Exxon Valdez Oil Spill
Restoration Project Annual Report

SEA Fish Energetics

Restoration Project SEA 320U
Annual Report

This annual report has been prepared for peer review as part of the Exxon Valdez Oil Spill Trustee Council restoration program for the purpose of assessing project progress. Peer review comments have not been addressed in this annual report.

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Study History: SEA is a hypothesis driven ecosystem study designed to obtain an understanding of the mechanisms that influence levels of production for herring in Prince William Sound by investigating their early life stages. SEA research focuses on the timing and magnitude of energy and carbon flowing through the food web. Tracking this flow provides insight into links between primary and secondary production and species interactions. Food and predation are key forces that operate within the context of environmental parameters like temperature and transport. This component of SEA provides information on whole body energy content of key fish species so that interactions within and between species can be quantified, and insight into the feeding conditions on geographical and temporal scales can be described. The data from it supports inquiries into the River-Lake hypothesis, the Over-Winter hypothesis, and the key question "is it food impeding recovery of herring". Energetic data flows to the SEA models which will be used to predict production potential. This project was initiated in April of 1995, thus this report constitutes the second year of a three year field sampling program.

Abstract: The Exxon Valdez oil spill may have altered the trophic structure of the plankton feeding fish community by injuring intertidal spawning species: pink salmon and herring. This project has started to describe the interannual variations in the somatic energy cycle of juvenile *Clupea pallasi*. Collections were made in the spring and fall of 1995-96, and summer, fall, winter and spring 1996-97. This information was not previously available and is needed to determine if food resources are limiting growth of recruits and to determine if the over-winter period is important in regulating recruitment of age 0 herring. The analysis of somatic energy content (SEC) showed that there was large geographical differences in the nutritional status of recruiting herring based on whole body energy content. This is also true for fish at individual capture sites. Other SEA components are examining the physical oceanographic and prey distribution patterns related to these differences. The energy profile of over-wintering herring showed recruits from the 1994 year class over-wintered with a surplus of stored energy, but in 1995 many of that years recruits were food limited and exhibited nutritional stress during the winter of 1995-96.

During the fall of 1995 and spring of 1996, the SEC of Pacific herring relative to age, size and sex was examined. Whole body energy (kJ.g^{-1} wet wt) exhibited a wide range of values relative to fish length. In the fall young of the year recruits had an average of 5.7 kJ.g^{-1} wet wt for whole body samples vs 8.0 for age 1 and 9.4-10.2 kJ.g^{-1} for fish of ages 2 to 7. Many of the young of the year (YOY) fish in the fall collection had not maximized energy stores for over-wintering. The following spring the 1995 year class which had just survived their first winter averaged 4.4 kJ.g^{-1} wet wt for somatic samples, and age 1 fish had similar values, while herring ages 2 to 7 had SEC >5 kJ.g^{-1}. The difference in somatic energy content between adult male and female herring captured in fall and again in the spring just prior to spawning, was about 4 kJ.g^{-1} wet wt, or about a 40% change. Thus, all age classes of herring rely heavily on stored energy to survive the winter. The difference in mean values for somatic energetic content for YOY herring was only about 1.4 kJ.g^{-1} suggesting only those with higher than average energy stores survived the winter. The fall measures of SEC showed the YOY, and 1 year old Pacific herring, stored markedly less energy to over-winter

than older herring. Thus, energetically the recruiting year class, and those entering their second winter, are the most at risk for nutritionally related over-winter mortality.

Ovarian energy content (OEC) of ripe whole ovaries and $kJ.g^{-1}$ of ovary, were examined for Pacific herring. Specimens were collected in 1995 and 1996. The OEC of whole ovaries was related linearly to whole body weight, but OEC $kJ.g^{-1}$ wet weight was not. Just prior to spawning OEC was typically between 5 and 7 $kJ.g^{-1}$ wet weight. There were no significant differences in OEC $kJ.g^{-1}$ wet weight between groups of females from different capture sites in the 1995 collections, but in 1996 there were small but significant differences in OEC values related to capture site. When the OEC values from all fish collected in 1995 were pooled and compared to all those collected in 1996, there was no significant difference in $kJ.g^{-1}$ wet weight between years. The number of ova present just prior to spawning exhibited no clear relationship to OEC $kJ.g^{-1}$ wet weight. About 97% of OEC was expended during spawning. The OEC measurements were used to make estimates of the energy from herring spawn added to Prince William Sound beaches from 1988 to 1995. Since 1989, when there was a massive oil spill, the amount of energy added to the Prince William Sound ecosystem by herring eggs has decreased from 68×10^9 kJ to 10×10^9 kJ in 1995, which in addition to being a concern for recruitment, could also be important to species relying on herring spawn as an energy source. If egg predator populations remain stable or increase while the amount of herring spawn decreased the impact of predation may be limiting recruitment.

This project measures fall and spring somatic energy content of juvenile pollock (*Theragra chalcogramma*) to compare their nutritional status to that of competitors like juvenile herring and pink salmon fry. This energetic profile will aid in the understanding of how pollock compete with these two injured fish species. Pollock are a major prey of many seabird species injured by the oil spill and our energetic measures will be useful in estimating bird energy intake. Information on the pollack energetics will not be processed until late 1997.

The information gathered by this energetics project is being related to SEA zooplankton surveys, prey selection studies and trophic isotopic studies through the SEA modeling effort. The data also supports the APEX predator-feeding analysis.

Key Words: *Clupea pallasi,* herring, energetics, ovary, somatic energy, *Theragra chalcogramma,* pollock.

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Figure 2. Whole body energy content $kJ.g^{-1}$ wet weight relative to age for Pacific herring captured in Prince William Sound, Alaska, during the fall of 1995 (upper) and spring of 1996 (lower). The data is plotted as mean and standard deviations.

Project Data:

Table 1 provides a list of samples collected for energetic analysis. Samples are frozen fishes that are dried and combusted. The process destroys the sample. Small amounts of tissue from selected fishes are passed on to SEA project 320I (Kline). The data collected is energy content of whole body tissues. Energetic data is stored as SIGMAPLOT, EXCEL, and ASCII files. The data becomes available as the material is published in journals. The custodian is Dr. A. J. Paul, University of Alaska, Seward Marine Center, POB 730, Seward, AK 99664 (Phone 907 224-5261; Fax 224-3392; email ffajp@aurora.alaska.edu).

Executive Summary:

During its second year this project examined somatic energy content of age 0 and 1 herring (spring and late fall), age 0 pollock (spring and late fall), herring ovaries just prior to spawning, and adult herring bodies during fall and spring. These parameters are key measures for SEA models which predict levels of fish production and species interactions. The key results for the species under study include:

Herring ovaries: Examination of the amount of energy in herring ovaries was used to estimate the deposition of herring egg energy on beaches in PWS between 1988 and 1995. Since 1989, when there was a massive oil spill, the amount of energy added to the Prince William Sound ecosystem by herring eggs has decreased from 68 x 10^9 kJ to 10 x 10^9 kJ in 1995. This precipitous decline in the amount of herring egg energy deposited on the beaches is a reflection of very poor recruitment since the 1989 oil spill.

Herring somatic energy: 1) There is considerable geographical variation in the fall energy content of recruits captured in different areas. 2) From the spring sampling it appears that recruits from the 1994 year class were well nourished and passed the over-winter period in good condition allowing for hope that a reasonable survival of individuals will follow. 3) Most of the 1995 year class were undernourished when entering the winter and were in poor condition the following spring. 4) Herring recruits store energy for poor feeding conditions in winter and as their length increases so does energy content at a much higher level than seen in pink salmon fry or pollock 5). The results of the surveys demonstrate that YOY herring metamorphose in July and so they start this phase of development long after the spring bloom is ended. They then have just a few months to prepare for the poor feeding conditions of winter and are at a disadvantage relative to older year classes of herring that have the whole spring and summer period to feed. Because of this YOY herring are susceptible to being under-nourished for over-wintering. Based on our current, and incomplete, knowledge of the energy needs for age 0 herring during the over-winter period it appears that many individuals are under nourished. These measures of energy storage and use will provide insight into the potential of individuals to survive winter. It will also help understand the effect of "River and Lake" conditions, and be used to estimate consumption of herring by predators. SEA measures secondary standing stock by a variety of methods. Herring are users of zooplankton and their SEC at the end of the feeding season reflects secondary productivity. The somatic energy values provide a separate measure by which the SEA prey standing stock estimates can be evaluated.

Age 0 pollock: Pollock exhibit the same growth mode as pink salmon fry (see 1996 annual report), preferentially increasing in length. Pollock recruits appear to increase in length during the winter at some sites and maintain their nutritional status or improve it unlike herring who lose somatic energy during the winter. The energetic profile for age 0 pollock will aid in the

understanding of how pollock compete with the two injured: species pink salmon fry and herring recruits.

Introduction:

During the second field season this project focused on somatic energy content of two species of pelagic fish in the EVOS region. It started to explore over-winter survival of juvenile herring and herring reproductive energetics. A portion of the effort examined somatic energy in age 0 pollock during the fall and spring, which are trophic analogs with herring, so the nutritional status of these forage species can be compared. In recent history, herring and pollock have been among the most abundant pelagic forage fishes in south central Alaska. After the Exxon Valdez oil spill the herring population of Prince William Sound has been exhibiting reduced abundance, increased prevalence of disease, and spawning anomalies that may be related to pollution. This research effort will help identify the role of food in delimiting survival of recruiting herring.

Typically high latitude fishes store energy during spring and summer feeding and throughout the winter reallocate energy to maintenance and reproduction (Smith *et al.*, 1990). Thus, seasonal tissue samples must be taken to account for the temporal variation in energy content. Age 0 and 1 year old herring store energy during the summer feeding season and either fast or feed at low rates during the winter. If they have insufficient energy stores to maintain normal schooling activities until the spring zooplankton bloom, then high mortalities might occur. Low energy storage might be due to low zooplankton standing stocks or to competition for food resources.

Objectives: The objectives of this project were:

1. Describe the interannual somatic energy content of herring especially ages 0 and 1 relative to geographical location.
2. Examine fall and spring energy stores of juvenile herring from several sites in Prince William Sound and describe the role nutritional status plays in over-winter survival.
3. Describe the spawning energetics of herring. Measure ovarian energy relative to weight, age and spawning site in female herring.
4. Measure fall and spring energy content of adult herring.
5. Measure fall and spring somatic energy content of juvenile pollock and make comparisons of their nutritional status to geographical location and that of juvenile herring.
6. Relate the analysis of all the above objectives to SEA zooplankton surveys, prey selection studies and trophic isotopic studies through the SEA modeling effort and multi-author journal papers.

Methods:

The methods applied to the energy cycles were similar to those used by the investigator in previous bioenergetic studies (Harris *et al.*, 1986; Paul *et al.*, 1993, Smith *et al.*, 1988; Smith *et al.*, 1990). All fish lengths in 320 U were standard length (SL) measured to the nearest mm. All whole fish or ovary weights were taken to the nearest 0.1 g. All calorimetric samples were weighed to the 0.0001 g level.

Herring Ovarian Energetics

Colleagues in the Alaska Department of Fish and Game, who were monitoring gonad ripeness for a possible roe fishery, collected adult herring just prior to and after spawning.

Collections for this project were made from several sites when the product quality was at its peak, indicating spawning was imminent. Ripe females were collected 14 April to 14 May 1995 and 15-16 April 1996 and frozen immediately. In 1995 adult female herring were collected from 3 sites, Eaglek Bay in northern Prince William Sound (n=35), Fish Bay in Port Fidalgo (n=29) and Rocky Bay on Montague Island (n=46) just prior to spawning. Just after the spawning was completed 26 spent females were collected from Zaikof Bay on Montague Island. In the spring of 1996 ripe females were collected at Boulder Bay (n = 40) on Bligh Island, Rocky Bay (n = 50) on Montague Island, Rocky Point (n = 50) in northeastern Prince William Sound, Stockdale Harbor (n = 50) on Montague Island, and Sunny Bay in Port Fidalgo (n = 47). No spent females were collected in 1996.

In the laboratory the fish were partially thawed for measurement, but not enough so that the carcass lost fluids. The females were measured for whole body wet weight to 0.1 g. Both ovaries were removed from the female and weighed to the nearest 0.1 g. Then a subsample, weighing about 0.1 g of 1 ovary was removed, weighed, and all the eggs in it were counted. These subsamples typically contained about 100 eggs. The number of ova in the ovaries was estimated from the number of ova per gram in the subsample and the ovary weight. Because the fish were ready to spawn the clumps of eggs could be separated by physical manipulation and then counted under a microscope. The gonosomatic index was determined by dividing ovary weight by wet body weight. The relationship of gonosomatic index to OEC was examined to illustrate the variability associated with the degree of ripeness that results because not all fish spawn at the same time.

Ovarian subsamples of 10 to 15 g were removed from each ripe female for measurement of OEC. The wet weight of the subsample was taken to the nearest 0.1 g. After freeze drying for 24 h, ovarian tissues were placed in a convection oven at 60°C until they reached a constant weight. Individual sample wet and dry weight values were used to calculate the moisture content. Dried tissues were ground in a mill and measurements of OEC $kJ.g^{-1}$ were made by bomb calorimetry. OEC was converted to $kJ.g^{-1}$ wet weight using the percent moisture in the ovary subsample. The energy content of whole ovaries was obtained by multiplying $OEC.g^{-1}$ by ovary weight.

Energetic estimates of whole ovaries just after spawning were obtained from females collected at Zaikof Bay 2 April 1995. The whole ovary was weighed and treated as above for energy measurement. Whole dried ovaries were combusted for each calorimetric analysis.

Scales were removed from every fish just above or below the lateral line, 3 rows behind the operculum for aging. They were cleaned manually and mounted on glass slides. Mounted scales were placed in a microfiche reader, and winter annuli counted in the conventional manner. The age is equivalent to the number of winter annuli counted because all herring in Prince William Sound hatch in the spring.

Somatic Energy of Herring

Juvenile herring were captured with 50m diameter x 4m deep purse seines with 3 mm stretch mesh. At each collection site at least three sets were made to capture specimens. Adult herring were collected with commercial herring purse seines (182m diameter, 22m deep, 3cm mesh). After capture all fish were immediately frozen in seawater aboard ship and kept frozen until processing. During the fall of 1995 YOY and age 1 herring were collected from Green Island 25 October (n = 100); Jack Bay on 3 November (n = 100); Knowles Head 1 November (n = 98). Larger fish were taken at Green Island 25 October (n = 174); Jack Bay 3 November (n = 91); and Knowles Head 1 November (n = 100). During 1996 YOY and age 1 herring were collected at Port Fidalgo 11 March (n = 80); Boulder Bay 11 March (n = 94) and in Rocky Bay on 17 March (n = 58). During the following spring ripe herring were collected between 15-17 April 1996 at Boulder Bay (n = 90); Port Fidalgo 15 April (n = 97); Rocky Bay 16 April (n = 100); and Stockdale Harbor 17 April (n = 100).

In the laboratory the fish were partially thawed, just enough to handle, but not enough so fluids were lost. Scales were removed from every fish just above or below the lateral line, 3 rows behind the operculum for aging as above. All fish were measured for standard length (SL) to the nearest mm, then weighed to the nearest 0.1 g. The SEC of the whole individual was determined in terms of $kJ.g^{-1}$ wet weight. Herring under 150 mm SL were freeze dried whole. Larger fish while still partially frozen were ground, then the ground body made into a paste in a mortar. A 30 g subsample was then freeze dried. After freeze drying, test tissues were placed in a convection oven at 60°C until they reached a constant weight. Individual tissue wet and dry weight values were used to calculate the moisture content of every fish. Dried tissues were ground in a mill and measurements of caloric content made by bomb calorimetry. All calorimetric samples were weighed to the 0.0001 g level with a single sample burned per fish.

Somatic Energy of Age 0 Pollock

Pollock under 115 mm SL were collected at several sites and frozen in seawater for analysis. Fish were analyzed for standard length, wet weight, condition factor [CF = g wet wt x 100/(cm standard length)^3], and whole body energy content using standard calorimetric methods noted above.

Results:

Herring Ovarian Energetics

Whole ovary energy in kilo-Joules (kJ) was correlated with body wet weight ($r^2 \geq 0.76$). Whole ripe ovaries typically contained 50 to 300 kJ wet weight. The linear relationships between the energy content for whole ovaries and fish weight in 1995 and 1996 had slightly different regression equations, but the differences were small. Energy content of the whole ovary (Y) was related to ovary weight (X) by the equations: Y(kJ) = 5.4X + 4.8; $r^2 = 0.99$, $P < 0.0001$ in 1995; in 1996 this relationship was Y (kJ) = 5.4X + 3.7; $r^2 = 0.98$, $P < 0.0001$. Energy content of the whole ovary was not strongly related to the gonosomatic index. Whole ovary energy of spent females averaged 0.9 kJ (range 0.1-6.0) showing that most of the energy contained in the ovaries was expended with spawning. The spent ovaries consisted primarily of structural tissues with very few eggs inside. In 1995 a 150 g female expended about 97% of the energy stored in the ovary with spawning. We calculated population OEC based on mean numbers of females from the 1988-1995 Prince William Sound roe fishery population and age-specific biomass surveys. That population OEC estimate indicates a marked decline in the amount of energy supplied to Prince William Sound by the herring spawning since 1992 (Figure 1). The results of the OEC study will be published in Paul et al. (1997).

Somatic Energy of Herring

In the fall there was a tendency for somatic energy content (SEC) to increase with age, the most profound differences being between the YOY and age 1 fish, and the other age groups (Figure 2 upper panel). The average SEC values for all YOY fish (n = 214) and age 1 herring (n = 78) were 5.7 (± 0.6) and 8.0 (±1.2) $kJ.g^{-1}$ wet wt respectively. The SEC values for YOY herring were significantly lower than those of age 1 fish. Likewise, the age 1 fish had significantly lower (MW test; P<0.0001) SEC values than the 2 year old fish. The age 2 and older fish had similar SEC values with mean values ranging from 9.4 to 10.2 $kJ.g^{-1}$ wet wt. There was considerable range in SEC values between individuals at any SL, or weight indicating many individuals did not eat enough to maximize their energy reserves.

The following spring the individual plots of SEC demonstrated that after over-wintering, all size classes of herring had markedly less stored energy than those captured in the fall (Figure 2 lower panel). Like the fall samples, there was also lots of variability in individual SEC values in the spring specimens relative to measures of fish size. The average SEC values for all YOY (n = 64) and age 1 (n = 178) fish in their respective age classes were nearly identical at 4.4 (± 0.6) and 4.4 (±0.6) $kJ.g^{-1}$ wet wt respectively. The SEC values for YOY herring were not significantly lower than those of age 1 fish (MW test). The age 1 fish had significantly lower (MW test) SEC values than the 2 year old fish. The age 2 and older fish had SEC with mean values ranging from 5.2 to 6.3 $kJ.g^{-1}$ wet wt with lots of variability. These results are being prepared for publication.

Somatic Energy of Age 0 Pollock

Pollock samples from the SEA study area have all been processed, but the data will not be analyzed in time for this report. The data will provide insight into how recruiting herring and age 0 pollock compete for food resources and their relative success and link to APEX studies of pollock-bird interactions, APEX and SEA fish stomach analysis-isotope studies, and assessments of secondary productivity.

Disscussion:

Our population ovarian energy content estimate indicates a marked decline in the amount of energy supplied to Prince William Sound by the herring spawning since 1992 (Figure 1). This decline in population OEC is primarily due to decreased female biomass. In 1991 there was a good recruitment of age 3 fish that resulted from the pre-oil spill 1988 spawning, but there were very few females recruiting from the 1992 to 1995 year classes. The effect of such large interannual variations in the kilo-Joule input to the ecosystem from herring eggs is unknown, but may be significant. If egg predator populations remain stable or increase while the amount of herring spawn decreased the impact of predation may be limiting recruitment. Our size-OEC relationships can be used to make more sophisticated estimates of ovary energy input into Prince William Sound in future models using more detailed individual fish information available in the extensive Alaska Department of Fish and Game herring fisheries data base. These in turn can be used in egg predator consumption estimates and herring recruitment models based on energetics.

The examination of somatic energy content of age 0 herring, and their competitors age 1 herring and age 0 pollock shows promise for understanding the level of competition between these pelagic analogs. Coupled with SEA models and APEX and SEA stomach analysis these prey competition interactions could be quantified in EVOS synthesis models now under consideration for funding. The somatic energy measures should identify individuals that have not stored enough energy to survive the winter period. The bioenergetic over-winter model (Mason) hopes to be able to identify poor year classes 3 years in advance of their entry into the fishery. It will not be able to identify strong year classes ahead of time but will alert managers to year classes which have potential to recruit to the fishery. The SEC signatures also are a reflection of zooplankton standing stock.

This project is focused on collecting information on the geographical and interannual variability in nutritional status of herring recruits. Thus, until the field collections are completed, and analyzed in 1998 it is difficult to interpret the significance of the project's findings. The existing data does suggest that over-winter analysis of whole body energy content of YOY herring is a measurement that has potential to identify poor year classes years in advance of their entering the fishery.

CONCLUSIONS

Somatic and specific tissue energy measurements are a valuable tool for identifying the transfer of energy through the food web to pelagic fish. They measure subtle differences that are not observable from length wet weight measures. Quantifying energy transfers is critical to building SEA and other EVOS models and the energetics component of SEA provides critical input values. for these models. Energetics measures are being used to simulate and test SEA hypothesis Lake-River and Over-Wintering and the production and competition models. Additionally the energetic data set allows for trophic comparisons of pelagic analogs like pollock and herring, and transfer of energy to other animals like APEX birds. Satifactory progress is being made towards achiving all objectives. No metholodical problems have occured. The project should be successfully competed on time for all objectives relating to the tasks of this individual SEA project.

ACKNOWLEDGEMENTS

Several SEA staff aided in field collections, laboratory analysis and data handling. Youth Area Watch also aided in some fish collections and laboratory work. The Seward Marine Center Laboratory provide all the facilities.

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Table 1. List of samples collected for energetics.

Juvenile herring

LOCATION	DATE	BOAT #	SET #	FISH #	FILE
BOULDER BAY	3/11/96	11	1018	1-43	J34
AREA 623	3/11/96	12	1014	44-94	J34
CULROSS PASSAGE AREA 605	3/28/96	12	1066	1-46	J44
DRIER BAY	3/19/96	12	1042	1-14	J40
AREA 622		11	1045	15-27	J40
		12	1041	28-74	J40
		11	1044	75-89	J40
		12	1040	90-150	J40
EAGLEK BAY	5/10/95		9530013	1-100	J11
AREA 584	11/5/95		9512053	1-96	J20
			951205?	97-100	J20
	3/13/96	12	1026	1-51	J36
		12	1024	52-88	J36
		12	1022	89-150	J36
	5/10/96	4	1044	10819-10843	NH1
		4	1045	10844-10868	NH1
		4	1047	10869-10893	NH1
	6/10/96	12	1168	10894-10993	NH5
		12	1169	10994-11043	NH5
		12	1170	11044-11093	NH5
	8/1/96	2	1265	12522-12621	NH11
		2	1270	12622-12640	NH11
		4	1071	12641-12740	NH11
	10/8/96	12	1321	740-789	J53
		12	1322	790-837	J53
		12	1323	840-886	J53
		12	1324	887-934	J53
HODGKIN PT.,	5/17/95		9520117	1	J3&6

ESTHER ISLAND		5/18/95		9520119	2	J3&6
AREA 502				9520124	3-7	J3&6
				9530059	8-9	J3&6
(files J3 & J6 were				9530063	10	J3&6
combined for this				9530066	11-13	J3&6
sample)				9530067	14	J3&6
				9550627	15-17	J3&6
		5/14/95		9520090	1-14	J3&6
				9530036	15-17	J3&6
				9530037	18-19	J3&6
GREEN ISLAND	AREA 630	10/25/95		9512032	1-100	J24
HOGG BAY		5/7/95		9530010	1-100	J8
AREA 582		11/8/95		9512061	1-25	J29
				9512062	26-41	J29
				9512063	42	J29
JACK BAY		11/3/95		9512050	1-89	J21
AREA 604				9511052	90-100	J21
		3/12/96	12	1017	1-50	J35
			11	1021	51-76	J35
			12	1015	77-125	J35
			12	1016	126-131	J35
			11	1015	132-150	J35
JACK POT BAY	AREA 610	7/8/96	2	1245	13468-13617	NH16
KNOWLES HEAD	AREA ?	11/1/95		9512040	1-98	J26
MacLEOD HARBOR	AREA 580	3/28/96	12	1050	1-95	J43
PT. HELEN, KNIGHT IS.	AREA 522?	8/8/95		95107-1T	1-100	J9

NAKED ISLAND		3/18/96	12	1037	1-49	J39
AREA 520			12	1038	50-80	J39
			11	1041	81-94	J39
ORCA INLET		10/26/94	TPNH	9422	1-93	J2
AREA 517		4/30/95		9520001	1	J10
				9520003	2-10	J10
				9520005	11-13	J10
				9590002	14-22,101	J10
				9590004	23-31	J10
				9530001	32-51	J10
				9590003	52-100	J10
PADDY BAY		3/23/96	11	1049	1-120	J41
AREA 610			12	1052	121-136	J41
			11	1063	137-150	J41
PORT FIDALGO	AREA 585	3/11/96	12	1013	1-80	J33
PORT GRAVINA		10/29/94	TPRH	9415	1A1-4A10 (100 fish)	J1
AREA 518 &528		5/27/95		9520127	1-100	J7
				9520129	101	J7
	AREA 621	7/3/96	2	1213	13368-13467	NH15
ROCKY BAY	AREA 583	3/17/96	12	1035	1-58	J38
SAWMILL BAY	AREA 616	11/7/95		9512059	1-100	J23
SHEEP BAY		3/8/96	11	1007	1-75	J32
AREA 611			12	1008	76-100	J32
			12	1006	101-125	J32
			12	1007	126-150	J32
SIMPSON BAY		10/16/95		9512002	1-50	J27
AREA 601				9512003	51-100	J27

	3/7/96	12	1002	4-104	J31
		12	1003	105-153	J31
	5/15/96	4	1049	10470-10568	NH4
		4	1050	10570-10668	NH4
		12	1103	10669-10693	NH4
		12	1105	10769-10818	NH4
		4	1052	10694-10743	NH4
		12	1106	10744-10768	NH4
	6/15/96	4	1056	11594-11643	NH8
		12	1199	11644-11693	NH8
		12	1201	11694-11743	NH8
		12	1202	11819-11868	NH8
		12	1204	11869-11918	NH8
		12	1205	11919-11968	NH8
	8/5/96	2	1289	13168-13267	NH14
		2	1292	13268-13367	NH14
	10/3/96	12	1299	300-348	J50
		12	1300	349-399	J50
		12	1302	400-447	J50
		12	1307	592-641	J50
	11/6/96	12	1343	1220-1319	J62
	12/5/96	?	1346	1320-1412	J70
		?	1347	1413-1512	J70
SNUG CORNER COVE AREA 603	11/3/95		9512046	1-100	J28
TIPPING PT., PERRY IS.	5/5/95		9520034	1-6	J4
AREA 506			9520035	7-10	J4
			9540029	11-61	J4
	5/6/95		9590027	62-65	J4
			9590029	66-70	J4
			9590032	71-112	J4
WHALE BAY	10/19/95		9512012	1-48	J25
AREA 602			9513004	51-98	J25

	3/24/96	12	1045	1-51	J42
		11	1053	52-101	J42
		12	1043	102-150	J42
	5/12/96	12	1091	10001-10075	NH2
		11	1088	10151-10250	NH2
		12	1093	10076-10150	NH2
	6/11/96	4	1053	11094-11143	NH6
	6/12/96	4	1054	11144-11218	NH6
		4	1055	11744-11818	NH6
		12	1181	11219-11267	NH6
	7/9/96	2	1247	12169-12268	NH10
		4	1063	12269-12421	NH10
		2	1248	12422-12521	NH10
	8/2/96	4	1072	12741-12840	NH12
		4	1075	12841-12940	NH12
	10/7/96	12	1317	642-689	J52
		12	1318	690-734	J52
	11/5/96	12	1338	935-1034	J60
ZAIKOF BAY	5/2/95		9540014	1-2	J5
AREA 521			9520015	3-9	J5
			9540011	10-57	J5
	3/16/96	11	1036	1-25	J37
		12	1030	26-85	J37
		12	1032	86-106	J37
	5/13/96	11	1089	10251-10379	NH3
	5/14/96	12	1099	10380-10427	NH3
		12	1100	10430-10469	NH3
	6/13/96	11	1157	11269-11343	NH7
		12	1193	11344-11443	NH7
	6/14/96	12	1196	11444-11518	NH7
		12	1198	11519-11593	NH7
	7/11/96	2	1260	11969-12168	NH9
	8/4/96	2	1280	12941-13016	NH13
		2	1278	13018-13067	NH13

		2	1288	13068-13167	NH13
	10/5/96	12	1308	448-493	J51
	10/9/96	11	1215	542-591	J51
	10/10/96	12	1334	494-540	J51
	11/5/96	12	1340	1035-1169	J61
	11/6/96	12	1342	1170-1219	J61
	12/5/96	12	1348	1513-1547	J71
	12/6/96	12	1350	1548-1599	J71

RESURRECTION BAY	3/95	fasting experiment 1		1-33	SMORT
AREA 524	12/1/95	fasting experiment 2		1-22	STV1
	12/28/95	fasting experiment 2		1-22	STV2
	1/25/96	fasting experiment 2		1-22	STV3
	3/20/96	fasting experiment 2		1-30	MORT2
	4/1/96	fasting experiment 2		1-18	LIVE95KJ
	3/19/96	SEA spring sample		1-50	J30

POLLOCK INVENTORY

DRIER BAY	3/19/96	12	1040	1471-1479	P27
AREA 622		12	1039	1480-1512	P27
EAGLEK BAY	11/5/95		9512053	1-50	POL1
AREA 584			9512054	51-99	POL1
	3/14/96	12	1025	1371-1421	P26
		11	1031	1422-1470	P26
	5/10/96	11	1080	10001-10075	NP1
	6/10/96	11	1140	10366-10415	NP5
		11	1141	10417-10515	NP5

		8/1/96	2	1265	13568-13652	NP9
		10/8/96	12	1324	2252-2401	P43
HOGG BAY		11/7/95		9511070	1-8	POL2
AREA 582				9512063	9-41	POL2
				9512062	42-68	POL2
				9512061	69-100	POL2
KNOWLES HEAD		11/1/95		9512040	1-2	POL3
AREA ?				9512041	3-8	POL3
				9511041	9-19	POL3
				9512042	20-69	POL3
				9511042	70-100	POL3
ORCA NARROWS		3/7/96	11	1001	1001-1031	P20
AREA 517			11	1002	1032-1070	P20
ORCA BAY			11	1004	1171-1270	P22
PADDY BAY	AREA 610	3/23/96	11	1052	1513-1612	P28
PORT GRAVINA		3/10/96	11	1011	1271-1320	P24
AREAS 518 & 528			11	1012	1322-1370	P24
SAWMILL BAY		11/7/95		9511063	1-2	POL4
AREA 616				9511065	3-14	POL4
				9512058	15-38	POL4
				9512059	39-100	POL4
		3/27/96	12	1049	1613-1663	P30
SIMPSON BAY		10/16/95		9512001	1	POL5
AREA 601				9512002	2-9	POL5
				9512005	10-16	POL5
				9512006	17-29	POL5
				9511005	30-49	POL5
				9512003	54-100	POL5
		3/7/96	11	1003	1071-1120	P21

		11	1067	1121-1170	P21
	5/15/96	11	1092	10276-10365	NP4
	6/15/96	11	1170	10776-10876	NP8
		11	1174	10877-10977	NP8
	10/3/96	12	1299	1700-1774	P40
		11	1179	1775-1843	P40
WHALE BAY	10/18/95		9512010	1-37	POL6
AREA 602			9512009	-62	POL6
	5/12/96	11	1088	10076-10225	NP2
	6/11-12/96	12	1179	10516-10539	NP6
		12	1181	10549-10593	NP6
		12	1182	10603-10678	NP6
	8/3/96	2	1276	13368-13467	NP10
	10/8/96	11	1195	2140-2176	P42
		12	1318	2177-2251	P42
ZAIKOF BAY	10/20/95		9512015	1-80	POL7
AREA 521			9512016	81-100	POL7
	5/13/96	11	1090	10226-10275	NP3
pollock	6/13-14/96	11	1157	10679-10753	NP7
		12	1196	10754-10774	NP7
	8/4/96	2	1280	13468-13567	NP11
	10/5,9-10/96	11	1215	1850-1916	P41
		11	1191	1917-2064	P41
		11	1222	2065-2137	P41

ADULT HERRING WHOLE BODY ENERGY

PORT FIDALGO area)	(Sunny Bay	4/15/96	50 males, 47 females	AH12
ROCKY BAY		4/16/96	50 males, 50 females	AH13

BOULDER BAY	4/15/96	50 males, 40 females	AH11
STOCKDALE HARBOR	4/17/96	50 males, 50 females	AH10
HERRING WHOLE OVARY INVENTORY			
STOCKDALE HARBOR	4/17/96	50 ovaries	OVA10
BOULDER BAY	4/15/96	40 ovaries	OVA11
PORT FIDALGO	4/15/96	47 ovaries	OVA12
ROCKY BAY	4/16/96	50 ovaries	OVA 13
ROCKY POINT	4/16/96	50 ovaries	OVA14