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OBSERVATIONS ON ABUNDANCE AND DIET OF PACIFIC MACKEREL (*Scomber japonicus*) CAUGHT OFF THE WEST COAST OF VANCOUVER ISLAND, SEPTEMBER 1984

by

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ABSTRACT

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Large numbers of Pacific or chub mackerel, Scomber japonicus were reported off the west coast of British Columbia during the 1982-1984 El Niño event. The stomach contents of twenty-five specimens caught in Barkley Sound during September 1984 were examined to determine whether they were feeding on juvenile herring and salmon. General observations on the abundance and stomach contents of Pacific mackerel in the area from June to September 1984 are reported.

RESUME

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En meme temps que l'El Niño était présent de 1982 à 1984, de grands nombres de maquereaux blancs, Scomber japonicus, ont été signalés au large de la côte ouest de l'île Vancouver. On a examiné les contenus stomacaux de 25 spécimens capturés dans la baie Barkley en septembre 1984 afin de déterminer s'ils avaient consommé du hareng et du saumon juvéniles. On présente des observations générales sur les contenus stomacaux et l'abondance du maquereau blanc dans cette région entre juin et septembre 1984.

INTRODUCTION

The appearance of large numbers of Pacific or chub mackerel, Scomber japonicus (former name: Pneumatophorus diego) on the Canadian west coast during the anomalous El Niño period, 1982-1984, is well known. (El Niño Task Force, 1984; J. Mitchell, South Coast Management Division, D.F.O., pers. comm.; J. Boutillier, D.F.O. Biologist, pers. comm.). The presence of this species in these waters is not unusual (Rounsefell and Dahlgren 1934; Hart 1943; Foerster 1943). Hart (1973) reports that the range of Pacific mackerel extends from the Revillagigedo Islands off Mexico to the Gulf of Alaska and throughout the intervening waters, but that their occurrence is sporadic in the northern part of this range. It is primarily in Southern California that numbers are high enough for a commercial fishery (Fitch 1953; Parrish and MacCall 1978).

During the most recent El Niño event, Pacific mackerel were seen in greater numbers than usual in some areas in the north. In purse seines 10-15 miles off of Oregon, Pacific and jack mackerel (Trachurus symmetricus) ranked first and second respectively, in abundance of all species caught in 1983 and 1984. This has never happened previously in the observer's experience (Dr. William Pearcy, Oregon State University, Dept. of Oceanography, pers. comm.).

From 1981 to 1984, during the salmon test fishery in Barkley Sound, the numbers of Pacific mackerel taken incidentally in purse seines increased from 0 in 1981 to 200 or more in one set in 1984. Throughout 1984 catches of 100 or more Pacific mackerel were not uncommon (J. Mitchell, pers. comm.). These catches probably do not accurately reflect the magnitude of the mackerel population present because the mesh size is larger than would be used to fish the smaller mackerel. Because salmon were the test fishery target the numbers of mackerel caught were commonly documented, if at all, by comments such as 'a lot of chub in all sets' rather than by accurate counts. However these observations indicate that during 1983 and especially 1984, there were significantly large numbers of Pacific mackerel in the Barkley Sound area.

The purpose of the present work was to obtain samples of Pacific mackerel from Barkley Sound to determine whether they were feeding on juvenile herring and salmon. Previous work indicates that juvenile herring and other small fish are frequent constituents of mackerel diets. Fry (1936) discusses the voracious appetite of these fish in Californian waters and says that the diet consists of any animal matter, alive or dead, that they can swallow -- from fish and squid several inches long, down to copepods. He found that they tend to feed almost exclusively on one type of food at a time (i.e. copepods, squid, or anchovies) but not on a mixture of these. Nikol'skii (1961) reports that in Japanese waters, Pneumatophorus japonicus (S. japonicus) feeds on plankton, fish fry, adult sardines, anchovies, glassfish (Salangichthys) and other fish.

During the salmon test fishery in Barkley Sound in June and July 1984, the stomach contents of a few of the mackerel caught incidentally were examined on a gross level by South Coast Management Biologist, Jim Mitchell. Juvenile herring and salmon smolts were important constituents of their diets over this period.

METHODS

SAMPLE COLLECTION

The sampling design consisted of sounding for mackerel and purse seining suspected concentrations to obtain a sample for analysis of stomach contents. Mackerel were tentatively identified on sonar by their rapid movements. Sounding and sampling were conducted over a four day period, from 12 to 15 September 1984 in Barkley Sound, British Columbia (Fig. 1), from the 13 m charter seine vessel the MIDNIGHT RAIDER, skippered by Paddy Harrison of Qualicum Beach, B.C.

Initially a salmon seine net was used but this was changed for a smaller mesh anchovy net when all the mackerel caught in the first two sets escaped through the mesh. A total of 16 sets were made in the areas shown on Figure 1; however, mackerel were only taken successfully in 2 sets. Local fishermen commented that the large concentrations of mackerel had left the area two weeks previously.

LABORATORY ANALYSIS

Twenty-five Pacific mackerel stomachs were processed for diet composition following the procedure outlined below. Whole gastro-intestinal (GI) tracts were preserved in formalin and placed individually in labelled glass jars. Portions of some labels were illegible so precise data on fish length is not available for some samples; however, all fish were in the narrow range of 29.0 to 33.0 cm.

The GI tract was removed from the sample jar and placed in a beaker under running tap water for several minutes to rinse formalin from the tissues. It was then blot-dried using paper towels and weighed on a Sybron Digimetric balance. All wet weights were done to 0.01 g. The stomach was then dissected out and all adhering mesenteries and fatty tissues removed. It was then weighed. The contents were then extracted, blot-dried and weighed.

Individual prey items were subsequently sorted under a dissecting microscope into the following groups, invertebrates: copepods, amphipods, decapod larvae, euphausiids, chaetognaths, nematodes and fish: herring, and anchovy. If the contents were in suitable condition (i.e. discrete and recognizable individuals) the number of individuals in each group was counted. If unsuitable, the contents were described qualitatively. Each group was separated out and wet weighed after blot-drying (fish) or suction-drying (invertebrates) in a millipore filter apparatus for 10 seconds.

In one case the stomach was packed with plankton and it was deemed necessary to split it with a Folsom plankton splitter prior to processing. Estimates of numbers and weights were made from the subsample.

Any remaining detritus was identified, if possible, as fish or invertebrate, suction dried and weighed.

All data for each stomach were recorded and the state of digestion reported. This information is presented in Table 1.

RESULTS

Sounding and seining sites are indicated on Figure 1. Sets were made when sounding indicated the presence of rapidly moving targets, or of apparent feed.

Pacific mackerel were taken in 4 out of 16 sets. Unfortunately those captured in the first two sets in San Mateo Bay escaped through the wide mesh of the salmon seine net. The most successful set was made in Rainy Bay, NE of the Boyson Islands (water temperature 9.3°C), and netted 99 mackerel. Of these, 24 were retained for stomach analysis (sample no.1). The other successful set was in San Mateo Bay. Of the 6 mackerel caught, only 1 was retained for stomach analysis as the other 5 had empty stomachs (sample no. 2). The results of the stomach analysis are presented in Table 1.

Lengths of the fish in both sets were determined by random selection of individuals for measurement. The lengths of fish in both sets were all in the range of 29.0 to 33.0 cm (set 1: $n = 44$, $\bar{X} = 30.4$ cm, std. dev. = 1.028; set 2: $n = 5$, $\bar{X} = 30.4$ cm, std. dev. = 1.56). The weight of 91 randomly selected fish from set 1 was 37.0 kg ($\bar{X} = 406$ g) and of 5 fish from set 2 was 2.0 kg ($\bar{X} = 400$ g).

Juvenile herring were present in 60% of the stomachs analyzed, anchovy in 28%. In 13 out of 15 stomachs containing herring, herring made up 73 to 100 % of the wet weight of the stomach contents. In the remaining 2 stomachs containing herring, there was a large unidentifiable detrital component present and only approximately 50% of the wet weight of the stomach contents could definitely be identified as herring.

Invertebrates (copepods, amphipods, decapod larvae, euphausiids and chaetognaths) were commonly present in mackerel stomachs but, except in one fish, their wet weight was always less than 0.5 g. One stomach contained euphausiids only, with a wet weight of 2.03 g.

During the salmon test fishery in Barkley Sound in June and July 1984, the stomach contents of a few of the mackerel caught incidentally were examined on a gross level by South Coast Biologist, Jim Mitchell. On June 2, 1984 from a set that included approximately 100 Pacific mackerel, taken from the Ellis Islet area, a few stomachs were examined. These mackerel were packed solidly with 8-10 juvenile chinook salmon per fish. They were so full of salmon that gently flexing the back of a mackerel would cause partially digested salmon to be disgorged.

A month later, on July 7, in a set off Danvers Islet approximately 200 mackerel were caught. The stomachs of 12 of these fish were examined and found to contain 3 to 4 juvenile herring each (J. Mitchell, pers. comm.).

During a prawn survey in Barkley Sound in August and early September, D.F.O. Biologists Jim Boutillier and Wayne Harling caught numerous mackerel on sports trolling gear in Alberni Inlet, Uchucklesit Inlet and NE Trevor Channel (map, Fig. 2). Mackerel were caught as far up Alberni Inlet as Nahmint Bay and at the head of Uchucklesit Inlet in the mouth of Uchuck Creek. Fishermen in the area at the time reported that mackerel had been caught further 20 miles up the inlet at Port Alberni. The lower salinities in these areas apparently did not deter the mackerel. Twenty fish caught on August 29 in Uchucklesit Inlet were weighed ($\bar{X}$ = 430 g; std. dev. = 80) and their stomach contents examined. The stomachs of 17 out of 20 were empty; the remaining 3 contained "red plankton".

DISCUSSION

Whether or not Pacific mackerel have a serious impact on the stocks of juvenile salmon and herring could not be ascertained from this work as a time series of samples was not taken; however, given the observations of significant numbers of the predator combined with cursory stomach contents examination this conclusion is not unreasonable.

The average fork length (304 mm) and weight (406 g) of mackerel indicate that they were approximately 2 to 2 1/2 years old when caught in September 1984 (Mallicoate and Parrish 1981). Knaggs and Parrish (1973) report that most female Pacific mackerel are mature or are maturing by their third year of life and that males mature well before this. This indicates that Pacific mackerel remaining in the sampled year class may be numerically sufficient to form a breeding population in Barkley Sound beginning in the spring of 1985. Knaggs and Parrish (1973) state that the majority of spawning occurs from April to August in California. Whether water temperatures and other environmental factors would favour a successful spawning population in B.C. waters is, however, doubtful as such a population would probably already exist in view of the previous occurrences of Pacific mackerel off the west coast of Vancouver Island.

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Table 1. Pacific mackerel stomach content analysis.

Sample	1	1	1	1	1	1	1	1
Fish Length cm	29.0	31.0	?	31.0	29.5	30.0	31.0	31.0
Wet weight (g) of:								
GI tract	44.87	38.27	38.06	47.16	33.46	33.47	56.03	42.35
Stomach + contents	8.42	13.91	6.16	14.21	3.60	4.62	15.34	10.06
Contents	2.97	7.28	1.57	7.23	0.03	1.28	10.06	5.91
Counts/weights (g):								
Invertebrates								
Copepods	1[p]/0.00		1[p]/	22/0.00				
Amphipods				13/0.02				
Decapod larvae	1/0.01			6/0.01				
Euphausiids				2+bits/0.01				
Chaetognaths								
Nematodes (p)	4/0.00			2/0.00				
Cephalopods								
Fish								
Herring	1[t]/2.70	2/5.85		1/5.90			1/4.99	
Anchovy		1/0.14		1/0.04			1[t]/1.24	
Other		1[f]/0.00						
Detritus								
Fish		0.70	0.32		0.03		1.24	0.13
Invertebrate			1.02			1.28	3.34	4.81
Unidentifiable				1.31				
State of digestion	AD	MOD	AD	MOD-AD	AD	AD	AD	AD

Table 1 (cont'd)

Sample	1	1	1	1	1	1	1	1
Fish Length cm	?	33.0	30.5	30.5	33.0	30.5	?	33.0
Wet weight (g) of:								
GI tract	46.97	50.84	30.41	45.94	38.27	39.28	35.02	34.11
Stomach + contents	5.44	11.08	7.57	9.37	9.82	9.63	3.71	5.71
Contents	0.24	4.72	2.73	5.39	4.74	5.52	0.28	2.60
Counts/weights (g):								
Invertebrates				s				
Copepods				2268/0.44		399/0.09	2/0.00	
Amphipods				28/0.00		6/0.00	3/0.00	
Decapod larvae	5/0.01		2/0.00	108/0.32	21/0.07	3/0.00	6/0.02	
Euphausiids				8/0.02				33+bits/2.03
Chaetognaths					10/0.04			
Nematodes (p)								
Cephalopods							1/0.00	
Fish								
Herring		1/3.55	1/2.00	1/2.67	1/4.50			
						1/5.08		
Anchovy					1/0.09			
Other								
Detritus								
Fish	0.15	0.66						
						0.03		
Invertebrate				1.54				
						0.19	0.14	
Unidentifiable			0.67					
State of digestion	AD	AD	AD	MOD-AD	MOD	MOD-AD	MOD-AD	MOD

Table 1 (cont'd)

Sample	1	1	1	1	1	1	1	1	2
Fish Length cm	29.5	30.0	30.0	30.0	30.0	31.0	31.0	?	31.5
Wet weight (g) of:									
GI tract	43.38	38.34	50.22	38.52	43.63	33.01	51.75	50.50	30.02
Stomach + contents	8.69	9.61	13.10	4.98	16.33	4.35	23.06	17.61	5.69
Contents	4.37	5.69	6.26	0.21	10.69	0.35	17.74	12.95	0.85
Counts/weights (g):									
Invertebrates									
Copepods							11/0.01		7/0.00
Amphipods							5/0.01		2/0.00
Decapod larvae	1/0.00								4/0.00
Euphausiids							1[bit]/0.00		1[bit]/0.02
Chaetognaths									112/0.28
Nematodes (p)								1/0.01	
Cephalopods									
Fish									
Herring	1/4.09	1/4.78	1/5.97		3/10.69		4/17.41	4/12.89	
Anchovy	1/0.16	8/0.72				1/0.35			
Other									
Detritus									
Fish									
Invertebrate									0.40
Unidentifiable	0.27		0.27	0.21			0.05		
State of digestion	MOD	MOD	AD	AD	MOD	AD	MOD-AD	MOD-AD	AD

State of Digestion: FResh, MODerate, ADvanced.

p = parasitic (parasitic copepods are Caligus - this stage parasitizes herring).

f = fir needle.

t = tentative identification (i.e. best guess!).

s = split sample.

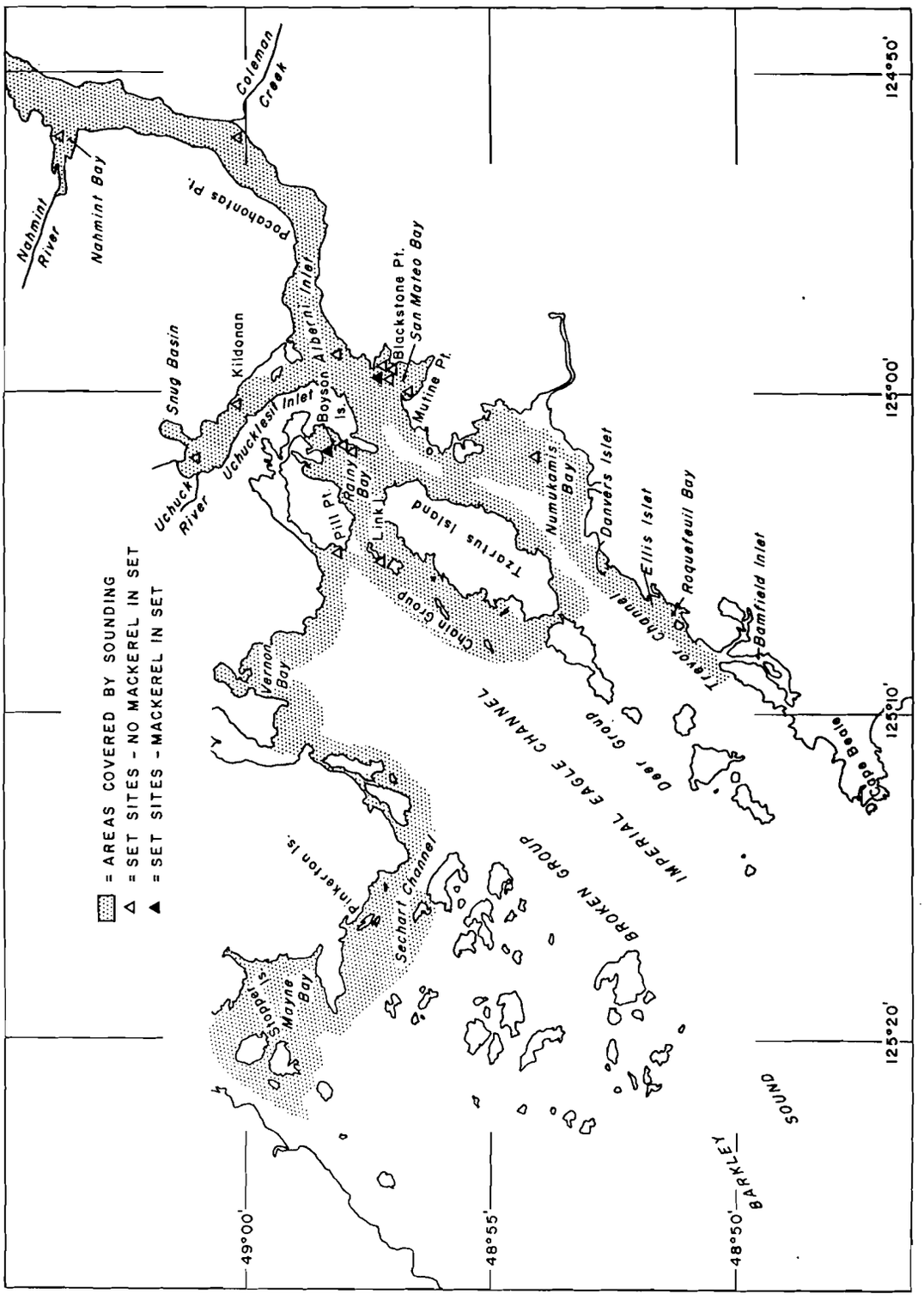

Fig. 1. Sounding and sampling locations, Barkley Sound, September 12-15, 1985.

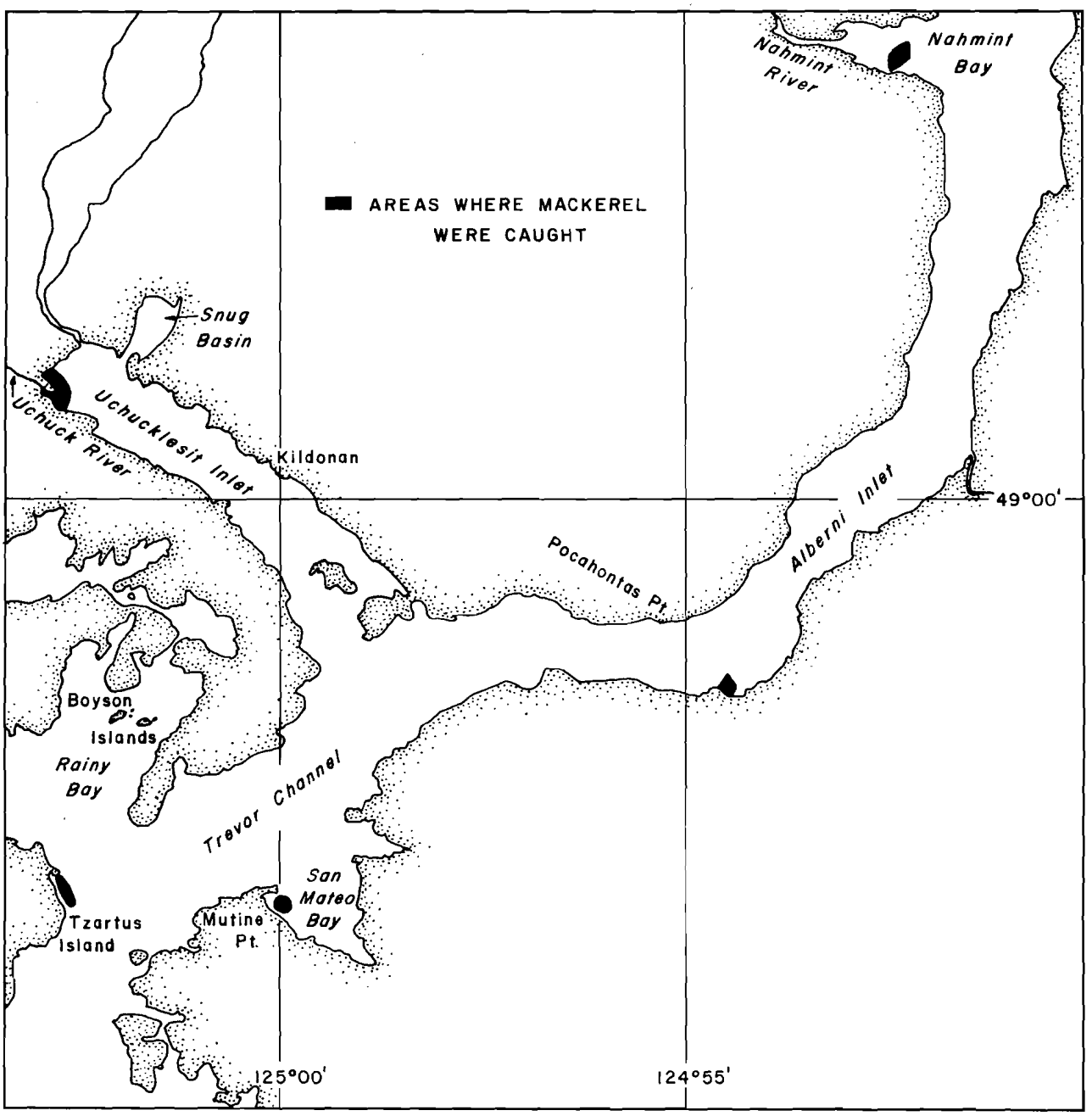

Fig. 2. Areas where Pacific mackerel were spotted by DFO biologists August 11 to September 5, 1985.