Essential Fish Habitat project status report

Reporting date: 4/04/2008

Project number: 2006-01

Title: Mapping Long Term Equilibrium Impacts of Fishing and Evaluation of Impacts of Fishing on Fish Condition, Fish Distribution, and Fish Diet

PIs: Kerim Aydin, Angie Grieg, Al Hermann, Anne Hollowed, James Ianelli, Craig Rose, Paul Spencer, William Stockhausen, Tom Wilderbuer

Funding year: FY 2006

Funding amount: $6,000

Status: X Complete ☐ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete:

Reporting: Have the project results been reported? If yes, where were the results reported?
Yes. The data have been reported in the following NOAA Technical Memorandum (a followup peer-review publication is planned):
Aydin, K.Y., B. Matta and T. Buckley. Trends in bioenergetic foraging potential for walleye pollock in the Bering Sea. AFSC Tech. Memo. (in internal review).

Results: What is the most important result of the study?

We have created a series of bioenergetic maps on a 20-km resolution for the Bering Sea, showing (quantifying) the projected growth rates at fixed ration of walleye pollock in the summer, and interannual variation in this "growth potential." These maps are based on water temperature and the quality of prey (caloric contents) measured on this 20-km scale from 1984-2006. We have automated the method of creating these maps to update them annually in the future based on trawl-survey data. The maps are available in gridded form or in the ArcGIS format by request and through the Tech Memo. These maps will become an important component of the Bering Sea Integrated Research Project (BSIERP) modeling effort for spatial variation in fish production (FEAST – Forage Euphausiid Abundance in Space and Time). The automation of this method through database tools means we can extend our work to other species with minimal effort; specifically arrowtooth flounder and Pacific cod are planned as part of the BSIERP research.

Essential Fish Habitat project status report

Reporting date: 10/30/2007

Project number: 2006 - 2

Title: Modify trawls to reduce fishing impacts / Better characterize fishing's footprint

PIs: Craig S. Rose

Funding year: FY 2006

Funding amount: $49,860

Status: ☒ Complete ☐ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete:

Reporting: Results were presented to the ICES Boston Symposium on Fishing Technology in the 21st Century (10/30-11/3, 2006) and at the December 2006 meeting of the NPFMC. Rose, C. 2006. Development and evaluation of trawl groundgear modifications to reduce damage to living structure in soft bottom areas. Available NOAA Alaska Fisheries Science Center 7600 Sand Point Way NE, Seattle WA 98115.

Results:

Installing widely spaced disk clusters on the sweeps of bottom trawls reduces damage or disruption to sessile seafloor invertebrates without reducing the herding of flatfish into the trawl.

Essential Fish Habitat project status report

Reporting date: 9/05/2007

Project number: 2006-03

Title: Assessment of critical habitats for juvenile Pacific cod

PIs: Allan Stoner, Benjamin Laurel, Thomas Hurst, Alisa Abookire & Clifford Ryer

Funding year: FY 2006

Funding amount: $55,638

Status: X Complete ☐ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete:

Reporting: Have the project results been reported? If yes, where were the results reported?
Yes. The data have been reported in two manuscripts:

Laurel, B.J., A.W. Stoner, C.H. Ryer, T.P. Hurst and A.A.Abookire. 2007. Comparative habitat associations in juvenile Pacific cod and other gadids using seines, baited cameras and laboratory techniques. J. Exp. Mar. Biol. Ecol. (in press)

Stoner, A.W., Laurel, B.J. and T.P. Hurst. Using a baited cameras to assess relative abundance of juvenile Pacific cod: field and laboratory trials. J. Exp. Mar. Biol. Ecol. (in review)

Results: What is the most important result of the study?
1) 2006 appears to have been an unusually strong year for recruitment of age-0 Pacific cod to the Kodiak system. This is despite a very weak spawning season shown by poor winter fishing success. [Indeed, comparative data from 2007 reveal that 2006 was an exceptional year for Pacific cod recruitment to the 0-year class.]
2) A baited camera is a highly efficient system for observing and quantifying age-0 Pacific cod in habitats not easily sampled with traditional gear. Results from July collections show a direct correlation between numbers of cod observed in camera sets and seines. Data from expanded sampling in August will better test the relationship. The baited system is also a good tool for surveying predatory species. Experiments show that Pacific cod are most attracted to baits, while walleye pollock are weakly attracted.
3) Age-0 Pacific cod, saffron cod and walleye pollock occur in close proximity in the nearshore habitats of Kodiak. However, their occurrences in seagrass, *Laminaria* beds, and deeper sand/mud habitats vary inter-specifically, and the relationships shifted with time and fish size over the summer. In July, the cod species were closely associated with the macrophytes beds, and then expanded to unvegetated and deeper habitats in August.

4) In laboratory experiments age-0 Pacific cod did not demonstrate significant preference for habitats (sand, boulder, seagrass, kelp) except in the presence of a predator, when shelter-seeking was exhibited.

Essential Fish Habitat project status report

Reporting date:

Project number: 2006-5 & 2007-2

Title: Habitat effects on growth and condition of northern rock sole

PIs: Hurst, Abookire, Heintz, & Short

Funding year: 2006 & 2007

Funding amount: $17,652 FY06; $28,865 FY07

Status: ☒ Complete ☐ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete:

Reporting: Have the project results been reported? If yes, state where the results were reported and attach an electronic copy of the report.

The results of this work are reported in a manuscript submitted to Canadian Journal of Fisheries and Aquatic Sciences. The manuscript received positive reviews and will be accepted pending final minor revisions.

An electronic copy of the MS is attached. A final version of the manuscript will also be sent when accepted.

Results: What is the most important result of the study?

The most important results of the work are that the growth rates at our three focus study sites have maintained their rank order over the 3+ sampling seasons to date. Holiday Beach has consistently supported faster growing age-0 rock sole than Pillar Creek Cove and Shakmanof Beach. While growth variation is correlated with temperature variation, it is not the primary driver of growth variation in this system. Growth rates were not correlated with fish density. In addition, analyses indicate that size and time of settlement may be significant contributors to size variation.

Essential Fish Habitat project status report

Reporting date: September 4, 2007
Project number: EFH Project 2006-08
Title: Essential Fish Habitat Requirements for Skate Nurseries
PIs: Gerald R. Hoff
Funding year: FY 2006
Funding amount: $78,000
Status: ☒ **Complete** ☐ **Incomplete, on schedule** ☐ **Incomplete, behind schedule**
Planned completion date if incomplete:

Reporting: Have the project results been reported? YES **If yes, where were the results** reported? My Ph.D. dissertation (University of Washington, School of Aquatic and Fishery Sciences). Also results are being prepared in three manuscripts for submission in the primary literature during fall of 2007.

Results: What is the most important result of the study?
The research in 2006 confirmed the distribution of two previously known skate nursery sites for the Alaska and Bering skates, and located two additional sites for the Alaska and Aleutian skates. Seven nurseries located to date all occurred along the upper slope of the eastern Bering Sea. The nurseries were small in area (<2 km^2) and occurred over a narrow depth range (from 150 to 375 meters) on generally flat sandy to muddy bottom with little bottom structure or attached biota. Many sites were associated with canyon areas and were generally located in the upper portion of canyon heads. Nurseries were highly productive, with >100,000 viable eggs/km^2 occurring in some sites. Newly deposited embryos experienced mortality from snail predators with evidence of higher predation rates at northern sites, and evidence of multiple predators present within a single nursery site. At all sites Pacific halibut and Pacific cod showed evidence of consumption of newly hatched skates.

Conclusions drawn from this research suggest the shelf slope interface is an important habitat for successful skate reproduction possibly due to ample food availability and relatively warm constant bottom temperatures. In general the upper slope habitat is important for skate egg deposition and embryo development. However, nursery areas do not appear to be utilized by juvenile and sub-adult individuals. Evidence suggests these stages move to either shallower shelf waters (Alaska skate) or deeper waters (Aleutian and Bering skates) soon after emergence from the egg case.

Essential Fish Habitat project status report

Reporting date: 28 August 2009

Project number: 2006-11

Title: Convene a workshop to plan for the development of a habitat data inventory system for the AFSC.

PIs: Jon Heifetz, Bob McConnaughey, John Olson

Funding year: 2006[1]

Funding amount: $15,000

Status: ■ Complete ☐ Incomplete, on schedule ☐ Incomplete, behind schedule

The EFH Data Inventory Workshop was held 20-21 September 2007 in the Jim Traynor Conference Room at the AFSC in Seattle, Washington.

Planned completion date if incomplete:

Reporting: Have the project results been reported? If yes, where were the results reported? McConnaughey, RA, JV Olson, MF Sigler. 2009. Alaska Fisheries Science Center Essential Fish Habitat Data Inventory. AFSC Processed Rep. 2009-01, 40 p.

Results: What is the most important result of the study? A total of 22 habitat-related data sets were summarized in a standard written format and orally presented to 27 individuals representing five AFSC Divisions, the Alaska Regional Office, the Alaska Department of Fish and Game and the environmental group Oceana. The Workshop thereby satisfied the primary objective to improve awareness of these data within the AFSC research community.

[1] The workshop was not funded on the primary FY06 list of projects. The $15K travel money was allocated from national EFH money but was received too late in the fiscal year to be used. The funds were carried into FY07 with the assistance of the RACE and ABL Directors.

Essential Fish Habitat project status report

Reporting date: October 28, 2009

Project number: 2006-12, 2007-12, 2008-06

Title: **Habitat Influence on Rearing Condition and Overwinter Survival of Juvenile Capelin (*Mallotus villosus*)**

PIs: J. Vollenweider, J. Hudson, R. Heintz

Funding year: FY 2008

Funding amount: $44,540

Status: ☐ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete: All field collections, chemical analyses, and data analyses are complete. Two manuscripts are currently in progress describing the overwinter energy allocation strategies of juvenile 1) eulachon and 2) capelin. The juvenile eulachon manuscript is under review and will be submitted to a journal this winter (FY10). The capelin paper, which is also in draft, will be submitted to a journal the following summer (FY10).

Reporting: The project has not yet been reported, however 2 manuscripts are in progress and are anticipated to be published in FY10.

Results:

Winter starvation mediated by low-levels of foraging is likely an important mechanism structuring recruitment success of juvenile forage fish. Over the course of two winters, we observed size-selective mortality in juvenile eulachon and capelin stemming from starvation in the smallest individuals. Between the fall and subsequent spring sampling periods, length frequency distributions of juveniles shifted towards larger individuals, which could either be indicative of a loss of smaller fish or growth (Figure 1). Growth overwinter is highly unlikely, however, as fish lost energy during this period and therefore surplus energy would not have been available for growth.

Winter energy deficits resulted from the loss of both lipid and protein energy. The magnitude of the deficit and relative depletion of lipid and protein were size dependent (Figures 2 and 3). Larger juveniles began winter with greater lipid reserves than smaller fish. During winter, larger fish depleted more of their pre-winter lipid reserves than smaller fish, and as a consequence, the contribution of lipid catabolism to the winter energy deficit increased with body size (Figure 4). Although the relative proportion of protein loss was independent of body size, the smallest fish lost more energy in the form of protein than lipid. By the end of the winter, the energy content of the smallest surviving juveniles was very near the energetic threshold, below which mortality occurs (Figure 5). Thus, the smallest juveniles were under extreme nutritional stress and were forced to metabolize protein to meet most of their metabolic demands, apparently as a consequence of exhausting lipid reserves.

Comparisons from two bays (Fritz Cove and Berners Bay) indicate that prey availability plays an important role in survival of juvenile fish that are on the brink of starvation in winter. Despite a general scarcity of prey during winter, what little forage juvenile fish could consume appeared to help stave off starvation. Nearly half the juvenile eulachon were feeding during the winter, as evidenced from stomach contents. Zooplankton prey species, particularly copepods, were more abundant in Fritz Cove than Berners Bay (Figure 6). Though juvenile eulachon in Fritz Cove

were smaller and had lower energy reserves going into winter, they were in better condition than those from Berners Bay in the spring, suggesting that prey availability may help to preserve lipid reserves and thereby reduce starvation risk.

Collectively, these results indicate that the smallest eulachon and capelin do not store sufficient reserves of lipid for winter, are forced to metabolize protein, and may suffer a greater risk of winter mortality. Winter foraging, despite low prey abundance, may be crucial for survival. We suggest that disproportionately high rates of starvation among the smallest age-0 forage fish are important mechanisms influencing recruitment.

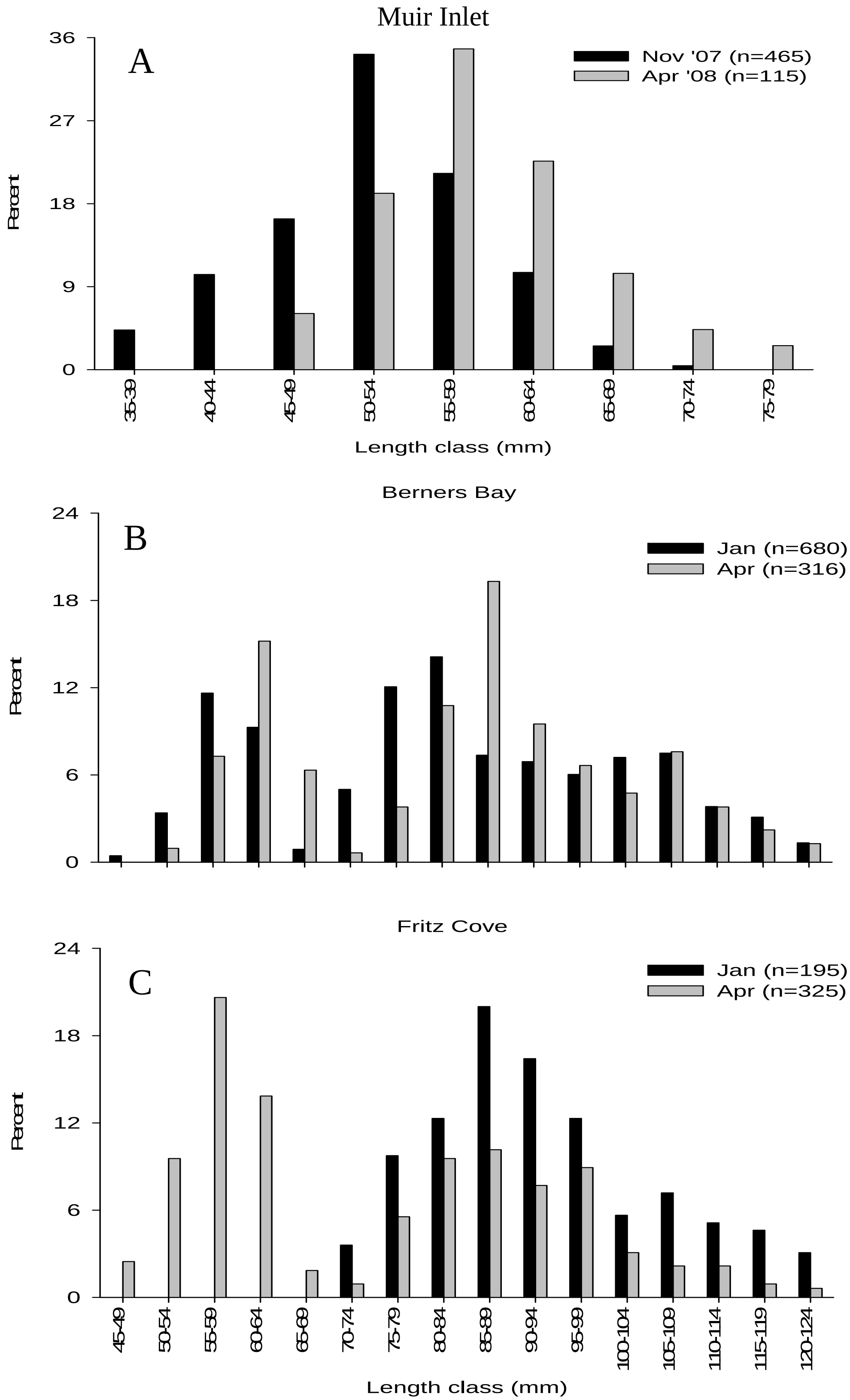

Figure 1. Shift in size distribution of juvenile capelin (A) and eulachon (B & C).

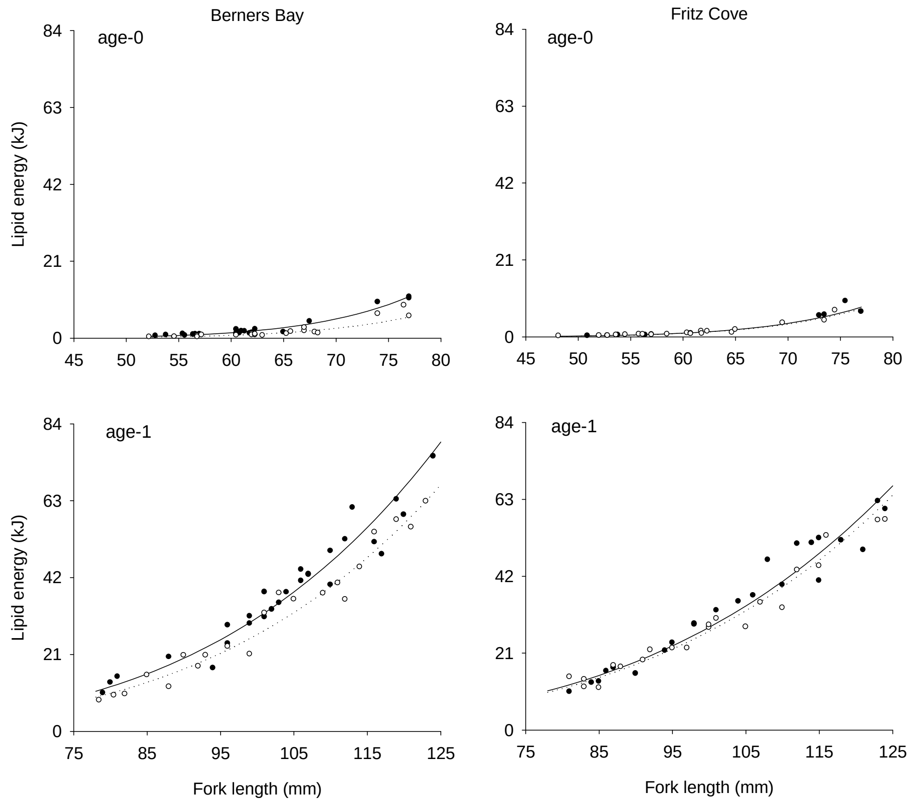

Figure 2. Energy allocated to lipid in age-0 and age-1 eulachon in January (solid circles and lines) and April (open circles and dashed lines) in Berners Bay and Fritz Cove.

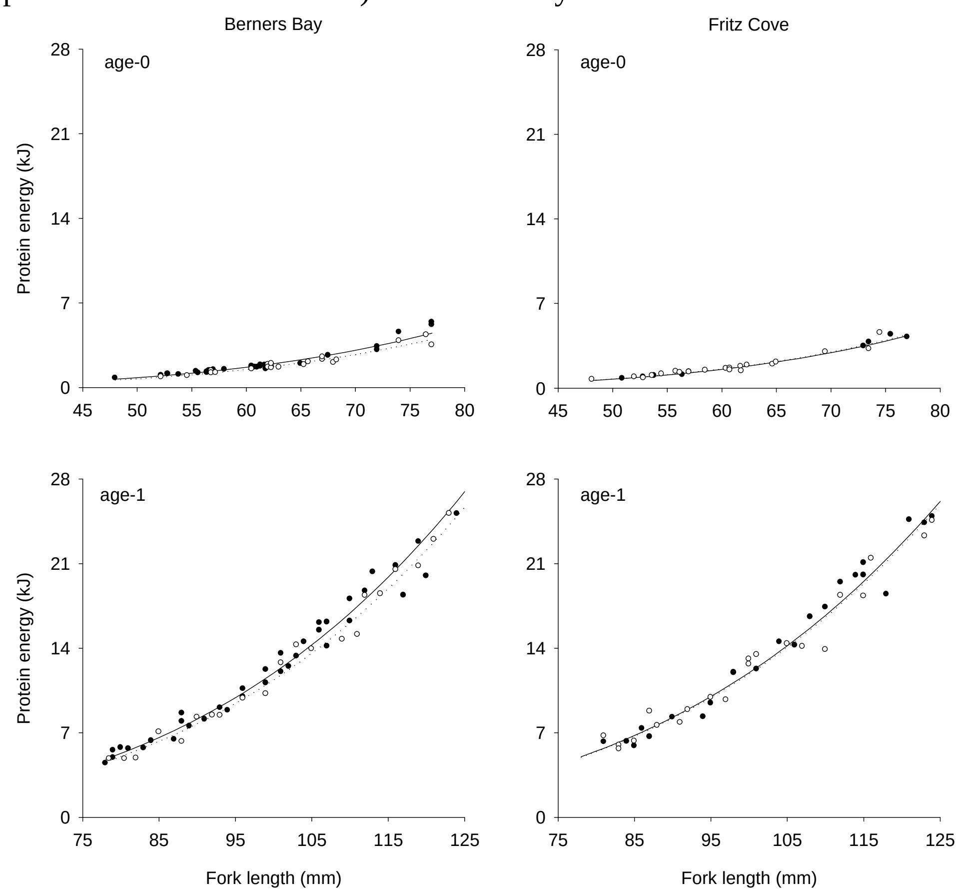

Figure 3. Energy allocated to protein in age-0 and age-1 eulachon in January (solid circles and lines) and April (open circles and dashed lines) in Berners Bay and Fritz Cove.

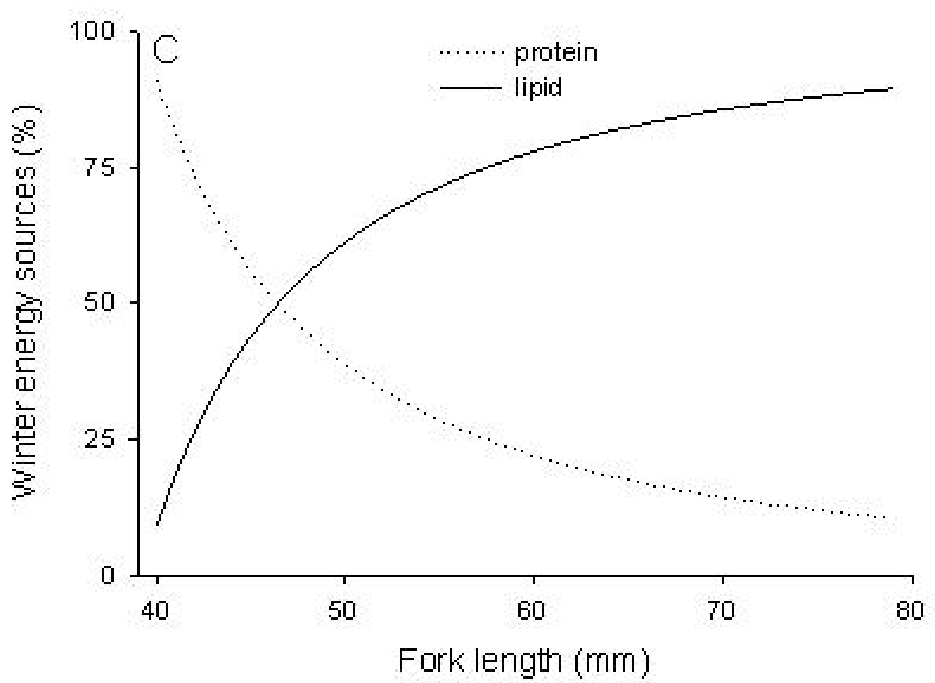

Figure 4. Modeled relationships between capelin fork length and the relative contribution of lipid and protein energy to the winter energy deficit.

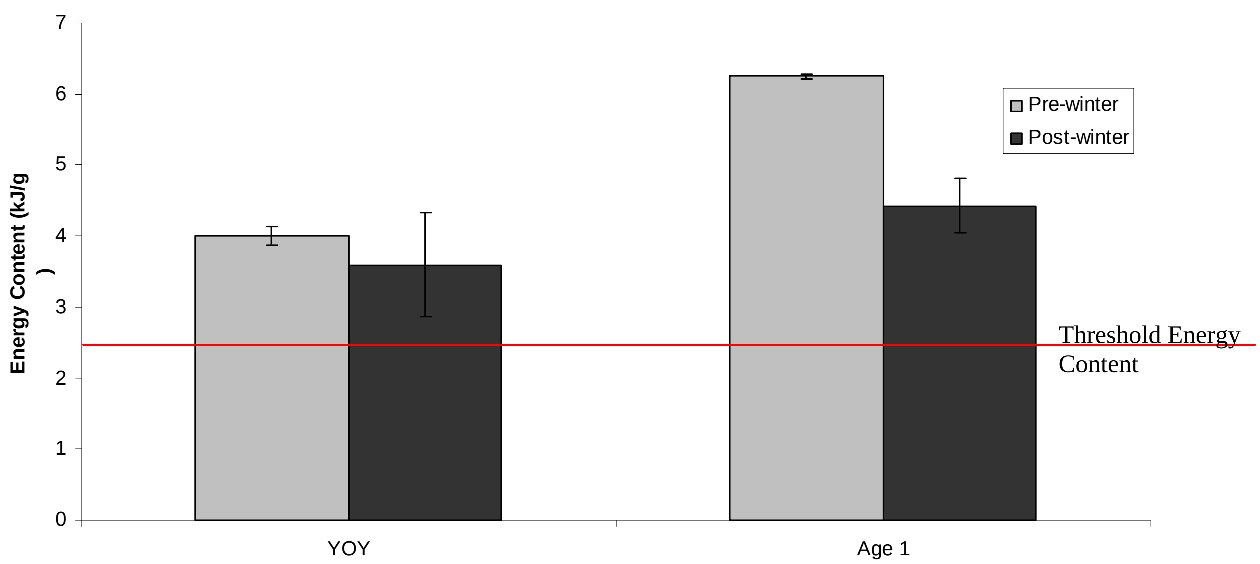

Figure 5. Overwinter energy loss (kJ g^{-1}) of juvenile capelin. Red line denotes the threshold energy content below which mortality occurs.

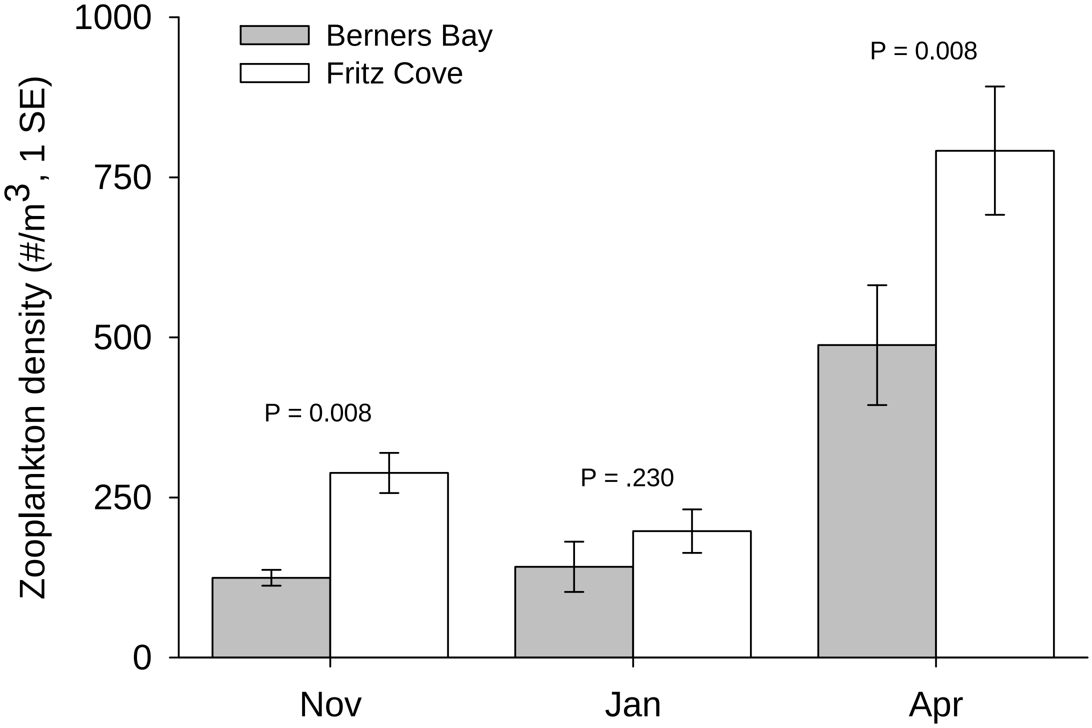

Figure 6. Zooplankton abundance in Berners Bay and Fritz Cove during winter 2006/2007. P-values are from Mann-Whitney U tests.

Essential Fish Habitat project status report

Reporting date: 10/29/2009

Project number: 2006-14

Title: Juvenile Rockfish Habitat Utilization

PIs: Pat Malecha

Funding year: 2006

Funding amount: $38,200

Status: ☐ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete: Habitat preference trials and predator trials with juvenile quillback rockfish are complete. A manuscript is in preparation and shall be completed by February 2010.

Reporting: Preliminary results were reported at the 15Th Western Groundfish Conference and in an oral presentation as part of the HEPR-themed AFSC seminar series. A manuscript is in preparation and shall be completed by Spring 2010.

Results: Habitat preference trials indicate that quillback rockfish utilize coral more than any other habitat type particularly during daytime. Sponge and cobble are also preferred to gravel; however, the strength of association between rockfish and the various habitat types is considerably weaker at night. At night, quillback rockfish were more often in contact with bottom substrate and were less closely associated with emergent habitats. The pattern of quillback rockfish habitat utilization in the presence of a predator was remarkably similar except that rockfish utilized the coral, sponge and cobble habitats to a greater extent than when no predators were present. The lowest rate of predation was observed within coral habitat whereas, the highest rate of predation occurred in with gravel habitat. The average number of rockfish consumed per trial was about four times lower in the coral habitats than in the gravel habitats. Predation rate among the sponge and cobble habitats was intermediate to the rates among coral and gravel. The rate among sponge habitats was slightly lower than the rate among cobble habitats.

Essential Fish Habitat project status report

Reporting date: 8/29/08

Project number: 2006-16

Title: Nearshore Essential Fish Habitat–Seasonal Fish Use, Mapping, GIS Database

PIs: Johnson, Thedinga, Lindeberg, Harris

Funding year: 2006

Funding amount: $110,000

Status: [X] Complete [ ] Incomplete, on schedule [ ] Incomplete, behind schedule

Planned completion date if incomplete:

Reporting: Have the project results been reported? If yes, where were the results reported? Yes

1. Johnson et al. 2008. Seasonal Distribution, Habitat Use, and Energy Density of Forage Fish in the Nearshore Ecosystem of Prince William Sound, Alaska. Final report submitted to NPRB on 30 July 2008. Three peer-review publications will result from this final report.

2. Nearshore Fish Atlas of Alaska website (http://www.fakr.noaa.gov/habitat/fishatlas/) available to resource managers online; database includes fish catch by habitat type, fish size, species composition, fish and site photos, site coordinates, temperature, and salinity data for the Arctic, the Aleutian Islands, Cook Inlet, Prince William Sound, and southeastern Alaska.

Results: What is the most important result of the study?

1. Four species accounted for 92% of the total catch in Prince William Sound–Pacific herring, saffron cod, pink salmon, and capelin. Total catch (all spp.) increased seasonally in 2006 (4,653 fish in April, 5,274 fish in July, 7,861 fish in September); this indicates that fish occupy shallow, nearshore waters for at least several months a year. More importantly, species composition changed with season–pink salmon dominated catches in April, saffron cod and herring in July, and capelin in September. Catches differed among habitat types for some species–catches of saffron cod were greater in eelgrass than in bedrock or kelp, whereas catches of capelin were infrequent and mostly in kelp. Fish abundance was similar in eelgrass and kelp during day and night, but mean size of fish increased and number of fish species in kelp increased at night. Nearshore habitats are utilized by young-of-the-year herring and saffron cod as nursery areas to grow and to store energy before winter.

Essential Fish Habitat project status report

Reporting date: 9/6/07

Project number: 18

Title: Food habits and small scale habitat utilization of Atka mackerel in the Aleutian Islands, Alaska

PIs: Sandra Lowe

Funding year: FY 2006

Funding amount: $13,761

Status: ☒ Complete ☐ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete:

Reporting: Have the project results been reported? If yes, where were the results reported? Yes. An initial report is completed and we are revising this report for submission to the Alaska Fishery Research Bulletin.

Results: What is the most important result of the study? Atka mackerel feeding habits including diet composition and feeding intensity varied both spatially and temporally. Water column mixing and stratification seemed to play a significant role in feeding intensity at Seguam Pass and marginally near Amchitka Island. Trawl exclusion zone boundaries (disturbed and undisturbed habitat) appear to be significant in determining feeding intensity near Amchitka Island, as average stomach fullness was greater inside the trawl exclusion zones.

Essential Fish Habitat project status report

Title: Evaluation of Essential Fish Habitat Recovery at Log Transfer Facilities in southeastern Alaska by Katharine Miller, Stanley Rice, and John Hudson

Reporting date: 31 October 2007

Project number: 20 Funding year: 2006 Funding amount: $43,500

Status: Pilot study completed August 2006

Reporting: Have the project results been reported? If yes, where were the results reported? See attached report.

Results: What is the most important result of the study?

This was the first of a planned two-year study evaluating the recovery of Essential Fish Habitat impacted by log transfer facilities (LTFs) 10 to 30 years ago. The study focused on six LTFs and one log storage facility (LSF) located in estuaries and embayments on Baranof and Kruzof Islands in southeastern Alaska. The pilot year was designed as a survey to assess physical and biological recovery and to evaluate different sampling methods to assess recovery. Funding for a second more detailed study year was not received.

Recovery of physical habitat was noted at all LTFs, particularly with respect to bark degradation as divers often had difficulty identifying the edge of bark deposits. Non-recovery was observed at an LSF in Shulze Cove. Habitat at this site was highly impaired as evidenced by the presence of a 1 m deep gelatinous bacterial/organic layer that was anoxic and sulfide producing.

Fish and invertebrate abundance and species diversity differed between the facility sites and reference sites at six of seven locations, and the organic content of sediment samples was generally higher at LTFs than at adjacent reference sites. The results of nonparametric stepwise regression suggest that, for both fish and invertebrate assemblages, differences are correlated with a transition of species from outside to inside waters and with differences in organic content of the sediments

This pilot study indicates that benthic habitats impacted by LTFs are mostly in a recovering state, whereas habitat at the LSF has not yet begun. Additional time is needed for complete recovery at all sites and our findings suggest that biological recovery of the invertebrate and fish communities will lag behind physical recovery. The intense studies conducted 25 to 30 years ago by Shultz and Berg (1976) and O'Clair et al. (1988) should be repeated to determine the long term impacts of LTFs on essential fish habitat. This study attempted to evaluate recovery by spending one day assessing each site. A future study should spend several days at one site to evaluate recovery as a single day does not allow time for adequate study. We recommend that candidate sites for evaluation should be screened by assessing the bark content, depth, and water quality of sediments. For cost reasons, this study was restricted to a relatively small area; a more comprehensive study, not restricted to 10 field days, should focus on the most impacted sites in southeastern Alaska, as determined by volume of timber transferred to specific LTFs.

Evaluation of essential fish habitat recovery at Log Transfer Facilities in southeastern Alaska

Katharine Miller, Stanley D. Rice, and John Hudson

Introduction

Logging activities on the Tongass National Forest in southeastern Alaska were extensive from the 1950s to the 1980s, supporting two pulp mills and several saw mills for local development and export of lumber. Damage to essential fish habitat from harvest and road-building activities was obvious in the uplands as streams in affected watersheds suffered were denuded of buffer strips, and spawning and overwintering habitat was negatively impacted (USDA 1995). Less obvious were impacts to essential fish habitat at log transfer facilities (LTFs) where logs were placed into marine waters for transport to mills. These habitats were extensively surveyed in the late 1970s and early 1980s (Schultz and Berg 1976, Freese et al. 1988). These surveys revealed negative impacts to water quality and benthic communities within areas of bark deposition.

The purpose of this pilot study was to evaluate the physical, chemical, and biological characteristics of some of these log transfer facilities 25-30 years after closure. Information from this cursory study can be used to justify further study, and possibly the need for intervention in some habitats to support active restoration. Our general study design was to compare water quality, fish and invertebrate community composition, and substrate characteristics between an LTF zone of deposit and an adjacent Reference (REF) site. This study design was intended to evaluate the rate and effectiveness of natural recovery of benthic habitats near LTFs. Study methods were similar to those used in earlier studies with the addition of a fish community assessment component.

Study Approach and Site Selection

We chose six former LTFs located in estuaries and embayments on Baranof and Chichagof Islands in southeastern Alaska (Figures 1 and 2) based on the following criteria: 1) volume of timber transferred through the LTF when it was operational, 2) years since the LTF was operational, and 3) inclusion in prior studies (Schultz and Berg 1976; Freese et al. 1988). We also included a log storage facility (LSF[1]) in Schulze Cove in the study. Both the Alaska Department of Environmental Conservation and the U.S. Fish and Wildlife Service have documented habitat loss and water quality problems at this LSF.

At each location, a four person dive team and two surface biologists spent approximately one day measuring a variety of physical, chemical, and biological parameters at each LTF and a nearby REF site. After locating the zone of deposit (ZOD), the dive team marked

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[1]For simplicity, the Schulze Cove LSF is herein referred to as an LTF.

the ZOD boundary, measured bark depth, and collected pore-water samples along transects established across the ZOD. At the same time, a surface team in a skiff measured several water quality parameters at the LTF and REF sites. The fish community was sampled at LTF and REF sites with a small bottom trawl. Physical and biological data from each LTF site were compared to companion REF sites to determine if adverse effects were continuing, and where possible, comparisons were made to the surveys completed 25-30 years ago. The study was conducted in July and August 2006 during a single 10-day cruise aboard the M/V *Sundance*.

OBJECTIVES AND METHODOLOGY

1. Determine the extent of bark deposit at each site: At each site (Figures 1 and 2), the location of the ZOD was determined from latitude and longitude coordinates provided in the earlier reports and from visual inspection of the upland area. A four-person dive team working in pairs was deployed to delineate the bark ZOD. ZODs were delineated in the same manner as in the earlier studies. The two-person dive teams entered the water from shore and swam away from shore until bark was encountered. Each team then swam in opposite directions until reaching the edge of the ZOD. Next, the divers swam in opposite directions along the perimeter releasing marking buoys to demarcate the ZOD. Surface biologists in a skiff used the buoys as a guide to map the ZOD using a GPS unit. Divers did not attempt to delineate the Schulze Cove ZOD due to its large size.

2. Determine the sediment depth and sediment composition at each site: Bark depth was our primary means of evaluating habitat recovery at LTF sites because depths could be compared to those measured in previous studies. During this study it became apparent to the divers that depth measurements included intact and decomposed bark as well as natural underlying sediments. Therefore, depths from this study are likely not comparable to those from earlier studies. However, in this study, sediment samples were collected and analyzed in the lab to compare the organic matter content of sediment from LTF and REF sites. Bark and other plant matter was visually sorted from the largest size fractions of these samples while the smallest size fractions were burned to determine their ash-free dry mass content, a surrogate for bark content since bark from these fractions was too small to distinguish visually.

Once the bark zone of deposit (ZOD) was delineated, one or more transects were established along a depth contour within the center of the deposit. A REF site was selected near the LTF site in an area with similar bathymetric features. Buoys were used to establish a transect in the REF site at the same depth as in the LTF site. At each site except Schulze Cove, divers collected a minimum of five 250 ml sediment samples along each transect by scooping the top layers of sediment into collecting jars. The depth of the sediment at LTF sites was measured to the nearest centimeter by pushing a marked rod into the bottom to refusal. In the earlier reports, the sediment depth was equated to the depth of bark (Table 1). In this study we refer to “sediment” depth because divers could not determine to what degree they were measuring bark and natural underlying sediment. In our study, the percent organic content of the sediment was determined by dry sieving the sediment through .063, .500, 2.00, and 4.75 mm sieves. Sediment in the 2.00-4.75

mm and > 4.75 mm fractions was separated by hand with the aid of a dissecting microscope into mineral (rock and shell) and organic (bark and other organic debris) components. Each component was then weighed (0.001 g) and the percent organic fraction calculated. Percent ash-free dry mass (AFDM) was determined for the .063-.500 mm and .500-2.00 mm fractions by burning samples in a muffle furnace at 500°C for 5 to 19 hours. Because individual LTF and REF pairs were co-located within the same estuary, it is reasonable to expect that in the absence of a secondary source of organic material, the organic content of the sediment would be relatively similar at both the LTF and REF sites. Therefore, we used the difference in organic content in the smaller sediment size fractions (0.063-0.500 mm and 0.500-2.00 mm), rather than the substrate depth, to represent bark in these samples.

3. Determine water quality at each LTF and Reference site: Hydrogen sulfide concentration in sediment pore water was measured at each LTF and REF site. With the exception of Schulze Cove, pore-water samples were collected from well points inserted into the substrate at three locations along each dive transect. Immediately after inserting the point, two water samples were withdrawn into a 60 ml plastic syringe. The first sample was discharged and the second sample was retained in the syringe until analyzed. Water samples from the Schulze Cove LTF site were collected using a horizontal water sampler that was lowered into a 1 m layer of colloidal ooze overlying the natural bottom. Water samples were analyzed 2-6 hours after collection using a colorimetric test kit (Hach Company™ Model HS-WR). Dissolved oxygen (D.O.) and water temperature were measured at the sediment/water interface at three locations in each LTF and REF site with a YSI 55™ dissolved oxygen meter. Salinity and temperature profiles were obtained from the center of each site with a CTD profiler (SEACAT SBE 19 plus, Sea-Bird Electronics, Inc.).

4. Determine biological use on the surface of the bark deposit: A small-mesh otter trawl (3 m x 1 m) towed behind a skiff was used to sample fish and invertebrates near the bottom of each LTF and REF site. The trawl was towed at approximately 3 knots with a minimum of one haul in each direction along the same transect. Tow speed and bottom-time were recorded. Fish were identified, counted, and measured for length and invertebrates were identified and counted. To minimize variability between LTFs and their paired REF sites, trawl transects in the LTFs were selected to ensure the entire trawl occurred within the bark footprint or ZOD, and at a location roughly in the middle of the identified bark footprint while transects at the REF sites were selected to match the length and depth of the transects at the LTF sites as closely as possible. The length of the trawl transects at each LTF and REF site was calculated as the distance between the beginning and ending latitude and longitude coordinates of each transect.

<u>Data Analysis:</u>

The relationship of fish and invertebrates assemblages to water quality variables and sediment organic content were performed using nonmetric multidimensional scaling (NMDS) and step-wise analysis of weighted Spearman rank-correlations using the PRIMER 6® statistical software. Abundance data was transformed to the fourth root and standardized prior to calculation of Bray-Curtis similarity coefficients The Bray-Curtis coefficient calculates the similarity between the *j*th and *k*th samples using the following formula:

$$S_{jk} = 100 \frac{\sum_{i=1}^{p} 2 \min(y_{ij}, y_{ik})}{\sum_{i=1}^{p} (y_{ij} + y_{ik})}$$

Where y_{ij} represents the *i*th row and *j*th column of that matrix of species abundances and y_{ik} is the *i*th species in the *k*th sample. S= 0 if the two samples have no species in common and 100 if they are identical (Clark and Warwick, 2001).

Because of the differences between fish and invertebrate assemblages at sites inside and outside Peril Strait, stepwise nonparametric regression on the ranked biotic and abiotic similarity matrices was conducted separately for each group. The analysis evaluates whether biologically similar sites also are similar in terms of the environmental variables.

A similarity matrix of water quality and sediment organic content was calculated using Euclidean distance. Environmental variables included average temperature, average percent saturation, ash free dry mass (AFDM) in the .063 to .500 mm and the .500 to 2 mm sediment samples, percent organic content by weight in the 2.00 to 4.75 mm and > 4.75 mm samples. Step-wise correlations between the environmental and biotic similarity matrices were conducted, and combinations of variables with the highest Spearman rank correlation coefficient (ρ) were considered to provide the best match to the fish and invertebrate assemblage data.

Results

Bark/Sediment depth and sediment size composition

Sediment analyses indicated that bark is still present at LTFs but is showing signs of decomposition. Mean sediment depths ranged from 4 to 11 cm (Table 1). Sediment depths measured during this study were lower than those reported in earlier studies at all locations except Appleton Cove and Camp Coogan Bay. Bark depths at Hanus Bay, Mud Bay, and Rodman Bay declined by 13 to 83% compared to earlier measurements. The organic content of sediment samples varied among size fractions and locations, but was usually greater in LTF sites than in REF sites (Figures 3 and 4). Organic content was lowest in Hanus Bay and Rodman Bay and highest in Mud Bay and St. John the Baptist Bay. At the latter two sites, LTF sediment less than 2.00 mm in diameter had 2.4 to 8.7 times more AFDM content than sediment from the adjacent REF site (Figure 3). Differences in the organic content of LTF and REF sediment were more extreme in the larger size fractions (Figure 4) where most organic matter consisted of bark fragments as well as other plant material. More than one-third and one-half of large sediment from

LTF sites at Mud Bay and St. John the Baptist Bay, respectively, consisted of organic material (Figure 4). In contrast, large sediment from REF sites contained less than 15% organic matter and the large sediment from several locations was devoid of organic material. Non-organic material in sediment samples consisted of sand, gravel, and shell fragments.

Sediment samples were not obtained from Schulze Cove where the bottom of the LTF site was covered by a 1 m thick layer of diffuse organic material. Divers were not able to retrieve sediment from below this layer, and attempts to obtain samples of the organic layer itself were unsuccessful. Because the purpose of this study was to compare LTF sites with adjacent reference sites, no sediment was collected at the Schulze Cove REF site.

Water Quality

Water quality at the Schulze Cove LTF site was poor within the layer of ooze. Sulfides were detected in this layer which did not contain any dissolved oxygen (Figure 5). Water samples from this layer smelled of rotten eggs and hydrogen sulfide levels in two samples measured 5.0 and 9.6 mg/L.

Water quality at other sites was good and there were no differences in water temperature or dissolved oxygen between the LTF and REF site pairs (Figure 5). Sulfide was not detected in pore water at other sites. Percent saturation of oxygen at the sediment/water interface ranged from 58% to 69%, exceeding 83% at Hanus Bay. Bottom water temperatures ranged from 10.2 C to 12.9 C. Temperature and salinity profiles at paired LTF and REF sites were nearly identical (Figure 6).

Fish and invertebrate assemblages

Approximately half of the fish and invertebrate species were caught at both LTFs and REF sites, with the remainder caught at either type of site. Because of differences in the size of trawl areas, we could not compare species diversity between LTF and REF sites. Twenty-two species of fish and 45 species of invertebrates were caught at the LTF and REF sites (Tables 2 and 3). The most commonly caught species of fish were yellowfin sole (*Limanda aspera*), snake prickleback (*Lumpenus sagitta*), and southern rock sole (*Lepidopsetta bilineata*) which were caught at both LTFs and REFs. Sunflower sea stars (*Pycnapodia helianthoides*) were the most common invertebrate followed by shrimp (*Heptacarpus sp*), sea cucumbers *(Parastichopus californicus*) and lyre crabs (*Hyas lyratus*). These species were caught at both LTF and REF sites.

With the exception of Appleton Cove, similarity coefficients for fish and invertebrate assemblages between paired LTF and REF sites were less than 50%. Fish and invertebrate assemblages also differed between sites with more direct access to the open ocean (outside Peril Strait) and those located in interior channels and bays. Eighteen fish species were found either at inside or outside sites but not both (Table 4). The average dissimilarity of fish groups inside and outside of Peril Strait was 95.5% (100% = total dissimilarity). Invertebrate assemblages showed less of a pattern of difference between inside and outside locations than fish assemblages (Figure 8) with 23 species captured at either outside or inside sites. As with the fish assemblage data, only the Appleton Cove LTF and REF sites are similar at a 50% or greater level.

For sites inside Peril Strait, the highest correlation between the ranked environmental and fish similarities occurred for the two-variable combinations of average AFDM and percent saturation, and average percent organic component and average temperature had the same correlation coefficient (ρ = .647). Temperature and percent saturation are highly correlated, so the inclusion of one or the other of these variables in the two-variable pairs is not surprising. Similar analysis on the correlation between fish assemblages and sediment grain size did not result in a high correlation coefficients (highest ρ = .172) suggesting that size of the sediment is not an important factor in determining fish assemblages. The analysis however suggests that, for sites inside Peril Strait, the presence of organic matter may be a factor affecting fish assemblages. Relatively high correlation between environmental variables and fish assemblages was not observed for sites outside Peril Strait. The highest correlation (ρ = .153) was associated with average AFDM. This correlation is slightly smaller than the correlation between the smallest two sediment size fractions (ρ = .172) and fish assemblages.

Invertebrate assemblages had a pattern similar to fish assemblages. Average organic content and average temperature had the highest correlation (ρ = .509) with invertebrates inside Peril Strait, followed by average AFDM and average temperature (ρ = .466). For invertebrate assemblages outside Peril Strait the highest correlation (ρ = .586) was for average percent saturation. Organic content of the sediment was correlated at ρ = .193 or below. Invertebrate assemblages also showed little correlation to sediment grain size (high of ρ = .102).

Discussion

LTF ZODs

Identifying and delineating the ZOD was difficult at most locations. Bark was not always easily identified and often merged or graded into natural sediments. With the exception of Hanus Bay and Appleton Cove, the seaward edge of the ZOD occurred in water that was too deep for divers to access. The inability to identify the seaward extent of the ZOD was a concern only for the placement of the REF sites, since we wanted these to be sufficiently close to the LTFs to reduce variability while still being outside the ZOD. At most sites, the area of the ZOD was sufficiently large to accommodate trawling. Only at Camp Coogan Bay did we encounter bark at the REF site while trawling. Sediment analyzed from this site confirmed that the LTF and REF sites were not sufficiently far apart. connected.

At some sites delineation was further complicated by the inability of divers to distinguish between highly decomposed bark and natural sediment. We suspect that ZOD boundaries were more obvious during the earlier studies since the bark was less decomposed at the time. Freese et. al. (1988) indicated that bark within the ZODs at some of the LTF sites they evaluated had deteriorated and some of the bark fragments were as small as 2 mm. Identifying the bark component of such fine sediment underwater was extremely difficult. This difficulty stimulated increased effort in analyzing sediment for organic content, a surrogate for bark depth.

Recovery and non-recovery

Diver observations and water quality measurements indicate that most LTF sites (6 of 7) are recovering. At most sites bark deposits were substantially degraded and sometimes difficult to delineate. Trawl catches indicated that fish and invertebrates use LTFs, and that there are subtle differences between fish and invertebrate assemblages at LTF and REF sites. The Schulze Cove LSF was a notable exception. Divers at this site encountered a strange layer of sediment. Approximately 1 meter in thickness, this layer consisted mostly of water, lacked dissolved oxygen, and water samples contained toxic sulfides. These poor habitat conditions appear to influence fish and invertebrate diversity which was only one-third of that found at the REF site.

Problems of species diversity measurements

The difference in species diversity between impacted sites and nearby reference sites has been widely used in ecology to assess recovery based on the assumption that fewer species occur in impacted sites than non-impacted sites. This assumption has been strongly criticized (Gray 2000), and research suggests that diversity indices are useful in differentiating between communities only when the impact is severe (Mouillot et. al. 1995; Rice 2000; Cao et. al 1996). Species diversity indices also are dependent on the size of the sample area, which in our study differed between sites as a result of differences in the size of the LTF ZODs. Therefore, we could not compare diversity between LTF and REF sites.

The multivariate analyses used here are widely used in benthic ecology and are becoming more common in estuarine and demersal fish research (Mueter & Norcross 1999). These approaches are useful in detecting change in community structure given sufficient sample size. In our study, we detected differences in species assemblages between inside and outer coast sites. Estuaries on the west side of Baranof and Chichagof Islands (outside Peril Strait) tend to have more direct access to ocean water than estuaries in Peril Strait and Hoonah Sound, and this appears to affect fish and invertebrate assemblage membership. Others also have noted clines of distribution in southeastern Alaska from north to south, and from east to west (Johnson et al. 2003). With only seven sites in our pilot study; 4 inside Peril Strait and 3 outside Peril Strait, the sample size is too small to separate potential LTF effects from natural geographic effects. Future studies should consider the transition of species from inside to outside waters in site selection. Additionally, multiple samples should be taken at each LTF and REF. This may require sampling over a period of weeks or months to adequately assess fish and invertebrate usage of individual sites.

Future evaluation of habitat recovery

Day-long site visits are too cursory for measurements of habitat recovery and determination of rates of recovery. The results of this study should be considered a screening procedure, and not detailed or intense enough to compare to the earlier studies by Shultz and Berg (1976) and Freese et al. (1988). To determine the impacts and status of recovery, measurements of biological processes and better measurements of habitat use by species are needed. Although costly, focusing on infauna and less mobile invertebrates may be a better way to assess long-term impacts. Further, measuring bark depths and the size of the ZOD as a means of evaluating habitat recovery has limitations. Measures of bark depth and the ZOD boundary can be accurately determined when the deposit is young; however, over time obtaining accurate measures becomes more difficult as the bark decomposes and/or is redistributed. Organic content, as well as a chemical marker surrogate for bark combined with systematic sampling would likely be a better measurement strategy. Future studies should include a large suite of sites selected based on the amount of timber transferred through the facility. Additionally, more time should be allocated to evaluating each site than was allowed in this study.

Evaluating candidate sites for restoration

One-day site visits using a remotely operated video camera and collection of water quality measures would probably be a satisfactory screening method for establishing a group of LTF and REF sites for further study. Specific attention should be given to sites similar to Schulze Cove to determine the factors that may be inhibiting recovery. This information may lead to recommendations on appropriate locations for siting such facilities in the future to adequately protect EFH. In addition to the type of data collected for this study, a future study should evaluate benthic communities as organisms living within and on the bottom directly exposed to the physical and chemical characteristics of bark deposits. The intense studies conducted 25 to 30 yeas ago by Shultz and Berg (1976) and Freese et al. (1988) should be repeated to determine the long term impacts of LTFs on EFH. These studies should include evaluation of benthic communities to determine whether they follow the same pattern as the fish and invertebrate assemblages in this study.

Conclusion

Most sites (86%) sampled in this study were recovering, as shown by difficulty in identifying the zone of deposit for bark, good water quality, and the presence of fishes and invertebrates. One-day site visits are not adequate to assess habitat recovery rates; a large-scale comprehensive survey of more sites is needed to better understand recovery of LTFs across the region. Benthic habitat at the Schulze Cove Log Storage Facility remains highly impaired, as evidenced by a 1 m layer of colloidal ooze and poor water quality. There are likely other sites like Schulze Cove where habitat recovery is not satisfactory.

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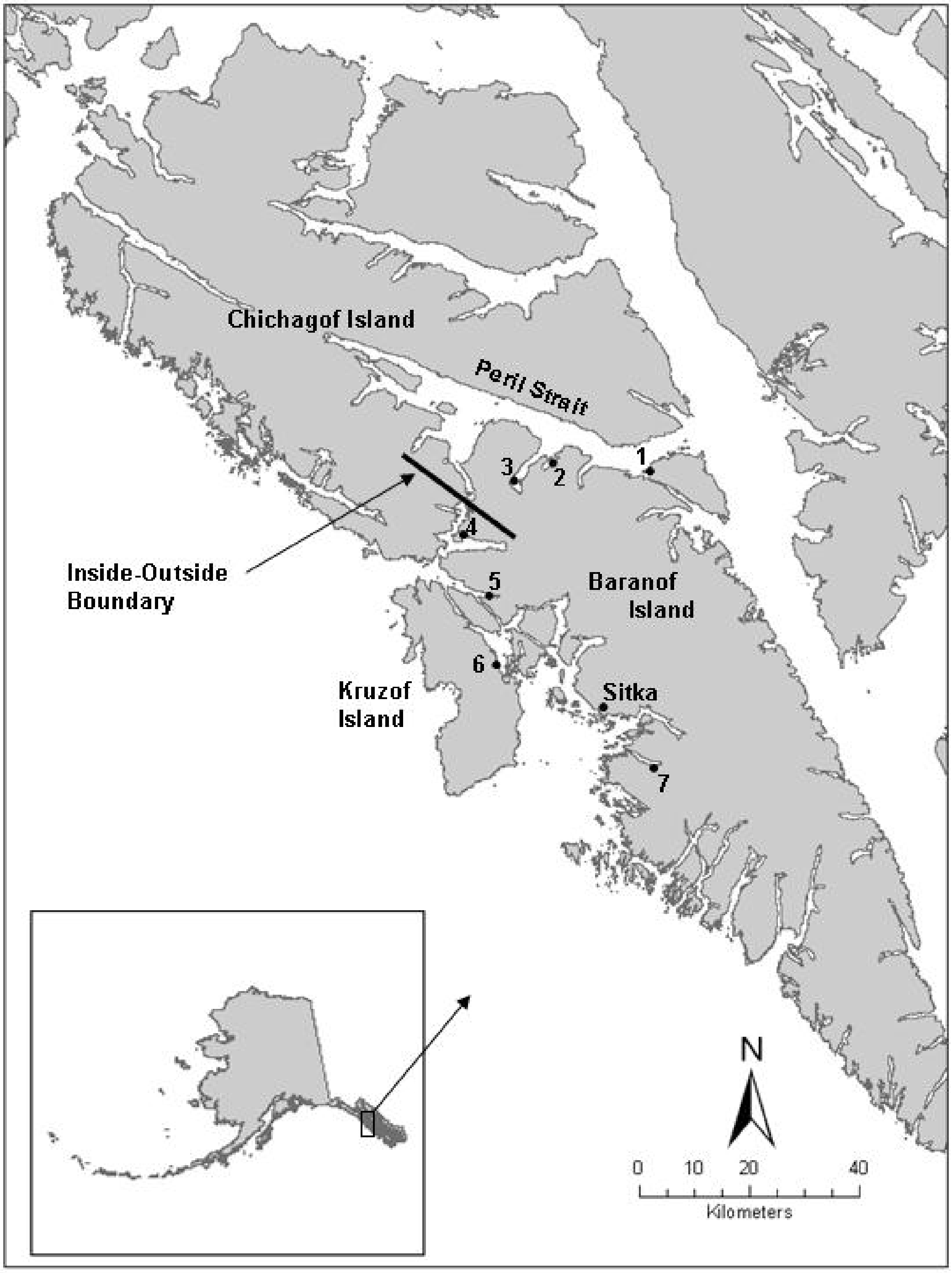
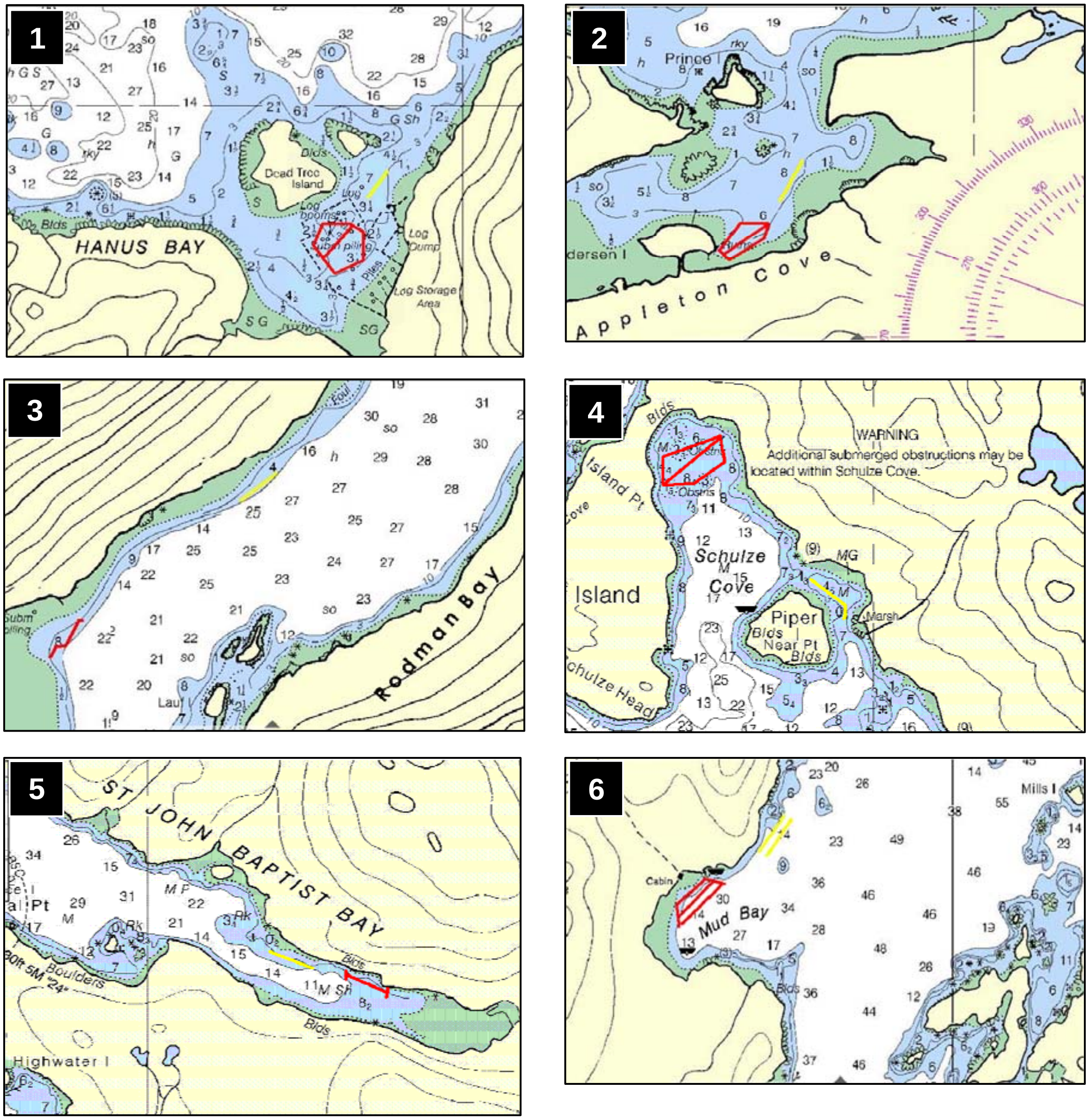


Figure 1. Map of the study area showing the location of study sites and the boundary between the outside and inside waters of Peril Strait. Log transfer facilities sampled in this study were located in Hanus Bay (1), Appleton Cove (2), Rodman Bay (3). Schulze Cove (4), St. John the Baptist Bay (5), Mud Bay (6), and Camp Coogan Bay (7).



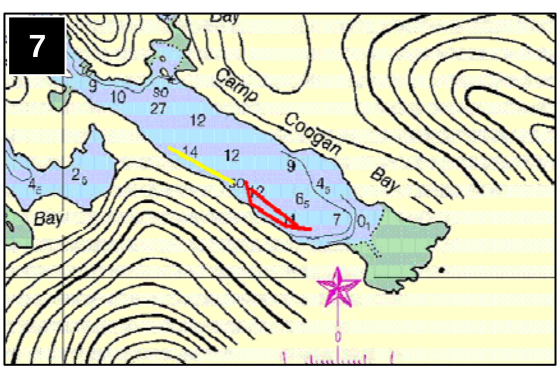


Figure 2. Study sites showing the log transfer facility (LTF) zone of deposit (red polygon) and location of trawl transects at each LTF (red line bisecting polygon) and REF (yellow line) site. Only a partial delineation of the ZOD was completed at sites 4 – 7. Hanus Bay (1), Appleton Cove (2), Rodman Bay (3), Schulze Cove (4), St. John the Baptist Bay (5), Mud Bay (6), and Camp Coogan Bay (7).

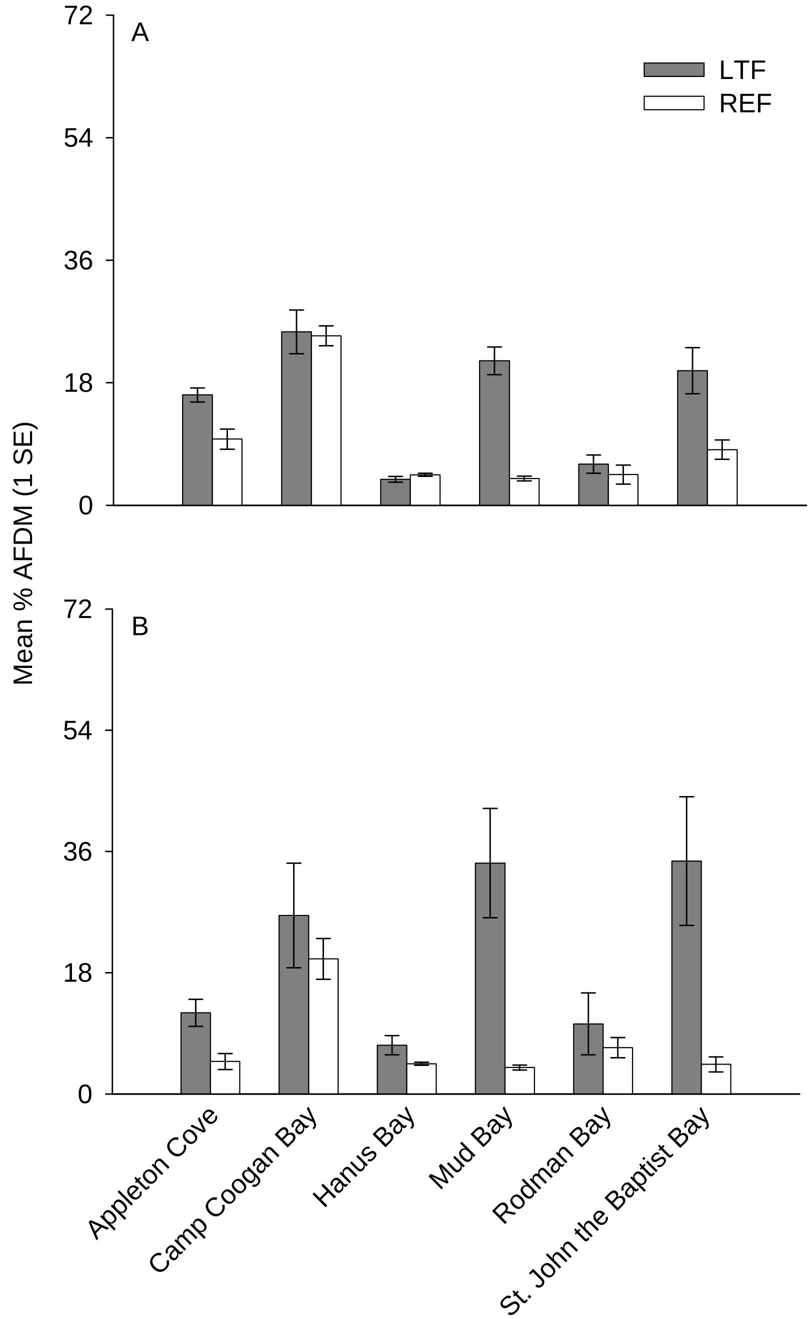


Figure 3. Ash-free dry mass content (%) of sediment (A, .063-.500 mm; B,.500-2.00 mm) collected from log transfer facility (LTF) and reference (REF) sites in July and August 2007 at six locations in southeastern Alaska. (SE = standard error)

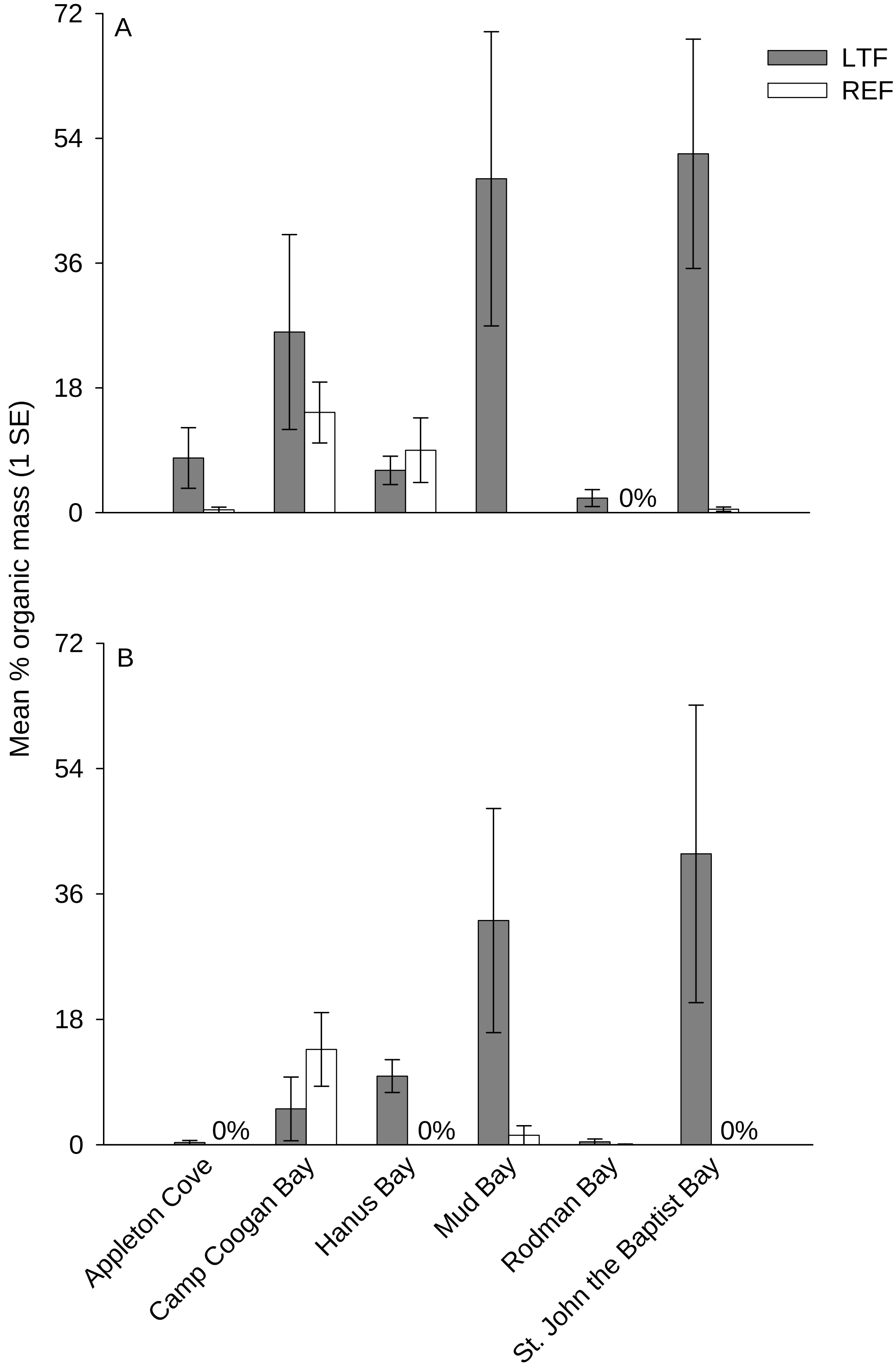


Figure 4. Percent organic mass of sediment (A, 2.00-4.75 mm; B, > 4.75 mm) collected from log transfer facility (LTF) and reference (REF) sites in July and August 2007 at 6 locations in southeastern Alaska. (SE = standard error)

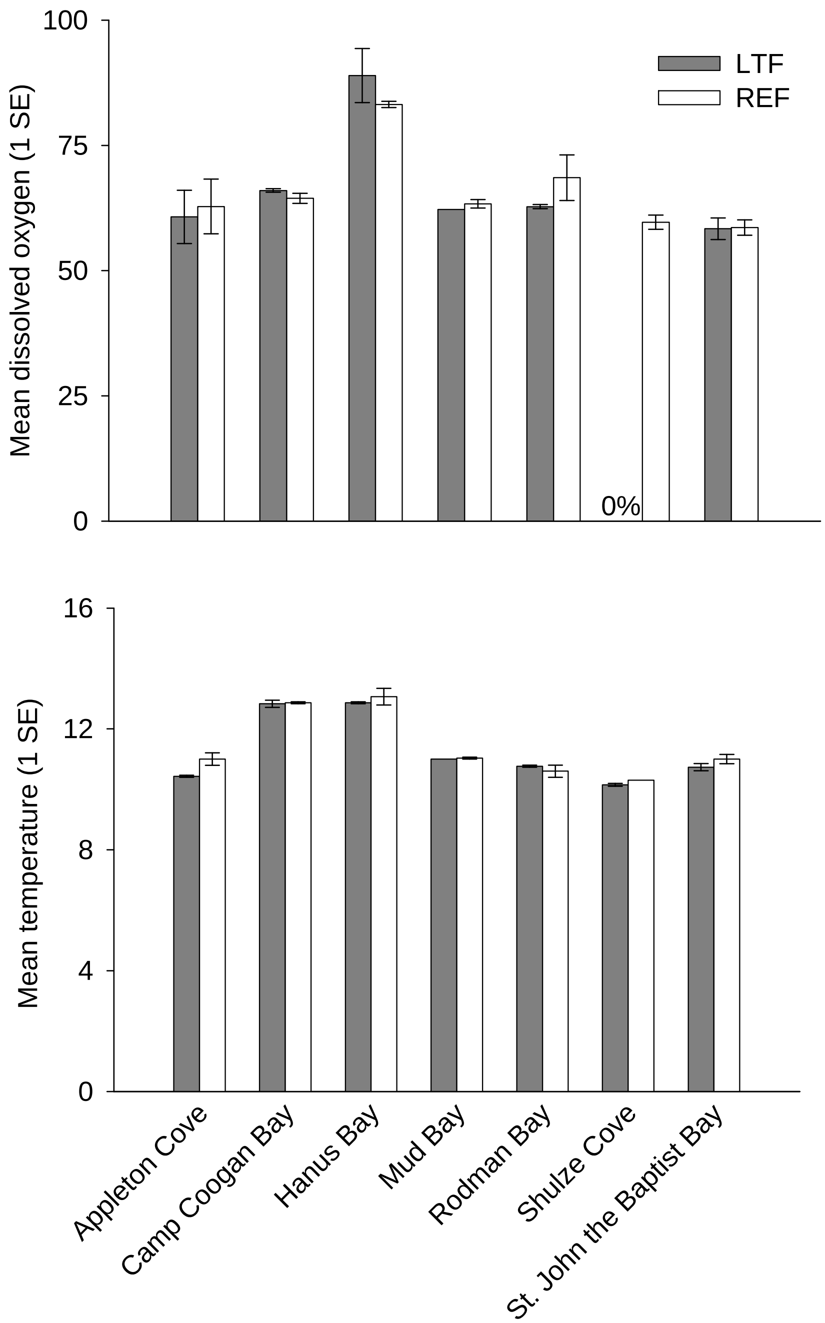


Figure 5. Dissolved oxyen (% saturation) and water temperature (Celcius) at the sediment/water interface of log transfer facility (LTF) and reference (REF) sites in July and August 2007 at six locations in southeastern Alaska. (SE = standard error)

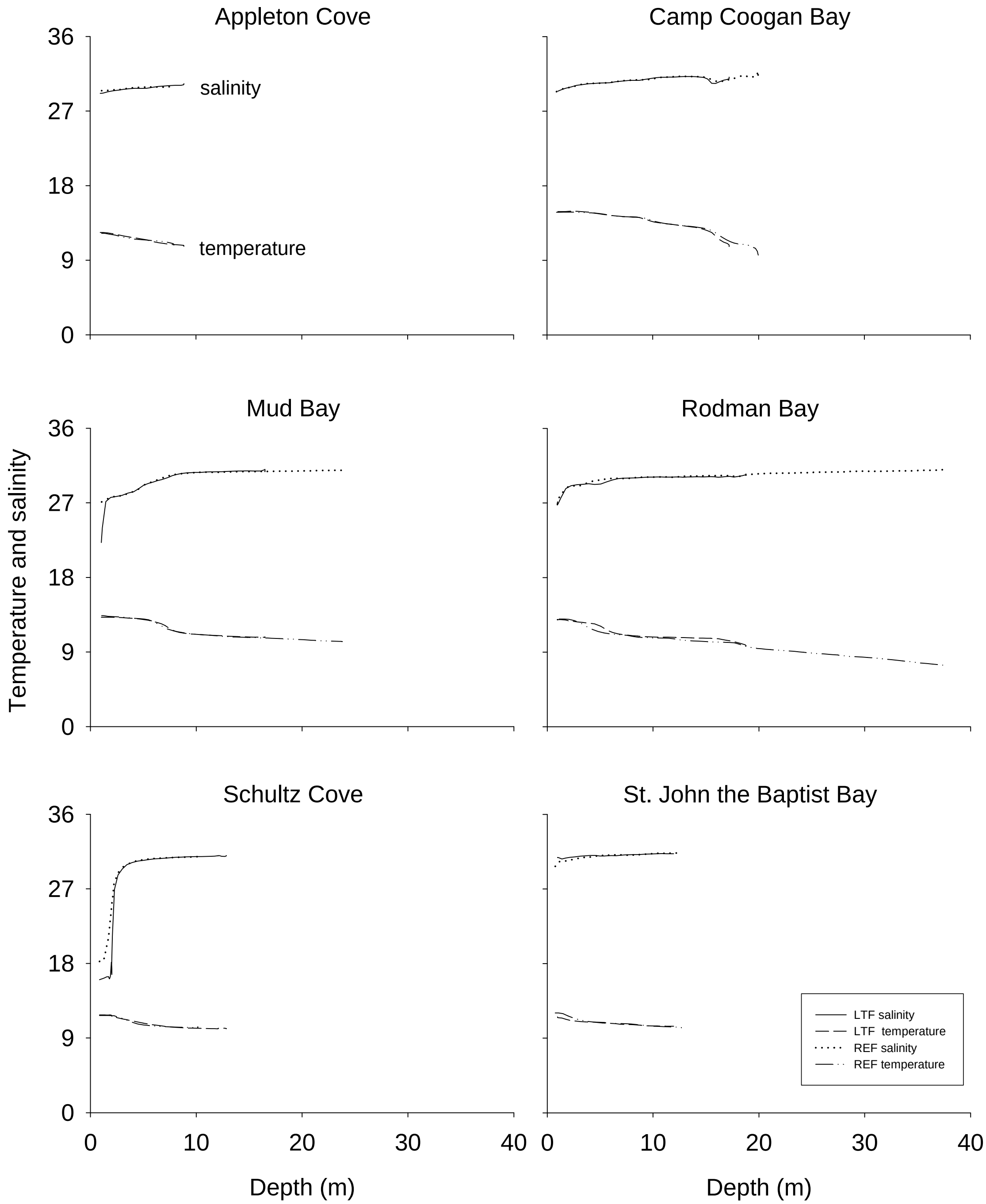


Figure 6. Salinity (parts per thousand) and water temperature (Celcius) profiles at log transfer facility (LTF) and reference (REF) sites studied in July and August 2007 at six sites in southeastern Alaska. Data from Hanus Bay were not available.

Figure 7. Plots of the first two axes from an NMDS (multidimensional scaling) ordination of fish trawl catch for LTF and REF sites. Distances between two points in the ordination diagram approximately reflect their dissimilarity in terms of species composition.

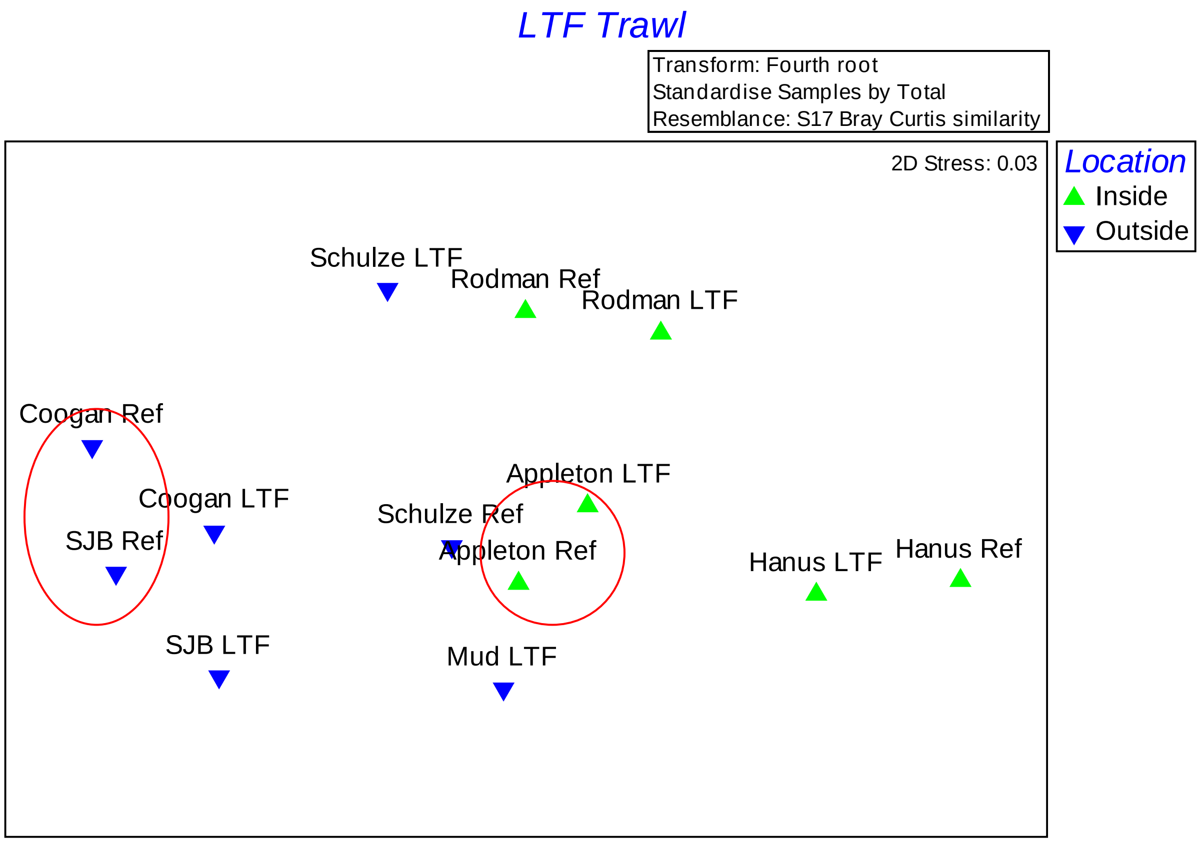


Figure 8. Plots of the first two axes from an NMDS (multidimensional scaling) ordination of invertebrate trawl catch for LTF and REF sites. Distances between two points in the ordination diagram approximately reflect their dissimilarity in terms of species composition.

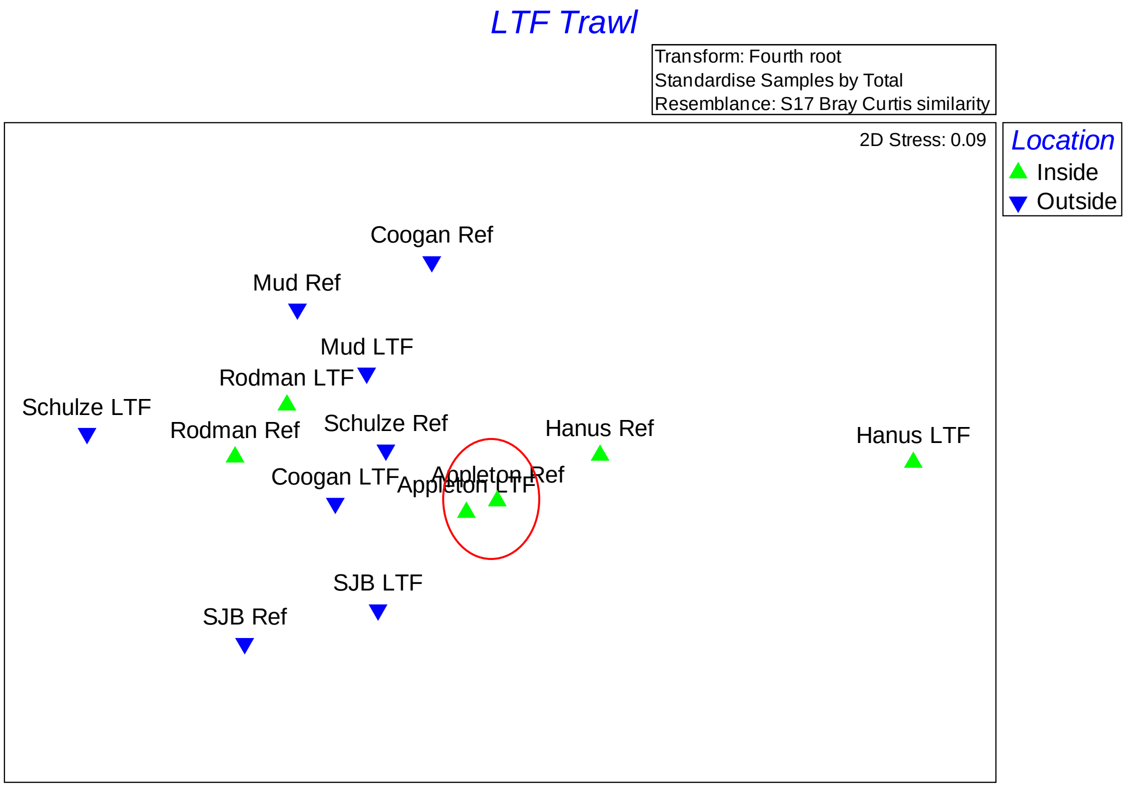


Table 1. Comparison of sediment depths at LTF sites in present study to bark depths reported from the same sites in earlier studies.

LTF Location	Present study mean sediment depth (cm, 1 SD)	Mean bark depth (cm)	
		Freese et. al. 1988	Schultz and Berg 1976
Appleton Cove	3.96 (2.29)		3
Camp Coogan Bay	10.67 (4.76)		2
Hanus Bay	3.43 (1.73)		20
Mud Bay	8.75 (2.94)	35	25
Rodman Bay	6.17 (2.39)	20	15
St. John the Baptist Bay	9.54 (3.92)		11

Table 2. Fish taxa collected at log transfer facility (LTF) and reference (REF) sites studied in July and August 2006 at seven locations in southeastern Alaska.

	Appleton Cove		Camp Coogan Bay		Hanus Bay		Mud Bay		Rodman Bay		Schulze Cove		St. John the Baptist Bay	
Taxon	LTF	REF	LTF	REF	LTF	REF	LTF	REF	LTF	REF	LTF	REF	LTF	REF
Aulorhynchus flavidus					x	x								
Citharichthys stigmaeus			x	x										x
Enophrys bison									x					
Eopsetta jordani									x					
Eumicrotremus orbis		x							x					
Gadus macrocephalus		x									x			
Glyptocephalus zachirus												x		
Hexagrammos decagrammus												x		
Lepidopsetta bilineata	x	x					x					x		
Limanda aspera	x								x	x	x	x		
Lumpenus sagitta		x	x									x	x	
Microstomus pacificus												x		
Myoxocephalus polyacanothocephalus		x					x					x		
Oligocottus maculosus	x	x			x									
Ophiodon elongatus												x		
Parophrys vetulus													x	
Podothecus accipenserinus											x			
Psychrolutes paradoxus	x	x												
Sebastes flavidus														x
Sebastes maliger			x										x	x
Stichaeus punctatus		x								x				
Theragra chalcogramma			x								x			

Table 3. Invertebrate taxa collected at log transfer facility (LTF) and reference (REF) sites studied in July and August 2006 at seven locations in southeastern Alaska.

	Appleton Cove		Camp Coogan Bay		Hanus Bay		Mud Bay		Rodman Bay		Schulze Cove		St. John the Baptist Bay	
Taxon	LTF	REF	LTF	REF	LTF	REF	LTF	REF	LTF	REF	LTF	REF	LTF	REF
Amphipoda											X			
Actinaria	X													
Cancer gracilis	X		X				X		X					
Cancer magister		X										X		
Cancer oregonensis												X		
Chlamys spp			X	X			X	X						
corumba pacifica													X	
Crangon alaskensis	X	X	X	X		X								
ebasteria									X	X				
Platyhelminthes													X	
H. tenuissimus						X								
Heptacarpus carinatus						X								
Heptacarpus spp.	X	X	X			X	X	X	X	X		X		
Heptacarpus brevirostris						X								
Hyas lyratus	X	X				X						X	X	
hyppolyte spp						X								
Scyphozoa			X				X		X			X		
Lebbeus spp		X												
Lophopanopeus bellus									X	X	X			
Ophiura spp			X										X	X
Oregonia gracilis						X						X		
Paguridae		X			X					X				
Pandalus danae	X	X												
Pandalus goniurus	X	X												
Pandalus hypsinotus						X								
Pandalus platyceros						X								

Pandalus spp		x				x								
Parastichopus californicus	x							x	x	x		x		
Pluerobranchia spp.	x			x			x							
polychaete	x						x							
Pycnapodia helianthoides	x		x							x		x	x	x
scale worm	x	x					x						x	
Schlerocrangon boreas		x												
sipunculid														x
Solaster spp								x				x		
Strongylocentrotus spp			x	x				x				x		
Telemesus cheiraonus	x				x									
Tonicella lineata								x				x		
tunicate			x	x			x							

Table 4. Fish species collected inside and outside of Peril Strait in July and August 2006 in southeastern Alaska.

Species	Inside	Outside
Aulorhynchus flavidus	X	
Citharichthys stigmaeus		X
Enophrys bison	X	
Eopsetta jordani	X	
Eumicrotremus orbis	X	
Gadus macrocephalus	X	
Glyptocephalus zachirus		X
Hexagrammos decagrammus		X
Microstomus pacificus		X
Oligocottus maculosus	X	
Ophiodon elongatus		X
Parophrys vetulus		X
Podothecus accipenserinus		X
Psychrolutes paradoxus	X	
Sebastes flavidus		X
Sebastes maliger		X
Stichaeus punctatus	X	
Theragra chalcogramma		X

Essential Fish Habitat project status report

Reporting date:

Project number: 2006-5 & 2007-2

Title: Habitat effects on growth and condition of northern rock sole

PIs: Hurst, Abookire, Heintz, & Short

Funding year: 2006 & 2007

Funding amount: $17,652 FY06; $28,865 FY07

Status: ☒ Complete ☐ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete:

Reporting: Have the project results been reported? If yes, state where the results were reported and attach an electronic copy of the report.

The results of this work are reported in a manuscript submitted to Canadian Journal of Fisheries and Aquatic Sciences. The manuscript received positive reviews and will be accepted pending final minor revisions.

An electronic copy of the MS is attached. A final version of the manuscript will also be sent when accepted.

Results: What is the most important result of the study?

The most important results of the work are that the growth rates at our three focus study sites have maintained their rank order over the 3+ sampling seasons to date. Holiday Beach has consistently supported faster growing age-0 rock sole than Pillar Creek Cove and Shakmanof Beach. While growth variation is correlated with temperature variation, it is not the primary driver of growth variation in this system. Growth rates were not correlated with fish density. In addition, analyses indicate that size and time of settlement may be significant contributors to size variation.

Essential Fish Habitat project status report

Reporting date: August 12, 2008

Project number: EFH 2007-5

Title: Habitat Specific Production of Pacific Ocean Perch in the Aleutian Islands

PIs: Rooper, Heintz

Funding year: 2007

Funding amount: 52,700

Status: ☒ Complete ☐ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete:

Reporting: Have the project results been reported? If yes, where were the results reported? Not reported

Results:

Juvenile Pacific ocean perch (POP; *Sebastes alutus*) were collected from two sites near the Islands of Four Mountains during early June 2008 and in August 2008. The two sites were sampled over two days using an AFSC bottom trawl and plankton net to collect both juvenile POP and their zooplankton prey. Juvenile POP were found at both locations in high abundances, with > 650 individuals captured during four tows of less than 5 minutes each in June, and similar abundances in August. This is the fourth year since 2003 that juvenile POP sampling has occurred at these sites and rockfish densities were higher in 2008 at the nursery sites than in preceding years. Fish dissections and analysis of stomach contents and fish condition are expected to take place during FY2009.

Six successful drop camera deployments (3 at each study site) using a stereo video drop camera system were also conducted over the two days in June. The video captured during the Islands of Four Mountains study shows many juvenile POP and other rockfish inhabiting boulder fields at the study site. There were significant amounts of coral and sponge observed in the study areas. Additionally, adult dusky rockfish (*S. variabilis*) and northern rockfish (*S. polyspinis*) schools were observed at one site. Analysis of the 6 hours of video collected at the study sites will be completed this fall.

Essential Fish Habitat project status report

Reporting date: 10/09/2009

Project number: 2007-6

Title: Recovery of a sessile invertebrate of the Bering Sea shelf from trawling

PIs: Craig S. Rose

Funding year: FY07

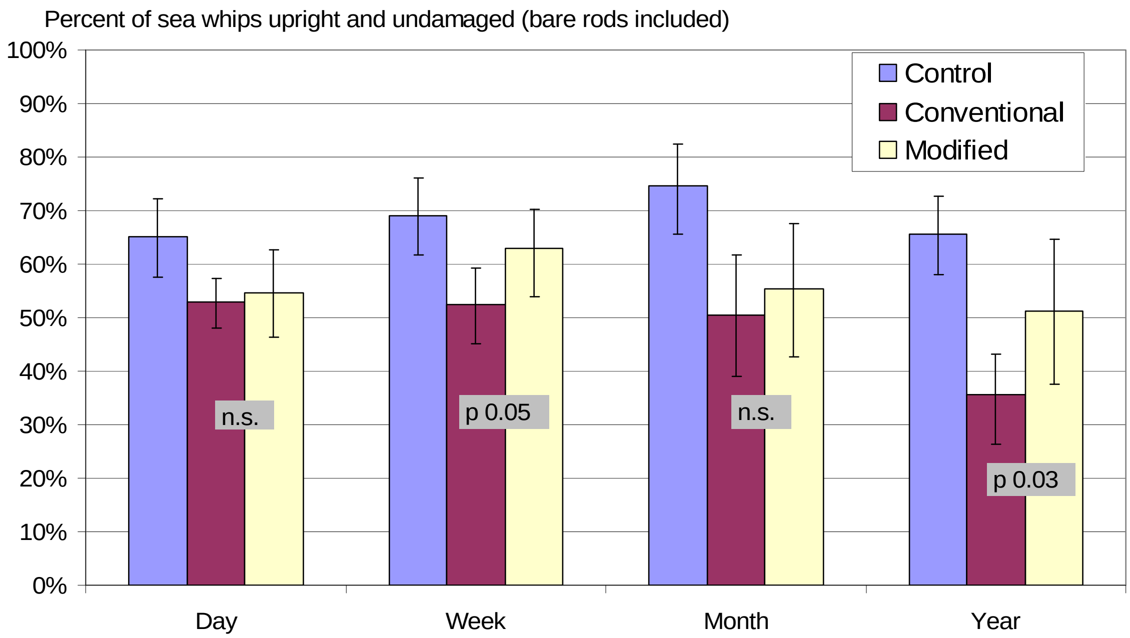
Funding amount: $9888

Status: X Complete ☐ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete:

Reporting: The results of this project were part of a presentation on the effectiveness of trawl sweep modifications in reducing impacts to sea whips. This was presented to the Alaska Marine Science Symposium and the North Pacific Fisheries Management Council. Slide 7 of the presentation is attached, indicating percent undamaged after one year.

Results: EFH funding allowed extension of a larger project to include observations of trawl impacts out to one year after trawling. There was no indication of recovery (increase in the percent of undamaged animals) after one year. Sea whips affected by the conventional sweeps had fewer undamaged animals than were observed at the day, week, and month periods, perhaps indicating delayed mortality. Those contacted by the modified sweeps showed no additional drop after a year relative to the shorter periods.


Percent of sea whips upright and undamaged (bare rods included)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Control
Conventional
Modified
n.s.
p 0.05
n.s.
p 0.03
Day
Week
Month
Year

Essential Fish Habitat project status report

Reporting date: 8/25/2008

Project number: 2007-07

Title: Temporal dynamics of habitat use in juvenile Pacific cod

PIs: Allan Stoner, Benjamin Laurel, Brian Knoth, Clifford Ryer & Thomas Hurst

Funding year: 2007

Funding amount: $46,317

Status: Complete

Planned completion date if incomplete:

Reporting: Have the project results been reported? If yes, where were the results reported?
The results of this study have been reported in a manuscript entitled "Temporal and ontogenetic shifts in habitat use by juvenile Pacific cod" submitted to the Journal of Experimental Marine Biology and Ecology.

Results: What is the most important result of the study?
1) Comparisons in seine collections and baited camera surveys in two focal sites in Kodiak (20 permanent stations) showed that recruitment of age-0 Pacific cod in 2006 was approximately one order of magnitude larger than in 2007. The same trend also appears to be mirrored in the other gadid species i.e., walleye pollock and saffron cod. Despite low catches in 2007, the ontogenetic shift in habitat preference (i.e., eelgrass to Laminaria to open habitats) appears to be identical to the patterns observed in 2006.
2) The 2006 year class was prevalent as age-1 juveniles in the 2007 survey, allowing for a detailed examination of their distribution by depth and habitat complexity. Age 1 cod were seldom caught in the seine survey but were routinely surveyed in large numbers using a baited cameras set along various depth gradients.
3) Age-0 cod were most abundant in shallow (<3 m), inshore habitats, while age-1 cod were typically found deeper and they make diel movements inshore and offshore.
4) Laboratory experiments, designed to complement field observations showed that age-0 cod tolerate high light conditions, while larger cod avoid bright light.
5) Age-1 Pacific cod and saffron cod were moderately piscivorous but there was no evidence of predation on smaller conspecifics.
6) Despite the lack of apparent cannibalism, age-0 and age-1 gadids partition the habitat by both depth and by fine-scale temporal shifts in habitat.

Essential Fish Habitat project status report

Reporting date: 10/29/2009

Project number: 2007-10

Title: Juvenile Pacific Ocean Perch Habitat Utilization

PIs: Pat Malecha, Andrew Gray, Chris Lunsford

Funding year: 2007

Funding amount: $89,300

Status: ☐ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete: Results from this work will be combined with work accomplished in 2008. A draft manuscript shall be completed by summer/fall 2010.

Reporting: Preliminary results from this research were reported in an oral presentation as part of the HEPR-themed AFSC seminar series. A draft manuscript shall be completed by spring 2010.

Results: Surface trawling (up to 60 nautical miles offshore) with an aquarium codend (livebox) successfully captured 221 live juvenile slope rockfish ranging in size from 14-60 mm. Rockfish were transferred to behavior laboratory aquariums at Little Port Walter Marine Station and were acclimated to a modified photoperiod. Genetic determinations identified seven rockfish species including, Pacific ocean perch, rougheye and redstripe rockfish. Habitat preference trials were performed although sample sizes were inadequate to identify statistical differences. Results from this work will be combined with work initiated in 2008.

Essential Fish Habitat project status report

Reporting date: 10/31/2008

Project number: 2007-11A

Title: Biological parameters to estimate the recovery of disturbed benthic habitat in Alaska, study A: Coral growth

PIs: Robert Stone (AFSC), Allen Andrews (Moss Landing Marine Laboratories)

Funding year: FY 2007

Funding amount: $45,000

Status: ☒ Complete ☐ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete: October 31, 2008.

Reporting: Have the project results been reported? If yes, where were the results reported? The results are planned for presentation at the 4th International Symposium on Deep-sea Corals in December 2008 and a manuscript is in preparation.

Results: What is the most important result of the study?

Growth rate estimations were successful for bamboo corals but not for the gorgonian *Fanellia compressa*. Specimens of the latter species are currently being analyzed using C-13 and C-14 techniques by Dr. Tom Brown at the Center for Accelerator Mass Spectrometry (supplemental funding provided by the Alaska Regional Office – Habitat Conservation Division). Age and growth were determined for two bamboo corals (*Keratoisis* sp. B group and *Isidella* n. sp.) using lead-210 dating. The largest colony made available for this research was a *Keratoisis* sp. (B group) that measured 120 cm in height. Lead-radium dating provided an age of 116 ± 13 years with an average axial growth rate of 1.03 cm yr^{-1} (0.93-1.16 cm yr^{-1}, 2SE) for this colony. The *Isidella* n. sp. colony measured 72 cm in height and was aged at 53 ± 4 years; this colony grew most rapidly with a radial growth rate of 0.099 mm yr^{-1} and an average axial growth rate of 1.32 cm yr^{-1} (1.23-1.46 cm yr^{-1}, 2SE). Application of lead-210 dating to *Fanellia compressa* was not successful because measured lead-210 uptake was highly irregular at three points in the 67 cm colony; however, age was estimated at 47 to 57 years from growth zone counts in a skeletal cross section. Our findings of slow growth rates and high longevity compare favorably to those determined for bamboo corals from other regions of the Pacific Ocean and highlight the need for immediate conservation measures to protect these important members of deep-sea ecosystems.

Essential Fish Habitat project status report

Reporting date: 9/28/2009

Project number: 2007-11C

Title: Biological parameters to estimate the recovery of disturbed benthic habitat in Alaska, study C: Coral genetics

PIs: Robert Stone (AFSC), Scott France (University of Louisiana)

Funding year: FY 2007

Funding amount: $14,050

Status: ☒ Complete ☐ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete:

Reporting: Have the project results been reported? If yes, where were the results reported? No. We were not able to complete the project within the timeframe and with the funds received. The project will be completed with alternative funds being requested by Dr. France and will be reported at a later time.

Results: What is the most important result of the study? We developed microsatellite primers from *Primnoa pacifica* colonies collected in Tracy Arm, Holkham Bay. To our knowledge, this is the first attempt to develop microsatellite loci in *Primnoa pacifica* (or any other Alaskan octocoral). Initial tests of primers for four loci on 40 individuals from 4 separate collection sites reveal high levels of alleleic diversity within sites. More extensive optimization and testing will be required to further develop these loci (additional loci can likely be developed from the data we have already collected) for use in population studies of fjord corals. However, this preliminary study shows that this approach is likely to yield appropriate genetic markers to study fine-scale population processes of these cold-water corals.

A summary of the project history and findings to date follows:

Tissue samples for genetic analysis from 150 *Primnoa pacifica* colonies were collected in 2007 & 2008 from Tracy Arm and Endicott Arm, Holkham Bay. Our initial objective was to extract high molecular weight (HMW) DNA to be used to construct enrichment libraries for detecting and developing taxon-specific microsatellite markers. These markers typically show sufficient variation that they can detect fine-scale population structure and, if variation is present, would allow for an assessment of the relative contribution of asexual reproduction in patches of coral. Subsequent to the library construction, our objective is to screen sequenced clones for microsatellite loci, and test them for variability among the *P. pacifica* samples collected.

Objective 1: In March, 2007, 80 samples were collected from four sites. Although we were able to extract DNA from these samples, we did not have success obtaining the unsheared, HMW DNA required for the library construction. We concluded the problem may have been in the initial preservation of samples, i.e., DNA was degrading before tissues were preserved. The best solution was to resample colonies, paying particular care to rapid preservation, and this effort took place in May 2008 (70 samples from 5 sites). DNA extractions on a subset of these specimens did produce HMW DNA from multiple individuals.

Objective 2: HWM DNA from three extractions was sent to the SREL (Savannah River Ecology Lab) DNA Lab in September 2008 for construction of an enriched genomic library for microsatellite development. The following steps have been successfully completed by the SREL DNA Lab:

1) DNA digestion and linker ligation, cloning, double enrichment with biotinylated probes, and PCR amplification of inserts.
2) DNA sequencing of inserts from > 100 clones

DNA sequences of clones (>100) containing microsatellite motifs were delivered by SREL to UL Lafayette on 10/27/2008.

Objective 3: Examination of clone sequences revealed 6 repeat regions (4 tetra-, 1 tri- and 1 di-nucleotide repeat) that were suitable for PCR primer development (more such sequences are likely among the clones available and will be examined in our continuing research). We tested the 6 pairs of primers (= 6 presumptive microsatellite loci) initially on ≈10 colonies to determine whether the loci would amplify all individuals and to determine appropriate reaction conditions for optimal banding. All 6 loci produced reaction products in all individuals tested. We isolated and sequenced some of the reaction products to verify that we were amplifying the expected repeat regions (see locus and primer information below). Despite repeated manipulations of conditions, the dinucleotide repeat could not be effectively optimized, and was dropped from further analysis.

The remaining 5 loci were tested on 40 individuals from 4 collection sites within Tracy Arm, to look for variability (= multiple alleles) and if there were any preliminary evidence that this diversity might be structured within the fjord, i.e., differences in allele frequency among the collection sites. PCR reaction products were run out on 2.75% Metaphor agarose (Cambrex) gels to allow for discrimination of bands (alleles) between 160 and 300 nucleotides length. Four of five loci produced variable-size PCR products within an expected size range (based on the initial clone); the fifth locus included non-specific products and was not further analysed. For four loci we classified the products into allele classes, but acknowledge these could change somewhat when the products are amplified using a fluorescently-labeled primer and run on an automated sequencer for visualization; such methods provide higher spatial resolution among bands. All four loci showed high levels of band (presumptive allele) variation (Figure 1). Two of the loci (F10 and C01) produced sufficiently distinct bands to allow for further analysis of the scored alleles (loci H10 and C09 produced banding patterns that did not conform to the expected diploidy, i.e., there were as many as 3 alleles per individual. Without further analysis, we could not determine which bands were real.).

At loci F10 and C01, many more homozygotes, and fewer heterozygotes, were observed than expected. This may be the result of one or a combination of the following:

- incomplete resolution of allelic bands. Although the Metaphor gel system has high resolution in the size range we targeted, it is possible that alleles of heterozygotes that differed by a single repeat unit were not recognized as distinct and scored as homozygotes.
- There is a high level of inbreeding or asexual reproduction at each site.
- Colonies collected from single sites actually come from separate interbreeding populations ("Wahlund effect").

At locus F10, site 4 (farthest up the Tracy Arm) did show frequency differences to sites 1 & 2 (individuals from site 3 did not produce strong enough bands to score for this locus), suggesting perhaps a different origin of individuals compared to other sites, but this will need confirmation with additional colonies and loci before any confidence can be put in this interpretation.

Microsatellite locus and primer information

F10 Tetranucleotide repeat (CTGT)
Primer 1: F10f: GCATTTCTCGACTTTCATGT
Primer 2: F10rev: gttTGACCAAGAAACAACAGACACA
Number of alleles scored: 14
Expected number of homozygotes: 3.7627
Observed number of homozygotes: 22
Expected number of heterozygotes: 26.2373
Observed number of heterozygotes: 8

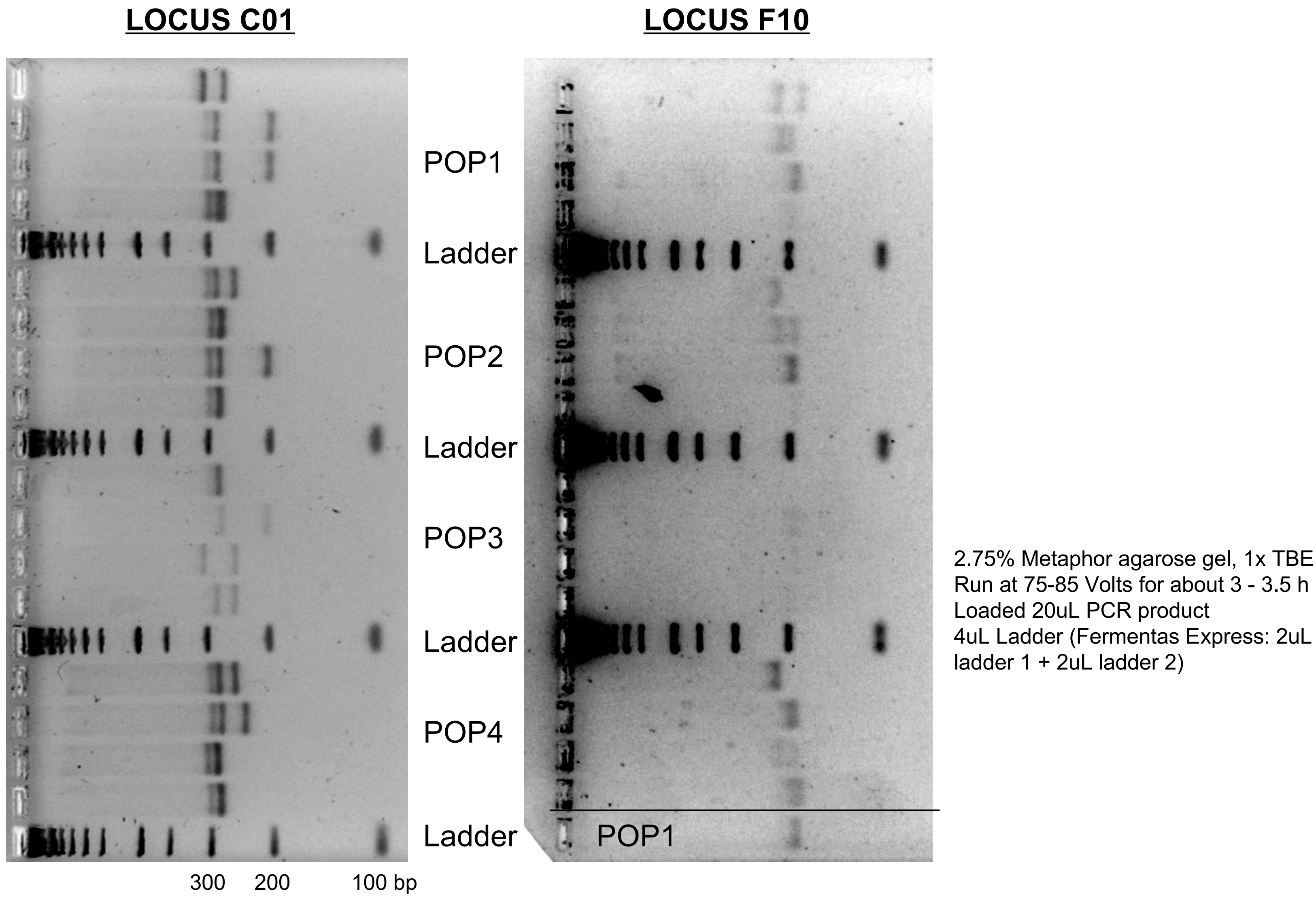
C01 Tetranucleotide repeat (GATT)
Primer 1: C01f: GCTGGCTACACAGGTCGTCT
Primer 2: C01rev: gTTTTTCCCGTGAACCCAAT
Number of alleles scored: 20
Expected number of homozygotes: 3.1688
Observed number of homozygotes: 21
Expected number of heterozygotes: 35.8312
Observed number of heterozygotes: 18

C09 Trinucleotide repeat (AGT)
Primer 1: C09f: GCGGCTTGGTATAGCTGATG
Primer 2: C09rev: gttTGATCCTGCTCCTATTCCTCT

H10 Tetranucleotide repeat (ACAG)
Primer 1: H10_P2f: CATTGTAGTGCCGGCCATC

Primer 2: H10_P2rev: gttTCTGTCTGTCTCTTGCTCTCT

B01 Tetranucleotide repeat (AACT)
Primer 1: B01f: aTGGCAGTGTAGCCACAGTA
Primer 2: B01rev: gtttGCAGAATCACAGACCACTCG



An example of size variability of PCR bands (presumptive alleles) for microsatellite loci C01 and F10. DNA extracted from individual colonies of *Primnoa pacifica* collected from four localities (POP1-4) in Tracy Arm, Holkham Bay were PCR amplified and run on the gels (migration from left to right); a different set of individuals is shown on each gel.

Essential Fish Habitat project status report

Reporting date: October 28, 2009

Project number: 2006-12, 2007-12, 2008-06

Title: **Habitat Influence on Rearing Condition and Overwinter Survival of Juvenile Capelin (*Mallotus villosus*)**

PIs: J. Vollenweider, J. Hudson, R. Heintz

Funding year: FY 2008

Funding amount: $44,540

Status: ☐ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete: All field collections, chemical analyses, and data analyses are complete. Two manuscripts are currently in progress describing the overwinter energy allocation strategies of juvenile 1) eulachon and 2) capelin. The juvenile eulachon manuscript is under review and will be submitted to a journal this winter (FY10). The capelin paper, which is also in draft, will be submitted to a journal the following summer (FY10).

Reporting: The project has not yet been reported, however 2 manuscripts are in progress and are anticipated to be published in FY10.

Results:

Winter starvation mediated by low-levels of foraging is likely an important mechanism structuring recruitment success of juvenile forage fish. Over the course of two winters, we observed size-selective mortality in juvenile eulachon and capelin stemming from starvation in the smallest individuals. Between the fall and subsequent spring sampling periods, length frequency distributions of juveniles shifted towards larger individuals, which could either be indicative of a loss of smaller fish or growth (Figure 1). Growth overwinter is highly unlikely, however, as fish lost energy during this period and therefore surplus energy would not have been available for growth.

Winter energy deficits resulted from the loss of both lipid and protein energy. The magnitude of the deficit and relative depletion of lipid and protein were size dependent (Figures 2 and 3). Larger juveniles began winter with greater lipid reserves than smaller fish. During winter, larger fish depleted more of their pre-winter lipid reserves than smaller fish, and as a consequence, the contribution of lipid catabolism to the winter energy deficit increased with body size (Figure 4). Although the relative proportion of protein loss was independent of body size, the smallest fish lost more energy in the form of protein than lipid. By the end of the winter, the energy content of the smallest surviving juveniles was very near the energetic threshold, below which mortality occurs (Figure 5). Thus, the smallest juveniles were under extreme nutritional stress and were forced to metabolize protein to meet most of their metabolic demands, apparently as a consequence of exhausting lipid reserves.

Comparisons from two bays (Fritz Cove and Berners Bay) indicate that prey availability plays an important role in survival of juvenile fish that are on the brink of starvation in winter. Despite a general scarcity of prey during winter, what little forage juvenile fish could consume appeared to help stave off starvation. Nearly half the juvenile eulachon were feeding during the winter, as evidenced from stomach contents. Zooplankton prey species, particularly copepods, were more abundant in Fritz Cove than Berners Bay (Figure 6). Though juvenile eulachon in Fritz Cove

were smaller and had lower energy reserves going into winter, they were in better condition than those from Berners Bay in the spring, suggesting that prey availability may help to preserve lipid reserves and thereby reduce starvation risk.

Collectively, these results indicate that the smallest eulachon and capelin do not store sufficient reserves of lipid for winter, are forced to metabolize protein, and may suffer a greater risk of winter mortality. Winter foraging, despite low prey abundance, may be crucial for survival. We suggest that disproportionately high rates of starvation among the smallest age-0 forage fish are important mechanisms influencing recruitment.

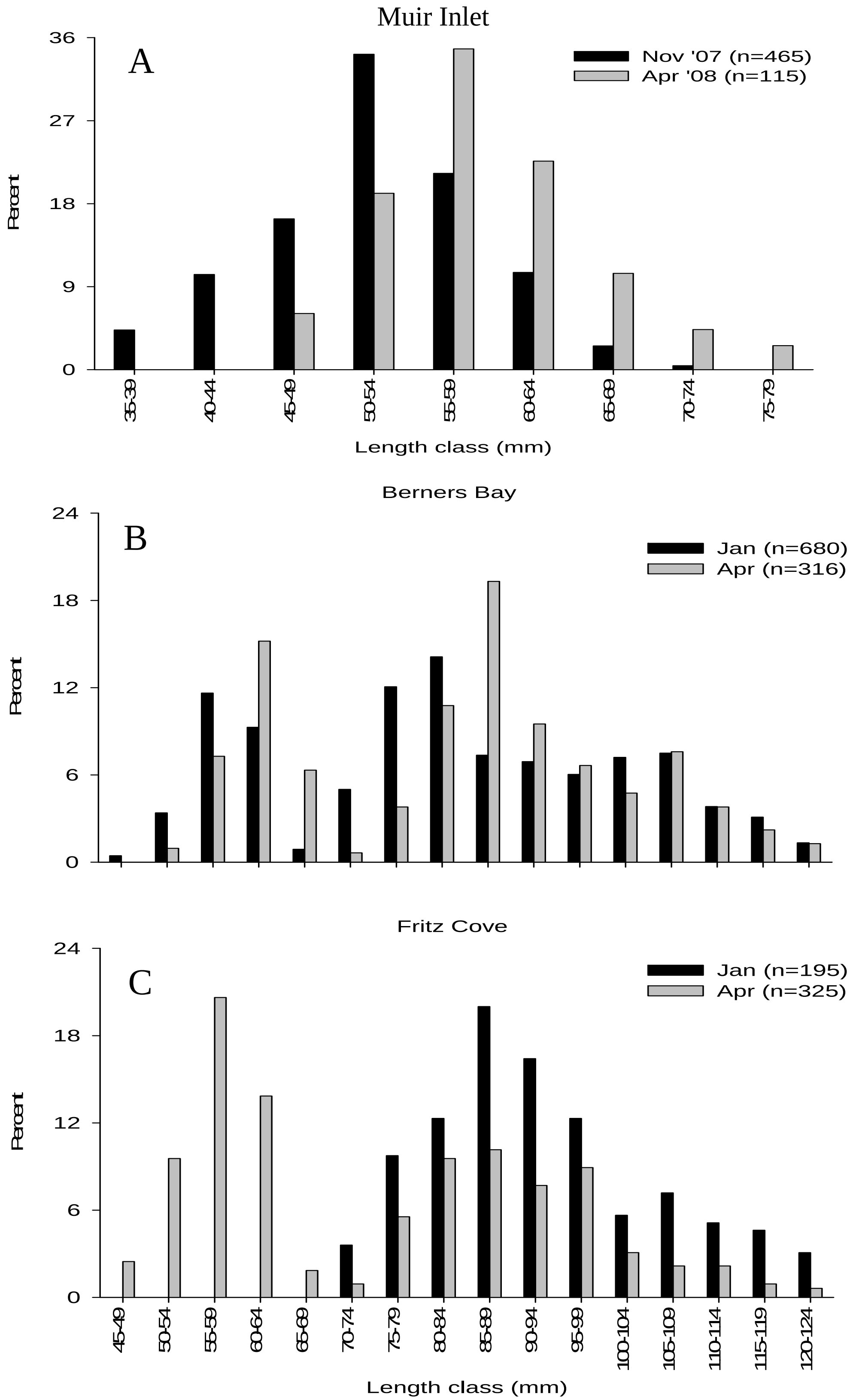


Figure 1. Shift in size distribution of juvenile capelin (A) and eulachon (B & C).

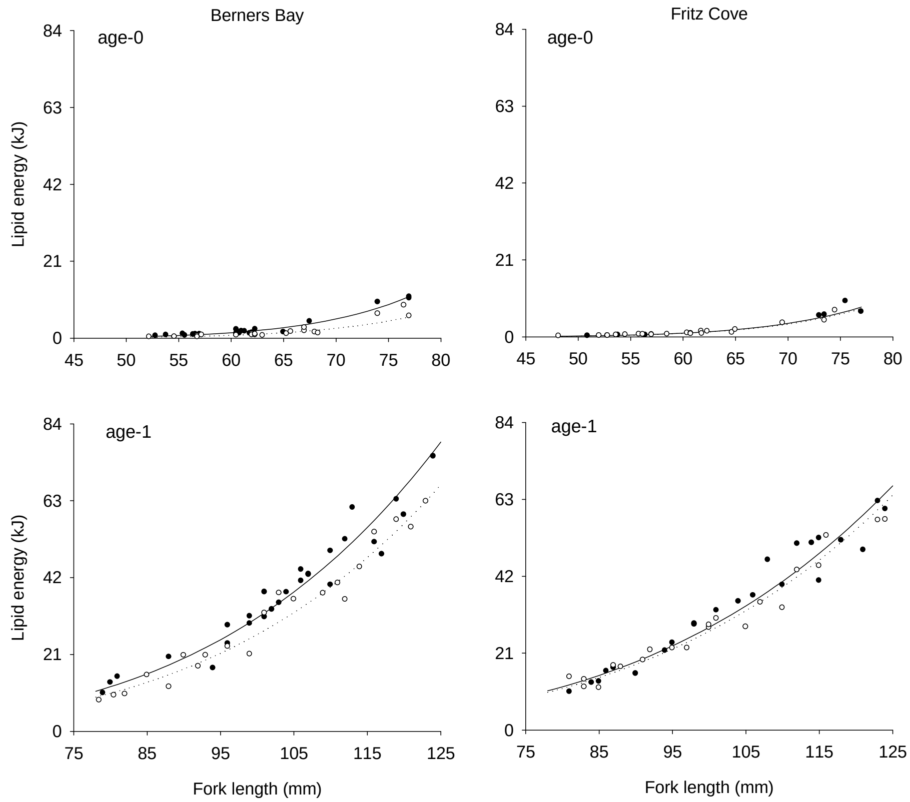


Figure 2. Energy allocated to lipid in age-0 and age-1 eulachon in January (solid circles and lines) and April (open circles and dashed lines) in Berners Bay and Fritz Cove.

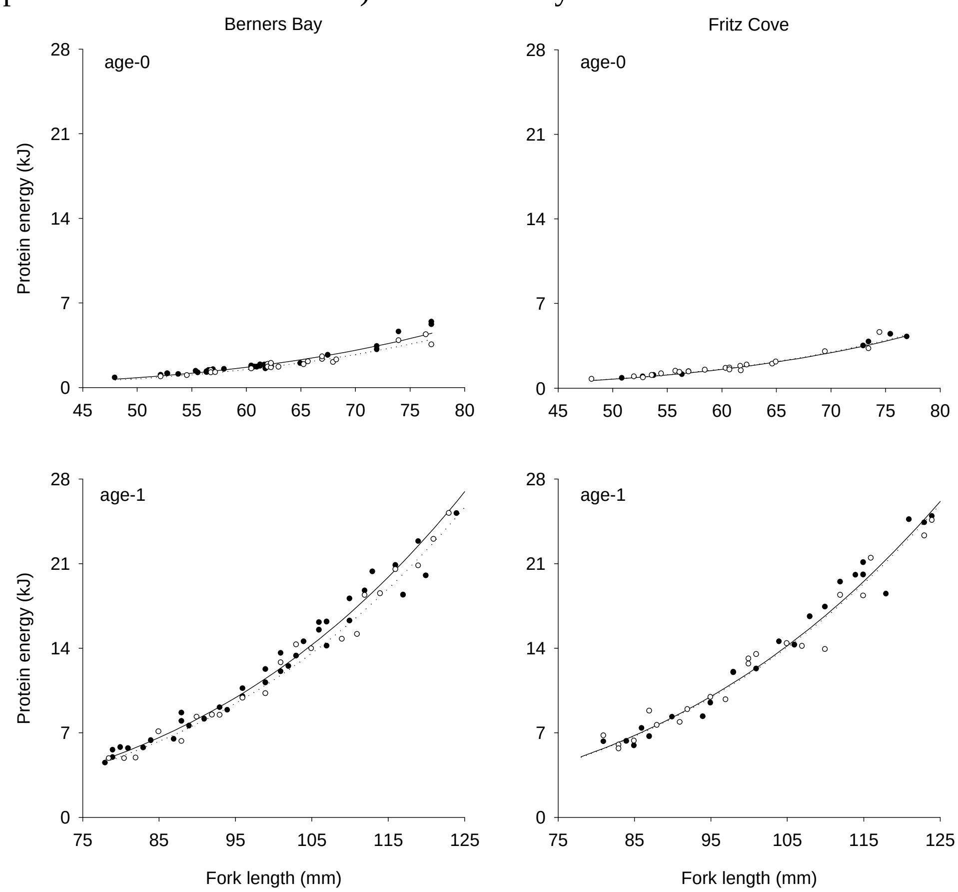


Figure 3. Energy allocated to protein in age-0 and age-1 eulachon in January (solid circles and lines) and April (open circles and dashed lines) in Berners Bay and Fritz Cove.

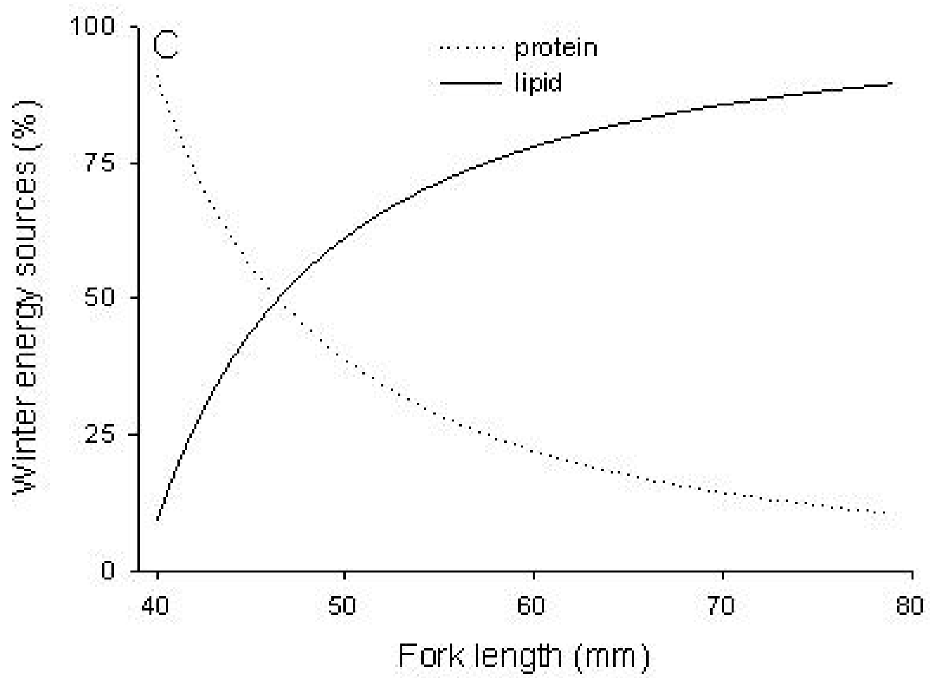


Figure 4. Modeled relationships between capelin fork length and the relative contribution of lipid and protein energy to the winter energy deficit.

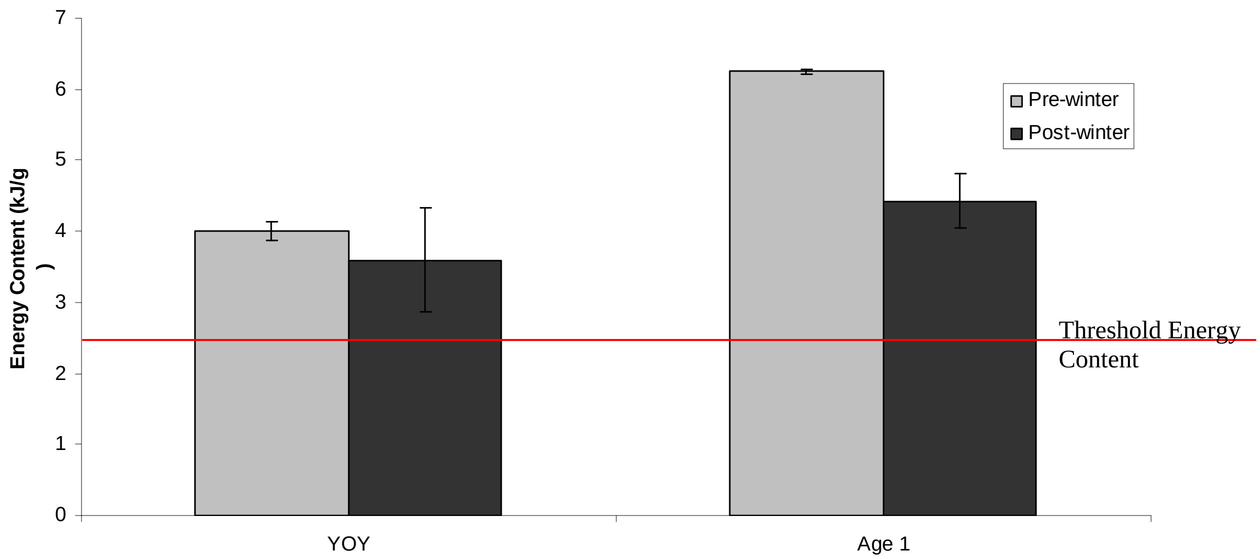


Figure 5. Overwinter energy loss (kJ g^{-1}) of juvenile capelin. Red line denotes the threshold energy content below which mortality occurs.

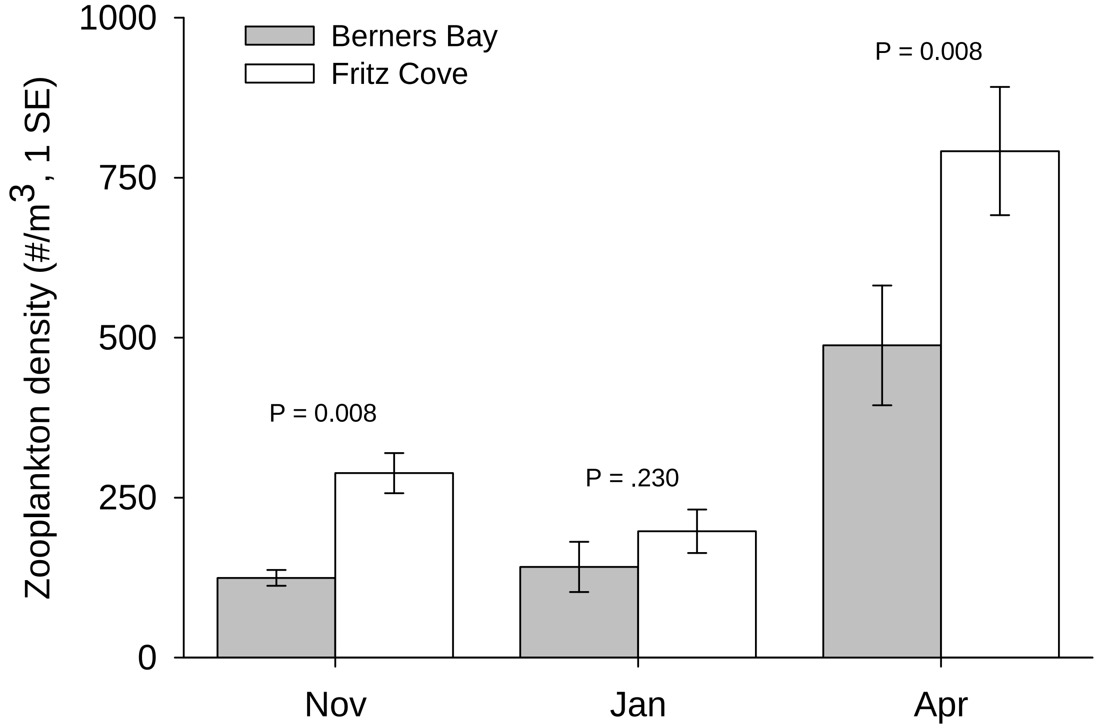


Figure 6. Zooplankton abundance in Berners Bay and Fritz Cove during winter 2006/2007. P-values are from Mann-Whitney U tests.

Essential Fish Habitat project status report

Reporting date: October 23, 2007

Project number: 2007-9

Title: Mapping and fish utilization of coastal habitats vulnerable to disturbance from development and climate change

PIs: Johnson, Thedinga, Lindeberg, Harris

Funding year: FY 2007

Funding amount: $92,000

Status: [x] Complete [ ] Incomplete, on schedule [ ] Incomplete, behind schedule

Planned completion date if incomplete: Fall 2007

Reporting: Have the project results been reported? Yes. About 6,100 km of shoreline in southern southeastern Alaska (Dixon Entrance) were imaged with *ShoreZone* in 2007– within this mapped area, nine locations (30 seine sites) were sampled in June 2007 to determine fish utilization by habitat type. All data has been entered into an existing GIS database and online Fish Atlas (http://www.fakr.noaa.gov/habitat/fishatlas/) for reference by resource managers. Southeastern Alaska now has 20,076 km (60%) of shoreline imaged and 8,500 km mapped. Statewide, imagery has been collected for a total of 39,483 km of shoreline (about 20,190 km has been mapped). Both the mapping and GIS database (*ShoreZone*/Fish Atlas) will need continuous updating as more shoreline is mapped and fish distribution and relative abundance data is collected.

To address data deficiencies in the distribution and habitat use of nearshore fishes in the Arctic, we sampled nine sites in the Chukchi and Beaufort Seas with two gear types (beach seine and small bottom trawl). All data has been entered into an existing GIS database and online Fish Atlas (http://www.fakr.noaa.gov/habitat/fishatlas/) for reference by resource managers. Additional sampling (2008 and 2009) is planned at these sites to establish a baseline for monitoring changes in nearshore fish assemblages in a rapidly changing environment.

Results: What is the most important result of the study? Forage fish dominated catches in the Arctic. For example, juvenile capelin and Pacific sand lance were the most abundant species captured with a beach seine. Juvenile Arctic cod were one of the most abundant species captured with a trawl. All of these species are extremely important in the diet of other fishes, sea birds, and marine mammals and justify the need to protect nearshore areas from development.

Essential Fish Habitat project status report

Reporting date: 9/1/09

Project number: 2008-01

Title: Nearshore Fish Habitat Assessment

PIs: Johnson, Thedinga, Lindeberg, and Harris

Funding year: 2008

Funding amount: $91,000

Status: ☐ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete: 6/10

Reporting: Have the project results been reported? If yes, where were the results reported? No

Results: What is the most important result of the study?

1. Monitoring sites were sampled in the Chukchi and Beaufort Seas for the third consecutive year in 2009. Arctic nearshore waters are used by forage fish, especially capelin and Arctic cod. A peer-review manuscript is planned for 2010.

2. Four eelgrass monitoring sites were resampled in 2008 for the first time in five years. Little change was observed in size or health of three of the beds; the eelgrass bed in Crab Bay, however, was reduced in size and very sparse compared to earlier years. Scouring from ice may partly explain the deterioration of this bed and emphasizes the importance of long-term monitoring. The Crab Bay site was resampled in 2009 and the bed has made some recovery. A peer-review manuscript is planned for 2010.

3. We extended the Nearshore Fish Atlas of Alaska into Cook Inlet; the Atlas now includes southeastern Alaska, Prince William Sound, Cook Inlet, the Aleutian Islands, and the Arctic.

4. With the CBJ, additional eelgrass beds not accessible by road were inventoried in Admiralty Cove (2008), Oliver’s Inlet (2008), and Hawk Inlet (2009).

Essential Fish Habitat project status report

Reporting date: 10/21/2009

Project number: 2008-02

Title: Productivity, habitat utilization and recruitment dynamics of Pacific cod

PIs: Laurel, Ryer, Stoner, Knoth, Urban

Funding year: 2008

Funding amount: $29,000

Status: ☐ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete: October 2010

Reporting: Project has not yet been fully reported. Partial results and details are found in:

Laurel BJ, Ryer CH, Knoth B, Stoner AW (2009) Temporal and ontogenetic shifts in habitat use of juvenile Pacific cod (*Gadus macrocephalus*) J. Exp. Mar. Biol. Ecol. 377: 28-25

Results: What is the most important result of the study?

1) Age-1 and age-2 juvenile fish can be assessed using the baited camera. The 2006 year class is well-distinguished in 2008 as 2-yr old fish, suggesting there is high survival in the coastal nursery areas.
2) Preliminary analysis of fisheries independent data sets support the idea of an extraordinarily abundant and unprecedented 2006 year class.
3) Stomachs from age 1+ Pacific and saffron cod were also collected and frozen for the ongoing examination of cannibalism in these species. Three years of stomach data are now collected and archived at the KFRC.
4) Progress has been made towards the assembly of local adult recruitment indices based on ADF&G survey and the shrimp small-mesh survey. These data will be necessary in a final analysis in 2010.

Essential Fish Habitat project status report

Reporting date: Oct. 29, 2009

Project number: 2008-03, 2009-05

Title: Contrasting predation intensity and distribution in 2 rock sole nursery areas: a principle factor controlling nursery productivity - Component A: Contrasting predation.

PIs: Ryer, Laurel, Knoth

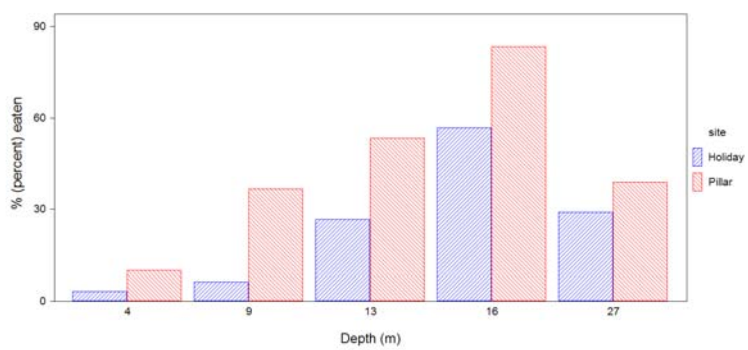
Funding year: 2009

Funding amount: $20,000

Status: ☒ Complete ☐ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete:

Reporting: Have the project results been reported? If yes, state where the results were reported and attach an electronic copy of the report. Thus far, one manuscript derived from this project has been submitted for publication to Marine Ecology Progress Series (see attached manuscript). We anticipate submitting either 3 or 4 additional manuscripts, supported in part by this and prior HEPR funding, during the course of the next 24 months.



Results: What is the most important result of the study? As in 2008, worm turf constituted a dominant habitat feature at Pillar Creek Cove, and to a lesser extent at Holiday Beach. However, unlike 2008, when the turf was extremely dense and contiguous, during 2009 the turf was less dense and more patchy. In 2008, fish were aggregated along the edge of the turf. In 2009 fish were most abundant within the sand patches within the turf. Tethering (15 min sets) revealed increasing predation risk with increasing depth at both sites. This was particularly evident as depth increased from 4 to 16m. Sixteen m corresponded to the shoreward edge of the worm turf, which then extended out to approximately 50m depth. Importantly, predation decreased significantly at 27m, at depth at which tethers were set in the worm turf proper. These result support one of our principle theories regarding use worm turf habitat by juvenile flatfish; worm turf provides protection from predators, but is avoided when it becomes so dense as to preclude unfettered access to the bottom and interferes with movement and burial.

A second important finding was that predation was uniformly lower at Holiday Beach than at Pillar Creek Cove. These results are consistent with our prediction stated in our original proposal to HEPR for 2008 funding. We had previously documented comparable predation rates at these 2 sites (see attached manuscript). These results suggest that the nursery value of these sites may vary from year to year. The significance of this data may become more clear as video survey data of predator abundance from 2002 – 2009 in completed this winter.

Lastly, as expected, predation upon juvenile flatfish was much lower at night than during the day.

Essential Fish Habitat project status report

Reporting date: Oct. 29, 2009

Project number: 2009-11

Title: Contrasting predation intensity and distribution in 2 rock sole nursery areas: a principle factor controlling nursery productivity - Component B: Monitor worm turf recovery and seasonal changes.

PIs: Ryer, Laurel, Knoth

Funding year: 2009

Funding amount: $13,000

Status: ☐ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete:

Reporting: Have the project results been reported? If yes, state where the results were reported and attach an electronic copy of the report. We anticipate submitting a manuscript for peer-reviewed publication during the next 12 months.

Results: What is the most important result of the study? We are still analyzing video footage. However, disturbance of the worm turf habitat attributable to our simulated bottom trawling activity appears to have been relatively minor compared to the seasonal pattern of benthic disturbance driven by winter storm activity. Initially, scrape marks where worms were removed by our gear were readily evident along our disturbance tracts. Also, consistent with our results from component A, juvenile flatfish abundance increased in these disturbed tracts. However, within several months wave action began to erode away sections of the worm turf, so that by late winter/spring, the formerly contiguous turf had be reduced to a patchwork of turf habitat, and trawl disturbed tracts were no longer recognizably different from control areas. We suspect that excavations attributable to sea stars and/or sea otters constituted initial disturbances, which were subsequently expanded by bottom surge (much in the same way wave action expands small holes in mussel mats caused by log impacts in the inter-tidal). We will finish data analysis in the next 6 months and anticipate submitting a manuscript this year.

Essential Fish Habitat project status report

Reporting date: 10/5/09

Project number: 2008-04

Title: Physical and temporal aspects of pollock spawning habitat utilization

PIs: Kevin Bailey and Kung-sik Chan

Funding year: 2008

Funding amount: $33,980

Status: x☐ Complete ☐ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete:

Reporting: A draft manuscript has been completed. This manuscript is being revised. In the continuation funding for 2009, the modeling results will be refined.

Results: Our project examined the temporal and spatial aspects of occupation of spawning habitat by walleye pollock in the Gulf of Alaska as reflected by ichthyoplankton data. Larval hatchdate distributions are shaped by the inflow/outflow dynamics of spawning and mortality. We developed statistical modeling techniques using a 20 year time series of hatchdate distribution data, with which we were able to describe how habitat related variation in temperature and transport, harvesting and intervention effects (regime shift and oil spill) influenced the spawning time and survival of pollock larvae.

Essential Fish Habitat project status report

Reporting date: 1 October 2009

Project number: 2008, No. 5

Title: **Habitat characterization and utilization of early benthic phase red king crab**

PIs: **Persselin, Stoner, Foy, Eckert**

Funding year: FY-08

Funding amount: $45,166

Status: ☒ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

1) Laboratory studies are complete and in manuscript or in preparation for publication
2) Field work is nearly complete – see progress report for Kodiak (below)

Planned completion date if incomplete: Fall 2009

Reporting: Have the project results been reported? If yes, state where the results were reported and attach an electronic copy of the report.

Some of the laboratory results are presently in manuscript form:

Stoner, A.W. Habitat-mediated survival of newly settled red king crab in the presence of a predatory fish: role of habitat complexity and heterogeneity. J. Exp. Mar. Biol. Ecol. (accepted pending minor revision)

Pirtle, J.L. and A.W. Stoner. Red king crab (*Paralithodes camtschaticus*) early post-settlement habitat choice: structure, food, and ontogenetic shifts. J. Exp. Mar. Biol. Ecol. (AFSC and UAF - internal review)

Results: What is the most important result of the study?

Important results from Laboratory studies:

a) Survival of early benthic stage RKC was tested in the presence of juvenile Pacific halibut, northern rock sole, and Pacific cod (all approximately the same size). Halibut were the most effective predators, while cod were intermediate, and northern rock sole were very poor predators of RKC.
b) Survival of RKC increased with amount of physical structure and was highest in the most heterogeneous habitats. Survival was as high in habitat islands as it was in continuous cover.
c) RKC were capable of detecting predators and adjusting their behavior to increase survival. Avoidance capability increased with crab size/age.
d) Newly settled RKC selected living, structurally complex biogenic substrata (hydroids, bryozoans, and algae) over other substrata, and this association was related to foraging opportunities. However, predation experiments show that

choosing complex biological structures provides for survival as well as trophic advantage.

e) Placing RKC seed stock in habitats with abundant protective habitat will be key to stock enhancement, but high quality microhabitats may serve as well as continuous cover.

2009 Kodiak research – progress report

The 2008/2009 EFH project objectives were to identify larval supply, settlement density, and habitat use by early benthic phase and juvenile red king crab. To accomplish this, Marginal Pier in Womens Bay and multiple locations in Chiniak Bay, Kodiak were monitored from March to September. Monitoring will be complete in mid October followed by assessment of larval densities, transect analysis of % habitat type, and crab use.

Identification of larval supply

To identify of larval supply patterns larval collectors were distributed at multiple locations in Chiniak Bay consistent with historical known locations of larval drift (Kalsin Bay, Middle Bay, Womens Bays, and Gibson Cove). Larval collectors were also placed at multiple depths in Womens Bay to address the potential changes in current patterns with depth. In addition, quadrats at each location were sampled for early benthic phase settlement using a suction dredge. A benthic air-lift sampler was constructed to collect early benthic stage red king crab which would have settled in the summer of 2008.

Field operations began in April with divers deploying a recording light meter and field testing the photographic methods. Four days of boat operations were required to set the SAC arrays at the Chiniak Bay sites, and at Marginal Pier, photo baselines were set parallel to the SAC arrays down the slope at the three sampling locations in Womens Bay near Marginal Pier. Two boat operations have been conducted to check on the Chiniak Bay larval collectors, one in June and one in July, with all SAC arrays found intact and as deployed.

Juvenile habitat use

To identify habitat use by early benthic phase and juvenile red king crab, relationships between crab presence and habitat type were assessed with dive transects and systematic photographs taken throughout the year in Womens Bay. Biogenic habitat was assessed to quantify the annual progression of habitat available in a known red king crab nursery. In 2009, an underwater camera stand, quadrats, and photo quadrat location markers were designed and constructed to standardize the photographs.

Dive operations began in May with four dives required to stake down the SAC lines, set out the photo quadrat markers, lay out the lateral lines in the 6 habitat zones, and field-test the benthic air-lift sampler. The benthic sampling began when divers sampled quadrats with the air-lift at all 4 Chiniak Bay sites. The first of the bi-weekly photo dives were conducted in late May, with 3 dives required to photograph the 6 photo quadrat locations on each of the three sampling sites. The first Marginal Pier benthic sampling, combined with quadrat photos on the habitat zone lateral lines, were also started in late May, with one dive required for each of the six habitat zones.

Twenty four dives were conducted to photograph and record diver observations at 6 photo quadrat sites on each of the three Marginal Pier sampling locations. These were done bi-weekly, with one period missed due to both divers' duties on the EBS survey. Divers conducted 24 dives to benthic sample and photograph quadrats set along the 6 habitat zone lateral lines. Three dive days are required to complete each sampling series, with 4 series completed to date.

Quadrat sampling use a suction dredge looking for juvenile crab and identifying habitat.

Juvenile red king crab on a larval crab collector in Chiniak Bay.

Essential Fish Habitat project status report

Reporting date: October 28, 2009

Project number: 2006-12, 2007-12, 2008-06

Title: **Habitat Influence on Rearing Condition and Overwinter Survival of Juvenile Capelin (*Mallotus villosus*)**

PIs: J. Vollenweider, J. Hudson, R. Heintz

Funding year: FY 2008

Funding amount: $44,540

Status: ☐ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete: All field collections, chemical analyses, and data analyses are complete. Two manuscripts are currently in progress describing the overwinter energy allocation strategies of juvenile 1) eulachon and 2) capelin. The juvenile eulachon manuscript is under review and will be submitted to a journal this winter (FY10). The capelin paper, which is also in draft, will be submitted to a journal the following summer (FY10).

Reporting: The project has not yet been reported, however 2 manuscripts are in progress and are anticipated to be published in FY10.

Results:

Winter starvation mediated by low-levels of foraging is likely an important mechanism structuring recruitment success of juvenile forage fish. Over the course of two winters, we observed size-selective mortality in juvenile eulachon and capelin stemming from starvation in the smallest individuals. Between the fall and subsequent spring sampling periods, length frequency distributions of juveniles shifted towards larger individuals, which could either be indicative of a loss of smaller fish or growth (Figure 1). Growth overwinter is highly unlikely, however, as fish lost energy during this period and therefore surplus energy would not have been available for growth.

Winter energy deficits resulted from the loss of both lipid and protein energy. The magnitude of the deficit and relative depletion of lipid and protein were size dependent (Figures 2 and 3). Larger juveniles began winter with greater lipid reserves than smaller fish. During winter, larger fish depleted more of their pre-winter lipid reserves than smaller fish, and as a consequence, the contribution of lipid catabolism to the winter energy deficit increased with body size (Figure 4). Although the relative proportion of protein loss was independent of body size, the smallest fish lost more energy in the form of protein than lipid. By the end of the winter, the energy content of the smallest surviving juveniles was very near the energetic threshold, below which mortality occurs (Figure 5). Thus, the smallest juveniles were under extreme nutritional stress and were forced to metabolize protein to meet most of their metabolic demands, apparently as a consequence of exhausting lipid reserves.

Comparisons from two bays (Fritz Cove and Berners Bay) indicate that prey availability plays an important role in survival of juvenile fish that are on the brink of starvation in winter. Despite a general scarcity of prey during winter, what little forage juvenile fish could consume appeared to help stave off starvation. Nearly half the juvenile eulachon were feeding during the winter, as evidenced from stomach contents. Zooplankton prey species, particularly copepods, were more abundant in Fritz Cove than Berners Bay (Figure 6). Though juvenile eulachon in Fritz Cove

were smaller and had lower energy reserves going into winter, they were in better condition than those from Berners Bay in the spring, suggesting that prey availability may help to preserve lipid reserves and thereby reduce starvation risk.

Collectively, these results indicate that the smallest eulachon and capelin do not store sufficient reserves of lipid for winter, are forced to metabolize protein, and may suffer a greater risk of winter mortality. Winter foraging, despite low prey abundance, may be crucial for survival. We suggest that disproportionately high rates of starvation among the smallest age-0 forage fish are important mechanisms influencing recruitment.

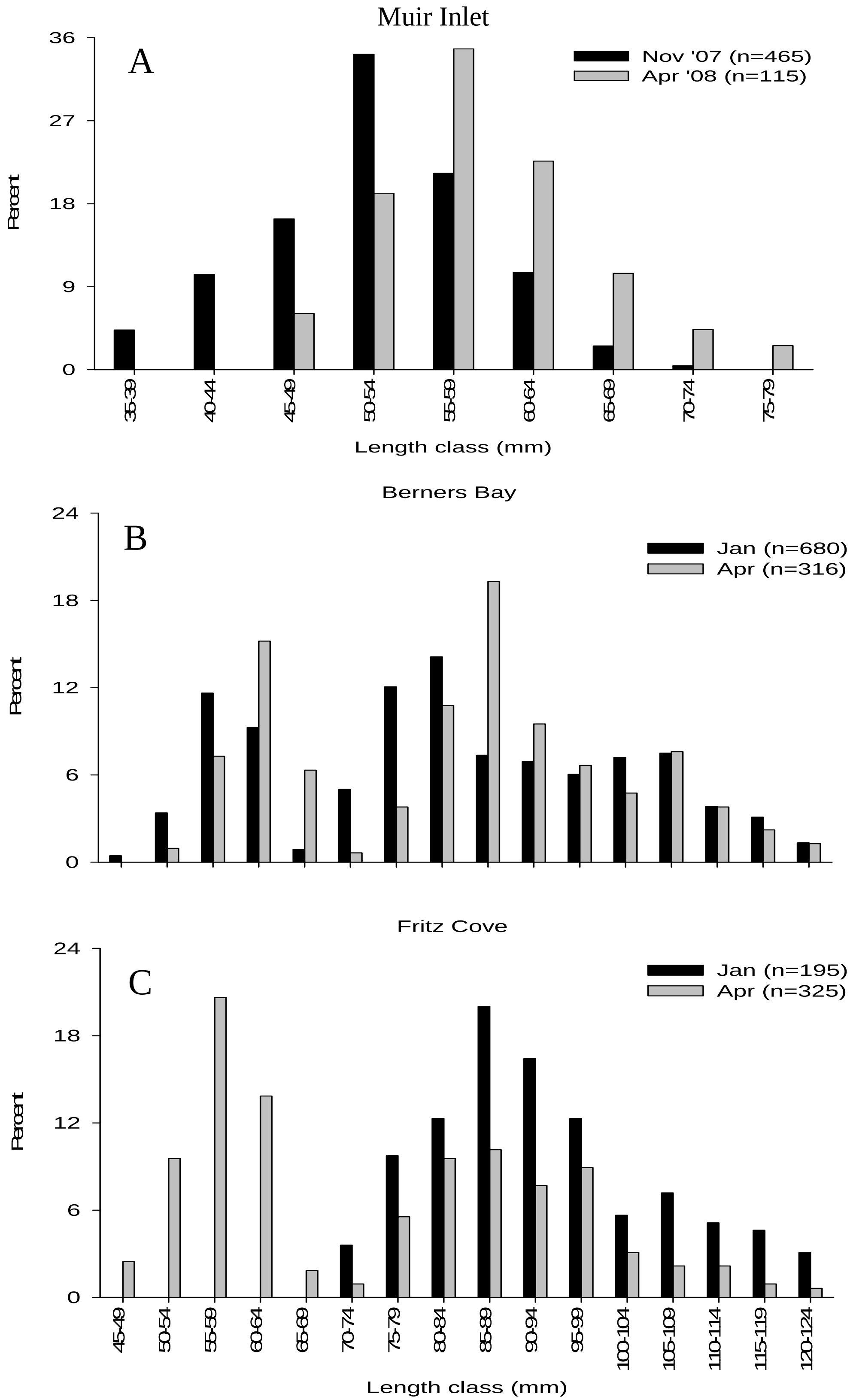


Figure 1. Shift in size distribution of juvenile capelin (A) and eulachon (B & C).

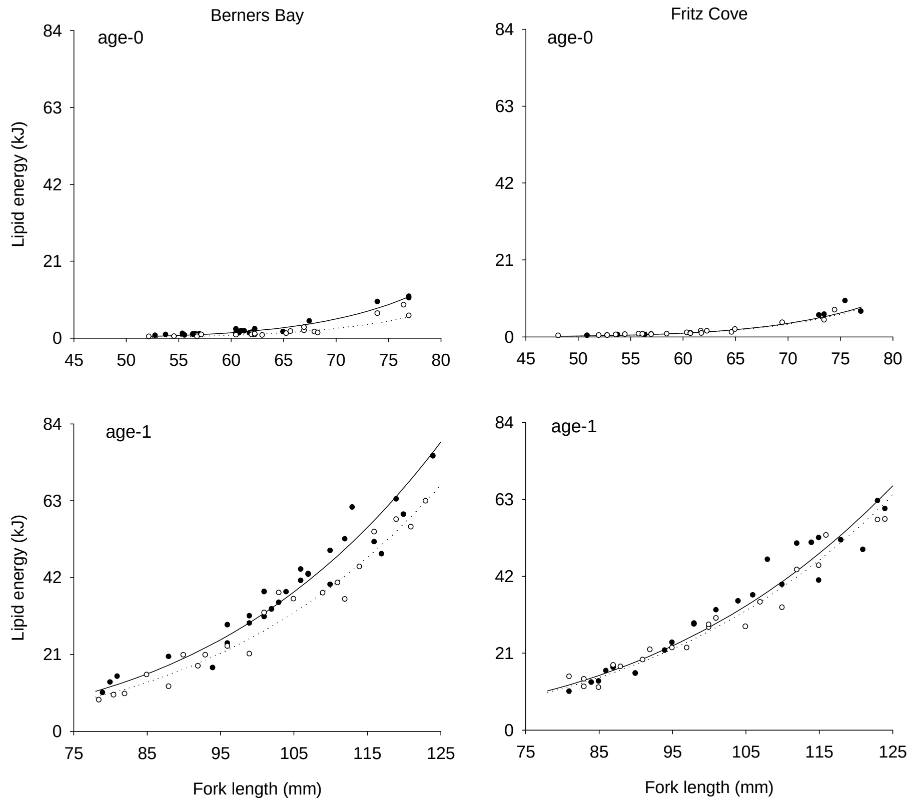


Figure 2. Energy allocated to lipid in age-0 and age-1 eulachon in January (solid circles and lines) and April (open circles and dashed lines) in Berners Bay and Fritz Cove.

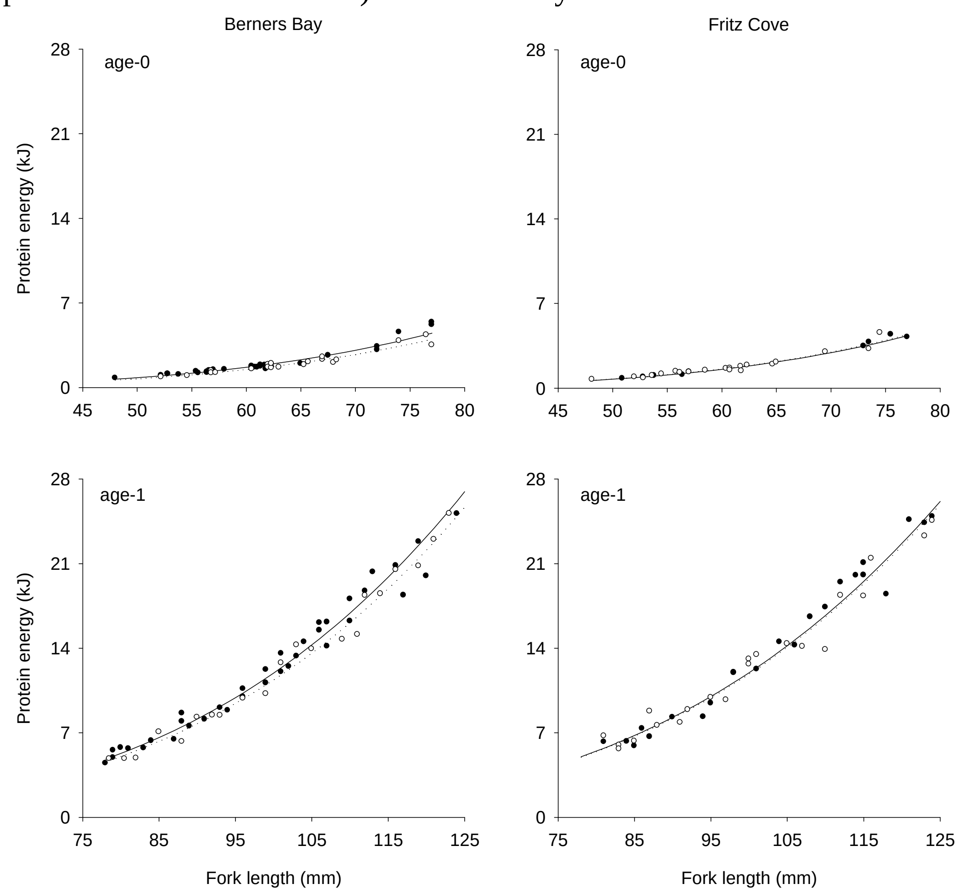


Figure 3. Energy allocated to protein in age-0 and age-1 eulachon in January (solid circles and lines) and April (open circles and dashed lines) in Berners Bay and Fritz Cove.

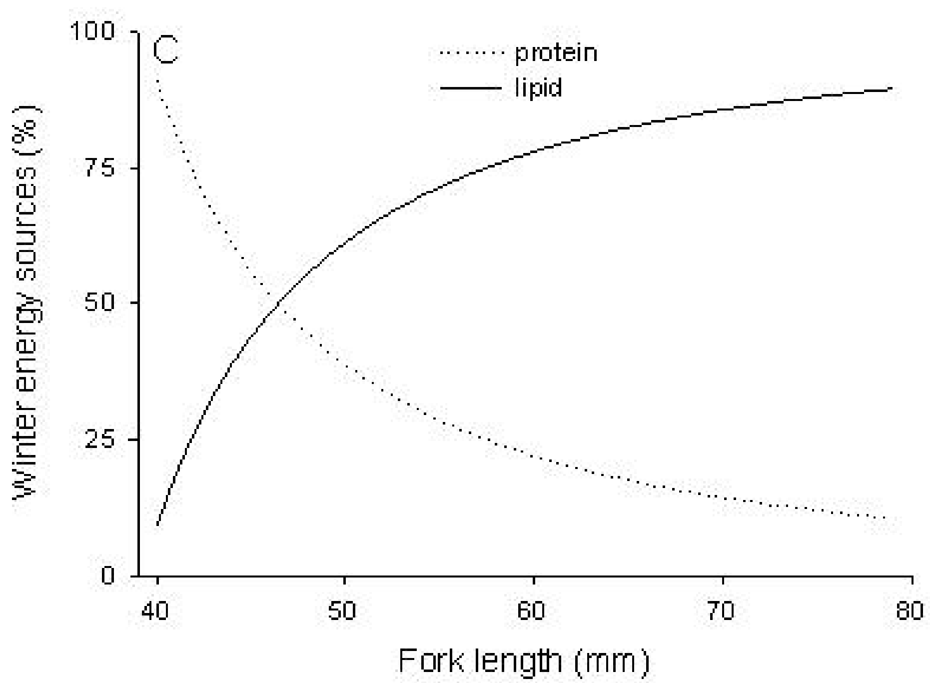


Figure 4. Modeled relationships between capelin fork length and the relative contribution of lipid and protein energy to the winter energy deficit.

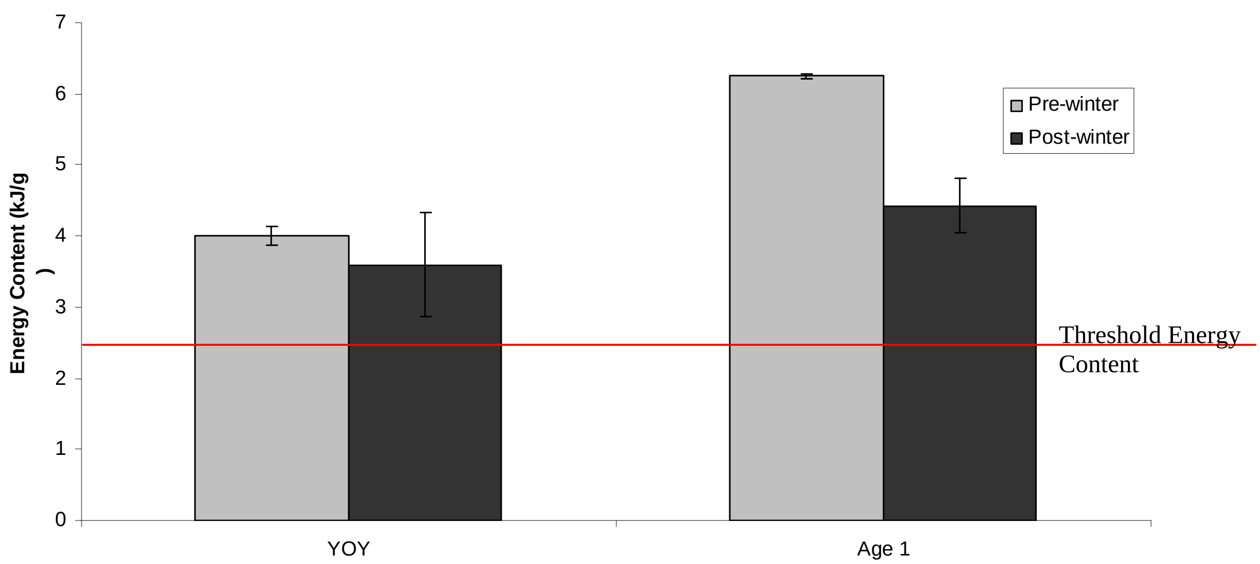


Figure 5. Overwinter energy loss (kJ g^{-1}) of juvenile capelin. Red line denotes the threshold energy content below which mortality occurs.

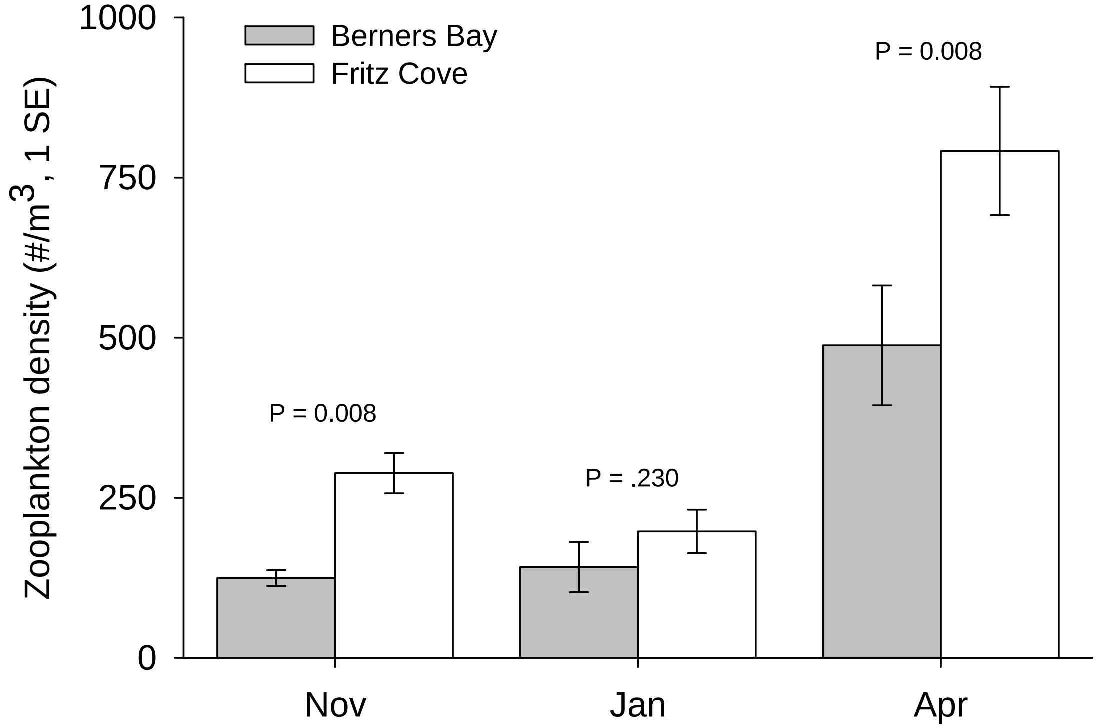


Figure 6. Zooplankton abundance in Berners Bay and Fritz Cove during winter 2006/2007. P-values are from Mann-Whitney U tests.

Essential Fish Habitat project status report

Reporting date: September 17, 2009

Project number: 2008-07

Title: Rockfish abundance and diurnal habitat associations on isolated rocky habitat in the eastern Bering Sea

PIs: Gerald R. Hoff, Chris Rooper

Funding year: 2008

Funding amount: $90,850

Status: ☒ Complete ☐ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete: June 2009

Reporting: Have the project results been reported? Yes
If yes, where were the results reported?

Rooper, C.N., G.R. Hoff, and A. DeRobertis (in review) Assessing habitat utilization and rockfish biomass on an isolated rocky ridge using acoustics and stereo image analysis. Canadian Journal of Fisheries and Aquatic Sciences

Results: What is the most important result of the study?

During July 11-17 of 2008 a study was conducted aboard the FV/*Vesteraalen* on two unique rocky ridge habitats in the southern Zhemchug Canyon region. Acoustic data for biomass estimates as well as bottom topography and substrate type were collected along transects on each ridge using an EK60 single beam (38 kHz) echosounder during daylight hours and during nighttime hours. A stereo-video drop camera system was used to collect species and length composition data on fish and invertebrate species and their habitat associations at 15 transects.

EK60 transects conducted during daylight and nighttime hours along the same tracklines showed adult fish and larger juveniles were in the water column during the daylight hours and on bottom during nighttime. Video analysis from camera drops concurred by showing rockfish to be predominantly benthic during night, when fish were observed lying directly on the bottom and not visible to hydroacoustic methods. During daylight hours fish were demersal to pelagic forming large active schools above the bottom shown both by EK60 and video analysis. The distribution of rockfish on the ridges showed that while in the water column they were observed primarily on the southern side of the two ridges and found predominantly over the ridges in contrast to an adjacent flat sandy area.

Hydroacoustic and video data showed the rocky ridges to be highly productive as rockfish habitat and the ridges possessed an abundance of HAPC species such as coral and sponges, unlike the surrounding eastern Bering Sea slope habitat. We estimated 15,447 t of adult rockfish (predominantly northern rockfish) and 916 t of juvenile rockfish (predominantly POP). This is a much larger biomass of northern rockfish than has previously been estimated for the eastern Bering Sea shelf or slope. This research produced a habitat-based biomass estimate for fishes in an untrawlable area using acoustics as the primary tool for measuring fish biomass and stereo video for estimating both species composition and fish length.

Essential Fish Habitat project status report

Reporting date: 10/31/09

Project number: 2008-08

Title: Characterization of Benthic Infauna Community for Modeling Essential Fish Habitat in the Eastern Bering Sea

PIs: Cynthia Yeung, Mei-Sun Yang, Robert McConnaughey

Funding year: 2008

Funding amount: $66,500

Status: ☒ Complete ☐ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete:

Benthic sampling and stomach collection were the two requisite field elements in this project. Benthic sampling planned for this project was not completed in 2008 because the designated research vessel, the NOAA ship *Fairweather*, was unable to sail on schedule. Only 3 of 31 planned benthic stations were sampled in the single working sea-day salvaged. Stomach collection was completed in August 2008 as a special project on the annual eastern Bering Sea (EBS) bottom-trawl survey. Missing the benthic samples, the objective of investigating the spatial correspondence among fish diet, infauna community and sediment properties was not achievable.

All research elements of this roject were instead put into a new EFH project that was funded in 2009 (EFH Project No. 6: Characterization of Benthic Infauna Community for Modeling Essential Fish Habitat in the Eastern Bering Sea - Reduced plan, $77,800). This project is therefore considered complete. Funds originally for processing stomach, sediment, and infauna samples in this project were applied to the new project. A separate project status report is submitted for the new project.

Reporting: Have the project results been reported? If yes, where were the results reported?

No.

Results: What is the most important result of the study?

One of three passes on one of six planned acoustic transects and three of 31 planned grab stations were sampled in this project (Fig. 1). We requested the collection of 15 stomachs per fish species (6) per station at 27 of the 31 planned infauna and sediment grab stations (Fig. 1) on the 2008 EBS bottom trawl survey (total stomachs requested=1620). If possible, the 15 stomachs for each species were to be obtained from three length classes (<20 cm, 20-40 cm, >40 cm) in equal numbers (5 from each class). Collection was not requested at all 31 stations because effort was a concern. Actual numbers obtained were: 229 Alaska plaice (AKP); 260 yellowfin sole (YFS); 286 northern rock sole; 215 flathead sole (FHS); 70 long head dab (LHD); 10 spinyhead sculpin (SHS); (total stomachs collected=1,070). The number of stomachs collected from target groundfish species at each grab station is given in Table 1.

Without a concurrent set of sediment and infauna data to correlate with the stomach data, it was agreed by the EFH program and grantees that the processing of the stomach samples should be postponed indefinitely. Instead, those 2008 funds for processing stomach samples should be applied to the new project in 2009, when concurrent sets of stomach and benthic data would be collected. Likewise, the 3 infauna samples and the chemistry of the 3 sediment samples were not analyzed in order to redirect funds to 2009, when the complete set of 31 grab samples would be collected. However, granulometric analysis of the 3 sediment samples has been completed (Table 1). These would serve as replicates for analyzing the spatial-temporal variability of granulometry in the vicinity of those 3 stations.

Table 1. Classification of sediments collected in July-August 2008 with van Veen grab on the NOAA ship *Fairweather*, and the corresponding numbers and species of stomach samples collected in the same period during the bottom trawl survey on FV *Arcturus* and *Aldebaran*.

Sediment							Stomachs						
station	lat	lon	type	%gravel	%sand	%mud	station	LHD	AKP	NRS	YFS	FHS	SHS
A02	55.00	166.95	SM	0.0	48.8	51.2	A02	0	0	0	0	15	11
X10*	56.44	164.44	MS	0.0	62.5	37.5	E06	0	2	15	10	0	0
F07	56.67	164.00	MS	0.0	59.8	40.2	F07	0	15	15	15	0	0

*~17 km (~9 nmi) NE of E06 in same trawl cell; see Fig. 1
type – SM=sandy mud; MS=muddy sand

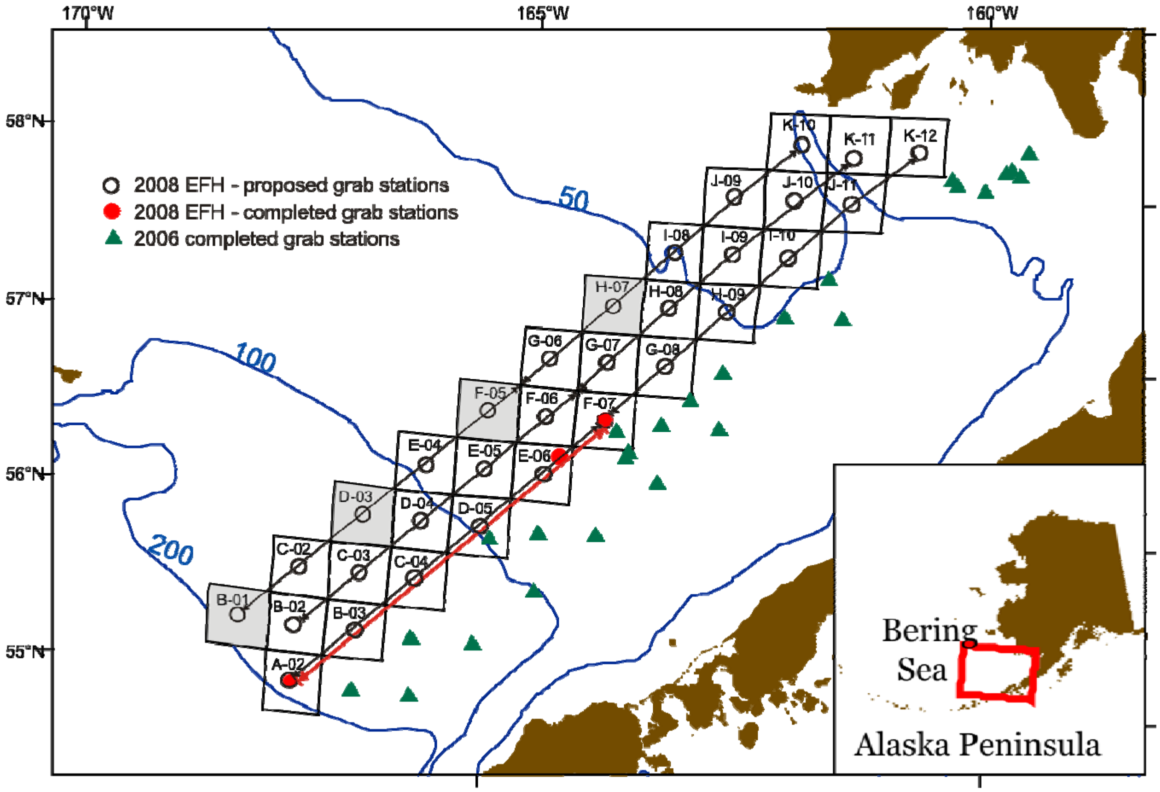


Figure 1. Map of EBS study area proposed in the 2008 EFH project, and the trawl survey grid cells involved. Solid black lines represent acoustic transects proposed in the project; solid red line represents the one actually completed. Stomachs were collected at all trawl stations, except ones in the shaded cells.

Essential Fish Habitat project status report

Reporting date: 10/29/09

Project number: 2008-9

Title: Juvenile Slope Rockfish Habitat Utilization

PIs: Pat Malecha, Andy Gray, Chris Lunsford, Dave Clausen

Funding year: 2008

Funding amount: $93,300

Status: ☐ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete: Habitat preference and predator trials were completed in January, February, and March of 2009. A draft manuscript shall be completed by summer/fall 2010.

Reporting: No reporting has occurred yet.

Results: Surface trawling (up to 60 nautical miles offshore) with an aquarium codend (livebox) successfully captured over 1200 live juvenile rockfish. Live specimens were transferred to the TSMRI wet laboratory with minimal mortalities. A genetic analysis was completed and identified five distinct rockfish species among the captured specimens. The two most abundant species were Pacific ocean perch and yellowtail rockfish. Great sculpin were acquired near Little Port Walter, transferred to the TSMRI wet laboratory and were used as predators. Suitable observational arrays were obtained and installed in the TSMRI wet laboratory and fish were acclimated to a modified photoperiod. Habitat preference and predation trials were completed in March 2009. Data analyses are currently underway.

Essential Fish Habitat project status report

Reporting date: 10/29/09

Project number: 2009-1

Title: Recovery of deep water sponges and sea whips from bottom trawling

PIs: Pat Malecha, Jon Heifetz

Funding year: 2009

Funding amount: $105,900

Status: ☐ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete: Video processing from submersible transects will be completed during the winter and spring of 2009/2010. A draft manuscript shall be completed by fall 2010.

Reporting: No reporting has occurred yet.

Results: In 1996, Freese et al. observed the immediate effects of trawling on sponges and other invertebrates near Salisbury Sound. At that time, trawl paths and submersible transects were marked on the seafloor with flags attached to fiberglass stalks. Thirteen years later, we successfully relocated 12 of 14 markers and completed 7 transects within trawl paths as well as 7 reference transects outside trawl paths. This data will be used to compare sponge and sea whip disposition in trawled versus reference areas. Additionally, we obtained close-up video of individual sponges both inside and outside the trawl paths to further examine the incidence of injury and the rate of recovery of damaged sponges. In total, we completed 16 dives with the *Delta* submersible. In some areas, trawl evidence, including seafloor gouging, boulder displacement, and sponge damage, was still apparent. Processing of the video transects will be completed during the winter and spring of 2009/2010. The original flags were no longer attached to their fiberglass stalks and the stalks were easily confused with sea whips. In order to facilitate the potential for continued monitoring of seafloor recovery, we deployed new markers that should be easier to find and more durable than the originals.

Invertebrate colonization of PMEL moorings - Progress Report October 31, 2009

Principal Investigators: Mark Zimmermann NMFS, AFSC email: mark.zimmermann@noaa.gov
William Floering OAR PMEL email: william.floering@noaa.gov
Bob Van Syoc, California Academy of Sciences email: bvansyoc@calacademy.org
Phyllis Stabeno, OAR PMEL email: phyllis.stabeno@noaa.gov

EFH 2009-02

Incomplete, on schedule.

Due to lack of notification, our successful funding in May, 2009 was only discovered accidentally in August, 2009. Much of August was spent writing and submitting a sole source justification for our partner Bob Van Syoc at the California Academy of Sciences, along with a Statement of Work (SOW), before the 2009 fiscal year deadline.

In October 2009, Bill Floering participated in one of the regular PMEL mooring cruises to recover and redeploy some substrates, as we have been pursuing the project with our own resources for the last few years. Over those years most of the mooring deployments in the Gulf of Alaska (Cross Sound and Shelikof Straight) and Aleutians (Amukta Pass) have been discontinued but the Bering Sea deployments have been continued and are expanding northward.

Horizontal settlement plates with 3M friction tape and fiberglass cloth were deployed at 4 Bering Sea sites (along the 70 m depth contour) and Slime Bank in April or May 2009. Three of the Bering Sea mooring plates were recovered without any damage or problems, but, because of lack of obvious colonization, the samples were not collected. On the fourth Bering Sea mooring substrate the fiberglass cloth was completely unwoven and torn apart, perhaps due to some mechanical action, fishing gear interaction or other unknown cause. These four Bering Sea moorings were redeployed with fiberglass and high-density plastic substrates. The mooring at Slime Bank in the southern Bering Sea was accidentally trawled up by a fisherman and left onshore in Dutch Harbor.

A fiberglass cloth substrate, mounted vertically on the release mechanism, was deployed at Pavlof Bay mooring in September 2008. It was recovered intact, preserved in ethanol and will be shipped to Bob VanSyoc at the California Academy of Sciences for analysis in late October/early November, 2009. This mooring was redeployed with a fiberglass cloth and a high-density plastic substrate.

The next mooring cruise will probably occur in the spring of 2010.

Essential Fish Habitat project status report

Reporting date: 10/29/09

Project number: 2009-3

Title: Recruitment and response to damage of an Alaskan gorgonian coral

PIs: Pat Malecha, Robert Stone

Funding year: 2009

Funding amount: $38,000

Status: ☐ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete: This is a multi-year study that requires additional site visits and observations. Field operations are scheduled to finish May 2011. Laboratory analysis of settlement substrata will be completed by June 2011. Video processing from scuba observations will be completed by September 2011. A draft manuscript shall be completed by December 2011.

Reporting: No reporting has occurred yet.

Results: In August 2009, a team of four divers located and tagged 48 *Calcigorgia spiculifera* colonies in Kelp Bay, Southeast Alaska. Of that total, 9 colonies were fitted with settlement rings equipped with natural rock tiles. The settlement rings were epoxied to the seafloor and on future site visits, a subsample of the tiles will be collected and inspected for adhesion of coral planulae, i.e., recruitment. The remaining 39 tagged colonies were ascribed to three damage treatment groups and a control group to assess the sensitivity and recovery of disturbed coral. The damage treatments were designed to mimic actual damage that can occur from passing fishing gear. These treatments were performed *in situ* and included deflection, gorgonin excision, and branch severance. Video of each colony was recorded before and after the treatments were performed to establish baseline coral characteristics and to identify immediate treatment effects. The deflection treatment was completed by passing a simulated trawl footrope over each colony. This resulted in immediate dislodgement of one coral colony. Subsequent monitoring of the damaged corals will detail the long-term effects of disturbance.

Essential Fish Habitat project status report

Reporting date: 9/1/09

Project number: 2009-04

Title: Nearshore Fish Assemblages in the Arctic: Establishment of Monitoring Sites in a Rapidly Changing Environment from Energy Development and Climate Change

PIs: Johnson and Thedinga

Funding year: 2009

Funding amount: $65K

Status: ☐ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete: 9/10

Reporting: Have the project results been reported? If yes, state where the results were reported and attach an electronic copy of the report. No.

Results: What is the most important result of the study?

1. NOAA Fisheries Essential Fish Habitat (EFH) funds and the North Slope Borough have supported the continuation of Arctic studies to help establish a baseline of nearshore fish assemblages near Barrow. Fish are collected with a beach seine and a bottom trawl, and environmental data including water temperature and salinity are recorded annually during summer at eight baseline sites in the Chukchi and Beaufort seas. Over 20 fish species have been identified to date; the two most abundant are capelin (*Mallotus villosus*) and Arctic cod (*Boreogadus saida*). Changing ice conditions in the Arctic will likely affect the distribution and abundance of nearshore fishes; a northward expansion of species is expected as ocean temperatures warm and sea ice retreats. Thus, additional sampling of our nearshore sites is needed to establish a robust baseline for long-term monitoring of fish use in the nearshore Chukchi Sea related to climate change. All fish catch data from our Arctic sampling has been added to an online database (www.fakr.noaa.gov/habitat/fishatlas) and is available to resource managers and the public. A peer-review manuscript will be prepared by 9/10.

Essential Fish Habitat project status report

Reporting date: Oct. 29, 2009

Project number: 2008-03, 2009-05

Title: Contrasting predation intensity and distribution in 2 rock sole nursery areas: a principle factor controlling nursery productivity - Component A: Contrasting predation.

PIs: Ryer, Laurel, Knoth

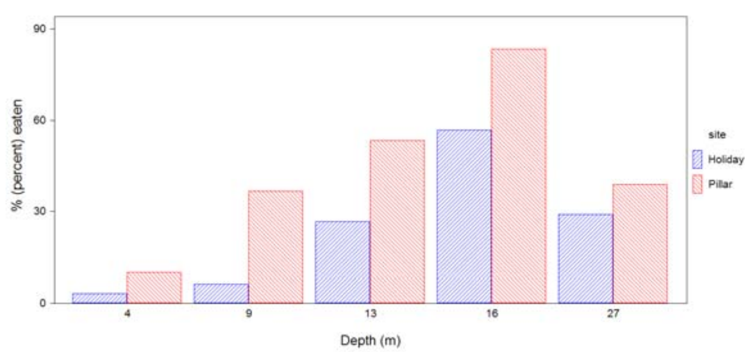
Funding year: 2009

Funding amount: $20,000

Status: ☒ Complete ☐ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete:

Reporting: Have the project results been reported? If yes, state where the results were reported and attach an electronic copy of the report. Thus far, one manuscript derived from this project has been submitted for publication to Marine Ecology Progress Series (see attached manuscript). We anticipate submitting either 3 or 4 additional manuscripts, supported in part by this and prior HEPR funding, during the course of the next 24 months.



Results: What is the most important result of the study? As in 2008, worm turf constituted a dominant habitat feature at Pillar Creek Cove, and to a lesser extent at Holiday Beach. However, unlike 2008, when the turf was extremely dense and contiguous, during 2009 the turf was less dense and more patchy. In 2008, fish were aggregated along the edge of the turf. In 2009 fish were most abundant within the sand patches within the turf. Tethering (15 min sets) revealed increasing predation risk with increasing depth at both sites. This was particularly evident as depth increased from 4 to 16m. Sixteen m corresponded to the shoreward edge of the worm turf, which then extended out to approximately 50m depth. Importantly, predation decreased significantly at 27m, at depth at which tethers were set in the worm turf proper. These result support one of our principle theories regarding use worm turf habitat by juvenile flatfish; worm turf provides protection from predators, but is avoided when it becomes so dense as to preclude unfettered access to the bottom and interferes with movement and burial.

A second important finding was that predation was uniformly lower at Holiday Beach than at Pillar Creek Cove. These results are consistent with our prediction stated in our original proposal to HEPR for 2008 funding. We had previously documented comparable predation rates at these 2 sites (see attached manuscript). These results suggest that the nursery value of these sites may vary from year to year. The significance of this data may become more clear as video survey data of predator abundance from 2002 – 2009 in completed this winter.

Lastly, as expected, predation upon juvenile flatfish was much lower at night than during the day.

Essential Fish Habitat project status report

Reporting date: Oct. 29, 2009

Project number: 2009-11

Title: Contrasting predation intensity and distribution in 2 rock sole nursery areas: a principle factor controlling nursery productivity - Component B: Monitor worm turf recovery and seasonal changes.

PIs: Ryer, Laurel, Knoth

Funding year: 2009

Funding amount: $13,000

Status: ☐ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete:

Reporting: Have the project results been reported? If yes, state where the results were reported and attach an electronic copy of the report. We anticipate submitting a manuscript for peer-reviewed publication during the next 12 months.

Results: What is the most important result of the study? We are still analyzing video footage. However, disturbance of the worm turf habitat attributable to our simulated bottom trawling activity appears to have been relatively minor compared to the seasonal pattern of benthic disturbance driven by winter storm activity. Initially, scrape marks where worms were removed by our gear were readily evident along our disturbance tracts. Also, consistent with our results from component A, juvenile flatfish abundance increased in these disturbed tracts. However, within several months wave action began to erode away sections of the worm turf, so that by late winter/spring, the formerly contiguous turf had be reduced to a patchwork of turf habitat, and trawl disturbed tracts were no longer recognizably different from control areas. We suspect that excavations attributable to sea stars and/or sea otters constituted initial disturbances, which were subsequently expanded by bottom surge (much in the same way wave action expands small holes in mussel mats caused by log impacts in the inter-tidal). We will finish data analysis in the next 6 months and anticipate submitting a manuscript this year.

Essential Fish Habitat project status report

Reporting date: 10/31/09

Project number: 2009-06

Title: Characterization of Benthic Infauna Community for Modeling Essential Fish Habitat in the Eastern Bering Sea - Reduced Plan

PIs: Yeung, C, Yang, M.-S., McConnaughey, R.A.

Funding year: 2009

Funding amount: $77,800

Status: ☐ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete:

The precursor of this project was the EFH project under the same title funded in 2008 (Project No. 8: Characterization of Benthic Infauna Community for Modeling Essential Fish Habitat in the Eastern Bering Sea, $66,500). The preceding project was defunct because the designated research vessel, the NOAA ship *Fairweather,* was unable to sail on schedule. This project replaces the 2008 project, with essentially the same sampling plan and objectives of building a knowledge base and spatial maps of benthic infauna communities and sediment characteristics in the eastern Bering Sea (EBS), and generating input variables to advance habitat modeling. The 2008 project is considered complete, and a separate status report is submitted.

Field sampling for this project was successfully completed in August 2009. Infauna, sediment, and stomach processing is in progress, on schedule and due to be completed by July 2010. Data analysis, reporting, and manuscript preparation is due to be completed by October 2010.

Reporting: Have the project results been reported? If yes, state where the results were reported and attach an electronic copy of the report.

No.

Results: What is the most important result of the study?

Grab sampling for this project was conducted on the NOAA ship *Fairweather* (Jul 27 - Aug 5, 2009) along cross-shelf transects. One sediment and 1 infauna sample were collected with a 0.1-m^2 benthic grab at each of 31 standard stations of the annual EBS bottom-trawl survey (Fig. 1). These stations are approximately 40 km apart along the north-south or the east-west axis. Two hull-mounted multibeam echosounders (50 and

100 kHz, respectively) acquired bathymetry and backscatter while the ship was underway.

Three sets of 3 stations were also sampled, to investigate habitat variability on a spatial scale finer than that between standard trawl stations (Fig. 1). Each set consists of 3 benthic grab stations located respectively on the inner shelf (depth: <50 m; grainsize: coarse), the middle shelf (>50-100 m; medium), and the outer shelf (>100-200 m; fine) (Fig. 1). The 3 stations in each set are placed equidistant (~13 km) along a line whose end points are two trawl stations that are adjacent to each other (~52 km apart) along the cross-shelf transect.

Granulometric analysis of sediment samples has been completed. Chemical analyses of sediment samples (chl-a, TN, TOC, TP, and CN isotopes) and processing of infauna samples (identification, counts, wet-weights) are currently in progress.

Stomachs of targeted groundfish species that are benthic-feeders (longhead dab *Limanda proboscidea*, flathead sole *Hippoglossoides elassodon*, northern rock sole *Lepidopsetta polyxystra*, yellowfin sole *Limanda aspera*, Alaska plaice *Pleuronectes quadrituberculatus*, spinyhead sculpin *Dasycottus setiger*) were collected for this project on the 2009 EBS bottom trawl survey. We requested 15 stomachs maximum per fish species per station at 27 of the 31 infauna and sediment grab stations (Fig. 1). Collection was not requested at all 31 stations because effort was a concern. If possible, the 15 stomachs for each species were to be collected from 3 length classes (<20 cm, 20-40 cm, >40 cm) in equal numbers (5 from each class). Actual numbers obtained were: 264 Alaska plaice; 263 yellowfin sole; 295 northern rock sole; 231 flathead sole; 32 long head dab; 80 spinyhead sculpin (total stomachs collected=1165) (Table 1). Length class distributions of the fish by species are being determined. Stomach content analysis is in progress.

Sediment properties and benthic infauna community are defining habitat characteristics for benthic-feeding groundfish species. Infauna compose a significant portion of their diets, and surficial sediment properties are the main structuring force of infauna communities. The usefulness of infauna and sediment properties as indicators of EFH will be tested through the spatial correspondence among fish distributions, infauna assemblages, and sediment properties. Direct evidence of fish and habitat linkages will also be deliberated through the correspondence between stomach contents of the fishes and infauna assemblages in the habitats. Multivariate ordination analyses as well as regression-type modeling will be used.

Table 1. Number of stomachs collected by species at each designated station in 2009.

Vessel	Haul	Station	LHD	AKP	NRS	YFS	FHS	SHS	Total
Aldebaran	18	J11	2	15	15	15	0	0	47
Aldebaran	19	J10	1	15	15	15	0	0	46
Aldebaran	21	J9	0	15	15	15	0	0	45
Aldebaran	22	I9	0	15	15	15	0	0	45
Aldebaran	23	H9	0	12	15	15	1	0	43
Aldebaran	35	G9	0	15	15	15	10	0	55
Aldebaran	51	D5	0	0	15	0	15	0	30
Aldebaran	55	C4	0	0	0	0	15	15	30
Aldebaran	56	D4	0	0	0	0	15	15	30
Aldebaran	57	E4	0	12	15	0	15	0	42
Aldebaran	70	C3	0	0	0	0	15	6	21
Aldebaran	73	A2	0	0	0	0	15	15	30
Aldebaran	74	B2	0	0	0	0	15	4	19
Arcturus	18	K12	0	11	15	15	0	0	41
Arcturus	19	K11	14	15	15	15	0	0	59
Arcturus	20	K10	15	15	15	15	0	0	60
Arcturus	21	I10	0	15	15	15	1	0	46
Arcturus	35	F7	0	15	10	10	15	0	50
Arcturus	37	G8	0	15	15	15	15	0	60
Arcturus	38	H8	0	15	15	15	0	0	45
Arcturus	39	I8	0	15	15	15	2	0	47
Arcturus	52	G6	0	12	15	15	5	0	47
Arcturus	55	F6	0	15	15	15	15	0	60
Arcturus	56	E6	0	9	15	15	17	2	58
Arcturus	57	E5	0	13	15	13	15	0	56
Arcturus	76	C2	0	0	0	0	15	15	30
Arcturus	80	B3	0	0	0	0	15	8	23
Total			32	264	295	263	231	80	1165

LHD, Long Head Dab; AKP, Alaska Plaice; NRS, Northern Rock Sole
YFS, Yellowfin Sole; FHS, Flathead Sole; SHS, Spinyhead Sculpin

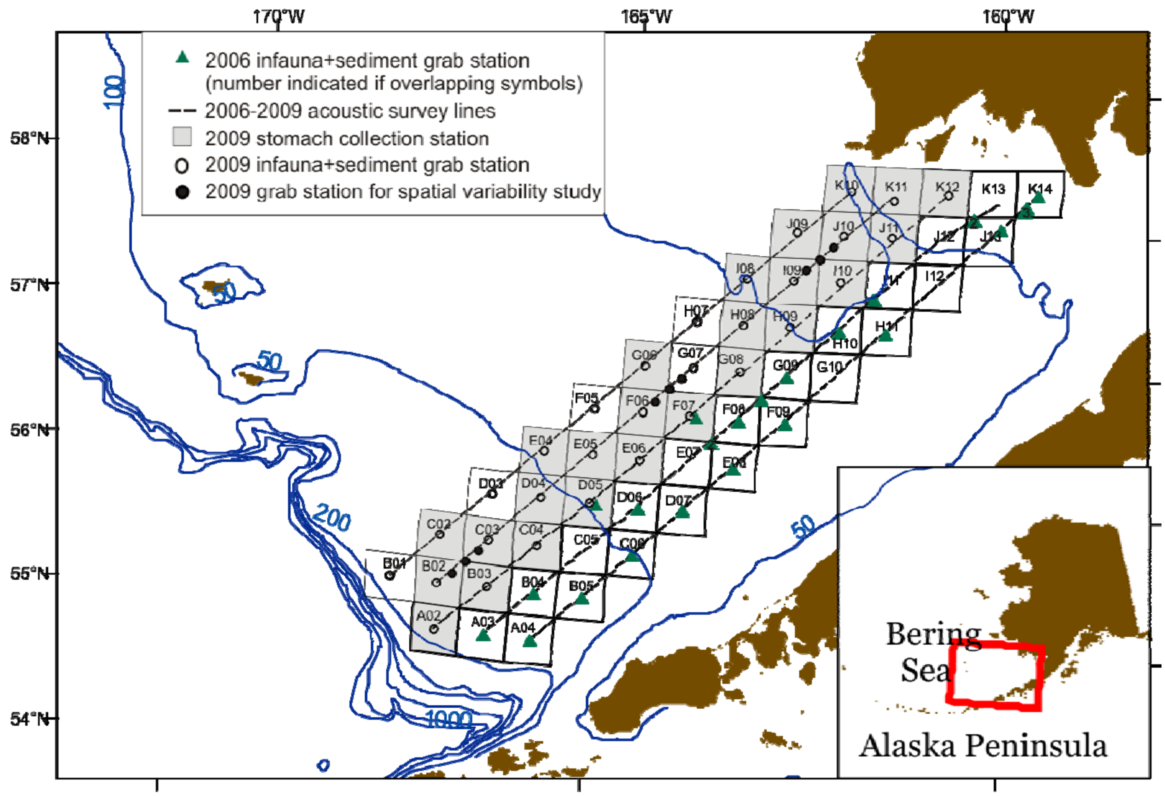


Figure 1. Sampling stations in this project (2009) and previous projects (2006-2008) in the southeastern Bering Sea.

Essential Fish Habitat project status report

Reporting date: October 5, 2009

Project number: 2009-07

Title: Assessing the physical and temporal aspects of spawning pollock habitat utilization in Shelikof Strait, Gulf of Alaska (Year 2)

PIs: Kevin Bailey and Kung-sik Chan

Funding year: 2009

Funding amount: $34,446

Status: ☐ Complete x☐ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete: July 2010.

Reporting: Yes, results have been reported. A copy of a manuscript published in Marine Ecology Progress series is attached. The remainder of the time remaining on the contract will be utilized in refining the model on timing of occupation of spawning habitat using the hatchdate distribution and final preparation of a manuscript.

Results: We used a general additive model to show that the spatial extent of occupation of spawning habitat as reflected by egg distribution is influenced by biological and harvest related parameters and by environmental factors. As spawning biomass declines, the egg distribution shrinks at its periphery. Increasing transport results in a dislocation of eggs, and increasing temperature is related to an expansion of egg distribution further up Shelikof Strait.

Essential Fish Habitat project status report

Reporting date: 10/21/2009

Project number: 2009-08

Title: Productivity, habitat utilization and recruitment dynamics of Pacific cod

PIs: Laurel, Ryer, Stoner, Knoth, Parrish, Urban

Funding year: 2009

Funding amount: $41,600

Status: ☐ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete: October 2010

Reporting: Project has not yet been fully reported. Partial results and details are found in:

Results: What is the most important result of the study?

1) Age-3 cod were observed on the baited camera for the first time, suggesting high survival from abundant 2006 year class.
2) Fatty acid (FA) biomarker experiments were successfully completed using both juvenile Pacific cod and walleye pollock. Experiments were conducted at two temperatures using both a marine and terrestrial signal. See figure 1 showing the partial analysis for juvenile Pacific cod. Results will be fully available by the end of 2009, but preliminary data indicate that biomarkers are clearly observed in the different tissues. We were pleased to see that the FA biomarkers were temperature and tissue dependent as it will allow us to potentially temporally assign juvenile cod to coastal nursery habitats if a terrestrial signal is detected in their tissue.
3) Stomachs from age 1+ Pacific and saffron cod were also collected and frozen for the ongoing examination of cannibalism in these species. Three years of stomach data are now collected and archived at the KFRC.

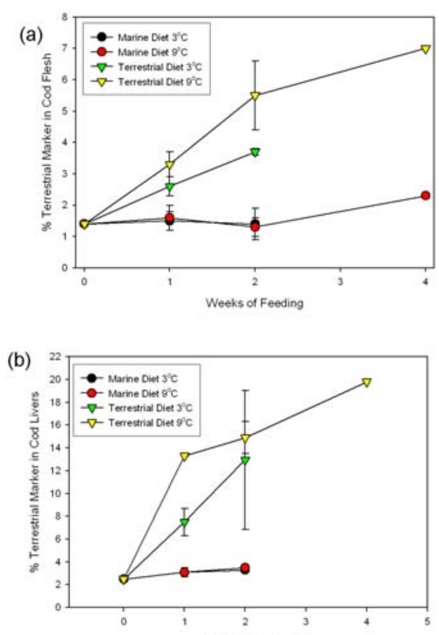


Figure 1: Percent uptake of terrestrial FA biomarkers into the a) flesh and b) liver of juvenile cod at two temperatures. Remaining data (e.g., wk 3-6 and heart tissue) will be available in Nov 2009.

Essential Fish Habitat project status report

Reporting date: 9/8/09

Project number: 2009-09

Title: Characterize habitat utilization and productivity for rockfish species

PIs: Rooper, Heintz, Aydin, Boldt

Funding year:FY09

Funding amount: $23,200

Status: ☐ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete: 12/31/09

Reporting: No

Results:

During 2009, laboratory analyses were conducted on juvenile Pacific ocean perch (POP; *Sebastes alutus*) collected from two sites near the Islands of Four Mountains during 2007 and 2008. These analyses were conducted to determine the condition of fish from length-weight residuals, the stomach fullness, the stomach contents (taxa in terms of weight and number), and the energetic content of the whole animal tissue. Analysis was also conducted on zooplankton samples collected in 2007 and 2008 to determine the amount and taxa of zooplankton available to the juvenile POP. Analysis of otoliths from the juvenile POP is anticipated to be completed this fall. In total, these data will be combined with data collected in 2003 and 2004 to determine growth potential for juvenile POP in nursery habitats at the Islands of Four Mountains. Eventually this will be expanded to the entire Gulf of Alaska to estimate the value of habitat for juvenile POP in terms of growth potential. These analyses are expected to be completed in early 2010 and will culminate in a manuscript describing the results.

Essential Fish Habitat project status report

Reporting date: October 2009

Project number: FY09-10

Title: Natural and man-made disturbance of eelgrass beds in northern southeastern Alaska: damage and recovery

PIs: Patricia Harris

Funding year: FY09

Funding amount: 8K

Status: ☐ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete: Sept. 2010

Reporting: Preliminary results will reported on a poster presented at CERF (Coastal and Estuarine Research Federation) meeting Nov. 2009

Results: In 2009, we resampled eelgrass *(Zostera marina)* beds at three undeveloped eelgrass beds (Funter Bay, Crab Bay, and Bridget Cove) and two developed beds (Auke Nu Cove and Bay Creek) to examine changes in eelgrass characteristics and associated fish assemblages.

Bed areas did not change from those in 2008 except at Auke Nu Cove where the bed was reduced by 10% in 2009. In addition, several inches of soft sediments accumulated over the eastern portion of the Auke Nu bed and altered drainage patterns caused some erosion of the existing bed.

Eelgrass density, biomass, and cover at Auke Nu and Bay Creek, significantly reduced in 2008, recovered to baseline levels in 2009. Similarly, the bed at Crab Bay showed some recovery in 2009, but density, biomass, and cover were still below baseline values. The southern end of Bridget Cove bed showed signs of erosion and reduced biomass and cover in 2009. Biomass and density at Funter Bay was unchanged both in 2008 and 2009 compared with the baseline.

Total fish catch was not correlated with eelgrass characteristics except where eelgrass density and biomass significantly declined (Crab Bay in 2008 and western Auke Nu Cove in 2009) suggesting a critical eelgrass density for good fish habitat. Although overall catch was similar to that in the baseline years at Auke Nu, catch in the western portion of the bed that became bare in 2009 was reduced by 78% over base catches. Catch composition changed as well at western Auke Nu; staghorn sculpin became proportionately more numerous and tubesnout less. Although fish catch at Crab Bay recovered to baseline levels in 2009, resident species that were common in baseline years (e.g. 3-spined stickleback and snake prickleback) remained proportionately few. A large catch of Pacific herring (n = 3655) at Bridget Cove dominated the catch, making the catch 400% larger than baseline. Catch of resident species may be the best indicator of habitat change.

In addition to the beds discussed above, we sampled a bed at Hawk Inlet and mapped the linear extent of several other beds in the inlet.

Monitoring will continue in 2010, but EFH funds will not be requested.

Essential Fish Habitat project status report

Reporting date: Oct. 29, 2009

Project number: 2009-11

Title: Contrasting predation intensity and distribution in 2 rock sole nursery areas: a principle factor controlling nursery productivity - Component B: Monitor worm turf recovery and seasonal changes.

PIs: Ryer, Laurel, Knoth

Funding year: 2009

Funding amount: $13,000

Status: ☐ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete:

Reporting: Have the project results been reported? If yes, state where the results were reported and attach an electronic copy of the report. We anticipate submitting a manuscript for peer-reviewed publication during the next 12 months.

Results: What is the most important result of the study? We are still analyzing video footage. However, disturbance of the worm turf habitat attributable to our simulated bottom trawling activity appears to have been relatively minor compared to the seasonal pattern of benthic disturbance driven by winter storm activity. Initially, scrape marks where worms were removed by our gear were readily evident along our disturbance tracts. Also, consistent with our results from component A, juvenile flatfish abundance increased in these disturbed tracts. However, within several months wave action began to erode away sections of the worm turf, so that by late winter/spring, the formerly contiguous turf had be reduced to a patchwork of turf habitat, and trawl disturbed tracts were no longer recognizably different from control areas. We suspect that excavations attributable to sea stars and/or sea otters constituted initial disturbances, which were subsequently expanded by bottom surge (much in the same way wave action expands small holes in mussel mats caused by log impacts in the inter-tidal). We will finish data analysis in the next 6 months and anticipate submitting a manuscript this year.

Essential Fish Habitat project status report

Reporting date: October 31, 2009

Project number: 2009-12

Title: Utilization of nearshore habitat by fishes in Nushagak and Togiak Bays (Bristol Bay)

PI: Olav A. Ormseth (AFSC/REFM)

Funding year: 2009

Funding amount: $68,000

Status: ☐ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

Reporting: Have the project results been reported?

Project results have not been reported.

Results: What is the most important result of the study?

Project overview

The data gathered during this project have not been analyzed, so the following is only a brief summary of preliminary results. The project consisted of a nearshore fish, invertebrate, and habitat study in northern Bristol Bay (Fig. 1). For the survey, I chartered a 32-ft. gillnet vessel, the F/V *Willow*. A 20-ft. aluminum skiff with 90-hp. motor was leased from a Dillingham resident. The survey was staged out of Dillingham, Alaska (Fig. 2) and took place from July 26-August 8, 2009. During July 26-August 1, 2009 sampling was conducted in Nushagak Bay (Fig. 2). High wind and waves hampered the sampling throughout this entire week and largely determined possible sampling locations (we sampled in the lee of the wind, so sampling depended on wind direction). Two days were completely lost due to weather. August 2 was spent in Dillingham dealing with an injured NOAA crewmember (he was not injured in connection with this project) and finding a suitable replacement volunteer in Dillingham. On August 3 we traveled from Dillingham to the west side of the Nushagak Peninsula (Fig. 2) and from August 4-8 sampling was conducted along the Nushagak Peninsula and in Kulukak, Nunavachak, Ungalikthluk, and Togiak Bays (Fig. 2). During most of this time we experienced high winds but they did not hamper the sampling to the same degree as in the Nushagak. On August 8 we traveled back to Dillingham.

The main gear types used during the survey were a beach seine and a bottom beam trawl (Fig. 3). Hydroacoustic transects were attempted in Nushagak Bay but that effort was abandoned for several reasons, including excessive noise due to the extreme shallowness of the water and interference from the vessel's echosounder. Similarly, attempts to deploy a plankton sampling net were rendered unsuccessful due to extremely high tidal currents. A surface pair trawl (towed by the vessel and the skiff) was deployed in one location in Togiak Bay. This haul was successful, but because a great deal of time was required to rearrange the deck and change lines and gear we did not subsequently use this gear. Using all of these gear types, we sampled from the shoreline to 17 m depth, as well as surface waters ~1 km from the shoreline. Catches were sorted to species, enumerated, and when possible weighed using spring scales. To the extent possible, captured specimens were kept and released alive using tubs, buckets, and aerators. Length measurements were taken for most species. Voucher specimens were preserved in 10% formalin for confirmation of species identification. A small number of samples were frozen for age and energetics analysis . Photographs were taken of most species.

Small, datalogging conductivity-temperature-depth recorders (CTDs) were deployed on the trawl gear and also placed on moorings several locations (Fig. 2). In Nushagak Bay, we deployed four such CTDs at different locations throughout the bay (Fig. 2) and left them there for a 24-hour period in order to study fluctuations in temperature and salinity over two tidal cycles. We also recorded habitat variables at beach seine sites according to the methodology used in the Nearshore Fish Atlas of Alaska (I collaborated with the designers of the Atlas in designing this study).

Preliminary results

1) Despite the weather we completed 20 bottom trawl hauls, 17 beach seine hauls, and one surface trawl (Fig. 2). Over 40 fish and invertebrate species were encountered during the survey (Table 1). Most of the captured individuals were small (20 cm or less).
2) Shrimps of the family Crangonidae (Fig. 4) and rainbow smelt *Osmerus mordax* (Fig. 5) were the most abundant and ubiquitous species encountered, occurring in almost every trawl and seine haul. The dominance of these individuals in catches was especially high in very shallow water and mud/silt bottoms.
3) Rainbow smelts appeared to be much less hardy than capelin. The mortality rate of rainbow smelt was near 100%, while we were able to release many capelin alive.
4) I had originally hypothesized that fish and invertebrate communities would be very different between Nushagak Bay and the waters west of the Nushagak Peninsula, due to differences in topography and hydrography. Surprisingly, this was not the case. Instead, there was a gradual change in species composition as we moved west. This result may be due to the similarity in habitat between Nushagak Bay and the Kulukak Bay area (Fig. 2), consisting mainly of shallow waters and mud/silt bottoms. As we moved west, sand and rocky bottoms became more common and so did species such as helmet crabs (Fig. 6). One exception to this gradual change was the presence of large numbers of juvenile yellowfin sole in outer Kulukak Bay.
5) A change in species composition was also observed in Nushagak Bay depending on the distance from the bay mouth (Fig. 2). In the outer reaches of the bay sea stars, helmet crabs, and herring were more prevalent than in the inner portion.
6) Nushagak Bay, and particularly the upper bay, experiences substantial variation in salinity over the course of a tidal cycle. The relatively inexpensive CTDs (~$2K each) we purchased proved to be a very useful tool in studying temporal variation in water characteristics.
7) For some species, we encountered different ages in the same location. For example, we frequently encountered a small number of adult rainbow smelt in

8) The vessel and gear types we used in this project proved to be very effective for nearshore sampling. I anticipate performing similar work in the future in the same area and in the Gulf of Alaska. Things I would like to improve include finding a surface/midwater trawl that is easier to deploy and developing a methodology for performing shallow-water acoustic transects. The only drawback of a small vessel turned out to be the limited scientific crew (me and one scientific crewmember). This limited the amount of time and effort that I could devote to each research task. A vessel capable of carrying another crewmember would be an asset.

Table 1. Preliminary list of species and species groups encountered during the nearshore survey.

species encountered during Ormseth EFH study, northern Bristol Bay 2009		
Crangonid shrimp	sea star (several species)	green sea urchin
capelin	helmet crab	king crab (juvenile)
rainbow smelt	star jelly	snake prickleback
unidentified amphipods	unidentified ctenophores	whitespotted greenling
smelt larvae	hermit crab	unidentified snail
moon jelly	yellowfin sole	threespine stickleback
ninespine stickleback	brightbelly sculpin	humpy shrimp
blackline prickleback	unidentified sponges	Pacific lamprey
mysid shrimp	saffron cod	belligerent sculpin
starry flounder	unidentified tunicate	chum salmon smolt
plain sculpin	unidentified mussels	pink salmon smolt
Pacific herring	unidentified snailfishes	sockeye salmon smolt
unidentified small clams	tubenose poacher	unidentified salmon smolt
unidentified isopods	Arctic flounder	unidentified sculpins
Bering poacher	Alaska plaice	

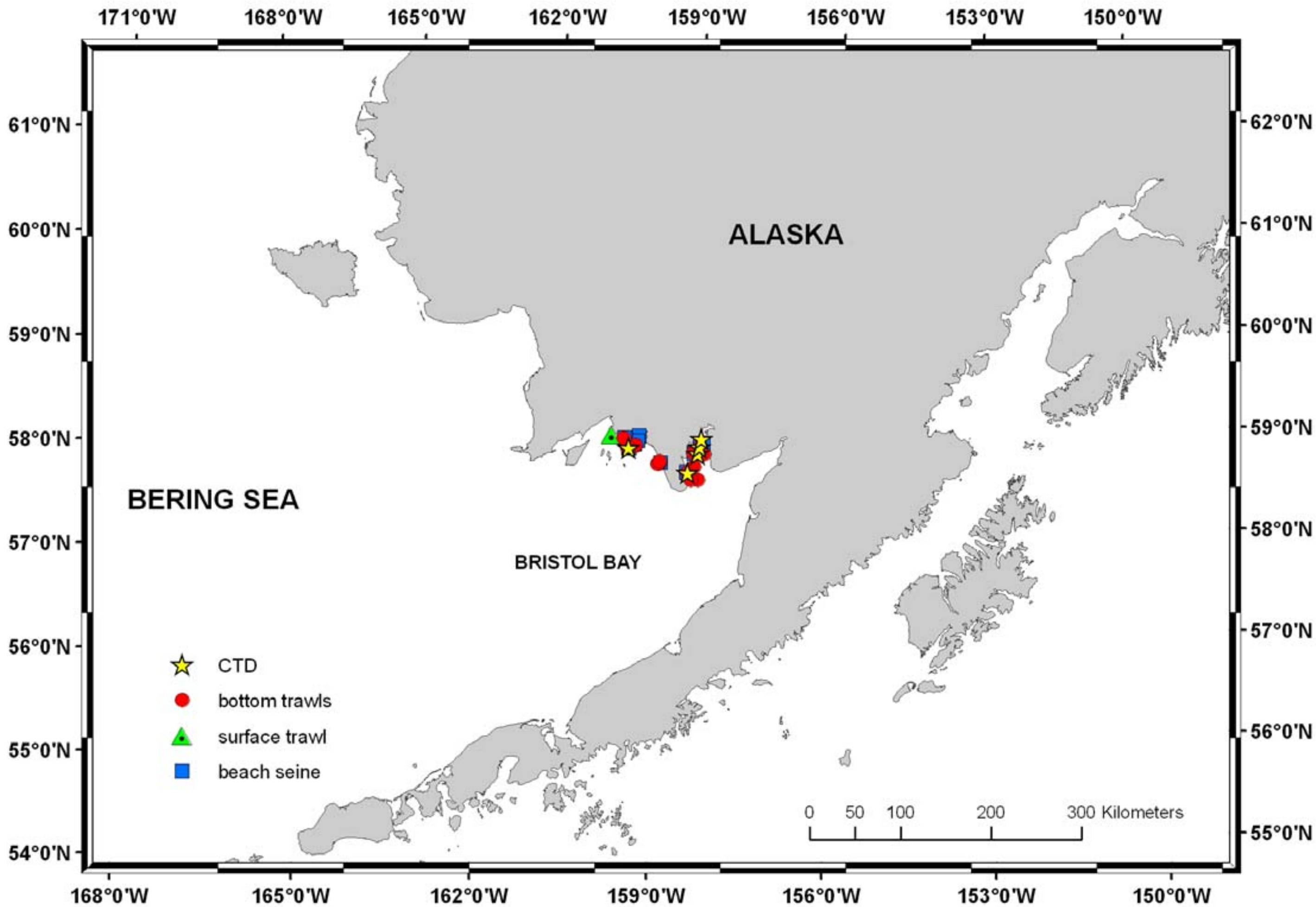


Figure 1. Map of southwestern Alaska showing location of study area.

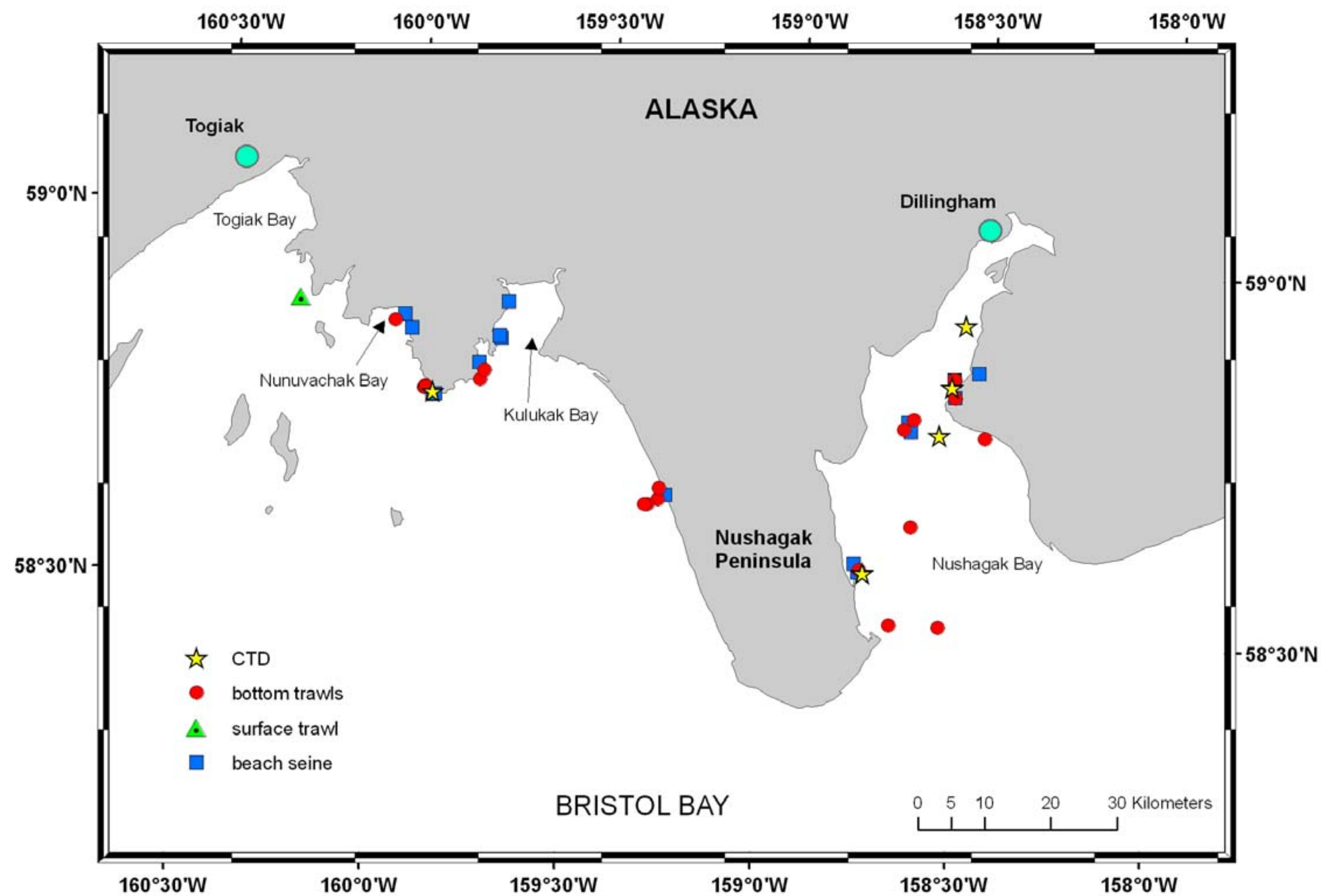


Figure 2. Detail map of sampling locations in northern Bristol Bay. The beach seine hauls that apparently occurred in the middle of Nushagak Bay were in fact conducted on an enormous sand spit that emerges at low tide.

Figure 3. Bottom beam trawl deploying from the stern of the *Willow* in Nushagak Bay.

Figure 4. Shrimp of the family Crangonidae.

Figure 5. Juvenile rainbow smelt, *Osmerus mordax*.

Figure 6. Sampling bin, length board, and crabs and clams captured during a bottom trawl.

Essential Fish Habitat project status report

Reporting date: 9/1/09

Project number: 2009-13

Title: Nearshore Fish Assemblages in Coastal Areas Facing Development in Southcentral Alaska

PIs: Eagleton and Johnson

Funding year: 2009

Funding amount: $12K

Status: ☐ Complete ☒ Incomplete, on schedule ☐ Incomplete, behind schedule

Planned completion date if incomplete:

Reporting: Have the project results been reported? If yes, state where the results were reported and attach an electronic copy of the report. No.

Results: What is the most important result of the study?

1. The AKRO Habitat Conservation Division (HCD) in Anchorage identified several priority areas in southcentral Alaska where shoreline development may affect fisheries habitat. In 2009, we sampled three of these priority areas (Upper Cook Inlet, Passage Canal (Whittier), and Resurrection Bay (Seward). Juvenile Pacific herring dominated catches, particularly in Passage Canal and Resurrection Bay. In addition to AKRO staff, other agencies that assisted in sampling were the U.S. Army Corps of Engineers (USACOE) and the Sea Life Center. A data report will be prepared for the AKRO and USACOE by 1/10. This effort allowed us to work together with different agencies and will lead towards better decision-making.