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

OS22H-03 1405h

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.

OS22H-04 1420h INVITED

Benthic Fluxes and Bioturbation Around a Salmon Cage Farm in Loch Creran, Scotland

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Bioturbation is important in the redistribution of material (including anthropogenic inputs) in sediments however the controls on mixing intensity and the consequences for sedimentary geochemistry are still poorly understood. In order to evaluate the relationships between bioturbation, sedimentary organic matter and associated geochemical parameters, four benthic stations were selected in Loch Creran on the basis of their proximity to a fish farm and on known differences in bioturbating macrofauna.

At each station divers collected sediment cores using 10 or 6 cm plastic core tubes. These were sectioned for chlorophyll a content and organic matter by loss on ignition and by CHN analysis. Cores were returned to the lab for incubation to determine oxygen uptake rate after which they were preserved for assessing infaunal biomass. On ship, cores from each station were examined for redox profile and a core was examined for oxygen penetration using a micro-electrode. At each station, stirred benthic chambers were placed on the sea bed and incubated for several hours in order to determine the rate of oxygen consumption and nutrient flux over a larger scale. On recovering the chambers, three 6 cm cores were taken at each station and sectioned to determine infaunal biomass depth distribution. Megafaunal densities at each site were estimated using diver observations and counts of surface features and static underwater video was used to determine the activities of mobile epibenthic fauna.

The results are used to better establish relationships between organic matter profiles in sediments, benthic remineralization and oxygen uptake rates, and the macrofaunal abundance and bioturbation intensity and mode. A model of sedimentation from the fish farm incorporating carbon degradation and hence oxygen fluxes is presented.

OS22H-05 1435h

Impacts of Milkfish aquaculture on carbon and nutrient fluxes in the Bolinao area, Philippines

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Sediment oxygen consumption, TCO2 production and nutrient fluxes across the sediment-water interface were measured in sediments inside and in a transect from 4 fish pens with production of milkfish (Chanos chanos) in the Bolinao area, The Philippines. There was a positive linear relationship between the rates of sedimentation inside the fish pens and the sediment oxygen consumption indicating that the benthic processes were controlled by the input of organic matter from fish production. The nutrient fluxes were generally higher inside the fish pens, and nitrate was taken up (1.7-5.8 mmol m-2d-1) whereas ammonium (1-22 mmol m-2d-1) and phosphate (0.2-4.7 mmol m-2d-1) were released from the sediments, which may have stimulated the primary production in the water column as indicated by higher chlorophyll a concentrations inside the fish pens. The sediments were enriched in organic matter with up to a factor 4 compared to outside. There was a loss to the surroundings of carbon and nitrogen of 51-68 % of the total input, whereas there was a net burial of phosphorus in the sediments. The results obtained suggest that fish pen culture leads to even greater impacts on benthic carbon and nutrient cycling than those of suspended cage culture.

OS22H-06 1450h

In-situ studies of seabed stability along an organic enrichment gradient in Loch Creran, Scotland UK

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Resuspension of fine-grained bottom sediments is a prevalent process at the seabed in shallow coastal regions. Resuspension is a complex phenomenon that is governed by the interplay between a hydrodynamical driving force (tides and waves) and biophysical and biogeochemical processes that contribute to sediment cohesive strength and thus act to retain sediments on the seafloor. This presentation reports field measurements of contrived fine sediment resuspension along an organic enrichment gradient away from an active large scale fish farm in Loch Creran, W. Scotland UK, collected using a variety of in-situ instruments, including near bed current meters, transmissometers and a submersible benthic flume. This paper specifically describes the use of the benthic flume. Bottom sediments were exposed to step increases in current flow in the flume chamber. Time-series data of the suspended sediment evolution and trace metal release in the chamber were obtained using an optical backscatter instrument and a syringe sampler respectively. From this data various sediment hydraulic indices were computed (the critical entrainment stress for significant transport, erosion rates for specified stresses and the still-water mass settling rate) together with the temporal flux of dissolved metals. Variations along the transect in these hydraulic parameters are discussed with reference to spatial differences in dissolved oxygen sediment penetration depths (measured using in-situ microelectrode profiles), bottom sediment properties, in particular organic content, sediment density, mineral particle size and epifaunal bioturbation intensity (from in-situ video). Low-temperature scanning electron microscopy of retrieved seabed samples was also used to relate bed structure to bed properties and to the observed erosion pattern. The observed erosion rates are compared with predictions from a fish farm resuspension model. This model contains low values for the parameters of critical erosion threshold and erodibility constant thus generating frequent, relatively small erosion events.

OS22H-07 1505h

The Physical, Biological and Geochemical Pathways of Metals Around Fish Farms in Scottish sea Lochs

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Marine fish farms are sources for various contaminants entering the coastal environment but very little attention has been given to the discharge of metals. Fish farms release metals both as constituents of food and as antifoulant treatments.

The environmental behaviour of metals depends on physical factors such as hydrography and sediment type, the biological communities present in the sediment and the geochemical conditions e.g. redox potential. In addition, the changes in sediment chemistry around farms caused by the large amount of organic matter deposition, and the effects that this has on bioturbating benthos, influences the distribution and availability of metals in sediments

This presentation describes the distribution of metal concentrations around a fish farm in Loch Craignish, W. Scotland and how these vary over time with changing farm input. Copper concentrations in sediments near the farm are greater than 270 μg g^{-1} (dry wt.) and zinc concentrations are greater than 410 μg g^{-1}. These are regarded as eco-toxicologically significant concentrations.

Opportunist polychaetes known to be community dominants at fish farm sites are important in remineralising organic wastes from farms. A mesocosm tank experiment to establish the toxicity of copper to polychaete assemblages typical of a farm impacted sediment showed decreasing survival of capitellids and spionids. The results are analysed to give NOEC, LOEC, LC_{50} and ChV values for copper and these are discussed in terms of ecological significance.

OS22H-08 1540h

Mixing and Dispersion in a Macro-Tidal estuary, with Application to Salmon-Pen Aquaculture: Cobscook Bay, Maine

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Cobscook Bay is a macrotidal estuary situated near the entrance to the Bay of Fundy, where the mean semidiurnal tidal range is 5.7 m. A net-pen salmon aquaculture industry has rapidly expanded in the last decade, raising questions about sustainable levels of production in the environmentally pristine bay. Recent problems with water-transported fish diseases have lead to fish mortality and pen closures. The present study addresses the question of dispersion and flushing of materials in the bay, using a three-dimensional numerical model to simulate the circulation driven by the semidiurnal tide and runoff from principal rivers. Tidal-mean flushing times vary from less than one day in the main channel near the entrance to more than a week in the extremities of the inner arms of the bay. The detailed distribution of particles is strongly influenced by a pair of counter-rotating eddies that forms in the central bay during each flooding tide. The effective horizontal mixing coefficient in the main channel of the central bay is 300-400 m2s-1, leading to rapid dispersal of particles and pollutants in the along-channel direction and into the shallow inner arms of the bay where they tend to accumulate.

URL: http://cobscook.tamu.edu

OS22H-09 1555h

Ecological consequences of near bottom mariculture on foreshore ecology

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Our objective was to assess the impact of the shellfishery on the ecology of the foreshore. To meet this objective we compared several indices of ecosystem structure and function among three beaches experiencing different intensities of shellfish farming and wild shellfish harvesting. Indices of ecosystem structure included species richness, abundance and distribution of bivalves, and, community composition; ecosystem function was measured as percent organic matter (carbon) in surface sediments collected from the three beaches. Our findings indicate that intensive shellfish farming in combination with the wild shellfishery alters intertidal ecosystem structure by reducing species richness (students's t-test, á = 0.008), altering bivalve abundance and distribution (ANOVA; P<0.0001) and changing the composition of the foreshore community from one which was represented by surface species to one dominated by bivalves; ecosystem function is altered as indicated by increased accumulation of organic matter (ANOVA; P<0.001). If diversity gives rise to ecosystem stability then the intentional reduction in intertidal diversity increases the probability that the ecosystem on which the shellfishery is based will destabilize and collapse. It is imperative that prior to the rapid expansion of this resource most notably into the pristine regions of coastal British Columbia, shellfish farmers are provided with and adopt sustainable farming practices. Studies on the impacts of the shellfishery at higher trophic levels such as sea ducks are urgently needed prior to any further exploitation of this industry.

OS22H-10 1610h

Biofiltration as a Method of Ameliorating the Impacts of Aquaculture

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This presentation gives a brief overview of the environmental, biological and socio-economic impacts of predominantly cage-based marine finfish aquaculture on a pan-European scale and discusses how biofiltration could be employed in the future to mitigate negative impacts. The exact budget of materials flowing through a fish farm is imprecisely known and varies depending on a range of parameters, including husbandry practice, overall biomass and the nature of the receiving environment. However, it is clear that only a minority of the nutrients added to the system as feed is removed in the harvest and that the remainder is lost to the environment. This loss consists of wasted feed and small feed fragments, faecal particles, mucus scales and dissolved organic and inorganic components. In some instances, this concentrated point source of nutrient inputs into the marine system can cause localised benthic and water column effects. Biofilters are hard substrate structures designed to maximise the surface area presented to a nutrient input source. It is hypothesised that a filter surface deployed in a nutrient-rich environment associated with mariculture will become rapidly colonised by marine fauna and flora settling out from the plankton, and that the developing community will be composed of sessile organisms that are able to extract dissolved nutrients and/or particulate material from the water column. The hypothesis is that as the biofilters become heavily colonised with fouling organisms this will lead to a significant reduction in the particulate material that settles on the seabed.

This presentation will review existing types of mechanical biofiltration commonly found in total or partial recirculation systems and give additional filtration capabilities of predicted biofouling communities. Using quantitative information related to existing nutrient inputs and the measured biofouling and filtration rates of the accumulative biomass, calculated estimates of biofiltration potential per unit structure will be given. These estimates will be compared with previous studies that have examined biofiltration within a mariculture context. The concluding synthesis will discuss the likely scale of intervention required, the possible levels of efficiency and rates of both filtration and mitigation. It will also include a brief overview of the related legal and environmental issues associated with biofilter use, such as disposal, deployment acceptability, associated aquaculture possibilities and pollutant bioaccumulation.

This presentation is supported by European Commission contract number Q5RS-2000-30305: Biofiltration and aquaculture an evaluation of hard substrate deployment performance within mariculture developments.

URL: http://www.sams.ac.uk/biofaqs

OS22H-11 1625h

Colonisation of Biological Filters Suspended in Waters Adjacent to Caged Mariculture Systems and Their Influence on Water Quality

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Scottish marine cage culture has an annual value in excess of GBP 300m and is dominated by the salmon industry. It is widely known that only a fraction of the nutrients added to caged mariculture systems as feed is removed in the harvest and that the remainder is lost to the environment. This loss consists of wasted feed, faecal particles and dissolved organic and inorganic components. While most of the dissolved compounds are quickly taken up within the micropelagic food web, particulates either fall rapidly to the seabed causing localised seabed enrichment or remain suspended indefinitely until they are remineralised or consumed by filter feeding organisms.

This paper presents the results of a 6 month study to compare the colonisation by marine flora and fauna of hard substrate structures deployed adjacent to fish farm cages and at a control location and to determine the efficacy of these bio-filters in removing dissolved nutrients and/or particulate material from the water column on the west coast of Scotland. Bio-filters were suspended at a depth of 8 m and at a distance of 10 m (fish farm) and 500 m (control) from a salmon farm, which supports approximately 800 tonnes of Atlantic salmon. The filters were rapidly colonised by filter feeding organisms at both the fish farm and control sites. Over the experimental period, approximately 40 different taxa were identified and the main fouling organisms included; hydroids, tunicates and bivalves. The biofilters suspended adjacent to the caged mariculture had a significantly higher abundance of bivalves, particularly mussels and scallops than the biofilters suspended in the water column at the control site.

Mesocosm trials held at Dunstaffnage Marine Laboratory, in association with the field based research, showed that the efficacy of the bio-filters from the fish farm and control sites in reducing the suspended particulate material in the water column over a 48 hour period was positively correlated with fouling biomass. The bio-filters adjacent to the fish farm also showed a significant increase in the release of dissolved nutrients, particularly ammonia and phosphate during this period compared to the control. The effectiveness of utilising biological filters to mitigate the environmental impacts of aquaculture will be discussed.

This presentation is supported by European Commission contract number Q5RS-2000-30305 - Biofiltration and aquaculture, an evaluation of hard substrate deployment performance within mariculture developments.

URL: http://www.sams.ac.uk/biofaqs

OS22H-12 1640h INVITED

Offshore Culture of the Pacific Threadfin *Polydactylus sexfilis*in Hawaii: Results of the Hawaii Offshore Aquaculture Research Project (HOARP)

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NOAA and the National Sea Grant Office have identified demonstration of the feasibility of offshore aquaculture in the United States as a top priority to address issues of sustainability of U.S. fisheries. HOARP is a joint research effort between the Oceanic Institute (OI) and the University of Hawaii Sea Grant College Program, in partnership with state governmental agencies, commercial farmers, and seafood processors. The ultimate goal of HOARP is to provide a scientific basis for evaluation of the biological, environmental, and economic feasibility of offshore aquaculture in the Pacific region. HOARP Phase I sought to combine newly developed sea cage designs from Ocean Spar Technologies, Inc. of Washington with technologies of Pacific threadfin mass culture and fish management developed by OI. Phase I successfully demonstrated the technical feasibility of raising and harvesting large numbers of fish in an offshore containment structure under completely submerged conditions. Phase II addressed issues to increase final harvest density, improve feed utilization, lower harvest size variability, and expand environmental monitoring efforts. Phase II also addressed the economics of production.

Monthly growth of fish raised in a single 2,600m^3 Sea Station^{TM} offshore during Phase II paralleled that of siblings raised in triplicate, onshore reference tanks at similar biomass densities. Peak biomass before harvest at 235 days of age offshore (mean wt. = 417.7 $\pm$ 33.0 g) was 12.1 kg/m^3, double that achieved during Phase I. The overall feed conversion ratio offshore (2.4) was higher than that achieved in onshore tanks (1.3 $\pm$ 0.1) at the end of the trial. Overall recovery of fish offshore (57.5%) was lower than that achieved onshore (90.2 $\pm$ 0.5%) owing largely to unaccounted losses. Harvested fish fell into a normal bell-shaped distribution with 66.9% of the fish falling into size classes ranging from 400 899 g.

Total ammonia levels measured near peak biomass and directly downstream from the cage four hours after the initial feeding of the day tended to increase slightly from upstream levels and began to dilute 15 m from the cage edge. There were no discernable trends in total phosphorous, chlorophyll A, turbidity, and total dissolved solids in weekly or quarterly samples. The polychaete, *Ophryotrocha*, became more abundant in the benthos directly underneath the cage than at control sites indicating a community response to increased organic load. The cage also acted as a fish aggregation device sustaining approximately 800 kg of resident species near the end of the trial. Improved economic outlook of Pacific threadfin culture offshore requires increased offshore nursery survival and final harvest density, and lowered feeding costs.

OS22H-13 1655h

Environmental Impact and Status of the Aimakapa and Kaloko Hawaiian Fishponds, Kaloko-Honokohau National Historical Park, Hawaii

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Aimakapa and Kaloko fishponds are two of several coastal ponds in the Koloko-Honokohau National Historical Park on the west side, or "Kona", coast of the island of Hawaii. These ponds are part of an extensive anchialine system of ponds, usually having no direct connection to coastal waters, but showing measurable salinity and tidal rhythms. Aimakapa and, in particular, Kaloko fishponds served as useful fish-producing systems up until the 1960s but have fallen into disuse, and may be becoming increasingly eutrophic. The National Park Service, in cooperation with the Native Hawaiian community, have recently cleared Kaloko, the northern fishpond, of invasive mangroves, and are in the process of rebuilding the original seawall (or kuapa) and inlet channels (or 'auwai kai) which has promoted circulation within the pond. In contrast, the southern pond, Aimakapa, has no current opening to the sea, and has become heavily silted and in-filled. The more stagnant Aimakapa system, however, provides a relatively-protected habitat for many endangered waterbirds, such as the Hawaiian stilt and the Hawaiian coot. In contrast, the more open and well-circulating Kaloko system does not have near the waterbird populations as at Aimakapa. In cooperation with the National Park Service we have begun an examination of the biogeochemistry of the waters and sediments of these two large ponds, to understand the current- and projected-impacts these systems may have on local coastal coral reef ecosystems, should they be restored to full use. We are also assessing the overall inorganic nutrient levels, their fluxes, and their sources, in order to assess the relative impact of planned and existing industrial developments near the Park, as well as to understand the biogeochemical function of these ancient ecosystems. The sediments within the more stagnant Aimakapa system are anoxic and may harbor harmful anaerobic microorganisms such as Clostridium botulinum. We have examined the Aimakapa system in a series of inland-shore (mauka-to-makai) sampling transects for pond water and sediment. Our preliminary data indicates the systems are of lower salinity (approximately 11 ppt.) on the bottom of the ponds than that of the surface waters (approximately 13 ppt.), consistent with the anchialine flow component. We will present our cross-pond interstitial water inorganic nutrient profiles and estimates both of diffusive and advective fluxes of inorganic nutrients.

TUE

OS22H-14 1710h

Water Column Processes in Mangrove Creeks Receiving Aquaculture Effluent.

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Water column processes in undisturbed mangrove creeks and in creeks receiving effluent from prawn farms in North Queensland, Australia were studied. Small scale discharges into tidal creeks did not elevate dissolved nutrient concentrations compared with non-impacted creeks, but did elevate concentrations of particulate nutrients, chlorophyll and suspended solids proximal to the site of the effluent discharge. Turbulent mixing caused rates of primary and bacterial production downstream from the discharge to exceed rates in the prawn ponds. In the lower reaches of the mangrove creeks and immediately offshore, standing stocks of particulate material and rates of primary and bacterial production were within the range of values found in non-discharge areas. During discharge periods microzooplankton grazing removed >120% of primary production and 117-266% of bacterioplankton production in the mixed lower reaches of the creeks and immediately offshore. Grazing by bacterivores was saturated in the upper reaches of the creeks, but was very high near the mouth of the creeks (5.2-11.8 d^{-1}). Baitfish juveniles were abundant in the creek systems, and fed either directly on macro-particulates by indiscriminate filter feeding, or by selective feeding on microfauna. We suggest that trophic processes and their concomitant respiratory losses are instrumental in the assimilation and dissipation of effluent materials within the creek system, and are responsible for returning concentrations of bio-available materials to ambient levels.

URL: http://www.aims.gov.au/pages/research/pipe/pipe-01.html

OS22H-15 1725h

Are Commercial Fish Farms and Scleractinian Corals Mutually Exclusive?

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It is a widely accepted dogma that scleractinian corals require clear, oligotrophic waters for their survival. Moreover, several field and laboratory studies have found a negative correlation between high levels of nutrients and/or turbidity (such as found in the waters adjacent to fish farms) and coral health and growth rates. Commercial fish farms that employ intensive net cage aquaculture technology release large fluxes of dissolved nutrients and particulate matter to the surrounding waters. Therefore, we would not expect to find stony corals in the waters immediately adjacent to fish cages. During summer and autumn 2000, we carried out a SCUBA-diver census of the corals found within a radius of 45 - 60m around the Ardag fish farm situated at the northern tip of the Gulf of Aqaba (Red Sea) in order to establish the abundance and diversity of coral colonies and their distribution with respect to the fish farm. It is noteworthy that although the Gulf of Aqaba supports some of the richest and most diverse coral reef communities worldwide, there have never been coral reefs in the near-shore region where the Ardag farm was established; presumably because this environment is impacted at least once annually by very heavy siltation following seasonal flash floods. The census revealed that corals generally did not live directly below the cages, however we found more than 470 coral colonies in the zone adjacent to the cages (0 - 50m). We identified 230 corals to 21 genera yet 240 of the corals were not identified and some of these probably belong to additional genera and species, i.e. the coral community adjacent to the fish farm is quite diverse. The largest numbers of corals were found in the shallower parts of the study area, presumably due to higher light levels. However, one of our more surprising observations was that the largest branching colonies found (mostly *Pocillopora* sp.) were situated on some of the fish cage anchor lines, only meters away from the fish cages, at depths of 3 - 4m, i.e. at sites that probably experience the highest fluxes of dissolved nutrients. It is noteworthy that fluxes of ammonia from a typical fish cage may exceed 14 kg per day and each of the 3 Ardag pontoons supports 15 cages or more. These and other observations highlight how poorly we understand the environmental impacts of fish farms.

OS22I HC: 318 A Tuesday 1330h

Bridging the Gap: From Molecular Biology to Marine Ecology I

Presiding: **G F Steward,** University of California, Santa Cruz**; E J Gaidos,** University of Hawaii Manoa**; M G Weinbauer,** Netherlands Institute for Sea Research (NIOZ)

OS22I-01 1330h

Detection of *Pfiesteria piscicida* Using Genetic Markers and Antibodies

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Mitochondrial cytochrome b (mt *cob*), a commonly used genetic marker whose utility in dinoflagellates remains unexplored, and its 5' flanking region were cloned and sequenced for the potentially toxic dinoflagellate *Pfiesteria piscicida* (*Ppcob*). Species-specific PCR primers were designed from unique domains in the *Ppcob* coding and the 5' flanking regions and PCR with these primers showed high species-specificity and sensitivity. In the meantime, antisera against the cell surface antigens of *P. piscicida* (Ppab) were developed using two immunization methods. The subset produced using purified cell wall/membrane fraction displayed high titer and specificity in immunofluorescence staining (IF). Tested against 20 different algal cultures and field samples, the PCR primers and the antisera both consistently recognized *P. piscicida* and gave negative results for other species including *P. shumwayae*. Based on the two methods, some unnamed *Pfiesteria*-like cultures were identified as it P. piscicida and some as non-*P. piscicida*. A quantification protocol was also developed for both the PCR (Time-Step PCR) and immunofluorescence (filter-based IF) to measure *P. piscicida* cell concentration. The protocol provided a lower detection limit of 0.2 and 0.3 cells/mL for the Time-Step PCR and the filter-based IF, respectively. The two methods were used to detect *P. piscicida* in *P. piscicida*-spiked and natural water samples collected from Chesapeake tributaries, eastern Long Island Sound, and Boston Harbor. Results from both methods agreed well. The tests and limited field surveys demonstrate that the combined use of *Ppcob* and Ppab is highly promising in accurate identification and enumeration of *P. piscicida*.

OS22I-02 1345h INVITED

Diversity in the nitrogen cycle: Characterization of functional guilds in the environment

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Complex biogeochemical cycles, such as the microbially mediated nitrogen cycle, are deceptively simple when viewed in terms of the net chemical transformations they include. For example, the oxidation of ammonium to nitrite or the denitrification of nitrate to N2, can be determined from the net nitrogen fluxes measured using geochemical methods during incubations. Every biologically mediated process in a particular environment can be ascribed to the activity of an enzyme, encoded by a functional gene (e.g., ammonia monooxygenase or nitrite reductase). Sequence analysis of such genes from the environment reveals a vast diversity within functional guilds; many different variants or alleles of the same functional genes are seen to be associated with each biogeochemical transformation. We are investigating the extent to which this genetic diversity is important in determining or regulating the overall rates of biogeochemical processes. Gene chips carrying multiple versions of genes involved in the nitrogen cycle are being developed to interrogate the microbial assemblage along a gradient of measured biogeochemical transformation rates from Chesapeake Bay to the Sargasso Sea. Preliminary results on the resolution of gene microarrays, transformation rates and diversity of functional groups in this environment will be presented.

OS22I-03 1400h

Whos blooming? Genetic Diversity of a Centric Diatom During a Spring Bloom

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A characteristic feature of diatoms is their ability to form large blooms. Diatom blooms dramatically impact coastal ecosystems and yet, despite considerable effort, the factors dictating the timing, magnitude or composition of a bloom remain elusive. Bloom dynamics may be difficult to unravel, in part, because of the complex interaction between the environment and the genetic and physiological diversity present within individual species. Dramatic evidence of the interaction between a species and its environment can be observed during blooms, as rapid asexual reproduction leads to an exponential increase in abundance. However, the consequence of a massive increase in cell number on the dynamics of individual cell lines is unknown. We have developed sensitive DNA fingerprinting techniques to examine how the extent of genetic diversity within a diatom species may influence bloom dynamics. Using these techniques, we recently identified an enormous amount of genetic and physiological diversity in a fall bloom population of the centric diatom *Ditylum brightwellii*. In this study, we not only sampled a single population but actually monitored the progression of a *D. brightwellii* spring bloom. Over the course of 11 days, we isolated more than 1000 individual cells from Dabob Bay, a temperate fjord. Analysis of cells isolated during the initial 2 days of sampling reveal lower levels of genetic diversity than we observed in a fall bloom population suggesting that spring and fall blooms may have very different genetic and physiological characteristics. Analysis of subsequent isolates will reveal whether one or many genetically distinct clones dominate at the height of the bloom. Furthermore, our results will provide insight into how environmental conditions shape the genetic composition of a diatom species.

OS22I-04 1415h INVITED

From mRNA to Satellites: A View of the Mississippi River Plume in the Gulf of Mexico

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Coastal plumes can often influence carbon cycling and sequestration many miles into the open ocean. The Mississippi River plume forms a low salinity feature that is constrained by the Loop Current and often can be detected from Louisiana to the Straits of Florida by SeaWiFS ocean color imagery. We have investigated the transcriptional activity and diversity of rbcL, the gene encoding the large subunit of ribulose-1,5-bisphosphate carboxylase/oxygenase, the major carbon fixation enzyme, in natural populations of this plume. In 1999, we focused on the genetic diversity of the actively fixing phytoplankton population by sequence analysis of mRNA-derived clones in a profile of the plume. These studies indicated that the low salinity surface water (top 10 m) of the plume was dominated by rbcL sequences consistent with PE-containing Synechococcus. Below the surface waters, a high-light clade of Prochlorococcus rbcL was found, and below that, a low-light clade of Prochlorococcus rbcL clones were recovered. Throughout the water column, a diversity of chromophytic rbcL sequences were found, including those of prymnesiophytes, pelagophytes, diatoms, and others. In 2001, we returned to the plume to study the nitrogen nutrition and diversity of the low salinity, surface plume populations along the axis of the plume. Additionally, the expression of the nitrogen controlling