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**Pacific Halibut as Predator and Prey**

by

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## **ABSTRACT**

The International Pacific Halibut Commission has occasionally examined, at sea, the stomach contents of halibut sacrificed for other research purposes. The stomachs of over 2,700 juvenile halibut collected from across a broad expanse of the Gulf of Alaska and over 1,300 adult halibut from waters off British Columbia and Alaska were examined. Halibut were found to be opportunistic feeders. Juvenile halibut fed almost exclusively on small crustaceans. With increasing size, the diet shifted to larger crustaceans and fish. Pacific sand lance, walleye pollock, octopus, and Tanner crab made up a significant proportion of the halibut diet. The weight of the content of some stomachs has been recorded, but no quantitative analysis has been done.

A literature search was conducted to define the role of halibut as a prey item. Little definitive information was located. References indicated that halibut contribute to the diet of several species of fish and marine mammals. In all instances, halibut represented only a minute proportion of any animal's diet.

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## INTRODUCTION

Since its inception more than 60 years ago, the International Pacific Halibut Commission (IPHC), as it is known today, has gathered considerable data on the feeding habits of the Pacific halibut (*Hippoglossus stenolepis*). However, the information has nearly always been collected incidentally to other investigations of higher priority, and is not as comprehensive as it might otherwise have been. The purpose of the present paper is to summarize this accumulation of data to provide a base for planning of more thorough studies, and to review world literature on the role of the halibut both as a predator and prey.

Halibut may reach a length of over 2 m and a round weight of 200 kg. An animal this large, and one which has a current estimated biomass of over 240,000 metric tons in the eastern North Pacific Ocean (IPHC 1984), obviously will require a substantial annual food supply and will likely have a significant effect on the abundance of those species that are a large part of its diet. Gulland (1968), referring to the remarkable recovery of Northeast Pacific halibut stocks from the 1930's to the 1960's, concluded there may have been a contemporaneous reduction in the exploitable biomass of other food fishes.

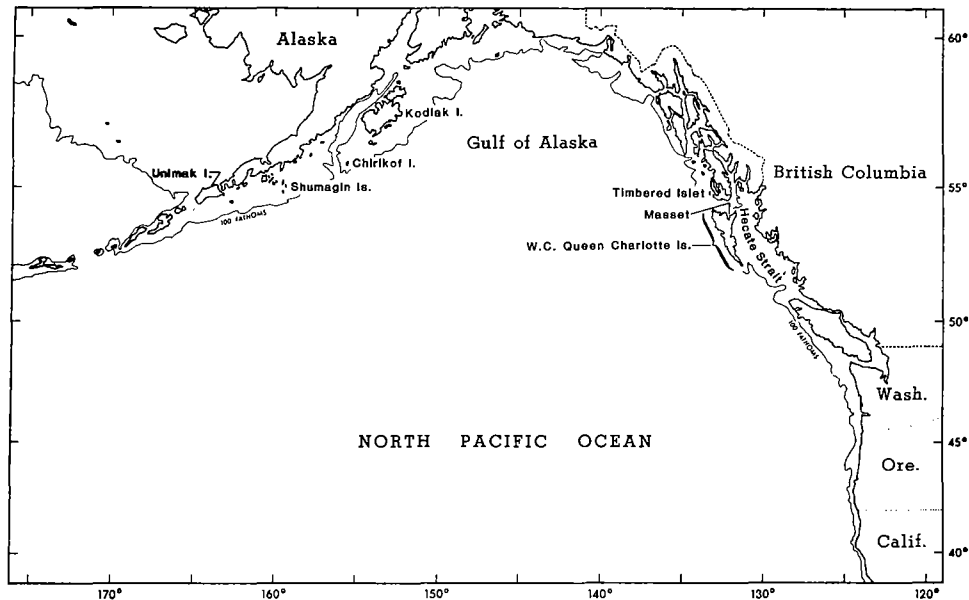
Halibut spawn immediately beyond the edge of the continental shelf from December to February. Freshly spawned ova are about 3 mm in diameter. After two or three weeks they hatch into pelagic larvae 8 to 15 mm in length. Newly hatched larvae float in deep water outside the continental shelf. In the next four or five months, the developing larvae are carried northward and westward around the Gulf of Alaska. During this period they gradually rise to the surface and drift inshore to complete metamorphosis. During this pelagic period the diet presumably consist of a variety of micro-planktonic organisms. The larvae are presumably vulnerable to predation by larger pelagic fishes such as salmon and young sablefish. Small halibut begin their bottom dwelling existence about May or June in shallow inshore areas at a size of 2 to 3 cm (Thompson and VanCleve 1936). During the next four years they remain in the shallower areas of the continental shelf while growing to a size of 40 to 50 cms, a size when they are probably no longer vulnerable to predation by numerous other species of groundfish inhabiting the shelf region.

## SAMPLING OPPORTUNITIES AND METHODS

### Juvenile Halibut

As part of the juvenile halibut surveys, some fish in each cm size group were sacrificed to determine the age composition of the catch. The juvenile halibut were trawl-caught and sampled immediately. Food items were identified as completely as possible at sea. No attempt was made to record the quantity of food consumed. The frequency of occurrence was defined as the number of stomachs from which an identifiable food item was observed. A food item was counted only once from each stomach, regardless of the number of individuals of that species in that stomach. Some stomachs contained more

than one prey species. The halibut were collected in the Gulf of Alaska between Unimak Island and southeastern Alaska (Figure 1).



**Figure 1. Collection sites of fish utilized in the analysis of stomach contents.**

### **Adult Halibut**

IPHC often utilizes setline gear to obtain larger adult fish for tagging and survey purposes. During these operations, the stomach contents of halibut that are dead or receive a severe hook injury when caught were sometimes examined. Setline fishing requires that the gear be anchored to the bottom and is usually left from 4 to 12 hours before retrieval.

During research cruises in 1955, 1980, 1981, and 1983, stomachs of halibut between 80 and 204 cm were examined. The 1955 work was carried out on halibut grounds in British Columbia and southeastern Alaska; the 1980 observations were made off the west coast of the Queen Charlotte Islands, Chirikof Island, and Shumagin Islands; the 1981 survey was in Hecate Strait; and the 1983 survey was in Hecate Strait and in the Gulf of Alaska near Cape St. Elias (Figure 1). The contents of each stomach examined were processed and recorded in the same manner as for the juveniles. Items identified as bait used on the setline gear were excluded.

## **HALIBUT AS A PREDATOR**

### **Juvenile Halibut**

During the months of June, July, and August of 1976 through 1981, the stomachs of 2,709 juvenile halibut were examined, of which 2,408, or 89%, contained food. The organisms observed in the stomachs of juvenile halibut are listed in Table 1. The data have been listed in order of frequency of occurrence and grouped by length of halibut in increments of 10 cm. The smaller halibut fed on small crustaceans to a large degree. As the size of halibut increased, larger crustaceans and fish became more important components of the diet. Jespersen (1926) reported essentially the same shift in feeding pat-

**Table 1. Food items identified in stomachs of juvenile halibut from the Gulf of Alaska, 1976 to 1981.**  
**Numbers of stomachs in which each item was observed.**

Food Item	10-cm size group									Total
	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	> 80	
Unidentified										
Shrimp	33	148	167	86	50	28	19	2		533
Sand lance		16	95	87	77	37	15	8		335
Tanner crab		6	23	42	69	75	32	12	14	273
Hermit crab	2	19	59	84	39	27	6	2		238
Unidentified crab	3	36	36	55	47	24	13	5	1	220
Walleye pollock			2	4	12	29	25	16	6	94
Sand fish		9	32	12	7	13	14	5		92
Eel pout		4	18	10	15	13	5			65
Octopus			6	3	13	20	6	4	1	53
Rock sole	2	21	13	8	1	1		1	1	48
Pacific cod			1	6	10	12	5	4	1	39
Cottids		10	4	3	7	4	3	2		33
Clam siphons			1	5	13	6	6			31
Pacific herring			1		2	13	7	5	2	30
Blennie			4	5	6	8	4		1	28
Poachers	2	1		4	8	8	2			25
Amphipod	10	2	5	2	2	1				22
Euphausid	5	11	1	2	1	1				21
Osmerid			2	5	4	6	3			20
Ronquil			1	1	6	5	4	1		18
Annelid worm			1	4	4	4	1			14
Squid		1		2	3	4	1	2		13
Lingcod			5	2	4					11
Unidentified eggs		3	2	1	1			1		8
Dungeness crab			1	1	2	1				5
Sand sole			1				1	2	1	5
Rex sole			2		1	1				4
Flathead sole					2		1			3
Dover sole						1	1	1		3
Arrowtooth flounder					1	1	1			3
Pacific halibut		1			1					2
Salmonid									2	2
King crab			1		1					2
Brittle star					1	1				2
Wrymouth					1					1
Sablefish						1				1
Snail fish							1			1
Box crab							1			1
Scallop					1					1
Starfish						1				1
Digested flatfish		13	9	8	5	3	3	4	1	46
Digested fish	7	52	97	126	113	84	72	28	9	588



**Table 2. Food items identified in stomachs of adult halibut from northern British Columbia and Gulf of Alaska waters, 1955, 1980, 1981, and 1983. Numbers of stomachs in which each item was observed.**

Food Item	Hecate Strait	Masset	WC QCI*	Timbered Islet	Gulf of Alaska	Chirikof Island	Shumagin Island	Total
Octopus	12	5	13	13	1	16	32	92
Crab**	39	22	3	4	6	8	3	85
Pacific herring	16			3	33	1		53
Pacific cod	6	13	5	3	5	5	1	38
Sand lance	34	3			1			38
Arrowtooth flounder		14		1	5			20
Walleye pollock	5				13	1		19
Tanner crab					18			18
Pacific halibut		8		9				17
Rockfish	4		4	3			1	12
Salmonid	4	4		1	1			10
Unidentified eggs	1					2	7	10
Starfish	1	1			1	1	4	8
Sablefish	2	1	2				1	6
Clam siphon	4			1				5
Flathead sole					4			4
Skate	1	2		1				4
Dogfish			2		1	1		4
Hermit crab	4							4
Snail fish	2						1	3
Ratfish		1	1	1				3
Snails			1			1	1	3
Petrals sole		1		1				2
Rex sole	2							2
Sea urchin			2					2
Lingcod			1					1
Rock sole	1							1
Poacher						1		1
Mussel			1					1
Scallop						1		1
Digested flatfish	8	27		20	10	1		66
Digested fish	59	47	11	34	10	54	79	294

\*West Coast, Queen Charlotte Islands

\*\*Crabs from British Columbia and S.E. Alaska include at least 6 identifiable species plus unidentified crabs; Chirikof Island had 6 Tanner and 2 unidentified crabs; and Shumagin Islands had 1 rock, 1 hair, and 1 unidentified crab.

tern for 2- and 3-year-old Atlantic halibut (*H. hippoglossus*) off Iceland.

IPHC (1978) and Hunter (1979) found that small rock sole (*Lepidopsetta bilineata*) were an important food of juvenile halibut in some years at areas west of Kodiak Island. Since small rock sole and halibut are difficult to distinguish from one another and often occur in the same localities, it is difficult to understand why the young halibut were not fed upon as readily as the rock sole, except that small rock sole were several times as abundant as halibut and halibut may have a much higher swimming/escape speed than comparably-sized rock sole.

Novikov (1964) gave a detailed breakdown of the percent of halibut prey by species from the eastern, central, and northwestern parts of the Bering Sea. He found that halibut under 30 cm long fed primarily on crustaceans, with a preference for shrimp. Larger halibut fed to a much greater degree upon fish, with yellowfin sole (*Limanda aspera*) and walleye pollock (*Theragra chalcogramma*) as the dominant food items. Gordeeva (1954) reported halibut less than 60 cm long in the northwest Bering Sea fed heavily on crustaceans with hermit crab (*Paquridae*) the primary species. Larger halibut utilized more fish with walleye pollock the main prey item. The feeding habits of halibut were included in studies of the food web in the vicinity of Kodiak Island. Hunter (1979) reported that halibut under 30 cm fed mainly on shrimp (*Crangon* spp.); halibut from 30 to 60 cm depended less on crustaceans and more on walleye pollock and Pacific sand lance (*Ammodytes hexapterus*); and halibut above 60 cm utilized walleye pollock and Tanner crab (*Chionoecetes bairdi*). Rogers et al. (1980) simply reported Bivalvia (clams), Natantia (shrimp), Paquridae (hermit crab), and *Chionoecetes* spp. (Tanner crab) in the diet of halibut caught by otter trawls off Kodiak Island during the summer months. Feder (1977) reported that Tanner crab was the primary species observed in halibut stomachs collected from Cook Inlet.

### **Adult Halibut**

During the August 1955, September 1980, and August 1981 setline research cruises, 1,253 stomachs were examined and 568, or 45%, contained food items. However, on the May 1983 research cruise when the stomachs of 178 trawl-caught adult halibut were examined, 143, or 80%, contained some food. Hoag et al. (1984) suggested that well-fed fish may be less likely to ingest a bait. It is also possible that some of the empty stomachs observed on the setline fishery may be due to regurgitation or flushing of the stomach during the retrieval of the fishing gear.

Fish was the predominant prey observed in large halibut stomachs (Table 2). In the overall results, octopus was found to be a preferred food, occurring nearly twice as often as the next most frequently identified species. It's possible the squid's unique shape and texture make it recognizable for a longer time than other species, or the selected fishing locations were on bottoms suitable for octopus as well as halibut. The Masset area has a sand and mud bottom suited to crabs, which were the most frequently reported food item. The ability of halibut to consume large crabs was previously reported (McIntyre 1953, Gray 1964). The occasional occurrence of small starfish and snails might be due to their attraction to bait and subsequent ingestion with the bait.

On the Timbered Islet ground, the stomachs of 37 large halibut containing identifiable food were examined. Fish, especially flatfish, were most prevalent in the stomachs sampled. It is possible that small flatfish were attracted to the bait and may have been taken by the larger fish, which in turn took a baited hook. However, there was no clear

evidence that this indeed had been the case. Approximately 20% of the identified food items in the stomachs from this area was halibut. There were more octopi and fewer crab present here than off Masset (Table 2).

Thompson (1915) examined halibut stomachs from northern British Columbia and Alaska and listed 17 species of fish observed, roughly in order of importance. Halibut was listed as number 11 with the comment "principally viscera," which would indicate they were feeding on the refuse of the dressing process aboard the halibut vessels fishing in the area. Willey (1916) reported some random observations of halibut prey. Halibut from off Vancouver Island had "stomachs full of crabs;" they were feeding heavily on Pacific sand lance in Hecate Strait and Pacific cod (*Gadus macrocephalus*) off Kodiak Island. He also reported that fresh octopus (Octopodidae), salmon (*Oncorhynchus* spp.), and viviparous perch (Embiotocidae) were considered good bait.

Simenstad et al. (1977) assessed the marine food web in the vicinity of Amchitka Island, Alaska, and reported 6 instances of lithodid crabs, golden king crab (*Lithodes aequaspina*) and red king crab (*Paralithodes camtschatica*), in 69 halibut stomachs examined from inshore areas. Offshore, 57 halibut had eaten no lithodid crabs. These authors noticed some selectivity in halibut feeding for both fish and crabs: "This apparent selectivity also occurred in this species' predation on decapod crustaceans, primarily horse crabs and shrimp, although king crabs appear to occur in equal abundance. The reason that rock sole and king crab were not preyed upon is not apparent." (p. 475).

#### **Weight of Food Consumed**

Reports listing halibut prey have provided little information on the quantities consumed. McIntyre (1953) provided some data on volume of food found in various sized Atlantic halibut listing the species found, primarily ocean perch (*Sebastes marinus*), in 1,225 stomachs examined. In another instance, a 130 pound Pacific halibut, presumably caught off the coast of Oregon, ". . . contained, all at the same time, a hake (*Merluccius productus*), a silver salmon (*Oncorhynchus kisutch*), and a red rockfish (*Sebastes ruberrimus*), the so-called 'rock-cod'. Each of these weighed fully ten pounds, and had been swallowed only a short time before the halibut was caught" (Rankin 1915, p. 117). A sport-caught halibut from near Petersburg, Alaska, weighing 370 pounds round and measuring 236 cm total length contained a freshly eaten octopus weighing 12 pounds, plus the remains of Pacific cod and sculpins (Cottidae) (T. Koeneman, Alaska Department of Fish and Game, personal communication). A large halibut (176 cm) examined on a Halibut Commission cruise contained one 68 cm salmon, the remains of crab, fish, and octopus, and the posterior section of a halibut which measured 40 cm long, 25 cm wide, and approximately 10 cm thick. The piece of halibut appeared to have been freshly sliced from a medium-sized fish, probably discarded by one of the fishing vessels operating in the vicinity. This piece of halibut was not included in Table 2 on types of food.

Mature halibut, 79 to 105 cm long, held in captivity in 3 m diameter circular tanks for several years were fed two or three 6- to 10-inch Pacific herring (*Clupea pallasii*) daily plus some supplemental salmon (*Oncorhynchus* spp.) or other fish (N. Tomlinson, Canadian Department of Fisheries and Oceans, personal communication). These halibut ate little or nothing during February and March and did not resume feeding until May (Tomlinson and Baker 1973).

As part of a 1983 IPHC experiment on setline catchability, the wet weights of the

stomach content of legal-sized (> 81 cm total length), trawl-caught halibut were collected (Hoag et al. 1984). The species and number of individuals consumed were also recorded. The weights represent only the solid material in the stomach as the digestive fluid was drained to obtain the weight of solid material. The weights, obtained at sea, are not as precise as laboratory observations but are sufficient to provide insight into the amount of food consumed. Samples were taken from Hecate Strait and from the eastern Gulf of Alaska. A fish- by-fish list of the amount and species consumed for each area is given in Appendix Tables 1 and 2 and these data are included in text Table 2.

Stomachs from fish 82 to 144 cm long were examined from Hecate Strait. The food consumed was primarily Pacific sand lance, Pacific herring, and unidentified crabs. Of the 70 stomachs collected, 11 (16%) were empty. The weight of food in the remaining 59 stomachs, including bait items in two cases, ranged from 0.1 pounds (1 Pacific sand lance) in an 82 cm specimen to 4.10 pounds (1 Pacific cod and 8 unidentified crabs) in a 144 cm specimen. The mean weight of food items in the stomachs with food was 0.46 pounds. The average length of halibut with food was 92 cm. The calculated round weight was 21 pounds. Two individual fish 90 (20 pounds) and 95 cm (24 pounds) long each had consumed 42 Pacific sand lance that weighed 1.31 and 1.05 pounds, respectively.

From the Gulf of Alaska 108 stomachs from halibut 82 to 153 long cm were examined. Primary food items observed were Pacific herring, walleye pollock, and Tanner crab. Twenty-two (20%) of the stomachs were empty. The weight of food in the 86 stomachs, including bait items in 4 cases, ranged from 0.05 pounds for 3 halibut, 83 cm (15 pounds), 85 cm (16 pounds), and 129 cm long (63 pounds) to 2.88 pounds for a 140 cm (83 pounds) fish. The mean weight of food items in the stomachs containing food was 0.79 pounds and the average size of this group of fish was 100 cm (28 pounds). None of the fish in this area consumed large numbers of prey. Four fish that had food in excess of two pounds had consumed:

1. 1 arrowtooth flounder (*Atheresthes stomias*), 1 unidentified flounder, and 1 Tanner crab (2.88 pounds).
2. 2 arrowtooth flounder and 8 Pacific herring (2.44 pounds).
3. 3 walleye pollock (2.33 pounds).
4. 4 walleye pollock (2.30 pounds).

### **Cannibalism**

Halibut in their natural environment occasionally prey on their own kind. Rankin (1915) noted the presence of a partially digested halibut in one of the stomachs examined from the Oregon coast. Simenstad et al. (1977) and Hunter (1979) also reported some evidence of cannibalism in Pacific halibut (see next section). McIntyre (1953) reported that halibut amounted to 1% by volume of the stomach contents from 33 Atlantic halibut less than 31 cm in length examined from Iceland. Joensen (1954) reported finding a halibut skeleton in the stomach of one of 69 "large" halibut from near the Faroe Islands. however, Scott (1911) examined over 1,000 halibut stomachs from the North Sea and North Atlantic and reported no cannibalism.

One of the earliest regulations imposed by IPHC was the closure of two small areas (the Masset ground in Dixon Entrance and Timbered Islet ground off southeastern Alaska) because of their alleged importance as nurse areas for juvenile halibut. By

1955, after 25 years of regulation, adult halibut stocks had been largely restored. However, IPHC was concerned about the possibility of encroachment of large halibut onto nursery areas and possible adverse effects upon recruitment of the stock through cannibalism of smaller halibut. Therefore, the staff examined over 250 stomachs from halibut 120 cm long and larger from these areas. In both areas there was evidence of some cannibalism. Approximately 7% of the stomachs examined contained halibut (Table 2). However, the significance of cannibalism in respect to recruitment remains uncertain. More recent studies on grounds west of Kodiak Island which support large numbers of small halibut revealed no incidence of cannibalism. However, there was no reliable estimate of the availability of small halibut on any of these grounds at the time of fishing.

Quantitative food studies in conjunction with measures of abundance and distribution of the large and small halibut are necessary before the prevalence of cannibalism and its effect upon recruitment can be clarified.

## HALIBUT AS PREY

### Fish Predation

The incidence of cannibalism has already been explored in discussing the feeding of halibut. Simenstad et al. (1977) examined nearly 2,000 fish stomachs, including 126 halibut, collected in the vicinity of Amchitka Island in the Aleutian chain, and found only one incidence of halibut as a prey item and it was in another halibut stomach. Hunter (1979) investigated the food web around Kodiak Island and reported observing three halibut as food, one each in the stomachs of a halibut, Pacific cod, and sand sole (*Psettichthys melanostictus*). Jewett (1978) reported the presence of halibut in only 2 of 4,277 Pacific cod stomachs examined between 1973 and 1976. A 12-foot Pacific sleeper shark (*Somnius pacificus*) caught off northern California had a 10-pound halibut as a portion of its stomach contents; a halibut hook was also found in the shark's mouth, suggesting this halibut may have been hooked on fishing gear when it was eaten (Gotshall and Jow 1965). Thompson (1915) noted incidents of Pacific sleeper sharks feeding upon halibut that were hooked on the fishing gear.

Several comprehensive studies of the food web in various regions of the northern Pacific Ocean have not indicated that halibut are heavily utilized by any predator. Halibut spend their first three or four years of life in sometimes dense concentrations in relatively shallow inshore areas where they would be available to larger predatory fishes. Large sculpins, such as *Myoxocephalus*, seem to be logical predators but studies of their stomach contents from the vicinity of Kodiak, Alaska, did not include any halibut (Jewett and Powell 1979). The unidentified flatfish category listed in several studies could have contained some halibut, but if the proportion was large there would have been occurrences of identifiable specimens. Peterson et al. (1983) reported juvenile salmon feeding upon flatfish larvae off the coast of Oregon, but that area is outside the known range of larval halibut. Studies on the food habits of these and other pelagic fishes at times and places in the northeast Pacific Ocean where their distribution overlaps with that of larval halibut are needed to determine if they are a factor in halibut abundance.

### Mammal Predation

Marine mammals, especially the Stellar sea lion (*Eumetopias jubata*), are notorious

for preying upon halibut that are hooked on the setline fishing gear. Often their predatory behavior will force fishermen to change fishing grounds, as sea lions mutilate a large part of the catch, thereby reducing its marketability. However, halibut does not appear to be of major importance in the overall diet of sea lions. Kenyon and Schaffer (1955) reported small amounts of halibut eaten. Wilke and Kenyon (1952) collected a female sea lion on St. Paul Island, Alaska, with the remains of a halibut estimated to have weighed 25 to 30 pounds in its stomach. Thorsteinsen and Lensink (1962) examined 382 sea lion stomachs collected between Unimak Island in Unimak Pass, and Marmot Island, east of Kodiak Island. Only 56 stomachs contained food, with 1 containing the remains of a halibut. Imler and Sarber (1947) found 1 halibut in 23 sea lion stomachs examined at Barren Islands. That halibut accounts for about 10% of the food in that stomach. The feeding habits of sea lions from the west coast of the Queen Charlotte Islands were investigated by Spalding (1964) and only 1 halibut was observed in 57 stomachs examined. He also reported seeing a sea lion feeding upon a halibut on the surface in northern Hecate Strait. Thompson (1915) observed sea lions feeding upon halibut at the surface and speculated as to whether the halibut had been captured or plucked from the setline fishing gear.

Pitcher and Calkins (1977) examined 129 harbor seal (*Phoca vitulina*) stomachs collected between Kodiak and Yakutat, Alaska, and found only one halibut. Lowry et al. (1982) identified two halibut in 30 harbor seal stomachs from the Bering Sea. Earlier, observation of nearly 400 harbor seal stomachs had produced no halibut (Imler and Sarber 1947).

Perez and Bigg<sup>1</sup> reported on the food of over 5,842 fur seals (*Callorhinus ursinus*) collected from the eastern Bering Sea during the months of June through October for the years of 1958 through 1974. Only 1 stomach containing 2 halibut was reported from 2,930 animals examined from the eastern Bering Sea during August.

Rice (1968) reported a partially digested halibut weighing about 10.5 kg in the stomach of a killer whale (*Orcinus orca*) taken off Kodiak Island. The stomach of a killer whale examined from British Columbia waters was found to contain two halibut (Pike and MacAskie 1965). Tomilin (1957) also referred to halibut as an identified item in the diet of killer whales as well as narwhal (*Monodon monocerus*).

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<sup>1</sup>Perez, M.A. and M.A. Bigg.

Interim report on the feeding habits of the northern fur seal in the eastern north Pacific Ocean and eastern Bering Sea. Mimeographed report submitted to the 23rd annual meeting of the Standing Scientific Committee, North Pacific Fur Seal Commission, 1980.

## DISCUSSION

The observation of halibut stomachs to determine their feeding habits has not been a high priority program for IPHC. Consequently, not all seasons of the year, fishing localities, or sizes of fish have been sampled. Juvenile halibut less than 30 cm long feed on small crustaceans, chiefly shrimp and pagurid crabs. Larger halibut, 30 to 80 cm, shift to a diet with a greater proportion of fish. Pacific sandlance, Tanner crab, and walleye pollock are important food items to this size group. Halibut over 80 cm long fed heavily on various fish species. However, unidentified species of octopus were the most common food item observed in our cruises. Miscellaneous small crabs, such as kelp, rock, or hermit crabs, were the second most numerous item tabulated. Herring, cod, and sandlance were ranked third, fourth, and fifth in numerical order of importance in the halibut diet.

The Pacific halibut appears to be an opportunistic feeder, utilizing whatever is readily available, but some authors, e.g., McIntyre (1953) and Simenstad et al. (1977) consider that there may be selectivity in the feeding habits. At times we have found the stomachs of halibut to be gorged with sandlance, Tanner crab, or shrimp. When the biomass of halibut is large, their voracious feeding can have a temporary local effect on prey species.

Our overall impression of the utilization of commercial species as prey for halibut was that small Tanner crab are important, followed by herring, and Pacific cod. However, other non-commercial species, particularly the sand lance, are at least as important as food for halibut. A full scale food habit study, properly designed to cover all seasons and areas, needs to be done to evaluate properly the impact of halibut on other species in the ecosystem.

Predation on halibut, especially by marine mammals, is apparently low, except in cases where the fish were attached to fishing gear. This is understandable, because adult halibut are large, active animals that would be difficult to capture in open water. Also, their bottom dwelling habits, generally in offshore areas, make them less accessible to predation than schooling, pelagic species.

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## LITERATURE CITED

- Feder, H. M. 1977. The distribution, abundance, diversity, and biology of benthic organisms in the Gulf of Alaska and the Bering Sea. Environmental Assessment of the Alaskan Continental Shelf, Annual Report for year ending March 1977. Volume VIII, pp. 366-712.
- Gordeeva, K. T. 1954. Food of halibut in the Bering Sea. Izvestia TINRO, Volume 39, pp. 111-134.
- Gotshall, Daniel W. and Tom Jow. 1965. Sleeper sharks (*Somniousus pacificus*) off Trinidad, California, with some life history notes. California Fish & Game, Volume 51, No. 4, pp. 294-298.
- Gray, G. W., Jr. 1964. Halibut preying on large crustacea. Copeia 1964, No. 3, p. 590.
- Gulland, J. A. 1968. The concept of the maximum sustainable yield and future management. FAO, Technical Report No. 70, 13 p.
- Hoag, Stephen H., Richard B. Derios, and Gilbert St-Pierre. 1984. Recent changes in halibut CPUE: Studies on area differences in setline catchability. International Pacific Halibut Commission, Scientific Report No. 71, 44 p.
- Hunter, Mark Albert. 1979. Food resource partitioning among demersal fishes in the vicinity of Kodiak Island, Alaska. M.S. thesis, University of Washington, Seattle, 131 p.
- Imler, Ralph H. and Hosea R. Sarber. 1947. Harbor seals and sea lions in Alaska. U.S.F.W.S. Special Scientific Report No. 28, 23 p.
- International Pacific Halibut Commission. 1978. Annual Report 1977. 35 p.
- \_\_\_\_\_. 1984. Annual Report 1983. 59 p.
- Jespersen, P. 1926. On the halibut in Icelandic waters. Rapports et Proces-Verbaux des Reunions, No. 39, pp. 103-113.
- Jewett, Stephen C. 1978. Summer food of the Pacific, cod *Gadus macrocephalus*, near Kodiak Island, Alaska. National Marine Fisheries Service, Fishery Bulletin, Vol. 76, No. 3, pp. 700-706.
- Jewett, Stephen C. and Guy C. Powell. 1979. Summer feeding of the sculpins, *Myoxocephalus* spp. and *Hemilepidotus jordani*, near Kodiak Island, Alaska. Marine Sciences Communications, Vol. 5, Nos. 4 and 5, pp. 315-331.
- Joensen, J. S. 1954. On the life history of halibut in Faroe waters. Meddelelser Fra Danmarks Fiskeri-og Haundersogelser N.S., Vol. 1, No. 5, pp. 1-25.

- Kenyon, Karl W. and Victor B. Scheffer. 1955. The seals, sea lions, and sea otter of the Pacific coast. U.S. Fish and Wildlife Service Circular No. 32, 34 p.
- Lowery, Lloyd F., Kathryn A. Frost, Donald G. Calkins, Gordon L. Swartzman, and Susan Hill. 1982. Feeding habits, food requirements and status of Bering Sea marine mammals. North Pacific Fishery Management Council Document No. 19, 292 p.
- McIntyre, A. D. 1953. The food of halibut from north Atlantic fishing grounds. Scottish Home Department, Marine Research 1952, No. 3, pp. 1-20.
- Novikov, N. P. 1964. Basic elements of biology of the Pacific halibut (*Hippoglossus hippoglossus stenolepis* Schmidt) in the Bering Sea. IN: Soviet fisheries investigations in the northeastern Pacific, P. A. Moiseev, ed. Vol. 2, pp. 175-219.
- Peterson, W. T., R. T. Brodeur, and W. G. Pearcy. 1983. Food habits of juvenile salmon in the Oregon coastal zone, June 1979. National Marine Fisheries Service Fishery Bulletin, Vol. 80, No. 4, pp. 841-851.
- Pike, G. C. and I. B. MacAskie. 1965. Marine mammals of British Columbia. Fisheries Research Board of Canada, Bulletin No. 171, 49 p.
- Pitcher, Kenneth and Donald Calkins. 1977. Biology of the harbor seal, *Phoca vitulina richardi*, in the Gulf of Alaska. Environmental Assessment of the Alaskan Continental Shelf Annual Report for the year ending March 1977. Volume 1, pp. 189-225.
- Rankin, Edward P. 1915. The halibut fishery of the Pacific coast. California Fish & Game. Vol. I, No. 3, pp. 116-119.
- Rice, Dale W. 1968. Stomach contents and feeding behavior of killer whales in the eastern North Pacific. Norsk Hvalfangst-Tidende, Vol. 57, No. 2, pp. 35-38.
- Rogers, B. J., M. E. Wangerin, and D. E. Rogers. 1980. Seasonal composition and food web relationships of marine organisms in the nearshore zones of Kodiak Island — including ichthyoplankton, zooplankton, and fish. University of Washington, Fisheries Research Institute, FRI-UW-8017, 109 p.
- Scott, Thomas. 1911. On the food of halibut, with notes on the food of *Scorpaena*, *Phycis blennoides*, the garpike, and *Chemaera monstrosa*. Fishery Board for Scotland, 28th Annual report for 1909, Part III, pp. 24-37.
- Simenstad, Charles A., John S. Isakson, and Roy E. Nakatani. 1977. Marine food communities. IN: M. L. Merritt and R. G. Fuller, eds. The environment of Amchitka Island, Alaska. U.S. Department of Commerce, Springfield, VA.
- Spaulding, D. J. 1964. Comparative feeding habits of the fur seal, sea lion, and harbor seal on the British Columbia coast. Fisheries Research Board of Canada, Bulletin No. 146, 52 p.

- Thompson, William F. 1915. A preliminary report on the life-history of the halibut. Report of the British Columbia Commission of Fisheries for the year ending December 31, 1914, pp. 76-99.
- Thompson, William F. and Richard VanCleve. 1936. Life history of the Pacific halibut (2). Distribution and early life history. International Fisheries Commission Report No. 9, 194 p.
- Thorsteinson, Frederick V. and Calvin J. Lensink. 1962. Biological observations of the Stellar sea lions taken during an experimental harvest. Journal of Wildlife Management, Vol. 26, No. 4, pp. 353-359.
- Tomilin, A. G. 1957. Mammals of the U.S.S.R. and adjacent countries. Izdalestvo Akademi Nauk SSSR. Translated for the Smithsonian Institute. 717 p.
- Tomlinson, N. and E. G. Baker. 1973. Sexual ripening of Pacific halibut (*Hippoglossus stenolepis*) in captivity. Journal Fisheries Research Board of Canada, Vol. 30, No. 8, pp. 1255-1256.
- Wilke, Ford and K. and W. Kenyon. 1952. Notes on the food of fur seal, sea-lion, and harbor porpoise. Journal of Wildlife Management, Vol. 16, No. 3 pp. 396-397.
- Wiley, Arthur. 1916. Investigation into the Pacific halibut fisheries. Contribution to Canadian Biology, 1914-1915, pp. 1-17.

## APPENDIX

**Appendix Table 1. Stomach contents of 70 Pacific halibut from the Hecate Strait and Dixon Entrance areas of British Columbia, May 13-22, 1983.**

Location	Date	Depth (fms)	Length (cm)	Sex	Food Weight (lbs.)	Stomach Contents
51:06 128:46	5/13	34-50	89	M	0.36	26 sand lance
			89	F	0.20	1 sand lance, 1 shrimp, 1 unidentified crab
			103	F	0.66	8 sand lance, 1 rock sole
			86	M	0.30	23 sand lance
51:08 128:45	5/14	40-64	83	M	0.57	32 sand lance
			95	M	1.31	42 sand lance
			89	M	0.20	1 herring
			83	M	0.74	37 sand lance
			85	M	0.57	17 sand lance
			89	M	0.05	4 sand lance
			83	M	0.22	22 sand lance
			83	M	0.25	10 sand lance
			90	F	0.52	24 sand lance, 1 unidentified roundfish
51:10 128:54	5/15	58-68	82	M	0.69	1 rex sole (3 herring heads, 2 salmon tails - bait items)
			123	F	MT	
51:08 128:59	5/15	54-69	95	F	0.05	1 shrimp, 1 unidentified roundfish, 1 unidentified flatfish
			111	F	0.10	1 herring, 1 unidentified roundfish
			112	F	0.40	1 unidentified flatfish
			82	F	0.05	Pieces of octopus
			101	F	0.30	1 rex sole
51:26 129:07	5/15	30-63	83	M	0.15	1 herring, 3 sand lance
			87	F	0.15	1 herring, 3 sand lance
			99	F	0.05	2 sand lance
			137	F	MT	
			84	F	0.31	1 herring, 1 unidentified roundfish
			97	F	0.05	3 sand lance
			84	F	0.12	2 sand lance (salmon tail - bait)
			82	M	0.10	5 sand lance, 1 unidentified flatfish
51:25 129:11	5/16	47-78	84	M	MT	
			89	F	0.05	2 sand lance
			84	M	0.20	1 sand lance, 1 herring
			85	M	MT	
			84	M	0.50	3 herring
			88	M	MT	
84	M	0.50	4 sand lance, 1 unidentified crab			

**Appendix Table 1 (cont.). Stomach contents of 70 Pacific halibut from the Hecate Strait and Dixon Entrance areas of British Columbia, May 13-22, 1983.**

Location	Date	Depth (fms)	Length (cm)	Sex	Food Weight (lbs.)	Stomach Contents
51:44 129:21	5/17	44-51	83	M	0.10	2 sand lance, 2 hermit crabs
51:47 129:22	5/17	45-78	94	F	0.10	1 herring
			82	M	MT	
			84	M	0.80	2 sand lance, 3 herring
			86	M	MT	
52:55 130:48	5/18	22-26	83	F	0.28	1 sand lance, 10 unidentified crabs
53:33 131:09	5/19	20-34	98	M	0.46	3 unidentified flatfish, 1 unidentified crab, 8 clam siphons
			124	F	0.80	20 unidentified crabs
			82	F	0.12	4 unidentified crabs
			144	F	4.10	1 Pacific cod, 8 unidentified crabs
			82	F	0.01	1 sand lance
			87	F	0.38	14 sand lance, 2 unidentified crabs
			82	F	0.30	7 sand lance, 1 herring, 1 hermit crab, 1 clam siphon
			90	F	0.50	1 unidentified flatfish, 1 hermit crab, 6 unidentified crabs, 1 clam siphon
			129	F	0.59	5 sand lance, 1 unidentified crab, 1 Pacific cod
			134	F	0.20	1 unidentified flatfish
			87	F	0.81	1 hermit crab, 5 unidentified crabs
53:31 131:12	5/19	16-36	98	F	0.50	1 butter sole, 1 unidentified rockfish, 1 unidentified flatfish
			84	F	0.25	1 hermit crab, 4 unidentified crabs
			93	F	MT	
			87	M	0.73	1 herring, 1 hermit crab, 13 clam siphons
			96	F	0.80	1 Pacific cod, 4 unidentified crabs
			106	M	0.64	28 sand lance, 1 unidentified flatfish
			106	M	MT	

**Appendix Table 1 (cont.). Stomach contents of 70 Pacific halibut from the Hecate Strait and Dixon Entrance areas of British Columbia, May 13-22, 1983.**

<b>Location</b>	<b>Date</b>	<b>Depth (fms)</b>	<b>Length (cm)</b>	<b>Sex</b>	<b>Food Weight (lbs.)</b>	<b>Stomach Contents</b>
53:38	5/20	20-36	94	F	0.15	5 unidentified crabs
131:04			90	F	1.05	42 sand lance
			91	F	0.39	1 Pacific cod, 2 unidentified crabs
			91	M	0.95	4 Sand lance, 1 herring, 7 unidentified crabs
			94	F	0.52	10 sand lance
54:09	5/21	24-41	82	M	0.42	1 herring
131:56						
54:10	5/22	24-52	85	M	1.00	1 herring, fish viscera
113:52						
54:11	5/22	20-62	82	F	MT	
131:52			87	F	MT	
			85	F	0.18	3 herring
			83	M	0.13	2 herring

**Appendix Table 2. Stomach contents of 108 Pacific halibut from the eastern Gulf of Alaska, May 28-June 8, 1983.**

Location	Date	Depth (fms)	Length (cm)	Sex	Food Weight (lbs.)	Stomach Contents
59:42 140:01	5/28	53-70	83	M	0.24	(bait - herring)
59:14 139:18	5/29	29-46	86	F	0.10	2 Tanner crab
59:13 139:24	5/29	51-78	99	F	0.41	1 Tanner crab, 1 pollock
59:44 141:55	5/31	47-58	108 84	F M	0.10 MT	1 Arrowtooth flounder
59:50 144:00	6/1	42-54	83 109	M F	0.66 0.29	6 herring 3 herring, 1 unidentified flatfish, 1 starfish
			85	F	0.83	1 Pacific cod
			105	F	1.44	7 herring
			96	F	0.45	(bait - Pacific cod)
59:48 144:56	6/1	44-56	95 111 85 85 129 119 111 128	M F M M F F M F	0.32 1.17 0.64 1.10 0.05 0.20 0.11 0.89	1 herring 3 herring, 1 flathead sole 1 herring, 1 pollock 5 herring 1 unidentified crab 2 pollock 1 unidentified flatfish 1 flathead sole, 1 unidentified flatfish, 1 salmon
59:50 144:10	6/2	38-50	100 95 83	F M F	0.18 MT 1.19	1 Pacific cod 2 arrowtooth flounders
59:47 144:00	6/2	56-65	107 89	F M	0.65 0.39	(bait - salmon tail) (bait - salmon tail)
59:38 146:12	6/4	47-56	128 121 102 94 114 98 97 121 91 87	F F F M F M M F M F	0.79 0.91 1.37 0.76 0.59 1.62 0.56 1.51 0.32 MT	3 herring 2 pollock 4 herring 3 herring, 1 unidentified flatfish 4 herring 2 pollock 3 herring 7 herring 1 herring

**Appendix Table 2 (cont.). Stomach contents of 108 Pacific halibut from the eastern Gulf of Alaska, May 28-June 8, 1983.**

Location	Date	Depth (fms)	Length (cm)	Sex	Food Weight (lbs.)	Stomach Contents
59:38 146:06	6/4	48-56	113	F	0.10	1 Tanner crab
			140	F	2.88	1 Tanner crab, 1 arrowtooth flounder, 1 unidentified crab
			105	M	MT	
			88	M	0.55	3 herring
			106	F	0.69	3 herring
			125	F	2.44	8 herring, 2 arrowtooth flounders
			85	M	MT	
			85	M	MT	
			101	F	MT	
			82	F	MT	
59:36 146:09	6/5	56-68	93	M	0.35	2 herring
			89	M	0.70	4 herring
			102	M	1.05	1 Tanner crab, 1 flathead sole, 1 unidentified flatfish
			84	M	MT	
			83	F	0.60	1 herring, 1 flathead sole
			101	M	0.47	1 herring, 1 Tanner crab, 1 unidentified roundfish
			84	M	1.37	5 herring, 1 Tanner crab
			82	M	0.46	1 herring
			89	M	0.19	1 herring
			108	M	0.84	1 arrowtooth flounder, 1 Tanner crab
			86	M	0.08	1 herring
			85	M	0.35	6 herring
			135	F	1.83	8 herring
86	M	0.18	Unidentified fish			
87	M	0.28	2 Tanner crab			
59:32 146:08	6/5	61-81	116	F	1.18	4 herring, 4 Tanner crab
			116	M	MT	
			111	F	MT	
			129	F	MT	
			90	M	MT	
			85	M	MT	
			102	M	MT	
			85	M	0.05	Fish bones
88	M	0.54	Unidentified roundfish			
118	M	MT				
59:28 146:03	6/6	54-82	111	M	MT	
			145	F	MT	
			98	M	0.10	1 unidentified flatfish
			82	M	MT	
			83	F	0.05	Fishbones
98	F	0.38	1 herring, 1 unidentified crab			



Appendix Table 2 (cont.). Stomach contents of 108 Pacific halibut from the eastern Gulf of Alaska, May 28-June 8, 1983.

Location	Date	Depth (fms)	Length (cm)	Sex	Food Weight (lbs.)	Stomach Contents
59:35	6/6	54-66	84	M	0.12	1 herring
146:11			90	F	0.17	Fish bones
			103	M	0.26	1 herring, 1 unidentified crab
			90	M	0.73	2 Tanner crab, 1 unidentified flatfish
			82	F	0.10	Unidentified crab
			138	F	0.82	1 pollock
			88	M	0.14	2 Tanner crab
			95	M	0.91	1 dogfish
			130	F	MT	
			153	F	1.15	1 Tanner crab, 1 unidentified flatfish, 1 unidentified roundfish
			87	M	0.10	2 shrimp, 1 unidentified crab
			89	M	0.10	1 Tanner crab
			111	F	MT	
			82	M	0.12	3 Tanner crab
			101	M	0.63	1 unidentified flatfish, 1 unidentified roundfish
			94	M	1.44	1 unidentified flatfish
			83	M	0.24	1 Tanner crab, 1 unidentified roundfish
			119	M	1.44	7 herring
	92	M	1.05	1 Pacific cod		
	83	M	0.10	Fish bones		
	144	F	0.18	1 pollock		
	83	M	0.45	2 herring		
	86	M	0.31	1 Pacific cod		
59:32	6/7	59-64	97	M	0.09	5 sand lance, 1 Tanner crab
146:36						
58:57	6/8	120-128	86	M	0.71	1 Pacific cod
149:41			97	M	MT	
58:56	6/8	84-104	126	F	0.32	1 Tanner crab
150:15			108	M	1.81	2 pollock
			90	M	1.39	1 octopus
			116	F	2.33	3 pollock
			82	M	1.13	4 pollock
			117	F	2.30	4 pollock
			101	F	1.30	2 pollock
			106	M	1.35	1 pollock

Appendix Table 2 (cont.). Stomach contents of 108 Pacific halibut from the eastern Gulf of Alaska, May 28-June 8, 1983.

Location	Date	Depth (fms)	Length (cm)	Sex	Food Weight (lbs.)	Stomach Contents
59:38 146:06	6/4	48-56	113	F	0.10	1 Tanner crab
			140	F	2.88	1 Tanner crab, 1 arrowtooth flounder, 1 unidentified crab
			105	M	MT	
			88	M	0.55	3 herring
			106	F	0.69	3 herring
			125	F	2.44	8 herring, 2 arrowtooth flounders
			85	M	MT	
			85	M	MT	
			101	F	MT	
			82	F	MT	
59:36 146:09	6/5	56-68	93	M	0.35	2 herring
			89	M	0.70	4 herring
			102	M	1.05	1 Tanner crab, 1 flathead sole, 1 unidentified flatfish
			84	M	MT	
			83	F	0.60	1 herring, 1 flathead sole
			101	M	0.47	1 herring, 1 Tanner crab, 1 unidentified roundfish
			84	M	1.37	5 herring, 1 Tanner crab
			82	M	0.46	1 herring
			89	M	0.19	1 herring
			108	M	0.84	1 arrowtooth flounder, 1 Tanner crab
			86	M	0.08	1 herring
			85	M	0.35	6 herring
			135	F	1.83	8 herring
			86	M	0.18	Unidentified fish
87	M	0.28	2 Tanner crab			
59:32 146:08	6/5	61-81	116	F	1.18	4 herring, 4 Tanner crab
			116	M	MT	
			111	F	MT	
			129	F	MT	
			90	M	MT	
			85	M	MT	
			102	M	MT	
			85	M	0.05	Fish bones
			88	M	0.54	Unidentified roundfish
118	M	MT				
59:28 146:03	6/6	54-82	111	M	MT	
			145	F	MT	
			98	M	0.10	1 unidentified flatfish
			82	M	MT	
			83	F	0.05	Fishbones
			98	F	0.38	1 herring, 1 unidentified crab

**Appendix Table 2 (cont.). Stomach contents of 108 Pacific halibut from the eastern Gulf of Alaska, May 28-June 8, 1983.**

Location	Date	Depth (fms)	Length (cm)	Sex	Food Weight (lbs.)	Stomach Contents
59:35	6/6	54-66	84	M	0.12	1 herring
146:11			90	F	0.17	Fish bones
			103	M	0.26	1 herring, 1 unidentified crab
			90	M	0.73	2 Tanner crab, 1 unidentified flatfish
			82	F	0.10	Unidentified crab
			138	F	0.82	1 pollock
			88	M	0.14	2 Tanner crab
			95	M	0.91	1 dogfish
			130	F	MT	
			153	F	1.15	1 Tanner crab, 1 unidentified flatfish, 1 unidentified roundfish
			87	M	0.10	2 shrimp, 1 unidentified crab
			89	M	0.10	1 Tanner crab
			111	F	MT	
			82	M	0.12	3 Tanner crab
			101	M	0.63	1 unidentified flatfish, 1 unidentified roundfish
			94	M	1.44	1 unidentified flatfish
			83	M	0.24	1 Tanner crab, 1 unidentified roundfish
			119	M	1.44	7 herring
			92	M	1.05	1 Pacific cod
	83	M	0.10	Fish bones		
	144	F	0.18	1 pollock		
	83	M	0.45	2 herring		
	86	M	0.31	1 Pacific cod		
59:32	6/7	59-64	97	M	0.09	5 sand lance, 1 Tanner crab
146:36						
58:57	6/8	120-128	86	M	0.71	1 Pacific cod
149:41			97	M	MT	
58:56	6/8	84-104	126	F	0.32	1 Tanner crab
150:15			108	M	1.81	2 pollock
			90	M	1.39	1 octopus
			116	F	2.33	3 pollock
			82	M	1.13	4 pollock
			117	F	2.30	4 pollock
			101	F	1.30	2 pollock
	106	M	1.35	1 pollock		