Predation by Killer Whales in Cook Inlet and Western Alaska: An Integrated Approach 2008-2009 Project R0303-01 Final Report – Revised April 2011

Principal Investigator:

Craig O. Matkin, M.Sc. North Gulf Oceanic Society, 3430 Main St, Suite B1, Homer, Alaska 99603. Tel. 907 235-6590; email cmatkin@acsalaska.net

Cooperating Investigators:

Lance Barrett Lennard
Vancouver Aquarium and Marine Science Center
Vancouver, British Columbia
Russ Andrews
Alaska SeaLife Center
Seward, Alaska
John Durban
Southwest Fisheries Science Center
La Jolla, California

ABSTRACT

Killer whales are listed as a possible factor in the lack of recovery of the endangered Cook Inlet beluga whales and have been suggested as agents in the decline of other marine mammal species as well. In this study we develop research methodologies in False Pass/Unimak Island, Alaska and initiate pilot work photodocumenting individuals and observing feeding ecology of killer whales entering Cook Inlet, Alaska. In False Pass/Unimak Island photo-identification coupled with satellite tracking indicated that over 100 killer whales feed on migrating gray whales during May and June. Using ARGOS telemetry we have determined that some killer whales remain in the area, but many move north into the Bering Sea, possibly following the gray whales. From 6 to 50 percent of the gray whale calf production may be taken in a given year, depending on the number of calves recruited. In fifteen encounters with killer whales in lower Cook Inlet, five were with mammal eating transients. Sightings/photographs were also contributed by charter boats. Observed prey included non-calf humpback whales, minke whale, and sea otter. Weather, tidal conditions, and the infrequent encounter rates make work on killer whales entering lower Cook Inlet problematic. A sighting network, rapid response capabilities, and a systematic observer network in upper Cook Inlet are suggested in future examination of killer whale predation on beluga.

PURPOSE

Killer whale predation has been hypothesized as a cause of the decline of numerous marine mammal species in recent years (Springer et al. 2003). Predation on Cook Inlet belugas has been observed and described sporadically over the years (Shelden et al 2003). In the 2008 National Marine Fisheries Service Final Conservation Plan for the Cook Inlet Beluga (NMFS, 2008) predation has been listed as a possible factor limiting the recovery of the Cook Inlet beluga population. The Cook Inlet beluga is currently considered endangered under the ESA and critical habitat is being established. The Plan stressed that the removal of even a small number of beluga by killer whale predation could have significant impact on recovery. Belugas once maintained summer range in the lower Inlet but have failed to reoccupy the area despite the elimination of native subsistence harvest. It is also been postulated that the killer whales observed preying on belugas in upper Cook Inlet (Shelden et al 2003) move into that area through lower Cook Inlet. This project is a first systematic attempt to assess the role of killer whale predation on Cook Inlet belugas by determining the number, identities, and feeding habits of transient killer whales entering lower Cook Inlet during summer. Also, research techniques such as satellite tracking and lipid/fatty acid food habit analyses were developed in an established study in False Pass/Unimak Island (Matkin et al 2007). These are techniques that could be applied in the future to studies in the Cook Inlet region. Initial field work occurred in False Pass/Unimak I. in May-June 2008 and Cook Inlet in July-early August 2008 and completed in Cook Inlet in July 2009.

Our basic objectives included the following:

1) Estimate abundance and site fidelity of transient killer whales in western Alaska and Cook Inlet.

2) Examine distribution, ranging patterns, and feeding habits of killer whales in False Pass/Unimak I using telemetry and chemical analysis and explore feasibility of similar techniques in Cook Inlet.

3) Continue development diet description and study of feeding ecology of killer whales in False Pass/Unimak I and initiate similar work in Cook Inlet as a first step in determination of the impact of killer whale predation on Cook Inlet belugas

APPROACH

Detailed Description

Objectives were addressed using an integrated research approach employing a combination of established research techniques proven successful in previous studies as well as newly developed approaches. These newer methods were developed in False Pass/Unimak Island studies with the intent of application to Cook Inlet studies

a) ***Photo-identification*****.**

This powerful and cost-effective method will be used to identify and enumerate killer whales using the study area. Identified whales will be compared to established NGOS and NMFS photo-identification catalogues from the Aleutians Islands and Gulf of Alaska to provide direct data on movement patterns and stock structure. Photographic markrecapture data from this effort are being used to estimate the abundance of whales using both the Eastern Aleutian and Prince William Sound/Kenai Fjords regions and can eventually be applied to Cook Inlet. Long term photo-identification also provides a tool for assessing population dynamics and social structure.

b) ***Satellite telemetry***.

We have developed satellite transmitters and tags for killer whales in the Eastern Aleutians in the Gulf of Alaska that have provided daily movement data for up to two months. In False Pass this movement data has given preliminary indication of feeding hotspots and allowed examination of ranging patterns.

c) ***Fatty acid/stable isotope/ contaminant analysis to investigate diet composition***.

Skin and blubber biopsies were collected for lipid fatty acid, contaminant, and stable isotope analyses to investigate prey preferences. All blubber biopsy samples were processed at the NOAA Northwest Fisheries Science Center as part of an existing collaboration with Gina Ylitalo and Dave Herman. Initial examination of dietary preferences of killer whales using a suite of chemical markers has been encouraging (Herman et al 2005. In False Pass these methods were used to test assumptions about diet composition of killer whales made from field observations, and to compare dietary differences between groups of whales and over time.

d) ***Genetic sampling and analysis***.

We used biopsy samples and prey collection to a) continue to determine the ecotype of all new killer whale groups encountered in this project b) provide a greater sample size for analysis with polymorphic nuclear DNA markers to determine whether the False Pass transients belong to the same population as transient killer whales from the eastern Aleutians and/or southern Alaska, c) genetically analyze fragments of tissue collected near feeding transients to determine prey species.

e) ***Acoustic monitoring and analysis***.

We collected acoustic recordings of whales whenever possible to establish ecotype (resident/transient/offshore) especially when biopsy sampling was not possible or proved inconvenient. Calls can also be used to determine when feeding events occur with transient killer whales.

f) ***Systematic observations of foraging areas and hunting behaviors.***

In past studies we have documented transient killer whales preying on fur seals, gray whales, minke whales, and Steller sea lions in the Eastern Aleutians and on harbor seals, Dall's porpoise, harbor porpoise, Steller sea lions and northern fur seal in Kenai Fjords/Prince William Sound. We extend those behavioral observations of feeding habits in this study to False Pass and lower Cook Inlet.

Project Management

Responsibility for overall management of the project was assumed by **Craig O. Matkin** (North Gulf Oceanic Society, 3430 Main St, Suite B1, Homer, Alaska 99603. Tel. 907 235-6590; email cmatkin@acsalaska.net). The North Gulf Oceanic Society provided all bookkeeping and logistical support. Matkin was assisted in the field in western Alaska by **John Durban,** Southwest Fisheries Science Center, La Jolla, California, and **Lance Barrett Lennard**, Vancouver Aquarium and Marine Science Center Vancouver, British Columbia and in Lower Cook Inlet by **Cy St. Amand and L.A. Holmes**, North Gulf Oceanic Society. **Russ Andrews** at the Alaska Sea Life Center Seward, Alaska designed satellite tags and provided assistance in tag construction by Wildlife Computers, Seattle, WA

FINDINGS

False Pass/Unimak Island

Our single field season in False Pass/Unimak Island began on 8 May 2008 and ended on 4 June 2008 for a total of 28 field days, with three of these days seriously limited by weather. An additional 3 days were inoperable due to weather. We logged 14 encounters with transient killer whales. Five of the encounters were composed of a total of 3-4 whales (Avg 3.8, sd 0.4) and the remaining nine contained 12-54 whales (avg 26.1, sd 12.4). The smaller groups are representative of foraging groups that find and attack gray whales, the larger groups generally occur as feeding/social aggregations in the day(s) following a kill when numerous killer whales may visit and potentially feed on the carcass. These aggregations at the site of a kill consist of multiple matrilines that are not necessarily closely related as evidenced by the multiple haplotypes that may occur determined by biopsy and genetic analysis. Killer whales were observed at returning to and/or feeding on a submerged carcass for periods of up to three days. Feeding and slick location was evidenced by oil slicks and bits of blubber. It was not always certain that the submerged carcass was the same whale on subsequent days and portions of carcasses were observed being moved by the whales.

We identified a total of 91 different killer whales during the False Pass/Unimak I fieldwork in 2008. There were four new calves recruited by previously identified whales and 12 whales that were new to the study (one of these whales could not be assigned a designation because of a poor photo and one was a previously unreported juvenile of a known whale). We have now identified 199 killer whales in the spring False Pass/Unimak Island aggregations since 2003 (Table 1). Although the number of new whales (not including new recruited calves to known mothers) has declined steadily since 2003 to a low of 12 in 2008, new adult whales are observed each season and may be whales that have operated in adjacent areas but were unseen in previous years. We expect the number of new whales to continue to decline in future years if the study continues.

Table 1. Number of individual transient whales identified by year in False Pass/Unimak I. in spring (May-early June)

Year	**Total whales**	**Whales not previously identified**
2003	84	84
2004	75	30
2005	79	25
2006	87	24*
2007	108	20**
2008	91	16**
Total	**Avg 87/yr**	**199^**

*3 were new calves recruited to previously known individuals
**4 were new calves recruited to previously known individuals
^ 11 were new calves to previously known individuals

Our identification catalogue for western Alaska transients includes all whales identified in the False Pass/Unimak Island work through 2008 and is available in digital format from the North Gulf Oceanic Society (NGOS), Homer, Alaska or National Marine Mammal Laboratory (NMML), Seattle, WA. This Catalogue of Western Transients (WT) is a collaborative effort with NMFS/NMML and includes all transient killer whales identified in Western Alaska (south and west of the Shumagin Islands) which currently number 438. Information on tagging and biopsy sampling of individuals is incorporated into the metadata for each individual.

We made preliminary estimates of predation rates on gray whales based on the following observations and assumptions. First that within the entire region (both sides of the lower Alaska Peninsula from Port Moller on the west side and Sand Point on the east side and Unimak I.) we estimate 120 transients feed on gray whale calves and yearlings for 40 days from early May to mid June. Gray whale predation is observed here after this period, however, based on tagging data and NMFS surveys (J. Durban pers. com) we think that many killer whales have left the area by mid June, although gray whale attacks have been recorded in early July (J Durban, pers comm.). Our estimate of killer whale numbers takes into account that every whale that uses this region in given year is not photographed. We assume that calves and yearling or juvenile whales are taken in a ratio of 60% calves and 40% yearling/juveniles although this ratio is based on a relatively small number of observations. We estimate killer whale average caloric requirements at 50 kg/day. Calves arriving in False Pass are thought to average about 2500kg and yearlings/juveniles 9000 kg. A portion carcass is bone and organs that are not likely consumed, and scavengers such as Pacific sleeper sharks also remove parts of the carcass. If 60% of the carcass is actually consumed, by the whales then approximately 100 calves and 20 juveniles are killed each year in this region during the gray whale migration. Since calf recruitment varies from 1% to 8% of the population of approximately 20,000 gray whales, killer whales in this region alone may remove 6-50% of the calf production. Killer whales are known to prey on gray whale calves (only) during migration in

Monterey Bay, California and on also the Bering/Chukchi Sea feeding grounds. The overall impact of predation could be significant on years of poor calf production.

Tagging data from Wildlife Computers SPOT5 (location only) satellite tags were cleaned of poor quality and false location data visually and by using Douglas filter software. Cleaned location data was imported into Google Earth for basic visual inspection into an ArcMap 9.3.1 for further and future analysis. Distance traveled was calculated for each tagged animal as well as a calculation of home range developed by subtracting the land area from the total area in the Minimum Convex Polygon (perimeter of all satellite locations) (Fig 1, Table 2).

Figure 1. Example of Maximum Convex Polygon (red) denoting the home range for WT345 during the 59 day period from 28 May to 26 July 2007.

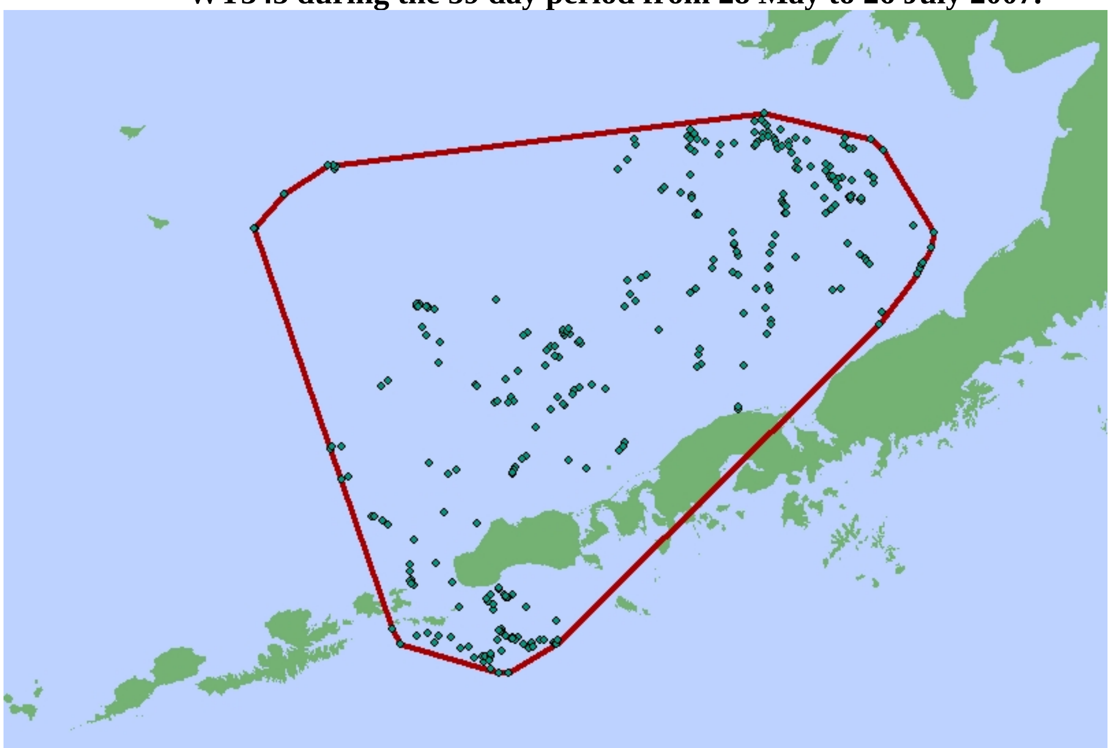
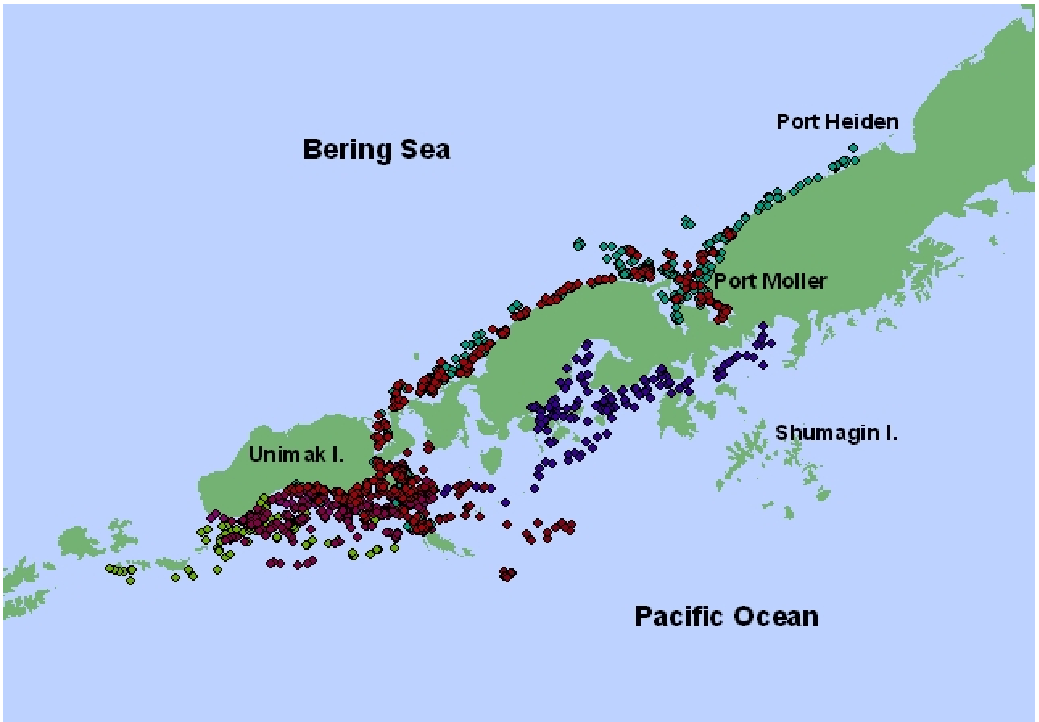


Table 2. Summary of tagging results for killer whales tagged in False Pass/Unimak Is 2008

Animal	Tracking Time Period	Days	Distance Traveled (km)	Average km/day	Minimum Convex Polygon in km^2	Land Area within the MCP (km^2)	Home Range (km^2)
WT55	5/27/2008 - 6/13/2008	18	1641	91	19074	9758	9316
WT54	5/26/2008 - 6/25/2008	31	2919	94	24651	11514	13138
WT45	6/3/2008 - 6/19/2008	16	1614	101	4749	369	4380
WT368	5/27/2008 - 7/1/2008	35	4760	136	406691	6083	400608
WT364	5/16/2008 - 8/9/2008	86	8907	104	439551	167227	272325
WT221	5/27/2008 - 6/2/2008	7	747	107	6432	541	5891
WT178	5/13/2008 - 5/21/2008	8	636	80	5403	264	5139
WT14	5/26/2008 - 6/4/2008	10	549	55	2253	403	1850
WT127	5/19/2008 - 5/26/2008	8	967	121	8833	2867	5966
WT113	6/3/2008 - 7/17/2008	44	5945	135	433186	78810	354376
	AVERAGE	**263**	**28685**	**109**			

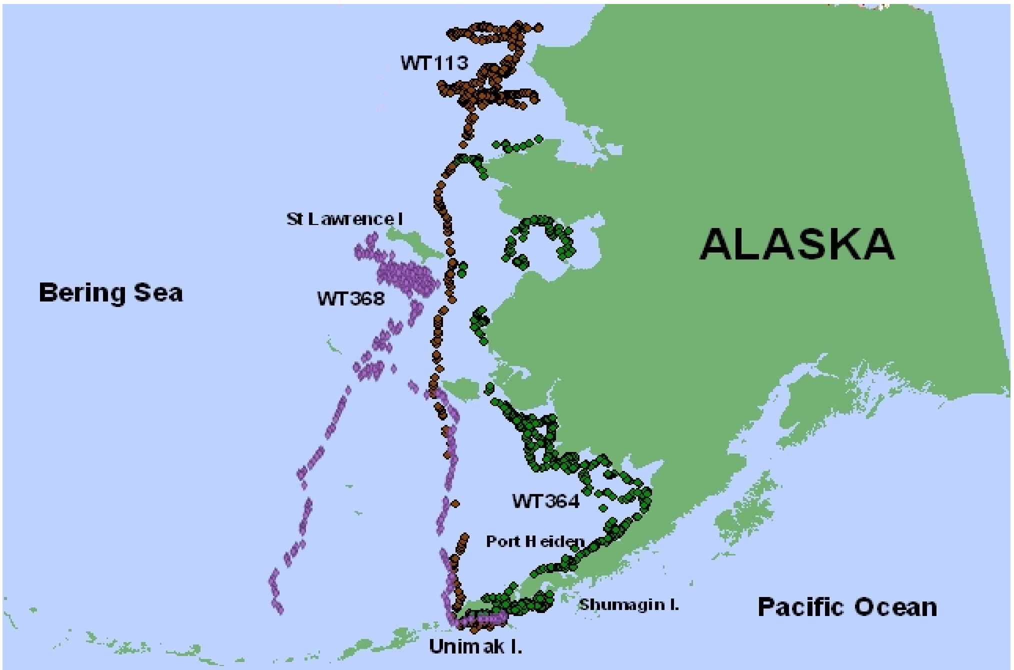
The ten individual whales that were tagged in 2008 traveled a total of 28,685 km over 263 days of tracking time for an average of 109 km travel per day. The distance traveled by individual whales ranged from 55-136 km/day during the period tags were attached Tagged whales fell into two groups, the seven whales whose attachments lasted 7-31 days with home ranges of 1850-13,138km (average 6526km) and three whales whose attachments lasted 35-86 days that demonstrated home ranges of 272,325-400,608km (average 342,436km). All of the whales in the first group remained in the lower Alaska Peninsula/Unimak I. area where they likely continued to predate on gray whales (Figure 2). Although some of these whales may have made extensive migrations after transmissions ceased, we suspect some such as WT54 and WT55, which were tracked into late June, may remain in the region during much of the year.

Figure 2. ARGOS locations of the seven whales that did not leave the Alaska Peninsula/Unimak Island area during tag attachment. Tags operated between 13May and 25June 2008 and tag attachments lasted from 7 to 31 days.



The northward movements of WT368, WT 364, and WT113 suggest that these groups of whales followed the migrating gray whales into the Bering and Chukchi seas (Figure 3). Both WT 368 and 364 spent considerable time in known gray whale habitat, while WT113 also spent time near the ice edge which may reflect feeding on pinnepeds although gray whales are also known to feed in that region of the Chukchi Sea as well. The wide discrepancy in home ranges reflects attachment time, but also suggests that some of the animals that congregate in May/June in this region undertake extensive migrations while others may not.

Figure 3. ARGOS locations of the three whales that made extensive migrations out of the Alaska Peninsula/Unimak I. region during the 35-86 days that the tags transmitted.



Stable isotope (N15) values and principal component analysis of dietary fatty acids from blubber biopsy samples (Figs 4, 5) suggest a broader range of prey items in False Pass/Unimak I killer whales prior to their arrival in the region. These values measure prey consumption 1-2 months prior to sampling. This coupled with the variability in mtDNA (there are three haplotypes, GAT1, GAT2, and AT1) and nuclear DNA diversity that is similar to other wide ranging populations such as the West Coast transients of British Columbia and southeast Alaska indicate a group of unrelated matrilines with a variety of feeding habits that gather annually in the study region annually to feed on gray whales. The tracklines from tagging also indicate that there is a broad dispersal of at least some of these matrilines following the May-June aggregation in the study area. The range of dietary fatty acid values (Fig 4.) is only matched by samples from the Pribilof Islands which may also be an aggregation point for varied and widely distributed matrilines that gather to feed on the seasonally abundant fur seals (Durban et al, in prep). It should be noted that the variation in isotope values and fatty acid signatures in the whales also may reflect food chain differences in isotope values due to consumption of the same prey species in these widely separated regions. Samples of prey from the different regions where these whales are determined to feed would be needed to evaluate that possibility.

Figure 4. Comparison of prey variability as indicated by 15N values in seven transient KW populations from the regions indicated

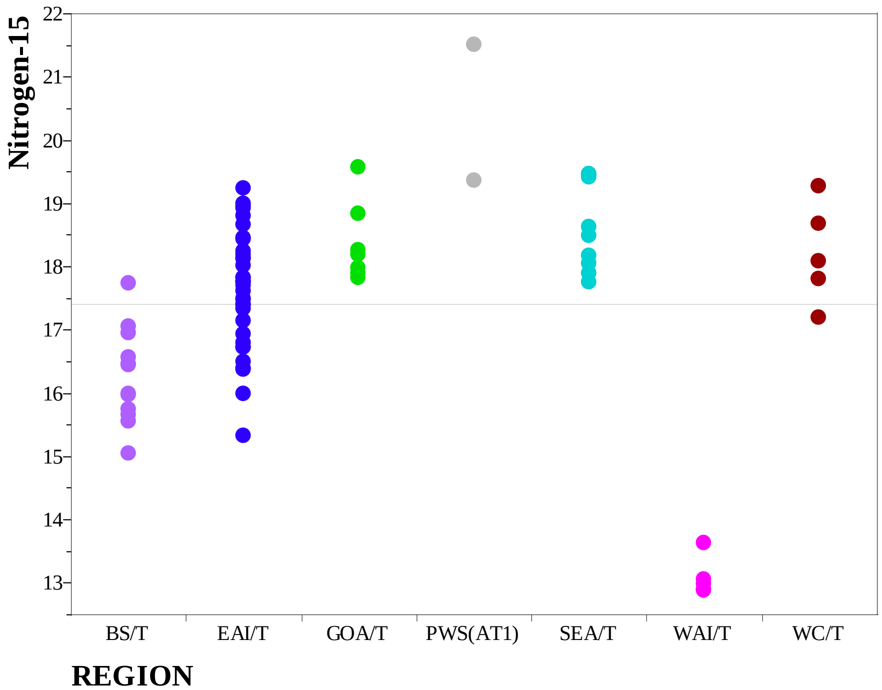
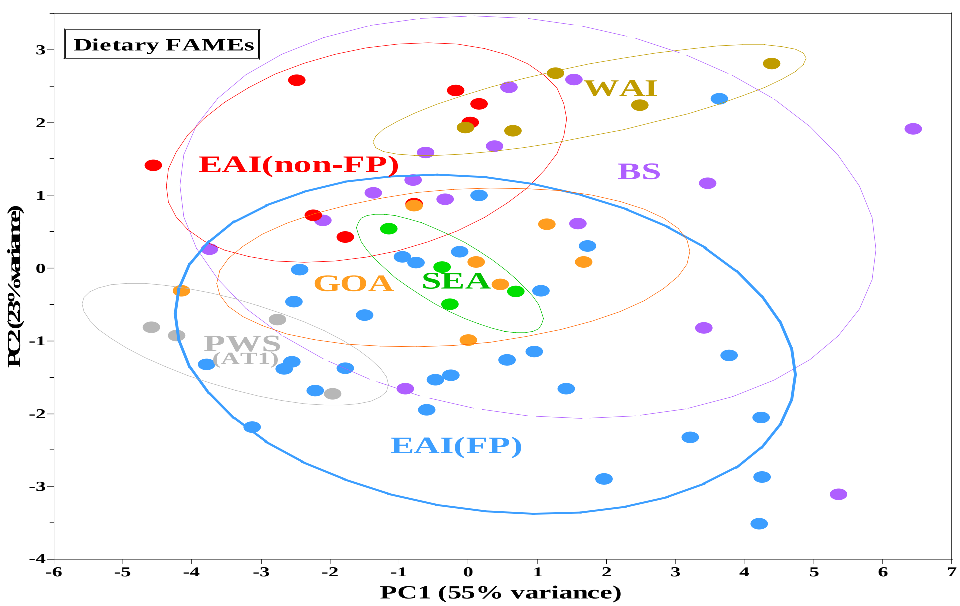


Figure 5. Comparison of dietary fatty acid profiles between False Pass transient killer whales biopsy sampled in spring and six other Alaskan transient populations also



Lower Cook Inlet

In 2008 in lower Cook Inlet field work began on 25 June and continued through 4 August and we responded to killer whale sightings on two additional days; 12 August and 26 August. We logged 32 working field days, of which 6 were seriously limited by weather. An additional 7 days were in-operable due to weather. Our search trackline for the period was approximately 1644 nm (Fig 6). We recorded a total of 10 encounters with killer whales; four were with transient (mammal eating) whales and 6 with resident (fish eating) whales (Fig 7). Ecotypic classification (resident or transient) was made by using association or acoustic data. In 2009 in lower Cook Inlet field work began on 8 July and continued through 2 August. We logged 26 working field days, of which 18 were seriously limited by weather. An additional 7 field days were inoperable due to weather. Our total search track line for the period was approximately 739.9 nm. During much of the survey period in both years, the research vessel was stationed at the mouth of Port Chatham in Chrome Bay, adjacent to the Barren Islands in order to intercept killer whales as they first entered Cook Inlet. Most surveys were initiated from this location when weather permitted and/or in response to sightings and communications from other vessels.

Figure 6. Tracklines of vessel surveys of lower Cook Inlet in 2008 and 2009.

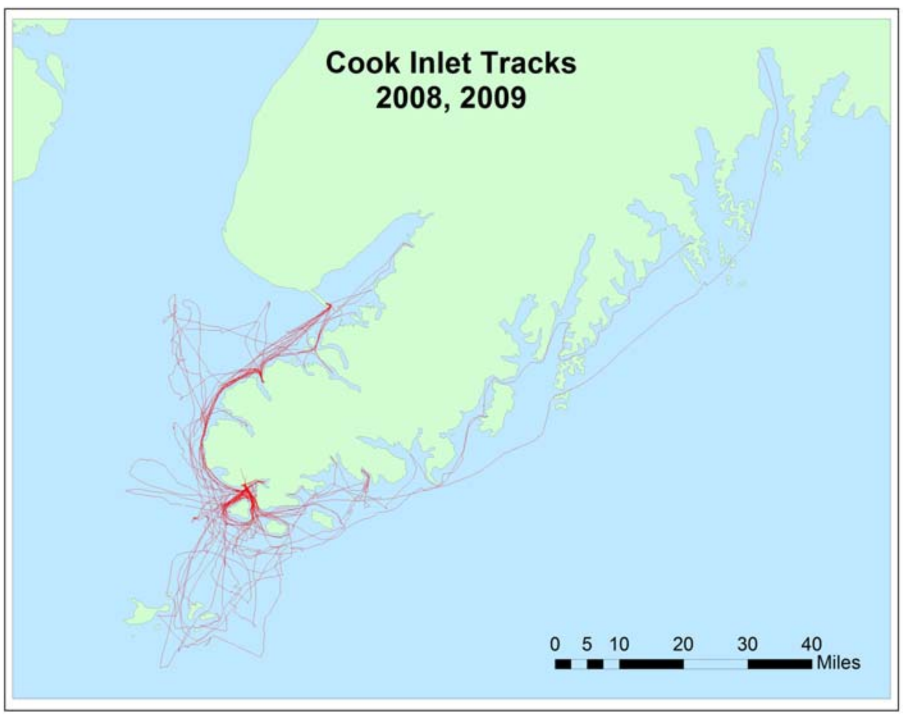
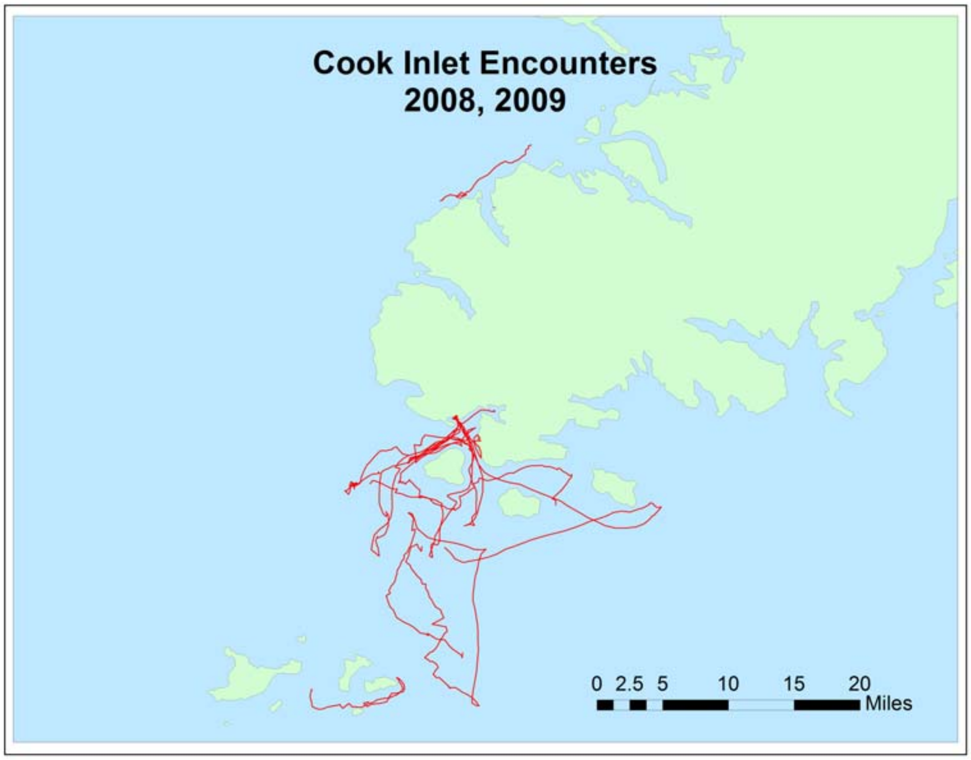


Figure 7. Tracklines of killer whales during encounters in lower Cook Inlet in 2008 and 2009



Data from daily vessel logs and data from each encounter with killer whales was entered into the killer whale database designed at the Alaska Sea Life Center (and supplied with this report). The database has been updated with all NGOS field data collected since 2002. A separate annual summary spread sheet of individual identifications for each encounter in the False Pass/Unimak Is region and northern Gulf of Alaska (including Cook Inlet) is available on request.

During the July-early August study period in 2008 we had a total of 10 killer whale encounters, four with transient (fish eating) whales and six with resident (fish eating) whales as determined by previous identification and association, acoustics or previous genetic work. (Tables 2, 3). A total of 18 transient whales were identified including thirteen that had not previously been photographed, one that had been photographed by NMFS off Kodiak Island, and 4 that had been catalogued as Gulf of Alaska transients in the course of other studies in Prince William Sound/Kenai Fjords in previous years. Transient whales that observed for the first time in this study were given a CI prefix.(Table 2) Eleven of these whales were involved in attacks/feeding on humpback whales. None have been matched with killer whales photographed in past years in upper Cook Inlet preying on or harassing beluga whales. One adult male (CI1/ WT174) was matched with photographs taken by NMFS offshore Kodiak Alaska).

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Table 2. Summary of Lower Cook Inlet Transient Encounters

Date	Ecotype	# Individuals	Individual ID's	Behavior
8-Jul-08	Transient	11	CI1,2,3,4,5,6,7,8,9,10,11	Attack HW cow/calf unsuccessfully
15-Jul-08	Transient	3	CI12,13,14	Forage, Rest
26-Jul-08	Transient	8	CI1,2,3,4,5,6,7,8	Rest/slow travel, many HW nearby
30-Jul-08	Transient	4	AT146,147,148,158	Attack and possibly feed on sea otter
25Oct09	Transient	4	AT141,AT143,AT151	Travel

Table 3. Summary of Lower Cook Inlet Resident Encounters

Date	Ecotype	# Individuals	Pods present	Behavior
4-Jul-08	Resident	35*	New whales	Rest/Travel
15-Jul-08	Resident	34	AA,AX27,AS	Social
25-Jul-08	Resident	27	AX1	Travel
4-Aug-08	Resident	79+*	AX27,AX32,AX40,AG	Rest
12-Aug-08	Resident	75+*	AX27,AX32,AX40,AG	Rest
26-Aug-08	Resident	7	AD5	Rest
12-Jul-09	Resident	7	AK1	Forage fish
14-Jul-09	Resident	28	AX27	Forage fish
28-Jul-09	Resident	35	AX1	Forage fish
1-Aug-09	Resident	23	AX27	Forage fish
3-Aug-09	Resident	20	AG	Forage fish

*estimated, all whales not photographed

During the 2009 fieldwork we recorded a total of 5 encounters with killer whales, however, all were with resident (fish eating) whales (determined by acoustics) and only one was with transient (mammal eating) whales (determined by previous genetic sampling). Photo -identification work has not been completed; however, over 100 different resident whales were photographed. The severe weather coupled with the apparent irregular visits of transient killer whales to the area resulted in the low killer whale encounter rate. The predation by transients on humpback whales recorded in 2008 by both in our field observations and by charter boat operators was not reported or observed in 2009. Only one harassment event was observed in 2009 when a resident killer whale harassed an adult humpback whale; however, there was no attack or obvious contact between the two whales.

We have examined photographs contributed by sportfish charter and other vessels in Lower Cook Inlet. A majority were determined to be known resident type (fish eating) killer whales and not pertinent to our examination of killer whale predation on beluga whales. The contributed data that included transient killer whale photographs are listed in Table 4

Date	Est# Ind	Individual IDs	Behavior
14June07	**6**	AT141,142,143?149?,151?	Feed on Minke whale
17July 08	**12**	CI01,02,03,04,07,08,09?,11?,13? AT131,132 w/juv	Feed on Humpback whale

? = probable but not certain IDs

The 14 June 2007 photos taken by a sportfish charter boat near Anchor Point, Alaska were originally listed by NMFS as a Cook Inlet beluga predation event. It was determined by our examination of additional contributed photographs to be a minke whale predation event. A photograph of lower jawbone and the conformation of the head clearly identified the prey as a minke whale. The whales identified from these photos included transient killer whales first previously photographed in 1996 in Prince William Sound and observed occasionally since then in the region. They were last photographed during this study in October 2009 in Kachemak Bay and apparently are regular visitors to lower Cook Inlet waters. The contributed photographs from 17 July 2008 include photographs of feeding on a humpback whale carcass. Most of the whales photographed were previously identified by during this study in conjunction with the 2008 humpback whale attack events. There were two additional whales (AT 131 and 132) involved in this feeding event that had been previously photographed in Kachemak Bay in December 2002.

During transit from Seward to Lower Cook Inlet we logged 6 working field days, of which 3 were seriously limited by weather. Our search track line for the period was approximately 328 nm. We recorded a total of three encounters with killer whales, one was with three transient whales of the AT1 group and two with resident whales of AD8 and AY pods.

EVALUATION

Continuation of our tracking and diet studies in False Pass/Unimak Island were successful and provided new information on feeding ecology and movements of killer whales from that population as well as producing minimum population numbers that can be used for estimating impacts of predation. Although these techniques are potentially applicable to Cook Inlet, the results of our pilot work in Cook Inlet is more problematic. The region presents special issues both logistically and due to sparse distribution and poorly understood movements of transient killer whales in the region.

Weather coupled with extreme tides is always a potential issue in the lower Cook Inlet/Barren Islands region and proved a serious hindrance to data collection in both years of this pilot project, especially during the study period in 2009 when we registered winds up to 70 knots in Port Chatham during storm periods. Large tide exchanges in conjunction with foul weather restricted operations on the majority of days during the 2009 season. Broad surveys will require a significantly larger vessel than the 34’ R/V *Natoa* used in this study. Also, it is suspected that transient movement into upper Cook Inlet occurs only sporadically and is difficult to predict as suggested by Shelden et al. (2003). This would require a more consistent monitoring program or a quick response system with vessel on standby. It may be more efficient and cost effective to have a well developed observer network in upper Cook Inlet as the primary method used to assess the role of killer whale predation on remaining Cook Inlet beluga whales. At the current time, beluga whales are rare in the lower Inlet and direct interactions with killer whales are unlikely, although even a small number of predation events could have a significant effect on the beluga population (NMFS, 2008). Over the past two decades none of the killer whales photographed opportunistically in upper Cook Inlet in conjunction with the sporadic killer whale/beluga predation events that have been made available to us have matched with whales photographed in lower Cook Inlet. This not only suggests that predation events are rare, but that the transients typically observed in lower Cook Inlet are not involved in those events. It is unclear where the killer whales involved in these upper inlet events originate, nor how frequently they enter the inlet. However, due to the infrequent sightings of killer whales in the upper Inlet, it is unlikely these whales remain in the region for extended periods. It would behoove the NMFS Anchorage office to create a complete catalogue of photographs of individual killer whales from upper inlet predation events and circulate it to all other killer whale researchers working in Alaska.

If we wish to continue to assess killer whale predation in lower Cook Inlet there must be further development of our sighting/photographic network and additional effort made to obtain photographs taken opportunistically by other vessel operators. NGOS has an observer network that relays reports of killer whales, but at this time due to lack of funding there is not a dedicated vessel or system of quick response to sighting reports.

Three papers have been submitted or are being submitted using results of this work, The first "Marine Mammal Predation and Underwater Prey Caching by Transient Killer Whales in the Eastern Aleutian Islands" by Lance Barrett-Lennard, Craig Matkin, Dave Ellifrit and John Durban is in press at Marine Mammal Science. Two additional papers, "Novel Techniques in Satellite Tagging of Killer Whales" by Russ Andrews, Craig Matkin and John Durban and "Decline of Two Sympatric Transient Killer Whale Populations in the Northern Gulf of Alaska" by Craig Matkin, John Durban, Eva Saulitis. and Graeme Ellis are nearing completion and will be submitted in the near future to appropriate journals. A poster presentation is being made at the Alaska Marine Science Symposium 2010 which details work in False Pass/Unimak Island reported on here. A popular article on this work is being submitted to Natural History magazine.

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