OS22F-08 1605h

Minority Recruitment and Retention in a Coastal State: The UNO Example

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The result of the Y2K census demonstrates that significant proportions of persons under-represented in oceanography live in coastal states, especially those of the Gulf of Mexico. The failure of marine science programs in these states to recruit and retain students of color results from many factors. We believe that the largest of these factors is student access and information about these fields of study as professions.

In this talk, we use our program in recruitment and retention of minority students, especially African American students, in the Department of Geology and Geophysics. Our twenty-eight year program is recognized as among the most successful in recruiting, retaining, and graduating minority students in geosciences in the United States. Our success comes form our holistic approach to improving diversity which includes a) recognition of the demographics of the local population we wish to attract into our program, b) working with local school boards to improve earth science education in the schools, c) keeping active with state and local programs and clubs for teachers of earth science, and d) a summer field experience for high school students to the Rocky Mountains. Finally, a key aspect of our modern program is the support of local industry which provides scholarships and other forms of support for our students.

OS22F-09 1620h

Oceans to Classrooms: Infusing the Standards with Ocean Science Research

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The Marine Science Institute (MSI) at the University of California, Santa Barbara has developed a new educational outreach program entitled, Oceans to Classrooms (OtC). The primary mission of UC outreach programs is to increase the number of underrepresented and low-income students attending the UC. MSI aims to achieve this goal by stimulating student interest in science, specifically the ocean sciences, so that students are motivated to improve their academic performance, become UC eligible, and pursue the study of ocean sciences. OtC capitalizes on the resources available through MSIs scientifically diverse research group to infuse science taught in grades 68 with a broad range of ocean science concepts and cutting-edge research. OtC facilitates interactions between ocean science researchers, teachers and students through organizing professional development workshops for teachers, developing new ocean science research-based curriculum, and coordinating student field trips to MSI ocean science labs and field sites. All of these efforts focus on using recent ocean science research to create hands-on activities based on the scientific method, and to teach the required state standards. Here, we report the feedback from teachers participating in OtC. We also discuss why simply offering ocean science-based curriculum and student visits to labs, etc. is not an entirely adequate approach. To effectively infuse the ocean sciences into K12 curriculum, the teachers must be first transformed. Commonly, particularly in the low-income serving schools, pre 9th-grade teachers lack the resources, the confidence, and the motivation to develop or use new curriculum in their classrooms. We will discuss mechanisms to overcome these psychological and logistical impediments.

OS22F-10 1635h

"Young Women in Science:" Summer Science Programs for Middle and High School Girls

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Encouraging young womens interest in science has been the motivation for developing summer science programs for both middle and high school girls at the University of Southern California Sea Grant Program in conjunction with the USC Wrigley Institute of Environmental Studies and the Office of the Provost. While it is generally acknowledged that middle school is a key time to engage students in science, especially girls, it is also important to maintain and encourage that interest during the students high school years. Based on that idea and the demand by the young women who had completed the middle school programs, we piloted a summer science program for high school girls in 2001. These programs held at the Wrigley Marine Science Center on Catalina Island, offer hands-on lab and field activities that allow the girls to pursue a wide range of topics. The theme of "fun and learning in science" is housed in a larger context of "Women in Science." Female research scientists, graduate students, and teachers, as well as Sea Grant staff interact with the girls, who are given the opportunity to see women in a variety of marine related careers in marine policy, research science, education, and diving safety. Program development, challenges, and results of these programs will be addressed.

URL: http://www.usc.edu/go/seagrant/education

OS22G HC: 317 A Tuesday 1330h

Hyperspectral Remote Sensing of Nearshore and Open Ocean Environments II

Presiding: **C L Leonard,** Science and Technology Intl.**; J Campbell,** University of New Hampshire

OS22G-01 1330h

Hyperspectral Imaging of the Coastal Ocean

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Compared to the open ocean the coastal ocean is a far more complex optical environment. There is a much wider range of water column optical properties due to runoff from land, high levels of phytoplankton growth, sediment resuspension and other processes. An additional level of complexity is added when the bottom is visible through the variable water column. Resolving the bottom features as viewed through the complex and varying optical properties of the water column is the central problem in coastal remote sensing which requires hyperspectral imaging. The Naval Research Laboratory has a focussed program to develop hyperspectral imagers and the algorithms for processing that data for the coastal ocean. Here I report recent improvements in the Ocean Portable Hyperspectral Imager for Low Light Spectroscopy (Ocean PHILLS) aircraft hyperspectral sensor and present data collected during the July 2001 Hyperspectral Coastal Ocean Dynamics Experiment (HyCODE) at Tuckerton, NJ.

OS22G-02 1345h

Hyperspectral Remote Sensing of Nearshore Kelp Beds

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Hyperspectral remote sensing technology has proven to be a powerful tool in a broad array of applications including ocean sciences. Passive hyperspectral remote sensing of surface and/or subsurface objects or phenomena yields a wealth of high resolution spectral and spatial information useful for detection, identification and classification on multiple levels. One specific application for this technology is the detection of kelp beds in coastal waters. The distinct absorption and reflection features exhibited by kelp can be sensed by the narrow contiguous bands of the Advanced Airborne Hyperspectral Imaging System (AAHIS) 3, developed by Science and Technology International (STI). Analyzing the hyperspectral data cubes using algorithms such as principal component analysis and spectral angle mapping allow for kelp detection and mapping. An STI data set collected over the coastal regions in Oceanside, California in March 2001 will be used to demonstrate these methods.

OS22G-03 1400h

A new method for the determination of phytoplankton pigments from spectral in vivo light absorption.

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Multivariate regression models have made it possible to estimate pigment concentrations and phytoplankton abundance from spectral in vivo light absorption. Models were derived for both phytoplankton monocultures and natural samples differing significantly with respect to pigment composition, concentration and cell size. Model performance was evaluated against the conventionally used Gaussian decomposition method. The new method proved to be more accurate and sensitive at deriving pigment content than the Gaussian method. With the multivariate technique it was also possible to determine the concentration of many accessory pigments and the dominant phytoplankton classes. The new method presented here is more sensitive and suitable for analysing the spectral fingerprints of phytoplankton pigments than the Gaussian method.

URL: http://www.dmu.dk/1_om_dmu/2_afdelinger/3_hav/4_projects/5_bio_optics/

OS22G-04 1415h

Subpixel Linear Mixing Within a Coral Reef Environment Based on in situ Hyperspectral Measurements

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It is often necessary to assume a relatively homogeneous benthic cover within a remotely sensed pixel when attempting to identify bottom type in a coral reef environment. In reality, however, with the benthic complexity common on a coral reef, there will always be mixing within a pixel given the spatial resolution of contemporary satellite imagery. It therefore becomes important to determine how spectral components of a pixel combine to result in one integrated pixel value. To address this issue, pure endmember high spectral resolution measurements were taken in Buck Island Marine Park, off St. Croix, U.S. Virgin Islands. Linear spectral mixing was used with these endmember spectra (coral, sand, grass, bleached coral, and benthic algae) to examine the integrated pixel signals. Results indicate that when sand is a component of the mixed spectra, there is a notable increase in magnitude of reflectance, even at only 25% sand cover. Cluster analyses of end member spectra and mixed spectra indicate that a relatively small sand component within a mixed pixel will effectively dominate the pixels spectral signal. The pixel spectral signal lacks similarity to other endmembers present, retaining spectral characteristics specific to sand.

OS22G-05 1430h

Shape Analysis of Hyperspectral Bottom Reflectance Data: Application to Remote Sensing Classification of Benthic Habitats

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Remote sensing is a valuable tool for rapid classification of benthic features in shallow coastal environments. Past applications have been limited, however, by multispectral models that are typically difficult to apply when bottom types are heterogeneous and complex. A way to overcome these limitations is to utilize hyperspectral data and classify reflectance signatures through spectral feature analysis. The work presented here is a study of hyperspectral benthic remote sensing, involving a recursive technique to retrieve bottom reflectance by removing the effects of the water column. Bottom reflectance is then classified by principal components analysis and compared to ground truth observations.

Optical data were collected at Lee Stocking Island (LSI), Bahamas using a Satlantic hyperspectral tethered spectral radiometer buoy (TSRB) towed 20 m behind a small boat. The TSRB measured upwelling radiance (L_u) and downwelling solar irradiance (E_d) at wavelengths of 395-795 nm, with 5 nm bandwidth. Depth was measured using a Suzuki ES2025 echo sounder. Water inherent optical properties (IOPs) were measured with a WetLabs ac9. The program AO (Sequoia Scientific Inc.) was used to calculate bottom albedo from TRSB, ac9, and depth measurements by iteratively solving an underwater radiative transfer equation. Albedo calculated by AO was separated into multiple bottom types using an unsupervised classification routine based on spectral shape analysis. The results were promising; classified bottom types correlated with ground truth observations taken from underwater video and were comparable to existing bottom type maps. This approach can also be employed to analyze full scenes from satellite and airborne hyperspectral sensors, assuming that water IOPs are consistent over an image. Bottom albedo calculated in AO from a hyperspectral PHILLS (Portable Hyperspectral Imager for Low Light Spectroscopy) image of Lee Stocking Island were found to have similar spectral shapes and magnitudes to the albedo found using TSRB data.

As remote sensing systems migrate from multispectral to hyperspectral imagers, there is a need for more robust tools to interpret spectral information from shallow marine environments. Spectral shape analysis provides a method for rapidly classifying complex benthic optical signatures and, when coupled with a system of removing water column attenuation, can be used to produce accurate maps of the bottom.

OS22G-06 1445h

Hyperspectral Remote Sensing of the Seafloor Near Lee Stocking Island, Bahamas

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The Ocean Portable Hyperspectral Imager for Low-Light Spectroscopy (Ocean PHILLS) was deployed on an Antonov AN-2 aircraft in a region near Lee Stocking Island (LSI), Bahamas, in May/June 1999 and May 2000. The deployments were part the Coastal Benthic Optical Property program (CoBOP) sponsored by the U. S. Office of Naval Research (ONR). The study site consists of a large expanse of optically shallow water with high spatial variability in the seafloor. The seafloor contains regions of several different types of sediment (oids, peloids, and skeletal grains) covered with patches of seagrass beds and algal mats. There are also areas of pavement and coral reefs colonized by variable proportions of gorgonians, hydrocorals, sponges, and brown and green algae. The data sets collected with the PHILLS contain 128 spectral channels over 400 nm to 1000 nm with an on-ground spatial resolution of approximately 1.25 m by 1.25 m. The high spatial and spectral resolution in the data set provides the opportunity to develop and test algorithms that search for subtle changes in the radiance spectrum that contain information about the atmosphere, the depth and optical properties of the water column, and the nature of the seafloor. The data also provides a baseline from which to monitor changes in the health of coral and seagrass beds near LSI. We have made great progress in the past year in recalibrating the PHILLS, identifying and removing artifacts from the data, and geocorrecting the 2000 imagery. We present example imagery and remote sensing spectra from these data sets, demonstrating the recent improvements. We also evaluate the feasibility of mapping and monitoring various benthic species and environmental characteristics with hyperspectral remote sensing.

OS22G-07 1520h

Hyperspectral Remote Sensing of Nearshore Bathymetry Offshore of Sarasota, Florida: Comparisons With High-Resolution Multibeam Bathymetry

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Due to the complexity that characterizes the optical properties of nearshore coastal environments, it is necessary to understand the nature of the seafloor and its influence on the optical signal in order to accurately interpret remote sensing data. In support of the Hyperspectral Coupled Ocean Dynamics Experiments (HyCODE), a set of three high resolution bathymetry surveys within an 18 km by 1.5 km shore-perpendicular transect 5km offshore of Sarasota Florida were collected at water depths ranging from 8m to 16m. Hyperspectral aircraft data were collected concurrently with the Ocean PHILLS (Ocean Portable Hyperspectral Imager for Low-Light Spectroscopy) instrument. The study site offshore of Sarasota, Florida was chosen as one of three HyCODE areas due to existing AVIRIS (Airborne Visible-Infrared Imaging Spectrometer) data, and represents an optically-shallow (i.e., where the signal detected by the airborne sensor is affected by the seafloor) environment. Bottom depths derived from the AVIRIS data by means of a semi-analytical remote sensing reflectance model were compared with bathymetry measured by a Kongsberg Simrad EM 3000 multibeam swath bathymetry system operating at 300 kHz. The pixel size of the multibeam bathymetry and AVIRIS data are 0.25m and 10m, respectively. When viewed at full resolution, the multibeam bathymetry data show small-scale sedimentary bedforms (wavelength 0.5m, amplitude 0.1m) that are not observed in the lower resolution hyperspectral bathymetry. However, model-derived bottom depths agree well with a smoothed version of the multibeam bathymetry. In areas where diver observations confirmed biological growth and bioturbation, derived bottom depths were less accurate. Co-registered acoustic backscatter corresponds well with the aircraft hyperspectral imagery and in situ measurements of bottom reflectance. Acoustic backscatter as a proxy for bottom albedo, in conjunction with multibeam bathymetry data, will allow for more precise modeling of the optical signal in coastal environments.

OS22G-08 1535h

Initial Results of Seabed Classification Using Fused Hyperspectral and Acoustic Data

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Seabed classification is the organization of the seafloor and shallow subsurface sediments into distinct classes based on certain physical characteristics. One important reason to map the seabed is that the resulting classes often correspond to, or may be used to discriminate, benthic habitats for particular marine species or communities.

Optical data including aerial photographs and multispectral satellite imagery have been used in the past to discriminate major bottom types such as sediments, seagrass and corals, but they have had less success at delineating more refined classes. Aerial multi- and hyper-spectral digital imagery have had somewhat better success delineating more specific seabed types. Nevertheless, all of these optical data are limited to regimes of optically shallow water.

Acoustic instruments are useful for penetrating optically thick water, which is an obvious advantage in deep or turbid areas. Furthermore, acoustic signals respond to different physical characteristics of the bottom than optical signals, which may provide a means to distinguish different classes than can be accomplished with the optical data. However, acoustic instruments require much more time than optical imagery to survey the same area. The hypothesis of this work is that combining optical and acoustical data will provide a better seabed classification than either data source can provide independently.

Results of a survey conducted during June 2001 in the vicinity of Lee Stocking Island, Bahamas, are presented. Classifications from tethered hyperspectral radiometer, acoustic echo sounder, and fused "opti-acoustic" data sets show promise for the technique. The potential for extending the method to hyperspectral imagery is also discussed.

OS22G-09 1550h

Neural Network and Optimization Methods: Estimating Water Depth and Bottom Reflectance Using Hyperspectral Imagery

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We compared two techniques to extract bathymetry and bottom reflectance from hyperspectral imagery in Case 2 waters. The optimization method and the neural network method were compared using two hyperspectral images (HyMap of Ship Island, Mississippi and AVIRIS of Tampa Bay, Florida). Both methods attempt to solve the inverse optics problem where the optimization method utilizes forward solutions provided by a semianalytical method and the neural network utilizes HYDROLIGHT. The analysis of the respective inversion procedures and results is accomplished using sensitivity analysis, error distribution analysis, and observations on convergence. The methods are compared on the basis of accuracy, efficiency, robustness, and extension to the aforementioned complex coastal environments. The final product of this research is a quantitative comparison to show the robustness and applicability of the two methods to two varied water column and bathymetry cases. Results of the neural network and optimization methods concerning robustness and efficiency will be presented and discussed.

OS22G-10 1605h

Strategies for sun-glint identification and correction in water-leaving radiances measured from MODIS

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The Moderate Resolution Imaging Spectroradiometer (MODIS) has provided daily, global multispectral data since it became operational early inthe year 2000. MODIS is in a 10:30 polar orbit on board NASAs Terra satellite, and as such a large percentage of its image swath is contaminated by sun glint at low– and mid–latitudes. To improve data quality and spatial coverage for ocean color products, it is desirable to identify those data that are glint-contaminated and to attempt to recover useful values when possible through corrections to radiances involved in the calculation of water-leaving radiance. Comparisons of normalized water-leaving radiances (nLw) from MODIS with *in situ* nLw measurements from the Marine Optical Characterization Experiment (MOCE) cruises have indicated that the estimated radiance contribution from atmospheric aerosols in the 865nm band (Lg_{865}) was too large and thus led to an underestimate of nLw in most bands. A correction term that accounts for the glint radiance, Lg, was derived using an empirically–derived scaling factor in conjunction with spectrally–dependent diffuse transmittance functions. While this has proved successful in identifying and removing sun glint contamination up to the edge of the region of extreme sun glint, its application is limited by the availability of an appropriate wind field. We have experimented with a multi-spectral technique to recover the pertinent information in this region. A combination of the glint-contaminated MODIS medium wavelength infrared radiances with those of the glint-free long wavelength infrared bands can be appropriately scaled to the 865nm radiances to enable the extension of the sun-glint correction through the extreme glint region.

OS22G-11 1620h

Shallow-Water Heat and Salt Models with Optical Parameters Derived from MODIS or SeaWIFS Imagery

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Princeton Ocean Model (POM) implementations for circulation in shallow waters, whether applied to estuarine or coastal settings, must account for photons absorbed or reflected from the ocean bottom. Standard implementations of the POM typically ignore the bottom, effectively treating it as transparent. This makes them highly inaccurate for simulating the hypersalinity fields found for shallow regions adjacent to the west coast of Andros Island, Bahamas. Large areas of the Bahamas Banks are at times covered by waters in excess of 40 psu with occasional calcium-carbonate whitings. Using an optimization type of spectral technique with known bathymetry, bottom albedos were derived for the Bahamas Banks from SeaWiFS and MODIS imagery. The bottom depth, albedo, and spectral absorption and scattering coefficients were used to derive solar-absorption fields required by heat and salt-budget models used to calculate thermal and salinity fields. The January to May 2001 period was simulated using AUTEC environmental fields with model results compared to AVHRR thermal and historical salinity data. Sensitivity analyses are presented regarding the effects of bottom albedo and depth on thermal (T) and salinity (S) fields. High-salinity tongues, observed to depths of 40m in summer Bahamian waters, have been reported in the literature and attest to the importance of shoal-water evaporation in delivering surface waters to depth for these regions. Is coral distribution affected by proximity to high-TS runoff in the Bahamas?

OS22G-12 1635h

New Developments in Airborne LIDAR Remote Sensing: Advanced Oceanic LIDAR Biomonitoring

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An advanced pump-and-probe (P&P) airborne laser technology has been recently developed at NASA Goddard Space Flight Center. The P&P system provides remote measurement of important phytoplankton photosynthetic variables, such as the functional absorption cross-section of photosystem II (PSII), PSII photochemical efficiency, PSII turnover time, the rate parameters of singlet-singlet and singlet-triplet annihilations, and carotenoid triplet lifetime along with pigment and organic matter fluorescence, down-welling and upwelling hyperspectral measurements and IR surface temperature. The utilization of an airplane as a platform provides the potential for rapid remote characterization of phytoplankton photosynthetic activity, biomass and diversity over large aquatic areas at synoptic space/time scales. The new airborne technology can be utilized to address the following issues: (1) Spatial and temporal variability of marine ecosystems, their driving forces and impacts; (2) Biological carbon sources and sinks in the ocean; (3) Natural and human environmental impacts and their consequences in the coastal areas; (4) Spatial/temporal gaps in satellite validation/calibration over meso- and synoptic scales.

This presentation summarizes results of five airborne measurement campaigns conducted in 1999-2001 in the Chesapeake Bay, Middle Atlantic Bight, Gulf of Mexico, and Pamlico Sounds (NC). Data on P&P validation with shipboard techniques, observations of local to regional spatial variability in PSII photochemical characteristics, coastal and offshore phytoplankton blooms, physical and biological interactions and diel photosynthetic photoregulation are presented. Pathways to improved assessment of pigment biomass and photosynthetic rate parameters based on airborne P&P laser measurements of biophysical and bio-optical characteristics are discussed. Validation data indicate generally good agreement between SeaWiFS and LIDAR Chl assessment except areas of high concentration of dissolved organic matter.

The PP technology may be complimented by recent developments in assessments of phytoplankton taxonomic variability from airborne LIDAR measurement. This research is primarily focused on multicolor laser excitation of Chl, PUB, PEB and phycocyanin fluorescence bands (560, 590, 650, 685, and 720 nm) to remotely implement fluorescence excitation technique. A laboratory prototype of the laser pigment analyzer (LPA) has been successfully tested with representative set of phytoplankton cultures and their mixtures. Initial results of taxonomic analysis in natural seawater samples and potential for airborne implementation of the LPA technology are discussed.

OS22H HC: 323 B Tuesday 1330h

Mariculture and Its Impacts on the Marine Environment: What We Know and What We Dont

Presiding: **D Angel,** Massachusetts Institute of Technology**; M Holmer,** Odense University

OS22H-01 1335h INVITED

Aquaculture and the Environment

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This presentation will comprise a review of the interactions that various components of aquaculture has with the environment. Biological and abiotic interactions will be presented through quantitative models, accompanied by case studies. Examples of those case studies include shrimp farming in Mexico and intensive salmon farming in British Columbia, Canada. A web-based course called Aquaculture and the Environment, representing the contents of this presentation has been developed and is now available through the University of British Columbia. The development of the course and our experiences during the current first offering will be presented.

OS22H-02 1350h

Results from Conference Proceedings on Aquaculture and the Environment

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Marine aquaculture is a global growth industry in which the US is lagging. Aquaculture already contributes an average of 30% of world production across all seafood categories, but only a small fraction of U.S. production. Imported seafood is the second largest contributor behind oil in the natural resources sector to our nation's trade deficit. As national demand for seafood grows in the face of declining natural fisheries, the expansion of U.S. aquaculture is inevitable. However, serious environmental, political, and technological issues must be addressed first by listening to the concerns of the public, environmental groups, local, federal, and state governments, the seafood industry and the scientific community, and next by structuring collaborative efforts to resolve them. Marine aquaculture operations presently include finfish, shellfish, algae, and seaweed, as well as their associated hatcheries, operational support, and pen and cage deployment requirements. Uses may conflict between public and private activities, and native aquatic species inhabit areas that may be impacted by the aquaculture infrastructure deployment. Coastal user groups range from property owners to maritime recreation, education, and conventional fisheries activities. Policy guidelines are needed on many factors affecting this rapidly growing industry, including nutrient releases, leasing of public lands below the ocean surface, control of escapees from hatcheries, native specie protection, pen and cage technology, and feed components.

This report presents conclusions and recommendations created from breakout and working groups participating in an international workshop held at the University of Massachusetts Boston from January 11-13, 2001 entitled Marine Aquaculture and the Environment: A meeting for Stakeholders in the Northeast. Models of solutions from Canada, Norway, Germany, and Europe were reviewed and habitat considerations and experiences from the U.S. were included to incorporate information from a broader geographical base. The conference focused on four areas: 1) impacts on habitats; 2) interactions between cultured and wild species; 3) mechanisms for building consensus for action among stakeholders; and 4) effects on marine animals, birds, and invertebrates. The final product of the meeting will be a publication outlining current knowledge and discussing recommendations for changes in policies, practices, and procedures to support environmentally sustainable marine aquaculture.

URL: http://www.alpha.es.umb.edu/mae01/

TUE

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Habitat Implications of Mussel Farming in Coastal Newfoundland, Canada

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Under the authority of the Canada Fisheries Act, the Department of Fisheries and Oceans (DFO) has a legislative mandate for the conservation and protection of fish and fish habitat supporting Canadian fisheries (i.e. commercial, recreational and Aboriginal). The Act prohibits the harmful alteration, disruption or destruction of fish habitat unless authorized by the minister. If an Authorization is issued, then DFO is obligated to conduct an environmental assessment under the Canadian Environmental Assessment Act. Potential environmental effects of aquaculture operations are now under review by DFO. Finfish-environment interactions are relatively well documented, however, shellfish operations in particular those in cold water systems, are less well studied. As part of a multidisciplinary study of the environmental sustainability of shellfish aquaculture, our team has examined the potential for alteration of benthic habitat at two mussel farms in Newfoundland, Eastern Canada. Both farms are located in small embayments with significant depositional areas and might be considered "poor" locations relative to most of the productive mussel farms in Newfoundland. Our results indicate that while there may be differences in organic matter content between areas with and without mussels, these are most likely the result of differences in bathymetry and water movement rather than the presence or absence of mussels. Sediment redox and sulfide concentrations under mussels were not significantly different from those in depositional areas without mussels. Erosional areas surveyed showed no evidence of sediment accumulation under the mussel lines. There was however, evidence of increases in mobile herbivores and predators feeding on kelp and mussels sloughed off the lines. Thus even at sites where there is potential for benthic habitat effects to occur, it is not possible to distinguish significant habitat damage from mussel aquaculture as it is currently practised in Newfoundland.