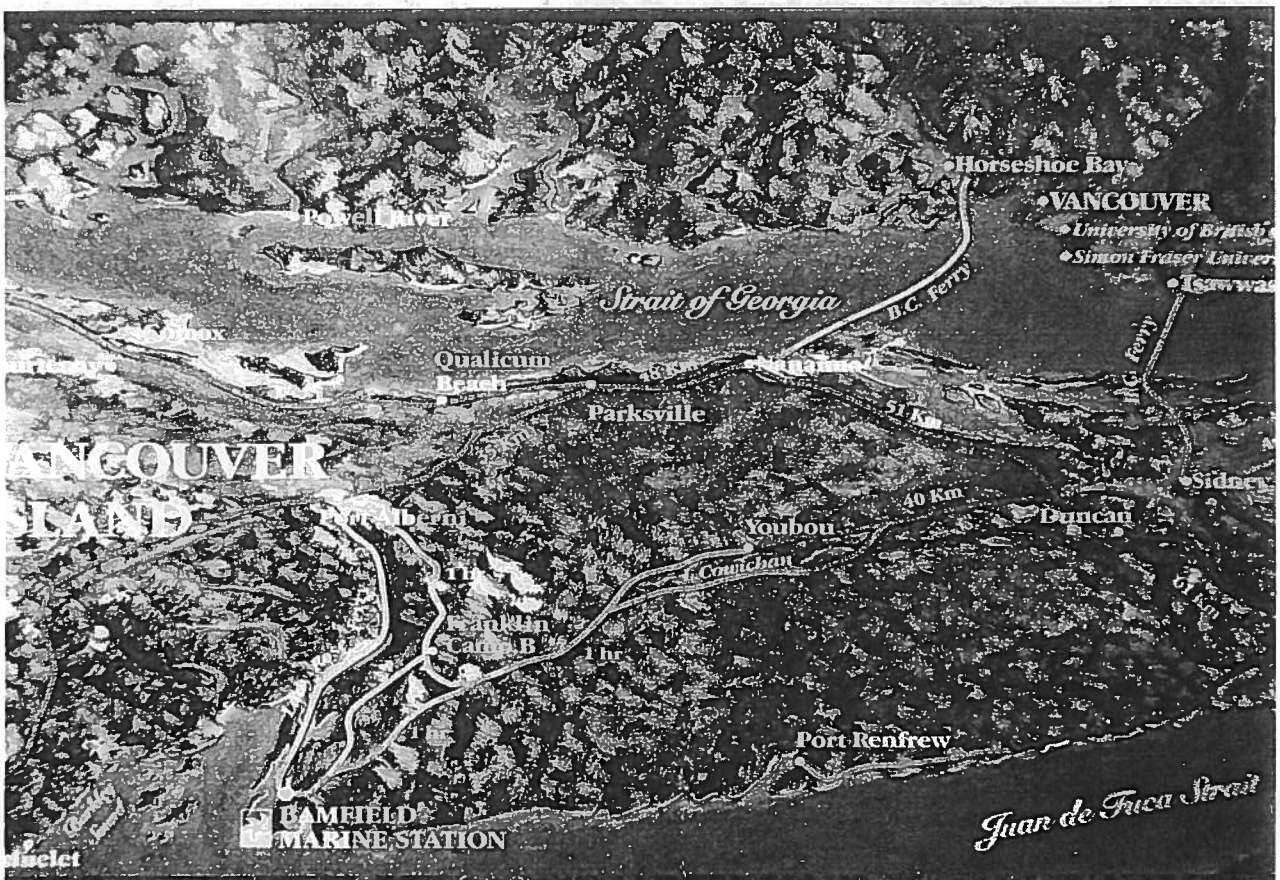
THE 18TH NORTHWEST ALGAL SYMPOSIUM

PROGRAMME & ABSTRACTS

BAMFIELD MARINE SCIENCES CENTRE

BAMFIELD, BRITISH COLUMBIA


Horseshoe Bay
VANCOUVER
Powell River
Strait of Georgia
B.C. Ferry
Qualicum Beach
Parksville
51 Km
40 Km
Sidney
Duncan
Youbou
Cowichan
Port Renfrew
Juan de Fuca Strait
BAMFIELD MARINE STATION

18th NORTWEST ALGAL SYMPOSIUM
BAMFIELD MARINE SCIENCES CENTRE
APRIL 23 – 25, 2004

Schedule of Presentations and Activities

Friday, April 23

1700 - Lady Rose departs Port Alberni
1800 - Pizza dinner onboard Lady Rose
2000 - Lady Rose travelers arrive at BMSC
2000 - Registration and Activities sign-up
2000 - Phycological Social, no host bar.

Saturday, April 24

[TIDES: LOW TIDE @ 1019 HRS, 0.95M; HIGH TIDE @ 1521, 2.8M]
All oral presentations will be in the Lecture Hall, same building as the Dining Hall

0730 - 0815 Breakfast in Dining Hall
0820 Welcome

0845 – 1025 SESSION 1 ECOLOGY Student presentations indicated with an [S]

0845 – 0900 Bullard, Aimee M. and Murray, Steven N. Department of Biological Science, California State University, Fullerton. **NET PRIMARY PRODUCTIVITY OF SOUTHERN CALIFORNIA ROCKY INTERTIDAL COMMUNITIES: POTENTIAL EFFECTS OF SHIFTS IN MACROPHYTE ABUNDANCES. [S]**

0900 – 0915 Boizard, Sophie D. Department of Botany, University of British Columbia and Bamfield Marine Sciences Centre. **MORPHOLOGICAL AND BIOMECHANICAL VARIABILITY OF *LAMINARIA SETCHELLII* HOLDFASTS, STIPES AND BLADES ALONG A WAVE EXPOSURE GRADIENT. [S]**

0915 – 0930 Russell, Roly & Spencer Wood. Zoology Department, Oregon State University . **LOCAL ECOLOGY VERSUS REGIONAL EVOLUTION AS DRIVERS OF COMMUNITY DIVERSITY. [S]**

0930 – 0945 Bates, Colin. Department of Botany, The University of British Columbia, Vancouver, B.C., Canada. **MICRO-INVERTEBRATE COMMUNITY RESPONSES TO CHANGING SEAWEED FUNCTIONAL DIVERSITY. [S]**

0945 – 1000 Martone, Patrick T. Hopkins Marine Station, Stanford University. **DO *CALLIARTHRON* GENICULA GROW LARGER TO SUPPORT LARGER FRONDS? [S]**

1000 – 1015 Michael Guiry Martin Ryan Institute, National University of Ireland, Galway, Ireland. **ALGAEBASE**

1015 – 1040 COFFEE BREAK

1045 – 1230 SESSION 2 MOLECULAR and MORPHOLOGICAL STUDIES; Student presentations indicated with an [S]

1045 – 1100 Choi, Lauren Y., Hoyt, A., and Cattolico, R.A., Department of Biology, University of Washington. **ISOLATION AND CHARACTERIZATION OF RUBISCO ACTIVASE. [S]**

1100 – 1115 Lakeman, Michael B., Cattolico, Rose Ann, Department of Biology, University of Washington. **CHANGES IN CHLOROPLAST NUMBER IN THE TOXIC ALGA *HETEROSIGMA AKASHIWO* IN RESPONSE TO IRON AVAILABILITY. [S]**

1115 – 1130 Veluppillai, Jean M., Ebrey, T.G., *Lybrand, T.P. and Cattolico, R.A., Department of Biology, University of Washington. *Department of Structural Biology, Vanderbilt University. **PUTATIVE CHLOROPLAST ENCODED G PROTEIN-COUPLED RECEPTOR IN *HETEROSIGMA AKASHIWO* (RAPHIDOPHYCEAE). [S]**

1130 – 1145 Cattolico, Rose Ann, Lauren Choi, Melinda Duplessis, Alex Simon, Ellie Adman, and Michael Jacobs Departments of Biology and Oceanography, University of Washington. **TWO-COMPONENT SIGNAL TRANSDUCTION IN *HETEROSIGMA AKASHIWO* CHLOROPLASTS.**

1145 – 1200 Lindstrom, Sandra C., & Louis Hanic, Department of Botany, University of British Columbia. **INTRON PHYLOGENY MIRRORS ITS PHYLOGENY IN NORTH AMERICAN *UROSPORA* (ULOTRICHALES, CHLOROPHYTA).**

1200 – 1215 Goldstein, Melvin E.,Biology Department, University of Victoria, McLachlan, Jack L. Biology Department University of Victoria, & Moore, Janice, Aquatic Ecology Laboratory, Water Department, CRD, Victoria, B.C. **OBSERVATIONS ON THE VEGETATIVE MORPHOLOGY AND REPRODUCTION IN *SYNURA LAPPONICA* SKUJA, (SYNUROPHYCEAE).**

1215 – 1230 Open

1230 – 1330 LUNCH

1330 – 1430 SESSION 3 ECOLOGY

1330 – 1345 Jeong Ha Kim, Yoo Jin Nam, Young Wook Ko, Yongwoo Choi, Seungshic Yum, Department of Biological Science, Sungkyunkwan University. South Korea. **INTENSITY OF DISTURBANCE AND THE RESPONSES OF INTERTIDAL COMMUNITY.**

1345 – 1400 DeWreede, Robert E., Boizard, Sophie. Department of Botany, The University of British Columbia, Vancouver, B.C., Canada. **EFFECT OF KELP CANOPY COVER MANIPULATION AND WAVE IMPACT ON THE DENSITY, AND SIZE CLASS DISTRIBUTION, OF THE BLACK CHITON *KATHARINA TUNICATA*.**

1400 – 1415 Dickey, Kathleen, UC Berkeley Herbarium, Berkeley, California. **DISCERNING PATTERNS OF DISTRIBUTION OF MARINE ALGAE IN THE ROCKY INTERTIDAL AT SOUTHEAST FARALLON ISLAND, SAN FRANCISCO COUNTY, CALIFORNIA.**

1415 – 1430 Dyck, Leonard J. & DeWreede, R. E. Department of Botany, University of British Columbia. **SIZE AND SURVIVAL IN *MAZZAELLA SPLENDENS* AT SECOND BEACH, BARKLEY SOUND.**

1430 – 1445 Edwards, Matthew S.[1] and Hernandez-Carmona, Gustavo.[2] [1]Department of Biology, San Diego State University. 92182. USA, [2]CICIMAR-IPN. Ap. Posta 592. La Paz, Baja California Sur 23000. Mexico. **FACTORS REGULATING THE SOUTHERN RANGE LIMIT OF GIANT KELP IN THE NORTH PACIFIC OCEAN.**

1445 – 1545 POSTER SESSION and COFFEE BREAK

Carlile, Amy, Waaland, J. Robert, and Hall, Benjamin D. Department of Biology, University of Washington. **EVOLUTIONARY RATES IN THE RED ALGAE: A STUDY OF THREE GENES. [S]**

Fox, Caroline H. and Louis D. Druehl. Bamfield Marine Sciences Centre, Bamfield, BC, V0R 1B0, Canada. **VITAL STAINING SUGGESTS A NOVEL GROWTH PATTERN FOR *ALARIA*.**

Harper, John[1], Saupe, Susan[2], and Morris, Mary[3]. [1]Coastal and Ocean Resources Inc., Sidney, BC. [2]Cook Inlet Citizens Advisory Council, Kenai, AK. [3]Archipelago Marine Research, Victoria, BC. **A SHOREZONE MAPPING PROTOCOL FOR USE IN MAPPING REGIONAL VARIATIONS OF NEARSHORE HABITAT ALONG THE GULF OF ALASKA COAST.**

Lindstrom, Sandra C., & Vera Ronningen, Department of Botany, University of British Columbia. **THE BIOGEOGRAPHY AND MOLECULAR DIVERSITY OF *MASTOCARPUS PAPILLATUS* (RHODOPHYTA, PHYLLOPHORACEAE). [S]**

Mersereau, Jennifer. Bamfield Marine Sciences Centre. **Devonian Library.**

Morris, Mary C.[1], Saupe, Susan M.[2], and Lindeberg, Mandy R.[3] [1]Archipelago Marine Research, Victoria, BC. [2]Cook Inlet Citizens Advisory Council, Kenai, AK. [3]National Marine Fisheries Service, Auke Bay, AK **SHOREZONE MAPPING IN THE GULF OF**

ALASKA: LINKING INTERTIDAL SPECIES ASSEMBLAGES FROM GROUND SURVEYS TO REGIONAL MAPPING.

Thompson, Sarah Ann (1), Dylan Digby (1), Spencer A. Wood (2), Roly Russell (1), Maria T. Kavanaugh (1), Gary Allison (3), Bruce Menge (1), Jane Lubchenco (1). 1. Department of Zoology, Oregon State University. 2. School of Biological Sciences, University of Canterbury, New Zealand. 3. Dept. of Evolution, Ecology and Organismal Biology, the Ohio State University. **POPULAR CONCEPTIONS OF WAVE-EXPOSED ALGAE: TESTING THE RELATIONSHIP BETWEEN ALGAL ABUNDANCE AND WAVE EXPOSURE. [S]**

1545 – 1730 FREE TIME AND ACTIVITIES

Activities:
A. Kelp farm visit
B. Beach walk
C. Station Tour

1800 – 2130 HAPPY HOUR AND BANQUET

1800 hrs: Happy Hour (No host bar); Bamfield Community Hall
1900 hrs: Banquet; Bamfield Community Hall
2030 hrs: Talk: The life and times of William Henry Harvey (1811-1866); Michael D. Guiry, Martin Ryan Insititute, National University of Ireland, Galway, Ireland.
Followed by: Benefit Auction

Sunday, April 25

[TIDES; LOW TIDE @ 1121 HRS, 1.1M; HIGH TIDE @ 1815 HRS, 2.7M]

0830 - 0930 Breakfast/Bag lunch

0930 – 1015 SESSION 3 (Continued)

0930 – 0945 Carney, Laura T. Department of Biology, San Diego State University. **FACTORS LIMITING THE RESTORATION OF *NEREOCYSTIS LUETKEANA* (BULL KELP).**

0945 – 1000 Klinger, Terrie. School of Marine Affairs, University of Washington
Padilla, Dianna K. Dept. of Ecology and Evolution, Stony Brook University
Britton-Simmons, Kevin. Dept. of Ecology and Evolution, The University of Chicago.
DENSITIES OF *SARGASSUM* AND PACIFIC OYSTERS ARE HIGHEST INSIDE MARINE RESERVES.

1000 – 1015 Watson, Jane. Malaspina University-College – **SPATIAL AND TEMPORAL VARIATION IN KELP FOREST COMPOSITION OF THE NW COAST OF VANCOUVER ISLAND, B.C.**

1015 – 1045 Coffee Break & BUSINESS MEETING

1045 – 1215 Touring/Free time (Kelp farm, beach); Station Tour

1230 - Bus departs Bamfield for Port Alberni
1430 - Bus arrives in Port Alberni.

NWAS – APRIL, 2004
BAMFIELD MARINE SCIENCES CENTRE
[Abstracts in alphabetical order]

Bates, Colin. Department of Botany, The University of British Columbia, Vancouver, B.C., Canada. **MICRO-INVERTEBRATE COMMUNITY RESPONSES TO CHANGING SEAWEED FUNCTIONAL DIVERSITY.** Understanding the roles that species play within communities and ecosystems is an important prerequisite for understanding the consequences of species loss. Yet, the ecological literature presents two different views: 1) all species are different and therefore functionally unique, and, 2) there is functional overlap allowing species to be classified into groups of functionally redundant species.
To determine which view best describes the role of seaweeds as habitat for microinvertebrates, I manipulated seaweed community structure to simulate three different macroalgal species loss patterns: random loss, functional group loss, and species loss while maintaining functional group presence. I then quantified the effects on invertebrate richness and community structure. I will present results suggesting that a functional group approach is most applicable to seaweed-invertebrate habitat interactions.

'Bullard, Aimee M. and Murray, Steven N. Department of Biological Science, California State University, Fullerton. **NET PRIMARY PRODUCTIVITY OF SOUTHERN CALIFORNIA ROCKY INTERTIDAL COMMUNITIES: POTENTIAL EFFECTS OF SHIFTS IN MACROPHYTE ABUNDANCES.** Southern California intertidal communities have changed during the last five decades, shifting towards higher abundances of crustose and turf-forming macrophytes. We determined cover and light-saturated, net photosynthetic rates for macrophytes at two sites with contrasting communities to understand how shifts in seaweed abundances might affect productivity. Macrophyte cover (75 % in winter and summer) was lower at Corona del Mar (CDM), a site dominated by coralline and crustose algae, and did not vary between seasons. Higher macrophyte cover occurred at Dana Point (DPT), a site supporting greater abundances of frondose seaweeds, and ranged from 85 % (winter) to 97 % (summer). Net photosynthetic rates of macrophytes varied little between sites and seasons and were comparable to previously reported values for the same species. Community productivity at CDM ranged from 171.3 (summer) to 180.5 mg C m^{-2} h^{-1} (winter), and was 22 to 35 % lower than at DPT (winter: 220.1 mg C m^{-2} h^{-1}; summer: 232.5 mg C m^{-2} h^{-1}). Turf-forming articulated corallines and crustose algae contributed 36 to 45 % of the productivity at CDM, whereas "fleshy" algae accounted for the greatest production (60 to 85 %) at DPT. Our results demonstrate that changes in macrophyte types can significantly affect the primary productivity of southern California intertidal communities.

Boizard, Sophie D. Department of Botany, University of British Columbia and Bamfield Marine Sciences Centre. **MORPHOLOGICAL AND BIOMECHANICAL VARIABILITY OF *LAMINARIA SETCHELLII* HOLDFASTS, STIPES AND BLADES ALONG A WAVE EXPOSURE GRADIENT.** Phenotypic plasticity is well known in kelps. Variability in lamina and stipe size and morphology in response to changes in flow regime has been documented for a number of species. Remarkably, very little attention has been given to phenotypic plasticity of kelp holdfasts. Specifically, how kelp holdfast morphology and biomechanics varies with changes in flow regime. I examined the effect of wave exposure on the morphology, size and attachment force of the intertidal kelp *Laminaria setchellii* Silva in the Deer Group Archipelago, Barkley Sound, British Columbia. The lamina length and surface area, and stipe length of *L. setchelli* varied with wave exposure. In general, wave-exposed *L. setchellii* had shorter and smaller lamina but longer stipes than kelps at wave-sheltered sites. However, the pattern was not consistent across all sites indicating that factors other than wave exposure might be influencing lamina and stipe phenotypes. Similarly, holdfast

surface area and biomass also varied with wave exposure. Wave-exposed *L. setchellii* had much larger holdfasts than wave-sheltered kelps. *L. setchellii* attached itself firmly to the substratum (removal force ranged from 60 to upwards of 500 N). However, wave-exposed *L. setchellii* were not consistently attached more strongly than wave-sheltered kelps. This was in part due to the high occurrences of crab burrows and barnacles, which undermined holdfast integrity and attachment at the wave-exposed sites.

Carlile, Amy, Waaland, J. Robert, and Hall, Benjamin D. Department of Biology, University of Washington. **EVOLUTIONARY RATES IN THE RED ALGAE: A STUDY OF THREE GENES.** As researchers turn to molecular techniques to infer phylogenetic relationships, the challenge is to find an appropriate molecular marker for the taxonomic level that one wishes to examine. Useful in this evaluation is knowing the evolutionary rate of the gene. In this study, the evolutionary rates of three genes were considered within the red algae. Two nuclear encoded genes, *RPB*1 and *EF*2, along with the plastid gene *rbc*L were analyzed. Parsimony and distance methods were used to measure differences between the sequences. Differences in the third codon position were also compared with overall changes to infer the disparity between synonomous and nonsynonomous changes in the sequence. The results show a faster evolutionary rate in the nuclear encoded gene *RPB*1 than the other two genes considered. This will be useful in future work where phylogenetic relationships within the family *Ceramiaceae* will be determined. POSTER

Carney, Laura T. Department of Biology, San Diego State University. **FACTORS LIMITING THE RESTORATION OF *NEREOCYSTIS LUETKEANA* (BULL KELP).** *Nereocystis luetkeana* is negatively impacted by anthropogenic disturbances and, in some cases, mitigation is necessary. Techniques to establish a *Nereocystis* bed in the northwestern waters of Washington, USA were examined and compared. Techniques investigated were as follows: 1) out-planting the zoospores versus the microscopic sporophytes (0.5-1.0 mm blade length); 2) out-planting these directly on natural substrate versus at elevated positions; and, 3) transplanting juvenile sporophytes (< 15 cm stipe length), bypassing the culturing phase. Juvenile transplanting resulted in reproductive adults and was found to be most successful. These had a 10-30% higher survival rate than previously reported kelp transplanting efforts using larger individuals. The collection of these smaller recruits for transplanting purposes imposes less of an ecological cost to natural populations than the collection of larger, established plants. The 28% surviving at the end of the study (135 d) developed and shed sori for at least 80 d. Stipe breakage caused by the grazing gastropod *Lacuna vincta* posed the largest limiting factor on transplant survival. Lack of survival among the out-planted zoospores and microscopic sporophytes indicates that other methods would be more successful. It was concluded that restoration efforts in the nearshore marine environment will benefit from an adaptive management approach in which lessons learned from failure are applied to future efforts.

Cattolico, Rose Ann, Lauren Choi, Melinda Duplessis, Alex Simon, Ellie Adman, and Michael Jacobs Departments of Biology and Oceanography, University of Washington
TWO-COMPONENT SIGNAL TRANSDUCTION IN *HETEROSIGMA AKASHIWO* CHLOROPLASTS. Plastids monitor physiological signals initiating from both cytosol and extracellular milieus. These signals are detected with a reliable degree of specificity, chemically amplified, and then transduced into a chemical reaction that alters the metabolic profile of the organelle and ultimately its host cell. The stramenopile *Heterosigma akashiwo* has been used in the functional analysis of Trg1– the putative response regulator component of a chloroplast-encoded His-to-Asp signal transduction circuit. Molecular modeling of the 27 kD protein is consistent with a winged helix-turn-helix protein identity - a class of proteins that are known to transcriptionally impact gene expression. Homologues of the *trg*1 gene are found in all rhodophyte

chloroplast DNAs examined but not in the organelle genome of the stramenopile *Odontella*. Modeling data support the hypothesis that *Heterosigma* Trg1 interacts with the σ70 protein subunit (encoded by *rpo*D) of a eubacterial- type RNA polymerase. New data haveverified the presence of a nuclear-localized *rpo*D gene in *Heterosigma*. A hypothesis concerning the evolution of the more complex signal transduction arrays found in terrestrial plants and green algae will be discussed.

Choi, Lauren Y., Hoyt, A., and Cattolico, R.A., Department of Biology, University of Washington.
ISOLATION AND CHARACTERIZATION OF RUBISCO ACTIVASE
The conversion of CO_2 into carbohydrates by autotrophic organisms may influence the global warming by altering the levels of this greenhouse gas. Although over half of carbon fixation on earth is performed by photosynthetic algae, studies of this process have focused primarily on terrestrial plants. Understanding the impact of CO_2 management on algal productivity will help in the development of realistic models for predicting changes in the oceans biochemical cycle.

In terrestrial plants, CO_2 entrance in the Calvin Cycle is driven by the catalytic enzyme *RuBisCo*. In the past, *RuBisCo* has been thought to be the rate limiting enzyme that drives Calvin Cycle function, but it is now known that *RuBisCo* is essentially non-functional without the cooperative enzyme *Rubisco activase*. Though chlorophytic algae contain the *Rubisco activase*, it is unknown whether this enzyme is present in chromophytic and rhodophytic algal representatives.

Full length, putative *Rubisco activase* genes have been cloned and overexpressed in the chromophytic alga, *Heterosigma akashiwo*, and in the diatom *Odontella sinensis*. This putative gene also has been identified in the diatoms, *Thalassiosira weissflogii* and *Cylindrotheca fusiformis*, and in the Dinoflagellate *Pyrocystis lunula* using PCR analysis. In the future, our studies will focus on determining the catalytic parameters of recovered proteins.

DeWreede, Robert E., Boizard, Sophie. Department of Botany, The University of British Columbia, Vancouver, B.C., Canada. **EFFECT OF KELP CANOPY COVER MANIPULATION AND WAVE IMPACT ON THE DENSITY, AND SIZE CLASS DISTRIBUTION, OF THE BLACK CHITON *KATHARINA TUNICATA*.** *Katharina tunicata* Wood (the black chiton) and the kelp *Hedophyllum sessile* (C. Agardh) Setchell (a kelp) are two common species in the rocky low intertidal zones of the NE Pacific Ocean. Density of *K. tunicata* is reported to vary widely within this zone. We manipulated canopy cover of *H. sessile* at two sites differing in wave exposure, to study the impact on *K. tunicata* density, size class abundance, and interaction strength between *H. sessile* and *K. tunicata*. *Katharina tunicata* density was always highest in the wave exposed site. Removal of *Hedophyllum sessile* canopy resulted in the following changes in the *K. tunicata* population: 1) a decline in density in the wave exposed site only, 2) a significantly lower abundance (and proportion of total) of the largest size class. Calculations using a rough estimate of physical variables suggest that individuals of *K. tunicata* longer than 7 cm are subject to removal by water velocities exceeding about 8 m s^{-1}. Interaction strength followed the same pattern as density changes due to canopy manipulation; the largest size class of *Katharina tunicata* had the strongest interaction with *Hedophyllum sessile*.

Dickey, Kathleen, UC Berkeley Herbarium, Berkeley, California. **DISCERNING PATTERNS OF DISTRIBUTION OF MARINE ALGAE IN THE ROCKY INTERTIDAL AT SOUTHEAST FARALLON ISLAND, SAN FRANCISCO COUNTY, CALIFORNIA.**
The Gulf of the Farallones National Marine Sanctuary has sponsored intertidal censuses on Southeast Farallon Island since 1992. More than two hundred species of marine algae have been documented, including several algae uncommon on the central coast of California, and one that had been reported only in Japan. Although typical in many ways of rocky intertidal zones found in

cold waters, the Farallones are unusual in that there is a marked absence of rockweeds, (Fucus, Silvetia, and Pelvetiopsis), a paucity of Laminariales and few plants that thrive in sanded-in habitats. Dominant algae include Corallina, Mastocarpus, and Mazzaella.

Dyck, Leonard J. & DeWreede, R. E. Department of Botany, University of British Columbia. **SIZE AND SURVIVAL IN *MAZZAELLA SPLENDENS* AT SECOND BEACH, BARKLEY SOUND.** Populations of *Mazzaella splendens* are predominantly gametophyte during summer in wave-sheltered habitats, sometimes shifting to tetrasporophyte dominance in winter. In wave-exposed habitats, there is tetrasporophyte dominance throughout the year. Hydrodynamic modeling of the forces acting on gametophytes *vs.* tetrasporophytes predicts greater survival of the diploid phase, as wave force increases, for blades 15 cm or longer. Such a difference could act in maintaining diploid dominance in wave-exposed habitats and facilitating a shift to winter diploid dominance in wave-sheltered habitats.

Survival for various size classes of *Mazzaella splendens* was measured from November 1997 to December 2000 in a wave-sheltered and a wave-exposed habitat at Second Beach, Barkley Sound. Significant differential survival between phases was absent in both habitats. In the wave-sheltered site, severe population decline in early summer led to the loss of most blades before increased wave action in fall and winter could have an effect. At the wave-exposed site, patterns of tissue gain and loss suggest that gametophytes are more likely to lose part of the blade than tetrasporophytes, reconfiguring their surface area in response to wave action. This may result in similar chances of removal at the stipe-holdfast junction for both life history phases.

Edwards, Matthew S.[1] and Hernandez-Carmona, Gustavo.[2] [1]Department of Biology, San Diego State University. 92182. USA, [2]CICIMAR-IPN. Ap. Posta 592. La Paz, Baja California Sur 23000. Mexico. **FACTORS REGULATING THE SOUTHERN RANGE LIMIT OF GIANT KELP IN THE NORTH PACIFIC OCEAN.** The giant kelp *Macrocystis pyrifera* occurs from central California, USA to central Baja California, Mexico. While its northern range limit is relatively stable, its southern limit is highly dynamic, varying over a ~120 kilometer range during the past 20 years. Prior to the 1982/83 ENSO, the southern range limit occurred at Punta San Hipólito, BCS while following this ENSO, it moved northward ~50 km to Punta San Roque, BCS. This range limit remained stable until the 1997/98 ENSO when it moved northward ~70 kilometers to Bahia Tortugas. This persisted for only ~two years, with giant kelp recolonizing Punta San Roque in late 1999. Then, in late 2001, giant kelp recolonized Punta San Hipólito after ~20 years of absence, again setting the southern range limit at its pre-1982/83 ENSO location. We have investigated the physical and biological factors responsible for setting the southern range limit of giant kelp in the northeast Pacific through observational and experimental procedures. The primary factors responsible for setting this limit are availability of suitable substrate, elevated sea temperatures and the corresponding decreases in nutrients, and competition with the subsurface kelp *Eisenia arboraea*. The relative importance of the factors however, is highly spatially and temporally variable.

Fox, Caroline H. and Louis D. Druehl. Bamfield Marine Sciences Centre, Bamfield, BC, V0R 1B0, Canada. **VITAL STAINING SUGGESTS A NOVEL GROWTH PATTERN FOR *ALARIA*.** Earlier studies on the growth of *Alaria* have indicated that, on occasion, the stipe grows shorter. To understand growth in *Alaria marginata* Postels and Ruprecht Calcofluor White S.T., a fluorescent vital cell-wall stain, was employed. The procedure was to stain entire plants and then after a period of growth determine the distribution of stained (old) and unstained (new) tissue by viewing the thalli under black light. Preliminary results indicate that pre-sporophyll-bearing protists have three meristems. The haptera grow from their tips, the stipe appears to elongate from the region that will later produce sporophylls, and the wings of the blade grow from their lower margins down the stipe, thereby changing the stipe into midrib. These preliminary results will be followed by

further, more intensive investigation. This study was started in 1984 and has been conducted by numerous student researchers, including the presenters of this poster. POSTER

Goldstein, Melvin E.,Biology Department, University of Victoria, McLachan, Jack L. Biology Department University of Victoria, & Moore, Janice ,Aquatic Ecology Laboratory, Water Department, CRD, Victoria, B.C. **OBSERVATIONS ON THE VEGETATIVE MORPHOLOGY AND REPRODUCTION IN SYNURA LAPPONICA SKUJA, (SYNUROPHYCEAE).** *Synura lapponica* is reported for the first time in Canada. The species was collected from three oligotrophic bodies of water administered by the Water Department of the Capital Regional District (CRD), Victoria, British Columbia. The present study provides the first detailed description of variations in vegetative morphology and asexual reproduction in the species. Typical colonies of *S. lapponica* possess a colonial envelope bound by a peripheral scale case and colony fission as described in *Tessellaria volvocina* Playfair. Also described are variations such as "halo colonies" and palmelloid reproductive colonies probably induced by environmental perturbations during collection and/or microscopic observations. In conclusion, the results of this study expand the circumscription of the species, but also provide further support for the affinity of *S. lapponica* and *T. volvocina*..

Harper, John[1], Saupe, Susan[2], and Morris, Mary[3]. [1]Coastal and Ocean Resources Inc., Sidney, BC. [2]Cook Inlet Citizens Advisory Council, Kenai, AK. [3]Archipelago Marine Research, Victoria, BC. **A SHOREZONE MAPPING PROTOCOL FOR USE IN MAPPING REGIONAL VARIATIONS OF NEARSHORE HABITAT ALONG THE GULF OF ALASKA COAST.** A rapid survey and mapping technique involving the use of oblique aerial video imagery has been used to map resources on over 5,000 km of shoreline in the Gulf of Alaska during 2001, 2002 and 2003. Geomorphic and biotic categorization of coastal habitat uses the *Alaska ShoreZone Mapping Protocol*, which is based on the ShoreZone system that is widely used throughout the Pacific Northwest (approximately 40,000 km of shoreline mapped in Washington and British Columbia). There are several unique aspects of the mapping system: (1) digital imagery has been web-posted allowing public access of the low-tide imagery, (b) exposure levels are determined from biotic assemblages within each shore unit, (c) regional distributions in biotic communities, including wetlands, red algae, brown algae, eelgrass, and kelps, are mapped and (d) man-made disturbances are characterized. Detailed definitions and descriptions of intertidal classifications are provided by coordinated on-the-ground surveys. The hierarchical nature of the classification makes it a powerful habitat management tool, and data have been used in spill response planning, research, essential fish habitat documentation, stewardship programs, and regional land-use planning. Example queries of data from the northern Gulf of Alaska show that wetlands occur along ~20% and eelgrass along 7% of those shorelines and geographical differences in the distributions of kelp. The protocol (Harper and Morris 2003) specifies a set of standards for intertidal and nearshore mapping so that (a) users have a clear understanding of the assumptions and methods incorporated into the mapping data and (b) future mappers have guidelines to ensure mapping consistency among agencies and mappers. POSTER

Jeong Ha Kim, Yoo Jin Nam, Young Wook Ko, Yongwoo Choi, Seungshic Yum, Department of Biological Science, Sungkyunkwan University. South Korea. **INTENSITY OF DISTURBANCE AND THE RESPONSES OF INTERTIDAL COMMUNITY.** Effects of disturbance intensity were investigated in the two different types of rocky intertidal community in the south coast of Korea, a mussel bed and macroalgae-dominated community. The experimental design includes four conditions: complete removal, partial removal, complete removal with *Ulva* excluded and control. Partial removal plots represented approximately 50% reduction of the existing coverage of each species of organisms. To test the influence of *Ulva pertusa* in the early succession of disturbed plots, we continuously removed *Ulva pertusa* thalli every month after all organisms were removed

at the beginning of experiment. Each experimental condition constituted of 50_50cm plots with 7 replicates. In the mussel bed, total algal covers were mostly consisted of *Ulva pertusa* and *Enteromorpha* spp. *Mytilus edulis* was recovered mostly during the recruit season (May and June 2002), and the greater recovery (e.g. 43.6% in May 2002) of mussel was observed in the partial removal plots, indicating that the existing adult mussels might play a key role in post disturbance recovery. Results also indicated that the introduction of new species (i.e., increased biodiversity) can be possible when the perennial dominant was partially removed. In the algal bed, the greater rate of recovery was found in the complete removal plots than partial removal and control plots. However, this difference was only caused by a few opportunistic algae, such as *Scytosiphon lomentaria* and *Enteromorpha* spp., with a highly seasonal pattern. Overall difference in algal recovery between partial removal and control plots was minimal in algal beds. In conclusion, patterns of recovery in early successional process were influenced by intensity of disturbance. But this study indicates that different communities might have different responses probably due to seasonality of recruitment and recovery speed of existing species.

Klinger, Terrie. School of Marine Affairs, University of Washington; Padilla, Dianna K. Dept. of Ecology and Evolution, Stony Brook University; Britton-Simmons, Kevin. Dept. of Ecology and Evolution, The University of Chicago. **DENSITIES OF *SARGASSUM* AND PACIFIC OYSTERS ARE HIGHEST INSIDE MARINE RESERVES.** The non-native species *Sargassum muticum* and *Crassostrea gigas* have been present in some areas of Puget Sound and Georgia Basin for up to a century. Only recently have these two species begun to spread rapidly through the San Juan Archipelago. We tested whether marine reserves in the San Juan Archipelago differed from similar but unprotected areas outside reserves in their vulnerability to invasion. Surprisingly, we found that *Sargassum* and *Crassostrea* both reached significantly higher densities inside reserves than outside them. These results could not be attributed to differential human harvest. We suggest that physical or biological attributes of the reserves themselves may enhance the success of these non-native invaders.

Lakeman, Michael B., Cattolico, Rose Ann, Department of Biology, University of Washington. **CHANGES IN CHLOROPLAST NUMBER IN THE TOXIC ALGA *HETEROSIGMA AKASHIWO* IN RESPONSE TO IRON AVAILABILITY.** As part of an ongoing project in our lab investigating the effects of iron-limited growth on the estuarine alga, *Heterosigma akashiwo*, we subjected cultures to low-iron stress and observed growth responses and changes in chloroplast number per cell over time. The average chloroplast number per cell exhibited by these cultures was directly related to the iron level in the media, with the low-iron cultures having fewer chloroplasts per cell than the replete cultures. On the other hand, the final cell yield was inversely related to iron availability, with a greater density of cells in the low-iron cultures. Interestingly, the cell-independent density of chloroplasts in each treatment was nearly identical. Our interpretation is that under low-iron conditions, the same total number of chloroplasts is produced, but they are divided amongst a greater number of similarly sized cells, thereby increasing the cell surface area per chloroplast. Such a behavior would be of adaptive significance as number of iron uptake channels available per chloroplast would be greater in low-iron conditions. Likewise, this adaptation would be advantageous in the nutritionally dynamic estuarine environment, yielding cells which are poised to take up as much iron as possible when Fe-rich freshwater is sporadically influxed.

Lindstrom, Sandra C., & Louis Hanic, Department of Botany, University of British Columbia. **INTRON PHYLOGENY MIRRORS ITS PHYLOGENY IN NORTH AMERICAN *UROSPORA* (ULOTRICHALES, CHLOROPHYTA).** Field and culture studies of North American *Urospora* from both the Pacific and Atlantic coasts have revealed at least nine forms based on sexual characters. To determine how many species these nine forms represent, we amplified the

ribosomal cistron of representative isolates from within the SSU through the ITS and 5.8S regions into the LSU. These amplifications produced fragments of different lengths in different individuals that did not necessarily reflect the species to which they belonged (based on ITS sequences). Rather, the lengths depended on the absence or presence of up to three introns, located at positions 943, 989, and 1512 of the SSU (positions based on the *E. coli* sequence). Introns occurred in all species except *U. penicilliformis*. Intron sequences and phylogeny supported recognition of the same species groups as the ITS data and helped resolve relationships among the species. *Urospora penicilliformis*, *U. wormskioldii* and two undescribed taxa ('Aberdeen' and 'Viking') occurred in one clade, and *U. neglecta* in a separate clade. Pacific *U. neglecta* diverged from Atlantic *U. neglecta* in intron sequence and occurrence. SSU sequences (excluding the introns) varied among species at no more than two base pair positions. Comparisons with other Ulvophycean taxa support the placement of *Urospora* in the Acrosiphoniaceae, order Ulotrichales. The uninucleate genus *Chlorothrix* and not the multinucleate *Acrosiphonia* is sister to *Urospora*.

Lindstrom, Sandra C., & Vera Ronningen, Department of Botany, University of British Columbia. **THE BIOGEOGRAPHY AND MOLECULAR DIVERSITY OF *MASTOCARPUS PAPILLATUS* (RHODOPHYTA, PHYLLOPHORACEAE).** *Mastocarpus papillatus* is a common intertidal red alga found along the west coast of North America from Baja California to Alaska. Sequencing of the ribosomal ITS region of the nuclear genome revealed a surprising level of diversity in specimens from California to Alaska, some from the same sites. Phylogenetic analysis of the data produced five well-supported clades, which we interpret as indicative of cryptic species. Two of the clades showed a closer relationship to *Mastocarpus jardinii* than to *M. papillatus*. Some of the clades exhibited distinct phenotypes, which should aid in their identification in the field. Each clade exhibited a different pattern of geographic distribution: one clade was found throughout the area sampled whereas the remainder had somewhat narrower distributions, either from northern Washington/southern British Columbia north to Alaska or south to California. POSTER

Martone, Patrick T. Hopkins Marine Station, Stanford University. **DO *CALLIARTHRON* GENICULA GROW LARGER TO SUPPORT LARGER FRONDS?** The decalcified segments (genicula) of the articulated coralline *Calliarthron* act not only as flexible joints, but also as breakage points in a mechanical system. Previous research has suggested that mature genicula lack nuclei and cytoplasm and, as such, may be empty cell walls incapable of cell division or growth, whose function is purely structural. However, at comparable genicular positions along small and large fronds, large fronds have larger genicula. This suggests that genicula get bigger as fronds grow. How genicula increase in size is unknown and potential growth strategies will be proposed. Furthermore, within a single articulated frond of *Calliarthron*, large branches are supported by large genicula and small branches are supported by smaller genicula. In other words, large branches that impose more drag force on the frond are supported by larger, stronger genicula. This suggests that genicula may actively respond to distal growth of the frond and increase in size to prevent breakage. Experiments testing this positive feedback are currently in progress and will be discussed.

Mersereau, Jennifer. Bamfield Marine Sciences Centre. **DEVONIAN LIBRARY** The Bamfield Marine Sciences Centre would like to showcase its diverse phycological holdings during the NWAS Conference. The library collection includes over 6000 volumes emphasizing marine biology. This would include such materials as: monographs, journals, reprints and student reports. As a compliment to the library holdings, BMSC maintains an extensive Herbarium on the teaching level. POSTER

Morris, Mary C.[1], Saupe, Susan M.[2], and Lindeberg, Mandy R.[3] [1]Archipelago Marine Research, Victoria, BC. [2]Cook Inlet Citizens Advisory Council, Kenai, AK. [3]National Marine Fisheries

Service, Auke Bay, AK **SHOREZONE MAPPING IN THE GULF OF ALASKA: LINKING INTERTIDAL SPECIES ASSEMBLAGES FROM GROUND SURVEYS TO REGIONAL MAPPING.** Using an innovative database design, on-the-ground observations of intertidal biophysical characteristics from over 50 shore stations in southcentral Alaska were used to define and describe characteristics mapped during an aerial mapping program conducted in the same area. These descriptions provide the 'bottom-up' link to the definitions of intertidal attributes used during the ShoreZone biophysical mapping project underway along the northern Gulf of Alaska coastlines. The ShoreZone mapping project uses low-tide aerial video imagery to classify and map intertidal geomorphology and biota across wider geographic ranges. The ground station database is spatially linked to over 4,500 along-shore mapping units, including estuaries and exposed rocky coasts from Cook Inlet to Port Bainbridge in Prince William Sound. The shore station database was used to determine the species composition and geomorphic characteristics of features identified during the aerial classification. Illustrated descriptions of 17 'biobands' (characteristic species assemblages visible in aerial imagery) and 11 'habitat classes' (summary categories of intertidal biophysical characteristics) were defined. The database will provide user-friendly definitions of the habitats and species assemblages, as well as links to information about dominant individual species and type locations. POSTER

Russell, Roly & Spencer Wood. Zoology Department, Oregon State University . **LOCAL ECOLOGY VERSUS REGIONAL EVOLUTION AS DRIVERS OF COMMUNITY DIVERSITY.** For decades, ecologists have been identifying the roles that independent factors play in determining how many species exist in a place. From local studies on competition, disturbance, and predation, up to continental and epochal scale analyses, ecologists can say with certainty that there are myriad factors that influence local diversity. However, we still have a poor understanding of how different factors *relatively* influence the number of species in a place. Plotting local species richness as a function of the regional species pool has been presented as one way to test the relative influence of local ecological constraints versus regional historico-evolutionary factors as drivers of local diversity. Supposing that local ecological interactions constrain species richness, two predictions arise. First, as we increase spatial scale of 'local' communities, patterns driven by local ecological interactions should disintegrate into regionally-driven relationships. Second, we expect a tendency towards locally-limited communities where species groups are more strongly interactive. Using an extensive dataset of marine rocky intertidal algal and invertebrate communities, we present evidence against local ecological interactions limiting species richness of local communities. This, in turn, lends support to the notion that evolutionary processes may have dramatic influences on local species richness of intertidal communities.

Thompson, Sarah Ann (1), Dylan Digby (1), Spencer A. Wood (2), Roly Russell (1), Maria T. Kavanaugh (1), Gary Allison (3), Bruce Menge (1), Jane Lubchenco (1). 1. Department of Zoology, Oregon State University. 2. School of Biological Sciences, University of Canterbury, New Zealand. 3. Dept. of Evolution, Ecology and Organismal Biology, the Ohio State University. **POPULAR CONCEPTIONS OF WAVE-EXPOSED ALGAE: TESTING THE RELATIONSHIP BETWEEN ALGAL ABUNDANCE AND WAVE EXPOSURE.** Those familiar with intertidal algae know that some species grow more favorably at a particular level of wave exposure. Some species, such as *Postelsia palmaeformis*, are widely regarded as "wave-exposed" indicators despite a lack of supporting analyses. Here, we investigate correlations between wave exposure and the presence and abundance of intertidal algal species. Data about the presence and abundance of species was collected in a rocky intertidal survey along the West Coast of the continental U.S. Our analyses suggest that patterns of algal abundance are related to the degree of wave exposure, but not always aligned with the popular conception. These species-specific

responses to wave exposure are characteristic of intertidal communities and essential to our understanding of how they are structured. POSTER

Veluppillai, Jean M., Ebrey, T.G., *Lybrand, T.P. and Cattolico, R.A., Department of Biology, University of Washington. *Department of Structural Biology, Vanderbilt University. **PUTATIVE CHLOROPLAST ENCODED G PROTEIN-COUPLED RECEPTOR IN *HETEROSIGMA AKASHIWO* (RAPHIDOPHYCEAE).** G protein-coupled receptors (GPCRs) form a large and very important superfamily of signal transduction proteins. These proteins enable cells to receive cues from and respond to their surrounding environment. GPCRs are integral membrane proteins with seven transmembrane spanning helices connected by loop regions. Upon binding of a ligand or capture of a photon by a GPCR, a signal is transduced within the cell that results in a change in a biological or physiological property of the cell. GPCRs, along with G-proteins and effectors (enzymes and channels modulated by G-proteins), are the components of a complex signaling system that connects intracellular second messengers to extracellular inputs.
An open reading frame of 1368 bases coding for a predicted protein of 455 amino acids was discovered in the chloroplast genome of the toxic Raphidophyte *Heterosigma.* Using a bioinformatics approach, it has been ascertained that ORF 455 is an integral membrane protein with seven apparent transmembrane segments. The profiles obtained from various analyses place this protein as a putative representative of the Rhodopsin/Beta-Adrenergic Receptor class of GPCRs and a possible opsin molecule. Molecular studies have shown that this chloroplast encoded ORF is not a pseudogene. Northern analyses to determine an expression profile under various environmental conditions will be discussed.

Watson, Jane. Malaspina University-College – **SPATIAL AND TEMPORAL VARIATION IN KELP FOREST COMPOSITION OF THE NW COAST OF VANCOUVER ISLAND, BC.** Variation in the species composition of kelp forests in areas occupied by sea otters was documented from 1987-2003. Although predictable successional changes occurred in response to the removal of red urchins by sea otters long-term changes were less predictable. Water temperature, episodic algal recruitment events and demographic processes all affected the relative abundance and species composition of kelp forests at permanently marked sampling sites, as well as sites randomly sampled at ~ 5 year intervals. In general, annual species such as *Desmarestia* spp, were highly variable in abundance, whereas long-lived species such as *Pterygophora californica* and *Laminaria setchellii*, underwent a gradual decline in abundance over the 17 year period. *Eisenia arborea* and *Macrocystis integrifoilia* appeared recruited and increased in abundance during periods of elevated water temperature.

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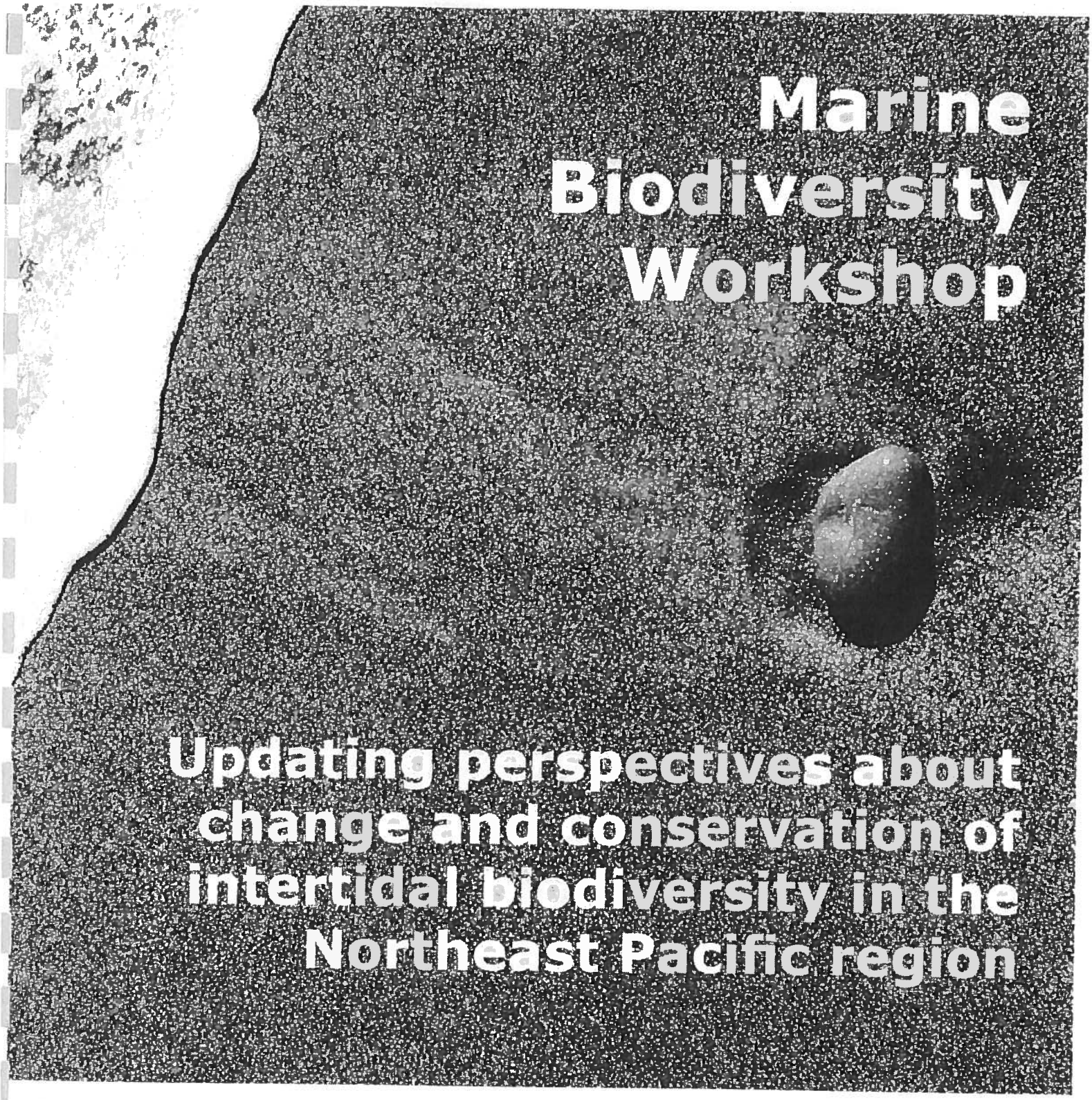


Bamfield Marine Sciences Centre

April 25-27, 2004

Intertidal Biodiversity Workshop

Updating Perspectives About Change and Conservation of Intertidal Biodiversity in the Northeast Pacific Region.

Bamfield Marine Sciences Centre, April 25-27, 2004, following the Northwest Algal Symposium

Background

Worldwide, human activities have induced changes in coastal biotic communities. The Northeast Pacific has not been spared from the increases in anthropogenic influences that could potentially affect this coast. Examples include: increased nutrient loading, forest practices that occur with increasing proximity to aquatic environments, increased frequency of El Nino events, marine pollution, introduced species, and increased use of park lands. Yet, comprehensive and up-to-date perspectives about how these impacts are affecting NE Pacific coastal biotic communities are lacking. Are local intertidal communities being altered, and if so, what are the implications of these changes? What role should scientists from the Pacific Northwest play in including intertidal algae, plants, and animals into coastal conservation and management plans? These questions are the focus of a two-day workshop following the Northwest Algal Symposium in April 2004.

Over three days, four sessions will be held. Each session will have a mix of formats, including symposia, large- and small-group discussions, and hands-on workshops (computer, lab, and/or field). The final content of the workshop will depend on the attendees, but a preliminary outline includes the following topics:

1) Demonstration of change in local coastal biotic communities

Symposium: presentations from participants regarding changes in intertidal communities in their region

Discussion: Overcoming hurdles to demonstrating biotic impact, coping with a lack of baseline data, and overcoming limited taxonomic expertise

2) Methods and challenges in quantifying change in intertidal communities

Discussion: highlighting problems and determining solutions specific to quantifying change in intertidal communities, methods in data collection and analysis

Workshop: multivariate community structure analysis using PRIMER software

3) Ramifications of change in intertidal communities

Symposium: what happens when intertidal communities change? Loss of functional diversity and the alteration of community and ecosystem services provided by seaweeds and invertebrates.

Discussion: Are intertidal communities in the Pacific Northwest under stress? Should seaweeds and sessile invertebrates be targeted in marine conservation plans?

4) Challenges and futures in intertidal conservation in the Northeast Pacific
Discussion: Highlighting challenges and determining the future of intertidal conservation in the Northeast Pacific. What are the challenges to including seaweeds and sessile invertebrates in current marine conservation plans, and what are the ramifications of ignoring them? What can we do to overcome these challenges?

Outcomes:
These sessions are intended to be highly interactive and participant driven. It is anticipated that the proceedings will be published either in a peer-reviewed journal, or as an independent workshop proceedings.

Contact
To register for this workshop, please see the attached registration form. To be added to the mailing list, offer suggestions for the workshop, or to indicate interest in participating, please contact Colin Bates (colinba@interchange.ubc.ca). Please note that the registration deadline for this workshop is March 27th, 2004.

SCHEDULE OF ACTIVITIES

Day 1: Sunday, April 25, 2004

1:30 – 2:00 Colin Bates (University of British Columbia) Welcome, Introduction, Administrative Notes, Questions

Session 1: Demonstration of change in local coastal biotic communities

Symposium:

2:00 – 2:20 Kathleen Dickey (UC Berkeley Herbarium): The biogeography of Southeast Farallon Island.

2:20 – 2:40 *Robert E. DeWreede, Sophie Boizard, and Russell Markel (Department of Botany, the University of British Columbia and Bamfield Marine Sciences Centre): Disturbance in a low intertidal community: Effect of variation in scale and location.

2:40 – 3:00 *Gayle I. Hansen and Michael S. Stekoll (Hatfield Marine Science Center, Oregon State University, Newport, and School of Fisheries and Ocean Sciences, University of Alaska, Juneau): Using similarity analyses to examine the distribution of marine algae in south-central Alaska.

3:00 – 3:20 Coffee

3:20 – 4:20 *Round Table:* Are northeast Pacific nearshore communities changing as a result of increases in anthropogenic pressures?

a) Introduction of Participants
b) Outline of Goals for session
c) Discussion

4:20 – 6:00 *Working Groups* (split into groups according to your knowledge of one of the following geographic regions: California, Oregon, Washington, BC, or Alaska)

TASK: to create regional maps of known cases where human influence has had an impact on nearshore biota. For each case try to include the: stressor(s), mechanisms, temporal and spatial scale, and genetic / population / community / ecosystem ramifications. Each group should aim to make a 10-minute presentation. The BMSC library and computer lab are available to aid your search.

6:00 – 6:30 Dinner

7:00 – 8:00: Group presentations of maps and summaries

8:00 - ... Follow up discussion and wrap up.

Day 2: Monday, April 26, 2004

7:30 – 8:00 Breakfast

8:30 – 8:50 Andy Spencer (Director, Bamfield Marine Sciences Centre): Welcome to BMSC

Session 2: Methods and challenges in quantifying change in intertidal diversity

8:50 – 9:00 Preamble: Colin Bates

9:00 – 9:20 Sandra C. Lindstrom (Department of Botany, University of British Columbia): The biogeography and molecular diversity of *Mastocarpus papillatus* (Rhodophyta, Phyllophoraceae).

9:20 – 9:40 Colin Bates (University of British Columbia): Beyond stewardship: overcoming challenges to incorporating non-scientists into intertidal monitoring programs.

9:40 – 10:00 *Roly Russell and Spencer Wood (Zoology Department, Oregon State University) Local ecology versus regional evolution as drivers of community diversity.

10:00 – 10:20 Brenda Konar (University of Alaska Fairbanks): A Global Survey of Nearshore Biodiversity: the NaGISA (Natural Geography in Shore Areas) Project.
CANCELED

10:20 – 10:30 Coffee

10:30 – 11:00 *Round Table:* highlighting problems and determining solutions for quantifying change in nearshore communities; methods in data collection and analysis.

11:00 – 12:30 *Computer Workshop:* multivariate community structure analysis using PRIMER software (Session 1, 10 people); or beach walk

12:11pm Low Tide (3.3 ft)

12:30 –1:00 Lunch

1:30 – 3:00 *Computer Workshop:* multivariate community structure analysis using PRIMER software (Session 2, 10 people); or beach walk.

3:00 – 3:20 Coffee

Session 3: Ramifications of change in nearshore communities

3:20 – 3:30 Preamble: Colin Bates

Symposium:

3:30 – 3:50 *Aimee M. Bullard and Steven N. Murray (Department of Biological Science, California State University, Fullerton): Changes in macrophyte communities and net primary productivities of southern Californian rocky shores.

3:50 – 4:10 *Terrie Klinger and Dianna K. Padilla (School of Marine Affairs and Friday Harbor Laboratories, University of Washington): Spread and potential impacts of Pacific oysters in the San Juan Archipelago, WA.

4:10 – 4:30 *Jonathan Whiteley and Leah Bendell-Young (Simon Fraser University) Measuring differences in intertidal benthic communities associated with clam farming.

4:30 – 5:00 *Round Table:* What are the consequences of changes in NE Pacific nearshore communities?

5:00 – 6:00 *Working Groups* (split up by expertise in: genetic, population, community, or ecosystem biology)

TASK: Based on impacts that were summarized on the maps (Session 1), each group should try to answer the following question: what are the risks and consequences of change/stressors to your chosen level of biological organization? Try to come up with specific examples, and wherever possible you should indicate the mechanisms.

6:00 – 6:30 Dinner

7:00 – 8:00 Presentations by working groups

8:00 - ... Follow up discussion and wrap up.

After: Social Time

Day 3: Tuesday, April 27, 2004

7:30 – 8:00 Breakfast. Make sure to pack a Bag Lunch!

8:30 – 8:40 Preamble: Colin Bates

Session 4: Challenges and futures in intertidal conservation in the Northeast Pacific

Symposium:

8:40 – 8:50 Barb Beasley (Clayoquot Alliance for Research, Education and Training): A review of stewardship initiatives in North Barkley Sound and Clayoquot Sound: how can we ensure that we're counting what counts?

8:50 – 9:10 Melinda McComb (Member of Ocean Shores & Oceana): Informal introduction to marine conservation issues.

9:00 - 9:45 *Round Table:* Highlighting challenges and determining the future of intertidal conservation in the Northeast Pacific. What are the challenges to including nearshore organisms and habitats in current marine conservation plans?

9:45 – 10:30 *Working Groups* (Split up into: A) Academic Faculty, B) Graduate Students, D) Other Scientists)

TASK: What can we do to overcome the challenges that were tabled in the discussion? Groups should outline a prescription for each major challenge, and give specific recommendations.

10:30 – 10:45 Coffee

10:45 – 11:30 Presentations by Working Groups

11:30 – 11:50 Synopsis of Workshop findings

11:50 – 12:00 Colin Bates: Closing Remarks

ABSTRACTS

Session 1: Demonstration of change in local coastal biotic communities

Kathleen Dickey (UC Berkeley Herbarium): The biogeography of Southeast Farallon Island.

Small-scale, fine-stroke intertidal studies have an important role in the monitoring, conservation and management of coastal resources. The ten-year census of the Southeast Farallon Island (SEFI) intertidal region is a good example of such a study. Located just twenty-seven miles from the city of San Francisco, California, and near the convergence of three major shipping lanes, SEFI is nevertheless a rare opportunity to study a pristine site, protected both as a refuge and as part of the National Marine Sanctuary. As part of the mainland within the last ten thousand years, SEFI shares many of the same species with the nearby coast. More than 200 algal species have been documented, including some not previously found in central California. Intriguingly, some of the most common algae of the Pacific Northwest are absent at SEFI.

***R.E. DeWreede, Sophie Boizard, and Russell Markel (Department of Botany, the University of British Columbia and Bamfield Marine Sciences Centre): Disturbance in a low intertidal community: Effect of variation in scale and location.**

The *Hedophyllum sessile* community is common on rocky low intertidal shores of temperate western North America. We studied the impact on of regional (El Nino), site (waves), and local (canopy removal) factors on abundance of *H. sessile* and other understory algae, and on the predominant herbivore *Katharina tunicata* , in Barkley Sound, Canada. The canopy removal impacts were experimentally induced, at scales that imitate their natural occurrence. Wave impact differed naturally at our two sites, and we defined this difference using wave impact recorders.

El Nino occurred in 1997/'98, and resulted in a near absence of juvenile *H. sessile* in 1997, followed by an absence of adult H. sessile in 1998. Both recovered in the year following their decline. Abundance of coralline algae did not change significantly. During the El Nino, *K. tunicata* abundance was reduced significantly in 1998, but recovered the next year. In non-el Nino years *H. sessile* adults were significantly more abundant in wave exposed sites and juvenile *H. sessile*, and *K. tunicata* density were also positively affected by waves. Only articulated coralline algae were affected significantly (positively) by canopy reduction.

These results indicate that this community has resilience to a regional scale impact, recovering from El Nino within a year. Site scale effects (wave impact) at our sites resulted in greater abundance of the major community constituents, *H. sessile* adults and juveniles, and *K. tunicata*; these differences persisted over some 5 years of monitoring. Our local small-scale manipulation (canopy removal) had impact, which differed from similar large scale manipulations.

***Gayle I. Hansen and Michael S. Stekoll (Hatfield Marine Science Center, Oregon State University, Newport, and School of Fisheries and Ocean Sciences, University of Alaska, Juneau): Using similarity analyses to examine the distribution of marine algae in south-central Alaska.**

Herbarium specimens of marine algae have long provided an extensive and valuable resource for determining the distribution ranges of species. However, these specimens are often overlooked in biogeographic analyses that employ similarity methods since they lack quantitative data on collection effort. However, by using Gauch's method of merging sites into biogeographic areas, it is possible to use herbarium and general collection data to determine biogeographic patterns. We have employed these methods for the following study.

During Coastal Habitat Injury Assessment studies of the Exxon Valdez oil spill, extensive voucher collections of seaweeds were taken from study sites throughout south-central Alaska to be used for taxonomic and biogeographic study. For our study alone, 10,442 specimens from 198 sites were curated and databased. They contained 324 seaweed species. Preliminary analyses of the data showed that half of the species were widely distributed throughout the study area while a third, including many rare species, were limited to only one of the three major regions investigated. Species richness varied extensively between sites and was heavily influenced by collection effort. To accommodate this variation, the sites were merged at different increments geographically and then compared with unmerged >50 species sites in our analyses. To make the study more ecological, the dominant site features of wave exposure and salinity were also incorporated into the analyses.

Our results showed that species similarity was highest between neighboring areas and between areas subjected to similar amounts of wave exposure. Exposed outer coastal areas clustered with the western sites segregating due to the intrusion of Aleutian species. Areas in Prince William Sound clustered with sheltered areas along the western Kodiak chain. Overall species richness was highest in areas with moderate to high but not extreme wave exposure and lowest in areas with low exposure and low salinity.

Session 2: Methods and challenges in quantifying change in intertidal diversity

Sandra C. Lindstrom (Department of Botany, University of British Columbia): The biogeography and molecular diversity of *Mastocarpus papillatus* (Rhodophyta, Phyllophoraceae).

Mastocarpus papillatus is a common intertidal red alga found along the west coast of North America from Baja California to Alaska. Sequencing of the ribosomal ITS region of the nuclear genome revealed a surprising level of diversity in specimens from California to Alaska, some from the same sites. Phylogenetic analysis of the data produced five well-supported clades, which we interpret as indicative of cryptic species. At least one of the clades showed a closer relationship to *Mastocarpus jardinii* than to *M. papillatus*, and a single collection conspecific with western Pacific *M. pacificus* was made in Alaska. Each clade exhibited a different pattern of

geographic distribution: one clade was found throughout the area sampled whereas the remainder had somewhat narrower distributions, either from northern Washington/southern British Columbia north to Alaska or south to California. Some of the clades exhibited distinctive morphologies, but the two most widespread genotypes also had the most variable phenotypes.

Colin Bates (University of British Columbia & Bamfield Marine Sciences Centre): Beyond stewardship: overcoming challenges to incorporating non-scientists into intertidal monitoring programs.

Long-term monitoring of macroalgal community structure can yield information applicable to marine reserve placement and environmental stress assessment, provide ongoing and up-to-date baseline records, and allow a constant watch for introduced species in the marine environment. Yet, such monitoring programs often require strong taxonomic expertise and are relatively labor intensive. These requirements can serve to exclude untrained individuals from participating in monitoring programs designed to yield reliable and scientifically useful data.

In an effort to determine the limits to these barriers, I will address the following questions: 1) is it necessary to collect abundance data, or is presence-absence information sufficient; and 2) is it necessary to sample at a species level or is a more coarse (higher taxon or functional group) resolution sufficient to resolve patterns of change in algal community structure? I will present data from Northeast Atlantic, Northwest Atlantic, Northeast Pacific, and New Zealand monitoring studies to show that protocols can be relaxed substantially before differences between sites can no longer be distinguished. These findings will aid the development of monitoring protocols that will allow nonscientists to move beyond stewardship into practices that will produce reliable and scientifically useable data.

***Roly Russell and Spencer Wood (Zoology Department, Oregon State University) Local ecology versus regional evolution as drivers of community diversity.**

For decades, ecologists have been identifying the roles that independent factors play in determining how many species exist in a place. From local studies on competition, disturbance, and predation, up to continental and epochal scale analyses, ecologists can say with certainty that there are myriad factors that influence local diversity. However, we still have a poor understanding of how different factors relatively influence the number of species in a place. Plotting local species richness as a function of the regional species pool has been presented as one way to test the relative influence of local ecological constraints versus regional historico-evolutionary factors as drivers of local diversity. Supposing that local ecological interactions constrain species richness, two predictions arise. First, as we increase spatial scale of 'local' communities, patterns driven by local ecological interactions should disintegrate into regionally-driven relationships. Second, we expect a tendency towards locally-limited communities where species groups are more strongly interactive. Using an extensive dataset of marine rocky intertidal algal and invertebrate communities, we present evidence against local ecological interactions limiting species richness of local communities. This, in turn, lends support to the notion that evolutionary processes may have dramatic influences on local species richness of intertidal communities.

Brenda Konar (University of Alaska Fairbanks): A Global Survey of Nearshore Biodiversity: the NaGISA (Natural Geography in Shore Areas) Project.

The ecological and economical consequences of marine biodiversity, and the potential loss of it, have recently initiated an increasing number of studies trying to identify the importance of biodiversity for ecosystem functioning. Coastal marine biodiversity has the potential of being high because of the three-dimensional structure of macroalgal habitats and seagrass communities. These shallow water coastal areas, however, are also the areas most impacted by humans, which can have severe effects on near-shore biodiversity. Within the last decade the need for nearshore biodiversity studies on a large spatial or even global scale has become increasingly obvious but comparisons are often hampered by the use of different methods. For a comparative biodiversity assessment on various spatial and temporal scales, a unified approach is needed.

NaGISA is the Initial Field Project for the Census of Marine Life (CoML) established to examine nearshore biodiversity in macroalgal and seagrass communities on a global scale. The overall goal of this project is to sample a pole-to-pole latitudinal transect and an equatorial longitudinal transect using protocols developed under the Census of Marine Life program.

NaGISA uses a standard set of protocols to select larger core areas and replicate sample sites within the core areas. Standard protocols are also used for all sampling. There are 2 levels of sampling with increasing difficulty. Non-destructive sampling involves the use of photography and observational techniques within random quadrates. Destructive sampling involves the clearing of macrophytes, small macrobenthos and meiobenthos within random quadrats. All materials are sorted and quantified. Various diversity indices are applied and voucher specimens are made. All data are stored in an international database.

Session 3: Ramifications of change in nearshore communities

***Aimee M. Bullard and Steven N. Murray (Department of Biological Science, California State University, Fullerton): Changes in macrophyte communities and net primary productivities of southern Californian rocky shores.**

Changes have occurred in intertidal macrophyte communities along the southern California coast during the past five decades. The past fifty years have also been a time of changing environmental conditions in this region. Coastal habitats have become increasingly influenced by human activities and coastal waters have been subjected to shifts in ocean climate, including the regime shift of the 1970s that affected coastal plankton, fish, and sea bird populations. Our lab re-surveyed rocky intertidal sites originally sampled by E. Y. Dawson in the late 1950s and sites sampled during the mid-1970s by Mark Littler and colleagues to determine changes in the abundances of rocky intertidal macrophyte populations and communities. All sites were sampled using line transect or plot-based methods similar to those used by earlier investigators. Our results reveal that significant changes in macrophyte abundances have occurred throughout the region during this period. At many sites, disturbance-resistant seaweeds dominate cover where large, fleshy species have decreased in abundance. These sites now consist mostly of low-producing crustose,

articulated coralline and small, turf-forming algae. Increases in these algal forms, together with decreases in larger, and generally more-productive fleshy seaweeds have resulted in a significant decline in the availability of frondose canopy habitat and have changed the primary productivity of southern California rocky intertidal communities.

***Terrie Klinger and Dianna K. Padilla (School of Marine Affairs and Friday Harbor Laboratories, University of Washington): Spread and potential impacts of Pacific oysters in the San Juan Archipelago, WA.**

The Pacific oyster (*Crassostrea gigas* Thunberg) has been grown in commercial culture in Washington state for nearly a century. This species was first introduced to northern Puget Sound in 1919. Although cultivation has been a commercial success, the region has long been considered to be too cold for successful reproduction of oysters in the wild. In the mid-1990s, Pacific oysters began to appear for the first time in rocky intertidal habitats throughout the San Juan Archipelago. Oysters now are widely distributed among rocky shores in the archipelago, at densities ranging from $< 1/m^2$ to $> 10/m^2$. Multiple size classes are present, and repeated recruitment is evident. We are testing whether local warming or genetic adaptation are responsible for the spread of oysters through this system.

Densities of Pacific oysters in rocky intertidal habitats are highest in the mid- to upper-intertidal zone, in areas typically dominated by the rockweed *Fucus gardneri* Silva. Where oysters are very dense, *Fucus* abundance declines sharply, with consequent declines in other species commonly associated with *Fucus*. The interaction between oysters and *Fucus* appears to be mediated by native limpet species. Our findings have relevance to intentional introductions of non-native bivalve and other species for aquaculture and restoration purposes. This work was supported by a National Sea Grant award to the authors.

***Jonathan Whiteley and Leah Bendell-Young (Simon Fraser University) Measuring differences in intertidal benthic communities associated with clam farming.**

Clam farmers aim to enhance production of the commercial species *Venerupis philippinarum*, primarily using two practices: seeding the beach with hatchery-reared juveniles, and applying plastic netting over the sediment, with the intention of excluding predators. Using data from a paired-site study, we examine differences between intertidal areas used for commercial clam culture, and unfarmed reference areas. We expected that changes would be most dramatic within infaunal bivalve communities (clams), because the commercially cultured species should compete most intensely with other clams. A comparison of clam density, biomass, and community composition reveals which non-target species could be most affected by clam aquaculture. While the dominance of *V. philippinarum* tends to increase in communities on aquaculture sites, it is not yet known what effects such changes may have on ecosystem processes, such as nutrient cycling, carried out by species in this community. We also outline some potential positive and negative effects of the use of netting to enhance clam production on aquaculture sites.

PARTICIPANT BIOS

Colin Bates

colinba@interchange.ubc.ca

Affiliation: Biodiversity Research Centre, Department of Botany, University of British Columbia & Bamfield Marine Sciences Centre

Background: Colin is a PhD student working with Rob DeWreede. His PhD work is geared toward understanding the consequences of human-induced alterations in intertidal community structure. In particular, he is using manipulative and observational experiments to determine what the ramifications of change in seaweed communities are, with specific reference to resultant change in invertebrate communities. As well, he is collaborating with Dr. Gary Saunders (University of New Brunswick) to maintain a long-term monitoring program in the Bay of Fundy.

Barb Beasley

beasley@island.net

Affiliation: Clayoquot Alliance for Research, Education and Training

Background: Barb helps coordinate and is a participant in a number of biodiversity monitoring projects within the UNESCO Clayoquot Biosphere Reserve region. These include a Shorekeepers program, eelgrass mapping, the B.C. Coastal Waterbird Survey, and the Living REEF subtidal fish and invertebrate monitoring program, in and around Ucluelet Inlet. They plan to initiate a stewardship program for the Tofino Mudflats Wildlife Management Areas and a kelp forest monitoring program in Clayoquot Sound this summer. Barb is interested in learning about indicators of detrimental change, and if & how they can be detected using simple survey techniques.

Leah Bendell-Young

bendell@sfu.ca

Affiliation: Department of Biological Sciences, Simon Fraser University

Background: Leah is a Professor of Biological Sciences at SFU, and her research is directed at understanding the effects of anthropogenic activities on ecosystem structure and function. Leah co-edited the book 'Waters in Peril', which presents scientific evidence produced by internationally renowned ocean scientists on the current state of ocean ecosystems, globally.

Sophie Boizard *boizard@interchange.ubc.ca*

Affiliation: Department of Botany, University of British Columbia & Bamfield Marine Sciences Centre

Background: Sophie is a PhD student working with Rob DeWreede. Her experiences include over 10 years of field sampling and monitoring using various methodologies to determine species abundance and composition of intertidal and subtidal communities in both temperate and tropical climates. She has a strong interest in developing a long-term monitoring program on the west coast of Vancouver Island.

Kent Brothers *Kent@Brothers.ca*

Affiliation: Amateur biologist (employed as systems analyst at Creo Inc)

Background: Kent has a PhD in Statistics, and a general amateur interest in biodiversity. He has been compiling an inventory of organisms of the intertidal zone at Mackenzie Beach near Tofino, BC, for several years, and has now started including photographic records. Kent's professional background is in mathematical modeling, statistics, operations research, and computing.

Aimee Bullard *achele@aol.com*

Affiliation: California State University Fullerton

Background: Amy is a graduate student working with Dr. Steven Murray. Over the past two years she has been quantifying long-term changes in southern California's intertidal communities. For her Masters thesis, Amy is examining one implication of this change, primary productivity.

Rob DeWreede *dewreede@interchange.ubc.ca*

Affiliation: Department of Botany, University of British Columbia

Background: Rob is Professor of Botany at UBC. His research has dealt with both theoretical and practical aspects of the ecology of marine macro-algae, in both temperate and tropical habitats. In British Columbia, Rob has studied the structure and demography of marine algal populations, as well as competitive interactions, susceptibility to herbivores, and biomechanical properties. His research has produced both mathematical and conceptual models.

Kathleen Dickey *kdv@pacbell.net*

Affiliation: University of California Herbarium

Background: As a Research Associate with the UC Berkeley Herbarium, Kathleen has spent three years monitoring the rocky intertidal zone on the Southeast Farallon Island as part of a twelve-year census sponsored by the Gulf of the Farallones National Marine Sanctuary. She is interested in comparing the species distribution and diversity on the Farallones with the mainland and possibly other islands. Some plants and animals found on the Farallones are considerably out of their reported range, and Kathleen would like to explore this further.

Caroline Fox *aeryfox@hotmail.com*

Affiliation: Simon Fraser University and Bamfield Marine Sciences Centre

Background: Caroline is currently employed as a research assistant at BMSC, studying phycology. She will likely be pursuing a PhD in phycology and marine ecology in the near future.

Gayle Hansen *gaylehansen@harborside.com*

Affiliation: Hatfield Marine Sciences Centre

Background: Gayle specializes in macroalgal taxonomy and floristics. She is interested in using similarity techniques to interpret algal biogeography and recognize environmental change.

Terrie Klinger *tklinger@u.washington.edu*

Affiliation: University of Washington, School of Marine Affairs

Background: Terrie is a marine ecologist working in the San Juan Islands and the outer coast of Washington. Her interests focus on the application of genetic, population, and ecosystem-based studies to marine environmental decision-making. Her research has included diverse problems in ecology, including the population biology and ecology of kelps and other seaweeds, effects of global change on early development in seaweeds, ecological impacts and recovery from the Exxon Valdez and other oil spills, effects of thermal discharge into the marine environment, and biosafety assessment of engineered genes in the environment. Current research projects include issues in marine conservation biology, especially the design and implementation of marine protected areas.

Brenda Konar *bkonar@guru.uaf.edu*

Affiliation: School of Fisheries and Ocean Sciences, University of Alaska Fairbanks

Background: Brenda is part of the North American NaGISA Centre. NaGISA was established to examine nearshore biodiversity in macroalgal and seagrass communities on a global scale. The overall goal of the NaGISA project is to sample a pole-to-pole latitudinal transect and an equatorial longitudinal transect using a standard set of protocols established under the Census of Marine Life program.

Sandra Lindstrom *sandracl@interchange.ubc.ca*

Affiliation: Department of Botany, University of British Columbia

Background: Sandra is an Adjunct Professor at UBC. She is knowledgeable about the diversity and biogeography of seaweed species occurring in the Northeast Pacific. She uses molecular techniques to study seaweeds and their distributions. She is the co-author of 'North-Pacific Seaweeds'.

Melinda McComb *melinda_mccomb@yahoo.com*

Affiliation: Member of Oregon Shores & Oceana

Background: Melinda has spent the past three years researching, writing, speaking, and attending seminars with a focus on policies and practice of harvesting intertidal marine algae for commercial and individual use, impacts on ecosystems and species, management policies, and economics.

Vera Ronningen *verar@interchange.ubc.ca*

Affiliation: Faculty of Science, University of British Columbia

Background: Vera is currently finishing her undergraduate degree in ecology at UBC. Her main interest is kelp beds, but she is also interested in intertidal algal communities. Vera also works with Sandra Lindstrom at UBC, studying *Mastocarpus*.

Roly Russell *russelr@science.oregonstate.edu*

Affiliation: Oregon State University

Background: Roly is a graduate student working in the Lubchenco/Menge Lab. His research interests include a) the influence of algal diversity on ecosystem processes, specifically photosynthesis, and b) patterns of biological diversity in intertidal reef systems, using various metrics of diversity such as species richness or functional diversity.

Juan Saldarriaga *jsalda@mail.botany.ubc.ca*

Affiliation: Department of Botany, University of British Columbia

Background: Juan's main field of research is systematics/taxonomy of protists, in particular dinoflagellates. He now teaches part of the Protistology course at UBC.

Gerry Schreiber *gerry@island.net*

Affiliation: West Coast Vancouver Island Aquatic Management Society

Background: Gerry has a BSc degree in Environmental studies, and has been living and working on the west coast for over 5 years. He has been involved in mapping and monitoring eelgrass in the Ucluelet harbour (ongoing) and receives a small amount of funding to begin baseline kelp inventories along the west coast from the Broken Group to Hesquiaht Harbour. He is also currently coordinating the experimental Gooseneck barnacle fishery that is managed with a new model of local input through the Aquatic Management Society.

Sarah Ann Thompson *thompss2@science.oregonstate.edu*

Affiliation: PISCO & Oregon State University

Background: Sarah Ann works as a research technician for the PISCO project. She is responsible for conducting a rocky intertidal biodiversity sampling project along the west coast of the U.S. She is very keen to learn more about biodiversity and marine science.

Bob Waaland *jrw@u.washington.edu*

Affiliation: Department of Biology, University of Washington

Background: Bob is a Professor in the Department of Biology at UW. He is a phycologist with knowledge about Washington and the outer coast of British Columbia, and he has biogeographic interests on a larger scale. Bob is the author of several books, including 'Common Seaweeds of the Pacific Coast' & 'Algae and Human Affairs'.

Jonathan Whiteley *jawhitel@sfu.ca*

Affiliation: Department of Biology, Simon Fraser University

Background: Jonathan is an MSc student working with Leah Bendell-Young. His MSc thesis, part of the Sustainable Shellfish Aquaculture Initiative, is focused on measuring the interaction between shellfish aquaculture practices, mostly clam netting, and intertidal macrobenthic communities. He is currently working out how to measure and detect differences in communities, and describe consequences of the observed differences. His goal is to provide required information to the Shellfish Aquaculture industry to allow expansion under a sustainable framework.

Joline Widmeyer *jolinek@sfu.ca*

Affiliation: Department of Biology, Simon Fraser University

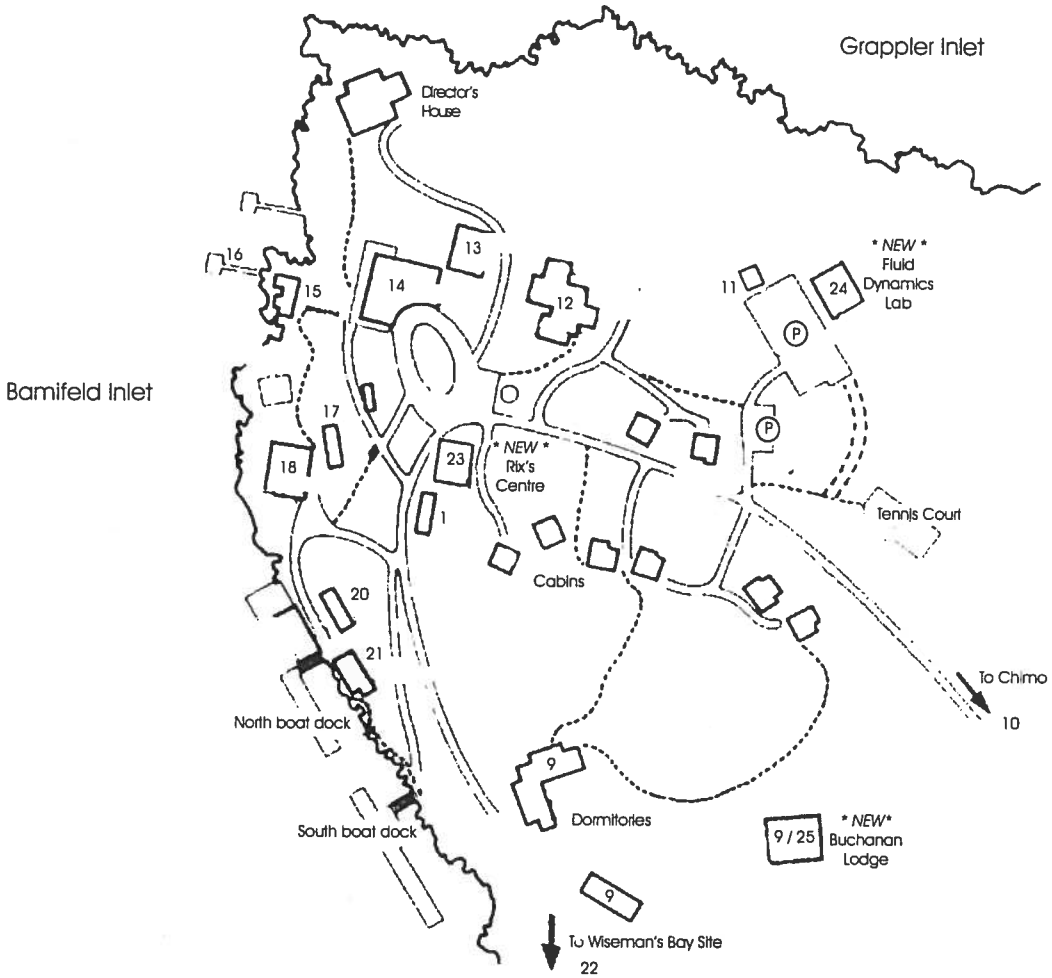
Background: Joline is a PhD student working with Leah Bendell-Young. She works with bivalves to understand marine toxicology and conservation. She is interested in understanding the impact of toxins (metals) on key monitoring species and food webs. She is also interested in studying impacts across different ecosystems (estuaries, intertidal zones, & ocean).

Spencer Wood *woodsp@science.oregonstate.edu*

Affiliation: Marine Ecology Research Group, University of Canterbury, New Zealand

Background: Spencer has been researching intertidal systems for a number of years, mostly as a technician with a number of different research groups. Much of his research has focused on rocky shore communities off the U.S. west coast. Approaches range from large scale, coast-wide community monitoring to small scale experimentation to tease apart specific drivers of local diversity.

BAMFIELD MARINE SCIENCES CENTRE FACILITIES MAP



HOUSING
1-8 ***Cabins***
9 ***Dorms***
10 ***Chimo***

11 STORAGE BUILDING

12 GENERAL HALL
- Lecture Hall
- Dining Hall
- Lounge
- Laundry Room

13 McMILLAN BUILDING
- Public Education Office
- Whale Laboratory

14 MAIN BUILDING

Main floor
- Director's Office
- Main Office
- Library

Teaching Level
- University Programs Coordinator
- Main Teaching Laboratory
- Small Teaching Laboratory
- Stores
- Computer Laboratory

Research Level
- Research Coordinator
- Offices
- Darkroom
- Molecular Laboratory
- Biohazards Laboratory

Aquarium (Basement) Level
- Inventory Room
- Aquarium Laboratory
- Basement Laboratory
- Aquarium Room

15 FURNACE BUILDING

16 FORESHORE (PIER) LAB

17 ECOPHYSIOLOGY BUILDING

1st floor:
- Neurophysiology Laboratory
- Fish Physiology Laboratory

2nd floor:
- General Laboratory
- Molecular Laboratory

18 COTC BUILDING

19 MAINTENANCE SHOP

20 BOATS BUILDING

1st floor:
- Boat and Diving Officer
- Skipper's Office

2nd floor:
- Offices

21 DIVING FACILITIES

22 WISEMAN'S BAY SITE
- Abalone hatchery

**** NEW * BUILDINGS***
23 RIX'S CENTRE
24 FLUID DYNAMICS LAB
25 BUCHANAN LODGE