EVOS ANNUAL PROJECT REPORT

Project Number: G-050635

Project Title: Trophic dynamics of intertidal soft-sediment communities: interaction between top-down and bottom-up processes

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Time Period Covered by Report: 1-September 2004 to 31 September 2005

Date of Report: 31 October 2005

1. Work Performed: Our overall hypothesis is that the distribution, abundance and production of benthic invertebrates residing in intertidal sediments of the Copper River Delta are controlled by a combination of top-down (predators) and bottom-up (nutrient and primary production) processes. To evaluate the central predictions of this hypothesis, a comprehensive sampling program was adopted to address four objectives. Objectives are designed under a multi-year project that leverages EVOS-GEM funding with funds provided by the Prince William Sound Oil Spill Recovery Institute (OSRI). At the time of this report, much of the 2005 lab work is ongoing. In this report, we highlight those activities completed in 2004 and in the spring of 2005.

Objective 1: *Characterize the spatial abundance of macrobenthic species inhabiting intertidal sediments within the Copper River Delta and Orca Inlet, Southeast Prince William Sound.*

Core sampling for invertebrates was conducted in September 2004 and April 2005. Areas sampled included low, mid-and high-tide plots near the outflows of Eyak River and Pete Dahl Slough, and low, mid, upper mid and high tide plots at Hartney Bay. All core samples (10-cm diameter) with the exception of a few samples from the April 2005 collection at Hartney Bay have been sorted, with all marine invertebrates identified, measured, and enumerated. Despite its low diversity (4 species account for the majority of animals and 1 species, *Macoma balthica*, account for >80% of the biomass), mudflats f the Copper River Delta support high densities of clams (~4,000 clams/m2), amphipods, and polychaetes that serve as prey for numerous species of migratory and resident species. Diversity of benthic invertebrates is significantly higher within mudflats of Orca Inlet compared to the Copper River Delta. This higher diversity likely results from the more saline conditions within Orca Inlet and the lower frequency of ice scour compared to the Copper River Delta sites. Biomass and density estimates of the dominant infaunal benthic invertebrates (*Macoma balthica* and *Mya arenaria)* are relatively stable over the 3 years of benthic data collection.

Table 1. Brief synopsis of invertebrate families and species collected in the Copper River Delta and Orca Inlet study area from 2003-2004.

	S.E. Prince William Sound	Copper River Delta	
	Orca Inlet - Hartney Bay	**Eyak**	**Pete Dahl**
Phylum Nemertea	Nemertean	Nemertean	Nemertean
Phylum Mollusca			
Gastropoda	Gastropod	Gastropod	
	Limpet		
	Nudibranch	Nudibranch	Nudibranch
Bivalvia	*Macoma balthica*	*Macoma balthica*	*Macoma balthica*
	M. expansa		
	M. inquinata		
	M. nasuta		
	Mya arenaria	*Mya arenaria*	*Mya arenaria*
	Mytilus trossuluss	*Mytilus trossulus*	*Mytilus trossulus*
	Pseudopythina compressa		
	Mysella tumida		
	Mactromeris polynyma		
	Clinocardium sp		
Phylum Annelida			
Polychaeta	Arenicolidae		
	Capitellidae	Capitellidae	
	Cirratulidae		
	Goniadidae	Goniadidae	Goniadidae
	Nephtyidae	Nephtyidae	Nephtyidae
	Nereididae		
	Orbiniidae		
	Oweniidae		
	Paraonidae		
	Pectinariidae		
	Phyllodocidae	Phyllodocidae	Phyllodocidae
	Polynoidae		
	Sabellidae		
	Spionidae	Spionidae	Spionidae
	Syllidae		
Phylum Arthropoda			
Subphylum Crustaceana			
Copepoda	Harpacticoid copepod	Harpacticoid copepod	Harpacticoid copepod
	Lepeophtheirus salmonis		
Isopoda	Isopods		
Amphipoda	Gammarid	Gammarid	Gammarid
	Corophids	Corophids	Corophids
	Caprellids		
Mysidacea	Mysids	Mysids	Mysids
Cumacea	Cumacea	Cumacea	Cumacea
Decapoda	Pagurid Crab		
Insects	Chironomidae	Chironomidae	Chironomidae

Objective 2: Determine and quantify those factors that best serve as predictors for primary production in the overlying water and within the sediments of tidal flat communities.

Conductivity-temperature-depth (CTD) profiles at 11 sites in Orca Inlet and the western Copper River delta were performed monthly from April through October 2004 and March though August 2005. All data from 2004 has been analyzed and placed in GIS format. Analysis of the 2005 data set will be completed after collection of the entire year's data set. GIS analysis of the 2004 data have documented the temporal and spatial influence of the Copper River's freshwater discharge on the intertidal waters and on adjacent water masses (Gulf of Alaska and Prince William Sound). Surface (Fig. 1) and bottom water salinities throughout the Delta and Orca Inlet are significantly reduced during the summer in response to the large input of freshwater from the Copper River Delta.

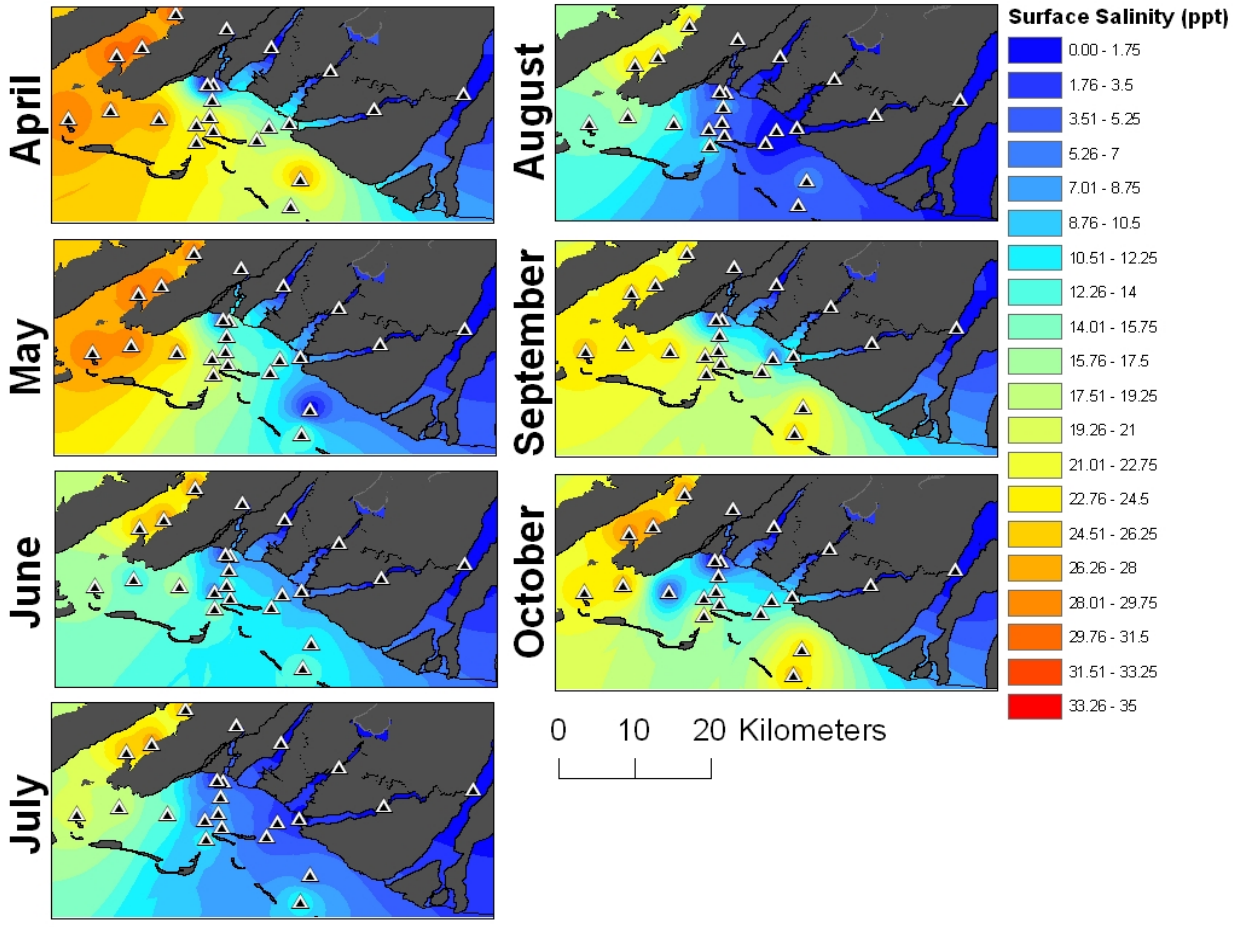

Figure 1. Interpolated surface salinity maps by month for the Copper River Delta study area, April – October 2004. Note the large influence of the Copper River outflow (far right river in images) in July during peak outflow.

We analyzed all nutrients and chlorophyll *a* samples from monthly samples obtained from April 2003 through May 2005. The remaining 2005 samples will be analyzed by February 2006. Based on visual examination of the interpolated plots, the Copper River is a large source of nitrate (Fig. 2) and ammonia (Fig. 3, 4) to the Delta ecosystem. Chl *a* concentrations in surface waters (Fig. 5) appear to reflect input of phytoplankton from the Gulf of Alaska. Chl *a* concentration in intertidal sediments increased as distance from the Copper River Delta increased (i.e. Pete Dahl < Eyak < Hartney Bay). Within each area, sediment chl *a* concentration was highest at mid tidal elevation, a location which generally demonstrates benthic biomass maximum.

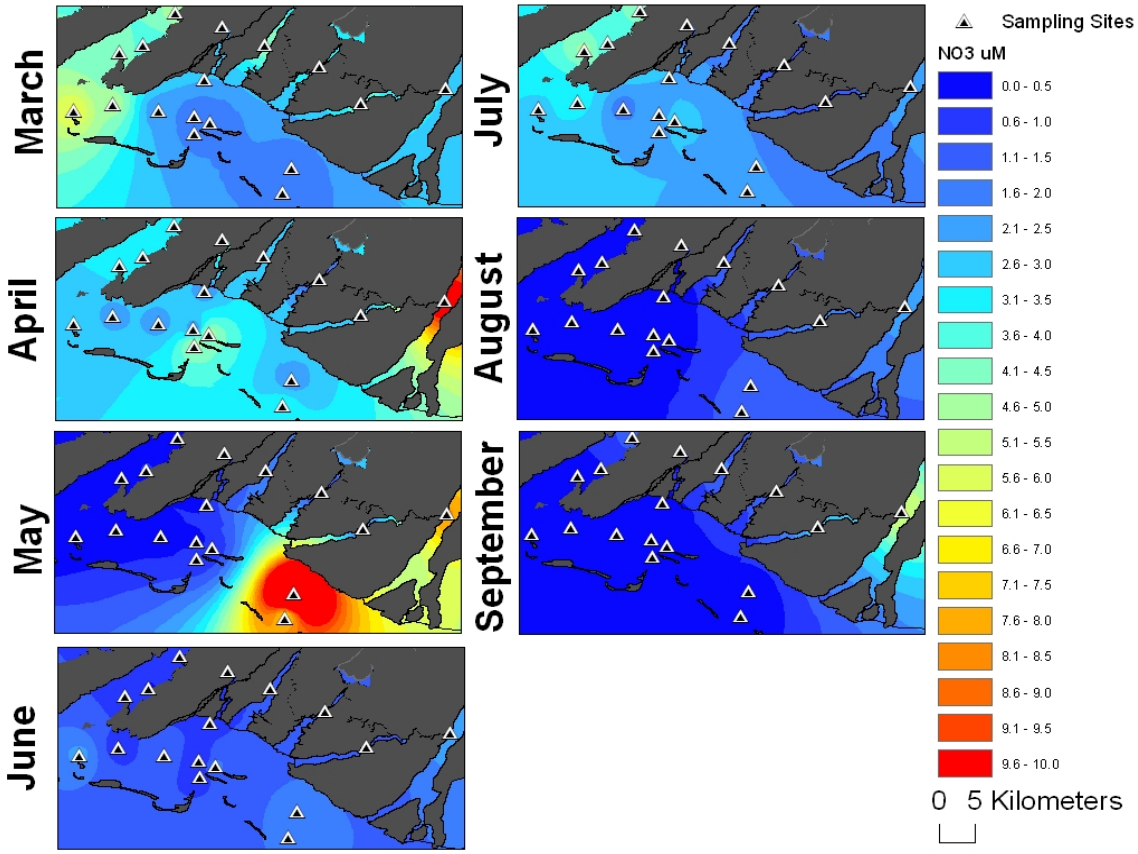

Figure 2. Surface nitrate concentrations on Copper River Delta, March – October 2004. Large inputs of nitrate from the Copper River Delta enter the Delta through exchanges between Egg Island and Pete Dahl channels with highest concentrations in late spring and late summer/fall.

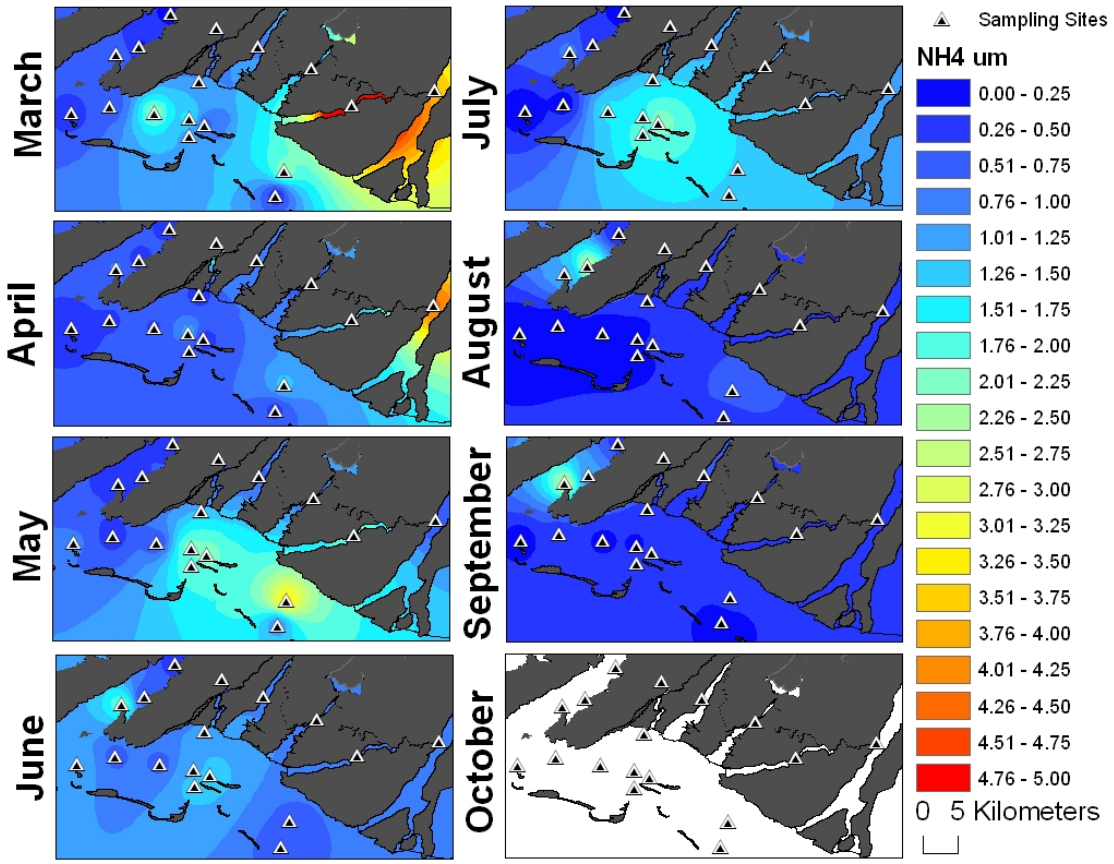

Figure 3. Surface ammonia concentration from March – September 2004. The large spikes in ammonia in Alaganik Slough and Copper River occurred during large eulachon returns (Fig 4).

Figure 4. Decaying eulachon carcasses at Alaganik slough in March-April 2004 may be a principle source of N into the Copper River Delta. Note the large numbers of Glaucous-winged gulls in the background that feed on these fish.

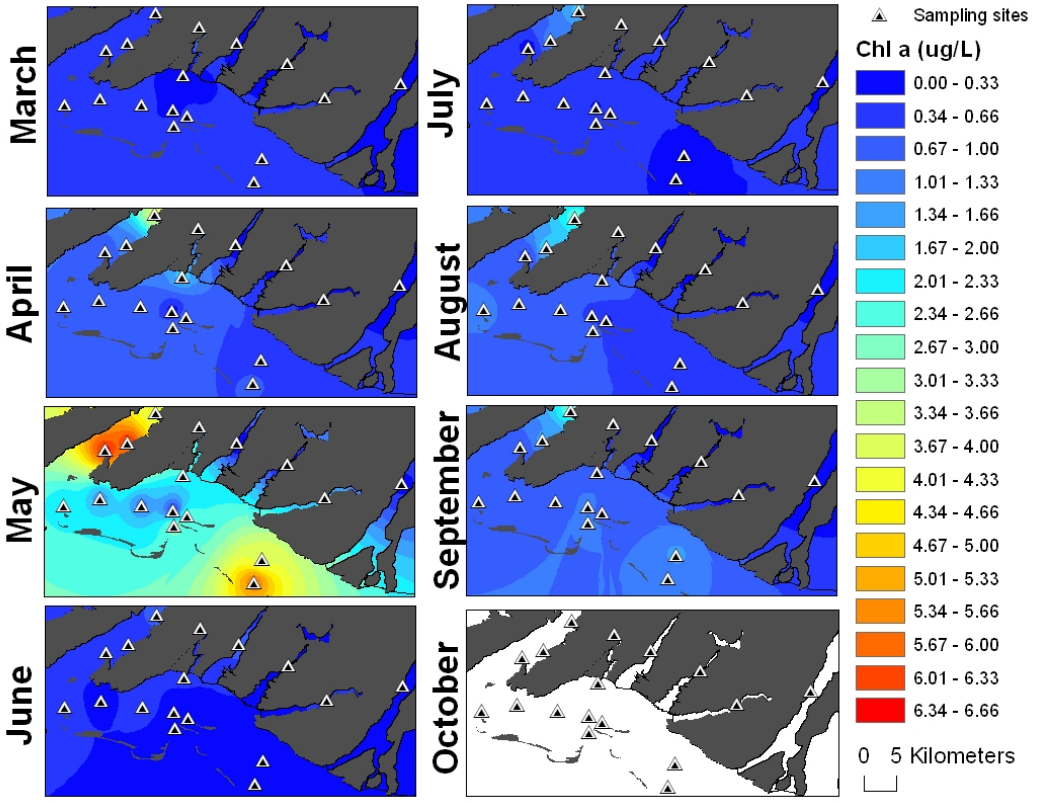

Figure 5. Surface chlorophyll *a* concentrations on Copper River Delta study area, April – October 2004. Chl *a* maxima are associated with higher salinity waters entering Pete Dahl Channel and in Orca Inlet during spring/early summer.

Objective 3. Characterize the spatial and temporal abundance of demersal and avian consumers and assess the role of epibenthic predation on recruitment of intertidal macroinvertebrates.

In an effort to document the abundance and distribution of demersal fish and crabs we conducted replicate otter trawl surveys monthly at 7 stations within our study area from March through October in 2004 and March through August 2005. Trawl surveys will continue through October 2005. All animals caught in trawls were identified and measured for TL (total length) and weighed. A diverse fish assemblage dominated by flatfish, sculpins, snake prickleback and *Crangon* shrimp is present on the Copper River Delta. Distinct spatial variability is evident in the demersal fish and crab distributions (Fig. 6). For example, Dungeness crabs show both a distinct spatial and temporal distribution with highest abundances found east of Orca Inlet, and peak abundances recorded June – September, respectively. The spatial pattern appears to reflect the abundance pattern of sea otters: higher numbers of sea otters are found in Orca Inlet compared to the Copper River Delta sites.

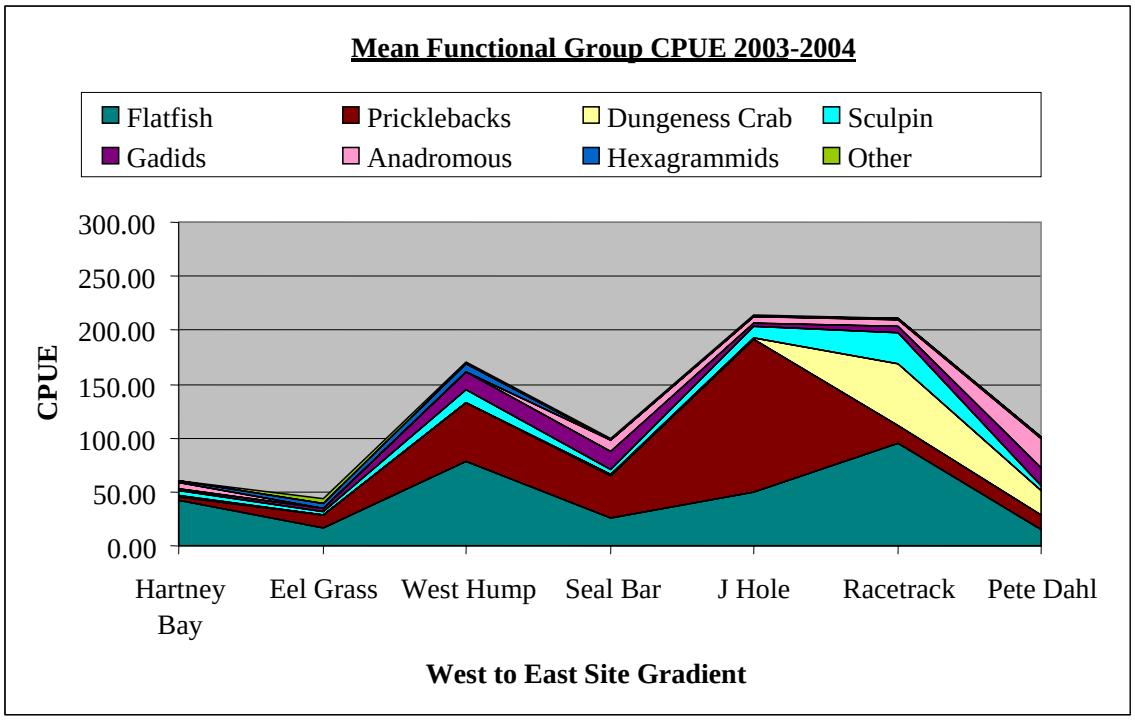

Figure 6. Spatial changes in the demersal fish community. Stations on the x-axis are arranged from West to East from Orca Inlet to the Copper River. Each data point represents the average catch per unit effort (CPUE, # of fish per 1000 m^2 of bottom)) for trawls collected over all sampling dates. One of the most striking patterns is the absence of Dungeness crabs west of the Seal Bar sampling site.

Interannual differences in recruitment of recreationally and commercially important fishes are also evident in our data set. Age 0 Pacific halibut were abundant in 2002, but catches of this age group decreased in 2003 and 2004 (Fig. 7). Age 0 and 1 lingcod were abundant in 2004, following two years of low abundance (Fig. 8). These patterns illustrate the importance of multi-year sampling programs.

Objective 4. Develop a cost-effective strategy and sampling design for long-term monitoring of the intertidal sedimentary habitats.

Objective 4 requires completion of the three years of field collections according to the observation program detailed in the proposal. We will continue to evaluate future monitoring activities as data from the current OSRI/GEM program are analyzed.

2. Future Work: Field work in 2006 will be conducted as detailed in the original proposal.

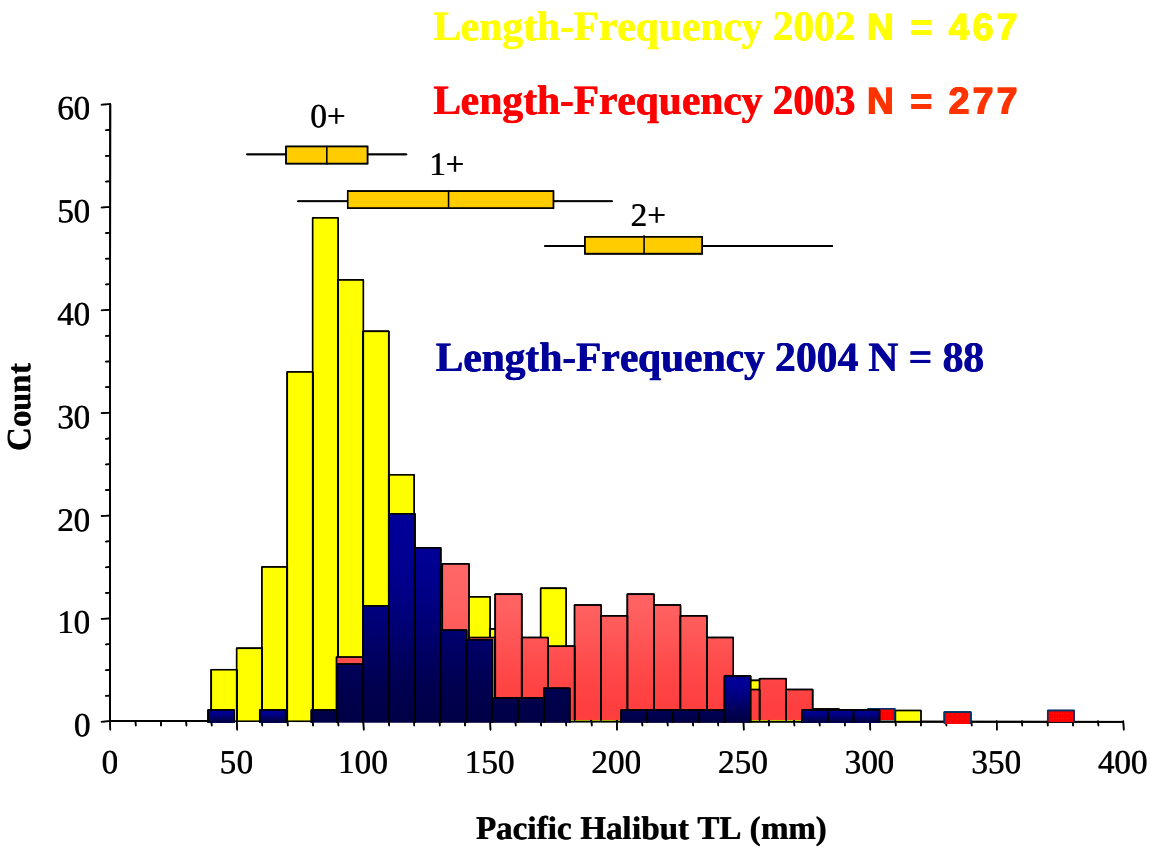

Figure 7. Length-frequency histogram for Pacific halibut captured in 2002, 2003, and 2004. Note the strong 0 year class in 2002. Ages are given above the graph and based on otolith annuli counts performed by the International Pacific Halibut Commission.

3. Coordination/Collaboration: Describe efforts undertaken during the reporting period to achieve the coordination and collaboration provisions of the proposal, if applicable.

This study is a multi-year project that couples funding from EVOS-GEM and the Prince William Sound Oil Spill Recovery Institute (OSRI). All data will be archived by the project staff in accordance with GEM standardized procedures. Our project also complements and benefits from the North Pacific Board supported project "Estuaries as essential fish habitat for salmonids: Assessing residence time and habitat use of coho and sockeye salmon in Alaska estuaries", which is being conducted on the Copper River Delta.

Our project has actively collaborated with 4 different EVOS projects: G-050712, G-050725, G-050687, and 050210. Below is a short description of each collaboration

G-050712
For the second year, our project provided continued to logistical support, samples, and data to the GEM sponsored project G-050712 "Research for nutrient-based resource management in watersheds and estuaries". This project is being jointly conducted by Dr. Carol Woody (USGS Alaska Science Center) and Dr. Tom Kline (Prince Willam Sound Science Center). We provided fish from our monthly fish trawls and macroinvertebrate samples from our invertebrate plots.

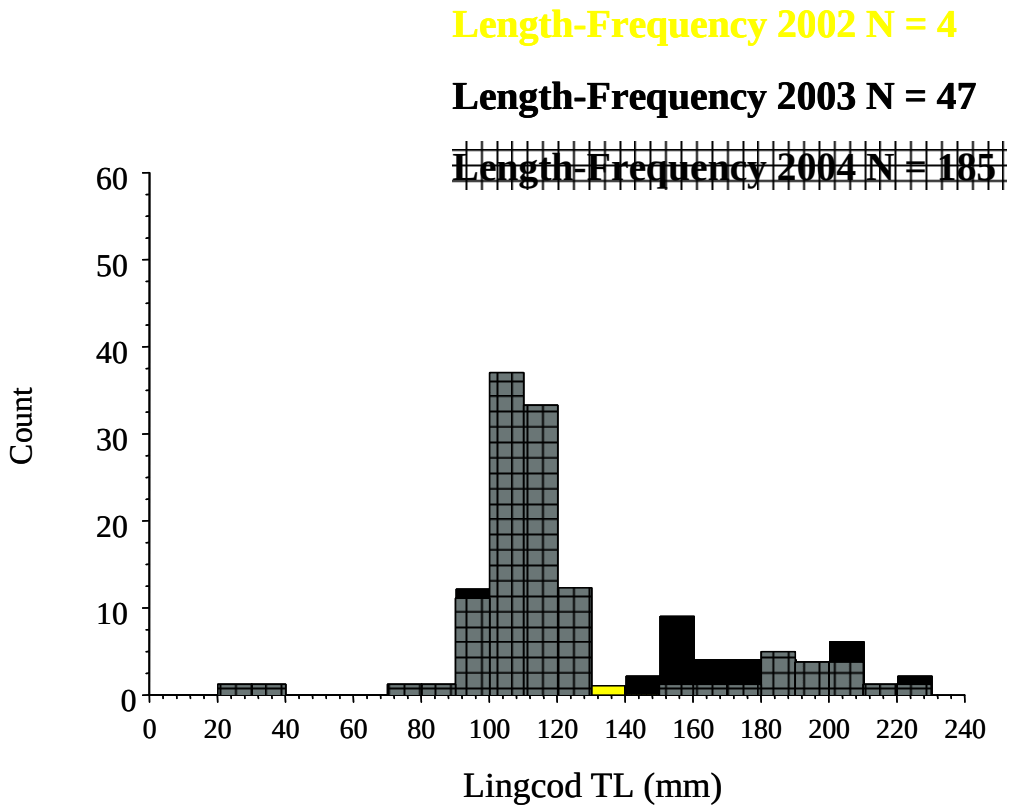

Figure 8. Length-frequency histogram for lingcod captured in 2002, 2003, and 2004. Note the increase in juvenile lingcod from 2002 to 2004.

050210 Youth Area Watch

The education and Dr. Bishop's Copper River research program at the Prince William Sound Science Center combined efforts to host the 2005 Youth Area Watch orientation the weekend of September 17-18, 2005. Youth Area Watch (YAW) is a program run by the Chugach School District and funded by the Exxon Valdez Oil Spill (EVOS) Trustee Council. The program is designed to involve students in working with scientists while making a meaningful contribution to research and long-term monitoring projects in oil spill affected Prince William Sound and Cook Inlet communities. Over 20 high school students participated from the communities of Tatitlek, Chenega Bay, Valdez, Cordova, Whittier and McCarthy. The weekend started with an introduction to ecosystem monitoring by Principal Investigator Dr. Mary Anne Bishop. She provided an overview of her Copper River Delta ecological monitoring project and reviewed the many sampling procedures used to collect data. Students then venture into the field with Science Center educator Kate Alexander and Biologist Brad Reynolds to try their own hands at some of the sampling techniques, specifically core sampling and beach seines. That afternoon, the students processed their core samples in the lab with Kate, attempting to identify the organisms left behind after rinsing away the mud. The next day the students were shown sampling methods used in the complementary NPRB juvenile salmon outmigration project. Upon completion of the

orientation, the students returned to their communities to focus on the task of developing a long-term monitoring project relative to their local communities and ecosystems. Some of the students have even decided to build their projects off of monitoring programs they were introduced to over the weekend, including tracking intertidal invertebrates in the mudflats using core samples.

G-050725
Our project also provided nutrient sample results from Orca Inlet to the GEM sponsored project G-050725 project, "Impacts of Seafood Waste Discharge in Orca Inlet, Prince Wiliam Sound. This project is being jointly conducted by Drs. Richard Thorne and Mary Anne Bishop, Prince William Sound Science Center, in cooperation with Kenwyn George, Alaska Department of Natural Resources.

G-050687
In November 2004, Dr. Bishop attended the GEM Nearshore habitat workshop. In March 2005, Bishop met with Tom Dean (Principal Investigator for G-050687), and Marilyn Sigman (Center for Alaskan Coastal Studies) to discuss the community science aspect of their project, including how our data could assist the nearshore project. Bishop also made a presentation on our project at the workshop that Dean and Sigman gave in Cordova.

OTHER COLLABORATIONS
Our project began collaborative efforts with the Alaska Department of Fish & Game, Invasive Species Program, in July. We will collect data on any and all invasive species collected during this project and provide it to the program. In particular, we will be monitoring for the presence of green crab (*Carcinus maenas*), and Mitten Crab (*Eriocheir sinensis*). In August, Bishop met with Dennis Lassuy, US Fish & Wildlife Service Invasive Species Coordinator, and with Dan Gilson, Project Manager, and Marilyn Leland, Vice Director of Prince William Sound Regional Citizens Advisory Council during their Community Green Crab Monitoring Workshop in Cordova. Bishop discussed with them our current monitoring efforts, and received information from Lassuy on a new invasive isopod that is impacting mud shrimp.

Bishop and Powers also participated in Prince William Sound Ocean Observing system Workshop held in Cordova during June.

We cooperated with Dr. Gail Blundell, Harbor Seal Coordinator for the Alaska Department of Fish & Game by collecting harbor seal *(Phoca vutulina)* scats during our March trawls. Scats will be analyzed by Jason Herreman, a graduate student at the University of Wyoming as part of his masters thesis.

4. Community Involvement/TEK & Resource Management Applications: Describe efforts undertaken during the reporting period to achieve the community involvement/TEK and resource management application provisions of the proposal, if applicable.

We tagged starry flounder >200mm and began the first of 3, weekly classified advertisements for tags on 30 June. Because of the extensive knowledge of local fishers and the historic knowledge of native Alaskans, an interactive exchange with local fishermen is of great benefit to the project.

Direct input to the project is provided through public presentations (see below) as well as direct fishermen involvement on the project (local charters for field work are performed by fishermen in the Cordova area).

Over 20 high school students from the communities of Tatitlek, Chenega Bay, Valdez, Cordova, Whittier and McCarthy came to Cordova for a weekend to learn about our research as part of the Youth Area Watch. See page 9 for a more complete description of this program. .

5. Information Transfer: List (a) publications produced during the reporting period, (b) conference and workshop presentations and attendance during the reporting period, and (c) data and/or information products developed during the reporting period.

(a) Publications:

Powers, S.P., M.A. Bishop, J. Grabowski and C.H. Peterson. 2005. Distribution of the invasive bivalve Mya arenaria L. on intertidal flats of southcentral Alaska. Journal Sea Research, In press.

(b) Public Outreach Activities

RADIO:

- July 28, 2005. Project featured on Laine Welch's "Fish Radio." Interviewed Bishop throughout the radio clip. "Fish Radio" is a daily feature on >20 radio stations in Alaska.

NEWSPAPER:

- August 2005. "Scientists tag Copper River Flounder, halibut." Laine Welch, "Fish Factor". Weekly fish column featured around the State. Printed in Cordova Times August 25, 2005 and in Anchorage Daily News

PRESENTATIONS

- Sept 2004 Ecology of the Copper River Delta. Semi-annual Meeting of the Board of Directors. Prince William Sound Oil Spill Recovery Institute. Cordova Alaska. Powers, Bishop, and Peterson.
- Sept 2004 Ecology of the Copper River Delta. Semi-annual Meeting of the Board of Directors. Prince William Sound Science Center Board of Directors. Cordova, Alaska. Powers, Bishop, & Peterson
- Jan 2005. "Ecology of the Copper River Delta: Evaluating the relative importance of bottom-up and top down processes in a marine soft-sediment community." By Powers & Bishop. 2005 Marine Science in Alaska Symposium. Anchorage, Alaska.
- Feb 2005. "The Copper River Delta's Mudflats. Bishop & Powers. Given by Bishop. Prince William Sound Science of the Sound Lecture Series. Cordova, Alaska.
- March 2005. "Ecology of the Copper River Delta. Bishop & Powers. Given by Bishop as introduction to "Gulf Ecosystem Monitoring Nearshore Program" at Prince William Sound Science of the Sound Lecture Series. Cordova, Alaska.
- April 2005. "Ecology of the Copper River Delta. Bishop & Powers. Talk read by Reynolds for Bishop. Alaska Section, American Water Resources Association Cordova, Alaska.

- May 2005. The Copper River Delta. Bishop & Powers. Given by Bishop. Alaska State Audubon Society, Board of Directors. Cordova, Alaska.
- June 2005. Copper River Estuary as nursery habitat for juvenile fish and crabs. Given by Bishop. *Exxon Valdez* Oil Spill Trustee Council. Cordova, Alaska.
- June 2005. Ecology of the Copper River Delta. Bishop & Powers. Given by Bishop. Murdock Foundation. Cordova, Alaska
- July 2005. Ecology of the Copper River Delta. Bishop & Powers. Given by Bishop for Denis Wiesenburg, Dean of the School of Fisheries, University of Alaska-Fairbanks.
- September 2005. Ecology of the Copper River Delta. Bishop & Powers. Given by Bishop for Youth Area Watch, for their Cordova field visit.

Cordova School District Presentations May 2005

May 2005 Shorebird presentation (in the field) for Discovery Room 5th Grade (presentor: Bishop).

May 2005 Shorebird Trapping Demonstrations (2x) for Cordova High School and the Discovery Room (6th grade). (presentor: A. Taylor)

May 2005 Benthic Invertebrate identification demonstration (2x) for Cordova High School Marine Biology Class (presentor: S. Fritsch)

WORKSHOPS ATTENDED

- EVOS GEM Nearshore Habitat Workshop. November 2004. Anchorage, Alaska. Attended by Bishop.
- Prince William Sound Ocean Observing System: Biological Workshop. June 2005. Cordova, Alaska. Attended by Bishop & Powers.

6. Budget: Explain any differences and/or problems between actual and budgeted expenditures, including any substantial changes in the allocation of funds among line items on the budget form. Also provide any new information regarding matching funds or funds from non-EVOS sources for the project. [**PLEASE NOTE:** Any request for an increased or supplemental budget must be submitted as a new proposal that will be subject to the standard process of proposal submittal, technical review, and Trustee Council approval.]

For FY05 Prince William Sound Oil Spill Recovery Institute (OSRI) provided $75,000, down $25,000 from the originally budgeted $100,000. In addition, the Prince William Sound Science Center provided oceanographic equipment and an additional $25,000 through funding from a Congressional earmark.support in order to make up for the change in OSRI funding. For FY06, OSRI will provide $75,000 and the Prince William Sound Science Center will provide oceanographic equipment. No requests for budget increases are anticipated for FY06.

Report Prepared By: Drs. Mary Anne Bishop & Sean Powers
Project Web Site Address: www.pwssc.gen.ak.us