A2. Forage fishes in the Gulf of Alaska

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Executive summary

The forage fish category in the Gulf of Alaska (GOA) Fishery Management Plan (FMP) contains over sixty species with diverse characteristics (Table 1). Many of the species in this category are rare and poorly sampled with standard survey methods, therefore the exact number and types of species in the forage fish category is not known. Species in the forage fish category have been identified as having ecological importance as prey, and directed fishing is prohibited for the group. As of 2011, the forage fish category in the GOA FMP is considered an "ecosystem component". Because forage fishes are not considered "in the fishery", annual catch limits are not required. Instead, forage fish abundance and incidental catches are monitored and an annual report is prepared for the North Pacific Fishery Management Council. "Full" reports are submitted as new data become available or important developments occur. In other years, a brief report updating catch and biomass information are made.

Although a full forage fish report has not been prepared since 2008, we are once again submitting an abbreviated report due to a lack of new data. The GOA Integrated Ecosystem Research Project (IERP), funded by the North Pacific Research Board, is expected to provide a wealth of new information regarding GOA forage fishes. The new data stem from offshore and nearshore research surveys conducted in 2011 and 2013, and from an extensive retrospective analysis of GOA forage fish ecology. The field work was finished only on October 28, 2011, and data from those efforts are not yet available. Similarly, although work has begun on assembling and analyzing historical information, no results from the retrospective analysis are yet available. We plan to submit a full report in 2012, when many of these data are expected to be reported.

Summary of current forage fish management measures
In federal waters, management of this group is governed by section 50 CFR 679b20.doc of the federal code. Briefly:

1) directed fishing for species in the forage fish category is prohibited
2) catches are limited by a maximum retention allowance (MRA) of 2% by weight of the retained target species (Table 10 to 50 CFR part 679)
3) processing of forage fishes is limited to fishmeal production.

The regulation applies only to vessels fishing in federal waters, so onshore processors are not affected by the rule. In 1999, the state of Alaska adopted a statute with the same taxonomic groups and limitations (5 AAC 39.212 of the Alaska administrative code), except that no regulations were passed regarding the processing of forage fishes.

Overview of status and catch
The status of forage fish populations in the GOA is difficult to determine, largely because the standard survey gear does a poor job of sampling forage fish species. This is due to their small size and their distribution in pelagic waters and nearshore areas. Biomass estimates for species such as capelin vary widely. Eulachon are likely the best-sampled species due to their slightly larger size and frequent distribution near the seafloor. The 2011 survey biomass estimate for eulachon was down slightly relative to the 2009 estimate, but was still higher than the long-term average (Table 2).

Eulachon are the main species captured in commercial fisheries (Table 3). Most of this catch occurs in the pollock midwater trawl fishery and peaks dramatically in some years for unknown reasons (Figure 1). Particularly high catches were reported in 2005 and 2008, but have been comparatively low since 2008.

Eulachon are also caught in various state-waters fisheries, including personal-use fisheries (Table 4). These fisheries concentrate on spawning runs of eulachon in rivers. Data regarding these fisheries are sparse and difficult to obtain, but suggest that the state-waters catch is well below the federal-waters incidental catch. In addition, the available data do not show periodic spikes in catch similar to those observed in federal-waters fisheries.

The 2% MRA is designed to both limit removals of forage fishes and provide an incentive for fishers to avoid areas of high forage fish bycatch. We performed an analysis of eulachon deliveries to processors in excess of the 2% MRA ("overages") in 2007 and 2008. Of 329 deliveries containing eulachon in 2007, 29 deliveries (9%) were overages. In 2008, 46 of 319 deliveries (14%) were overages. These results are based on analysis of delivered weights, and we were unable to determine how many of these overages (if any) resulted in enforcement action. There have been overages in the past and they typically occur over a very short time period when vessels encounter massive aggregations of eulachon. Anecdotal evidence suggests that during these fishers avoid areas of high eulachon bycatch in order to avoid overage penalties. The restriction on forage fish processing serves as an additional disincentive against incidental catches. Most eulachon are processed as fishmeal, but some have been sold for human consumption. Of the 787 t of eulachon delivered to processing plants in the GOA during 2007-2008, 86% was processed as fishmeal, 11% was discarded, and 3% was sold for human consumption.

The results described above suggest that the current restrictions on forage fish catches are working to limit incidental catch. Eulachon are apparently only caught in large amounts when they are in high abundance and difficult for fishers to avoid. Combined with the low catch relative to the minimum biomass estimates provided by the surveys, there does not appear to be a conservation concern for forage fishes in the GOA at this time.

Major developments

GOA Integrated Ecosystem Research

The GOA Integrated Ecosystem Research Project (GOA IERP) funded by the North Pacific Research Board has begun in earnest. The Middle Trophic Level (or forage) component (led by the author, Ormseth) is using comparative approaches to study the abundance, distribution, habitat preferences, and trophic linkages of GOA forage fishes and juvenile groundfishes. The core of the study is a comparison of southeast Alaska to the central GOA (Kodiak Island and Kenai Peninsula; see Figure 2 for a map of the study area and research activities). The project involves extensive field studies as well as retrospective analysis of historical information.

The GOA IERP has completed its first field season. Nearshore surveys were conducted at 10 sites in the GOA during spring, summer, and fall. Offshore surveys, including acoustic surveys, were conducted in the summer and fall. Data from these efforts will be reported in 2012. More information can be found at: http://goaierp.nprb.org/.

Southern eulachon listed as threatened

In May 2010 NOAA Fisheries listed the southern Distinct Population Segment (DPS) of eulachon as threatened under the Endangered Species Act. The southern DPS consists of eulachon stocks from the Mad River in northern California to the Skeena River in British Columbia. The inclusion of these stocks in a single DPS was based on several factors, including similarity in genetic markers, ecological similarities, and common environmental conditions faced by the listed stocks. The southern DPS was declared to be at "moderate" risk of extinction due to four main factors (in decreasing order of importance: 1) climate change effects on ocean conditions, 2) climate change effects on freshwater habitats, 3) dams and water diversions in the Columbia and Klamath rivers, and 4) commercial harvesting.

In October 2011, NMFS announced the designation of critical habitat for eulachon along 16 waterways in Washington, Oregon, and California (http://www.nwr.noaa.gov/Other-Marine-Species/Eulachon.cfm). Much of this designated area coincides with designated critical habitat for endangered salmon species, so the designation is unlikely to result in major changes to land-use management in these areas.

Although Alaskan stocks of eulachon are not included in this listing, two aspects of this decision are of importance to Alaska fisheries management. The main threat to the southern DPS is altered ocean conditions due to climate change. Alaska eulachon stocks face different environmental conditions (and a different oceanographic regime) but may also experience altered ocean conditions. In addition the team that reviewed the southern DPS noted the paucity of data regarding eulachon abundance and harvest and the resulting difficulty in assessing population status and trends. Similar conditions exist in Alaska and have been noted in past forage fish reports.

Table 1. List of scientific and common names of species contained within the forage fish category.

Scientific Name	**Common Name**
Family Osmeridae	smelts
Mallotus villosus	capelin
Hypomesus pretiosus	surf smelt
Osmerus mordax	rainbow smelt
Thaleichthys pacificus	eulachon
Spirinchus thaleichthys	longfin smelt
Spirinchus starksi	night smelt
Family Myctophidae	lanternfish
Protomyctophum thompsoni	bigeye lanternfish
Benthosema glaciale	glacier lanternfish
Tarletonbeania taylori	taillight lanternfish
Tarletonbeania crenularis	blue lanternfish
Diaphus theta	California headlightfish
Stenobrachius leucopsarus	northern lampfish
Stenobrachius nannochir	garnet lampfish
Lampanyctus jordani	brokenline lanternfish
Nannobrachium regale	pinpoint lampfish
Nannobrachium ritteri	broadfin lanternfish
Family Bathylagidae	blacksmelts
Leuroglossus schmidti	northern smoothtongue
Lipolagus ochotensis	popeye blacksmelt
Pseudobathylagus milleri	stout blacksmelt
Bathylagus pacificus	slender blacksmelt
Family Ammodytidae	sand lances
Ammodytes hexapterus	Pacific sand lance
Family Trichodontidae	sandfish
Trichodon trichodon	Pacific sandfish
Arctoscopus japonicus	sailfin sandfish
Family Pholidae	gunnels
Apodichthys flavidus	penpoint gunnel
Rhodymenichthys dolichogaster	stippled gunnel
Pholis fasciata	banded gunnel
Pholis clemensi	longfin gunnel
Pholis laeta	crescent gunnel
Pholis schultzi	red gunnel

Table 1 continued. List of scientific and common names of species contained within the forage fish category. Data sources: GOA FMP, "Fishes of Alaska" (Mecklenburg et al. 2002).

Scientific Name	**Common Name**
Family Stichaeidae	pricklebacks
Eumesogrammus praecisus	fourline snakeblenny
Stichaeus punctatus	arctic shanny
Gymnoclinus cristulatus	trident prickleback
Chirolophis tarsodes	matcheek warbonnet
Chirolophis nugatory	mosshead warbonnet
Chirolophis decoratus	decorated warbonnet
Chirolophis snyderi	bearded warbonnet
Bryozoichthys lysimus	nutcracker prickleback
Bryozoichthys majorius	pearly prickleback
Lumpenella longirostris	longsnout prickleback
Leptoclinus maculates	daubed shanny
Poroclinus rothrocki	whitebarred prickleback
Anisarchus medius	stout eelblenny
Lumpenus fabricii	slender eelblenny
Lumpenus sagitta	snake prickleback
Acantholumpenus mackayi	blackline prickleback
Opisthocentrus ocellatus	ocellated blenny
Alectridium aurantiacum	lesser prickleback
Alectrias alectrolophus	stone cockscomb
Anoplarchus purpurescens	high cockscomb
Anoplarchus insignis	slender cockscomb
Phytichthys chirus	ribbon prickleback
Xiphister mucosus	rock prickleback
Xiphister atropurpureus	black prickleback
Family Gonostomatidae	bristlemouths
Sigmops gracilis	slender fangjaw
Cyclothone alba	white bristlemouth
Cyclothone signata	showy bristlemouth
Cyclothone atraria	black bristlemouth
Cyclothone pseudopallida	phantom bristlemouth
Cyclothone pallida	tan bristlemouth
Order Euphausiacea	krill

Table 2. Gulf of Alaska trawl survey biomass estimates (t) for GOA forage fishes, 1984-2011.

capelin												
	1984	**1987**	**1990**	**1993**	**1996**	**1999**	**2001**	**2003**	**2005**	**2007**	**2009**	**2011**
WGOA	37	5	0	2	5	34	4	18	2	29	82	16
CGOA	387	38	136	46	718	102	275	7,272	428	631	295	277
EGOA	7	8	14	76	755	106		298	586	125	112	198
total	430	51	151	124	1,479	241	279	7,588	1,015	785	488	491
eulachon												
	1984	**1987**	**1990**	**1993**	**1996**	**1999**	**2001**	**2003**	**2005**	**2007**	**2009**	**2011**
WGOA	38	1,787	453	2,553	1,444	438	2,867	1,610	195	1,126	654	167
CGOA	4,767	8,663	19,043	24,172	26,470	11,665	49,061	94,991	40,796	41,184	73,902	49,212
EGOA	2,300	5,864	8,493	8,278	4,334	2,587		16,882	14,080	9,486	12,671	22,128
total	7,105	16,314	27,988	35,003	32,248	14,690	51,928	113,482	55,071	51,796	87,227	71,507
sandfish												
	1984	**1987**	**1990**	**1993**	**1996**	**1999**	**2001**	**2003**	**2005**	**2007**	**2009**	**2011**
WGOA	12	28	16	69	2	9	6	29	0	0	9	0
CGOA	1,858	558	329	155	135	22	89	80	383	931	93	31
EGOA	354	529	377	296	16	542		3,832	75	315	50	788
total	2,223	1,115	722	520	153	572	94	3,941	458	1,246	152	819
sand lance												
	1984	**1987**	**1990**	**1993**	**1996**	**1999**	**2001**	**2003**	**2005**	**2007**	**2009**	**2011**
WGOA	0	2	0	0	1	1	5	2	1	1	0	0
CGOA	3	13	63	2	5	8	7	8	32	4	2	3
EGOA	0	0	1	0	0	2		1	0	0	1	0
total	3	15	64	2	5	10	12	11	33	4	3	3
Stichaidae (pricklebacks)												
	1984	**1987**	**1990**	**1993**	**1996**	**1999**	**2001**	**2003**	**2005**	**2007**	**2009**	**2011**
WGOA	7	0	5	23	19	2	7	10	8	12	58	19
CGOA	163	9	141	180	100	187	2,001	230	221	1,427	351	199
EGOA	0	5	3	1	24	28		39	1	1	10	46
total	170	15	149	205	143	217	2,008	278	231	1,441	419	264

Table 3. Incidental catch of forage fish catches in GOA groundfish fisheries, 2003-2011. Data are from the Alaska Regional Office Catch Accounting System. GOA subregions indicated in table comprise the following NMFS statistical areas: WGOA, 610; CGOA, 620 and 630; EGOA, 640, 649, 650, 659. * 2011 catch data incomplete; retrieved November 3, 2011.

eulachon									
	2003	2004	2005	2006	2007	2008	2009	2010	*2011**
W	1	7	38	18	52	160	15	33	*60*
C	17	161	800	378	168	581	206	191	*279*
E	0	1	12	2	0	11	3	4	*3*
GOA	**18**	**169**	**850**	**397**	**220**	**752**	**223**	**227**	***342***
capelin									
	2003	2004	2005	2006	2007	2008	2009	2010	*2011**
W	1	1	0	0	0	0	0	0	*0*
C	5	66	3	0	0	0	0	0	*4*
E	0	0	0	0	0	0	0	0	*0*
GOA	**6**	**67**	**3**	**0**	**0**	**0**	**0**	**0**	***4***
smelts									
	2003	2004	2005	2006	2007	2008	2009	2010	*2011**
W	44	4	11	17	11	113	13	1	*12*
C	300	62	168	155	39	284	158	5	*66*
E	5	0	6	4	0	5	2	0	*1*
GOA	**349**	**66**	**185**	**175**	**50**	**402**	**173**	**7**	***79***
Pacific sand lance									
	2003	2004	2005	2006	2007	2008	2009	2010	*2011**
W	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	*0.01*
C	0.00	0.01	0.00	0.01	0.00	0.00	0.19	0.00	*0.05*
E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	*0.00*
GOA	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.20**	**0.00**	***0.06***
gunnels (Pholidae)									
	2003	2004	2005	2006	2007	2008	2009	2010	*2011**
W	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	*0.00*
C	0.01	0.00	0.00	0.02	0.00	0.03	0.00	0.00	*0.00*
E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	*0.00*
GOA	**0.01**	**0.00**	**0.00**	**0.03**	**0.00**	**0.04**	**0.00**	**0.00**	***0.00***
lanternfishes (Myctophidae)									
	2003	2004	2005	2006	2007	2008	2009	2010	*2011**
W	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	*0.00*
C	0.00	0.00	0.14	0.01	0.00	0.00	0.00	0.00	*0.00*
E	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	*0.00*
GOA	**0.00**	**0.00**	**0.15**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	***0.00***
pricklebacks (Stichaeidae)									
	2003	2004	2005	2006	2007	2008	2009	2010	*2011**
W	0.02	0.00	0.96	0.12	0.05	0.00	0.02	0.02	*0.00*
C	0.47	0.11	1.24	0.78	0.28	0.14	2.74	0.81	*0.46*
E	0.00	0.00	0.00	0.01	0.00	0.00	0.03	0.00	*0.00*
GOA	**0.49**	**0.11**	**2.20**	**0.91**	**0.33**	**0.14**	**2.76**	**0.83**	***0.46***

Table 4. Eulachon harvest (t) in state waters of Alaska, 1978-2006. Original data in numbers or pounds converted to metric tons (t) using an average body weight of 60 g or conversion factor 1 lb. = 0.454 kg, respectively. Total harvest values do not include Unuk River subsistence harvest.

	20-Mile River reported personal use	20-Mile River creel survey personal use	statewide reported personal use	Upper Cook Inlet directed fishery	Copper River directed fishery	Unuk River subsistence and personal use catch	**total minimum state-waters harvest**
1978	-	-	-	0.1	-	-	**0.1**
1980	-	-	-	1.8	-	-	**1.8**
1986	7.4	-	-	-	-	-	**7.4**
1987	7.9	-	-	-	-	-	**7.9**
1988	8.4	-	-	-	-	-	**8.4**
1989	6.2	-	-	-	-	-	**6.2**
1990	8.0	-	-	-	-	-	**8.0**
1991	4.2	-	-	-	-	-	**4.2**
1992	2.6	-	-	-	-	-	**2.6**
1993	1.8	-	-	-	-	-	**1.8**
1994	3.0	-	6.4	-	-	-	**6.4**
1995	2.0	-	3.2	-	-	-	**3.2**
1996	1.3	-	3.7	-	-	-	**3.7**
1997	2.3	-	4.6	-	-	-	**4.6**
1998	2.0	-	4.8	8.6	78.3	-	**91.7**
1999	2.7	-	6.5	45.5	no fishery	-	**51.9**
2000	0.8	-	4.7	-	59.2	-	**63.9**
2001	2.2	-	5.1	-	71	8.5	**76.1**
2002	4.6	14.9	5.8	-	no fishery	2.1	**5.8**
2003	2.2	-	4.7	-	no fishery	8.4	**4.7**
2004	0.6	-	4.5	-	16.7	0.7	**21.2**
2005	0.5	-	-	-	no fishery	no fishery	**0.0**
2006		-	-	41.3	no fishery	no fishery	**41.3**

Sources:

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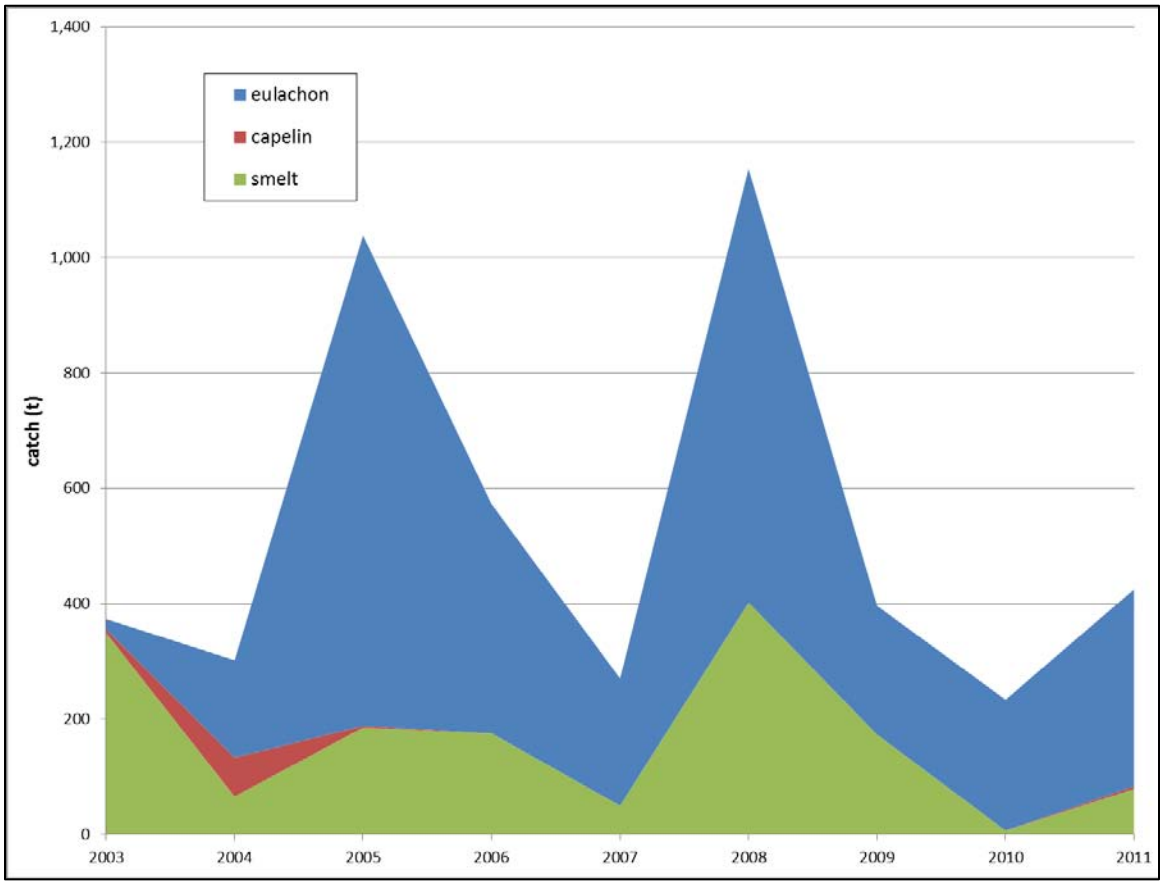

Figure 1. Incidental catches of eulachon and capelin in the GOA, 2003-2011. Eulachon and capelin are often identified as “smelts”; consistent species identification began in 2005. Data source: AKRO CAS. 2011 data are incomplete; reported as of November 3, 2011.

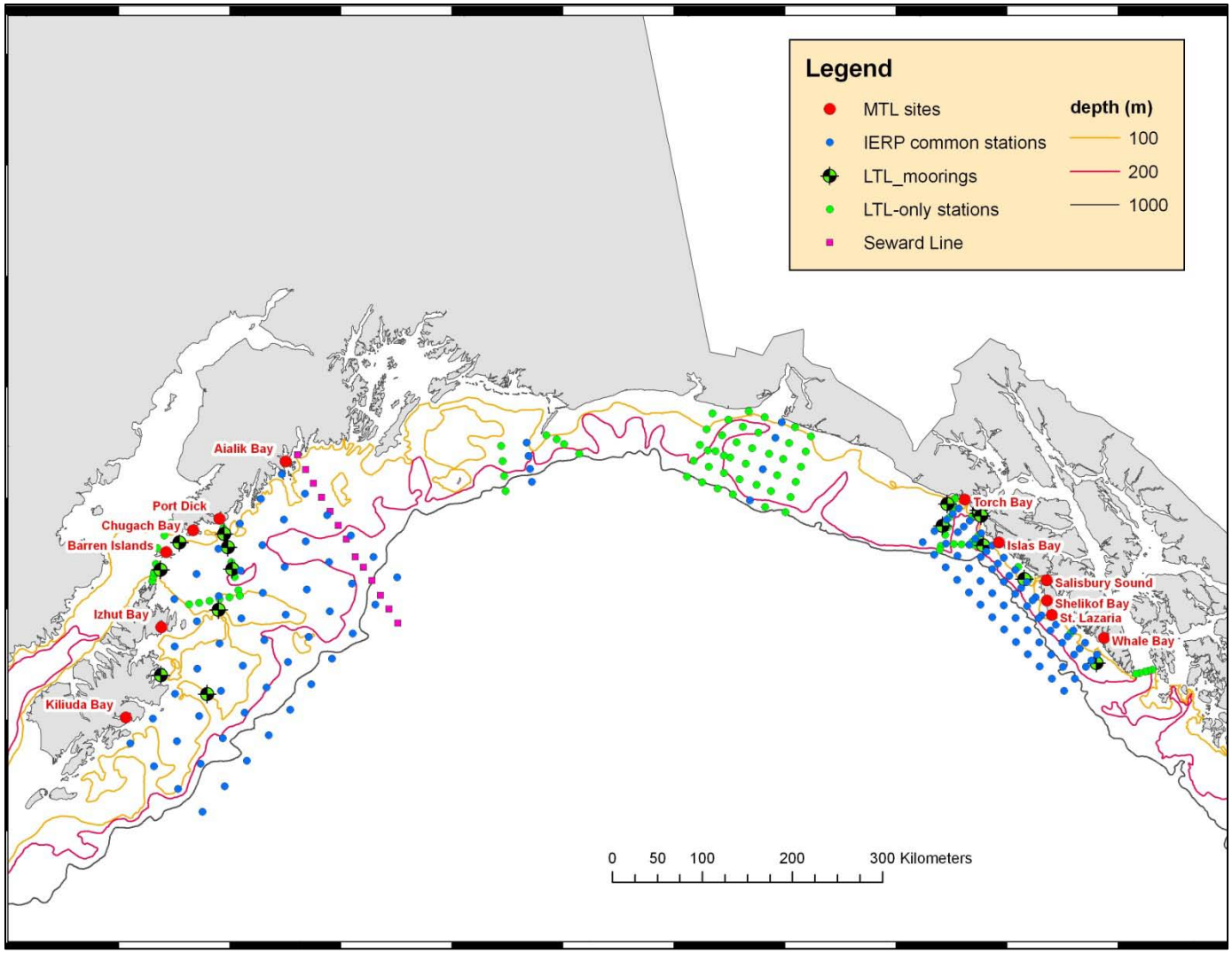

Figure 2. Map of the GOA showing GOA IERP research activities.