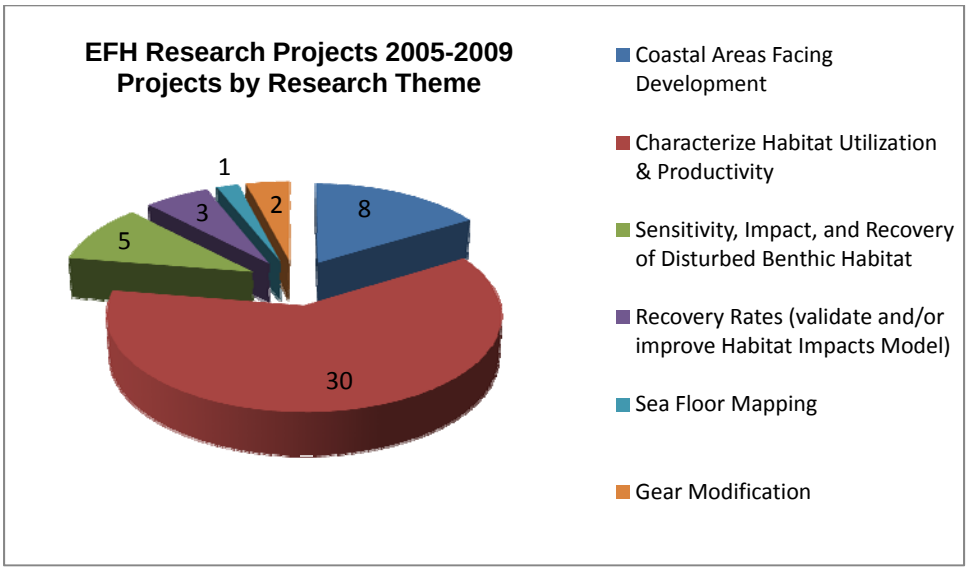
EFH Research Projects Summary 2005-2009

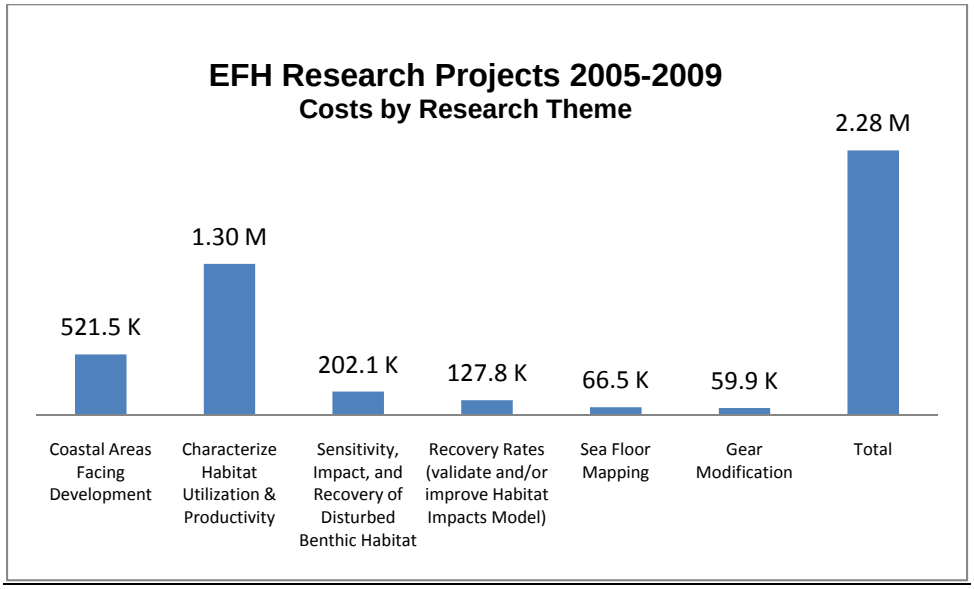
EFH research needs are 1) to identify habitats that contribute most to the survival, growth, and productivity of managed fish and shellfish species; and 2) to determine how to best manage and protect these habitats from human disturbance and environmental change.

Research projects are selected through a competitive AFSC request for proposal process based on research priorities from the EFH Research Implementation Plan for Alaska. Annually, approximately $500,000 is spent on about EFH research projects. Successful projects address major research themes (reference summary tables below). Project results are described in annual reports and the peer-reviewed literature [http://www.afsc.noaa.gov/HEPR/efh.htm]. Study results contribute to existing Essential Fish Habitat data sets.

EFH Research Project Summary by Themes



EFH Research Costs Summary by Themes



EFH Research 2005-2009 Project Summary Table

Funding Year	EFH Proposal #	Title	Pis	Coastal Areas Facing Development	Characterize Habitat Utilization & Productivity	Sensitivity, Impact, and Recovery of Disturbed Benthic Habitat	Recovery Rates (validate and/or improve Habitat Impacts Model)	Sea Floor Mapping	Cost (K)	Summary & Notes
2005	1	Interannual and habitat-specific growth rates of northern rock sole	Hurst		1				19.80	Examines anti-predator behavior, survival and habitat utilization behavior in juvenile northern rock sole and Pacific halibut, specifically how emergent structure such as sponge habitats potentially increase survival of juvenile flatfish compared to habitats without emergent structure. Ultimately, this work on Essential Fish Habitat will facilitate our understanding of habitat associations and relative productivity of different habitats for Pacific halibut and northern rock sole, as well the potential fisheries effects of habitats disturbance/removal by mobile bottom-tending gear.
2005	2	Trawl sweep and footrope modifications to reduce seafloor effects	Rose	Gear Modification					10.00	Project will suggest improvements to trawl gear and determine if new gear can lessen injury and removal sessile invertebrates, epifauna, and megafauna.
2005	3	Nearshore EFH: fish use, mapping, GIS database	Rice	1					100.00	Project will expand the nearshore fish habitat research conducted primarily in Southeast since 1990's into the rest of the state over time, including the Bering and Beaufort Seas in 2005. Shallow nearshore waters are some of the most productive in Alaska, particularly for juvenile life stages of many commercially important and forage fish species, but these habitats are also very vulnerable to climate change, environmental perturbation, as well as stress from anthropogenic disturbance. By combining funding from EFH with funds from NPRB, AKRO, Army COE, several field efforts will measure nearshore habitat use by fish, along with mapping and other parameters; most importantly, the southeast data set will be expanded to create a statewide data set and will be archived and accessed through a ShoreZone GIS database.
2005	4	Mapping and function of eelgrass beds	Harris		1				23.00	The measurements of eel grass bed size, function, and fish use in 2005 will be added to a series of long term information in a ShoreZone ArcIMS GIS data base. This will enable researchers to examine changes over time at multiple levels, such as: climate-driven changes in fish communities on a regional/geographic scale, changes at sites on temporal scales, and changes caused by anthropogenic stress.
2005	5	Video analysis of flatfish nursery habitat and gear impacts	Stoner		1				32.30	Preliminary analyses show that emergent invertebrates are more important features of the habitat for rock sole and Pacific halibut than traditional metrics of habitat such as sediment grain size. The long-term goal is to develop predictive models for flatfish habitat associations and gear impacts potentially caused by removal of habitat complexity.
2005	6	Atka mackerel spawning and nesting in the Aleutians	Lauth		1				14.00	Study is to revisit nesting sites in the western Aleutian Islands in October and January to determine if nesters are still present. The video drop camera will be used to determine the presence or absence of nesters during these periods. Egg samples from nests will be collected (if present in trawl catches) for estimating spawn and hatch dates.
2005	7	Submersible evaluation of eastern GOA corals	Stone			1			99.00	Project will evaulate several GOA coral areas. Areas may contain corals, as catch records indicate coral catch, and may have been subject to damage from bottom tending gear.

2006	1	Mapping long term equilibrium impacts of fishing and evaluation of impacts of fishing on fish condition, fish distribution, and fish diet	Kerim Aydin, Angie Grieg, Al Hermann, Anne Hollowed, James Ianelli, Craig Rose, Paul Spencer, William Stockhausen, and Tom Wilderbuer			1			6.00	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.
2006	2	Modify trawls to reduce fishing impacts / Better characterize fishing's footprint (Met 2006 priority of "fishing gear impacts to reduce impacts of fishing")	Craig Rose	Gear Modification					49.86	The tested modifications were effective at reducing the effects of trawl sweeps on sessile seafloor animals that are considered the most vulnerable habitat feature in the sand – mud habitats of the eastern Bering Sea shelf. The 8-inch disk clusters, creating up to 3 inches of opening under the sweeps, seems the best configuration; having no greater effects than the 10-inch disk clusters with no significant loss of target catch.
2006	3	Assessment of critical habitats for juvenile Pacific cod	Allan Stoner, Benjamin Laurel, Thomas Hurst, Alisa Abookire, and Clifford Ryer		1				55.64	2006 appears to have been an unusually strong year for recruitment of age-0 Pacific cod to the Kodiak system. A baited camera is a highly efficient system for observing and quantifying age-0 Pacific cod in habitats not easily sampled with traditional gear.Experiments show that Pacific cod are most attracted to baits, while walleye pollock are weakly attracted. 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.
2006	1	Habitat effects on growth and condition of northern rock sole	Thomas Hurst, Alisa Abookire, Ron Heintz, and Jeff Short		1				17.65	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.
2006	8	Essential Fish Habitat requirements For skate nurseries	Gerald R. Hoff		1				78.00	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. 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/km2 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.
2006	11	Convene a workshop to plan for the development of a habitat data inventory system for the AFSC	Jon Heifetz, Bob McConnaughey, and John Olson	Workshop					15.00	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.
2006	12	Essential Fish Habitat - Overwinter habitat use and energy dynamics of juvenile capelin, eulachon, and Pacific herring	Johanna Vollenweider, John Hudson, and Ron Heintz		1				50.30	Results suggest that size-dependent foraging success may also influence winter energy dynamics, and ultimately the survival and recruitment of juvenile forage fishes in north-temperate marine systems.

2006	14	Juvenile rockfish habitat utilization	Pat Malecha		1				38.20	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.
2006	16	Nearshore essential fish habitat-seasonal fish use, mapping, GIS database	Scott Johnson, John Thedinga, Mandy Lindeberg, and Pat Harris	1					110.00	1) Species composition changed with season–pink salmon dominated catches in April, saffron cod and herring in July, and capelin in September. 2) 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.
2006	18	Food habits and small scale habitat utilization of Atka mackerel in the Aleutian Islands, Alaska	Sandra Lowe		1				13.76	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.
2006	20	Log transfer facilities	Katharine Miller, Linda Shaw, Jeep Rice, and John Hudson	1					43.50	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. Nonrecovery 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. Study indicates that benthic habitats impacted by LTFs are mostly in a recovering state, whereas habitat at the one log storage facility has not yet begun.
2006	5	Habitat effects on growth and condition of northern rock sole	Hurst, Abookire, and Heintz		1				17.65	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.
2007	2	Habitat effects on growth and condition of northern rock sole	Hurst, Abookire, and Heintz		1				28.87	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.
2007	5	Habitat specific production of Pacific ocean perch in the Aleutian Islands	Rooper, and Heintz		1				52.70	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. 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.

2007	6	Recovery of a sessile invertebrate of the Bering Sea shelf from trawling	Rose				1		9.89	In June/July 2007, Camera/sonar sled covered 1 year-old trawl tracks to observe the effects on basketstars and seawhips. Imagery from other intervals (approximately 1 day, 1 week and 1 month) was also collected. Sonar data was used to classify which seafloor areas were swept by each component of the trawl gear, which was then used to categorize reviews of video imagery to enumerate animals in different damage states. The enumeration was completed in Summer 2008 and analysis is proceeding.
2007	7	Temporal dynamics of habitat use in juvenile Pacific cod	Stoner, Laurel, Knoth, Ryer, and Hurst		1				46.32	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. Laboratory experiments, designed to complement field observations showed that age-0 cod tolerate high light conditions, while larger cod avoid bright light. Age-1 Pacific cod and saffron cod were moderately piscivorous but there was no evidence of predation on smaller conspecifics. 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.
2007	9	Mapping and fish utilization of coastal habitats vulnerable to disturbance from development and climate change	Johnson, Thedinga, Lindeberg, and Harris	1					92.00	All data has been entered into an existing GIS database and online Fish Atlas (http://www.fakr.noaa.gov/habitat/fishatlas/). 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.
2007	10	Juvenile Pacific ocean perch habitat utilization	Malecha, Gray, and Lunsford		1				89.30	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.
2007	12	Habitat influence on rearing condition and overwinter survival of juvenile capelin (Mallotus villosus)	Vollenweider, Hudson, Heintz, and Calvert		1				57.90	There are few results available at this time. Length frequency distributions for age-0 capelin in November and April suggest size-selective overwinter mortality. Capelin appear to be more abundant in Muir Inlet than in Berners Bay and Fritz Cove.
2007	11A	Biological parameters to estimate the recovery of disturbed benthic habitat in Alaska, study A: Coral growth	Stone, Andrews, Lehnert, and France			1			45.00	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.

2007	11C	Biological parameters to estimate the recovery of disturbed benthic habitat in Alaska, study C: Coral genetics	Stone, Andrews, Lehnert, and France			1			14.05	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.
2008	1	Nearshore Fish and Habitat Assessment	Johnson, Thedinga, Lindeberg, and Harris	1					91.00	Monitoring sites were sampled in the Chukchi and Beaufort Seas for the second consecutive year. Arctic nearshore waters are used by forage fish, especially capelin and Arctic cod. 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. 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.
2008	2	Productivity, habitat utilization and recruitment dynamics of Pacific cod	Laurel, Ryer, Stoner, Knoth, Urban		1				29.00	Preliminary analysis of those data suggests age-0 Pacific cod recruitment in 2008 was significantly higher than 2007 but still far below densities observed in 2006.
2008	3	Contrasting predation intensity and distribution in two rock sole nursery areas	Ryer, and Laurel		1				53.00	Over 400 tether sets were completed. Both nursery sites were characterized by increased predation intensity with increasing depth. Benthic samples were successfully collected and are in the process of being shipped to Fairbanks, where Stephen Jewett, UAF, will oversee their processing. Visual estimation of samples during screening suggests that overall invertebrate biomass increases with depth. Importantly, this year we observed a recurrence of the polychaete worm turf that has appeared at these sites periodically. Invertebrate biomass appeared to 'go off the charts' in the worm turf, and video sled surveys indicate that the juvenile rock sole were aggregated at the shallow edge of the worm turf. As a side note, the study was able to 'double task' some of the benthic samples to characterize a disturbance experiment conducted in this worm turf habitat. Swaths of habitat were subjected to simulated trawling. Currently, video survey data is being assessed to determine whether or not disturbance of the worm turf altered the distribution of juvenile rock sole. There are plans to monitor the recovery of these disturbed treatments over the coming year.
2008	4	Physical and temporal aspects of pollock spawning habitat utilization	Bailey, and Chan		1				33.98	We tentatively have identified a novel statistical method to assess recovery of habitat from disturbance. We were able to apply this method to the recovery of pollock spawning from the Exxon Valdez oil spill. The oil spill truncated the earlier part of the hatchdate distribution in 1989, and postponed the peak of the pollock's hatchdate distribution somewhat in 1990. However, the post-oil-spill effects are found to decay with an annual rate φ, 0.61, so that the pollock system has a rather weak memory of the oil spill. The parameter φ is estimated by minimizing the generalized cross validation score (GCV), with the parameter range being [0, 1]. Since the estimated φ = 0.61 is a bit less than 1, the Exxon Valdez spill leaves a very weak memory in the hatchdate distributions. Quantitatively, the Exxon Valdez spill effects have a half-life of about 1.4 years (Cryer and Chan, 2008, Exhibit 11.2) in the sense that it takes about one year and five months for the oil spill effects to diminish by one half. We believe that this method may be potentially useful to look at the temporal aspects of habitat recovery time after a disturbance. Future work will be on this aspect of recovery from disturbance, as well as refining the overall model of temporal occupation of the spatial habitat. Finally during the next year of funding we will complete the analysis of the spatial modeling of habitat occupation.

2008	5	Habitat characterization and utilization of early benthic phase red king crab	Persselin, Stoner, Foy, and Eckert		1				45.17	All collectors were retrieved from the water in August and September. The near-complete absence of settling-stage king crab was surprising given the success the Alaska Department of Fish and Game (ADF&G) had with the collectors in Kodiak in the early 1990s. Our results indicate that one or more of the following may have contributed to this season's outcome: 1) there was a very low-level larval release of red king crab in Chiniak Bay in 2008, 2) larvae are being transported elsewhere than to their historical settlement areas, 3) collectors were not placed to adequately capture larvae, or 4) failure of the sampling methodology. Given the low numbers of adult red king crabs documented in Chiniak Bay by ADF&G and by NMFS divers, it is quite likely that the lack of larvae collected may be due to diminished levels of reproductive adults. Experiments on habitat preference showed that juvenile crabs in the earliest post-settlement stages have a strong preference for complex structure, and that biofilm is an important component of that relationship, and that habitat choices are not strongly density dependent. Early benthic stages showed no overt behavioral responses to the presence of predators and innate crypsis appears to be the primary form of defense by RKC in stages C1 to C3. In experiments with age-1 Pacific halibut as predator, survival of RKC less than 5 mm CL is significantly higher in habitats structured with algae or gravel compared with sand bottom. Survival increases in a direct response to amount of structural complexity. Lab experiments will continue into FY-09 as the crabs grow to larger size and predation experiments (with halibut and Pacific cod) will continue, exploring the role of habitat heterogeneity and patchiness.
2008	6	Habitat influence on rearing condition and overwinter survival of juvenile capelin	Vollenweider, Hudson, Heintz, and Calvert		1				44.54	Proximate analysis of young-of-the-year capelin collected in Muir Inlet before (November 2007) and after (April 2008) winter indicate that juvenile capelin suffered an energy deficit that is primarily fueled by lipid metabolism and, to a lesser degree, protein metabolism. These results suggest that starvation from the depletion of energy reserves is responsible for apparent size-selective overwinter mortality in this population.
2008	7	Rockfish abundance and diurnal habitat associations on isolated rocky habitat in the eastern Bering Sea	Hoff, and Rooper		1				90.85	During July 11-17 of 2008 a study was conducted aboard the FV/Vesteraalen on a unique rocky ridge habitat in the southern Zhemchug Canyon region. Acoustic data for relative biomass estimates as well as bottom topography and general substrate types were collected using an EK60 single beam (38 kHz) hydroacoustic system. A stereo-video drop camera system was used to collect data on fish and invertebrate species and habitat associations at 15 transects. EK60 transects conducted during daylight and nighttime hours along the same tracklines showed rockfish in greater abundance in the water column during daylight hours than night. Video from camera drops showed rockfish to be predominantly benthic during night, when fish were observed lying directly on the bottom and not visible using hydroacoustic methods. During daylight hours fish were demersal to pelagic forming large active schools above the bottom with smaller fishes present on bottom throughout the daytime. Hydroacoustic and video data showed the rocky ridges to be highly productive as rockfish habitat and the ridges possessed an abundance of HAPC indicating species such as coral and sponges, unlike the surrounding eastern Bering Sea slope habitat. Analyses of the acoustic data will be conducted during the fall and winter of FY09, and will produce relative biomass estimates for rockfish and substrate maps. The video analyses will produce species identifications, length frequencies (using the stereo video capabilities) and habitat associations for rockfish species.
2008	8	Characterization of benthic infauna community for modeling essential fish habitat in the eastern Bering Sea	Yeung, Yang, and McConnaughey					1	66.50	Sediment properties and benthic infauna community are defining habitat characteristics for certain fish species. Infauna compose a significant portion of the diets of these species, and sediment properties are the main structuring force of infauna communities. The strength of this relationship is examined by investigating the spatial correspondence between fish diet and infauna distribution, and the predictability of infauna community by sediment properties. Results showed the feasibility, effort-wise, to collect stomachs on the trawl survey even at all planned grab stations (31), since the actual number of stomachs attained will still likely be far less than the targeted number. Hence, ship time and man power requirements would still be manageable.

2008	9	Juvenile slope rockfish habitat distribution	Malecha, Gray, Lunsford, and Clausen		1				93.30	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. Based on physical morphology, it appears that approximately 600 specimens are Pacific ocean perch; the remaining specimens are a combination of species. Genetic confirmation of species identifications will occur at a later date. Great sculpin were acquired near Little Port Walter, transferred to the TSMRI wet laboratory and will be used as predators. Suitable observational arrays were obtained and installed in the TSMRI wet laboratory. Fish are currently being acclimated to a modified photoperiod and habitat preference and predation trials will begin shortly.
2009	20	Recovery of deep water sponges and sea whips from bottom trawling	Malecha, Heifetz				1		105.90	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.
2009	8	Invertebrate colonization of PMEL moorings	Zimmermann, Floering, Van Syoc, Stabeno				1		12.00	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.
2009	22	Recruitment and response to damage of an Alaskan gorgonian coral	Malecha, Stone			1			38.00	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, 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.

2009	12	Nearshore Fish Assemblages in the Arctic: Establishment of Monitoring Sites in a Rapidly Changing Environment from Energy Development and Climate Change	Johnson, Thedinga	1					65.00	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.
2009	4	Contrasting predation intensity and distribution in 2 rock sole nursery areas: a principle factor controlling nursery productivity - Component A	Ryer, Laurel, Knoth		1				20.00	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. These results suggest that the nursery value of these sites may vary from year to year. Predation upon juvenile flatfish was much lower at night than during the day.
2009	17	Characterization of Benthic Infauna Community for Modeling Essential Fish Habitat in the Eastern Bering Sea - Reduced plan	Yeung, Yang, McConnaughey		1				77.80	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. Granulometric analysis of sediment samples has been completed. Chemical analyses of sediment samples (chl-a, TN, TOC, TP, and N isotopes) and processing of infauna samples (identification, counts, wet-weights) are currently in progress. Length class distributions of the fish by species are being determined. Stomach content analysis is in progress.
2009	11	Year 2: Assessing the physical and temporal aspects of pollock spawning habitat utilization in Shelikof Strait, Gulf of Alaska	Bailey, Chan		1				34.45	A general additive model showed 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.
2009	5	Productivity, habitat utilization and recruitment dynamics of Pacific cod	Laurel, Ryer, Parrish, Stoner, Knoth, Urban		1				41.60	Age-3 cod were observed on the baited camera for the first time, suggesting high survival from abundant 2006 year class. 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. Stomachs from age 1+ Pacific and saffron cod were also collected and frozen for the ongoing examination of cannibalism in these species.
2009	1	Characterize habitat utilization and productivity for rockfish species	Rooper, Heintz, Aydin, Boldt		1				23.20	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.

2009	16	Natural and man-made disturbance of eelgrass beds in northern southeastern Alaska: damage and recovery	Harris	1					8.00	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.
2009	4	Contrasting predation intensity and distribution in 2 rock sole nursery areas: a principle factor controlling nursery productivity - Component B	Ryer, Laurel, Knoth		1				13.00	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).
2009	21	Utilization of nearshore habitat by fishes in Nushagak and Togiak Bays (Bristol Bay)	Ormseth, Norcross, Holladay		1				68.00	Project completed 20 bottom trawl hauls, 17 beach seine hauls, and one surface trawl. Over 40 fish and invertebrate species were encountered during the survey (Table 1). Most of the captured individuals were small (20 cm or less). Shrimps Crangonidae and rainbow smelt *Osmerus mordax* were the most abundant. Ubiquitous species were encountered in almost every trawl and seine haul and were especially high in very shallow water and mud/silt bottoms. The mortality rate of rainbow smelt was near 100%, while we were able to release many capelin live. It was 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. 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, 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. An exception to this gradual change was the presence of large numbers of juvenile yellowfin sole in outer Kulukak Bay. A change in species composition was also observed in Nushagak Bay on the distance from the bay mouth. In the outer reaches of the bay sea stars, helmet crabs, and herring

										were more prevalent than in the inner portion. Anticipate performing similar work in the future in the same area and in the Gulf of Alaska.
2009	13	Nearshore Fish Assemblages in Coastal Areas Facing Development in Southcentral Alaska	Eagleton, Johnson	1					12.00	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.

Conclusions

Essential Fish Habitats benefit from research directed to address affects from fishing and other anthropogenic activities. The EFH Research Implementation Plan and project review by AFSC HEPR allows EFH research to undergo peer-review scrutiny, a process implemented only in Alaska. EFH research struggles from a lack of adequate funding to address enormous unknowns, such as seafloor mapping and marine habitat delineations on the Alaska scale. However, this deficiency should not overshadow the exceptional research EFH has funded. A few highlights include:

- A better understanding of Atka mackerel spawning behaviors
- Bering sea seafloor substrate mapping
- Coral recovery and growth studies
- Gear modification research
- Shoreline mapping and fish distributions

The next 5 years of EFH Research will be drafted and conceptualized in the 2012-2016 EFH Research Plan. The new plan will incorporate many of the EFH 5 Year Summary Report Research Needs, as summarized in this section.