plastochrone method), epiphyte biomass, and biomass of each macroalgal species. We found highly variable species compositions, biomass, and productivity across these four eelgrass beds. While this survey will be repeated in multiple seasons, our initial conclusions from the summer survey are that the total and relative contribution of primary production varies dramatically across San Francisco Bay eelgrass beds, having implications for eelgrass health and food availability for higher trophic levels.

**Cook, A. E.\*** *The Evergreen State College* A MULTIDISCIPLINARY APPROACH TO TEACHING ECOLOGY

Many early naturalists drew the subjects of their study, including plants, animals and landscapes. With the development of photography, film and video fewer and fewer students recognize the value of drawing what they see around them. In 2004 I taught a class with an artist that we called “Visualizing Ecology”. The idea was to combine art and science in a way that would benefit both students whose primary interest was in the sciences and students whose primary interest was in the arts. We attracted a good mix of “art students” and “science students” and both groups benefited in a variety of ways from the combination of drawing and ecology. Students improved their observation skills, developed a deeper understanding of ecological concepts, and discovered the value of art and aesthetics in communicating with people outside of academia. In the process of teaching the class, I developed a great appreciation of how these two disciplines can support and enrich each other. Even in the absence of an institutional structure that supports interdisciplinary team teaching, there are ways to use art, and drawing in particular, to improve students’ understanding of ecology and the natural world.

†**Crim, R.N.<sup>1</sup>, Fredrickson, K.A.<sup>2</sup>, and S.L. Strom<sup>2</sup>** *1 - University of British Columbia 2 - Shannon Point Marine Center* PHENOTYPIC VARIABILITY AMONG STRAINS OF THE TOXIC ALGA, *HETEROSIGMA AKASHIWO* (RAPHIDOPHYCEAE) FROM NE PACIFIC WATERS

High levels of intra-specific variability are often associated with many harmful algal bloom (HAB) species. This variability is likely an important factor allowing HAB species to dominate the algal community. *Heterosigma akashiwo* is an ichthyotoxic raphidophyte alga capable of forming dense surface-water blooms in coastal temperate regions throughout the world. In this study we measured and compared maximum potential growth rates, growth rate dependence on salinity, photosynthetic capabilities, morphology, C and N content, and toxicity to a microzooplankton grazer of four single cell isolates of *H. akashiwo* isolated from fish-killing blooms that occurred in the Salish Sea, Washington, USA (2006-2007). We found substantial variation among the *H. akashiwo* strains used in this study. These strains were isolated from a small region of the Salish Sea and showed considerable variation in phenotypic characteristics that may be related to isolation location, source population, or bloom timing.

†**Donald, J.L.\*** *Romberge Tiburon Center, San Francisco State* “GROWTH RATE COMPARISON OF THE INVASIVE COLONIAL ASCIDIANS *BOTRYLLOIDES* AND *BOTRYLLUS SPP.* BETWEEN A COASTAL AND AN ESTUARINE ENVIRONMENT”

Colonial tunicates *Botryllus* and *Botrylloides spp.* of the protochordate family Botryllidae are invasive invertebrates found worldwide in fouling communities. They grow as flat irregularly shaped colonies composed of clonally-replicated zooid systems. Both species are used in a variety of studies concerning developmental biology, evolutionary ecology and allorecognition studies. At two San Francisco Bay area locations (one outer coast site and one inner bay), growth rates of adult individuals were measured over 3-4 weeks in October and November of 2007. Fouling panels were groomed to remove any organisms that could compete directly for space and food with the experimental subjects. Preliminary analysis of data compares growth patterns including zooid counts and colony spatial extent between these two separate habitats where both genera are commonly found. Use of outer coast and inner bay environments provides two dramatically different environments in terms of salinity, temperature, food abundance, composition and diversity and abundance of local and other invasive fauna. Information about growth rates of *Botryllus* and *Botrylloides spp.* will provide important information about the relative abilities of these organisms to successfully compete for space and invade new habitats.

†**Duerr, J.C.\***, **Rollwagen Bollens, G.C.**, and **S.M. Bollens** *School of Earth and Environmental Sciences, Washington State University Vancouver* CONTROLLING TOXIC CYANOBACTERIA BLOOMS IN VANCOUVER LAKE: THE EFFECTS OF GRAZING AND ENVIRONMENT

Vancouver Lake is a large, shallow lake located in the urbanized lower Columbia River floodplain in Vancouver, Washington. Seasonal toxic blooms of blue-green algae called cyanobacteria (*Aphanizomenon flos-aquae* and *Anabaena flos-aquae*) have been occurring in the lake for the past 20 years. These blooms can potentially harm small animals and children and degrade the aquatic habitat but may be controlled through predation and environmental factors, such as nutrient supply. It is unknown whether microzooplankton graze on cyanobacteria or other phytoplankton and how environmental conditions contribute to bloom formation. This ongoing research will analyze the relationships between environmental conditions, microzooplankton grazing, and growth rates of cyanobacteria, providing information for effective management of this and similar lakes. I conducted several dilution experiments which use varying ratios of filtered lake water to unfiltered lake water to determine the intrinsic growth rate of phytoplankton and the microzooplankton grazing rate. The dilutions ranged from 0-100%; less microzooplankton are present in diluted lake water and thus phytoplankton growth is less inhibited. I added nitrate and phosphate to some of the samples to determine if the phytoplankton growth rate was nutrient-limited. The phytoplankton were nutrient-limited at the beginning of the growing season (April – mid-June) and during the peak of the bloom (late August), but not immediately before the peak of the bloom (end of June – mid-August). The growth rate increased from April through June then declined. The grazing rate followed a similar trend. Further investigation will incorporate the community composition of the samples and other environmental variables.

**Dufault, A.M. \*, and P. Levin** *NOAA Fisheries* EATING THROUGH THE FOOD WEB? AN ANALYSIS OF SEAFOOD RECIPES IN PUGET SOUND

In his book “The world according to Pimm” ( 2001, McGraw-Hill), Stuart Pimm quips that one only has to compare two editions (1974 vs. 1997) of The Joy of Cooking to appreciate the effects of fisheries on ocean ecosystems. In 1974 higher trophic level species dominated, but by 1997 lower trophic level species were more prevalent in the cookbook. Following Pimm’s notion, we searched libraries in the Puget Sound region for locally published cookbooks. We reviewed nearly 1500 recipes from about 100 cookbooks published between 1885 and 2006. As Pimm would have predicted, in some cases, our results do reflect the changing fisheries of the region. Rockfish recipes, for example, rise and crash with the local fishery. On the other hand, we do not see dramatic temporal shifts in trophic level. Despite clear evidence that the trophic level of the catch has declined, trophic level of the recipes is consistently high. We interpret this as evidence for continued strong consumer pressure on higher trophic levels in the Puget Sound food web.

**Freeman, A. S. <sup>1\*</sup>, Short, F.T. <sup>1</sup>, Isnain, I. <sup>2</sup>, Razak, F. A. <sup>2</sup>, and R. G Coles <sup>3</sup>** *1 - Jackson Estuarine Laboratory, University of New Hampshire, Durham, NH, USA 2 - Sabah Parks, Marine Research Unit, Kota Kinabalu, Sabah, Malaysia 3 - Northern Fisheries Centre, Queensland, Australia* SEAGRASS ON THE EDGE: LOCAL LAND-USE PRACTICES THREATEN COASTAL SEAGRASS COMMUNITIES IN SABAH (MALAYSIA)

Seagrass habitats are susceptible to coastal, environmental impacts and serve as early indicators of system-wide degradation. SeagrassNet is a global seagrass monitoring network with 60 sites in 22 countries doing quarterly assessment of fixed transects for plant and environmental parameters ([www.SeagrassNet.org](http://www.SeagrassNet.org)). Two SeagrassNet sites were established in Sabah (Malaysia) in 2001 in a national park, with one as a reference (pristine) site and one anticipating impacts from nearby waterfront development. Seagrass percent cover at both sites declined significantly between 2003 and 2005, and has remained low in areas of both low and high seagrass diversity (ranging from 1 to 5 species). The extent of species loss, reduction in percent cover, and decreased biomass in both the pristine site and the impact site is indicative of system-wide degradation. We discuss possible causes of the seagrass decline with respect to our simultaneously collected environmental data (i.e., light extinction, temperature, and sediment parameters) and identify a link to a recent change in land-use practices which resulted in extensive

deforestation of the watershed proximal to the two Sabah SeagrassNet sites. Satellite imagery confirms the persistent sediment plume covering both SeagrassNet sites and the waters of the national park.

†**Friedenberg, L. E.\***, and **S.M. Bollens** *Washington State University Vancouver* FEEDING PREFERENCE OF LARVAL PACIFIC HERRING (*CLUPEA PALLASI*) ON NATURAL ASSEMBLAGES OF MICROPLANKTON

In this study we examined the role of protozoan microplankton in the diet of larval Pacific herring (*Clupea pallasii*). Larval fish may prey upon protozoans (single celled eukaryotes) during periods of food limitation when there is low food availability, or before their gape size can accommodate large prey. In order to determine if first feeding Pacific herring consume protozoans, we conducted six in vitro feeding studies during the herring spawning seasons of 2007 and 2008. Field collected larval Pacific herring were exposed to natural assemblages of prey (<200µm) from the coast of Marrowstone Island, Washington. Sixteen experimental chambers, filled with natural seawater containing prey items, were used in each experiment with a range of 0 to 16 herring larvae in each chamber. After each experiment, the seawater in the experimental chambers was preserved and the plankton were enumerated. This methodology allowed for the detection of soft-bodied protozoans in the diet. We found that the larval herring consumed all groups of protozoans available to them, including loricate ciliates, aloricate ciliates, and dinoflagellates. The herring also fed on other groups of microplankton, including crustaceans, rotifers, and diatoms. These results illustrate that larval herring will eat protozoans and that protozoans may potentially alleviate food limitation. By eating protozoans larval fish provide a link between the microbial loop and higher trophic levels.

†**Garske, Lauren E.\***, and **John L. Largier** *UC Davis/Bodega Marine Lab* ZONES OF IMPACT: FRESHWATER RUNOFF AND NEARSHORE HABITATS IN CENTRAL CALIFORNIA

The transport and dynamics of small-scale freshwater flows (daily mean < 100cfs) entering the nearshore ocean environment (< 30m depth and < 1km from shore) from land and river runoff are poorly understood. Meanwhile, some of the most intensely-studied marine ecosystems lie within this zone and their exposure to harmful runoff constituents (e.g., nutrients, toxins, pathogens) may be significant. Here, we introduce the 'zone of impact' concept and present an oceanographic dataset from near the San Lorenzo River (Santa Cruz, CA). During April-May 2008, we moored an array of near-surface sensors in adjacent kelp forest habitat (7-10m depths), which continuously recorded high-resolution temperature-salinity (TS) data. We also collected shoreline time series data along a 2km transect with a handheld instrument. Our results indicate that during a period when river flow averaged only ~30cfs, runoff identified by salinity differences could be detected at moored instruments 2km from the rivermouth; dilution factors within the emerging kelp forest ranged from 33-87. Inside the surf zone, river runoff mirrored this and could be traced at least 2km alongshore with dilution factors ranging from 1-76. Combined, these data suggest that the zone of impact for a pollutant requiring at least 100X dilution can extend to nearly 3km away; inclusion of parameters for constituent load, decay and sensitivity will refine this prediction. Tides, precipitation, local winds and waves were also examined as covariants in this study.

†**Gibble, C.M.\*** *Moss Landing Marine Laboratories* FOOD HABITS OF HARBOR SEALS (*PHOCA VITULINA RICHARDII*) IN SAN FRANCISCO BAY, CA

Harbor seals are carnivorous opportunists, and are considered one of the top predators in San Francisco Bay (SFB). Because they forage opportunistically, the diet of harbor seals may be a good indicator of prey species composition in the bay and ecosystem health. Harbor seals inhabiting SFB have a lesser growth rate than seals inhabiting the rest of the California coast, and there is evidence that changes in the distribution of fish populations within the bay have affected local food availability for resident seals. Because harbor seal numbers in SFB are of concern, and local food source depletion is a possible factor, it

is important to have an understanding of harbor seal diet within the bay. I collected scats at haul out locations in both Northern and Southern SFB in spring 2008 (March-June), and used scat analysis to determine diet (n=20). Scat analysis, a non-invasive technique, is used to determine diet by identifying skeletal remains. I compared the diet analysis with that of Torok (1994) for the same time of year. In spring 1994, in terms of percent frequency of occurrence, the diet primarily consisted of yellowfin goby (*Acanthogobius flavimanus*) (47.2%), plainfin midshipman (*Porichthys notatus*) (26.4%), and northern anchovy (*Engraulis mordax*) (20.8%), whereas in 2008 the diet primarily consisted of shiner surfperch (*Cymatogaster aggregata*) (27.7%), yellowfin goby (27.7%), plainfin midshipman (27.7%), and northern anchovy (27.7%). The differences in diet between years may be attributed to changes in local food availability. These are preliminary results, further investigation is in progress.

†Gravem, S.A.<sup>1\*</sup>, Campanale, J.C.<sup>2</sup>, Mallonee, M.<sup>2</sup>, Ewers, C.<sup>2</sup>, Malicoat, A.<sup>2</sup>, Goschke, G.<sup>2</sup>, Suronen, E.<sup>2</sup>, Daugherty, M.<sup>2</sup>, Maher, E.<sup>2</sup>, Strickler, S.<sup>2</sup>, and N.L. Adams<sup>2</sup> 1 - Cal Poly, San Luis Obispo and UC Davis 2 - Cal Poly, San Luis Obispo EFFECTS OF EXPOSURE TO SOLAR ULTRAVIOLET RADIATION (SUVR) AND ACCUMULATION OF NATURAL SUNSCREENS IN THE PURPLE SEA URCHIN (*STRONGYLOCENTROTUS PURPURATUS*)

Purple sea urchins, *Strongylocentrotus purpuratus* are commonly exposed to damaging levels of solar ultraviolet radiation (sUVR) and acquire natural sunscreens, mycosporine-like amino acids (MAAs), from their algal diets. To understand whether exposure to sUVR may affect reproduction, development of offspring and accumulation of MAAs, we reared *S. purpuratus* that were exposed to or protected from sUVR and fed either MAA-rich or MAA-poor algae from October 2007 through February 2008 (treatments = 1) -UVR -MAA, 2) -UVR +MAA, 3) +UVR -MAA, 4) +UVR +MAA). Gonads and epidermis of sea urchins were sampled three times over five months for proteins and MAAs. Eggs were harvested to evaluate whether diet and sUVR affect egg volume. Preliminary results indicate that exposure of females to sUVR significantly reduced egg volume (fecundity) (n=12, p<0.017), whereas MAA diet did not affect egg volume. Subsequent embryos from these batches of eggs were exposed to or protected from a 60-minute exposure to UVR. All embryos exposed to sUVR experienced a delay in cleavage rates. Embryos from +UVR adults experienced significantly shorter amount of delay, both in percent and minutes, than those from UV-protected adults (p<0.05). There was no difference in delay due to the diet of adults and there was no interaction in cleavage delay between adult UV-treatment and MAA diet. These data indicate that adults exposed to sUVR may transmit some protective factor, not specifically MAAs, to their eggs. MAA and proteomic analysis of eggs and early embryos is currently in progress.

†Gravem, S.A.<sup>\*</sup> Cal Poly, San Luis Obispo and UC Davis UBIQUITOUS AQUATIC NATURAL SUNSCREENS, THE MYCOSPORINE-LIKE AMINO ACIDS, ARE NOT PRESENT IN SEA OTTER EYE TISSUES

Mycosporine-like amino acids (MAAs) are a suite of natural sunscreens that absorb and provide protection against ultraviolet radiation (309-360 nm). MAAs are produced by unicellular and multicellular algae, bacteria and fungi. Non-photosynthetic organisms generally acquire MAAs dietarily or through symbiosis. Though MAAs have been documented in diverse marine and aquatic phyla including Chordate fishes, no marine mammals have been tested for MAAs. Eye tissues (including lens, cornea and retina) of a Central Californian sea otter (*Enhydra lutris*) were tested for the presence of MAAs. The individual tested exhibited evidence of a diet rich in purple sea urchins (e.g. purple teeth and bones), which can contain MAAs. No MAAs were detected in any tissues. These data are consistent with studies demonstrating that terrestrial mammals lack MAAs and suggest that sea otters lack the ability to acquire MAAs through their diets.

†Hartman, C.D.<sup>\*</sup>, White, J.S., and C.W. Osenberg Department of Zoology, University of Florida THE ROLE OF VERMETID SNAILS IN SEDIMENT REGULATION IN RELATION TO FARMERFISH

## TERRITORIES

Little is known about the effect of sediment-consuming vermetid snails on community composition. These snails are abundant on *Porites* reefs throughout the lagoons of Moorea, French Polynesia and, through their almost continuous feeding, appear to affect sediment dynamics. In particular, they can indirectly alter the rate of *Porites* overgrowth by algal turf farmed by the dusky farmerfish, *Stegastes nigricans*. The purpose of this study was to determine vermetid abundance in relation to *S. nigricans* and corresponding differences in sediment dynamics in the presence of farmed algal turf. We used recruitment tiles outplanted to *Porites* reefs in the presence, absence and removal of farmerfish to test whether farmerfish alter vermetid abundance and examine potential feedbacks on sediment dynamics. For each tile side, we identified algae and sediment abundance with stratified random points, and quantified the size and density of vermetids using in situ counts and Coral Point Count with Excel extensions (CPCe). This research builds upon previous lagoon surveys which indicated vermetids and *S. nigricans* commonly colonize dominant massive *Porites*, as well as experimental evidence suggesting vermetid presence can ameliorate overgrowth by farmed turf.

**Hondolero, D.E.<sup>1\*</sup>, and J.E. Palardy<sup>2</sup>** 1 - San Diego State University, Dept. of Biology, 5500 Campanile Dr., San Diego, CA, 92182-4614, USA 2 - Brown University, Dept. of Ecology & Evolutionary Biology, 80 Waterman Street, Box G-W, Providence, RI 02912, USA EFFECTS OF DISTURBANCE IN A HIGH-LATITUDE, ESTUARINE KELP COMMUNITY

While many studies have examined the effects of disturbance on kelp communities through experimental and observational methods at lower latitudes, fewer have done so in high-latitude kelp communities where seasonal fluctuations in light and nutrient availability can be far more extreme. Here, we report the effects of disturbance on canopy and understory kelp communities in Kachemak Bay, Alaska. Storm damage was simulated by removing all canopy-forming kelp species in three large (5 m radius), shallow (5 m below MLLW) patches. Changes to canopy and understory community structure were recorded following one year in disturbed and adjacent control patches. Recovery of the disturbed canopy community was rapid (<1 year), with stipe densities in disturbed plots higher than control plots. Disturbed plots were characterized by higher recruitment rates of the perennial kelps *Saccharina latissima*, *Saccharina subsimplex*, and *Agarum clathratum*. The understory of disturbed communities was characterized by an increase in recruitment of several red algal species. Our results suggest that kelp communities at sub-arctic latitudes may be more resilient than kelp communities found at higher or lower latitudes.

†**Jacobson, L.M.<sup>1\*</sup>, and P.J. Edmunds<sup>2</sup>** 1 - Dept. of Biology, Northeastern University, Boston, MA 2 - Dept. of Biology, California State University, Northridge, CA A PRELIMINARY INVESTIGATION OF SEAWATER QUALITY OVER FRINGING REEFS IN ST. JOHN, U.S. VIRGIN ISLAND

On some of the reefs in St. John, USVI, a combination of acute and chronic disturbances has killed 82% of the coral since 1987. While it is clear that storms, bleaching, and disease have served as acute disturbances, it is more difficult to account for the chronic losses. The objective of this study was to measure light transmission (LT), POM, and zooplankton content of seawater to gain insights into the role of water quality in contributing to chronic coral mortality. In August 2008, standard methods were used to quantify POM and zooplankton at the surface and at 10 m depth in Great Lameshur Bay (GLB), and light sensors were deployed at 9 m depth on the east and west sides of GLB and adjacent bays. The relative quality of the seawater was evaluated by a comparison with a study completed in GLB 38 y ago (Hickel 1974). Zooplankton concentrations were higher at eastern versus western sites, and in deeper versus surface waters, and while they were lower than those recorded by Hickel, they were higher than many reported for other reef locations. POM concentrations were remarkably high and similar at all sites, and LT was generally slightly higher at eastern compared to western sites. Although the present study can provide only a temporal snapshot of seawater conditions in GLB, the results are consistent with the

hypothesis that seawater quality has declined in the last 38 y. Local POM production in GLB may contribute to downstream deterioration of seawater quality.

**Jones A.M.<sup>1</sup>, and Lohse D.P.<sup>2</sup>** *1 - Division of Science and Environmental Policy (SEP), California State University Monterey Bay 2 - Department of Biology, University of California, Santa Cruz* A LOCAL COMPARISON OF SEA MUSSEL, *MYTILUS CALIFORNIANUS*, GROWTH RATES IN THE CENTRAL COAST OF CALIFORNIA

The rocky intertidal community is naturally dynamic. Abundance, diversity, and growth rates can significantly vary through time over large and small spatial scales. There is a need to better understand how basic oceanographic and benthic processes construct disparate ecological communities. Additionally, human-mediated impacts create differences between intertidal communities. Marine scientists, managers, policymakers and other stakeholders have difficulty distinguishing between variation due to natural phenomena and variation from anthropogenic disturbances. Multi-year, regional studies of intertidal organisms can provide insight to this problem. The north Pacific coastline from Alaska to Baja California is dominated by the marine mussel, *Mytilus californianus*. This organism can be used as a test system for investigating natural and human-caused community variation. In this study, data were collected from 2001 to 2006 at four central California sites and analyzed to determine if there were spatial and temporal differences in growth rates of *M. californianus*. Significant differences were found in mussel growth between sites, but not between years of study. To further explore how basic processes cause variation in intertidal communities, the next steps include data collection to establish any existing associations between differential growth and natural processes at each of the observed sites. This baseline understanding of natural variation is important for attributing intertidal community differences (e.g. in abundance, diversity, and growth) to human-related impacts such as those resulting from visitation, pollution, and arguably global climate change.

†**Julich, H.M.\* , and B.J. Becker** *University of Washington, Tacoma* AN EVALUATION OF CONDITIONS IN *IN SITU* MESOCOSMS

Scientists have utilized various systems to attempt to raise larvae in the ocean to answer questions about their ecology, biology, and behavior in nature. The artificial nature of *in situ* culturing often leads to high mortality and highly unrealistic results. In order to attempt a more realistic approach, large mesh enclosures (150L) were used to raise larval sand dollars (*Dendraster excentricus*) off of Friday Harbor Laboratories, San Juan Island, Washington. Mesocosms were designed to maximize water flow and facilitate cleaning, while providing a stable and relatively inexpensive study vessel for larvae. A comparison of most physical parameters inside and outside of mesocosms revealed small differences that were not significant at the  $p=0.05$  level. However, temperature and light results revealed several unexpected anomalies, indicating that mesocosms act as insulators, preventing to some degree the normal diurnal light and temperature fluctuations experienced by larvae in a marine environment. A follow up experiment was conducted to test temperature variance inside of small PVC enclosures used in previous elemental fingerprinting research. Three mesocosms in each of three sizes were fitted with temperature and light loggers and deployed in an unshaded and shaded location for one week each. Data analysis is ongoing, but preliminary results indicate that smaller mesocosms tracked most closely with external temperatures, while medium and large enclosures exhibited greater variability. These results could have implications in larval ecology and biology, as temperatures during growth and development impact the rate of growth and shell development.

†**Kelly, M.K.<sup>1\*</sup>, Lindholm, J.<sup>1</sup>, Knight, A.<sup>1</sup>, Kline, D.<sup>1</sup>, and J. deMarignac<sup>2</sup>** *1 - Institute for Applied Marine Ecology (IfAME), California State University Monterey Bay 2 - SIMoN Program, Monterey Bay National Marine Sanctuary* BIOGEOGRAPHY OF BLACK EYE GOBIES *RHINOGOBIOPS NICHOLSII* AROUND TEMPERATE REEFS ALONG THE CENTRAL COAST OF CALIFORNIA

The halo of biological activity around tropical coral reefs is well-established, while the extent to which a similar halo occurs around temperate rocky reefs continues to be an area of robust inquiry. One approach to the quantification of any “halo effect” around a rocky reef is to quantify the distance that key reef-associated species move out into the lower relief habitats surrounding reefs. Species such as the blackeye goby, *Rhinogobiops nicholsii*, may be able to be used to define the boundary of productivity that extends from a reef system, which could ultimately be used in conservation and management of these reefs. Video transects from July 2006 to July 2008 were compiled and reviewed for the presence of *R. nicholsii* and their relationship to rock “islands”. Data were collected using a towed camera sled at several locations along the central coast of California, including Pt. Lobos, Pt. Sur, and Piedras Blancas. In this study, temperate reefs were defined as a hard substrate surrounded by sandy bottom, and the distance that *R. nicholsii* extended out from this “island” was considered the halo. The distance between a fish and the nearest observed hard bottom was estimated using paired lasers. Preliminary results indicate that *R. nicholsii* extended out as far as 18 m (mean = 3 m). Additionally, there appears to be significant variance among two fish color morphs, with green pigment occurring more frequently over reefs while white occurred more commonly over sand.

†**Kuo, E.S.L.\***, and **E. Sanford** *Bodega Marine Laboratory, UC Davis* DO REGIONAL DIFFERENCES IN TIDAL REGIMES LEAVE AN EVOLUTIONARY SIGNATURE ON THE THERMAL TOLERANCE OF INTERTIDAL SNAILS?

Recent work by Helmuth and co-workers demonstrates that thermal stress in rocky intertidal habitats varies in a mosaic pattern along the Eastern Pacific coast, where northern sites can be more thermally stressful than southern sites due to variability in the timing of low tides at different latitudes. However, it has not yet been tested whether selection imposed by these geographic differences in thermal regimes have generated corresponding genetic variations in the thermal tolerance of intertidal invertebrates. In this study, we reared the Channeled Dogwhelk *Nucella canaliculata* collected from seven locations in Oregon, Northern and Central California through two generations in a common laboratory environment (to eliminate the potential for field acclimatization and other non-genetic effects). Sibling juvenile whelks from each population were challenged to a range of temperatures simultaneously in laboratory trials, and the temperature at which 50% of the whelks died (LT50) was used as a measure of thermal tolerance. Results suggest that *N. canaliculata* originating from Central California were significantly less thermal tolerant than their conspecifics from Northern California and Oregon. These differences in thermal tolerance among populations of this direct developing gastropod appear to match the patterns of thermal stress along the coast, in which the intertidal zone of Central California experiences shorter exposures to midday low tides than Northern California and Oregon. Our results suggest that variation in tidal regimes may be a selective force that can shape the physiology of intertidal species distributed across broad geographic ranges.

**Lee, K.J.M.\***, **Tang, E.**, and **C.D. Harley** *University of British Columbia* THE ROLE OF SALINITY ON THE VERTICAL LIMITS OF *PISASTER OCHRACEUS*, *MYTILUS TROSSULUS* AND *FUCUS GARDNERI* ALONG THE GEORGIA STRAIT

Abiotic factors such as salinity can influence the abundance and distribution of intertidal organisms. This study investigated the role salinity played on the vertical limits of the seastar *Pisaster ochraceus*, the mussel *Mytilus trossulus* and the rockweed *Fucus gardneri* along the Georgia Strait in British Columbia, Canada. There was no significant relationship between the salinity and the upper limit of *Fucus gardneri* or *M. trossulus*, both of which are tolerant of a wide range of salinities. However, a significant relationship was found between salinity and the upper limit of *P. ochraceus* as well as between salinity and the vertical extent of the *Mytilus trossulus* zone. Previous studies have shown *P. ochraceus* feeding rates and activity levels are greater at higher salinities (usually above 20 psu). At high salinity sites, *Pisaster* foraging forces the lower limit of the mussel bed upwards, resulting in a vertical decrease in mussel bed extent. Conversely, in areas where salinity is less than optimal, sea stars may be less active



and consume fewer mussels, allowing a greater vertical range in *Mytilus*. This hypothesis is currently being tested with a *Pisaster* exclusion experiment at a site where salinity fluctuates seasonally. These results provide insight on how the changing salinity due to climate change will affect the vertical distribution of species in the intertidal and their interactions with each other.

†**Lewis LS\*** *San Diego State University* FISHES POSITIVELY AFFECT SEAGRASS PERFORMANCE BY MEDIATING NEGATIVE EFFECTS OF GRAZING AND FOULING INVERTEBRATES

Seagrasses provide important nursery grounds for fishes and invertebrates, and though much research has been conducted in these habitats, the role of trophic interactions in influencing ecosystem function remains unclear. Previous work suggests that an abundance of fishes that feed on invertebrate grazers may, in turn, allow epiphytic algae to grow and smother seagrasses. I explored the importance of microcarnivorous fishes in the functioning of eelgrass (*Zostera marina*) beds in San Diego Bay, California. Over a 12-wk period in summer 2007, I manipulated the abundance of microcarnivorous fishes and observed their direct and indirect effects on invertebrates, algae, and eelgrass performance (growth). Contrary to expectations, my results indicate that fishes had positive indirect effects on eelgrass growth by directly removing invertebrate taxa that damage eelgrass leaves via fouling or direct grazing, while not targeting species that feed on epiphytic algae. My results emphasize the importance of fishes in structuring eelgrass-associated invertebrate communities, which indirectly benefits eelgrass performance.

**Lindstrom, Sandra C.\*** *Dept of Botany, University of British Columbia, Vancouver* NEWLY DISCOVERED AND YET-TO-BE-NAMED SPECIES OF ALASKAN SEAWEEDS

The seaweed flora of Alaska continues to reveal previously unknown species (and sometimes genera). Because seaweeds are restricted to shallow, usually rocky shores, and these are the habitats that were severely impacted during Pleistocene Ice Ages, it is surprising how rich and occasionally even unique Alaska's seaweed flora is. Here we present an overview of some newly discovered and yet-to-be-named species of seaweeds encountered during field work on multiple projects. The list includes cryptic species, i.e., those previously identified as other species, including species previously recognized as *Porphyra abbotiae*, *P. pseudolanceolata*, *P. pseudolinearis*, *P. schizophylla*, *Mastocarpus papillatus* and *Ulva (Enteromorpha) intestinalis*. These are distinguished primarily on the basis of distinctive genotypes that set them apart from the species with which they had been confused. It also includes species that were entirely previously unknown, including other species of *Porphyra*, species of the red algal families Palmariaceae and Phylloporaceae, and even species of kelp (order Laminariales), which are recognized as species new to science based on their distinctive morphologies as well as unique molecular sequences. These newly discovered species show a variety of distribution patterns with some species apparently being restricted to the northern Gulf of Alaska, some occurring from northern Washington to the Aleutian Islands and perhaps beyond, and others showing different biogeographic ranges. Continuing exploration and study will no doubt reveal additional diversity in this important but underappreciated marine resource.

**Matteson, R.S\***, and **K. Benoit-Bird** *Oregon State University* JUMBO SQUID DISTRIBUTION IN 3-DIMENSIONAL SPACE AS MEASURED BY ACOUSTICS IN THE GULF OF CALIFORNIA

The Humboldt squid, *Dosidicus gigas*, is a voracious, migratory predator and an important prey for large fish and marine mammals. This species has recently become an economically important fishery in the Gulf of California, with a catch of as much as 120,000 tons per year. However, information on the behavior, life history, and biomass of this species is limited. Current knowledge is based almost exclusively on fisheries records, which only contain nighttime observations and provide no information on squid distribution and behavior outside of heavily fished areas. Acoustic measurements have long been used to study fish behavior and biomass. Development of this method for application to squid provides a new, non-invasive technique to assess squid numbers and sizes to depths of 1000m. This method was

applied in March and April of 2007 in the Gulf of California, in a region spanning Santa Rosalia and Guaymas, both important fishing areas, and Isla San Pedro Martir, a region known for its sperm whale activity. The greatest number of individuals was observed near Guaymas at this time of year. In all areas, larger numbers of squid were observed at shelf breaks relative to other areas. Squid exhibited a marked diel vertical migration, with daytime depths of 300-400m, bathymetry allowing, and nighttime depths of 0-200m. In shallower coastal areas, the distribution of squid closely mirrored the shape of the bottom topography. This new technique is providing previously unattainable insights into the behavior and biology of this commercially and ecologically important squid species.

**McCormick, L.N.<sup>\*</sup>, Becker, B.J., and J. Roach** *University of Washington, Tacoma Campus* THE STUDY OF *DENDRASTER EXCENTRICUS*. LARVAL GROWTH AND SURVIVAL IN BALLAST TANK SIMULATIONS

Ballast tanks of tanker ships are closed systems and the conditions to support life are very poor. However, successful transport of larvae of non-indigenous species in ballast tanks has been documented multiple times. A previous experiment performed in 2007 centered around the survival and growth rates of bivalve larvae in ballast tanks by examining viability and growth under different feeding regimes. Results indicate that larvae are able to develop with limited amounts of available particulate organic matter (POM) as long as there is sufficient dissolved organic matter (DOM) available. The purpose of this experiment is to parallel the first effort using sand dollar larvae. Specimens of *Dendraster excentricus* were collected and spawned. Cultured larvae were raised with four different feeding treatments: no added organic matter, added DOM with no added POM, added POM with no added DOM, and added POM and DOM. Survival rates were monitored approximately every three days for 30 days. Preliminary results indicated that larvae in the POM treatment had a higher survival rate, however differences were not significant and some developmental irregularities were seen. Further research will be performed with healthier subjects.

**McMillan, S.M.<sup>1\*</sup>, Silliman, B.R.<sup>2</sup>, Gulis, V.<sup>3</sup>, and K. Demes<sup>1</sup>** *1 - Moss Landing Marine Laboratories 2 - University of Florida 3 - Coastal Carolina University* € TROPHIC ASSOCIATIONS BETWEEN *MACROCYSTIS PYRIFERA*, *CHLOROSTOMA BRUNNEA* AND MARINE FUNGI.

The importance of grazers in facilitating fungal infection in marine plants was only recently discovered in salt marshes. In these systems, gastropods were found to facilitate the fungi invasion through grazer-induced wounds. These fungal infections led to drastic decreases in plant biomass. In contrast, studies of trophic interactions in kelp forests have traditionally focused on macroscopic organisms. However, we observed fungal epibionts growing on blades of the giant kelp *Macrocystis pyrifera*. To investigate if snail grazing facilitates fungal growth on *M. pyrifera*, and how that may vary with temperature and densities of *Chlorostoma brunnea* (an abundant marine snail), we conducted mesocosm experiments manipulating these variables over a 6-month period. Sixteen 55-gallon tanks, plumbed with flowing seawater, were used to examine differences in *M. pyrifera* biomass, growth rates, and fungal biomass between treatments of high/low temperatures, snail presence/absence, and low to high snail densities. We found a significant relationship between temperature and fungi, with higher temperatures resulting in increased fungal biomass. Also, in the presence of moderate densities of *C. brunnea*, fungal biomass was significantly reduced while the *M. pyrifera* remained intact. However, at higher densities of *C. brunnea*, we observed the snails grazing directly on *M. pyrifera* causing the degradation of the alga, and increasing fungal biomass. The relationship between *C. brunnea* and the unidentified marine fungi resembles the associations previously reported for salt marsh systems at high, yet naturally occurring, snail densities. At moderate densities, the snail is a consumer of the fungi, and the *M. pyrifera* acts as fungal substrate.

**Monteforte, P<sup>1</sup>, McClintock, JB<sup>2</sup>, Vicknair, KE<sup>3</sup>, Feder, HM<sup>4</sup>, and JS Pearse<sup>5\*</sup>** *1 - Pacific Grove, California 2 - University of Alabama at Birmingham 3 - Berkeley, California 4 - University of Alaska Fairbanks 5 - University of California, Santa Cruz* DOWN THE HATCH: STAR-EATING GULLS IN MONTEREY, CALIFORNIA

We present photographs documenting Western gulls (*Larus occidentalis*) swallowing whole sea stars on the breakwater of Monterey, California. In all cases, the prey were adult individuals of *Pisaster giganteus*, a predominately subtidal species that is occasionally exposed at low tides. Although individuals of the more abundant, predominately intertidal species, *P. ochraceus*, were often seen overturned with their ambulacral system pecked clean, none were recorded being eaten whole. Specimens of *Patiria miniata* were also photographed overturned by gulls, but their ambulacrals were not pecked clean. Gulls swallowing whole specimens of the predominately subtidal *Pisaster brevispinus* have also been seen elsewhere in Monterey Bay (JP). In addition, gull predation on a variety of intertidal sea stars has been reported for many places and is not uncommon (Google: gull predation sea stars starfish). The impact of gull predation on sea star populations has never been carefully studied. Nevertheless, the recently documented decline of intertidal sea star populations at sites in Monterey Bay may result, in part, from gull predation (Pearse, JS, McClintock, JB, Vicknair, KE, Feder, HM. in press. Proceedings International Echinoderm Conference, Durham, New Hampshire, 2006.)

**Morrisson, S.A.\* , Ort, B, and S. Cohen** *San Francisco State University* GENETIC DIVERSITY IN A RECOVERING POPULATION OF EELGRASS (*ZOSTERA MARINA*) IN THE SAN FRANCISCO BAY

Eelgrass provides an important habitat for fish, invertebrates and waterfowl and provides benefits for substrate stabilization. Genetic diversity in eelgrass (*Zostera marina*) beds has been shown to be a factor in determining how resilient beds are to disturbance. As part of ongoing seagrass restoration efforts in San Francisco Bay, a population at Point Molate was chosen in 2005 as a donor site to harvest plants for establishment elsewhere. Unfortunately, the population nearly disappeared in 2006; only eight plants were located and there was an oily slick on the sediment where the bed had been growing previously. In 2007, the bed began to recover and an additional collection was made consisting of forty samples, including thirty-eight seedlings and two large plants that apparently had survived the die-off of 2006. To compare genetic diversity before and after the disturbance, and to determine whether a decrease in diversity occurred due to the sharp decline in population numbers, we are using seven microsatellite DNA markers on samples collected from 2005-2007. This data will be useful to ongoing restoration efforts aimed at maximizing genetic diversity and thus long term restoration success in the bay.

**Norton, S.F.\*** *Centralia College* AGGREGATION BY THREE SPECIES OF APOSEMATIC, CHEMICALLY-DEFENDED GAMMARID AMPHIPODS

In insects, chemical defense, aposematic coloration, and aggregation often occur as a linked suite of features; theory and limited lab experiments invoke learning by naïve predators and/or kin selection as advantages to aggregation. I examined aggregation by three species of chemically-defended, aposematic gammarid amphipods (*Chromopleustes lineatus*, *Ch. oculatus*, and *Cryptodius kelleri*) in the nearshore subtidal off Bell Is, Washington. I measured their distribution and abundance at several scales: visual counts in consecutive 0.1m<sup>2</sup> quadrats and 0.008m<sup>2</sup> photoquadrats and via a nearest neighbor analysis of amphipods within the photoquadrats. At the level of whole visual or photo transects, all three species demonstrated significant aggregation in almost all transects. Interspecific presence/absence and abundance data along single transects indicate that species abundances were generally independent, with a few cases of positive associations among species. I compared intraspecific nearest neighbor distances measured on the photoquadrats to distances expected if the individuals were randomly distributed. The most abundant species, *Ch. oculatus*, demonstrated significantly aggregation in 24 of 105 photoquadrats and a regular distribution in only two. *Cr. kelleri* were aggregated in 18 of 88 photoquadrats and uniform in only three. In the 12 slides in which *Ch. lineatus* appeared, individuals were randomly distributed. For all three species, observed nearest neighbor distances declined as density increased. Collectively, these field data and other laboratory experiments support the hypothesis that, like terrestrial insects, these gammarid amphipod species evolved a suite of characters to reduce predation: a powerful chemical

defense, aposematic coloration, aggregation.

**Pawluk, K.A.** \* *Bamfield Marine Sciences Centre* BAMFIELD MARINE SCIENCES CENTRE

The Bamfield Marine Sciences Centre (BMSC) is Canada's premiere coastal research centre. Situated in the remote town of Bamfield in Barkley Sound, BMSC offers researchers unparalleled access to both marine and terrestrial biodiversity. BMSC is owned and operated by the Western Canadian Universities Marine Sciences Society (WCUMSS). Untouched ecosystems next to well-equipped wet and dry laboratories allow researchers to conduct both field and lab-based science. Research at Bamfield ranges from biochemical aspects of physiology through to landscape ecology on any organism that can be found in the surrounding area. The station is committed to facilitating research of all kinds and fostering collaboration among researchers. The research community is dynamic and fosters interaction between researchers and students attending courses. It is an excellent place to recruit graduate students. In addition to a continuous flow open seawater system for holding organisms, BMSC has a 12 meter flume, an advanced microscopy suite including a confocal microscope, and a Remotely Operated Vehicle (ROV). The Centre has a well-developed scientific diving program, experienced animal care staff, staffed library, on-site housing and cafeteria, and a fleet of research vessels. BMSC provides support for graduate students in the form of teaching assistant positions and graduate scholarships. Course instructors may choose to take a research grant in lieu of salary. Details can be found on the BMSC website [www.bms.bc.ca](http://www.bms.bc.ca), or by directing inquiries to [director@bms.bc.ca](mailto:director@bms.bc.ca)

†**Rechsteiner, E.** \* *Vancouver Island University* SIZE-SELECTIVE AND SPECIES-SELECTIVE PREDATION BY THE PAINTED SEA STAR, *ORTHASTERIAS KOEHLERI*, ON THREE SUBTIDAL MARINE GASTROPODS IN BARKLEY SOUND, BC

Sea stars are abundant and important predators in subtidal marine communities, often affecting the population structure of their prey. In this study, experiments were conducted at Bamfield Marine Sciences Centre to determine whether the locally abundant painted sea star, *Orthasterias koehlerii* is a size-selective or species-selective predator of three sympatric gastropods. Size selectivity was examined by offering painted sea stars three size classes of the red turban snail, *Astraea gibberosa*. Painted sea stars showed a preference (Manly's alpha = 0.58 +/- 0.15) for medium sized (25.1-40 mm diameter) red turban snails, over small or large size classes (10-25 mm and > 40 mm respectively). In a second experiment, species selectivity was examined by offering painted sea stars prey choice between three local subtidal gastropod species: red turban snail (*A. gibberosa*), dusky turban snail (*Tegula pulligo*), and the lined top snail (*Calliostoma ligatum*). Painted sea stars showed significant preference for *T. pulligo* (Manly's alpha = 0.82 +/- 0.36), and avoided *A. gibberosa* and *C. ligatum* (Manly's alpha = 0.00 +/- 0.00, and 0.18 +/- 0.36 respectively). Physiological and/or behavioural defenses may deter the painted sea star from preying extensively on *A. gibberosa* or *C. ligatum*. Mean opercula retraction for *T. pulligo* was significantly deeper than for the other snails (Kruskal Wallis H=23.58, P=0.00, df=2). This may be an adaptation to avoid starfish predation; however the efficacy of deeper retraction in avoiding predation has not been studied.

**Robart, M.J., and J.L. Largier** *UC Davis/Bodega Marine Lab* TIDAL FLUSHING OF A LOW-INFLOW ESTUARY DURING SUMMER: SALT BALANCE AND CHLOROPHYLL IN DRAKE'S ESTERO, CALIFORNIA

Drake's Estero is a shallow, low inflow estuary located on the Southern side of Point Reyes National Seashore in the coastal upwelling region of central California. The Mediterranean-like climate of this region is characterized by dry summers and wet winters, with nearly all precipitation occurring during winter. Therefore, this estuary receives very little fresh water during summer, and evaporation results in warm hypersaline water in the upper reaches. Tidal pumping is the dominant physical forcing mechanism during this time of year. In this study, temperature and salinity were measured throughout the Schooner

Bay arm of the estuary. In-situ timeseries of temperature, salinity, and pressure were recorded for a 10 day period at three locations, and underway temperature and salinity data provided a near-synoptic view of temperature and salinity patterns at the beginning of the study period. These data were used to construct a salt balance to determine water residence times in these three locations, which showed short residence times (~2 days) near the mouth, and long residence times (~20 days) in the upper reaches. Furthermore, a chlorophyll fluorometer was deployed in the central portion of Schooner Bay to determine the potential origin of phytoplankton blooms within the estuary. Fluorometer data suggest a chlorophyll maximum in the mid-estuary on the interface between short and long residence times, demonstrating a balance between the requirements for nutrient supply from the ocean and time to allow phytoplankton population growth.

†**Saunders, A.D.M.**\* *Vancouver Island University* THE EFFECT OF HABITAT ON THE MOVEMENT OF RED TURBAN SNAILS *ASTRAEA GIBBEROSA*

Invertebrates such as sea urchins are known to exhibit different behaviours in different habitats. In detritus-rich environments such as kelp forests urchins may become largely stationary passive detritivores, whereas in detritus-poor habitats they become highly-mobile, active grazers. To see if a similar difference in behaviour occurs in red turban snails, *Astraea gibberosa*, we measured snail displacement in two different subtidal habitats; kelp forests and urchin barrens on the west coast of Vancouver Island. We tagged 20 similar-sized snails (29.5) at 3 sites in areas with kelp and at 3 sites in urchin barren areas without kelp. Daily displacement was measured by triangulating from two pins set into the substrate. At the barren sites an average of 15.5 (SE = 0.7) snails were found and measured daily (for 6 days) and in the kelp sites 13.2 (SE = .9) snails were measured daily (for 6 days). There was no significant difference in the snail displacement rate between either community type the snails in the barren moved 5.5 cm/hour (SE = .2), and in the kelp forest they moved 5.5 cm/hour (SE= 0.3) in kelp forests (DF = 533, P=0.05). There was no significant difference (DF = 26, P= 0.05) in substrate relief (rugosity) between the sites in the two treatments (kelp forest or urchin barrens). The results of this experiment suggest that the displacement rate of snails did not differ between community types during the duration of the experiment.

**Shishido, C. M.**\*, **Burnaford, J.L.**, and **S.Y. Henderson** *University of Puget Sound* THE EFFECT OF SEDIMENT TYPE ON THE DISTRIBUTION OF THE INVASIVE PURPLE VARNISH CLAM AND ASSOCIATED NATIVE KLEPTOPARASITIC PEA CRABS ON PACIFIC NORTHWEST BEACHES

*Nuttallia obscurata* (the purple varnish clam) is an invasive species that inhabits sandy and muddy beaches in the Pacific Northwest. This invasive clam is associated with at least 3 species of native kleptoparasitic pea crabs, and the distribution of clams and pea crabs varies from site to site. We investigated potential causes of variation in infection rates between sites by focusing on two locations, Jackson Beach and Argyle Beach on San Juan Island WA. These beaches are separated by less than 150m. We used field surveys to quantify the sediment characters and distribution of clams and crabs at each site. At Jackson Beach, where the sediment was sandy, *Nuttallia* were found deep in the sediment and pea crab infection rates were high. At Argyle Beach, where the sediment was muddy and rocky, *Nuttallia* were shallow and pea crab infection rates were low. We also used laboratory manipulations to determine whether these differences in sediment characteristics affected the clam/crab association. The data indicate that sediment type does affect a pea crab's ability to infect buried *Nuttallia* because it affects the crab's maneuverability. These data increase our understanding of this close association between native species and an abundant invader of Pacific Northwest beaches.

**Simmons, B. L.**\*, and **J. Kuz** *Vancouver Island University* INTERTIDAL FORAGING ON VARNISH CLAMS *NUTTALLIA OBSCURATA* BY RACCOONS *PROCYON LOTOR* ON NEWCASTLE ISLAND, BRITISH COLUMBIA, CANADA

The Varnish Clam (*Nutallia obscurata*) is an introduced species which has recently become common on sandy shores in many parts of British Columbia. It is an abundant species that provides a previously unavailable food resource for local marine and terrestrial vertebrates, including the Raccoon (*Procyon lotor*). Raccoons are an opportunistic species that forage in the intertidal zone during low tide. In this study we observed raccoons foraging on Newcastle Island, British Columbia to test the hypothesis that raccoons select Varnish clams over the sympatric Manilla clam (*Venerupis philippinarum*). We also collected and measured discarded and eaten Varnish clams to see if raccoons are size selective predators. The results of a clam survey indicated that Varnish and Manilla clams were equally abundant, however observations indicated that raccoons consumed Varnish clams more than expected ( $X^2=299.4$ ,  $df=1$ ,  $P<0.0001$ ). We also concluded raccoons may select larger individuals when preying on Varnish clams ( $t=24.7$ ,  $df=653$ ,  $P<0.0001$ ), although the abundance of small clams in the diet of raccoon may be underestimated.

†**Smart, T.I. \***, **Emllet, R.B.**, and **C.M. Young** *Oregon Institute of Marine Biology, University of Oregon*  
PROPERTIES OF PROTOSTOMY AND DEUTEROSTOMY IN THE EMBRYOGENESIS AND  
LARVAL DEVELOPMENT OF *OWENIA COLLARIS* (ANNELIDA: POLYCHAETA)

The wide variety of larval forms in the polychaetes is based on the ancestral trochophore form. Within the genus *Owenia* (family Oweniidae), the mitraria larva lacks most of the trochophore ciliary bands and those that are present are monociliated, typically a deuterostome characteristic. Adults of *Owenia fusiformis* also possess a monociliated epidermis and deuterostome-like nephridia. Juvenile tissues develop from an internal invagination of the hyposphere epidermis rather than through posterior growth of segments in the setiger larval stage. This study is the first in-depth account of early embryology for any member of the Oweniidae, *Owenia collaris*. Light, confocal, and scanning electron microscopy were used to investigate organogenesis from fertilization through metamorphosis to examine how deuterostome-like features develop in this group. Embryos undergo typical spiral cleavage, gastrulation by invagination, and begin swimming 24 hours after fertilization. Two important events, however, deviate from the usual process of embryogenesis in polychaetes: formation of the stomodaeum and formation of the prototroch. The vegetal blastopore becomes the anus, immediately anterior to the larval chaetal sac while the stomodaeum is a secondary opening formed after the archenteron has filled the blastocoel and formed a u-shaped gut. The trochoblasts (1q2 descendents) do not cleavage arrest and the prototroch never contains large, multiciliated cells. Development of the juvenile in *O. collaris* is similar to that described for *O. fusiformis*.

†**Smith, A. L. \***, and **S. C. Cohen** *Romberg Tiburon Center for Environmental Studies, San Francisco State University* THE INFLUENCE OF PHYSICAL DISTURBANCE ON THE REPRODUCTIVE ECOLOGY OF THE BROODING SEA-STAR, *LEPTASTERIAS AEQUALIS*

Environmental factors, such as physical stress, influence reproductive success and may contribute to the evolutionary success of particular reproductive modes. I investigated how environmental parameters related to hydrodynamics in a high energy rocky intertidal environment shape the reproductive ecology of the brooding sea-star, *Leptasterias aequalis*. I tested the hypothesis that high energy hydrodynamic patterns limit brooder establishment and increase brooder loss. Permanent quadrats within 4 transect belts were established at Mussel Rock in central California to track a brooding population of stars throughout the duration of the 2008 reproductive season. Dense aggregations of *L. aequalis* reside on the rocks with a mean density of 18.4 individuals per  $m^2$ . Flow rate, measured by dissolution of clod cards, had no significant influence on total brooder establishment nor on brooder loss cumulatively measured over the entire season. However, towards the end of the brooding period, a sand scouring event occurred at one of the four transect belts, wiping out a significant proportion of brooders. When brooder loss was reanalyzed excluding the scoured transect, high flow rate had a significant effect on brooder loss (Pearson correlation 0.730,  $sig<0.001$ ). The results of this study demonstrate that strong hydrodynamic forces in the rocky intertidal can decrease brooder success, potentially by dislodgement due to strong wave forces (although,

this is indirectly inferred from flow rates) or by scouring and smothering due to sand deposition and removal. Both types of events may be particularly important in environments in central California where rocky and sandy areas are interspersed.

†**Swanson, S.A.**<sup>\*</sup>, and **R.C. Carpenter** *California State University, Northridge* SPECIES-SPECIFIC EFFECTS OF ECHINOIDS ON CORAL REEF COMMUNITY STRUCTURE

Coral reefs are known for their exceptional species diversity and productivity, yet are extremely sensitive to biotic and abiotic perturbations. Many reefs have experienced phase shifts resulting from alterations in herbivore abundance. This research in Moorea, French Polynesia, is aimed at elucidating differential effects of sea urchin species on the coral reef community. Preliminary quantifications of benthic reef components suggest that the tropical echinoids *Diadema savignyi*, *Echinostrephus aciculatus* and *Echinometra mathaei* influence the community on different scales, likely as a result of different feeding modes and grazing intensities. On a small, 25-cm<sup>2</sup> scale, *E. mathaei* abundance correlated positively with cover of crustose coralline algae, while *E. aciculatus* was associated with cover by algal turfs and macroalgae. On a larger scale (> 1 m<sup>2</sup>), it may be possible to predict reef community structure based on species and abundances of echinoids. In order to test the hypothesis that diadematids are more effective than other echinoids in limiting macroalgal abundance, echinoid species on coral heads will be manipulated and macroalgal recruitment and growth quantified. The differential ability of echinoids to initiate and reverse phase shifts on already established communities will be tested by manipulating densities and compositions of echinoid species on coral heads dominated by either macroalgae, algal turfs or coral. Benthic community structure trajectories will be quantified over time through the assessment of percent cover of macroalgae, crustose coralline algae, turf and live coral. The results of this study will elucidate the ecological importance of species-specific interactions that shape coral reef communities.

**Thompson, S.A.**<sup>1\*</sup>, **Sydeman, W.J.**<sup>1</sup>, **Schwing, F.B.**<sup>2</sup>, **Largier, J.L.**<sup>3</sup>, and **W.T. Peterson**<sup>4</sup> 1 - *Farallon Institute for Advanced Ecosystem Research, PO Box 750756, Petaluma, California, USA 94975* 2 - *NOAA-NMFS SWFSC, Environmental Research Division, 1352 Lighthouse Avenue, Pacific Grove, California, USA, 93950* 3 - *Bodega Marine Laboratory, PO Box 247, Bodega Bay, California, USA 94923* 4 - *NOAA-NMFS Northwest Fisheries Science Center, 2030 S.E. Marine Science Drive, Newport, Oregon, USA 97365* THE CALIFORNIA CURRENT INTEGRATED ECOLOGICAL DATABASE (CCIED): LINKING OCEAN OBSERVING WITH INTEGRATED ECOSYSTEM ASSESSMENTS (IEA)

Ecosystems are geographic regions comprised of highly complex, and often non-linear, biogeochemical relationships. The developing IOOS and management schema, highlighted in particular by NOAA's Integrated Ecosystem Assessment initiative, should be linked by comprehensive bio-physical ecological databases that can be used to describe spatio-temporal ecosystem dynamics. Understanding and forecasting potential will be enhanced when appropriate derived data from a variety of sources are combined to represent meaningful ecological relationships. However, this is a difficult undertaking. Using information and complex long-term physical, chemical, and biological data from the California Current large marine ecosystem, we have created a simple ecological database (CCIED) focused on derived data maintained by distributed sources. Complex data are condensed into annual, seasonal, or monthly values, and related to complex biological data. As an example, we have created derived data from hourly HF radar plots in northern California and combined this information with derived data on copepod communities off central Oregon from another source, which then are related to salmonid and seabird productivity (again using derived data) from both regions. Derived values are developed using simple averaging to multivariate techniques (EOF/PCA), and represent qualitative indices of ecosystem state and status. In this presentation, we describe the CCIED, and demonstrate how it can be used to address multiple management (wildlife and fisheries) issues simultaneously.

**Tissot, B. N.**<sup>1\*</sup>, **Starr, R.**<sup>2</sup>, **Yoklavich, M. M.**<sup>3</sup>, **Lummio, M.**<sup>1</sup>, **Blaine, J.**<sup>1</sup>, **Graiff, K.**<sup>1</sup>, and **S.**

**Rooney<sup>1</sup>** - Washington State University Vancouver 2 - Moss Landing Marine Lab 3 - NOAA Fisheries, Santa Cruz  
ABUNDANCE AND DISTRIBUTION OF MEGAFUNAL INVERTEBRATES IN THE NEW CENTRAL CALIFORNIA MPAS

In 2007 California created 29 new marine protected areas (MPAs) along the central California coastline from Pt. Conception to Pigeon Point. In Fall 2007 and 2008 we conducted baseline surveys in 8 of these MPAs and 8 adjacent reference areas using direct observations from the manned submersible Delta to assess the abundance and distribution of demersal fishes, structure-forming invertebrates, and their associated habitats. The primary goal of the project is to collect baseline information and develop protocols for a deep water monitoring program, from which to evaluate long-term changes in demersal communities of rocky shelf and slope habitats associated with MPAs off central California. A total of 340 dives were conducted in depths from 23-328m, primarily on hard-bottom habitats. During the 2007 dives we observed nearly 158,000 aggregating and 14,000 structure-forming invertebrates from 70 taxa. Megafaunal invertebrates in the new MPAs were both diverse and abundant. They were dominated by echinoderms (crinoids, sea stars and brittle stars), sponges, and cnidarians (anemones and corals). Deep-sea corals were diverse and included several species of cup corals, scleractinian corals (*Lophelia*) gorgonians (*Anthomastus*, *Lophogorgia* and *Swiftia*), hydrocorals (*Stylaster*), and sea pens (*Stylatula* and *Ptilosarcus*).

**†Vuxton, E.A.\* , and J.S. White** Department of Zoology, University of Florida VARIATION IN ALGAL SUCCESSION IN THE PRESENCE, ABSENCE AND REMOVAL OF THE DUSKY FARMERFISH, *STEGASTES NIGRICANS*

The damselfish, *Stegastes nigricans*, farms algal turf within territories that it defends. These farming behaviors can alter the coral community composition. In Moorea, French Polynesia, algae is often scarce in the lagoons due to high grazing pressure. However, *S. nigricans* can defend their territories to produce large mats of algal turfs. *S. nigricans* territories can account for up to 40% of the lagoon environment in Moorea. This study analyzed changes in algal succession on reefs where *S. nigricans* was present, naturally absent, or experimentally removed. Recruitment tiles were outplanted to reefs in January 2006 and were brought in from the field, photographed, and returned to the reefs at 6 months, 18 months, and 26 months after deployment. Tile composition was recorded using stratified random point count using CPCe 3.4. Given algae usually only accumulate in cracks and crevices, we focused on the bottom of tiles which mimic these protected environments. Results indicate that algal taxa respond differently to the presence of *S. nigricans*. For example, the percent cover of crustose coralline algae was lowest, and red algal cover was highest, when *S. nigricans* was present. Algal diversity and abundance were similar on reefs in which *S. nigricans* were naturally absent or experimentally removed and these patterns usually differed markedly from reefs with *S. nigricans* present. These data suggest that farming behaviors can dramatically influence algal abundance and diversity. Additional research is underway to determine whether and how these changes affect the surrounding reef community, e.g., coral recruits and micro-invertebrates.

**†Whitlow, L.M.\* , and D.J. Eernisse** Cal. State Univ. Fullerton THE EFFECTS OF PHENOTYPIC PLASTICITY IN THE SURFGRASS LIMPET ALONG THE COAST OF CALIFORNIA

Limpets in different microhabitats can vary dramatically in their shell growth. Limpet shell geometry is simple so it can be related to the consequences of such phenotypic plasticity. The surfgrass limpet, "*Lottia*" *paleacea*, is restricted to living on either of two intertidal surf-grasses, *Phyllospadix torreyi* and *P. scouleri*, which differ considerably in their blade width: The limpet's shell is much more compressed laterally on the much narrower *P. torreyi* blades than on the wider *P. scouleri*. We hypothesize that extreme lateral compression must also impact the limpet's anatomy and life history traits. Our first prediction is that limpets found on *P. torreyi* will have a relatively lower total volume. We tested this by directly measuring volume of mineral oil or water required to fill each of 20 limpet shells selected to



represent observed variation throughout California. We then demonstrated that this volume could be effectively modeled as a pyramid as computed from three maximum shell dimensions,  $(LWH)/3$ , so these measurements alone would allow an approximate estimate of a surfgrass limpet's internal volume. We then measured these dimensions for about 350 limpets from six sites on the California coast, as well as the width of the surfgrass blade each was found on. Our next step will be to relate estimated total volume to a calculation of each limpet's gonad volume, inferred from sectioning, in order to address the potential impact of phenotypic plasticity on life history traits such as fecundity and body volume (= age?) at first reproduction.

†**Wrubel, K.R.<sup>1\*</sup>, Lindholm, J.B.<sup>1</sup>, DeVogelaere, A.<sup>2</sup>, de Marignac, J.<sup>2</sup>, Knight, A.<sup>1</sup>, and J.L. Watson<sup>1</sup>**  
*1 - Institute for Applied Marine Ecology (IfAME), California State University Monterey Bay 2 - Monterey Bay National Marine Sanctuary* SANCTUARY CHARACTERIZATION IMAGE DISPLAY (SCID):  
CLOSING THE TIME-GAP BETWEEN DATA COLLECTION AND DISSEMINATION

The endeavor of science is founded on the timely dissemination of research results to the wider world. However, the reality of data processing and analysis time frequently impedes this timely dissemination. The implications of delayed reporting of scientific data are particularly acute where management agencies and policy-makers are anticipating the arrival of information to support environmental decision-making. Over the past three years (2006-2008) a new partnership between the Institute for Applied Marine Ecology (IfAME) at CSU Monterey Bay and the Monterey Bay National Marine Sanctuary (MBNMS) has formed to use a towed camera sled to collect videographic data throughout the Sanctuary in support of Sanctuary site characterization efforts as well as MPA monitoring activities. Videographic data are analyzed post-cruise, along traditional scientific timelines, to answer a variety of research questions. However, using a programmable keyboard at-sea, a courser set of data (1-min intervals) are collected in real time to provide summary data virtually immediately post-cruise. The Sanctuary Characterization Image Display (SCID), the web-based vehicle for the rapid dissemination of camera sled data, is intended to render the water column transparent for a broader public audience. A species matrix characterizes all fish and invertebrate taxa and seafloor habitat attributes observed by the camera sled and the web-interface provides these data via the web as a clickable map of video clips and frame grabs distributed across transects. Through SCID we are closing the gap in the dissemination of scientific data.

†**Zachary, V. A., Mason, M. J., and W. G. Wright\*** *Dept. Biological Sciences, Chapman University, Orange, CA* BATTLES AGAINST COMPETITORS AND WAVES IN THE CALIFORNIA ROCKY INTERTIDAL: A STUDY OF THE TENACITY OF THE TERRITORIAL OWL LIMPET, *LOTTIA GIGANTEA*

Individuals of the owl limpet, *Lottia gigantea*, maintain food territories in habitats that are frequently exposed to significant wave action. Previous research has established that foraging limpets are more vulnerable to wave action than are stationary limpets. Foraging limpets normally move slowly (0.1-0.2 cm/min), while limpets engaged in agonistic contests often move 100 times faster. We hypothesized that risk of dislodgement by waves is increased in such limpets. To test this, we measured the adherence strength of limpets engaged in high-speed agonistic behavior. We pulled limpets perpendicularly off the substratum with a spring scale to estimate adherence strength. Adherence was weakest among small limpets (30-40 mm; overall adherence strength = 32.3 Newtons), and was inversely proportional to movement speed ( $r = -0.722$ ,  $P = 0.018$ ,  $n = 10$ ). Larger limpets (40-70 mm) were slightly more adherent (average = 42 Newtons), but adherence was not correlated with movement speed ( $r = -0.098$ ,  $n = 59$ , NS). Thus, the weakest adherence strength (15 Newtons) was observed in fast-moving (10-15 cm/min) small limpets (30-40mm). All of these adherence strengths were weaker than those of foraging limpets not engaged in high-speed agonistic behavior (83 Newtons). Using linear wave theory, we calculate that rapidly moving limpets in a 1 min high-speed chase have a 0.0006 probability of being dislodged in seas of 1 m significant wave-height, and 0.003 dislodgment probability in 2 m seas. We conclude that limpets engaging in high-speed agonistic behavior significantly amplify their risk of dislodgment by waves.

# Schedule worksheet

Friday, November 7

Time	Room	Talk
1300		
1315		
1330		
1345		
1400		
1415		
1430		
1445		
1500		Coffee break
1530		
1545		
1600		
1615		
1630		
1645		
1700		
1715		
1730		
1745		

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Notes:

## Saturday, November 8

<b>Time</b>	<b>Room</b>	<b>Talk</b>
1300		
1315		
1330		
1345		
1400		
1415		
1430		
1445		
1500		<b>Coffee break</b>
1530		
1545		
1600		
1615		
1630		
1645		
1700		
1715		
1730		
1745		

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Notes:

## Sunday, November 9

<b>Time</b>	<b>Room</b>	<b>Talk</b>
1000		
1015		
1030		
1045		
1100		
1115		
1130		
1145		
1200		

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Notes:



## RESTAURANT RECOMMENDATIONS

### Breakfast:

Goodfella's Café	1078 West Pender Street	604 331-0046
Moonpennies Café	1102 West Pender Street	604 669-6092
Caffe Artigiano	1101 West Pender Street	604 685-5333
Milestone's	1145 Robson Street	604 682 4477

### Grab and Go Lunch

Urban Fare	305 Bute Street	604 669 5831
Goodfella's Café	1078 West Pender Street	604 331-0046
Moonpennies Café	1102 West Pender Street	604 669-6092
Bentall Centre Food Court	West Pender Street right before Burrard Street	
Fujiya (Sushi)	#112-1050 W. Pender St.	604 608-1050
Green Leaf Salad Bar	560 Bute Street	604 677-5650

### Lunch & Dinner

Show Case (Hotel Lobby)	1128 W Hastings Street	604 684-1128
Tsunami Sushi	238-1025 Robson Street	604 687-8744
All India	1256 Robson Street	
Earl's On Top	1185 Robson Street	604 669-0020
Cactus Club	588 Burrard Street	604 682-0933
Elephant & Castle	385 Burrard Street	604 696 6730
Shanghai Chinese Bistro	1128 Alberni Street	604 683-8222
Kirin Mandarin	1166 Alberni Street	604 682-8833
Imperial Chinese Seafood	355 Burrard Street	604 688-8191
Hon's	1339 Robson Street	604 685-0871
Sala Thai	888 Burrard Street	604 683-7999
Zefferelli's	1136 Robson Steet	604 687-0665
India Gate	616 Robson Street/Seymour	604 684-4617
Moxies	808 Bute Street	604 696-9986
Red Robin	803 Thurlow Street	604 662-8288
Spaghetti Factory	33 Water Street	604 684-1288
The Keg Steakhouse	742 Thurlow Street	604 685-4688

### Seafood

Cardero's	1583 Coal Harbour Way	604-669-7666
The Boathouse	1795 Beach Ave	604-669-2225

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