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January 18, 2000

Dear Workshop Participant

These abstracts describe the results of most of the Research, Monitoring, and General Restoration projects carried out as part of the Fiscal Year 1999 Work Plan and are compiled here for the benefit and information of participants in the 2000 Restoration Workshop and the public

These abstracts describe works in progress and their contents are the responsibilities of the authors The abstracts have not received scientific peer review and are not intended for citation in scientific publications. If you have questions about a particular project, please contact that project's principal investigator or project leader.

Thank you

Sincerely,

Molly McCamm

Molly McCammon Executive Director

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Project Number and Title 99012 - Photographic and Acoustic Monitoring of Killer Whales in Prince William Sound and Kenai Fjords, Alaska

Principal Investigator Craig O Matkin, North Gulf Oceanic Society, PO Box 15244, Homer, Alaska 99603 (907) 235-6590 or (907) 299-0677

Abstract Annual monitoring of killer whales (Orcinus orca), a species currently considered non-recovering following the Exxon Valdez Oil Spill, has continued using photographic and acoustic techniques from 1984 to 1999 Since the spill emphasis has been placed on monitoring the status of damaged resident AB pod and the possibly endangered AT1 transient population In 1999 AB pod was observed very infrequently and was still traveling as two subgroups One subpod of 8 individuals remains associated with AJ pod In 1999 there were two apparent mortalities in AB pod These were AB5, an adult male at least 35 years of age, and AB52 a yearling calf One new calf, AB55 (mother AB39), was recruited in 1998/99 There were 24 whales in ABpod in late 1999, a net increase of only 2 whales since the pod reached its lowest level in 1994 Recovery to the pre-spill number of 36 whales is not likely in the near future. The loss of key animals at the time of the oil spill has apparently prevented significant recovery in the past decade. This demonstrates the sensitivity of resident pods and potential susceptibility of resident killer whale populations to environmental perturbations. Recovery periods for killer whales may be much longer than we originally anticipated.

There were only 6 encounters with the AT1 transient group in 1999 and only 7 of the original 22 whales in that group were photographed Eleven of AT1 whales that disappeared following the oil spill have not been observed for 10 years and are considered dead. There have been no new calves recruited into this group since 1984. Contaminant levels have averaged 237ppm PCBs and 346 PPM DDT (both in lipid weight) in biopsy samples. Similar levels have been implicated in reproductive impairment and/or immune dysfunction in other species. Harbor seals have been a primary prey item for the AT1 transient group during our study. The harbor seal population has declined by 80% in the past twenty years and this may contribute to the lack of recovery of the AT1 population. Call characteristics clearly separate these whale from all other populations studied. Genetic analysis indicates the group is reproductively isolated from all other known killer whale populations. Judging from genetic variability in nuclear DNA this population has recently declined from much higher numbers or is part of a yet undiscovered population in western Alaska. Evaluation of numerous parameters from available data suggests that the AT1 transients are a unique and endangered population.

Our catalogue of unique pod specific vocal repertoires is being used in conjunction with recordings from a remote hydrophone to document presence and absence of resident type killer whales in the study area during fall and winter months Whales are being tracked and identified via remote hydrophone using a new microwave relay system powered by a combination of wind and solar power

Because of the low number of sightings of transient whales and the annual variation in resident pod distribution, annual photographic and acoustic work has proven essential in monitoring this damaged species Recovery in both the AB pod and AT1 transient group has not occurred a decade after the *Exxon Valdez* oil spill

<u>Project Number and Title</u> 99025 - Mechanisms of Impact and Potential Recovery of Nearshore Vertebrate Predators (NVP)

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<u>Principal Investigators</u>¹ Leslie Holland-Bartels, Brenda Ballachey, James Bodkin, Dan Esler, David McGuire, and Glenn VanBlaricom, U S Geological Survey, 1011 E Tudor Rd, Anchorage, Alaska 99503, (907) 786-3512

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Chuck O'Clair, National Marine Fisheries Service, 11305 Glacier Highway, Juneau, Alaska 99801

<u>Abstract</u> The NVP Study, 1995-1999, examined four sentinel nearshore predators whose injury from the 1989 *Exxon Valdez* oil spill was still unknown or believed to be "not recovered" as of 1994 — the invertebrate-feeders sea otter (*Enhydra lutris*) and harlequin duck (*Histrionicus histrionicus*), and fish-feeders river otter (*Lontra canadensis*) and pigeon guillemot (*Cepphus columba*) These species represented different ecological perspectives of Prince William Sound and, thus, we believed they provided different insights into possible continuing ecological consequences of the spill Our central question was — has population recovery occurred If not, is that lack of recovery a function of direct toxicological effects of oiling, food limitations, or intrinsic demographic limitations on population recovery rates?

Both trophic pathway and scale appear to influence our findings Studies of nesting and rearing success suggest that recovery of pigeon guillemot is constrained primarily at a broad temporal and spatial scale represented by a marine regime shift, where food quality is insufficient to support population growth required to replace the 1989 mortalities However, adults did also demonstrate CYP 1A expression and the additional consequence of this indicator of continued oil exposure to population recovery is unknown Studies of the river otter indicate declining effects of the oil spill over the course of our project, with population recovery evident by 1998 However, for the two invertebrate-feeders, sea otter and harlequin duck, evidence exists over many lines of investigation to suggest that local-scale populations continue to be constrained by increased levels of mortality coincident with continued exposure to residual oil We speculate that sporadic releases of residual oil are occurring, and that invertebrate prey exposure is temporally and spatially patchy, but sufficient to transport oil up through the food chain Individual lines of investigation often contained uncertainty, but the collective weight of evidence from this project indicates lack of full recovery of the nearshore ecosystem from the Exxon Valdez oil spill nearly a decade following the event We conclude that, although responses of wildlife to large-scale anthropogenic perturbations are mixed, sensitive species and the ecosystems in which they occur can suffer effects that extend well beyond immediate, direct impacts We also suggest that an integrated, multi-species approach offers important insights for assessing ecological disasters and applying conservation solutions

¹ 46 investigators contributed to this study Their contributions are reflected in the authorship strings of the chapters and appendices of our study's final report

Project Number and Title 99043B - Cutthroat Trout and Dolly Varden Rehabilitation in Western Prince William Sound

Principal Investigators Dan Gillikin, Glacier Ranger District, PO Box 129 Girdwood, AK 99587 (907) 783-3242 dgillikin/r10_chugach_glacier@fs fed us

Abstract The oil spill damage assessment identified oil related injuries to cutthroat trout (Onchorvnchus clarki) and Dolly Varden Char (Salvelinus malma) in Prince William Sound In an attempt to mitigate these impacts to cutthroat trout and Dolly Varden, the Forest Service installed a total of 63-habitat improvement structures in Prince William Sound (EVOS project 95043B) at four different project locations in 1995 This study monitored those habitat improvement projects over a four-year period to evaluate their effects on cutthroat trout and Dolly Varden abundance The enhancement project was intended to improve cutthroat trout and Dolly Varden habitat Monitoring was designed to address concerns that habitat enhancements may increase coho salmon populations, thereby increasing competitive stress on cutthroat trout populations The abundance of juvenile cutthroat trout, Dolly Varden and coho salmon were annually monitored using standard mark recapture techniques However, bias in population estimates precluded their use in the final analysis and catch per unit effort information was instead analyzed Our study found that at only one of the four locations, Otter Creek, could the increase in cutthroat trout overall abundance be attributed to the improvement work done in 1995 Additionally no significant negative trends in overall abundance for the three species were observed at any of the project locations

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Project Number and Title 99052A - Community Involvement

Principal Investigator Patty Brown-Schwalenberg, Chugach Regional Resources Commission, 4201 Tudor Centre Dr, Ste 301, Anchorage, Alaska 99508

<u>Abstract</u> The *Exxon Valdez* oil spill caused severe disruption in the lives of those who live within the oil spill region Consequently, the contamination and devastation has caused the residents of these communities to be concerned over the safety of wild food sources and the integrity of the environment affected by the oil spill The majority of the scientific work conducted with Trustee Council funds is done with agencies in state and federal government, often being centered in Anchorage, Juneau, or Fairbanks The need for this project stems from concern by residents of spill-affected communities that their involvement was not adequately taken into consideration and that the information collected by scientist throughout the spill area was not reaching the communities

In an effort to enhance communication between the Trustee Council and the communities and to increase involvement in the process, a community facilitator has been hired through subcontracts between Chugach Regional Resources Commission and the village councils in the following communities Chenega Bay, Tatitlek, Valdez, Cordova, Port Graham, Nanwalek, Seldovia, Ouzinkie, Seward, and Chignik Lake In addition, a spill area wide community involvement coordinator has been hired by Chugach Regional Resources Commission to facilitate the communication between the communities, Trustee Council, and principal investigators

Results for FY 99 include continued transfer of scientific information between the Trustee Council and spill-affected communities in the form of monthly community reports regarding any EVOS activity, weekly phone calls between the spill area wide community involvement coordinator and community facilitators, a monthly report on Trustee Council activities sent to the communities by the spill area wide community involvement coordinator, and quarterly meetings of the community facilitators, Trustee Council staff, Alaska Department of Fish and Game staff, and Chugach Regional Resources Commission staff. Other accomplishments include the submittal of community-based proposals that primarily address subsistence restoration. These included the Port Graham Hatchery Reconstruction, Lower Cook Inlet Waste Management Plan, PSP Field Testing, Kodiak Island Youth Area Watch, Ouzinkie and Chenega Bay Intertidal Documentary, Spot Shrimp Assessment, and various other projects for consideration of the Trustee Council for fiscal year 2000

Other Accomplishments

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Community facilitator participation in the 10th Anniversary Workshop was regarded as very informative and valuable The Port Graham Facilitator worked with Jody Seitz and the "Coastal Currents" radio show to produce a series on community-based projects The Facilitators also worked with the Alaska Department of Fish and Game to institute the subsistence survey assessment project Restoration Reserve planning was held by project staff to involve local communities in the overall planning of the implementation of the Reserve fund priorities Project staff facilitated a field trip to the Department of Environmental Conservation shellfish testing facility in Palmer with Trustee Council staff and the Community Facilitator from Kodiak Island, Paul

Panamarioff, as well as the Ouzinkie Natural Resource Specialist They observed the procedures for testing for paralytic shellfish poisoning in shellfish from subsistence and commercial harvesters An internship program was instituted in conjunction with the Kodiak Island Borough School District and Ouzinkie Tribal Council to have oil spill interns in each of the six communities on Kodiak Island to better inform and involve the communities in the restoration process, as well as educate local youth in science and the restoration process Continued work was performed with the Alaska Department of Community and Regional Affairs to solicit and review proposals for the Exxon Criminal Settlement subsistence fund

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Project Title and Number 99052B - Traditional Ecological Knowledge

Principal Investigator Patty Brown-Schwalenberg, Chugach Regional Resources Commission, 4201 Tudor Centre Dr, Ste 301, Anchorage, Alaska 99508

<u>Abstract</u> The TEK project had three areas of emphasis in FY 99 holding information workshops, assisting in Jody Seitz's herring project, and preparing for long-term stewardship activities in conjunction with GEM and the community involvement project (99052A)

Three information workshops were held, and a fourth was canceled due to poor flying conditions We held workshops in Nanwalek and Seldovia on sea ducks with Dan Rosenberg of ADF&G These went well, and we discussed various aspects of scoters and harlequin ducks, including methods for live-capture We held a workshop in Tatitlek on herring with Evelyn Brown of UAF, discussing trends and changes in herring populations and possible human and environmental causes We tried to hold a workshop in Chignik Lake on harbor seals with Bob Small and Vicki Vanek of ADF&G, but were unable to reach the village due to severe turbulence on the flight in

Henry Huntington worked with Jody Seitz and Evelyn Brown on finishing Jody's project documenting traditional knowledge of herring in Prince William Sound and the outer Kenai Peninsula. The investigators have prepared a manuscript, revised several times, which has now been submitted for publication. The investigators also held a meeting in Tatitlek to review the results of the project with community members, including those who participated in the study.

CRRC organized a workshop in Anchorage to discuss community stewardship of natural resources, including tribal natural resource management programs An outcome of this workshop was a subsequent workshop held in Lac du Flambeau, Wisconsin, to examine tribal programs established by the Lac du Flambeau Tribe and to discuss opportunities and challenges for communities in the oil spill region. These discussions relate in part to the plans for the Gulf Ecosystem Monitoring (GEM) program, currently being developed by EVOS staff. We expect to continue our efforts in this direction. In FY 00, the TEK and community involvement projects will be combined to focus their work on monitoring and stewardship in the long term. **Project Number and Title** 99064 - Effort, focus, and preferred depth of diving for harbor seals, *Phoca vitulina richardsi*, in Prince William Sound, Alaska, 1993-1996

<u>Principal Investigators</u> Kathryn J Frost¹, Lloyd F Lowry¹ and Michael A Simpkins² ¹Alaska Department of Fish and Game, 1300 College Rd , Fairbanks, AK 99701 USA ²Institute of Marine Science, University of Alaska Fairbanks, Fairbanks, AK 99775 USA

Abstract Satellite depth recorders (SDRs) have been deployed on a variety of pinnipeds, providing insights into movements and diving behavior Unfortunately, individual variability and summing of data into bins have made analyses using standard statistical techniques difficult We have developed a statistically robust analytical method that accounts for individual variability, temporal autocorrelation, and the binned nature of data We used this method to analyze the diving behavior of 37 harbor seals, Phoca vitulina richardsi, tagged with SDRs in Prince Will-1am Sound, Alaska, during 1993-1996 Repeated measures mixed models for effort, focus, and preferred depth bin were created using the MIXED procedure in SAS Models indicated that diving effort remained steady throughout winter, then declined from February to July Preferred depth was deepest during winter and shallowest during May-July Diving was shallow and focused in Copper River Delta and Cook Inlet and deeper and less focused near Yakutat and Southwestern Montague, reflecting regional bathymetry Collinearity between month and region in the preferred depth model suggests that seals migrate to regions of deeper preferred depth in winter, perhaps indicating a seasonal cycle in type or depth of prey The steady decrease in diving effort during spring and summer indicates that seals gradually increase the proportion of time they spend hauled out as the molt period approaches However, diving effort increased abruptly in September, making it clear that surveys to estimate population size must be carefully timed Diurnal and demographic changes in diving behavior were minor but significant Diving effort was greatest at night (2100-0300 hrs), and most focused during the day (0900-1500 hrs) Diving was more focused for females than males, and for adults than subadults These insights into foraging and hauling out behavior have practical management applications for improving surveys and evaluating habitat use by season, region and depth

Project Number and Title 99090 - Monitoring of Oiled Mussel Beds in Prince William Sound

<u>Principal Investigators</u> Patricia Harris, Mark Carls, and Christine Brodersen, National Marine Fisheries Service, Auke Bay Laboratory, 11305 Glacier Highway, Juneau, AK

<u>Abstract</u> This project has monitored the long-term retention and loss of *Exxon Valdez* oil (EVO)in mussel beds in Prince William Sound since 1992 In 1999, sediments and mussels were sampled from 25 previously oiled mussel beds where concentrations of EVO in each of these beds were above baseline when the beds were last sampled (1996) (Previously estimated baseline total petroleum hydrocarbon (TPH) concentrations were 52 &g/g) Beds sampled in 1999 included nine beds that had been manually restored in 1994 because there was evidence in 1996 that some of the replaced surface sediments were becoming recontaminated

In 1999, oil distribution was patchy in both restored and non restored beds Concentrations in surface sediments from 15 (of 25 beds) ranged from 34 to 27,000 &g/g TPH (estimated fluorimetrically), but were less than maximum concentration of 65,000 &g/g observed in 1992 Concentrations of TPH within sediment from different parts of most beds differed by more than an order of magnitude Mean TPH concentrations, estimated from composite samples pooled across beds, ranged from 35 to 6,000 &g/g

Mean TPH concentrations in surface sediments of non-restored beds were typically greater than in restored beds (3,740 and 825 &g/g, respectively), but these differences were not significant due to high variability, especially among non-restored beds. In the five restored beds for which we now have 1999 data, concentrations in pooled surface sediments remained below pre-restoration levels in four beds. In restored beds, TPH concentrations in surface sediments of two beds were near baseline (36 and 141 &g/g and intermediate in 2 beds (α 1,000 &g/g), but reached 2,500 &g/g in one restored bed. In the non-restored beds TPH concentrations in pooled samples ranged up to 6,000 &g/g and approached baseline levels (248 &g/g) in only one bed

Changes in surface TPH concentrations since 1996 were mixed Concentrations in three restored beds remained stable, increased in one bed, and decreased in another In non-restored beds, concentrations in 5 of 11 beds were stable, five beds had lower levels in 1999 than in 1996, and one had higher levels

Preliminary results demonstrate continued persistence of EVO in the surface sediments of oiled mussel beds and the potential for continued mussel contamination and contamination of mussel predators Mussel tissue data, currently being analyzed, will document the bioavailability of oil remaining in the beds

Project Number and Title 99127 - Tatitlek Coho Salmon Release

<u>Principal Investigator</u> Sue Coggswell, Prince William Sound Economic Development Council, Cordova, AK

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<u>Abstract</u> Fiscal Year 1999 was the fifth year of this project In cooperation with the Valdez Fisheries Development Corporation, the Tatitlek IRA Council releases 20,000 coho salmon fry each year

As a result of this ongoing project, it continues to move forward to create a run of coho salmon for subsistence use in Boulder Bay The Solomon Gulch Hatchery continues to be responsible for the taking of eggs (enough to produce 50,000 smolt) and smolt production (standard fish practices are utilized to incubate the eggs and real the resultant fry) The village of Tatitlek is then responsible for imprint the eggs and releasing the smolt into the wild Approximately 2,000 to 3,000 adult coho salmon return to Boulder Bay for subsistence harvesting The residents of Tatitlek are beginning to notice increasing numbers of returning salmon which will insure subsistence recovery **Project Number and Title** 99131 - Nanwalek, Port Graham and Tatitlek Subsistence Clam Restoration

<u>Principal Investigators</u> Patricia Brown-Scwallenberg, Jeff Hetrick and Dave Daisy, Chugach Regional Resource Commission, 4201 Tudor Centre Drive, Suite 300, Anchorage Alaska 99508

Kenn Brooks, Aquatic Environmental Science, 644 Old Eaglemount, Port Townsend, Washington 98368

<u>Abstract</u> Clams were once a major susbsistence resource in the native communities of Nanwalek and Port Graham in lower Cook Inlet and Tatitlek in Prince William Sound This project has developed procedures for enhancing local beaches with the native littleneck clam <u>Protothaca staminea</u>

Surveys were conducted with residents, especially elders, to assess the best areas for enhancement Local beaches were surveyed and characterized for their potential for growing littleneck clams Beach sites were selected based on historical use, proximity to the villages and potential for growing clams

The Quteckak Shellfish Hatchery in Sewaid has developed the hatchery and early nursery techniques for producing littleneck clams Several nursery strategies were evaluated to maximize growth and survival Clams were held in the hatchery and grown to a size of 10mm, others were planted on the beach at 4-5mm and a final group was held in a <u>Fluidized Upwelling System</u> (Flupsy) throughout the summer for a late season planting

Several grow out culture techniques were evaluated for growth and survival Clams were planted at three tidal heights -1 5', 0 ' and +1 5' Different culture techniques were used at the three tidal elevations 1) Unprotected 2) Protected by fine plastic mesh (car cover) and 3) Hard plastic culture bags The clams were sampled throughout the three year growth period Clams did well in all three treatments and the different tidal heights Some clams reached a harvestable size of 38mm during the grow out period, two years sooner than expected

In 1999, over 100,0000 clams wer planted under car cover at each of the three villages and should provide the targeted harvest goal for each village in 2002 The project has recieved additional funding to continue refining the enhancement techniques

Project Number 99139A2 - The Effects of Groundwater on the Optimization of Drainage Patterns for the Port Dick Creek Tributary Restoration Project

Principal Investigators Geoff Coble, Coble Geophysical Services, 910 East End Road, Suite #1, Homer, Alaska, 99603, (907) 235-1066, email <u>CGS@alaska net</u>

Mark Dickson, Alaska Department of Fish & Game, 3298 Douglas Place Homer, Alaska 99603, (907) 235-8191, email Mark_Dickson@fishgame state ak us

Abstract Port Dick Creek, located 25 miles southeast of Homer on the outer coast of the Kenai Peninsula, is an important pink (*Oncorhynchus gorbuscha*) and chum salmon (*O keta*) producer in Lower Cook Inlet Because the stream experienced declines in total returns since 1987, the Alaska Department of Fish and Game conducted a five-year feasibility analysis and initiated EVOS-funded efforts to restore spawning habitat in two tributaries taken out of production by the 1964 Alaska earthquake Approximately 3,000 m³ of material was excavated from both tributaries Since 1996, over 6,200 pink and chum salmon have colonized and spawned in the restored habitat. To date, an estimated 336,790 pink and 201,554 salmon chum fry (538,055 total) have emigrated from both spawning tributaries

Project objectives include monitoring and evaluation of the long-term physical stability of the restored habitat, including the effects of low discharge events The evaluation of this project is discussed in terms of quantity and quality of riparian habitat A large seepage area is desirable during low discharge events in order to maximize spawning channel area through induced drainage This fact must be balanced with the design problems created during high discharge rates, however Groundwater potentials can play a large role in determining an optimum drainage pattern for low flow spawning channel design, and hence are important design factor in surface water enhancement projects Groundwater potentials were estimated from topography, aerial photography and 20 surveyed ground stations in selected areas to determine groundwater effects on the current project design. The effects of groundwater-surface water interaction on spawning channel area are explored using finite difference approximations to a site model of uniform hydrogeology. The effects of channel excavation on long-term groundwater levels and channel profile are discussed. An update on channel design with respect to high discharge events is presented including the latest tracer gravel movement data

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Project Number and Title 99144 - Common Murre Population Monitoring

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Background The Barren Islands, in the northwestern Gulf of Alaska, supported one of the largest breeding concentrations of common murres (Uria aalge) in the path of the Exxon Valdez oil spill When winds and currents swept oil through the region during April and early May 1989, many of these seabirds were killed they comprised 74% of 30,000 bird carcasses recovered by 1 August Based on this information and a computer modeling study, estimates of mortality suggested that 74,000-315,000 murres died after contacting floating oil Because mortality appeared to be high, the US Fish and Wildlife Service (FWS) conducted Exxon Valdez Oil Spill Tiustee Council-sponsored common murre damage assessment and restoration studies at the Barren Islands during 1989-1991 and 1992, respectively These projects obtained data on numbers of birds attending the colonies During 1990-1992, Exxon-sponsored studies collected additional information on Barren Islands murre numbers In 1993-1994, we counted birds at the East Amatuli Island - Light Rock and Nord Island - Northwest Islet colonies during Trustee Council-sponsored restoration monitoring Projects 93049 and 94039 Although complete censuses were not made in 1995, we counted three sets of East Amatuli Island - Light Rock monitoring plots during APEX Project 95163J In 1996 and 1997, we revisited the islands and censused murres at both colonies as part of restoration monitoring Projects 96144 and 97144, and we counted these colonies again as part of Project 99144 in 1999

Abstract The 1999 project objective was the same as that of previous common murre restoration monitoring studies-to monitor the recovery of murres at the Barren Islands colonies The islands are located at about 58% 55' N, 152% 10' W, between the Kodiak archipelago and the Kenai Peninsula Study sites consisted of East Amatuli and Nord islands and two closely associated islets, East Amatuli Light Rock (Light Rock) and Northwest Islet These areas, comprising the East Amatuli Island - Light Rock and Nord Island - Northwest Islet colonies, contain all of the known murre nesting habitat in the island group Counts were made from small boats by two observers using the same methods employed during the 1993-1997 studies. We censused Light Rock five times and Nord Island - Northwest Islet three times, and made up to six counts on several smaller plot sets (multicount plots) for statistical analyses of among-year differences and trends in population size Plots were treated as sample units and results were pooled with 1989-1997 FWS, 1990-1992 University of Washington (UW), and 1991 Dames & Moore (D&M) data Linear regressions were run to test for trends at the at the 0 1 significance level

Although trends were not present on three of the plot sets, significant increases were found on the 19 plots comprising the Light Rock subcolony (BCP 47-64, P < 0.1), East Amatuli Island -Light Rock multicount plots EAI-BMP 3-4 (P < 0.1), and the 27 plots representing the entire Nord Island - Northwest Islet colony (BCP 1-27, P < 0.9) The positive trends at the large Light Rock subcolony and EAI-BMP 3-4 were stronger than the trends found on these plots sets in 1997 This fact, coupled with the newly identified significant increase at the large Noid Island -Northwest Islet colony (now supporting at least 16,000-17,000 birds, compared to about 12,000 in 1989), indicate murre populations are continuing to recover at these important northern Gulf of Alaska nesting locations **Project Number and Title** 99145 - Relations among populations of coastal cutthroat trout and among populations of Dolly Varden in Prince William Sound

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Principal Investigators Griswold, KE, K Currens, and GH Reeves

<u>Abstract</u> Coastal cutthroat trout and Dolly Varden were determined to have been affected by the 1989 oil spill We examined the genetic relation among populations of coastal cutthroat trout and among populations of Dolly Varden across Prince William Sound in order to help develop a potential recovery program for these fish A total of 11 cutthroat trout populations and 12 Dolly Varden populations were sampled Variability among cutthroat trout populations was high, based on microsattelites and allozymes Dolly Varden variability was less based in the same procedures. These results can be explained in part by the differences in movement of the two species Cutthroat trout do not tend to move far from home streams while Dolly Varden exhibit a wide range of movement. Based on our results, it appears that cutthroat trout populations, if damaged by the oil spill, may recovery more slowly than Dolly Varden populations.

Project Number and Title 99159 - Population Trends of Marine Birds in Prince William Sound, Alaska Recovery following the *Exxon Valdez* Oil Spill [?]

Principal Investigators Brian K Lance, David B Irons, U S Fish and Wildlife Service, Migratory Bird Management, 1011 East Tudor Road, Anchorage, Alaska 99503

<u>Abstract</u> We evaluated recovery and increasing effects on marine bird populations in Prince William Sound (PWS) following the *Exxon Valdez* oil spill by comparing post-spill trends (1989-1998) of densities in oiled and unoiled areas Two criteria were employed First, we tested whether populations in the oiled and unoiled areas were changing at different rates by examining the homogeneity of the slopes between population trends in the oiled and the unoiled areas Second, we examined regression models of densities in the oiled areas of PWS alone to determine trends of affected species

Most taxa for which injury was previously demonstrated were not recovering and some were showing increasing effects nine years after the oil spill During winter, three taxa ("scoters" [Melanutta spp], "mergansers" [Mergus spp], and "goldeneyes" [Bucephala spp]) showed evidence of increasing oil spill effects, four taxa (Harlequin Ducks [Histrionicus histrionicus], "murrelets " [Brachyramphus spp], "loons" [Gavia spp], and Buffleheads [Bucephala spp]) were recovering, while seven taxa ("murres" [Uria spp], "cormorants" [Phalacrocorax spp], Pigeon Guillemots [Cepphus columba], Glaucous-winged Gulls [Larus glaucescens], Mew Gulls [Larus canus], Northwestern Crows [Corvus caurinus], and "grebes" [Podiceps spp]) did not exhibit any trend, suggesting populations of these taxa were not recovering During summer five taxa (Black-legged Kittiwakes [Rissa tridactyla], "mergansers," "scoters," Pigeon Guillemots, and "terns" [Sterna spp]) showed increasing oil spill effects, one taxa (Northwestern Crows) was recovering, and nine taxa (Black Oystercatchers [Haematopus bachmani], "cormorants," "goldeneyes," Glaucous-winged Gulls, Harlequin Ducks, "loons," "murrelets," "murres"," and Mew Gulls) showed no trend, suggesting they were not recovering. We showed evidence of lack of recovery in many taxa which utilize nearshore habitats where oil continues to persist and in taxa that prey on forage fish Potential lingering spill effects and reduced abundance of forage fish may be delaying recovery of many PWS bird populations

Project Number and Title 99163-The APEX Legacy

Principal Investigator David Cameron Duffy, Paumanok Solutions, Kailua, HI 96734 and Pacific Cooperative Studies Unit, University of Hawaii Manoa, Honolulu HI 96822

<u>Abstract</u> The five-year APEX project, now entering its penultimate year of analysis and synthesis, has left us a rich lode of information and insights about how predators and prey in the Gulf of Alaska estuaries interact. Analysis is not yet over and much remains unpublished, but the main results are already clear

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First, we know that our seabirds and marine mammals are living in an ecological depression, sort of like the 1930's in the U.S. We have linked this to changes in the food base and to wider shifts in the North Pacific from cooler to warmer waters. The oil spill added insult to injury, further diminishing populations that were already struggling. Second, we know that seabirds are closely dependent for success on a few energy-rich prey, such as hering, sandlance and capelin. Third, we know that seabirds, like their human counterparts, are skilled fishermen, with individuals exploiting certain techniques and areas, with some "high-liners" and others that can't even make ends meet

APEX informs us of several main lessons for the future First, APEX has reiterated the lesson that long-term standardized data is crucial to understanding any ecosystem Any fisherman knows this, but scientists too often tend to think in periods matching how long their funding will last Second, while the GEM project may have as one of its goals the detection of a 'regime shift", APEX has shown that a suite of climatic actors, beside regime shifts, are playing out their parts in the North Pacific It is very difficult to detect significant changes, as opposed to year to year variability, without the insight of hindsight, and hindsight comes best from long iuns of data Third, the future of North Pacific upper-level predators is probably intimately bound to a single energy-iich, cold-water loving prey species, the capelin When the capelin comes back, the birds, whales and seals will follow Everything else may just be "noise"

APEX leaves a legacy of core multi-year data collections that should be continued and even expanded geographically Continue the shrimp surveys The shrimp may never come back but the surveys are an inexpensive window into the early life of the prey resources of the Gulf of Alaska Fund a brief intense aerial survey of herring and other prey Continue to monitor kittiwake numbers and productivity from the Copper River to Middleton Island to Kodiak Sample the prey of puffins and kittiwakes and marbled murrelets by observation or brief, intensive sampling at a few key colonies and at foraging grounds like Montague Channel and the Barrens Do this year after year, even better decade after decade Above all, put the data together Don't let the scientists sit in their corners Provide a mechanism, like this very meeting, that encourages them to speculate about what their data means up and down the food chain **Project Number and Title** 99163A - Forage Fish Abundance and Distribution in Prince William Sound

Principal Investigators John Thedinga and Lee Hulbert, NMFS Auke Bay Laboratory, 11305 Glacier Highway, Juneau, AK 99801, (907) 789-6025, John Thedinga@noaa gov

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<u>Abstract</u> Forage fish abundance and distribution in Prince William Sound (PWS) is a project that began in 1996 that estimates the biomass and distribution of forage fish utilized by marine birds in nearshore habitats of three geographic regions of PWS (south, central, north) An additional study area near Montague Island was sampled from 1997 - 1999 Forage fish biomass was estimated with hydroacoustic equipment, and species composition and size were determined by sampling with purse seines, trawls, and underwater video Water temperature and salinity profiles were collected at standardized sites within each region The overall objective of this project was to estimate forage fish distribution, abundance, and availability to avian predators

In July 1999 researchers aboard the R/V Montague surveyed PWS with hydroacoustic equipment, while researchers on the F/V Pagan identified fish species within aggregations targeted with the hydroacoustic gear Preliminary data analysis indicates that young-of-the-year (YOY) pollock (Theragra chalcogramma) were the most abundant and widely distributed forage fish within all regions sampled in PWS in 1999, in contrast to previous years of the study in which herring (Clupea pallasi) were the most prevalent forage species The largest aggregations of YOY pollock were found in the central region, near Bay of Isles on Knight Island YOY pollock aggregations commonly associated with bottom structure were large and relatively dense, whereas YOY pollock schools occurring in the upper water column were small, more diffuse, and primarily associated with a jellyfish, Cyanea capillata Although YOY pollock were abundant, the depth of their aggregations may affect their availability to marine birds Adult herring were concentrated primarily in the passages of the southern region, while YOY herring were most abundant in the north, particularly in Port Gravina and Port Fidalgo YOY herring commonly occurred in the upper water column, and foraging birds were often associated with them Although Pacific sandlance (Ammodytes hexapterus) were rarely identified along hydroacoustic transects during the 1999 field season, observations from aerial surveys suggest that boat avoidance and not sampling in shallow habitats results in underestimating sandlance abundance by hydroacoustic surveys

Project Number and Title 99163B - Sand Lance Habitat Modeling for Prince William Sound, Alaska

Principal Investigator and Co-authors William D Ostrand (PI), Tracey A Gotthardt, John Kern, Evelyn D Brown, and Martin D Robards, US Fish & Wildlife Service, 1011 E Tudor Rd, Anchorage, Alaska 99503 (907) 786-3849, william_ostrand@fws gov

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Abstract We sought to model habitat selection by Pacific sand lance (*Ammodytes hexapterus*) by examining their distribution in relation to water depth, distance to shore, bottom slope, bottom type, distance from sand bottom, and shoreline type We determined bottom type by re-analyzing previously collected hydroacoustic data with sediment classifying software, which was calibrated with substrate samples we collected during the summers of 1998 and 1999 Through both logistic regression and classification tree analysis, we compared the characteristics of known sand lance locations to randomly selected sites. All models indicated a strong selection for shallow water by sand lance with weaker association between distribution and shoreline type, distance to shore, bottom slope, and distance to the nearest sand bottom. All sand lance locations were at depths < 60 m and 93 % occurred at depths < 40 m. We used the classification tree to determine potential sand lance habitat within the APEX study areas of Prince William Sound. We then developed a map of potential sand lance habitat and compared that coverage to independent data on sand lance locations collected by aerial observation.

Project Number and Title 99163E - Can Kittiwakes be Used to Predict Future Trends in Adult Herring Abundance?

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Evelyn Brown, School of Fisheries and Ocean Science, University of Alaska Fairbanks, Box 757220, Fairbanks, Alaska 99775

Mark Willette, Alaska Department of Fish and Game, Box 669, Cordova, Alaska 99574

<u>Abstract</u> Because the reproductive success and ultimately the population dynamics of many seabird species are strongly linked to marine productivity, seabirds are commonly promoted as useful indicators of change in the marine environment. Whereas these relationships are of ecological interest, the trophic associations are primarily viewed in hindsight. The ultimate value of seabirds as indicators would be the ability to predict future trends in prey populations. Moreover, if a prey species is of commercial importance, this predictive power could provide valuable information to resource managers. We propose that such a predator-prey relationship with predictive potential exists in Prince William Sound (PWS), Alaska, between Black-legged Kitti-wakes (*Rissa tridactyla*), a colonial breeding seabird, and Pacific herring (*Clupea pallasi*), a prey species of commercial importance.

Black-legged Kittiwakes colonies are located throughout Prince William Sound Studies in PWS over the past 10 years have demonstrated that the availability of high quality forage fish is critical to the reproductive success of these birds In particular, the success of kittiwakes nesting in northern PWS appears to be strictly regulated by the abundance of 1-yr-old herring The strength of this relationship is probably dependent upon kittiwakes in northern PWS having few, if any, alternative prey when the abundance of 1-yr-old herring is reduced (especially during early breeding season)

To evaluate a potential long-term relationship between kittiwakes and herring, we used a 16 year record of kittiwake reproductive success (1984-1999) and estimates of adult herring biomass and age structure during this same period. We considered reproductive success of kittiwakes to be a proxy for the relative abundance of 1-yr-old herring. We then assessed whether abundance trends of 1-yr-old herring, as indicated by kittiwake reproductive success, reflected abundance trends of 3-yr-old herring two years in the future. Preliminary analyses of this relationship indicates that trends in kittiwake reproductive success do reflect future trends in the abundance of adult herring. Given this association, data from kittiwakes indicate that adult herring populations in PWS will likely continue to decline into the year 2001.

Many other variables of kittiwake reproduction, diet, and foraging could be included to create a mathematical model for predicting future trends in adult herring abundance However, since reproductive success is typically the most parsimonious assessment of kittiwake breeding conditions, it is an appropriate starting point

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Project Number and Title 99163F - The breeding and feeding ecology of Pigeon Guillemots at Naked Island, Prince William Sound, Alaska

Principle Investigator Gregory H Golet, US Fish and Wildlife Service, 1011 E Tudor Rd, Anchorage, AK 99503

Abstract We conducted a study to determine mechanisms constraining population recovery of Pigeon Guillemots following the 1989 Exxon Valdez oil spill We asked whether recovery was limited by continuing exposure to residual oil, limitations imposed by prey availability, or other causes Our approach was to compare demographic, physiological and behavioral parameters between an oiled site pre- and post-spill, and between the oiled site and an unoiled site post-spill Following the spill, the guillemot population at the unoiled site increased, while the population at the oiled site remained at a depressed level Adult mass, body condition, and nestling survival were significantly lower at the oiled site post-spill compared to pre-spill, although only peak and fledging masses of the chicks were significantly lower in post-spill comparisons of the oiled site with the unoiled site Elevated CYP1A, LDH and AST enzyme activities detected in guillemots a decade after the spill at the oiled site suggest that continued exposure to residual oil may have limited guillemot population recovery, although reduced availability of sand lance may have also played a role Guillemot chick growth and reproductive success are positively related to the percentage of high-lipid forage such as sand lance in the chick diet Aspects of sand lance life history and the pattern Exxon Valdez oil deposition in Prince William Sound strongly suggest that sand lance were adversely affected by the spill, although reductions in this species' abundance may also have resulted from natural causes Our study suggests that the recovery of a top-level generalist predator may be constrained by both direct and indirect effects following a large-scale the perturbation Furthermore, it demonstrates that recovery following oil spills may take considerably longer for certain species than œ2 5 yrs, which was proposed as typical for marine birds

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<u>**Project Number and Title**</u> 99163G - Diet Composition, Reproductive Energetics, and Productivity of Seabirds Damaged by the Exxon Valdez Oil Spill

<u>Principal Investigator</u> Daniel D Roby, Co-Principal Investigator Patrick G R Jodice Oregon Cooperative Fish and Wildlife Research Unit, Biological Resources Division - USGS and Dept Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331, (541) 737-1955, Email robyd@ucs orst edu, jodicep@ucs orst edu

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<u>Abstract</u> We are studying energetic factors (diet composition, diet quality, meal size, meal delivery rate, and adult daily energy expenditure) potentially constraining seabird productivity in the EVOS area, focusing on Pigeon Guillemots (*Cepphus columba*) and Black-legged Kittiwakes (Rissa tridactyla) as models of fish-eating seabirds The major APEX hypothesis being tested is that differences in the nutritional quality of forage fishes are a primary determinant of energy provisioning rates to seabird nestlings, which influence not only growth and survival of young, but also other factors that regulate seabird populations (e g , post-fledging survival and recruitment rates) The primary study areas for each species are in both Prince William Sound (PWS) and Lower Cook Inlet (LCI) The project also cooperates with components NVP

Forage fish of seabirds exhibited a ten-fold difference in lipid content (% dry mass) and a fivefold difference in energy density (kJ g-1 wet mass) among individuals, such that predators could potentially experience large differences in foraging efficiency depending on prey choice Schooling pelagic fishes such as Pacific herring (*Clupea harengus*), capelin (*Mallotus villosus*), and Pacific sand lance (*Ammodytes hexapterus*) tended to have high lipid content and energy density while juvenile gadids had low lipid content and energy density Near-shore demersal fishes (e g, blennies, sculpins, gunnels) had intermediate lipid content and energy densities

Guillemot and kittiwake diets were composed predominantly of near-shore demersal and pelagic schooling fish, respectively Diet composition for each species varied within and among locations and years For example, guillemot diets at Jackpot Island contained a substantial proportion of juvenile herring in 1994 - 96 and in 1998, but this item was notably absent in 1997 Similarly, herring accounted for > 60% of kittiwake diets at Icy Bay in 1996 & 1998, but < 30% in 1997 Energy provisioning rates (EPRs, kJ nest-1 day-1), which are a product of feeding frequency, meal size, and meal energy density, also varied within and among colonies and years High EPRs and high values for each EPR component appear to be necessary to sustain guillemot productivity Differences in EPRs of kittiwakes within and among locations and years, and particularly differences in the feeding frequency component, suggest that kittiwake productivity may be limited by the spatial and temporal availability of forage fishes with high energy density

Analysis of daily energy expenditure (DEE) of adult kittiwakes raising young in PWS suggest that DEE may vary with food availability Results from Middleton Island, where a controlled feeding experiment has been under way since 1996, have shown that parent kittiwakes receiving supplemental food reduce their DEE significantly, suggesting that provisioning of young requires substantial demands on DEE During 1999, we measured DEE of telemetered parent kittiwakes Time-activity budgets of these foraging parents were monitored during all or most of the DEE measurement interval This combination of behavioral and energetics data has never before been collected for a seabird, and should elucidate the relationship between foraging patterns and DEE

Project Number and Title 99163J - Barren Islands Seabird Studies

<u>Principal Investigators</u> David G Roseneau, Arthur B Kettle, and G Vernon Byrd, Alaska Maritime National Wildlife Refuge, 2355 Kachemak Bay Drive, Ste 101, Homer, Alaska, 99603-8021, (907) 235-6546, Dave_Roseneau@fws gov

Abstract To study the response of seabirds to changes in food availability and quality during the breeding season, from 1995 to 1999 we collected data annually on several breeding and foraging parameters of surface-feeding (black-legged kittiwake, *Rissa tridactyla*) and diving (common murre, *Uria aalge* and tufted puffin, *Fratercula cirrhata*) seabirds at the Barren Islands, Alaska Breeding parameters included nesting dates, reproductive success, and chick growth rate, foraging parameters were adult nest attendance and foraging trip duration, and chick feeding frequency and meal size During the 1996-1999 field seasons we continuously recorded sea surface temperature at two locations in the Barren Islands We monitored the prey base by examining chick diets and by beach seining A related study conducted hydroacoustic and trawl surveys to obtain additional information on the food web Although the 1999 data have not yet been completely analyzed, the following preliminary conclusions can be drawn

During the summer of 1999, kittiwake reproductive success was lower than in 1995-1996 but higher than in 1997-1998 Nesting was late, although not as late as in 1998 Chicks that survived grew at rates similar to those of 1995-1998 Kittiwake chick diet samples were collected but have not yet been analyzed

In 1999, murre reproductive success was high and nesting was early As in previous years, murre chick diets consisted almost entirely of capelin Chick sea-going weight was similar to that of 1997 and higher than in 1996

Puffin reproductive success was high in 1999 and nesting was early Chick growth rates and fledging weights were high The proportion of capelin in puffin chick diet samples has increased each year during 1995-1999

During 1996-1998, sand lance was the most abundant species in beach seine catches In 1999 we caught very few sand lance Also absent during the 1999 breeding season (until late August) were pulses of warm surface water recorded during the 1996-1998 seasons This change in temperature pattern may have influenced the abundance of sand lance

In summary, preliminary analysis shows that in 1999 the marine environment near the Barren Islands was adequate to support average or higher levels of productivity and chick growth rates for kittiwakes, murres, and puffins More detailed relationships among environmental conditions, prey, and seabird reproductive and foraging parameters will be described and discussed in our final report and subsequent publications

Project Number and Title 99163K - Using Predator Fish to Sample Forage Fish

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Background Evaluating the influence of fluctuating prey populations (e.g., forage fishes) is critical to understanding the recovery of seabirds injured by the T/V Exxon Valdez oil spill. however, it is expensive to conduct hydroacoustic and trawl surveys to assess forage fish stocks over broad regions As part of the 1995 Exxon Valdez Oil Spill Trustee Council Alaska Predator Ecosystem Experiment, we tested the feasibility of using sport-caught Pacific halibut (Hippoglossus stenolepis) to obtain spatial and temporal information on capelin (Mallotus villosus) and Pacific sand lance (Ammodytes hexapterus), two forage fishes important to piscivorous seabirds We examined halibut stomachs collected from cooperating vessels in a 150-200 charter boat fleet fishing throughout Cook Inlet waters during late May - early September Catch locations and dates provided information on geographic and seasonal variation in the incidence of capelin and sand lance in seven eastern inlet subunits between Ninilchik and Shuyak Island Data on prev brought to black-legged kittiwake (Rissa tridactvla), common murre (Uria aalge), and tufted puffin (Fratercula currhata) chicks at Cook Inlet colonies were collected simultaneously as part of the APEX project to help evaluate the sampling technique The pilot study conducted in 1995 indicated sufficient types and amounts of data could be collected to test several APEX hypotheses concerning the relationship between seabird reproductive success and forage fish availability As a result, the study was refined and continued during 1996-1999

Abstract In 1999, we obtained 817 halibut stomachs from Homer-based charter boat operators and the Alaska Department of Fish and Game during 18 May - 27 August All of the halibut that were sampled were less than 57 inches (145 cm) long The stomachs were removed from the fresh carcasses, placed in individual ziplock bags labeled by date and location, and frozen until the end of the field season In September, the stomachs were thawed and their contents were identified to species (e g, capelin, sand lance) and other categories of prey (e g, cod, flatfish, crabs) by M Robards, USGS-BRD, using standard taxonomic keys and voucher specimens Data were initially recorded in a notebook and then entered into an Excel spread sheet for later analysis

Data are still being analyzed However, preliminary results revealed that over 500 (60%) of the stomachs contained 2,605 identifiable prey items, including 1,160 (45%) invertebrates and 1,445 (55%) fish, and the fish component was composed of 764 (53%) capelin and 574 (40%) sand lance, percentages similar to our 1998 results (50% invertebrates and 50% fish, 46% capelin and 41% sand lance) During final analysis, percentages of fish, including capelin and sand lance, will be compared among sampling areas and with prey items brought to common murre, black-legged kittiwake, tufted puffin, and horned puffin (F corniculata) chicks at the Barren Islands and Chisik, Duck, and Gull island seabird colonies Results from 1995-1998 indicated that the percentages of capelin and sand lance in the halibut stomachs reflected percentages of these important forage fish fed to kittiwake chicks at the Barren Islands Based on our preliminary 1999 data analysis, and information on kittiwake chick meals collected at these islands in 1999, we suspect that the halibut stomach contents will continue to reflect kittiwake chick diets at this northern Gulf of Alaska nesting location

Project Number and Title 99163L - APEX/ Historic Review of Forage Fish Data

Principal Investigator Paul Anderson, National Marine Fisheries Service, Kodiak, AK

Abstract The Gulf of Alaska (GOA) ecosystem has undergone some abrupt and significant environmentally induced changes starting in the mid to late 1970s (Piatt and Anderson, 1996, Anderson et al, 1997, Anderson and Piatt 1999) Most of the biological changes in the NE Pacific and the GOA follow from the lowest trophic levels through the benthic and pelagic fish stocks to sea birds and marine mammals The extent and degree of these changes are now well documented and provide an important perspective in determining future strategies for management of the marine ecosystem in the GOA Environmental change has been indicated as the greatest influence on the system, and it is likely that changes in the environment will continue to occur in the future as it has in the past. Forage species such as pandalid shrimp and capelin declined because of recruitment failure and predation, and populations have not yet recovered Total trawl catch biomass declined > 50% and remained low through the 1980s In contrast, recruitment of high trophic-level groundfish improved during the 1980s, yielding a > 250% increase in catch biomass during the 1990s This trophic reorganization apparently had negative effects on piscivorus sea birds and marine mammals. It is incumbent that the connections between the ecosystem components and their relationship with the environment are fully understood To operate successfully in this complex and ever-changing system we need long-term data on both physical and biological phenomena

Project Number and Title 99163M - Cook Inlet Seabird and Forage Fish Studies (CISeaFFS)

Principal Investigators John F Piatt, Alaska Biological Science Center, Biological Resources Division, U S Geological Survey, 1011 East Tudor Road, Anchorage, Alaska 99503, (907) 786-3549, john_piatt@usgs gov

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Abstract CISeaFFS ("Sisyphus") was initiated in 1995 as a long-term research project to characterize relationships between seabird population dynamics, foraging behavior and forage fish densities in lower Cook Inlet— the area in which most seabirds were killed by the EVOS CISeaFFS is a collaborative project of the Alaska Biological Science Center and the Alaska Maritime National Wildlife Refuge (AMNWR), with major funding and logistic support from the EVOS Trustees under the APEX Project (Apex Predator Ecosystem Experiment), the Biological Resources Division of the U.S. Geological Survey, the U.S. Fish and Wildlife Service, and the Alaska Department of Fish and Game From 1995 through 1999, populations, productivity, diets and foraging behavior of 6 seabird species (murre, kittiwake, guillemot, puffin, cormorant, gull) were studied at three seabird colonies in lower Cook Inlet (Chisik, Gull and Barren islands) Oceanographic measurements, seabird and hydroacoustic surveys, trawls, and beach seines were conducted in waters around (<40 km) each colony In all years, offshore and southern waters of Cook Inlet were dominated by juvenile walleye pollock and capelin, important prey for mures and puffins Nearshore waters were dominated by sand lance, which were consumed by seabilds (e g, kittiwakes, guillemots, murres) in proportion to their local abundance Acousticallymeasured forage fish biomass was lowest around Chisik Island, moderate in Kachemak Bay, and highest around the Barren Islands Correspondingly, seabird breeding success in all years ranged from relatively low in the Chisik Island area to relatively high in the Barren Islands area Populations of seabirds at Chisik Island continued a long-term decline, whereas populations at Gull and Barren Islands are stable or increasing Behavioral studies revealed that seabirds worked harder (longer foraging tups, less "free" time) at colonies where nearby fish densities were lower Breeding success at all three colonies varied between years, with 1996 being the best year for production, and 1998 being the woist- apparently because of elevated water temperatures resulting from the 1997/98 ENSO event In 1999, water temperatures cooled considerably (below long-term average) and we saw an increase in trawl catches of capelin in lower Cook Inlet, which was also reflected in diets of seabirds and a return to average or better productivity Field work for CISeaFFS is now complete, and data are being archived in preparation for final analysis and reporting

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Project Number and Title 99163-O - APEX Statistical Review

<u>Principal Investigator</u> Lyman L McDonald, Western EcoSystems Technology, Inc , 2003 Central Avenue, Cheyenne, WY 82001

Abstract Non-standard sampling designs were required in the Alaska Predator Ecosystem Experiment (APEX) in Prince William Sound, Alaska, because of severe logistical constraints, unequal length transects, and spatially correlated data These designs require specialized statistical analysis procedures including estimation of resource selection functions Our responsibility included review of modifications in study protocols for the 1999 field season and review of statistical analysis methods to help insure that appropriate statistical inferences are made in reports and papers submitted for publication Specifically in 1999, WEST personnel, Lyman L McDonald, John Kern, and Shay Howlin collaborated with APEX investigators, William D Ostrand, David Irons, Tracey A Gotthardt and Robert Survan providing basic statistical support on resource selection studies of sand lance in Prince William Sound, development of statistical methods to analyze feeding behaviors in nesting sea birds, and development of statistical methods for analysis of spatially distributed acoustic biomass estimates Analysis components included development and application of new geostatistical methods for hydro-acoustic biomass estimates [Kern, J W and K O Coyle, 1999 Estimation of the global block kriging mean with large sample sizes on irregular polygonal regions Applications to acoustic surveys for zooplankton in the Western Aleutian Islands Canadian Journal of Fisheries and Aquatic Sciences Submitted], comparison and evaluation of classification and regression tree methods to traditional classifications methods such as discriminant analysis to classify bottom type using raw hydro-acoustic indices [Ostrand, WD, TA Gotthardt, S Howlin, J Kern, and MD Robards, 1999 Habitat selection by Pacific Sand Lance in Prince William Sound, Alaska Under internal review], and application of spline regression models to analyze sea bird feeding behavior [Survan, R, and C Nations, 1999 Detecting variation in prey availability using daily foraging trip duration Manuscript in preparation]

Project Number and Title 99163 Q - Detecting Long Term Changes in Seabird Populations in Prince William Sound and the Gulf of Alaska Modelling Our Ability to Detect Trends

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Abstract Conditions in PWS and the GOA often vary widely from one year to the next, and this variation is reflected in the abundance and distribution of seabirds and their prey. These annual fluctuations are clearly demonstrated by data collected during a four year period of intensive aerial surveys for surface schooling fish and tracking of radio tagged BLKI carried out as part of the APEX program. Longer term data sets relating to colony productivity also show that a high level of spatial and temporal variability in annual reproductive success is the norm for seabirds in this area. The question which we address is. What level of sampling effort would be necessary to detect a long term trend in the distribution and abundance of seabird populations given the natural level of variability in the system?

We examine four types of data which might be collected as a part of a long term monitoring program (1) breeding success based on the number of birds that breed and successfully rear chicks at a colony, (2) abundance and distribution of seabirds as measured by boat or aerial survey, and (3) abundance and distribution of surface schooling fish as measured by aerial survey Each of these measures is a potential indicator of the population status of seabirds or the component of the fish populations on which they feed

We model our ability to detect changes in the system by superimposing observed annual fluctuations onto various scenarios of long term population level changes. We then create artificial sets of sample data that simulate what would be observed under each scenario. Results are expressed in terms of the likelihood that a change in a monitored parameter would be detected within a given period of time. We examine the efficiency with which various hypothetical sampling programs carried out at different temporal and spatial scales are able to detect these changes. **Project Number and Title** 99163R - Environmental Factors and Marine Habitat Associations of Adult and Juvenile Marbled Murrelets Implications to Monitoring Murrelet Productivity

<u>**Principal Investigators**</u> Katherine J Kuletz US Fish and Wildlife Service, 1011 E Tudor Rd, Anchorage, AK 99503, kathy_kuletz@fws gov

Abstract Monitoring the reproductive success of a non-colonial seabird poses special problems For the marbled murrelet (Brachyramphus marmoratus), the most abundant bird breeding in Prince William Sound (PWS), Alaska, productivity is measured by surveying juveniles at sea during the fledging period (Kuletz and Kendall 1998) Power to detect trends in juvenile murrelet densities are usually low, due to their low numbers and dispersal at sea One way to reduce variance in counts would be to determine if juveniles exhibit habitat preferences, and if so, stratify survey effort by habitat I examined the influence of habitat and survey conditions on juvenile murrelet densities at study areas in PWS The areas, comprised of shoreline transect sections, were surveyed 7-10 times each in July and August 1995 (6 sites), 1997-98 (3 sites), and 1999 (2 sites) To start, I used stepwise multiple regression to model both adult and juvenile densities at the transect level using 1995 data Based on the most parsimonious model, I used analysis of deviance tests on logistic regression models to select the best predictor of presence or absence of juveniles In preliminary models, area effect was an overwhelming factor, necessitating nested analyses Weather-related, surface marine conditions, and tidal state did not significantly add to the models The best model for juvenile density included shoreline type, exposure, and water depth In PWS, juveniles are most likely to occur along rocky shoreline with low to moderate exposure and relatively shallow waters (< 40 m) Water depth was the only significant predictor variable for adults, once area and date effects were controlled The best habitat models explained 36% of the variance in juvenile numbers and 23% of adult numbers Variability in counts of juveniles can probably be reduced by stratifying habitats for surveys, however, a large amount of variability was unexplained Area effect was clearly important, suggesting that other aspects of area need to be included Factors not included in these analyses, such as local inland nesting habitat and forage fish availability, likely are important to juvenile murrelet distribution The final step will be to incorporate murrelet nesting habitat (DeVelice et al, in prep) and patterns of prey habitat associations (Ostrand et al, in prep) into a model of murrelet productivity and distribution Toward this end, the model based on 1995 data will be tested and refined using 1997, 1998 and 1999 data, during which exact location of every bird encountered on transect was mapped with a Global Positioning System

Project Number and Title 99163S - Jellyfish in Prince William Sound Abundance, Aggregation, and Feeding Rates on Zooplankton

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<u>Abstract</u> Jellyfish are abundant predators of zooplankton, and therefore are potential competitors of forage fish species (herring, sandlance, juvenile walleye pollock, juvenile pink salmon) The main objective of this research is to determine the feeding effects of jellyfish on zooplankton populations, in order to evaluate their importance as potential competitors of forage fish In order to accomplish this objective, data on jellyfish and zooplankton abundances, jellyfish gut contents, and digestion rates were collected

Large jellyfish (*Cyanea, Aurelia*, and *Aequorea*) were sampled by herring seine in order to estimate their abundances Numbers and biomass of these species were measured Jellyfish populations differed among years In 1996, jellyfish were markedly more abundant as compared with other years (1997 to 1999)

Zooplankton populations sampled with 243 mm nets, were compared among years (1995 - 1998) and found to have very similar proportions of the various taxa (86 - 96% similarity) (PSI, Schoener 1974) This high degree of similarity allowed valid comparisons of jellyfish and fish diets to be made among years Zooplankton densities will be used in calculations of jellyfish feeding effects

Jellyfish were collected in July 1997, 1998, and 1999 from Prince William Sound for gut content analysis Dietary analysis showed that copepods and larvaceans were the main prey of jellyfish and forage fish (data from Dr Molly Sturdevant) *Aurelia, Pleurobrachia*, juvenile herring, juvenile walleye pollock, and sandlance ate mainly copepods and cladocerans, while *Cyanea*, *Aequorea*, and pink salmon ate mainly larvaceans The percent diet similarity index (PSI) was highest among the crustacean-eating species (60-70% similarity for *Aurelia* and 40-50% for *Pleurobrachia* versus pollock, sandlance, and herring) The PSI for larvacean-eating species also was high — 78% for *Cyanea* and 59% for *Aequorea* versus pink salmon These results show that jellyfish and forage fish diets overlap substantially, and potentially could compete for food

In order to estimate jellyfish feeding effects on zooplankton populations, digestion rates were determined Experiments showed that copepods and cladocerans required 2 hours to be digested by *Cyanea* and 3 hours to be digested by *Aurelia* Both jellyfish species digested larvaceans within 1 hour In order to calculate jellyfish feeding rates, the mean numbers of prey (copepods, cladocerans, and larvaceans) in each jellyfish species were divided by the digestion times The feeding rates were multiplied by the densities of medusae and divided by the densities of prey organisms, in order to estimate the percentages of the prey populations consumed Multiple regression analyses showed that the numbers of the main prey types found in each jellyfish were significantly related to jellyfish diameter and prey densities These relationships will be combined with direct predation calculations in order to estimate jellyfish predation effects

Project Number and Title 99163T - Ecological Factors Affecting the Distribution and Abundance of Forage Fish in Prince William Sound, Alaska, An APEX Synthesis Product

Principal Investigators Evelyn D Brown and Brenda L Norcross, University of Alaska Fairbanks, Institute of Marine Science, PO Box 757220, Fairbanks, AK 99775-7220, (907) 474-5801, ebrown@ims uaf edu

Abstract As part of the Alaska Predator Ecosystem Experiment (APEX) program, this study and has two main goals 1) to provide APEX researchers with data on the spatial and temporal distribution patterns of forage fish, associated sea birds, and jellyfish within Prince William Sound needed for their respective analyses (00163B, E, F, Q, R, and S), and 2) to improve our understanding of ecological factors affecting the distribution, abundance, and availability as prey of forage fish, specifically, Pacific herring (*Clupea pallasi*, injured by the spill), Pacific sand lance (*Ammodytes hexapterus*), capelin (*Mallotus villosus*), and eulachon (*Thaleichthys pacificus*)

We used aerial surveys repeated over established flight tracks up to 12 times over a six-week period. We coordinated with the APEX acoustic survey (00163A). We also collected data on marine mammals and salmon sharks, which has been shared with NOAA and other researchers. We obtained fish species identification and size from net catch, diver, visual observations, and underwater video footage collected by this project and others. In 1999, we compiled validations of over 400 schools. The underwater video images also provided previously unknown information on sand lance school configurations and spacing needed for expanding school size estimates to biomass. We will use literature values to expand estimates for herring, eulachon and capelin

Using geostatistical methods and general additive models, we will examine the effects of oceanographic conditions on forage fish and sea bird distribution and abundance Predictor variables include sea surface temperature and salinity from satellite and hydrographic data sets as well as the timing and duration of water column stratification We will also include the strength, duration and spatial extent of primary production (satellite data) and the zooplankton bloom Finally, we will look at bathymetry and ocean structure, such as eddies, over locations where we have repeatedly observed forage fish

Major findings to date include 1) beginning in May and peaking in June, surface schools of age-1 herring, adult pre-spawn capelin, and eulachon are commonly observed along with huge numbers of predators, 2) beginning in July (June for El Niño years), age-0 sand lance and herring recruit to beaches and bays (respectively) adding to the availability of forage, 3) there are several keys locations with species-specific aggregations of forage fish occurring every year, 4) surface occurrence of juvenile herring schools peaks with zooplankton abundance and therefore factors affecting the zooplankton bloom probably affect the availability of juvenile herring as forage **Project Number and Title** 99169 - A Genetic Study to Aid in Restoration of Murres, Guillemots and Murrelets to the Gulf of Alaska

Principal Investigators Vicki L Friesen, Queen's University, Department of Biology, Kingston, Ontario K7L 3N6, Canada, (613) 533-6156

John F Piatt, Alaska Biological Sciences Center, 1011 East Tudor Road, Anchorage, AK 99503 (907) 786-3549

Abstract Common murres (*Urua aalge*), marbled murrelets (*Brachyramphus marmoratus*) and pigeon guillemots (*Cepphus columba*) suffered high mortality from the *Exxon Valdez* Oil Spill Although populations of common murres now appear to be recovering, populations of pigeon guillemots and marbled murrelets apparently are not. The importance of genetic problems (such as genetic isolation of colonies or inbreeding) in the poor recovery of these species is unclear. Furthermore, most seabirds were migrating between wintering and breeding sites in March 1989, so the impact of the Spill on individual breeding populations is uncertain. We are conducting a genetic study to aid in the restoration of these species to the Gulf of Alaska Specifically, we are using molecular methods (1) to estimate gene flow both among colonies within the Spill area and between the Spill area and adjacent regions, and (2) to derive molecular markers to determine the impact of the kill on different breeding populations.

Tissue and blood samples have been collected from several colonies of each species from the Gulf of Alaska and neighboring regions Variation in mitochondrial DNA, nuclear introns and microsatellites is being compared among samples using a variety of mutation-detection methods A variety of analyses, including approaches based on maximum likelihood and coalescent theory, are being used to estimate the levels of genetic differentiation and gene flow among colonies, as well as to derive colony-specific markers

Preliminary results indicate that gene flow among colonies of pigeon guillemots is restricted, and that isolation-by-distance effects exist. Gene flow among local populations of marbled murrelets also is low, but migration into the Spill area from surrounding populations is slightly higher than for guillemots. These low rates of migration are consistent with the poor rates of recovery of populations in the Gulf of Alaska. Slight genetic differences exist among colonies of common murres, but gene flow is high compared to guillemots and murrelets, consistent with the higher rate of recovery of murre populations. Although few colony-specific alleles exist, molecular markers in the form of allele frequency differences at multiple loci may be used to identify the origins of birds killed by the Spill Results also indicate that common murres in the Gulf of Alaska hybridize with thick-billed murres (*U lomvia*)

Project Number and Title 99180 - The Russian River portion of the Kenai River Restoration

Principal Investigator Patrick O'Leary, Chugach National Forest, Seward Ranger District, PO Box 390, Seward, Alaska 99664

<u>Abstract</u> The Seward Ranger District of the Chugach National Forest is working on a project to rehabilitate damaged natural resources and protect cultural resources along the Russian River while continuing to provide a quality recreation experience for forest visitors Increasing numbers of people along the river have led to stream bank habitat deterioration, damage to cultural resource sites, and the existing trail and facilities adjacent to the river

The purpose of this project is to 1) Protect quality habitat for five species of fish, numerous aquatic insects, and wildlife species that utilize the Russian River and surrounding area, 2) Maintain a healthy, productive riparian area by reducing human caused impacts to vegetation, soils, and tree roots, 3) Preserve the unique cultural heritage of the area by protecting cultural resources from foot traffic and accelerated stream bank erosion, and 4) Repair or replace, detenorated facilities including boardwalks, fish cleaning stations, and trails

The scope of this project consist of closing 91% of the bank to foot traffic through fencing, constructing over 3,000 feet of new boardwalk, 25 river access points, and reconstructing the remaining sections of trail away from the riverbank All boardwalks within 25 feet of the river and the accesses are being constructed with light penetrating grating to allow for establishment of vegetation beneath the walking surface A fence/railing is being constructed on the riverside of all boardwalks and trail segments Gravel trails are being constructed of compactable material to a uniform 4' width Volunteers, through the Stream Watch Program, are providing education and monitoring users Interpretive signs are also being installed to assist in educating river users And the adjacent stream bank is being revegetated with the help of the Youth Restoration Corp

To date 1550 feet of trail and 6 river accesses have been reconstructed In the past 3 years the *Exxon Valdez* Oil Spill Trustees Council has contributed approximately \$250,000 towards trail reconstruction along Russian River In 1999 the Council's contributions were \$100,000 This money was used to build approximately 355 feet of elevated light penetrating boardwalk, reroute 265 lineal feet of 4' wide gravel trail, and reconstruct 105 lineal feet of gravel trail The work completed in 1999 connected the reconstructed gravel trail from the Grayling Access to work that was completed in 1997 and 1998 An improved trail is now in place from the Grayling Access to just upstream of the sanctuary Year 2000 work will consist of constructing an additional 240 feet of boardwalk towards the Sanctuary and 280 feet of boardwalk and trail upstream from Grayling

A review of this project through visitor contacts and personal observations made by Forest Service personnel and Steam Watch Volunteers indicate initial success and acceptance by the public The boardwalks and reconstructed trail makes travel more user friendly while providing vegetation protection along the riverbank River bank vegetation is showing a remarkable comeback where the trail work and the stream bank restoration work has been completed And through educational efforts, such as interpretive signs and the Stream Watch Program, river users are changing their habits from bank fishing to in stream fishing resulting in fewer violations of the riverbank exclosures **Project Number and Title** 99180 - Kenai River Habitat Restoration and Recreation Enhancement Project

<u>Principal Investigator</u> Art Weiner, Alaska Dept Natural Resources, 550 West 7th Ave , Suite 1400, Anchorage, AK 99501, artw@dnr state ak us

Abstract Adverse impacts to the banks of the Kenai River total approximately 19 miles of the river's 166 mile shoreline Included in this total are 5.4 river miles of degraded shoreline on public land Trampling, vegetation loss and structural development have impacted riparian habitats. This riparian zone provides important habitat for pink salmon, sockeye salmon and Dolly Varden, species injured by the *Exxon Valdez* oil spill. The project's objectives are to restore injured fish habitat, protect fish and wildlife habitat, enhance and direct recreation and preserve the values and biophysical functions that the riparian habitat contributes to the watershed. Restoration/enhancement techniques include revegetation, streambank restoration, elevated boardwalks, floating docks, access stairs, fencing, signs, and educational interpretive displays.

A total of twelve sites on the mainstem of the Kenai River were chosen for restoration/enhancement Construction status of these sites is as follows

- Kenai Dunes (Completed)
- Rotary Park (Completed)
- Endicott Sonar Site (Completed)
- Ciechanski (Completed)
- B1g Eddy (Completed)
- Funny River (Completed)
- Bing's Landing (Completed)
- Kobylarz (Completed)

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- Chester Cone (Completed)
- Centennial Park (Completed)
- Russian River [Phase I] (Completed)
- Russian River [Phase III Under construction]
- Slikok Creek (Under construction)
Project Number and Title 99190 - Construction of a Linkage Map for the Pink Salmon Genome

Principal Investigator Fred W Allendorf, University of Montana, Department of Biological Science, HS 104, Missoula, MT 59812 <u>darwin@selway umt edu</u>

Abstract We continue work on our project to construct a genetic linkage map for the pink salmon (*Oncorhynchus gorbuscha*) genome Such a map was proposed initially to provide the necessary platform to identify genetic damage in pink salmon inhabiting oiled streams following the March 1989 *Exxon Valdez* oil spill (EVOS) We are currently conducting experiments at the Alaska SeaLife Center (ASLC) that use the linkage map to test for organismal effects of regions of the genome on phenotypes that affect traits that are important to recovery of pink salmon (e g, growth and survival) Fifty-thousand progeny from 49 families produced from wild pink salmon collected from Likes Creek in August 1998 were marked and released from the ASLC in May 1999 Sexually mature adults from the 1998 cohort are expected to return to the ASLC in August 2000 We will compare genotypes in released fiy and returning adults to test for genetic diffeiences in marine survival and other life history traits (e g, body size, egg number, and egg size) This research will aid recovery efforts with pink salmon, including estimation of straying rates, description of stock structure, and testing if marine survival and other organismal measures of phenotypic variation have a genetic basis

We have determined the genotype of the parents of the 49 families that were released into Resurrection Bay at 49 polymorphic loci, 15 PCR-DNA and 34 allozyme loci. We have analyzed the inheritance of six of the 15 DNA loci in all 49 release families. This information will be used to place the returning adults into the correct family as well as to look for correlations between fitness traits and genotype. In addition this experimental design has allowed us to identify mutations resulting in allele length differences in progeny in some families. Currently we are investigating the mutation rate and any linkage relationship between loci in which mutations were detected.

In August 1999, we initiated the second part of this experiment Sixty-eight adults, 34 males and 34 females, from Likes Creek were collected, and their gametes were used to produce 68 half-sib families. These families are being raised at the ASLC and will be released in May 2000. We compared the size and meristics between year classes as well as sex and found significant differences between both sex and year class.

Project Number and Title 99191A - Injury to Pink Salmon Embryos in Prince William Sound

Principal Investigators Andrew K Craig¹, Brian G Bue², Mark Willette¹, David G Evans²

¹Alaska Department of Fish and Game, Commercial Fisheries Division, Cordova, Alaska ²Alaska Department of Fish and Game, Commercial Fisheries Division, Anchoiage, Alaska

Abstract We examined pink salmon embryo mortality in oil-contaminated and reference streams in Prince William Sound Pink salmon embryos that incubated in oil-contaminated spawning areas initially appeared to have been adversely affected by the Exxon Valdez oil spill from 1989 through 1993 Embryo mortality was elevated in oil-contaminated streams during this period (P<0 02 for all years) From 1994 through 1996, embryo mortalities were not elevated in oil-contaminated streams (P>0 47) indicating a possible recovery from the effects of oil contamination Then, in 1997 embryo mortalities were again significantly greater (P=0 03) in oiled than in reference streams In 1991, embryo mortality was elevated in both the intertidal and upstream zones of oiled-contaminated streams This result was unexpected, because the presence of observable oil was dramatically reduced in all areas, and the upstream zone had not been contaminated with oil Investigators proposed three hypotheses regarding the mechanisms that may have caused this result (1) oil-induced damage to the 1989 and 1990 broods included deleterious mutations in the germline, (2) incubating embryos continued to be damaged physiologically by an oiled environment even after observable oil was gone, and (3) differences in embryo mortality were due to natural environmental factors that differed between oiled and reference streams In 1993 and 1994, we conducted controlled incubation studies to test the third hypothesis The results from our field studies were consistent with those from the controlled incubation studies indicating that natural environmental factors between oiled and reference streams were not the cause of observed mortality differences

Recently, other investigators have hypothesized that the observed differences in embryo mortality between oiled and reference streams were due to sampling-induced mechanical shock Pink salmon embryos are sensitive to mechanical shock until completion of epiboly two to three weeks after fertilization depending on developmental rate. It has been suggested that the timing of sampling relative to spawning affected our results. We examined the effect of including a measure of embryo sensitivity to mechanical shock as a covariate in our analyses and found sporadic evidence of an involvement of mechanical shock in our observations, but a lack of runtiming data precluded an in-depth study of the phenomenon

Project Number and Title 99195 - Pristane Monitoring in Mussels

<u>Principal Investigators</u> Jeffrey Short and Patricia Harris, Auke Bay Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626, (907) 789-6065, Jeff Short@noaa gov

Abstract Pristane in Prince William Sound (PWS) mussels (*Mytilus trossulus*) has been monitored for the last 5 years to assess whether seasonal variability of tissue concentrations may be related to recruitment of salmon and herring Pristane is an environmentally persistent hydrocarbon naturally produced by *Neocalanus* copepods in PWS These copepods account for nearly all of the planktonic biomass available as prey for zooplanktivorous fishes during early Spring, especially juvenile pink salmon during initial marine residence Laboratory and field experiments have confirmed that these fishes excrete some of the pristane ingested with *Neocalanus* copepods in feces, and the feces are subsequently ingested by mussels. The time scale for pristane accumulation by mussels exposed to pristane-laden feces is a few days, and for depuration of accumulated pristane a few weeks. Monitoring pristane concentration increases in mussels during Spring thus indicates the conversion of nearby copepods into fish feces, implying growth of the zooplanktivorous predators. Rapid growth during early life history is essential for high survival

Last year, marine survival of juvenile pink salmon released *en masse* from PWS hatcheries was found to be significantly associated with pristane concentration increases in mussels near hatcheries 2 - 3 weeks following releases Pristane concentrations have been monitored during Spring at a network of 30 stations for each of the last 5 years in PWS Hatcheries in PWS have released most pink salmon juveniles in large groups of up to 130 million per group, usually during May Comparison of marine survival determined from adults returning to these hatcheries, with pristane concentration increases in mussels collected from sampling stations within 25 km of hatcheries before and 2 - 3 weeks following release of juveniles, showed that 33% of the interannual survival variability is explained by pristane increases (P < 0.05, df = 13)

These results strongly suggest that continued monitoring of pristane in mussels may have predictive value to forecast marine survival of hatchery-released pink salmon The current network of sampling stations is not optimized geographically with respect to hatchery locations At the one hatchery where the geographic locations of sampling stations are nearly optimal, pristane increases account for 82% of marine survival (P < 0.05, df = 3) Beginning Spring 2000, additional stations will be sampled near the other hatcheries to improve geographical coverage Annual survival forecasts will be made for each of the hatcheries on a provisional basis to evaluate the utility of pristane monitoring as a salmon management tool The relation of these hatchery forecasts to wild-stock survival will also be evaluated, based on concurrent pristane increases at stations more distant from hatcheries This may potentially extend the utility of pristane monitoring to wild salmon stock management in PWS **Project Number and Title** 99196 Genetics of Populations of Pink Salmon Inhabiting Prince William Sound

Principal Investigators Christopher Habicht, Lisa W Seeb, James E Seeb Alaska Department of Fish and Game, Gene Conservation Laboratory, 333 Raspberry Road, Anchorage, Alaska 99518 (Chris Habicht@fishgame state ak us, 907-267-2169)

Abstract Pink salmon, Oncorhynchus gorbuscha, embryos and alevins suffered increased mortality, diminished growth, and a high incidence of somatic cellular abnormalities as a result of spawning ground contamination and rearing in oiled areas Understanding the genetic structure of affected populations is critical to their management and conservation Our goal was to examine naturally occurring genetic markers to delineate the population structure of Prince William Sound (PWS) pink salmon and to provide a genetic basis for fishery management and restoration programs Because all pink salmon spawn at age two, even- and odd-year fish do not interbreed resulting in two genetically distinct groups Population structure was evaluated for each group separately

Allozyme and mitochondrial DNA (mtDNA) data were collected from putative populations spawning throughout PWS during 1991-1997 (total of 118 collections of approximately 100 fish each) We also analyzed archival data from 26 putative populations made in 1976 (approximately 40 fish each) Sixty-four allozyme loci were screened and 37 loci were used in statistical analyses for collections made in the 1990's Twelve allozyme loci were screened and six loci were used in statistical analyses for collections made in 1976 Additionally, 40 fish from each of the 1990s collections were screened for haplotype variation at the ND5/ND6 region fusing six restriction enzymes, 19 haplotypes were detected

In general, both marker types showed similar patterns of genetic structure, but the allozyme analysis detected more variation than the mtDNA analysis This difference between the two markers may be a result of higher statistical power of the allozyme data as a consequence of the larger number of fish and loci analyzed Significant differences were detected within some, but not all, streams from year to yeai (allozymes even- and odd-years, mtDNA even-year), between elevations (allozymes even- and odd-years, mtDNA even-year) and between tunings (allozymes even- and odd-years) Although variation within streams often overshadowed variation among streams, some among-stream and among-region variation was detected in all analyses except the mtDNA odd-year analysis Differences in the genetic structure of pink salmon in the 1990's relative to pink salmon in 1976, in combination with historic hatchery practices and recent tagging data, strongly suggest the hatchery program has had an homogenizing effect on genetic population structure of pink salmon in PWS

These findings will provide managers with a foundation to evaluate management, conservation and restoration proposals They provide reinforcement for managing pink salmon on as small a scale as financial resources allow, as is done presently Potential success or failure of restoration projects can be evaluated more rigorously For example, in supplementation programs where gametes are taken from adults returning to a stream, incubated in protected conditions and released back into the stream, care needs to be taken not to mix gametes from genetically distinct early- and late-spawning fish or upstream- and tidally-spawning fish

Project Number and Title 99210 - Youth Area Watch

Principal Investigators Jennifer Childress, Joshua Hall, Chugach School District, 9312 Vanguard Drive, Suite 100, Anchorage, AK 99507, (907) 522-7400, Fax (907) 522-3399, jhall@micronet net

<u>Abstract</u> Youth Area Watch is a project designed to involve students from 9 communities around Prince William Sound and lower Cook Inlet in EVOS funded research activities 28 to 30 students are involved in the project each year Students are trained by scientists in data collection protocol and procedures Students then collect data on a regular basis depending on the needs of the scientists Students also have opportunities to travel to remote sites by plane or research vessels to work with the scientists directly

Youth Area Watch is designed to encourage students to become more aware of the science happening in their "backyard" Through their meaningful contributions to local research projects, students start to realize that science can be an important factor in their lives They also learn that they can have an active rather than a passive role when it comes to science

In the past year, students have been involved in a number of research projects including blue mussel collection/pristane hydrocarbon analysis, surf scoter satellite tracking, harbor seal biosampling, meteorological/oceanographic data collection, and killer whale monitoring Students have also initiated local community research projects including pond restorations and studies, kittiwake monitoring, exhibit contribution at the Alaska SeaLife Center and coastal clean ups These local projects allow students to apply the scientific skills learned from researchers, as well as in their classrooms, to issues within their communities

This project is of benefit to students and their communities The students gain an understanding of how responsible citizens can be stewards of the local resources Initiating local projects also instills a sense of responsibility for the well-being of the community The project encourages rural young people of South Central Alaska to take on leadership roles and to educate themselves about the environmental issues facing them

Project Number and Title 99225 - Port Graham Pink Salmon Subsistence Project

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Principal Investigators Paul McCollum, PO Box 2016, Homer, Alaska 99603, (907) 284-2233 paulam@ptialaska.net

Abstract This project is helping to supply pink salmon (Oncorhynchus gorbuscha) for subsistence use in the Port Graham area during the broodstock development phase of the Port Graham hatchery Because local runs of coho and sockeye salmon, which are the more traditional salmon subsistence resource are at low levels, pink salmon are being heavily relied on for subsistence The project is helping to ensure that pink salmon remain are available for subsistence use until the more traditional species are rejuvenated By increasing the fry to adult survival of Port Graham hatchery pink salmon during the hatchery's broodstock development phase, more pink salmon can be used for subsistence use Two primary methods are used with the first being to increase marine survival of hatchery fish, i.e., the number of hatchery released fry that return as adults, and the other being to increase the utilization of the adult return through increased monitoring The principal method being applied to increase marine survival is to increase the size of the fry prior to release into the wild Rearing the fry to at least 75 grams and preferably 10 gram before releasing them can significantly improve marine survival Due to a fire in January of 1998, which destroyed all of the hatchery pink and sockeye salmon, there were no hatchery adult pink returns in 1999 The hatchery released 6 05 million pink salmon in 1996 in two different groups which returned as adults in July and August of 1997 About 205,000, or 3 3%, of the 6 2 million fingerling released in 1996 survived to return as adults in 1997 This was the highest overall manne survival rate for pink salmon as well as the largest adult return to the hatchery to date In 1997 about 920,000 fry emerged from the incubators The production group of 900,000 reached an average weight of 1 0 gram while the 18,000 experimental accelerated pinks reached 1 4 grams Both groups were released on June 9 All of the accelerated pinks were marked with an adapose fin clip and a coded wire tag. An estimated total of 20,471 adult pinks returned to the hatchery in 1998 This equates to a 2.3 % marine survival The escapement up the Poit Graham River was 12.559 pinks and 5.092 chums (coho were not counted) The preliminary analyses of the CWT tag data indicates that the accelerated pinks experienced twice the level of marine survival of the normal production group The additional stream surveys which is the second strategy for maximizing use of the adult return through increased monitoring went quite well in FY 98 & FY99 This resulted in providing the local Alaska Department of Fish & Game (ADF&G) fisheries manager with additional information with which he was able to allow more subsistence and broodstock harvesting opportunities without jeopardizing the wild escapement

Project Number and Title 99245 - Community-based Harbor Seal Management and Biosampling

Principal Investigators Monica Riedel, Executive Director, Alaska Native Harbor Seal Commission, PO Box 2229, Cordova, AK 99574 (907) 424-5882 email <u>aksealmr@ptialaska net</u>

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Abstract This project continues work supported through previous harbor seal (Phoca vitulina) restoration projects A biological sample collection program, implemented in FY96 will continue Village-based technicians are selected by the Alaska Native Harbor Seal Commission (ANHSC) and trained by the Alaska Department of Fish & Game to collect samples from subsistence caught seals The samples are transported to Anchorage or Kodiak for further sampling and distribution to participating scientists for analysis

The initial study area included villages in Prince William Sound where a continuing decline in the harbor seal population has been documented. The study then expanded to include the lower Cook Inlet villages then to the Kodiak Island area in FY97. This year, through EVOS, the study expanded to include Chignik Lake and Alaska Peninsula villages. In addition, the ANHSC was awarded a grant from the North Pacific Maine Research Initiative to further expand the scope of the sampling and Native involvement to include villages located in the Aleutian Islands and the Bering Sea. An additional funding source from the National Marine Fisheries Service was provided to implement the project in Southeast Villages

Native hunters are in an excellent position to assist in scientific studies by providing biological samples from subsistence taken marine mammals Subsistence hunters are trained using protocols developed by the ADF&G Subsistence, ANHSC, the University of Alaska Sea Grant Program, and the UAF Museum A detailed manual is used during the training sessions A student intern at the ANHSC office assembles biosampling kits and Dr Vanek demonstrates the sampling techniques and use of equipment Research results are shared through biannual ANHSC newsletters

This program supports collaboration between subsistence hunters of harbor seals, scientists, and iesource management agencies while promoting co-management Hunters have an opportunity to become directly involved in research and conservation efforts and share their vast traditional knowledge with Youth Area Watch participants To date, 79 hunters throughout the State have been certified to collect biological samples and over 185 samples have been collected and archived. We have found that the overall condition of the seals harvested has been generally healthy Archives such as museum collections are crucial to the study of long-term change. We know that molecular methods such as DNA sequencing and stable isotope analysis have become profoundly useful and that ultra cold storage preserves a broad suite of biochemical characteristics. Therefore, the accumulation of large, well documented, series of frozen specimens from high-trophic-level consumers can prove vital to the evaluation of environmental change.

Project Number and Title 99247 - Kametolook River Coho Salmon Restoration Project

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<u>Abstract</u> Subsistence users from the remote South Alaska Peninsula Native Village of Perryville noted declines in the coho salmon (*Oncorhynchus kisutch*) run in the Kametolook River since the *Exxon Valdez* oil spill (EVOS) The Trustee Council began funding this project in Federal Fiscal Year 1997 with the intent of restoring the run to historic levels. This project is a continuation of an evaluative phase of the project funded through the EVOS criminal settlement (Grant 2168588) Although data were not available or limited before the salmon decline, it was determined that instream incubation boxes in conjunction with commercial and subsistence harvest restrictions were the preferred restoration alternatives

Involvement by the villagers of Perryville and use of traditional knowledge are an integral part of restoring the Kametolook River coho salmon as a subsistence resource. As part of the community involvement, an aquarium has been set up where students participate in incubating eggs and releasing fry into the Kametolook River Since 1997, more than 125 coho salmon fiy have been released annually from the school project. In 1999, eggs were again placed in the aquarium, students will release any resultant fry in May 2000. In addition, the Perryville Village Council has hired local assistants that assist ADF&G with fieldwork including genetic and pathological sampling, incubation box installation and monitoring, egg takes and incubation techniques, and year around monitoring of the environment.

Annually, since November 1997, coho salmon eggs have been placed in two Kametolook Rivei instream incubation boxes. Since, 1997, the Kametolook River coho escapement has shown some improvement. The increased escapement is believed to be partially attributed to self-imposed initively harvest restrictions by the villagers and commercial fishing restrictions in marine waters. All facets of this project should provide sufficient escapement within two coho life cycles for subsistence and spawning requirements.

Project Number and Title 99252 - Investigations of Genetically Important Conservation Units of Species Inhabiting the EVOS Area

Principal Investigators James E Seeb, Lisa W Seeb, Jeffrey Olsen, and Dan Moore, Gene Conservation Laboratory, Division of Commercial Fisheries, Alaska Department of Fish and Game, 333 Raspberry Road, Anchorage, Alaska, 99518 (907) 267-2385, Jim_Seeb@fishgame state ak us

Abstract The commercial fishing industry in the Gulf of Alaska spill area underwent radical alterations from the impacts following the 1989 *Exxon Valdez* oil spill. Area closures, species closures, and price fluctuations cumulatively affected both the industry and the target species Understanding of the genetic structure of discrete stocks is a central feature of conservation and restoration of commercially exploited fisheries resources, and information concerning the complex interactions between the genetic structure of marine species and the oceanographic and environmental factors is particularly lacking

Three classes of genetic markers, allozymes, mtDNA, and microsatellites, were used to examine spatial and temporal genetic diversity in Walleye Pollock (Theragra chalcogramma) from the Gulf of Alaska (Prince William Sound and Shelikof Strait) and Bering Sea (Bogoslof Island) Three spawning locations were sampled in 1997 and 1998 The mtDNA data showed significant "basin level" stock structure in the 1997 samples Estimates of F_{s_T} (a relative measure of the amount of genetic difference) were significantly greater than zero (P < 0.005) for Gulf of Alaska versus the Bering Sea populations but was not greater than zero for the two Gulf of Alaska populations The other two marker classes revealed no significant genetic differences in 1997 In contrast, estimates of F_{st} from the allozyme data were significantly greater than zero for two pairs of populations sampled in 1998 (Prince William Sound and Bogoslof Island, P < 0.05, Prince William Sound and Shelikof Strait, P < 0.005) Interestingly, the "basin level" stock structure revealed by the mtDNA in 1997 was absent in 1998 and the microsatellites again showed no significant genetic differences between populations These results suggest that important genetic differences may exist between these populations but that these differences are not temporally stable Nevertheless, further genetic analyses may be very helpful in elucidating the complex interaction of life history and demographics influencing stock structure

We are also investigating the heavily exploited black rockfish, *Sebastes melanops* using both microsatellite and mtDNA analyses Black rockfish were collected from throughout the Gulf of Alaska region with sites ranging from Washington Coast to Aleutian Chain Analyses of mtDNA showed little variability across the entire range of the study, so effoits were directed towards microsatellite analyses We have developed tetra-nucleotide microsatellites primers from black rockfish (*Sme*) In addition, primers from other *Sebastes* species have been screened and incorporated into a 15-locus multiplex panel Preliminary data indicate that population structure of black rockfish may follow an isolation by distance model with gene flow among adjacent populations, but significant differences in allele frequencies exist between geographically distant populations

Project Number and Title 00256B - Sockeye Salmon Stocking at Solf Lake

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Principal Investigators Dan Gillikin, Glacier Ranger District, PO Box 129 Girdwood, AK 99587 (907) 783-3242

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<u>Abstract</u> This project is designed to benefit subsistence users of Western Prince William Sound Solf Lake has been recognized for many years as an opportunity to establish a self-sustaining sockeye salmon run The stocking program began in 1997 and will continue until the year 2002 Modifications to the two outlets to control water levels are complete However, further modifications to the eastern channel are still required to ensure adult returns to Solf Lake

Solf Lake is a clear approximately 150-acre lake located in Herring Bay on Western Knight Island Based on historical limnological data from the 1980's, stream survey data collected in 1996, and analysis of current limnological data it is reasonable to expect that the lake is capable of supporting a sustainable sockeye population Based on the available spawning area, it is estimated that Solf Lake could sustain a run of approximately 10,000 sockeye salmon An escapement goal of approximately 4,500 fish would be required to fully seed the system without depleting the zooplankton populations, leaving 5,500 sockeye available for harvest Currently stocking levels are 100,000 fry This meets the project objective while taking a conservative approach to stocking activities

ADF&G surveyed Solf Lake in 1985/1986 as part of a lake investigation study Results from the fish survey and the composition and biomass of the zooplankton populations suggested that the lake was fishless The survey also documented that water was flowing through the western outlet due to an incomplete seal at the old dam structure and identified three minor barriers to fish passage in the eastern channel. The eastern outlet to the lake required reconstruction of the "irrigation type" control dam, this work was completed in 1997. During the 1998 field season Forest Service personnel completed the installation of the diversion weir structure at the lakes western outlet. During the 1999 field season, both structures were inspected for serviceability and found operational and showing little sign of wear.

An engineering survey and preliminary design for the fishway improvement in the eastern outlet was completed in August of 1999 and approved by the Regional Engineer. The fishway is designed to provide sockeye salmon passage into Solf Lake at moderate flows. The design calls for two Alaska Steepasses with concrete head walls and footers. The upper steepass will spill into an excavated section of bedrock lined with concrete to form a watertight trench. Additionally five step pools will be created by the installation of notched concrete weirs.

ADF&G monitored smolt out-migration at the eastern outlet with a total collection weir during the Spring of 1999 Less than 200 smolt were captured emigrating from Solf Lake raising concerns that smolt were either emigrating prematurely (age 0's) or not surviving A hydroacoustic survey of the Lake was conducted in September revealing few targets Results from the survey are preliminary and discussions are occurring to address the situation **Project Number and Title** 99263 - Assessment, Protection, and Enhancement of Wildstock Salmon in the Lower Cook Inlet

Principal Investigator Walter Meganack, Jr, Port Graham Corporation, PO Box 5569, Port Graham, Alaska 99603

<u>Abstract</u> In 1999, the success of the Port Graham Fishpass and the Windy Creek Ponds was monitored The two projects were completed in 1998 The Port Graham Fishpass, consisted of the construction of five dams thereby removing a natural barrier to spawning on the Upper Port Graham River The second project was the construction of two wall-based rearing ponds for coho salmon *Oncorhynchus kisutch* on Windy Creek Left

The Port Graham River Fishpass monitoring was undertaken by designating stream reaches from the 1997 inventory and obtaining historic information for Port Graham River from ADF&G COMFISH in Homer Forms used for monitoring by foot surveys noted all anadromous fish species (coho targeted species), location, number of fish (including carcasses in later surveys) The stream reaches inventoried were down river from the 9.5 mile bridge to the fishpass and then from the fishpass to the 6.5 mile bridge and from 6.5 to the river mouth. Spot counts were made at the fishpass as needed. Surveys were made in July, August, September and October. The start of the coho run and the water height were determining factors for the timing of the surveys. The data and information from the surveys will be given to the Alaska Department of Fish and Game, Commercial Fisheries Division, in Homer and the Port Graham Hatchery.

On the Windy Creek Left Rearing Ponds the planting of local vegetation (willows and alders) in and around the rearing ponds was completed in July Spruce and alder branches were put in the ponds as cover for the fry and smolt Due to a leaky substrata type pond #1 required a substantial pond liner that was installed in July Silt was added later to plug the leaks Dissolved oxygen and water temperature were measure in late August and October and fry surveys using baited minnow traps to determine species composition, length and relative abundance were made at the same time Pond #2 had over 300 coho fry using it in October

Minoi repairs and adjustments were made to both the dams and ponds Surveys to October 1999 indicate that both these projects are succeeding

Project Number and Title 99273 - Scoter life history and ecology Linking satellite telemetry with traditional ecological knowledge

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<u>Abstract</u> This project is studying the distribution, seasonal movements, and migration patterns of surf scoters (*Melanitta perspicillata*) and white-winged scoters (*M fusca*) that winter-in or migrate through Prince William Sound (PWS) This information is being combined with traditional ecological knowledge (TEK) Scoters, known locally as "black ducks" are an important subsistence resource to the residents of PWS and lower Cook Inlet (LCI) TEK was obtained from residents in the villages of Tatitlek, Chenega Bay, Port Graham, Nanwalek, and Seldovia

Using floating mist-nets and decoys we captured 90 surf scoters and 77 white-winged scoters in St Matthews Bay in late-April and early May 1999 while they congregated to feed on the roe of spawning Pacific herring (*Clupea pallasi*) A veterinarian surgically implanted satellite transmitters in 18 surf scoters and 13 white-winged scoters Of these, 5 female and 3 male surf scoters and 5 female and 2 male white-winged scoters survived beyond two weeks Post-surgical mortality rates were 52% Due to post-surgical mortality some transmitters were recovered and re-deployed We recovered 9 transmitters from birds that had been predated or scavenged

The movements of scoters were monitored every two to four days For surf scoters we identified nesting areas in the Mackenzie and Anderson River watersheds in the Northwest Territories of Canada, Old Crow Flats in Canada's Yukon Territory, and the Yukon Flats National Wildlife Refuge, Alaska Molting areas were identified in Norton Sound and Kotzebue Sound and Kuskokwim Bay (mouth of the Kuskokwim River) in western Alaska Wintering areas were identified in PWS and British Columbia

For white-winged scoters we identified nesting areas in the Mackenzie and Anderson River watersheds in the Northwest Territories, molting areas in the Beaufort Sea (Canada), lower Cook Inlet, and Bristol Bay, Alaska, and wintering areas in Prince William Sound and Port Mollei on the Alaska Peninsula One female died at Tetlin Lake, Alaska during migration Additional information on the timing and routes of migration was also obtained One surf scoter and 4 white-winged scoter transmitters were still active as of December 1, 1999 Future efforts will focus on identifying the causes and reducing the mortality of surgically implanted birds

TEK indicates that all three species of scoters have declined in PWS with the lack of scoters in the Tatitlek Narrows being the most noticeable Some of the decline may be a result of changes in distribution and not solely in abundance. In general, the decline in herring stocks is a primary factor responsible for declining numbers and changing distribution of sea duck populations in PWS Black scoter (*M nigra*) populations have exhibited the greatest decline in LCI. The decline in clams after the 1964 Alaskan earthquake, the re-populating of sea otters in PWS and LCI, and the *Exxon Valdez* oil spill's deleterious effect on intertidal organisms are believed to have contributed to declining scoter populations. No specific values can be assigned to these parameters **Project Number and Title** 99278 - Development of an Ecological Characterization and Site Profile of the Kachemak Bay Watershed/Lower Cook Inlet Area

<u>Principal Investigators</u> Glenn Seaman (PI), Kachemak Bay National Estuarine Research Reserve (KBNERR), ADFG, 333 Raspberry Road, Anchorage, Alaska, 99518, (907) 267-2331, <u>glenn seaman@fishgame_state_ak_us</u>

Coowe Moss (Project Coordinator), KBNERR, 202 West Pioneer Ave, Anchorage, Alaska, 99603, (907) 235-4799, <u>coowe moss@fishgame state ak us</u>

Abstract The Kachemak Bay Ecological Characterization Project (KBEC) is a collaborative project between the KBNERR and National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center This project will collect, synthesize, analyze, and document available physical, biological, and human or socroeconomic information on the Kachemak Bay/Lower Cook Inlet area The overall project will represent a snapshot of and a guide to locate additional information on the Kachemak Bay/Lower Cook Inlet Ecosystem The main products are being produced in electronic format (hypertext markup language with selective use of compact computer disk – CD – and Internet media) Three main project components of the overall project include (1) the ecosystem narrative description, (2) a spatial data component using a Geographic Information System (GIS), and (3) the annotated bibliography and research summary/tracking system Injured resources and services include all resources injured by the spill (except cutthroat trout, Dolly Varden, and AB killer whale pod) and all the lost or reduced services This project is supported with funding from NOAA and the EVOS Trustee Council, with EVOS funds directed to assisting in the development of the GIS and bibliography components of the overall project

With respect to overall progress, the KBNERR has (1) completed a summary of GIS data available for the study area, (2) developed a web page (see <u>http //www state ak us/adtg/kbec</u>) for the project to include GIS data and associated metadata (i.e., information about the data), (3) completed over half the narrative component of the project, (4) developed a prototype for the project, and (5) collected approximately 900 bibliographic references for the Kachemak Bay/ lower Cook Inlet Area, approximately 45 percent of which have been annotated With respect to the bibliography, we expect the final product to include close to 1000 references, with from 60 to 80 percent of the references annotated The bibliography will be presented in searchable form using Procite The overall project is expected to be completed in draft form by September 2000 for training and user input in the fall, with the final project completed and available on both the CD and Internet no later than March 2001 This product will form an important tool for researchers, managers, educators, and the general public. It the intent of the KBNERR to periodically update the product

Project Number and Title 99290 - Hydrocarbon Data Analysis, Interpretation, and Database Maintenance for Restoration and NRDA Environmental Samples Associated with the *Exxon Valdez* Oil Spill

<u>Principal Investigators</u> Bonita D Nelson and Jeffrey W Short, Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 11305 Glacier Highway, Juneau, AK 99801, 907-789-6071, Bonita Nelson@noaa gov

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Abstract This project is an on-going service project providing data and sample archiving services for all samples collected for hydrocarbon analysis in support of Exxon Valdez Oil Spill Trustee Council projects These data represent samples collected since the oil spill in 1989 to the present and include environmental and laboratory Response (National Resource Damage Assessment - NRDA) and Restoration data Additionally, we provide interpretive services for the hydrocarbon analyses The data are organized into three matrix types tissues (representing 70 species), sediment and seawater samples collected from approximately 400 locations in or near the spill area or in laboratory facilities in the State of Alaska. The analytical results include concentrations of 63 hydrocarbons, summary statistics for the evaluation of the hydrocarbon sources and laboratory quality control data Features of the database include identification samples collected for analysis, presentation of results in dry or wet weight, correction for method detection limits of the analytes Two versions of this data exist. The archival database, named PWSOIL, is maintained in RBASE and ACCESS formats and contains all information relating to collection, shipping and handling, and analysis of data collected for NRDA and Restoration efforts A public release of this dataset The Exxon Valdez Oil Spill of 1989 State/Federal Trustee Hydrocarbon Database (EVTHD) which contains only the information from analyzed samples is available on diskette or CD-ROM in a stand alone application written in Visual Basic This dataset 1s available from the principal investigator, Bonita Nelson Updating the database and sample archival is an on-going, yet scaled back program

Project Number and Title 99306 - Ecology and Demographics of the Pacific Sand Lance in Lower Cook Inlet, Alaska

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Abstract Sand lance are one of the principle forage fish species found in the Gulf of Alaska and are the dominant fish in many nearshore communities Despite their importance, there is a lack of information pertaining to their life history and environmental requirements This project was initiated to assess the ecology and demographics of sand lance in lower Cook Inlet Sand lance in Kachemak Bay showed no sexual dimorphism Most matured in their second year, males earlier in the season than females, but females (31%) attained a higher gonadosomatic index than males (21%) Sand lance spawned intertidally once each year in late September and October on fine gravel or sandy beaches soon after the peak in seasonal water temperatures Schools were dominated 2.1 by males as they approached intertidal sites where spawning has occurred for decades Sand lance spawn vigorously in dense formations, leaving scour pits in beach sediments Fecundity of females (93-199 mm) was proportional to length, ranging from 1468-16,081 ova per female About half the school fecundity was derived from age 1 females (55% of school by number) Mean dry weight energy values of sand lance peaked in spring and early summer (20 91 kJ/g for males, 21 08 kJ/g for females), then declined by about 25% during late summer and fall Late summer declines in energy density paralleled gonadal development Gender differences in energy density (males<females) were only apparent from Aug to Oct Juvenile sand lance exhibit a relatively constant protein to lipid ratio until they reach 80 mm fork length, thereafter lipid proportions increased Energy densities of juveniles increased from a minimum of 16 67 kJ/g to a maximum of 19 68 kJ/g, and were higher than adults in late summer

<u>Project Number and Title</u> 99311 - Pacific herring productivity dependencies in the Prince William Sound ecosystem determined with natural stable isotope tracers

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Abstract Possibly the most surprising finding of the Sound Ecosystem Assessment project (SEA) was that Prince William Sound (PWS) herring and other fishes have significant dependence upon organic carbon that is generated in the Gulf of Alaska (GOA) rather than PWS The advective regime connecting the northern GOA with PWS may thus affect recruitment and nutritional processes in Pacific herring, *Clupea pallasi* This project was the first step to effect a better understanding of this fundamental environmental process by isotopically analyzing a time series of herring, thus expanding the SEA data that suggested the role of GOA carbon in PWS Project 311 was thus funded to expand the isotopic data series available from project 320I (SEA) to provide a total four-year time period, 1994-1998, corresponding to one period in the cyclicity of herring population abundance in Prince William Sound

Spatially-defined food source regimes for juvenile herring in PWS were characterized by natural carbon and nitrogen stable isotope abundance Phytoplankton in PWS and the adjacent GOA fractionated stable carbon isotopes ($^{13}C/^{12}C$) during CO₂ uptake differently Herbivorous *Neocalanus* copepods, a proxy for pelagic carbon sources, from GOA consistently had distinctive $^{13}C/^{12}C$ content compared to those from PWS Furthermore, $^{13}C/^{12}C$ content of GOA carbon underwent excursions of 6‰ (relative to the international stable isotope standard) among years whereas PWS varied little Since juvenile herring reflected the GOA changes and tended to isotopic signatures more similar to GOA carbon than PWS, it is deduced that Gulf production drives their food webs Variability in affinity for GOA carbon, which during 1994-98 ranged from ~50% to near 100%, is postulated to vary in accordance to cross-shelf transport processes

Herring ¹³C/¹²C content suggested that localized regimes may develop during the summer Fall and winter storms had a homogenization effect upon these regimes as evidenced by convergence in fish ¹³C/¹²C content among four PWS sites observed in time series. Thus localized feeding regimes occurred within narrow time scales. However, the food source changes that occur on annual time scales were of greater magnitude and persisted into the fall. Isotopic analysis may yield a greater understanding of how physical forcing impacts economically important species within the PWS pelagic ecosystem with the goal to further predictive capability needed for management.

That herring are subject to changes in carbon flow occurring between GOA and PWS was the case within the time-frame of the project Long term changes suggested by the recently recognized regime shift phenomenon suggest isotopic analysis as a tool for examining the GOA-PWS linkages in longer time frames Project Number and Title 99314 - Homer Mainer Park Habitat Restoiation Project

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Abstract The Homer Mariner Park Habitat Restoration Project is a community-based project to investigate opportunities of restoring an intertidal area, referred to as Mariner Park Lagoon, at the base of the Homer Spit which suffered damage as a result of the *Exxon Valdez* oil spill. This project was an opportunity for directly restoring the injury caused by the response to the *Exxon Valdez* oil spill, but also as a replacement for and enhancement of injured intertidal resources in other areas affected by the spill. The principle objective of this project was to develop a National Environmental Policy Act (NEPA) document that would provide a feasible project to restore or rehabilitate the intertidal community of the lagoon. This project was to "increase, preserve, and protect a diverse feeding habitat for migrating shorebirds." Additional objectives included developing a way to enhance the recreational use of the area in an environmentally compatible manner and to discourage the use of the area by large-bodied birds, which could affect aircraft safety

In developing the Environmental Assessment, several alternatives were investigated to enhance, preserve, and protect the intertidal habitats in Mariner Park Lagoon, promoting the use of the area by shorebirds and encouraging compatible recreational use of the area Alternatives included retention of water in the lagoon, physically modifying the substrate of the lagoon, diedging sand and gravel from the lagoon, reestablishing the connection with Mud Bay to the east, reinforcing the existing entrance, and maintaining the existing habitat through conservation easements

Baseline studies of the major habitats in Mariner Park were conducted to document the physical and biological environments of the project area including marine habitats, wetland assessment, invertebrate survey, fish survey, and observations on bird use Coastal engineering studies were conducted to develop feasible project alternatives including modeling of tidal current and sedimentation analysis

The primary issue raised during the scoping process was Mariner Park Lagoon is located near the western end of Runway 03 at the Homer Airport The FAA's Advisory Circular on Hazaidous Wildlife Attractants on or Near Airports (AC No 150/5200-33) recommends that any land use practices which attract, sustain, or cause hazardous wildlife to cross the approach or departing airspace of an airport not occur within 5 miles of a runway Therefore, any project alternative that would include enhancement or modification of the lagoon with the stated purpose of attracting more shorebirds or waterfowl would be in direct conflict with these guidelines

Because of the stated opposition of the FAA to enhancing habitats which would potentially attract hazardous wildlife near runways, a Pieferied Alternative was selected which pieserves the habitat in Marinei Park Lagoon through conservation easements on City-owned lands and iecommends conservation easements on privately held properties in the lagoon. No enhancement of habitat is proposed. Educational signs are suggested for encouraging environmentally compatible recreation in the area. This Alternative would preserve and protect this valuable resource in perpetuity as wildlife habitat for migrating shorebirds.

Project Number and Title 99320 - Sound Ecosystem Assessment (SEA)

Principal Investigator Robert T Cooney (Retired), Institute of Marine Science, University of Alaska Fairbanks, Fairbanks, Alaska 99775-7220, e-mail windsong@montana.com

<u>Abstract</u> Funds were provided in 1999 to complete a synthesis of SEA findings and to submit and respond to a final report of all work The single, integrated bundle of draft final reports was submitted in late June, and a package of manuscripts placed in review for the journal *Fisheries Oceanography* in early November

Principal SEA findings were presented and discussed at the March, 1999, EVOS public workshop in Anchorage - *Legacy of an Oil Spill 10 Years After Exxon Valdez* These findings included seasonal aspects of the physical and biological oceanography of Prince William Sound, critical linkages between juvenile pink salmon and herring populations and their growth environments, the effects of plankton_modified predation on juvenile fish survival, and insights about ecological factors affecting the health and sustainability of pink salmon and herring stocks Numerical models were developed to characterize ocean state (currents, temperature and salinity), the plankton production cycle, prey/predator relationships influencing pink salmon survivals during early marine residence, and herring larval drift and juvenile overwintering bioenergetics

SEA is developing a 30-min video detailing the 5-year study and its findings for the public This video is expected to be completed in early 2000

Project Number and Title 99320M - Physical Processes Influencing the Biological Components of Prince William Sound, Alaska

Principal Investigator Shari L Vaughan, Prince William Sound Science Center, P O Box 705, Cordova, Alaska 99574, (907) 424-5800

Abstract Prince William Sound (PWS) is a small, subarctic, semi-enclosed sea, located along the northern Gulf of Alaska (GOA) coast The roughly 400 to 450m deep central basin is surrounded by mountains, glaciers, coastal rivers, and numerous bays and fjords, which serve as nursery habitats for larval and juvenile fish The main connections between the Sound and the northern GOA are Hinchinbrook Entrance to the east and Montague Strait to the west The high biolgical production in PWS supports several large Alaskan fisheries Three physical processes that impact the biological components of PWS are described here surface stratification and frontal formation, upper layer circulation, and exchange between the northern GOA, PWS and the PWS nearshore bays and fjords Stratification forms initially in March in the PWS nearshore regions In April, stratification due mainly to surface freshening forms in the northern central Sound The northern stratified layer and the associated density front often persist through June, but interannual differences occur, which may account for differences in the strength and duration of the spring phytoplankton bloom In spring and summer, circulation in the central Sound can be cyclonic or anticyclonic September is characterized by a cyclonic circulation and isopycnal doming in the central Sound, with little interannual variability Transport from the central Sound to a nearshore bay or fjord, or from one bay or fjord to another is common The central Sound circulation may promote dispersion of plankton and larval fish populations In summer through early fall, the dominant upper layer (< 150m) GOA/PWS exchange pattern is outflow at Hinchinbrook Entrance and inflow at Montague Strait, although offshore easterly winds tend to produce surface Ekman layer inflow at both locations Inflow from the GOA could introduce additional zooplankton into PWS, or flush existing PWS stocks out into the Gulf At Hinchinbrook Entrance, northward transport is maximum in late fall through winter

Project Number 99320N - Sound Ecosystem Assessment (3-parts)

Project Title 1 Co-occurring patches of walleye pollock (Theragra chalcogramma) and zooplankton in Prince William Sound, Alaska, USA

Principal Investigators Geoffrey B Steinhart, G L Thomas and Jay Kirsch

Abstract We conducted two acoustic surveys of Prince William Sound (PWS) in the spring of 1995 The primary goal of these surveys was to observe the spring zooplankton bloom and the distribution of post-spawning walleye pollock (Theragra chalcogramma), one of the dominant fish species in the Sound In this paper, we examine the spatial distributions of pollock and zooplankton in April and May, 1995 Zooplankton biomass varied from 0 1-1 7g/m3 from the net tows, while acoustic estimates of zooplankton biomass varied by three orders of magnitude (1000x) We observed near surface (0-50m) patches of zooplankton from 100m to 5000m long In April, these patches were composed of 85% calanoid (72% Neocalanus spp) copepods by weight By May, calanoid copepods accounted for only 55% (24% Neocalanus spp) of the biomass, but pteropod density doubled (from 0 7 to 2 2g/m3) Acoustic data showed postspawning walleye pollock abundance was highest near the surface (0-50m), and was positively correlated with zooplankton biomass (r2=0 42 in April, and r2=0 31 in May) Post-spawning walleye pollock were feeding heavily on the plankton found in the patches copepods in April and pteropods in May Early-spiing feeding on zooplankton by adult walleye pollock is not fully understood, but could be an important factor affecting the annual production of pollock in PWS

Project Title 2 Acoustic estimates of zooplankton distributions in Prince William Sound, spring 1996

Principal Investigators Jay Kirsch, G L Thomas, and R Ted Cooney

Abstract A survey was conducted in Prince William Sound (PWS) in May 1996, to study the volume backscattering of zooplankton using a 420 kHz digital sonar and a Multiple Opening-Closing Net Environmental Sampling System (MOCNESS) While the digital sonar provided continuous fine-scale volume scattering strength measurements, the MOCNESS samples provided zooplankton species, size, and coarse-scale estimates of density and distribution This catch information was applied to acoustic scattering models (Stanton et al, 1994) to predict zooplankton volume backscattering strength By least-squares fitting the predicted backscatter values with the measured acoustic backscatter, we determined the reflection coefficients for neocalanus, pteropods, and eupausuds to be 0 0178, 0 1533, and 0 0341 respectively By applying these reflection coefficients and the measured animal sizes to the same acoustic models, we were able to calculate target strengths (TS) for these taxa, which were then applied to the volume scattering information, yielding estimates of the absolute densities of those selected species along continuous transects inside and outside PWS The comparison of these density values with the density estimates from the MOCNESS showed reasonable agreement, although the distribution of acoustic values was much wider than the MOCNESS due to finer sampling Since reflection coefficients valy from species to species, it is inappropriate to borrow this value from another species based on similarity

Project Title 3 The ecological role of walleye pollock (Theragra chalcogramma) in the trophic structure of Prince William Sound, 1993-1998

Principal Investigators G L Thomas, Jay Kirsch, Mark Willette, Geoff Steinhart, Jennifer Allen and Ted Cooney

Abstract A stock of walleye pollock (Theragra chalcogramma) has been observed to overwinter and feed in Prince William Sound This stock was composed of length groups >400 mm+ fish (adults), 120-400 mm fish (subadults), and <120mm fish (juveniles) In the winter, the adult walleye pollock were found in highly aggregated groups that were easily accessible to measurement Echointegration-midwater trawl surveys estimated the abundance of walleye pollock to be about 37,000 mt in 1995, 38,000 mt in 1997 and 114,000 mt in 1998 The only other pelagic fish observed to overwinter in the Sound at a comparable abundance was the Pacific herring (Clupea harengus) This finding indicates the marine food web of the Sound is similar to many other boreal and subboreal systems in that it has a "waist" dominated by two planktivorous fishes, walleye pollock and Pacific herring In recent years, this food web-waist has been dominated by walleve pollock but our observations suggest that a few years of high herring recruitment could cause a shift in the dominance of the food web-waist Traditional knowledge and records suggest that herring have dominated the food web waist in the past We postulate a feeding mechanism to explain the shifting dominance of the food web-waist Unlike the juvenile or subadults, after spawning the adult walleye pollock move to the surface (0-50m) and into the Sound in spring to feed on macrozooplankton, primarily large calanoid copepods (Neocalanus spps) We hypothesize that the ability of the walleye pollock to feed on Neocalanus copepods depends upon high prev density in the form of patches or layers When patches or layers of Neocalanus copepods are available in the spring, the walleye pollock can capture the bulk of the food or energy from lower trophic levels and dominate the food web-waist of the Sound Furthermore, we suggest that in windy years when surface turbulence is high, the resulting decrease in prey patches reduce the walleye pollock's ability to feed successfully on Neocalanus copepods Conversely, the herring's higher efficiency at raptorial feeding should favor it during windy climate regimes Since walleye pollock and Pacific herring populations represent the food web-waist in the Sound, they store the bulk of the carbon or potential energy in the Sound's food web Unless the dynamics of these two taxa are known and considered explicitly, models of the fate of lower level trophic production and the diversity and production of the piscivore assemblage will not repiesent dominant ecosystem processes

Project Number and Title 99325 - Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the *Exxon Valdez* Oil Spill Preparation of manuscripts

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Abstract The purpose of this project was to complete manuscripts summarizing previous subtidal studies in Prince William Sound A short synopsis follows The nearshore ecosystem in Prince William Sound, Alaska was severely impacted by the Exxon Valdez oil spill Impacts were greatest in sheltered bays that were subject to heavy oiling The immediate effect of oiling and associated cleanup activities on nearshore subtidal communities within these bays was more evident in eelgrass than in kelp habitats In 1990, a year after the spill, there were more groups of organisms impacted in eelgrass than in kelp beds Also, more groups showed a negative response to oil (i e, lower densities at oiled vs reference sites) in eelgrass habitats than in kelp beds Negative responses were most notable among crustaceans (phoxocephalid amphipods and helmet crabs) that are considered sensitive to oil impacts Positive responses were noted for several polychaete families that are stress tolerant and opportunistic The higher abundance at oiled sites was probably in response to organic enrichment Recovery was slower in eelgrass than in kelp habitats About 80% of the groups impacted in eelgrass beds failed to show clear signs of recovery by 1995, six years after the spill In contrast, most impacted groups in kelp beds recovered within two years The stronger, more persistent impacts in eelgrass beds were probably related to higher concentrations of oil that occurred there, and the more persistent nature of oil within these sheltered habitats Initial impacts of oiling were less severe in the nearshore subtidal than the intertidal zone However, effects on subtidal communities (especially in eelgrass beds) may have persisted for longer

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Project Number and Title 99327 - Pigeon Guillemot Restoration Research at the Alaska SeaLife Center

Principal Investigators Daniel D Roby, Oregon Cooperative Fish and Wildlife Research Unit, USGS-Biolgical Resources Division and Department of Fisheries and Wildlife, 104 Nash Hall, Oregon State University, Corvallis, OR 97331 Phone 541-737-1955 Email robyd@ucs orst edu

George J Divoky, 4505 University Way NE, Seattle, WA 98105, Andrew K Hovey, Oregon Cooperative Fish and Wildlife Research Unit, Department of Fisheries and Wildlife, 104 Nash Hall, Oregon State University, Corvallis, OR 97331

Abstract Pigeon Guillemots (Cepphus columba) are nearshore-foraging, cavity-nesting seabirds whose populations in Prince William Sound have failed to recover from declines before and after the Exxon Valdez Oil Spill Post-spill studies indicate that three factors may be limiting recovery 1) reduced availability of schooling forage fish and increased dependence on lower lipid fishes, resulting in decreased productivity and adult recruitment, 2) increased predation on eggs and chicks resulting in reduced nesting success, and 3) increased stress and/or physiological effects associated with continued exposure to residual oil and its effects on nesting success and survival A multi-year study examining these factors was initiated in 1998 at the Alaska SeaLife Center to investigate direct restoration techniques (including captive-iearing and release), prey quality effects on growth, and the presence of nondestructive petroleum-induced biomarkeis using controlled experiments with captive-raised birds

In 1999, chicks (n = 28) and eggs (n = 70) were collected from Pigeon Guillemot nest sites in the wild and transported to the Alaska SeaLife Center Forty-nine chicks were successfully hatched from artificially incubated eggs, for a 70 0% hatching success This compares to only 52% hatching success in 1998 (n = 44 eggs) There were significant differences in hatching success by year and collection area, and these differences are likely due to differences in egg-handling protocols Nestling survival for chicks collected in the wild was 89 3%, whereas it was only 71 4% for chicks hatched from eggs that were artificially incubated. All mortality for chicks collected in the wild (n = 3) occurred soon after collection, either in the field or during transport. All mortality for chicks hatched in captivity (n = 14) occurred in the first 11 days post-hatch and was apparently due to either brooder equipment malfunction (n = 9), lower GI tract blockage of unknown causes (n = 3), or microbial infections of the lower GI tract (n = 2) Thus, 61% of all eggs and chicks collected for captive-rearing in 1999 were successfully fieldged into the wild

Prey quality experiments were performed with captive-reared chicks using iso-biomass and *ad libitum* diets of high-lipid juvenile herring and low-lipid juvenile pollock Chicks raised on the restricted pollock diet had significantly lower growth rates, as measured by total body mass, when compared to chicks raised on the restricted herring diet Comparison of wing chords among fledg-lings raised on the restricted diets indicated no significant differences in structural growth rates Groups of chicks raised on the same diet of herring were also fed sublethal doses of weathered Prudhoe Bay Crude Oil (PBCO) to determine if any biomarkers were induced and to assess potential effects on growth rate.

cant reduction in growth rate, but analysis of these results was confounded by regurgitation of part of the dose by some subjects Analysis for blood biomarker is currently in progress Future dosing experiments will make use of even smaller and more frequent doses of weathered PBCO, to simulate a more realistic dosing regime in wild chicks and to eliminate the confounding effects of dose regurgitation

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Nesting platforms with decoys and audio playbacks were installed in Resurrection Bay in 1998, but have thus far failed to recruit any nesting Pigeon Guillemots Because local colony populations are relatively small and distant (southern Resurrection Bay), a lack of prospectors may be the major reason for the lack of adults observed in the area of the nesting platforms Nest boxes deployed in Prince William Sound, however, were occupied by Pigeon Guillemots that successfully raised young, so the technique shows some promise for enhancing restoration and recovery of damaged guillemot populations All captive-reared fledglings were color-banded and released into Resurrection Bay to monitor any members of this cohort that may return to breed in either natural nest sites in the bay or in the artificial nest sites located in front of the Alaska SeaLife Center **<u>Project Number and Title</u>** 99328 - Synthesis of the toxicological and epidemiological impacts of the *Exxon Valdez* oil spill on Pacific herring

Principal Investigators M G Carls, G D Marty, J E Hose, and R M Kocan

Abstract The Pacific herring (*Clupea pallasi*) population in Prince William Sound (PWS) was affected by two major events in the past decade, the *Exxon Valdez* oil spill in 1989 and a 75% collapse in the adult population in 1993 Two very different interpretations of results emerged from spill impact studies, divided along industry and Natural Resource Damage Assessment (NRDA) lines The NRDA researchers concluded that exposure of herring eggs to oil in 1989 caused egg mortality, morphological and cytogenetic abnormalities in larvae, and reduced growth Exposure of adult herring to oil was associated with increased prevalence of hepatic necrosis, and laboratory study provided evidence that hepatic necrosis was related to decreased immune function followed by activation of viral hemorrhagic septicemia virus in exposed fish Although herring were placed on the injured species list, NRDA researchers concluded that few herring eggs were exposed, that the spill had a minor impact on exposed eggs, and that the population did not decrease

We conclude that the weight of evidence demonstrates that the short-term spill consequences were detrimental to herring in PWS Specifically, 1) the nominal classification of the Naked Island and Montague Island spawn areas as oiled was corroborated by visual and chemical evidence, 2) mussels (used as a surrogate index of exposure by NRDA researchers) were exposed to oil, and 3) total polynuclear aromatic hydrocarbon (TPAH) concentration in mussels was correlated with TPAH in herring eggs Further, the timing of herring egg incubation roughly coincided with the time of peak hydrocarbon exposure in PWS Recent laboratory observation that exposure of eggs to <1 ppb aqueous TPAH concentrations causes embryonic abnormalities suggests that the TPAH concentrations reported by industry in some PWS herring eggs was probably detrimental Field and laboratory observations support this contention because heiring larvae collected from oiled areas in PWS in 1989 were malformed, small in size, and had higher instantaneous mortality rates than in reference areas Between 25% and 32% of the herring eggs spawned in 1989 were exposed to oil concentrations sufficient to cause subsequent mortality

Possible long-term consequences of the spill are difficult to discern Important stressors responsible for the collapse of the adult herring population in 1993 included large population size and possibly environmental conditions, but links between the *Exxon Valdez* oil spill and delayed population response are tenuous. The herring population in PWS may have approached oi exceeded carrying capacity between 1988 and 1992, thus the risk of a disease epizootic was high. Although the major agent in the epizootic, VHSV, can be induced by acute exposure to oil, and can cause rapid mortality in infected adult herring, delayed reaction of herring to oil toxicity in 1993 is unlikely. The estimated additional increase in population in 1989 resulting from the post-spill fishery closure was small, but the precipitous 1993 collapse of the population near its carrying capacity underscores the importance of formulating resource management decisions that integrate knowledge of the historical fishery. Populations at carrying capacity that are exposed to additional stress, such as oil, may be at greater risk than populations below carrying

capacity Environmental conditions unrelated to the oil spill, such as pre-winter prey availability and winter starvation, may have also been important contributory factors, and probably no single factor can completely explain the population collapse Although direct linkage of the heiring population collapse to the oil spill is unlikely, indirect effects of oil on the ecosystem cannot be ruled out entirely

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Project Number and Title 99329 - Synthesis of the Toxicological Inpacts on Pink Salmon

Principal Investigators Rice S D, M Carls, P Harris, R Heintz Auke Bay Laboratory, National Marine Fisheries Service, 11305 Glacier Hiway, Juneau, AK 99801

Abstract A decade after the *Exxon Valdez* spill, oil continues to be found in mussel beds and in oiled streams Many sites have continued to be protected enough from the environment, that 10 years after the spill, oiled samples can still be matched to spilled oil from the *Exxon Valdez* Twenty five mussel beds that were still oiled in 1995 were re-examined in 1999 Generally, oil concentrations continue to diminish, but are well above baseline levels in the majority of these beds and pockets of high concentrations of oil persist in sediments The highest concentration found in sediments in 1999 was 27,000 ppm of total petroleum hydrocarbons, compared to 65,000 ppm in 1992 In fall 1999, several oiled salmon stream banks were examined for lingering oil These streams had been sampled in 1995, and oil had been found The first data from the fall 1999 sampling is expected by time of presentation

What is the significance of the lingering oil exposures? The geographic distribution within the spill area of PWS is considerable, yet each contaminated spot is growing smaller in size and concentration. The impacts to some species and some life stages probably continued for some time after the spill, however these impacts have not been apparent for the last several years. If eggs or larvae were associated with the intertidal zone, then they were likely to be affected at a site specific level for several years. Pink salmon and Pacific herring toxicology studies demonstrate toxicities at the 1 part per billion level of polynuclear aromatic hydrocarbons, and the oil persistence studies in mussel beds (and possibly salmon streams) demonstrate that toxic weathered oil continues to be present. Entry into the food chain for animals dependent on the intertidal zone was likely for a number of species and a number of years past the spill.

Prince William Sound continues to recover from the original one-time oiling event stemming from the 1989 grounding of the *Exxon Valdez* The spill has evolved from a catastrophic point source pollution event, to a non-point source pollution event over a large area. The true significance of the long term *Exxon Valdez* studies has been to demonstrate (1) toxic 3-4 ringed aromatic hydrocarbons persist as oil weathers, (2) weathered oil was mobile and bioavailable for long periods of time in the intertidal zones, (3) sensitive egg and larval life stages are vulnerable to oil in both field and laboratory tests, and (4) that Prince William Sound can be considered a rare model to help sort out the complexities and insidious nature of non- point source pollution

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Project Number and Title 99330 - A trophic mass balance model of Alaska's Prince William Sound ecosystem for the post-spill period 1994-1996

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Abstract Knowledge about the biotic components of Alaska's Prince William Sound (PWS) has increased considerably since the 1989 *Exxon Valdez* oil spill (EVOS), but the structure and functional responses of the overall food web to disturbances and stressors is still not well understood A better understanding of the whole PWS food web and its dynamics was achieved by constructing a balanced trophic model using the Ecopath approach. This was the best available framework to summarize available ecosystem information in a trophic context, as it explicitly accounts for multispecies interactions. The PWS model is a cohesive synthesis of the overall biotic community with a focus on energy flow, and responses to perturbations—both natural and anthropogenic. Flows of biomass among the components of the food web were quantified using estimates provided by a collaborative group of over 35 experts on PWS ecosystem components.

Forty-eight biotic components were included in the PWS model ranging from life stages of individual species to aggregated functional groups. These groups were organized into primary producers, zooplankton, benthic invertebrates, 'forage fishes', larger fishes, birds, mammals, and detritus Estimates of biomass flows related to fisheries landings and discards in Prince William Sound are also incorporated

Empirically-based estimates of biomass, production rates, consumption rates, and diets were specified for each defined group, as were migration rates, biomass accumulation, and fishery catches and discards Outputs of the Ecopath model included biomass and flux estimates for groups that were refined through the collaborative mass-balancing approach, and whole food web characterizations

The dynamic modeling routines Ecosim and Ecospace can be used to simulate the ecosystem-level effects of disturbances and management actions, and to provide insights into ecosystem-level changes and dynamics that may occur in Prince William Sound These consist of simulated population trajectories through time, and habitat-based, spatial re-distributions. The Ecopath model of PWS can be used to help guide future research programs in the region, to help assess impacts of the EVOS, and to help resource agencies and local communities achieve ecosystem-based conservation and management in the face of increasing human activities in the region. This approach can also be used to help distinguish the relative importance of physical forces and tiopic forces in marine ecosystems.

An annotated list of Alutiik words was included in this volume to facilitate cross-cultural flows of ecosystem knowledge. This list might serve as one step in helping to promote a more community-based approach to management of the wild living resources of Prince William Sound.

This computer program is easy to use in a windows-based format, and is currently available from Villy Christensen at the UBC Fisheries Centre (villy@fisheries.com) It will be available from the EVOS restoration office and Alaska Sea Grant as part of an educational CD ROM in early 2000

Project Number and Title 99338 - Survival of Adult Murres and Kittiwakes in Relation to Forage Fish Abundance

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Abstract Populations of Common Murres and Black-legged Kittiwakes in lower Cook Inlet fluctuate over time, and changes in population size reflect the sum of three processes adult mortality, recruitment of locally-produced offspring, and the immigration/emigration of breeding adults from/to other colonies In APEX Project 00163M, we have been measuring population trends and productivity in relation to local food abundance since 1995, and there are also historical data spanning 25 years With this project (99338), we have begun to measure adult survival by marking birds with color bands and re-sighting them in subsequent years. We have now banded (1997-1999) a total of 901 birds 199 murres and 271 kittiwakes at Gull Island (foodrich, bird populations increasing) and 262 murres and 169 kittiwakes at Chisik Island (food-poor, bird populations decreasing) At least 3-4 years of re-sighting data are needed for statistical evaluation of survival data However, preliminary results suggest there are marked differences in survival of murres and kittiwakes between Gull and Chisik islands, which may be related to costs of breeding in food-rich versus food-poor environments The rate at which murre and kittiwake populations are declining at Chisik Island (7-9% per annum) can be attributed mostly to adult mortality The rate at which populations have increased at Gull Island (8-15%) cannot be explained solely by recruitment of locally produced juveniles (despite high productivity), and must also result from substantial immigration of adults from elsewhere

Project Number and Title 99339 - Western Prince William Sound Human Use and Wildlife Disturbance Model

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<u>Abstract</u> The primary work reported includes a description of current human use patterns in western Prince William Sound, distribution of selected species injured as a result of the *Exxon Valdez* Oil Spill [1 e, harbor seal (*Phoca vitulina*), pigeon guillemot (*Cepphus columba*), and cutthroat trout (*Oncorhynchus clarki*)], relationship of the species distribution to the distribution of human use, results of a literature review on the effects of human disturbance on wildlife, and general management recommendations relative to disturbance of wildlife

We used geographic information system techniques to describe current human use in western Prince William Sound Current human use patterns were constructed from numerous sources, including 1) surveys of recreational boaters using western Prince William Sound, 2) records from the Whittier Harbor Master's office, 3) interviews with and records of charter boat operators, and 4) information from the State of Alaska on commercial fishing use Resulting use patterns were verified through aerial surveys of western Prince William Sound during the 1998 boating season Digital maps of current use were incorporated with digital maps of the distribution of harbor seals, pigeon guillemots, and cutthroat trout

These patterns of human use provided a basis to identify areas where there may be conflicts between human use and wildlife concentrations resulting in disturbance Disturbance of injured wildlife may result in decreased productivity exacerbating the effects of the spill and prolonging the time to recovery Review of the published literature on the effects of human disturbance on wildlife allowed development of recommendations that may eliminate or minimize the negative effects of increasing human use Additional work will include projections of future human use patterns, descriptions of potential areas of conflict with the selected injured species, and specific management recommendations This information is expected to be useful to Federal, State, and private land managers in their land management planning efforts

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Project Number and Title 99340 - Toward Long-Term Oceanographic Monitoring of the Gulf of Alaska Ecosystem

Principal Investigators Thomas Weingartner, Institute of Marine Science, University of Alaska, Fairbanks, AK 99775, 907-474-7993

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Abstract This program documents and quantifies the natural physical variability of the Gulf of Alaska marine environment by maintaining a 29-yr time series of temperature and salinity measurements at a hydrographic station GAK 1 on the inner shelf near Seward We use these data in conjunction with other measurements from the Northeast Pacific GLOBEC Gulf of Alaska monitoring program to examine salinity variations on this shelf Salinity is influenced by the high rates of freshwater runoff into the Gulf of Alaska Salinity gradients control the density and circulation structure of this shelf and quite likely it affects the shelf nutrient levels and the distribution of plankton and juvenile fish. The precipitation and coastal runoff measurement network around the gulf is sparse, making quantification of the variability in the freshwater forcing difficult. The historical data consists of nominally monthly samples at a hydrographic station on the Gulf of Alaska shelf. This EVOS project is supporting hourly sampling from moored temperature and salinity recorders at the same station. The moored data show that the monthly samples are not seriously aliased by fluctuations on time scales shorter than one month

Interannual and interdecadal salinity variations suggest low frequency changes in the freshwater supply over this shelf and in particular within the Alaska Coastal Current This variability can be large For example in 1998, the volume of freshwater on the shelf was 10% greater and the alongshelf freshwater flux was 20% greater than that observed in 1999 Our data also suggests that shelf salinities were higher in the 1970s than during the 1980s and early 1990s although the magnitude of the interdecadal variability is similar to interannual differences. Several factors might account for the salinity variations Coastal runoff was lower in the 1970s than in the 1980s and early 1990s In agreement with these data, the leading EOF in atmospheric precipitable water over the Northeast Pacific Ocean (35-65N, 160-120W) has maximum amplitude over the northern Gulf of Alaska and shows decreasing precipitation tendency from 1960 through 1976 followed by an abrupt increase from 1977 to the present These findings agree with recent studies suggesting that salinities were higher along the Canadian west coast and at Ocean Station P in the 1970s Other mechanisms possibly contributing to freshwater variability include anomalous alongshore advection and/or anomalous cross-slope exchange of freshwater Finally we find that monthly anomalies in shelf dynamic height are significantly correlated with monthly sea level anomalies at Seward, Alaska with most of this variability due to salinity changes This suggests that historical Seward sea level records could serve as proxy salinity time series

<u>Project Number and Title</u> 99341 – Recovery of Harbor Seals Phase II Controlled Studies of Health and Diet

Principal Investigator Michael A Castellini, Institute of Marine Science, University of Alaska Fairbanks, Fairbanks, Alaska, 99775

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<u>Abstract</u> The objective of this study is to quantify the impact of specific diets on the health and body condition of harbor seals. This includes measuring the effect of diet on health status biomarkers which have been monitored in animals in Prince William Sound and determining whether specific diets are nutritionally adequate to maintain health. These studies are being conducted using eight captive harbor seals at the Alaska SeaLife Center (ASLC) in Seward, Alaska. An additional objective is to monitor the same condition indices during the recovery of abandoned, injured or sick harbor seal pups brought to the ASLC for rehabilitation. These data should complement data being collected by the Alaska Department of Fish and Game comparing health and condition of wild harbor seal pups from Prince William Sound and Tugidak Island, Alaska

Since September 1998, six of the captive seals have been on cross-over feeding trials in three seasonal blocks (September – December, January – April and May – August) One group of seals received an exclusively pollock diet during the first trial, then switched to exclusively herring during the next trial. The second group started the series of trials with herring, switching to pollock for the next trial. The seals continue to switch diets every 4 months throughout the experiment. By the time the experiment ends, each group will have experienced each seasonal block on a different diet. Two seals are being fed a constant mixed diet throughout the entire 24-month experimental period. Measurements of blood parameters (chemistry, hematology, biomarkers) and morphometrics are conducted bi-weekly. Total body water measurements using D_2O injection are conducted at the midpoint and end of each trial, as are measurements of prey assimilation.

Based on body morphology, percent body fat and mass gain, preliminary results suggest a seasonal influence over the impact of diet on seal condition During fall (Sept – Dec) seals gained fat on diets of either herring or pollock During winter (Jan – Apr) results were variable, with some seals from each group exhibiting increases in measurements of body condition, while others exhibited decreases in the same measurements During summer (May – Aug) seals fed herring had improved body condition, while those fed pollock had depleted body condition Conclusions cannot be drawn until the completion of the second year of the project due to the crossover nature of the design

Morphometric and blood chemistry/hematology data were collected weekly during recovery from harbor seal pups brought to the ASLC for rehabilitation (n = 3, 1998, n = 4, 1999, non-survivors n = 2, 1998) Preliminary data suggest that recovering seals are vulnerable to anemia As expected, some blood values appear to be influenced by diet and development Certain parameters such as percent granulocytes and gamma glutamyl transpeptidase (GGT) appeared to be indicative of various physiological stresses Non-survivors had a large number of blood variables that were outside the normal range Monitoring will continue through 2000 to increase the sample size

Project Number and Title 99346 - Publication of an Indexed Bibliography of the Genus Ammodytes (Sand Lance)

Principal Investigators Robert H Armstrong, 5870 Thane Road, Juneau, AK 99801 (907-586-6811, <u>boba56@hotmail.com</u>), Mary F Willson, The Nature Conservancy, 8 S Michigan Avenue, Suite 2301, Chicago, IL 60603, Martin Robards, USGS / BRD, 1011 East Tudor Road, Anchorage, AK 99503-6199

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<u>Abstract</u> The Pacific sand lance (*Ammodytes hexapterus*) is one of the most important forage fishes in the Noith Pacific Ocean Its importance within the Prince William Sound ecosystem has been documented by several studies presented at the 1996 International Role of Forage Fishes in Marine Ecosystems and by studies conducted under the APEX project In particular the sand lance may play a critical role in the recovery of certain species such as Pigeon Guillemot (*Cepphus columba*) and Marbled Murrelet (*Brachyramphus marmoratus*)

The purpose of this project is to provide researchers and others with a summary of what is known about Pacific sand lance and related species. This will help several Trustee funded projects by providing a ready access to information on an important forage fish as well as several Prince William Sound predators.

This project has been completed and published as Robards, Martin D, Willson, Mary F, Armstrong, Robert H, Piatt, John F, eds 1999 Sand lance a review of biology and predator relations and annotated bibliography Research Paper PNW-RP-521 Portland, OR US Department of Agriculture, Forest Service, Pacific Northwest Research Station 327 p The publication contains three parts

(1) Biology of the Genus Ammodytes, the Sand Lances Six species of sand lance (Ammodytes) in temperate and boreal regions are currently recognized Sand lance can occupy a wide range of environmental conditions, but all appear to be dormant predominantly in winter, and one species is in summer also They lack a swim bladder and spend much of their time buried in specific substrates Copepods are the primary food Spawning usually occurs in fall or winter (although some species also spawn in spring), eggs are demersal, and larvae may hatch at times of low food abundance Sand lance usually occur in schools and are regarded as a relatively high-quality forage fish

(2) Sand Lance as Cornerstone Prey for Predator Populations Sand lance constitute a major prey for at least some populations of over 100 species of consumer, including 40 species of birds, 12 species of marine mammals, 45 species of fishes, and some invertebrates Variation in the availability of sand lance (and other forage fishes) can have major effects on the breeding success and survival of their predators Commercial fishing and other pressures on sand lance populations potentially have ramifying effects on many species of wildlife

(3) Annotated Bibliography The bibliography contains over 1,700 references on the family Ammodytidae, with an emphasis on the genus *Ammodytes* Keywords are provided for each reference and have been further organized into taxonomic, geographic, subject, and predator indexes

The publication is available from the Pacific Northwest Research Station, PO Box 3890, Portland, OR 97208-3890 The entire document also is available online in Portable Document Format (pdf) To view publications and see instructions about downloading the Adobe Acrobat Reader, navigate to http://www.fs.fed.us/pnw/pubs.htm

Project Number and Title 99347 - Fatty Acid Profile and Lipid Class Analysis for Estimating Diet Composition and Quality at Different Trophic Levels

<u>Principal Investigators</u> Ron Heintz and Marie Larsen, Auke Bay Laboratory, National Marine Fisheries Service, 11305 Glacier Highway, Juneau, AK

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Abstract Project 99347 is aimed at identifying the utility of lipid class analysis for understanding the dynamics of surplus energy in forage fish The relative concentration of triacylglycerides (TAG) expressed as a percentage of the total lipid content is an index to the amount of surplus energy acquired by an organism We have been evaluating the spatial, temporal and ontogenetic components to variation in TAG content in sandlance, an important forage fish species in Prince William Sound Sandlance juveniles were sampled from several locations around Prince William Sound during late July, 1997 and 1998 to examine the spatial component to variation Samples collected from a specific site in Kachemak Bay between May and September 1998 provided a basis for examining temporal and ontogenetic changes in TAG content Our data demonstrate each of these variables has an important influence on the relative amount of triglyceride (TAG) in sandlance lipids Samples of juvenile sandlance collected from different locations revealed a high degree of spatial variability in TAG content, which is uncorrelated with lipid content. In addition, the temporal data indicate that the relative concentration of TAG in sandlance can change rapidly Consequently, spatial variation in TAG content may be indicative of local changes in prey availability Sandlance representing different developmental stages collected in Kachemak Bay in 1998 revealed a trend towards increasing TAG content with age, and TAG content for all developmental stages reached peak levels in mid July A secondary peak in TAG content was observed in both juvenile and adult sandlance in late August This secondary peak may influence their ability to survive overwinter

Project Number and Title 99348 - Responses of river otters to oil contamination a controlled study of biological stress markers

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<u>Abstract</u> Previous studies on free ranging coastal river otters (*Lontra canadensis*) from Price William Sound, Alaska, demonstrated elevated levels of biomarkers in animals from oiled areas compared with those from nonoiled areas throughout the Sound, shortly following the *Exxon Valdez Oil Spill (EVOS)* Although the data collected to date strongly indicated a relation between oil contamination and physiological stress in river otters, this evidence required verification through controlled experiments

In this study, we experimentally determined the effects of oil contamination on river otters Fifteen wild-caught male river otters were exposed to 2 levels of weathered crude oil (1 e, control, 5 ppm/day/ kg body mass, and 50 ppm/day/ kg body mass) under controlled conditions in captivity at the Alaska Sealife Center in Seward, Alaska, USA Responses of captive river otters to oil ingestion provided mixed results in relation to biomarkers. Although hemoglobin, white blood cells, alkaline phosphatase, and possibly interleukin–6 immunoreactive responded in the expected manner, other parameters did not. Aspartate Aminotransferase, Alanine Aminotransferase, and haptoglobin did not increase in response to oiling or decreased during rehabilitation. In addition, although expression of P450-1A increased in the captive river otters during oiling, several inconsistencies in the data complicated data interpretation. Nonetheless, we were able to establish that the reduction in hemoglobin led to increase in energetic costs of terrestrial locomotion, a decrease in aerobic dive limit, and a potential increase in foraging time due to a decrease in total length of submergence during each foraging bout. We offer a theoretical physiological model to describe interactions between the different biomarkers and advocate the exploration and development of other biomarkers that will be independent of the heme cycle **Project Number and Title** 99361 - Dynamic Graphical Techniques for Ecosystem Synthesis and Knowledge Transfer

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<u>Abstract</u> Project 99361 explored techniques for enhancing communication of scientific results to the public The two keys to our approach are (1) use of plain, simple language to communicate the rationale for the science and explain its larger meaning, and (2) use of carefully designed, attractive, high-level animated graphics to make complex results more understandable

Graphical presentation approaches have been shown valuable for illuminating complex conceptual relationships, because they take advantage of the full cognitive processing power of the human visual system and enable higher bandwidth information transfer This project successfully applied such techniques, including advanced computer imaging, realistic multidimensional graphical syntheses, animated computer simulations, and multimedia presentation formats, to the ecosystem research results of the Sound Ecosystem Assessment (SEA) program

The products from Pioject 99361 are (1) A high impact, dynamic graphical presentation of the synthesized results of the SEA program, targeted for a general scientific and informed lay audience, first presented live at the EVOS Ten Year Anniversary Symposium in March 1999, and (2) A VHS video of SEA research, targeted for the general public, available January 2000

In ecosystem-related scientific research, the imperative for information translation and transfer is now increasingly recognized Scientists have an obligation to give results back to stakeholders However, *useful* communication of results to the public, resource managers, policy makers and even to the wider scientific community remains in many ways still an unsolved challenge Techniques developed in Project 99361 will have direct application to future larger-scale synthesis, communication, and technology transfer tasks The results of this project are readily transferable to direct live, internet/web, CD/DVD, video and broadcast delivery media
Project Number and Title 99366 -- Improved Salmon Escapement Enumeration Using Remote Video and Time-Lapse Recording Technology

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Abstract We are evaluating the feasibility of using remote video and time-lapse recording technology to count adult sockeye (*Oncorhynchus nerka*), chum (*O keta*), and pink salmon (*O gorbuscha*) as they enter their natal streams to spawn Accurate escapement monitoring is an integral component of sustainable commercial, sport, and subsistence/personal use fisheries management, and also for following the recovery of salmon resources injured by the *Exxon Valdez* Oil Spill Currently, periodic, low-level aerial surveys from fixed-winged aircraft are used to monitor salmon escapements on small clearwater streams in remote areas around the state Although this technique is fast and efficient, allowing a single observer to cover a large area in a small amount of time, surveys are frequently compromised by a number of variables that are difficult to identify and to remove from the estimates. The resulting data often provide only a rough index of abundance that may not be appropriate for rigorous analyses such as evaluating escapement goals and productivity trends, or monitoring the recovery of injured resources.

We developed a Remote Video Escapement Recorder (RVER) system that is small, relatively lightweight, and easily deployed The system operates under its own, solar, wind or hydrogenerated power, depending on site characteristics RVER is designed to capture time-lapse images of adult salmon as they swim over a high contrast substrate panel fixed to the stream bottom below an overhead camera Because the camera operates continuously, it is potentially capable of providing near-census quality escapement data In contrast, aerial surveys provide periodic, instantaneous estimates of fish visible to an observer travelling at 100 mph, 300 feet above the stream Remote video escapement recorders are capable of providing a visual record of an area's environmental conditions (e g, stream discharge and water clarity), along with the timing and abundance of the stream's salmon returns, all on a few archivable videotapes

In 1999, we deployed RVER on Delight Creek, the outlet stream of a clearwater lake system on the outer coast of the Kenai Peninsula Delight Lake supports a modest sockeye salmon run (10-30 thousand fish) Five hundred meters upstream of the video system we erected an adult fish weir, the most accurate means available to estimate salmon escapement Our objective was to determine the accuracy and reliability of a remote video system for estimating sockeye salmon escapement into a small stream To accomplish this, we compared salmon counts derived by RVER, with those made at the adult fish weir and evaluated RVER's performance across varying stream discharge and escapement conditions

RVER successfully operated 87% (1,095 hrs) of the time it was programmed to run Most of the down time resulted from insufficient solar energy being available at the site RVER was deployed During this evaluation year it was necessary to locate the video system very close to the weir to reduce migration lag time and enable daily comparisons between the two counting

methods Only 41 7 hrs were required to review nearly 1,100 hrs of recorded videotape, averaging 38 minutes to review an entire day's escapement (range 18-125 minutes) Generally, daily video counts tracked well with daily weir counts, particularly after mid-July when subtle modifications to the video system dramatically improved image quality After these improvements, RVER documented 85-87% of the escapement counted through the weir We believe these preliminary results can be improved with further modifications, such as decreasing the timelapse interval to improve tracking of individual fish

In FY00, we intend to evaluate the feasibility of using RVER to count pink and chum salmon in a stream where intertidal spawning occurs If this application can be developed, remote video escapement recorders will be available to monitor the recovery of injured resources in many of the small, remote streams throughout the spill area Once we demonstrate the feasibility of these applications, we'd like to explore real-time, microwave transmission of images back to central locations. This single step would dramatically reduce RVER's power consumption, preclude the need for weekly air charters to change video tapes, and allow more timely escapement monitoring for inseason management of commercial, sport, and subsistence/personal use fisheries

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**Project Number and Title** 99368 - Summary Seasonal Maps Depicting Environmentally Sensitive Areas in Prince William Sound

**Principal Investigator** John Whitney, NOAA Hazmat, 510 L St, #100, Anchorage, Alaska 99501

<u>Abstract</u> NOAA is in the process of finalizing summary Environmental Sensitivity Index (ESI) maps for Prince William Sound and the Copper River delta areas ESI maps are a hallmark product of NOAA who, over the past 20 years, has produced these maps for nearly the entire United States coastline and a significant amount of worldwide coastline The primary intention of these maps is for oil spill response as distribution, abundance, life history, and sensitivity of the natural resources, human-use resources, and shoreline types and their vulnerability to oil are displayed Originally, these maps were developed for Prince William Sound in 1983 and 1988 However, with the diamatic increase in biological data as a result of the EVOS program, it was thought that these maps needed to be updated to incorporate this new information

As a result, NOAA will be producing four seasonal summary maps at a scale of 1 to 250,000 This information will be made available in three different formats, 1 ) 1500 poster quality maps will be printed, 2 ) 200 copies of these maps will be printed on weather resistant paper, and 3 ) a digital product will be produced in ArcInfo format. In general, these maps will contain more complete and better survey information primarily for western Prince William Sound than was available on the original summary maps in 1988. Some of the new and updated information that the EVOS project has provided include harbor seal surveys, sea otter work, pelagic seabird data, seabird nesting information, updated eagle nest sites, and the new inclusion of forage fish survey information. In addition the entire shoreline of Prince William Sound was flown and reclassified as to shoreline geomorphology, biological habitat, and vulnerability to oil. Only the most sensitive of these shoreline types will be portrayed on the summary ESI maps. In addition, it is planned to incorporate digital photos depicting the various biological species, shoreline types, and particularly sensitive areas

Of interest is a parallel project that NOAA has also under taken with other funds. That project involves producing much more detailed ESI maps at a 1 to 63,360 scale in both a printed and digital format. These more detailed maps will contain higher resolution distribution data for the natural resources in PWS, month by month life history tables, and a full classification of the entire shoreline of the Sound and the Copper River delta. Both of these projects are expected to be completed this summer

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**<u>Project Number and Title</u>** 99371 - Effects of Harbor Seal Metabolism on Stable Isotope Ratio Tracers

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<u>Abstract</u> Stable isotope transfers and fractionation in harbor seals are being investigated with the goal of identifying specific conservative biomarkers (essential amino acids or fatty acids) that carry isotope ratios unmodified by metabolism. The study is being conducted through controlled isotopically labeled feeding experiments of harbor seals at the Alaska Sealife Center in Seward. Three harbor seals were fed controlled diets from Sept , 1998 to Sept , 1999. Snapper, the control animal, a 15 years old male, was fed on a mixed diet of 50% herring and 50% pollock. Two other seals, Pender and Poco, were fed either herring or pollock and switched to the alternate diet for three months, then back to original <sup>15</sup>N-labeled glycine was injected intravenously on 8 Dec 1998 in order to track the metabolic processes during food assimilation experiments. Blood samples were collected at two week intervals and red blood cells (RBC) and serum separated immediately. Both nitrogen and carbon isotope ratios in serum and RBC were measured using continuous-flow isotope ratio mass spectrometry.

Preliminary results showed that d<sup>15</sup>N in serum increased immediately after injection, then decreased exponentially with half-lives of about 10 days for all three seals After 10 days, d<sup>15</sup>N values decreased gradually via metabolism with a half-life of approximately 40 days In contrast, red blood cells took much longer time to incorporate <sup>15</sup>N-enriched glycine so that isotopic ratios increased slowly with time, reaching equilibrium values after several days d<sup>15</sup>N values in RBC of the three seals then decreased linearly from 145 to 200 days (after injection) to a lower stable d<sup>15</sup>N value than initial values

 $d^{13}C$  values in serum of harbor seals tracked the diet switches almost exactly Relatively enriched  $d^{13}C$  values of pollock ( $d^{13}C = -198\%_0$ , n = 7) led to increase in serum  $d^{13}C$  and lower values for herring ( $d^{13}C = -2234\%_0$ , n=10) led to decrease  $d^{13}C$  values in RBC did not reflect the dietary changes over the course of the experiment reflecting a much longer turnover time for the cellular material

Future work will entail the isolation of individual amino acids and the measurement of transamination efficiencies in the seals Challenges of highly labeled alternate amino acids will be used to identify conservative amino acids useful as dietary markers in the wild This work will require development of new techniques for either HPLC isolation or gas chromatography-mass spectrometry protocols This work is currently underway **Project Number and Title** 99375 - Effect of Herring Egg Distribution and Ecology on Year-Class Strength and Adult Distribution

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<u>Abstract</u> The objective of this project is to refine our understanding of Pacific herring (*Clupea pallasi*) population structure and trends in Prince William Sound (PWS) by examining existing data on fish distribution within an ecological context. We start by examining temporal and spatial trends in spawning and recruitment then analyze the impact of that distribution in the context of the oceanographic conditions on population structure and abundance 3–4 years later. We are focusing on conditions affecting herring in their first year since that is when a strong or week recruiting cohort is likely produced. The timing of a significant variable in the analysis will provide clues as to bottlenecks in early life survival and to mechanisms that may operate in restricting recruitment success.

We are using multiple regressions and time series in an exploratory sense, then a General Additive Model (GAM) approach to account for variability observed Predictor variables are herring spawn, oceanographic, and meteorologic conditions and response variables are the recruitment of age-3 and -4 herring We will also look at size at age of recruits if available, define oceanographic regions and develop regional variables in order to determine coherence between regional recruitment and cross-correlations between regional spawn and regional recruitment Cycles in recruitment and ocean conditions and decadal trends are accounted for in the model due to the inclusion of autocorrelation

There is no obvious spawner-recruitment relationship between spawning and age 3 or 4 recruitment overall in PWS, but a significant 4-year cycle in recruitment exists. There was significant coherence in recruitment between eastern, northeastern and northern regions for age-3 herring, but not between Montague (where most spawn occurs at the present) and other regions. For age-4 herring, there was weak, but not significant, coherence between Montague and the Northeast Using multiple regression, only the Montague regional spawn was significantly correlated to recruitment and then only for age-3 recruitment to Montague. There were no other interregional relationships. Using cross-correlations, overall spawn and Montague region spawn were significantly correlated to age-4 herring recruiting to the Montague region. This indicates that Montague spawn may not contribute significantly to recruitment in other regions but other regions may contribute to Montague. Relatively high, but not significant, cross-correlations were found between the eastern and northern regions

The major environmental finding is an observed regime shift occurring at about 1989 evidenced by reduced winter downwelling and lower spring and fall regional salinities. This decadal shift coincides with a large reduction in herring recruitment and population size. Higher salinity and more highly variable downwelling coincided with the decade of highest herring production (1980s). Interestingly enough, this is also when pink salmon production peaked in Prince Will-iam Sound.

**Project Number and Title** 99379 – Assessment of Risk Caused by Residual *Exxon Valdez* Oil in PWS Based on P450 Activity in Fishes

**<u>Principal Investigator</u>** Stephen C Jewett, Institute of Marine Science, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, Fairbanks, AK 99775-7220

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**Abstract** Traces of residual oil from the *Exxon Valdez* Oil Spill (EVOS) can still be found in sediments in some coastal areas of Prince William Sound (PWS) One habitat still showing relatively high oil concentrations is in blue mussel (*Mytilus trossulus*) beds and underlying sediments Coincidentally, elevated levels of cytochrome P450 A1 (CYP1A) (a sensitive and specific adaptive response in vertebrates exposed to xenobiotics including petroleum hydrocarbons) in a number of higher-order vertebrates that live or feed in the near-shore environment provide evidence of continued exposure to hydrocarbons. It is uncertain whether elevated CYP1A levels are the result of exposure to residual oil or other hydrocarbons, but the fact that animals with elevated levels are largely restricted to parts of the Sound that were heavily oiled suggests that residual oil from the EVOS is the likely source of contamination. The potential consequences of exposure to populations or to individual animals are also unknown, but there is a strong correlation between exposure to oil and a lack of recovery in vertebrate populations.

In June 1999 we collected two coastal fishes, masked greenling (*Hexagrammos octogrammus*) and crescent gunnel (*Pholis laeta*), in western PWS for the purpose of identifying the relationship between hydrocarbons in mussel bed sediments and CYP1A in fishes adjacent to mussel beds Scientists from the Auke Bay Fisheries Lab sampled mussels and sediments Fish livers were subjected to two assays, IHC analysis and the more sensitive EROD analysis, at Woods Hole Oceanographic Institution For greenling, hepatocyte IHC scores were low (means < 0 2) at all ten sites, with no significant difference between oiled and reference sites Greenling EROD values were also low (means < 345 pmol/min/g liver), but with significantly higher values at several oiled sites For gunnel, no hepatocyte staining was observed, EROD was low (means < 96 pmol/min/g liver), but measurable, reflecting differences in detection limits for these techniques The relationship between hydrocarbons in mussel bed sediments and CYP1A in fishes adjacent to mussel beds will be determined once all sediment hydrocarbon analysis is complete Preliminary results of hydrocarbon concentrations in the top 2 cm of sediments at three oiled sites range from means ( $\pm$  SE) of 303 (201) to 11,201 (8,276) µg/g

In summary, it appears that the exposure of greening and gunnel to oil in 1999 was negligible, based on the two assays used However, in FY00 bile from greenling that had the highest EROD values will be analyzed to determine if oil was metabolized and if exposure to oil was the probable cause for elevated CYP1A activity

**Project Number and Title** 99381 - Status of Seabird Colonies in Northeast Prince William Sound

**Principal Investigator** Mary Anne Bishop, Prince William Sound Science Center, PO Box 705, Cordova AK 99574, 907-424-5800 (tel) -5820 (fax)

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Abstract Restoration Project 99381 began and was completed in 1999 We located and surveyed 7 active seabird colonies in northeast Prince William Sound (Port Gravina to Nelson Bay), including 3 colonies not previously reported Additionally at 2 historic colonies, Redhead and Hanks Island, we were not able to confirm nesting but did observe small numbers of pigeon guillemot (Depphus columba) and mew gull (Larus canus), respectively Within colonies, we recorded nests for 4 species Aleutian tern (Sterna aleutica), Arctic tern (S paradisaea), blacklegged kittiwake (Rissa tridactyla), and black oystercatcher (Haimatopus bachmani) The highest number of nests for any species at a colony was 16 Arctic tern nests Breeding numbers in 1999 may be low for all seabirds due to an unusually harsh and late winter Shoreline surveys for black ovstercatcher located 66 birds, and breeding pair densities were estimated at 0 11 pair/km for the study area Areas around northeast Prince William Sound were recently purchased by the Trustee Council to aid in the restoration of injured species The conversion of these acquired parcels from private land to public land, increased wildlife and fishing tours generated by cruise ship stopovers in Cordova and greater access to Prince William Sound due to the construction of the road from Portage to Whittier will increase human/wildlife interactions Because of its high potential for human disturbance, we recommend the Chugach National Forest post Hells Hole in Port Gravina against unapproved human trespass Seabird colonies should also be revisited every 5 years to provide data on possible colony shifts and increases in human/seabird colony interactions

**Project Number and Title** 99391 - Cook Inlet Information Management and Monitoring System (CIIMMS)

**Principal Investigators** Kelly Zeiner, Alaska DNR, 550 W 7<sup>th</sup> Ave, Suite 706, Anchorage, AK 99501, Tel (907) 269-8856, Email <u>kellyz@dnr state ak us</u>

Jeff Hock, Alaska DEC, 410 Willoughby Ave, Suite 105, Juneau, AK 99801, Tel (907) 465-5185, Email <u>hock@envircon state ak us</u>

**Abstract** The CIIMMS Project is a cooperative effort between Alaska DNR and Alaska DEC for the purpose of unifying a myriad of pre-existing Cook Inlet data and information, in order to develop a web-based watershed-wide information framework. The vision for the CIIMMS is to develop a comprehensive system, using the latest Internet technologies, to enable a wide range of users to contribute, identify, share, and access valuable information about. Cook Inlet resources and related projects and activities. Methodologies used include on-line metadata (of one kind or another) and website harvesting software, just to name a few. Toward the CIIMMS vision, in FY1999, this joint effort encompassed the following activities.

• Assessment of users' needs through surveys, focus groups, and a 100-person stakeholder workshop, which also evaluated current information management approaches within the Cook Inlet community,

• Development of the "Cook Inlet Information Management Requirements and Recommendations" post-workshop report This document outlined user priorities in terms of the proposed website's functionality, design, user interface, and target audience,

• Development of the CIIMMS Pilot Phase Implementation Plan,

• Development of the CIIMMS Pilot, or prototype, which focused on the high priority, short-term functions identified at the user needs workshop

• Evaluation of the Pilot by stakeholders

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The prototype focuses on the Kenai River watershed as much as possible, and allows users to search and browse a representative array of websites and metadata related to data, information, and projects in the Kenai River watershed Information accessible includes themes such as Spruce Bark Beetle infestation, wetlands, injured resources (i e anadromous streams and species data), and habitat protection parcel boundaries The FY2000 activities will expand access to data and information for the entire Cook Inlet watershed, including discovery and access to data generated by other EVOS funded projects

Members of the CIIMMS team will be available during the workshop to give website demonstrations Project Number and Title 99393 - Plince William Sound Food Webs Structure and Change

**Principal Investigator** Thomas C Kline, Jr, Ph D, Prince William Sound Science Center, PO Box 705, Coidova AK 99574, 907-424-5800 (tel) -5820 (fax), tkline@pwssc gen ak us

<u>Abstract</u> This project seeks to (1) conduct retrospective analysis of Gulf of Alaska (GOA) production shifts since EVOS, and (2) address Ecopath model validation data gaps. These analyses will enable us to gain a better understanding of the ecological role of 'regime shift' processes conjectured to be impeding the natural restoration of populations in Prince William Sound (PWS) affected by the EVOS

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Recent research has shown that the advective regime connecting the northern GOA with PWS may affect recruitment and nutritional processes in Fishes Accordingly, food webs are subject to changes in carbon flow occurring between GOA and PWS Stable risotopic analysis is being performed on the outer protein layer (periostracum) of shells and body tissues of Sea-mussels (*Mytilus califormanus*) of varying ages collected at Middleton Island using sections cut along annular growth rings Mussels of different age are providing data from various years (as annuli are wider and more distinct at earlier ages) to reconstruct an isotopic time series retracing conditions from 1997 backwards in time to EVOS and earlier Overlapping years (of periostracum samples) of good age resolution will be used to inter-calibrate mussels while younger mussels will be calibrated against the existing zooplankton database. The expected results will consist of an isotopic characterization of GOA isotopic signatures from 1989 (possibly earlier) to 1997. The following question will be asked. Did changes of the magnitude seen in 1996 occur in other years? If so, how often If not, then the 1996 will be considered an anomaly rather than a common occurrence.

The Ecopath modeling group Trustee Council sponsored synthesis of known ecological relationships of many of the organisms inhabiting PWS will be used to conduct perturbation experiments to examine EVOS and restoration effects. The utility of this effort will in part be dependent on how realistic their models are. One way to determine if the model is realistic is to compare model predictions with those made using an independent method. Ecopath generates as part of the output, the fractional trophic level for each functional group defined in the model input that can be validated with <sup>15</sup>N/<sup>14</sup>N data. T. Kline and D. Pauly validated a preliminary PWS Ecopath model using this novel approach. They used a limited number of functional groups which contrasts with the full Ecopath model which has 46. In comparison to the preliminary model, the artifact of functional group over-aggregation will be significantly reduced in the full model, enabling a more robust Ecopath validation for <sup>15</sup>N/<sup>14</sup>N data for a large proportion of the functional groups. <u>Project Number and Title</u> 99401 - Assessment of Spot Shrimp Abundance in Prince William Sound a Decade After the *Exxon Valdez* Oil Spill

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Abstract The commercial spot shrimp (Pandalus platyceros) harvest in Prince William Sound (PWS) began in the 1950's, increased rapidly after 1975 and peaked at over 110 tonnes in 1986 After 1988, the harvest decreased rapidly until 1992 when the fishery was closed and remains closed Annual surveys of spot shrimp abundance in western PWS from 1989 to 1998 by the Alaska Department of Fish and Game (ADF&G) have shown a continued decline in catch per unit effort (CPUE) The purpose of this project is to estimate the abundance of spot shrimp and determine the structure of the spot shrimp population in western PWS in order to determine whether the population is recovering from depletion. The project augments current Alaska ADF&G surveys by broadening the geographical coverage and increasing the amount of replication within the existing survey area The objectives in the first year of this study were to 1) estimate spot shrimp abundance (CPUE) in western PWS, 2) determine the sex and size composition of spot shrimp at the study sites, and 3) estimate spot shrimp fecundity and relative number of egg-bearing females at the study sites We sampled spot shrimp in October 1999 using strings (two/site) of 22 shrimp pots each Shrimp pots were fished at six sites in western PWS previously surveyed by ADF&G and at six additional sites in the ADF&G survey area We measured the carapace length of all shrimp and counted all ovigerous females Nonovigerous shrimp were subsampled for sexing and ovigerous shrimp were subsampled for fecundity estimates

Our preliminary mean CPUE estimates at traditional ADF&G sites in October 1999 appear to exceed those obtained by ADF&G in 1998 both in number and weight of shrimp per pot Mean CPUE by number in 1999 (12 shrimp/pot) exceeded that in 1998 by 30% Mean CPUE by weight in 1999 (273 g) exceeded that in 1998 by 6 times These interannual differences increased to 63% and 8 fold for CPUE by number and by weight, respectively, when our six additional sites were compared to 1998 values at traditional ADF&G sites However, estimates of the variability in the ADF&G CPUE data were not available at this writing Moreover, more than one year of increasing CPUE estimates would be necessary to indicate progress toward recovery in the spot shrimp population in western PWS Data analysis of sex ratios and shrimp fecundity are in progress

## Project Number and Title 99405 - Port Graham Salmon Hatchery reconstruction

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Abstract The Port Graham Hatchery Rebuild Project has enabled the native village of Port Graham to recover from the devastating fire of January 1998 that destroyed the existing hatchery and all of the pink and sockeye salmon that were in incubation at the time The existing hatchery was just getting up to capacity with its brood build up phase and ended up having to start over with the odd year pink salmon stocks. The new hatchery will help provide sustainable and optimum salmon returns for local subsistence and commercial fisheries It will also facilitate the promotion of local fisheries and natural resource education including the environment and habitats that they depend on The new hatchery will endeavor to build its new programs on the foundation of historical perspectives using local traditional ecological knowledge combined with new scientific fisheries principles The hatchery program seeks to preserve and promote an attitude of respect and responsible stewardship for all of the local fisheries resources The new hatchery has a capacity of 110 million pink eggs, 5 million sockeye eggs and 2 million coho eggs It is expected to achieve an annual production of 3.5 million adult pink salmon and potentially 150,000 sockeye salmon and 100,000 coho salmon The new facility has enough heating capacity to thermal mark all of its production which will greatly help to assess hatchery contributions to the local fisheries as well as enable local ADF&G managers to minimize mixed stock interception during targeted hatchery return fisheries The new hatchery construction began in May and was completed in December of 1999 The pink and sockeye eggs that were taken in 1999 were incubated to the eyed stage at the temporary hatchery facility and then transferred into the new hatchery on December 7<sup>th</sup> They were then started on the thermal marking program on December 8<sup>th</sup> There are currently about 1.2 million pink eggs and 1.3 million sockeye salmon eggs in incubation at the new facility. They will be hatching out in January and February The pink fry will be transferred out to saltwater net pens in mid April for about six weeks of rearing before release and the sockeye fry will be flown over to English Bay Second Lake on oi about June 1st where they will be reared until about mid November

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Project Number and Title 99423 - Patterns and processes of population change in sea otters

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Abstract. The purpose of this study is to track the recovery process of sea otters (*Enhydra lutris*) in western Prince William Sound through annual aerial surveys of abundance and to monitor the abundance and size distribution of a preferred sea otter prey, the green sea urchin (*Stronglycentrotus dioebachiensis*) Objectives in 1999 included, 1) estimate of sea otter abundance in Prince William Sound, 2) independent estimates of abundance at northern Knight Island (a heavily oiled site) and at Montague Island (an unoiled site), and 3) estimate the abundance and size distribution of green sea urchins and Knight and Montague Islands

Estimates of sea otter abundance were obtained through a standardized aerial survey methodology A single survey of Prince William Sound and a series of replicate aerial surveys at Knight and Montague Islands were completed in July 1999 Surveys of sea urchin populations at Knight and Montague Island were completed in August 1999

In July 1999 we estimated the Prince William Sound sea otter population at 8,355 individuals (se=1086), the Orca Inlet population at 4,879 (se= 2391) and the Western Prince William Sound population (a subset of the Prince William Sound population) at 2,475 (se=381) Prior estimates for Prince William Sound and Orca inlet weie 9,092 (se=1422) and 5,260 (se=1956) respectively, in 1994 The previous estimates for Western Prince William Sound were 2,852 (se=440) in 1998 and 2,228 (se=256) in 1994 We estimated population sizes of 81 (se=15) at Northern Knight Island and 586 (se=109) at Montague Island in 1999 At Northern Knight Island the mean estimated summer population size has remain unchanged since 1993 (mean=71, se=7) During this same period we have seen a significant increasing trend in population size at Montague Island from about 300 in 1993 to about 600 in 1999 (avg annual increase =12% adj,  $R^2$ = 0.72, P<0.01)

The relative stability of the larger Prince William Sound sea otter population over the past 5 years and the significant increases we have detected since 1993 in and around the spill area are indicating overall recovery of the EVOS injured sea otter population However, the lack of a concurrent increase around Northern Knight Island, where sea otter mortality was highest, indicate that recovery may not be occurring where oil spill effects were greatest

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Between 1996 and 1999, we also examined changes in sea urchin populations at Knight and Montague Islands In 1996 and 1997 at Knight Island, more than 40% of the sea urchins examined (N=2176) were larger than 20 mm (the minimum size generally consumed by sea otters) compared to the less than 20 % (N=678) at Montague Island However, in 1998 and 1999, there was a marked increase in the number of large sea urchins, especially at Montague Island, and there was a higher proportion of large sea urchins at Montague Island compared to Knight Island In 1999, 77% (N=265) of the sea urchins at Montague were larger than 20 mm compared to 54% (N=794) at Knight The increasing proportion of large sea urchins at Montague was in spite of high, and increasing density of sea otters there compared to Knight Island **Project Number and Title** 99434 - East Amatuli Island Remote Video Link

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**Abstract** The purpose of this project was to install and test a remotely operated video camera system in the Barren Islands in order to evaluate its effectiveness 1) for collecting supplementary data on breeding parameters for common murres (*Uria aalge*) being studied as part of the Alaska Predator Ecosystem Experiment (APEX) and 2) as a tool to increase public access to EVOS-supported research programs The study area included established APEX seabird sites on East Amatuli Island (APEX Project 99163J) From June through September 1999, two remotely-controllable video cameras and a system for microwave and UHF transmissions provided full-bandwidth real-time video and audio of nesting seabirds on East Amatuli Island to users 51 miles away at the Pratt Museum in Homer A control/monitoring station and exhibit with associated maps, diagrams, and seabird mounts were set up in the museum's Marine Room US Fish and Wildlife Service (FWS) and museum staff were instructed by the APEX research team on use of nest plot maps, photographs, data sheets and on protocols for observing and recording study data from the cameras

FWS and museum staff worked in the Marine Room daily as data collectors and public interpreters Between June 24 and August 17, observations of common murre study plots were made twice daily, Tuesday through Saturday, by FWS staff (postures and presence of eggs or chicks in the morning and general counts in the afternoon) Museum staff collected counts on about 60% of days when FWS observers were absent This combined effort produced an almost continuous string of observation records for an eight-week period Concurrently, the general public and students enrolled in the museum's summer science programs were given first-hand experience observing seabirds nesting in their natural habitat and watching staff make and record observations Interpreters led discussions of seabird behavior, adaptation, habitat, other marine organisms, oil spills, public lands, scientific methodology and the nature of EVOS sponsored research People were invited to try their hands at making observations and recording data

Image quality was excellent much of the time – in the estimation of one FWS staff person, clear enough to effectively collect data on the types of forage fish being utilized by nesting birds Image quality was periodically degraded by tidal-induced Fresnel interference, however Several transmission, mechanical, and power problems caused complete loss of images or control functions at various times, requiring field repairs In spite of these interruptions, FWS staff estimate that data could be collected effectively 80% of the time These data are yet to be analyzed They will be compared for consistency with data gathered by the field team for the same plots in order to assess the effectiveness of remote observation. Our preliminary assessment is that remote video technology appears to offer a potentially cost-effective way to supplement field observations at remote sites With some modification to address transmission and mechanical problems and with proper configuration of components there are many potential applications throughout the spill area, especially for research focusing on seabird and sea mammal populations. The combination of high quality video images of wildlife from remote field sites and knowledgeable interpreters proved a compelling educational tool as well. With interpreter interaction people spent substantial time with the cameras and demonstrated greater interest and understanding of seabirds and research. When presented through a museum or other appropriate public venue, research-linked remote video technology has potential to greatly increase public awareness of and appreciation for EVOS sponsored research and science in general

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**Project Number and Title** 99441 - Harbor Seal Recovery Phase III Effects of Diet on Lipid Metabolism and Health

**Principal Investigator** Randall Davis, Dept of Marine Biology, Texas A&M University at Galveston, 5007 Avenue U, Galveston, TX 77573, (409) 740-4712, davisr@tamug tamu edu

**Abstract** The harbor seal (*Phoca vitulina richardsi*) population in Prince William Sound has not recovered and may continue to decline An underlying hypothesis is that ecosystem-wide changes in food availability could be affecting harbor seal population recovery. To better understand the results from field studies of harbor seal health, body condition and feeding ecology, we need data for seals on diets that vary in nutritional composition. Working with the Alaska SeaLife Center, we will determine how fatty acid profiles in the blubber of captive harbor seals change over time during controlled diets of herring and pollock. In addition, we will assess the aerobic capacity and lipid metabolism of skeletal muscle in harbor seals fed controlled diets and for wild harbor seals in Prince William Sound. The results will augment already funded investigations of diet and health to provide a more in depth understanding of the nutritional role and assessment of dietary fat for harbor seals.

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Feeding trials for eight harbor seals began in early September 1998 and will continue until August 2000 at the Alaska SeaLife Center During the staggered feeding trials, the diet will be changed every four months We will obtain serial blubber samples every two months and muscle biopsies every four months from two sites on each animal The procedure will use a crossover repeated measures approach and will allow statistical comparisons within any one group of seals between diet and season This feeding matrix allows each group of seals to experience a different diet at similar physiologically relevant times of the year and allows us to study the impact of the phased switch on blubber and muscle lipid content and composition, and on muscle lipid metabolism In addition to captive studies, we have obtained muscle and blubber samples from harbor seals in Prince William Sound through the BIOSAMPLING program Working in conjunction with the Native community, we sampled eight haibor seals in June 1999 Preparations have been made for obtaining additional blubber and muscle samples from wild harbor seals in Prince William Sound in June 2000 The blubber samples from both captive and wild harbor seals will be analyzed for fatty acid profiles Muscle samples will be analyzed for % fiber type, volume density of lipid droplets and mitochondria, lipid enzyme activities, and myoglobin concentration This project is still underway, and no significant problems have been experienced

The Restoration Program has supported the population monitoring component of health assessment, diving behavior and food preferences of harbor seals in Prince William Sound Now, with controlled feeding studies of harbor seals underway at the Alaska SeaLife Center, we will continue our studies of the effects of diet on fatty acid signatures in blubber and the metabolic function of muscle, especially with regards to lipid The results will improve our understanding of harbor seal feeding ecology and the effects of diet on health and metabolism **Project Number and Title** 99459 - Persistence of Oil on Gulf of Alaska Shorelines Ten Years after the *Exxon Valdez* Spill

<u>Principal Investigators</u> Gail Irvine, U S Geological Survey Biological Resources Division Anchorage, AK 99503

Daniel Mann, Institute of Arctic Biology, Irving Building, University of Alaska Fairbanks, Fairbanks, AK 99775

Abstract Exxon Valdez oil came ashore only sporadically along the Gulf of Alaska coastline However, some sites were heavily oiled Over the past 10 years, we have monitored oil surface coverage, subsurface extent, and chemical degradation at six sites in Kenai Fjords and Katmai National Parks that were heavily oiled in 1989 Chemical analyses of samples collected in 1994 revealed that the stranded oil at several sites was negligibly different from 11-day old Exxon Valdez oil In August 1999, we re-visited our permanent plots, described surface and subsurface oiling conditions, and collected oil samples We are currently awaiting results of these chemical analyses Field observations record significant declines in surface oiling at all sites However, subsurface oiling persists, and this subsurface oil appears little changed in amount or physical state from 1994

Why is oil persisting in these high wave-energy beaches? Gravel beaches exposed to moderate and high wave energies develop a lag of boulders after smaller stones are winnowed away by waves This boulder lag forms an "armor" that shields the gravel substrate from wave disturbance Observations of plots established in 1994 suggest that on 5 of 6 boulder-armored beaches, only slight shifting of the boulder armor occurred over the past 5 years. While high wave energy does limit the persistence of surficial oil on armored beaches, it has little effect on the persistence of subsurface oil Subsurface oil can persist even within high wave-energy gravel beaches because the boulder armor prevents waves from disturbing the beach substrate

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**Project Number and Title** 99462 - Effect of Disease on Pacific Herring Population Recovery in Prince William Sound

**Principal Investigator** Gary D Marty, VM APC, Univ of CA, One Shields Ave, Davis, CA 95616-8732, (530) 754-8062, e-mail gdmarty@ucdavis edu

<u>Abstract</u> The Pacific herring (*Clupea pallasi*) population of Prince William Sound has not recovered from severe population decline in 1993 Lost services include commercial fishing and subsistence Viral hemorrhagic septicemia virus and the fungus *Ichthyophonus hoferi* have been identified as the two main diseases affecting the health of the population Population recovery was sufficient to allow commercial fisheries to reopen in fall 1996, but low returns in 1999 forced the fishery to again close The objective of this study was to examine the relationship of disease and failure of population recovery

METHODS Adult Pacific herring were randomly sampled from the bays of northern Montague Island, Prince William Sound, in October 1998 (n = 100) and April 1999 (n = 300) Each fish was subjected to complete necropsy, including determination of age, weight, and length, plus histopathology, blood analysis, and virus analysis

RESULTS Pacific herring population biomass in the spring of 1999 was below pre-run predictions, and most commercial herring fisheries were again closed Evidence from disease study indicated that significant mortality occurred in 1998 rather than 1999 For example, spring 1999 prevalence of virus (1%) and ulcers (0 6%) was significantly less than in spring 1998 (virus = 15%, ulcers = 3 2%) Further, spring prevalence of gill parasites was less in 1999 than in 1998 Spring 1999 prevalence of *Ichthyophonus hoferi* (23%) was greater than in spring 1998 (17%), but most of this difference was attributed to fish in the 1999 sample being more than 1 year older than in 1998 Increased age of sampled fish in 1999 was associated with extremely poor recruitment of the 1996 year class and good survival of the 1988 year class Virus was not isolated from samples collected in fall 1998

CONCLUSIONS We are able to explain the 1998-1999 population decline only through the availability of extensive pre-crash data—information that has never been available to explain the crash of a wild fish population The Pacific herring fisheries were not closed until 1999, but most disease-associated mortality probably occurred during and after spawning in 1998 This conclusion is based on the high prevalence of ulcers and virus in 1998, when fish behavior was abnormal Resultant mortality was not documented until spring 1999 because Pacific herring disperse during the summer, and accurate population estimates cannot be made until late March and early April of the following year, when the fish again congregate to spawn Because of low population biomass and poor recruitment of the 1996 year class, the Alaska Department of Fish and Game has already declared all Pacific herring fisheries closed for the 1999-2000 season Fish in 1999 were relatively healthy and disease-related mortality was probably low in 1999 The Pacific herring population of Prince William Sound has not had a strong recruiting class since the 1988 year class began entering the fishery in 1991 Population recovery will not occur until another large year class recruits into the fishery, and that might be several years into the future

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## Project Number and Title 99466 - Recovery Status of Barrow's Goldeneyes

**Principal Investigator** Dan Esler, Alaska Biological Science Center, U S Geological Survey, 1011 E Tudor Road, Anchorage, AK 99503, (907) 786-3485

**Abstract** Characteristics of Barrow's goldeneyes (*Bucephala islandica*) suggest that their populations may be susceptible to negative effects of the *Exxon Valdez* oil spill These characteristics include (1) close affiliation with intertidal habitats, where much of the *Exxon Valdez* oil was originally stranded, (2) a winter diet of blue mussels (*Mytilus trossulus*), which contained hydrocarbons in some areas through at least 1995, and (3) like other sea ducks, life histories that rely on high annual survival and result in relatively low potential population growth rates Along with their intrinsic vulnerability, two lines of evidence available at the outset of this project suggested potential population-level injury and lack of recovery First, higher induction of cytochrome P450 on oiled areas than unoiled indicated continued exposure to residual oil through at least 1997 Second, USFWS marine bird surveys described divergent population trends of goldeneyes during winter in oiled and unoiled parts of Prince William Sound through 1998, consistent with continuing oil spill effects The objective of this study was to examine these and all other available data to evaluate status of recovery of Barrow's goldeneyes

Much of the data relevant to assessment of Barrow's goldeneye population recovery was collected as part of Nearshore Vertebrate Predator (NVP) studies (99025) Other sources included the USFWS surveys, and blue mussel abundance and contamination data from NOAA, Auke Bay Lab All data were considered following the framework of NVP studies to identify potential constraints to recovery, including continued exposure to oil, food limitation, and demographic limitation (i e, lack of time for intrinsic population growth to achieve recovery)

Preliminary results are mixed with regard to recovery status Body mass and composition of Barrow's goldeneyes varied by age, sex, and season (mid versus late winter) but did not differ between oiled and unoiled study areas Also, body mass was not related to level of P450 induction. These results are consistent with a hypothesis of no lingering effects from the oil spill Winter densities of Barrow's goldeneyes varied in relation to substrate type, distance to a stream, and degree of wind and wave exposure. After accounting for effects of these habitat attributes, densities of Barrow's goldeneyes did not differ between oiled and unoiled areas, consistent with a hypothesis of recovery from the oil spill. However, as mentioned above, induction of P450 and divergent population trends are consistent with potential population level effects of oil contamination. Demographic data (e g, survival and dispersal) necessary to understand the mechanisms driving population dynamics are not available for Barrow's goldeneyes, these data would be particularly helpful for differentiating competing hypotheses of population recovery versus a source/sink dynamic in which immigration masks reduced survival related to residual oil exposure

Some analyses relevant to understanding Barrow's goldeneye recovery status are still pending (e g, mussel and sediment contamination sampling from summer 1999) A final assessment of recovery status and potential constraints will be reported during FY2000, the closeout year for this study

Project Number and Title 99468 - Ex situ measurements of Pacific herring target strength

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Abstract Echo sounders can be used to estimate numbers of fish, if the relation between sound energy and fish biomass can be established The factor used to convert sound energy to fish is called target strength (TS) Near-dorsal aspect, (TS) of individual, juvenile and adult Pacific herring Clupea Harengus pallis were measured ex-situ with 120kHz dual beam acoustics An experimental frame was designed to support a fixed-location transducer, fish cage, standard calibration target and two video cameras The herring swam freely in an acoustically transparent mesh cylinder secured three meters below the transducer The TS of 51 individual herring were measured at a variety of depths As expected, the TS of individual herring declined as they were lowered in the water column Using Boyle's Law and the algorithm determined for herring TS at four meters depth (TS=-26 16logL-72 54), we estimated TS=-26 16logL-76 23 at their nighttimeoverwintering depth of 40 meters, which is the near-equivalent of an algorithm used on past surveys in Prince William Sound (TS=-26 52logL-76 44, Thorne et al 1977a, 1977b) By standardizing this algorithm to the 20 log L format and using nighttime-overwinter depths for Noiwegian Fiords, we estimated TS=-20logL-71 02 at 120 meters and TS=-20logL-74 84 at 400 meters, which brackets the algorithm for Atlantic herring of TS=-20logL-72 35 (Foote 1987) Thus, we explain the possible discrepancy in published algorithms for Atlantic and Pacific herring TS by their different nighttime-overwintering depth preferences and Boyle's Law Since the vertical distribution of herring may vary over time and space, we recommend that TS estimates be referenced to depth of measurement and adjusted appropriately for changes from the reference depth This suggestion may be applicable to all fish with gas bladders

<u>Project Numbers and Titles</u> 99476 - Effects of oiled incubation substrate on pink salmon reproduction & 00454, Evidence and Consequences of Persistent Oil Contamination in Pink Salmon Natal Habitats

**Principal Investigators** Stanley Rice, Ron Heintz, Mark Carls, and Mike Murphy, National Marine Fisheries Service, Auke Bay Laboratory, 11305 Glacier Highway, Juneau, AK

<u>Abstract</u> Determination of pink salmon recovery in Prince William Sound (PWS) a decade after the *Exxon Valdez* oil spill remains problematic and controversial As a whole, healthy population levels have been evident for some time However, evidence collected after the spill indicated that wild pink salmon returning to oiled streams through 1993 had less viable gametes than those returning to unoiled streams, and there were reports of persistent oil contamination in stream banks through 1995 Exposure of developing pink salmon eggs to oil was first verified as a plausible explanation for reduced viability in 1992 by incubating pink salmon eggs in gravel coated with known amounts of oil Thus, persistent oil contamination may have inhibited recovery of wild stocks through the mid 1990s

Project 99476 extended the initial laboratory research beginning with exposure of incubating pink salmon eggs to graded oil doses in September 1998 When the survivors emerged in April 1999 experiments were initiated to 1) determine if exposed pink salmon are more susceptible to predation, 2) verify previous observations of reduced marine survival in exposed pink salmon, 3) determine if exposed pink salmon that survive to maturity have reduced gamete viability, and 4) evaluate the use of biomarkers for predicting delayed effects in exposed pink salmon populations. We assayed susceptibility to predation by repeatedly offering predators (chinook salmon smolts) five exposed and five unexposed pink salmon fry and recording the consumption rate for each type of fry. Pink salmon fry initially exposed to a TPAH concentration of 13.0 ppb were consumed at a higher rate than unexposed fry (n = 90 trials). To evaluate marine survival, more than 185,000 fry were fin-clipped and released, including controls and two oil exposure levels. These fish will return to the hatchery in September 2000, at which time survivors will be counted and evaluated for gamete viability. This project will be complete in FY2001

Project 00454 examines current natal habitat of pink salmon in PWS for evidence of oil contamination in eggs and spawning redds and extends preceding laboratory research to include intensity and timing of P450A1A induction, histopathological lesions, genetic mutation rates (K- ras codon), and growth of oil-exposed eggs Onset of P450A1A induction is currently unknown but under study by this project Rice et al will report preliminary results of oil contamination of wild spawning redds, expected in time for this meeting Analysis of hydrocarbons in eggs and sediment from PWS will be completed at a later date Results from both projects will be combined to examine the ability of biomarkers (P450A1A induction and K-ras mutations) to predict long-term effects (marine survival and reproductive ability) A synthesis of these two projects will reexamine pink salmon recovery and natal habitats in PWS and provide a status of that recovery

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**Project Number and Title** 99479 - Effects of food stress on survival and reproductive performance of seabirds

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**Abstract** Traditional field methods of assessing effects of fluctuations in food supply on the survival and reproductive performance of seabirds may give equivocal results. In this study we apply an additional tool. The measure of stress hormones (corticosterone) in free-ranging Black-legged Kittiwakes and Common Murres *Adult stress and survival*. We found that adult kittiwake body condition declined seasonally, and the decline was more pronounced in birds at a food-poor colony (Chisik Island). Correspondingly, baseline and acute stress-induced levels of corticosterone rose steadily through the reproductive season, and baseline levels were significantly higher in birds on Chisik compared to those at a food-rich colony (Guil Island). Birds breeding at Chisik had suppressed acute stress-response compared to those at Guil. Circulating levels of corticosterone in adult Common Murres were similar to those in Black-legged Kittiwakes. Overall, our results indicate that, in addition to a seasonal change in bird physiology during reproduction, food availability affects circulating levels of corticosterone may be useful for monitoring foraging conditions in breeding kittiwakes and murres, but more study is needed to confirm these results and to measure annual variability.

Are physiological stress levels observed in one year correlated with levels of over-winter mortality observed in the subsequent year? This remains to be tested by combining results of this study with those of Project 99338, a study of annual survival in murres and kittwakes Juvenile stress and survival We found that food-restricted kittiwake chicks had chronically elevated baseline and acute-stress induced levels of corticosterone compared to chicks fed ad libitum. An elevation of circulating levels of corticosterone in energetically stressed individuals was further magnified by low nutritional quality of food We conclude that the physiological condition of kittiwake chicks raised on differing diets and energy intakes can be assessed reliably by measuring circulating levels of corticosterone Do chronically high stress levels of corticosterone prior to fledging (owing to food deprivation or poor quality food) have any impact on subsequent survival? Chronic elevation of corticosterone can cause neuronal cell death, suppress memory and immune systems, and promote wasting of muscle tissue We conducted captive trials in 1999 to test learning and memory of kittiwake chicks exposed to a chronic elevation of corticosterone during their development We found that chicks exposed to a four-week period of chronic elevation of corticosterone had suppressed cognitive abilities compared to controls We conclude that chronic elevation of corticosterone in food-stressed kittiwake chicks can decrease their chances of survival after fledging

Project Number and Title 99514 - Lower Cook Inlet Waste Management Plan

**Principal Investigator** Marianne See, Alaska Department of Environmental Conservation, 555 Cordova Street, Anchorage 99501

<u>Abstract</u> This project was funded in Fiscal Year 1999 to assess on-shore pollutants leaching into the marine ecosystem, mainly Kachemak Bay, and hindering the recovery of injured species Montgomery Watson was contracted to prepare a waste management plan and recommend measures that would decrease the amount of pollutants in the marine environment. It is expected that the Trustee Council will be approached to implement a number of the recommendations in mid-Fiscal Year 2000

The project held two sets of meetings in the communities of Port Graham, Nanwalek, and Seldovia with the environmental staff and government leaders of each respective community After the two sets of meetings a draft waste management plan was prepared Currently, the project is in the process of final approval from involved communities regarding the proposed final plan Once complete, this plan will be presented to the Trustee Council