Midwater trawl catches from Queen Charlotte Sound and the open ocean adjacent to the Queen Charlotte islands

by F. H. C. Taylor

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E R R A T A   S H E E T

For: "Midwater trawl catches from Queen Charlotte Sound and the open ocean adjacent to the Queen Charlotte Islands"
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A reversal of syllables has occurred in the generic name Borodinula (incorrectly spelled Borodulina) and should be amended on the following pages:

Page 14, Section 7 - Heading should read "Borodinula infans (?) (Günther) instead of "Borodulina ..."

- Line 5, "Borodinula gilli"
- Line 11, "Borodinula Whitley 1931."

Page 19, line 13 - "Borodinula infans"

Page 29, Under "Species" column, Table II - "Borodinula infans" and "Borodinula gilli"

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FISHERIES RESEARCH BOARD OF CANADA
Biological Station, Nanaimo, B. C.

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MIDWATER TRAWL CATCHES FROM QUEEN CHARLOTTE SOUND AND THE OPEN OCEAN ADJACENT TO THE QUEEN CHARLOTTE ISLANDS

In 1964 and 1965 a survey was carried out in Queen Charlotte Sound and off the west coast of the Queen Charlotte Islands to describe the ocean sound-scattering layers and to determine the type of fish associated with them. This general area was chosen because of the variety of bottom topography offered. There are coastal banks and gullies which form a productive commercial fishing area, the continental slope, the continental borderland, and regions with seamounts. Off Queen Charlotte Sound the Dellwood Hills rise from 2200-2600 m to 550-915 m; farther north and west the Bowie Seamount rises from 2930-3110 m up to 45-90 m.

Three cruises (Fig. 1) were made with the 177-ft side trawler, CGS G.B. Reed. The first cruise, 64-6, from June 6-23, 1964, covered the coastal banks and gullies of Queen Charlotte Sound and the continental slope and borderland out to the Dellwood Hills. The second cruise, 64-12, from October 27 to November 14, 1964, was undertaken primarily to survey the herring potential of the west coast of the Queen Charlotte Islands and was confined mainly to the inlets and narrow shelf of these islands. However, six midwater hauls were made, four on the outer edge of the continental shelf off Cape St. James, one on the edge of the shelf off the Goose Island Bank and one in the gully southeast of this bank. The third cruise, 65-7, from July 8-18, 1965, covered two stations beyond the continental shelf, one 38 km southwest of Cape St. James, and the other 63 km southwest of Tasu Sound, and a third station on the Bowie Seamount about 125 km west of the northern end of Moresby Island.

METHODS AND EQUIPMENT

On the first cruise and on most of the third a large German Engel midwater trawl was used (Schärfe, 1960). This net was 1200 20-cm meshes in circumference, and graded through a series of mesh sizes to 2-cm mesh in the codend. The head and groundlines measured about 38 m, the breastlines about 35 m. On the six midwater tows of the second cruise a slightly smaller Engel net was used, 1200 16-cm meshes in circumference, grading back to a codend of the same size as the first. On both nets two 300 kg weights were attached to the lower wing corner; and 82 20-cm (8-inch) Phillips aluminum floats were spaced along the headline. Both nets had a vertical mouth opening of 13 to 15 m when towed at speeds of 3.7 to 6.5 km/hr. Five square-meter Süberkrüb otter boards were used to spread the Engel nets. On the first cruise 150-m bridles were used between otter boards and net, but were found too long for operating close to the bottom in relatively shallow water. On the second and third cruises 55-m bridles were used and found satisfactory in both shallow and deep water. The smaller Engel net was lost halfway through the second cruise. Trawling was then confined to bottom tows in shallow waters with a Gulf balloon shrimp trawl. This net had a 17-m headline and a 21-m groundline, the codend was 3.8-cm mesh. For the last seven tows of the third cruise a small 12-m Barraclough-Johnson trawl (Barraclough and Johnson, 1960) spread by 200-cm aluminum otter boards was tried.

No attempt has been made to compare the catches made by the shrimp trawl or by the Barraclough-Johnson trawl with those made by the Engel nets. Catches by the two Engel nets are probably reasonably comparable. The only difference between them was in the size of the mesh in the front part of the body. In both the body mesh sizes were large compared to the size of the fish caught. Problems associated with the differential selectivity of the various mesh sizes in the Engel nets make it almost impossible to determine the effective areas of the mouths, and so to express the catch quantitatively in terms of numbers of individuals per volume of water strained by the net. However the catches are probably comparable with one another, provided adjustments are made for differences in towing time and speed. Some contamination of the catches in deeper hauls probably occurred with the passage of the net on setting and hauling through shoaler sound scattering layers. However the amount is probably small as the length of time the net would spend in the shoaler concentration was short in comparison to the towing time at the desired depth.

The G.B. Reed is equipped with two Simrad 510-5 echosounders, operating on 38.5 kc/sec and 53.0 kc/sec, and a 30 kc/sec Simrad 580-5 echoranging set. This set can also operate as a sounder. The 510-5 sounders have a pulse power output of 450 watts; the 580-5 echoranger of 1000 watts. The sounders have four basic range scales of 0-70, 0-140, 0-275, and 0-550 fm[1], each with four phasing steps overlapping by about 25%. The echoranger has two basic ranges, 0-800 and 0-135 fm, the latter with two phasing steps, 100-235 and 200-335 fm[1]. An 11 kc/sec Edo model 185 sounder associated with a Westrex Precision Depth Recorder was available but not used as it was found to be operationally hazardous.

On all tows the depth of the trawl was monitored by a "net-sounder" system. The 38.5 kc echosounder (Simrad model 510-5) operated a 10 × 16 cm transducer attached to the headline of the net through 730 m of Amergraph type 3-H-1 cable. This cable has three insulated copper conductors in a PVC jacket, covered by double reverse layers of galvanized perforated steel wire, 18 strands to the layer. The cable is slightly less than 79 mm in diameter. The breaking strain is 3270 kg. In shallow water and in hauls close to the bottom the transducer sounded downwards. The echogram showed the vertical mouth opening of the net and the distance the net was above the bottom. In tows in deep water the transducer faced upwards sounding off the water surface. The echogram then showed the distance the net was below the surface. The net was set to fish above, below, or in a particular target zone by using the required length of warp (usually four times the desired depth). Adjustments to depth to keep the net at the right depth were made by changing the vessel speed. Most hauls were made at an average speed of 4.6 to 6.5 km/hr, approximately the maximum speed with the large Engel net. A pressure operated depth gauge recording on a small circular chart was used on some hauls. While this gauge operated satisfactorily, it did not provide as much or as accurate information as the net-sounder system.

RESULTS

The position of each tow on the three cruises is shown on the map (Fig. 1) and given in Table I together with pertinent information on time, depth,

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[1]The equivalent model of echosounder with metric scales has basic ranges of 0-125, 0-250, 0-500 and 0-1000 m, each with 4 phasing steps. The equivalent model of echoranger has 2 basic ranges 0-1500 and 0-250 m, the latter with 2 phasing steps of 200-450 and 450-650 m.

relation to scattering layers and size of catch. The two deepest tows were 64-6-21 and 65-7-19. The latter, made at a depth of 510-595 m required 1375 m of towing warp. The exact depth of tow 64-6-21 is not known; 1830 m of towing warp were used, the maximum possible. It exceeded the length of transducer cable available. Judging from the warp length-depth ratio of tow 65-7-19, the depth of 64-6-21 may have been about 730-825 m[2].

The species caught, the tows in which they occurred and the numbers of each taken are given in Table II. A total of 90 species in 39 families was caught, including eight not recorded before from British Columbia. The uncommon species are described in a later section of this report.

The appearance of the sound scatters, either layers or school, varied with depth and with the type of locality - over coastal banks or gullies, in inlets, or over the continental slope and borderland. Descriptions of the different types encountered are given, followed where applicable by information on the catches made.

I. Sound scattering layers

A. The surface layer

This layer was always present but varied considerably in intensity and thickness. It was frequently double. When single, this layer usually extended to about 16-22 m[3] below the surface (Fig. 2a - top, right side), the greatest thickness observed was 33 m. When double, the upper part usually extended to about 18 m, the lower part from 20-22 m to about 29-37 m (Fig. 2a - top, left side). The thickest double layer observed extended to 66 m.

When the surface layer was well developed, it gave the appearance of having a solid core with less intense top and bottom fringes. Individual echoes were not apparent (Fig. 2a - top, left side). As it became less intense it developed a "spikey" appearance; individual echoes could be distinguished (Fig. 2a - top, right side) but appeared softer or less solid looking than individual midwater echoes (Fig. 2a - bottom).

The intensity of the surface layer varied with season, location, and time of day. It was somewhat more intense, and double layers more frequent in summer (June-July) than late autumn (October-November). In both summer and

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[2]It is interesting to note that all the aluminum headline floats had collapsed from pressure.

[3]The receiver has a time-varied gain control incorporated in it. Suppression of the receiver is complete for the first 7-9 m and then decreases concomitantly over the next one-third of the scale range. Thus the first 9 m of depth appear blank on the paper.

autumn the layer was generally less intense over the coastal banks, particularly the Goose Island Bank than in the deeper water around the banks or over the continental slope and borderland beyond. However, over the Bowie Seamount, this layer (Fig. 3) was more intense than in the surrounding ocean.

In the autumn the surface layer was less intense along the west coast of the Queen Charlotte Islands than in the Goose Island Bank-Cape St. James region to the south and east. In the inlets the surface layer was almost always less intense and thinner than outside; it often had a smudgy appearance (Fig. 2b).

In any area the layer tended to be more intense at night than during the day. A striking example of rapid increase in intensity occurred in McIntyre Bay on November 7. At dusk the layer extended 7-15 m, and was smudgy appearing (Fig. 2c). In less than 10 minutes it had changed to an intense, solid appearing double layer 7-33 m thick (Fig. 2d). It continued intensifying but more slowly until a double layer 51-55 m thick was formed (Fig. 2e). Later in the evening the layer decreased in intensity to form a single layer 33 m thick.

The behaviour of the surface layer and its variation in intensity particularly at night suggest that it is biological in nature, most probably due to concentrations of zooplankton. It did not appear to be mechanically induced - by reverberations from the hull or by aeration of the surface waters. Surface tows were not productive. Catches where made were generally sparse. The composition of the catch appeared to depend on the type of locality and to reflect to some extent the composition of the corresponding midwater or bottom catches. The surface catches made are discussed in more detail in later sections.

B. Midwater and near bottom echoes in coastal waters

In appearance these echoes seemed to be of three general types:

(a) A diffuse, soft, rather formless or "smudgy" layer (Fig. 2a - left centre at 134 m). This type was observed by itself on only two or three occasions, however it probably occurred more frequently in conjunction with other types of echo.

Catches - The diffuse layer is thought to be produced by schools of the larger zooplankton. On several occasions when such echoes were observed large numbers of euphausiids were found entangled in the web or seen washing out of the net as it was hauled in.

(b) In the second type, the individual elements, where apparent, are diffuse or blurred; large schools have the homogeneous appearance typical of schools of herring and of similar small schooling fish (Fig. 2f). Recordings of this type were encountered mainly on the west coast of the Queen Charlotte Islands, in some of the inlets there, and along the edge of the very narrow continental shelf off Moresby Island.

Catches - The bottom where such echoes were encountered was usually too rough for trawling. However one short haul through such a school at the entrance to Port Chanal yielded a large catch of herring. Another haul on a large school off Skidegate Channel resulted in the loss of the Engel net on a peak hidden by the school. A few herring were however found still entangled in the part of the net that remained. No large schools of this type were observed in either summer or late autumn in the vicinity of the Goose Island Bank.

(c) The most common type of midwater or near-bottom echo in coastal waters appeared to be aggregations of separate dash-like traces (Fig. 2a scattered 90 m to bottom; 2b). Each dash may represent an individual fish. As the schools became denser the dashes tended to merge to form short streaks or blotches. The traces sometimes then developed a less hard, more diffuse appearance (Fig. 2g).

Echoes of this type were widespread; they were observed in Queen Charlotte Sound concentrated mainly along the southeast edge of the Goose Island Bank, in the gully between this bank and the coastline, in that southeast of the Sea Otter Group, in McIntyre Bay, off the northwest shore of Graham Island, and in some of the inlets along the west coast of both Graham and Moresby Islands.

(i) Coastal gullies - in both summer and late autumn this type of echo was probably most abundant off the southeast edge of the Goose Island Bank. Schools were sometimes extensive. On one occasion a midwater layer of single dash-like echoes was observed extending across the gully from the southeast edge of the bank to the shallows off Mexicana Point. The school began at about the 82 m contour on the edge of the bank and extended out at 75 and 110 m. It became denser and gradually intensified until on the Mexicana Point side of the gully in 201 m it reached from 70 to 165 m. Thereafter it decreased somewhat, although near the Sea Otter Group it intensified again extending from the bottom to merge with the surface layer.

Aggregations of echoes of this type were observed to migrate vertically. On one occasion in June off the southeast edge of the Goose Island Bank when two layers of these dash-like echoes were observed, both moved towards the surface during the night and descended again at daylight. At 2130 hours the upper layer was between 45 and 75 m and the lower between 110 and 145 m. By 2330 hours the two layers had merged, forming a trace down to 110 m with areas of greatest concentration at 35 and 75 m. At 0220 hours there was a concentration at 100-110 m which by 0310 hours had sunk to 140-145 m. The layer remained at this depth at least until 0930 hours when observations ceased. By this time it had become less intense and less persistent. The upper layer descended at dawn. At 0430 hours this layer was centred at about 90 m but by 0520 hours it was at 130 m.

Catches - In coastal waters the largest catches came from the gullies along the edge of the Goose Island Bank and those hauls where aggregations of echoes of this type were observed at the depth fished. Pacific ocean perch (Sebastodes alutus) and other species of rockfish (mainly S. flavidus, S. proriger and S. entomelas) were the dominant species (Tables III and IV) followed by Alaska pollock (Theragra chalcogramma) and blackcod (Anoplopoma fimbria). Catches from near the bottom were the largest and surface catches the smallest. Night catches were larger than day catches from the corresponding depth level except in midwater. The largest catches of turbot (Atheresthes stomias) were made at night near the surface rather than near bottom where one would normally expect to find flatfish in greatest numbers.

(ii) Coastal banks - Few midwater or bottom echoes were found on the Goose Island Bank itself or on the deeper Middle Bank.

Catches - Catches from these banks were small, and consisted mainly of salmon and a small amount of herring. While the actual number of salmon of all five species taken was small (47), more were taken per hour of trawling over the banks than elsewhere (Table IV). More salmon were taken at night than during the day and more from midwater tows than from surface or bottom tows.

(iii) Dixon Entrance - In early November midwater and near-bottom echoes were very numerous in northern Hecate Strait and the eastern part of McIntyre Bay. On one occasion very large, rather diffuse schools 35-45 m deep were encountered on the bottom between Triple Island and Rose Spit. In McIntyre Bay the character of the schools changed as numerous dash-like echoes became associated with it. Later the diffuse layer disappeared and the dash-like echoes formed a layer 45 m thick, 18 m off the bottom. On another occasion an intense midwater layer was encountered in McIntyre Bay from Rose Spit westward. The core of this layer lay between 35 and 55 m from the surface, later sinking and thickening until it lay at 55-110 m from the surface. A curtain of dash-like echoes extended below it to 130 m later merging with the layer when it sank. As the water shallowed towards Rose Spit the layer became less intense but formed with the surface layer a curtain from top to bottom (in 130 m). To the west of McIntyre Bay diffuse midwater layers were also encountered. On one occasion a layer similar in appearance to the surface layer and about 18 m thick was centred between 75 and 90 m, 18 to 35 m off the bottom. On another, a diffuse layer was observed at first near the bottom but later rising to 35-55 m from the surface.

Catches - In the two hauls made in McIntyre Bay, Alaska pollock were dominant in the surface haul and flatfish [principally lemon sole (Parophrys vetulus)] in the bottom (Tables III and IV). Turbot were relatively numerous in both.

(iv) Inlets, west coast, Queen Charlotte Islands - In most inlets midwater and near-bottom echoes were not numerous. In most, scattered dash-like echoes or small aggregations of such echoes were found. In some, such as Tasu Sound, small homogeneous schools were present. Larger schools of this type appeared off the entrance to some inlets, and along the edge of the continental shelf south of Tasu Sound.

Catches - With the exception of two hauls with the Engel net off Port Chanal and Skidegate Channel, the inlet catches were made with a shrimp trawl. They consisted mainly of young flatfish and eelpouts (Tables III and IV). Because of the large quantities of detritus and of small fish such hauls were only roughly sorted; counts of each species were not made. However in one haul in Skidegate Channel where the echosounder showed an aggregation of large dash-like echoes a good catch mainly of large bocaccio (Sebastodes paucispinis) and turbot was made.

(v) Bowie Seamount - On the Bowie Seamount bottom and near-bottom echoes were numerous and intense. Large schools were observed both over peaks and in the valleys between. In waters 365 m deep some schools appeared to extend 185 m vertically (Fig. 3b). In other cases in shallower water, 90 m deep, schools were 35-75 m high. The schools were more intense during the night than in the day. In some cases the main scattering layer was observed to merge with schools lying over peaks.

Catches - The very rough bottom with numerous sharp peaks usually made it impossible to trawl through schools lying either in midwater or near the bottom. In some cases by towing from deep water past a peak and into deep water again, it was possible to make short tows over this type of bottom. Catches were limited, one catch consisted of the rockfish (*Sebastodes entomelas*). Another made in the evening over a peak and apparently not in a scattering layer yielded a variety of bathypelagic fishes (the viperfish, *Chauliodus macouni* 40), lantern fishes of five species, *Lampanyctus leucopsarus* 6, *L. ritteri* 6, *Hierops thompsoni* 6, *Diaphus theta* 13, *Tarletonbeania crenularis* 1; the melanostomiatids, *Tactostoma macropus* 1 and *Bathophilus flemingi* 1; and the melamphid *Melamphaes lugubris* 1. Hook and line fishing while the boat was drifting yielded several large halibut and catches of several species of rockfish (*Sebastodes ruberrimus*, *S. aleutianus*, *S. paucispinis*, *S. helvomaculatus*, and *S. entomelas*).

Generally speaking the catches made in coastal waters or over seamounts suggest that the aggregations of dash-like echoes may be due to concentrations of the larger pelagic species, principally rockfish, Alaska pollock, and at times turbot and blackcod. In other areas it seems probable hake (*Merluccius productus*) and Pacific cod (*Gadus macrocephalus*) may give echoes of similar type.

C. Open ocean scattering layer

Observations on the depth and movement of the sound scattering layers were made using the Simrad 580-5 echoranging set as a sounder rather than the less powerful Simrad 510-5 sounders. The latter provided additional more detailed information at shallow depths.

Four scattering layers were distinguished but not all were necessarily present at the same time. In June and July the main or third layer, the most intense and persistent, lay generally between 220 and 330 m from the surface, usually at about 275 m. Below this a deeper layer, the fourth, was often observed at about 330-400 m. This layer was generally faint and rather intermittent. Above the main layer one and sometimes two shallower layers were present. The second layer was generally centered about 185 m but varied from 145 to 220 m. This layer was generally, but not always, present. It was considerably less intense than the main layer. The first layer was the least intense and the most intermittent. When present, it was usually found at about 90 m but varied between 75 and 130 m. The relatively few observations made in October-November suggested the main layer was generally a little shallower, lying at about 185 m and the deep layer possibly also somewhat shallower, lying between 310 and 365 m, but considerably more intense than in summer. The two upper layers were not observed at this season in the daytime.

In the evening the layers rose towards the surface, descending again towards dawn. Rates of ascent and descent of the order of 60-100 m per hour were observed.

The ascent appeared to have two phases. First there was a slow upwards drift, primarily of the main and second layers. This occurred between about 1800 and 2100 hours (PST) and covered 35-90 m. This upwards drift was followed by a rapid rise of 140-230 m by parts of the main layer (Fig. 4). This ascent usually began between 2100 and 2200 hours and was completed by 2300 to 2330 hours. The main layer seemed to split into three sections. One part tended to remain at the daytime level of about 220-275 m or to rise only slightly. The second part rose to 140-185 m, merging with and intensifying the second layer. The third part continued the rapid ascent to within 45-90 m of the surface, sometimes merging with the upper (first) layer or with the surface layer. Both this part of the main layer and the upper layer tended to fade out shortly after the main ascent. By midnight there were thus usually two layers present, one, the most intense, at 140-185 m, formed probably of parts of the main layer and of the second layer, the other at about 220-275 m being that part of the main layer which had not migrated.

Few observations on the behaviour of the deep layer were made. In one instance an upwards drift of 45 m was observed about 1700 hours, after which the layer faded out. However there sometimes appeared to be indications of an ascent towards the main layer at between 1900 and 2000 hours and again between 2200 hours and midnight. There were also sometimes faint indications of an ascent from the deep layer to the next layer above it between 0200 and 0400 hours.

The main descent occurred very rapidly over about 1-1/2 to 2 hours, between approximately 0400 and 0600 hours (Fig. 5). There was a gradual intensification of a layer at about 90 m over a period of possibly an hour. This was followed by a very pronounced intensification and rapid descent of this layer and that part of the main night-time layer at 140-185 m to approximately the daytime level of 220-275 m. Part of the layer apparently remains at the 185 m level forming the daytime second layer. A slow descent covering about 45 m occurred throughout the morning so that the layers reached their deepest point between about noon and 1400 hours. In two or three instances a faint layer was seen to break away from the lower night-time layer (at about 230-275 m) and to descend and fade out[4]. This may be part of the daytime deep layer descending.

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[4]Signal strength decreases as the square of the distance between transducer and target. As a layer producing a weak signal descends, signal strength will decrease rapidly and the layer appear to fade out. It is also possible that as the layer descends it disperses until it is no longer dense enough to return an echo.

Whether or not the second layer migrates vertically is not clear from the observations available. If it does, movement upwards and downwards is synchronized with that of the main layer. Like the latter, the second layer exhibited an early evening upwards drift. On the other hand, after the main ascent a more intense layer remained at the level of the second layer than before. Following the main descent a weaker layer remained behind. Part of this layer could have been carried up or down by the movement of the main layer, but part was obviously not affected. The second layer was observed to split, part moving upwards and shortly fading out.

During the day the depth of the main layer oscillated somewhat varying up to 35-45 m in 2 to 3 hours. The less intense first and second layers moved as well, often in synchrony, at times splitting and merging with each other.

In November the layers exhibited the same general pattern of diel migration. Because of the shallower general depth of the layer the ascent and descent covered a somewhat shorter distance. The timing was roughly the same to an hour later.

The scattering layers continued in to the continental slope, which acted as a boundary. At the edge of the slope the layers lay at slightly above their usual open ocean depth. In some instances the deep layer appeared to bend up and merge with the main layer just before reaching the slope. On the edge of the slope, lying above the main layer numbers of separate cloudlike schools were sometimes found.

Catches - A total of 49 midwater trawl hauls (Fig. 1) were made at various depths and in various positions relative to the sound scattering layers present in waters beyond the continental shelf. Of these hauls, 20 were made on Cruise 64-6, 14 in the day and 6 at night; 5 on Cruise 64-12, 2 in the day and 3 at night; and 24 on Cruise 65-7, 17 during the day and 7 at night.

Two hauls were made to below the deepest sound scattering layers recorded; one on Cruise 64-6 to about 730 m, the other on Cruise 65-7 to 510-595 m. The catches from these deep tows, the largest from each of those cruises, differed considerably from the other catches in species composition. While myctophids continued to be the dominant group, argentinids and melamphids were also numerous. Of the myctophids, *Lampanyctus leucopsarus* was the dominant species as opposed to *Hierops thompsoni* or *Diaphus theta* in the other tows.

In Cruise 65-7, except for the deep haul, the average total catch of all species per hour of fishing at 5.2 km/hr (Table V) was greatest in the daytime from the main layer. The average catch per hour from immediately below this layer was about one-half that in it. Catches from above the main layer, in the second layer, above the first layer, and in the deep layer were all small. On the other two cruises while no hauls were made below the main layer (except for one deep haul to about 730 m) the average catch per hour of fishing was again much greater in the main layer than above it.

At night it appeared that fish were not concentrated to the same extent in any one position relative to the layers. On Cruise 65-7 the average night catches per hour from the main layer was about one-quarter the daytime catches. The catch from below the main layer was the greatest but was somewhat less than the average daytime catch per hour from the same position relative to the layer, and less than the daytime catch from the same depth. The catch from the second layer was a little less than that from the main layer. On Cruise 64-6 the night-time catch from the main layer was a little greater than the daytime catch but was only about one-half the night catch from the second layer. There was an appreciable catch from the surface layer. On Cruise 64-12 in late October the night-time surface catch was the largest, much greater than that from either above or in the main layer. The average catch from above the main layer was a little larger than that in it.

The total catch from all three cruises, including the two deep tows, amounted to just over 10,600 individuals. In Table VI are shown the depth and position of each haul with reference to the sound scattering layers and the composition of the catch by species or in the case of less frequently occurring forms by family. Lanternfish (Myctophidae) by far the dominant group made up about 81%, viperfish (Chauliodontidae) 6%, deepsea smelt (Argentinidae) 4%, melamphids (Melamphaidae) almost entirely from the two deep tows 2%, rockfish (Scorpaenidae) about one-half pelagic juveniles 2%, and flatfish (Pleuronectidae) almost entirely larval forms 2%. The remaining 2% was made up of individuals from 27 species in 21 families.

Of the eight species of lanternfish taken, four were common, <u>Hierops thompsoni</u>, <u>Diaphus theta</u>, <u>Tarletonbeania crenularis</u>, and <u>Lampanyctus leucopsarus</u> and four were much less frequent, <u>Tarletonbeania taylori</u>, <u>Lampanyctus ritteri</u>, <u>Lampanyctus regalis</u> and <u>Lampanyctus nannochir</u>. Depth distribution and vertical migration varied appreciably with species.

On Cruise 65-7 the largest catches of <u>Hierops thompsoni</u> were made in the daytime at 230-275 m in the main scattering layer. The numbers caught decreased progressively in the deeper hauls (275-320 m and 320-365 m) still within this layer. In the one haul from 230-275 m when the main layer lay below this depth range the numbers, while still relatively high were only one-third to one-half those when the layer lay in this depth range. Again, in 320-365 m, although the numbers involved are considerably smaller, more were taken when the layer lay at this depth than when it lay above it (90 individuals compared to 75). At night the largest catches of this species were made in about the same depth range as the largest daytime catches but were now from below the main layer. The numbers caught were only about one-third the daytime level. The catches in the main layer at 140-185 m were considerably larger than daytime catches at this depth, although smaller than those from 230-275 and 275-320 m and below the main layer.

Catches of this species on Cruises 64-6 and 64-12 show the same general pattern of distribution. While the numbers caught were considerably less than in 1965 and the depths fished somewhat shallower, down to about 275 m, more were again taken from the main layer than from above or below it. At night there was again an indication of movement towards the surface with the layer.

On Cruise 65-7 the largest catches of Diaphus theta were two taken in the daytime at about 365 m, one from the main layer, the other from just below it. Of the two the former was the larger by about one-third. Below 365 m daytime catches were small. Relatively large catches were also made in the main layer at 230-275 m. Catches at this depth but above the main layer were again small. None were taken shallower. At night the largest catches were from the main layer but at a depth of 140-185 m. Catches from the second layer at 90-140 m were also relatively large, about one-half those in the main layer. Catches from 275-320 m but below the main layer were about one-third as large as those in it.

On the other two cruises the largest daytime catches were again made in the main layer but from somewhat shallower depths (185-230, and 230-275 m). Only one tow was made to depths greater than 275 m, this was the deep tow to about 730 m. The number of D. theta caught was small. At night on both cruises more were taken at 90-140 m just above the main layer, and in the second layer than in the main layer. In October (Cruise 64-12) a large catch was made at the surface at night.

Lampanyctus leucopsarus was not as numerous in the catches as either H. thompsoni or D. theta. The largest individuals were most abundant in the two deep hauls to below 550 m. Excluding these hauls, more of this species were taken in the day in the main layer than above or below it and more were taken when the layer was at about 230-275 m than when it was deeper. At night an upwards movement occurred. On Cruise 65-7 concentrations were found at night in the main layer at 140-185 m - as compared to the daytime level of 230-275 m - and increased numbers at 90-140 m. The numbers taken in 230-275 m but now below the main layer, while still relatively large were less than in the daytime. On Cruise 64-6 there was a night-time concentration in the second layer at 50-75 m and on Cruise 64-12 at the surface.

The numbers of Tarletonbeania crenularis taken were considerably smaller than of the three preceding species. However, once again more were generally taken from the main layer than from above or below it. In one case where significant numbers were taken below the main layer, over twice as many were taken in another haul from the same depth but in the main layer. There were indications of upwards dispersion at night.

Of the four less frequent species, it would appear from the small numbers taken that Tarletonbeania taylori resembled T. crenularis in distribution and Lampanyctus ritteri resembled L. leucopsarus. L. regalis may be a deeper water form than either L. leucopsarus or L. ritteri. It occurred mainly in the two deep daytime hauls and in the deeper night-time hauls. L. nannochir was only taken in two tows. This species may be synonymous with L. leucopsarus (Chapman, 1940).

The viperfish Chauliodus macouni, a stomiatoid, was the only species other than myctophids taken regularly in appreciable numbers. While more were taken in the main layer than above it, the greatest numbers were taken during the day below this layer in depths of 365-455 m. At night fewer were taken below the main layer than in the day and some appeared in catches above the main layer and in the second and surface layers, showing there was considerable vertical migration.

Another stomiatoid, the melanostomiatid Tactostoma macropus was taken fairly frequently, mainly at night or in the day in deep hauls below 365 m. It was apparently more abundant and had a shallower depth range in the late fall than in summer.

Five species of argentinid were taken. The two deep tows yielded not only all five species but also the greatest quantities. In these hauls Bathylagus milleri and B. pacificus were numerous. The latter species also occurred in the deeper night tows to 230-275 m. B. ochotensis was taken on only one occasion during the day, but at night, especially on Cruise 64-12 (late October), it occurred from the surface downward. Nansenia candida was taken in the daytime mainly in hauls below 320 m while at night it appeared more numerous in the upper 140 m. Only a single specimen of Leuroglossus stilbius was taken, in one of the deep hauls.

The depth distribution of the various species of fish caught tend to follow the same general pattern as the sound scattering layers. During the daytime there was a definite main layer, distinct and continuous, at about 275 m, but varying at times from 230 to 365 m. One and sometimes two secondary layers occurred above the main layer and these were much less distinct and generally intermittent. At times there was a faint deep layer below the main layer. At night pronounced changes occurred. The main layer rose toward the surface and frequently split. A portion, generally not very intense, sometimes remained behind at the daytime level. The migratory portion moved towards the surface crossing and apparently reinforcing the secondary layers. It was not apparent whether or not this layer entrained parts of the secondary layers in its upwards sweep. There was some suggestion from the increased intensity of the secondary layers that part of the main migrating layer may have remained with these layers while part migrates through them towards the surface. During the day the largest catches were from below 185 m, generally from the same depth as the main layer. Catches above the main layer tended to be very small. Different species apparently had different depth preferences. The maximum catches of H. thompsoni were from 230-275 m coincident with the presence of the main layer at this depth, while the largest catches of D. theta were from 310-365 m, again at a time when the main layer lay at that depth. At night there was less tendency for large catches to be made at a particular depth - such catches sometimes smaller than the maximum daytime catches were made over a wider range of depths - from the daytime depth of the main layer, from the main layer, and from the generally intensified secondary layer.

It would thus appear that certain species of the more common bathypelagic fish are associated with the sound scattering layers and tend to maintain this relationship at night as well as in the day. Concentrations of fish apparently also occurred below the main layer at depths where no sound scattering layers were detected. Because of the greater depth these concentrations could be almost as dense as those of the main layer and still not provide a detectable echo. Fish were not the only organisms in the scattering layers. Invertebrates, mainly coelenterates, which may or may not reflect sound waves, were numerous in most hauls. Sergistid prawns were taken in a number of the deeper hauls. Several forms of small squid were taken but never in quantity. Smaller zooplankton were not taken. However the mesh of the net was probably too large (codend mesh size 2.0 cm) to retain in quantity zooplankton smaller in size than euphausiids. The latter were observed entangled in the web in some tows from the continental shelf.

II. Unusual species and range extensions

On the three cruises a total of 90 species in 39 families (Table II) were caught, including 8 not recorded before from British Columbia. Range extensions and uncommon species are described in more detail in another report (Taylor, 1967a, MS) and are mentioned here only briefly:

1. Sagamichthys abei (?) Parr, 1953 - a single specimen, most probably of this species was taken from a depth of 510-595 m. A second specimen, a juvenile, in damaged condition taken in 185-275 m, was tentatively referred to this species. Lavenberg and Grinols (MS 1965) have reported S. abei from the Antarctic, off Japan, California, Oregon, and Washington and questionably off British Columbia.

2. Bathylagus ochotensis (Schmidt, 1938). A total of 19 specimens were taken in the open ocean hauls in 1964 and 1965, at depths from near the surface to 825 m. The first record of this species off British Columbia was from about 340 miles[5] west of Kyuquot Sound (50°N 135°W) by McAllister (1959). Aron (1960) collected 967 specimens between southern California and the Aleutian Islands, of these 53 could be considered as taken off British Columbia and two near the Aleutian Islands.

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[5]Miles used are nautical miles and equivalent to 1.85 km.

3. Nansenia candida Cohen, 1958 - a total of 22 specimens were taken from south and west of the Queen Charlotte Islands in 1964 and 1965 at depths ranging from 100 to 825 m. In addition 36 more specimens recorded as Nansenia sp. were taken in the same area in 1965. This species was first recorded off the British Columbia coast by McAllister (1959) from 50°N Lat., 135°W Long. Aron (1960) reported one specimen from 45°46'N, 146°25'W. Of specimens he listed as Nansenia sp. none are reported north of 50°N, 55 between 48°N and 50°N, and 30 south of 48°N. The present catches represent a range extension of about 400 miles.

4. Lampanyctus nannochir (Gilbert), 1891 - 44 specimens were identified in two hauls off the Queen Charlotte Islands (Tables I and II). There appears to be some doubt whether this species is distinct from L. leucopsarus. Bolin (1939) and Fraser-Brunner (1949) regard it so. Chapman (1940) could not separate the two species in a sample of over 1,100 specimens from southeastern Alaska and the Queen Charlotte Islands. Mrs. I. Radforth (personal communication) found that "only the fact that there were many L. leucopsarus (231) in the sample made the separation of the two species possible." If L. nannochir is a distinct species, these specimens are the only occurrence other than Chapman's of this species in British Columbia. It is not uncommon and has been reported from Alaska to northern California (Grinols MS).

5. Notolepis rissoi (Bonaparte), 1841 - 4 specimens were taken in an area 730-825 m, 230-255 m, and 155-185 m. Rofen (1966) considers that Notolepis coruscans (Jordan and Gilbert) is synonymous with Notolepis rissoi rissoi (Bonaparte). This species has previously been reported in the North Pacific from the Strait of Juan de Fuca (1), at Port Townsend, Washington, in Puget Sound (2), off California (6), and off Japan (1) (Rofen, 1966; Grinols, MS). The present specimens represent the first definite records of this species in British Columbia and a range extension of about 200 miles.

6. Scopelosaurus harryi (?) (Mead), 1953 - 2 specimens were taken off the Queen Charlotte Islands, one from a depth of 730-825 m, the other from 510-595 m. The species was previously known from the type taken off Iwate Prefecture, Japan (Mead and Taylor, 1953). The specimens have been referred to S. harryi; final confirmation will depend on the review of the family now in progress by N. B. Marshall of the British Museum.

7. Borodulina infans (?) (Gunther), 1878 - 4 specimens were taken in 1965, one about 30 miles S × W off Cape St. James in 220-275 m and the others about 50 miles southwest of Tasu Sound in 510-595 m. These are the first records for this species in British Columbia and extend the range north from the Gulf of Panama. The specimens differ from Bordulina gilli reported by Chapman (1940) from northern British Columbia in having more dorsal rays (300-350 instead of 260), more anal rays (265-270 instead of 205) and more lateral line pores (188-191 instead of 156) but agree with B. infans in these characters and also in certain body proportions. Whitley (1931) states that Avocettina 1888, Jordan and Davis (Pisces) is preoccupied by Avocettina, Mulsant and Verreaux 1866 (Aves), and provides a substitute name Borodulina Whitley 1931.

8. Serrivomer jesperseni Bauchot-Boutin, 1953 - one specimen was taken from a depth of 730-825 m. The nearest previous record was from the Gulf of Panama, some 2600 miles to the south. This specimen was compared with the

descriptions in the latest revision of the genus by Bauchot (1959) and Bauchot-Boutin (1953-1954). It agrees in dentition type, anal and caudal fin ray counts, and number and arrangement of branchiostegal rays. It differs in having 132 instead of 147-170 dorsal rays.

9. Caristius macropus (Bellotti), 1903 - a single specimen was taken 50 miles southwest of Tasu Sound from a depth of 265-280 m. This represents the second specimen recorded from British Columbia and the eastern north Pacific Ocean. The other specimen was taken from 389 m SSW of Estevan Point on Vancouver Island (Welander, Alverson and Bergman, 1957).

10. Oneirodes eschrichti group (Bertelsen), 1957 - a single specimen was taken 50 miles southwest of Tasu Sound on July 11, 1965, from a depth of 510-595 m. This is the second specimen from British Columbia. The first was taken in 1934 west of Graham Island. It was described by Chapman (1939) as Oneirodes bulbosus. Bertelsen (1951) grouped together a number of species of the genera Oneirodes and Dolopichthys into the Oneirodes eschrichti group pending the collection of more specimens.

11. Oneirodes acanthias (Gilbert), 1915 - a single specimen was taken in the same haul as the specimen of O. eschrichti group. It is the first record of this species from British Columbia; although it has been taken in the Gulf of Alaska. Bertelsen (1951) synonymizes Dolopichthys thompsoni Schultz, 1934, with Oneirodes acanthias (Gilbert, 1915). The former was described from the Gulf of Alaska, the latter from California. Two additional specimens have been taken off California.

12. Chaenophryne cf. parviconus Regan and Trewavas, 1932 - the damaged head is all that remains of a ceratioid taken from 730-825 m, 30 miles southwest of Cape St. James. From the shape of the operculum and suboperculum (Bertelsen, 1951) it would appear to belong to genus Chaenophryne rather than to Oneirodes, a genus known to occur in British Columbia. Grinols (MS) has reported C. parviconus from Oregon. On geographic grounds this head is referred to that species. The specific diagnostic characters are missing.

13. Paricelinus hopliticus Eigenmann and Eigenmann, 1889 - a specimen was taken in a haul on the Middle Bank in Queen Charlotte Sound. This represents the second record of this species from British Columbia. The first was taken somewhat to the north near North Danger Rocks in Hecate Strait (Barraclough and Ketchen, 1963).

14. Malacottus kincaidi Gilbert and Thompson, 1905 - this species is commonly taken by bottom trawls in the Strait of Georgia at depths of 27-120 m (Clemens and Wilby, 1961). The capture of two specimens off the Queen Charlotte Islands, in midwater, one in 90-140 m, the other in 220-275 m, over depths of 1830-2200 m is of interest.

15. Bathyphilus flemingi Aron and McCrery, 1958 - 4 specimens were taken, 3 about 50 miles southwest of Tasu Sound, and one near the Bowie Seamount. Aron (1960) records the previous most northern records as 49°59'N, 138°14'W. These specimens extend the range north about 250 km.

SUMMARY

I. Sound scattering layers

A. The surface layer

This layer was always present both in coastal waters and in the open ocean. It varied considerably in intensity and thickness frequently appearing as a double layer. It was less intense in the day than at night, in late autumn than in summer, in inlets and over banks than around the banks or in the open ocean. From its behaviour the surface layer appeared to be of biological rather than mechanical origin, and possibly due to concentration of the smaller zooplankton.

B. Midwater and near-bottom echoes

(1) Coastal waters - there appeared to be 3 general types of echo:

(i) A diffuse, soft rather formless layer. This layer is thought to be produced by echoes of larger zooplankton such as euphausiids. It was observed by itself on only 2 or 3 occasions but may have occurred more often in conjunction with other types of layer.

(ii) A homogeneous appearing layer in which the individual echoes when apparent are diffuse or blurred. This layer is probably produced by schools of herring or of similar small schooling fish.

(iii) Aggregations of separate dash-like traces. As the schools become more dense the dashes merge to form short streaks or blotches, and the traces develop a more diffuse appearance. This type of echo was widespread with concentrations in the gullies around the Goose Island Bank and southeast of the Sea Otter group, in McIntyre Bay, off the northwest shore of Graham Island, in some inlets on the west coast of the Queen Charlotte Islands and on the Bowie Seamount. Echoes of this type appeared to be associated with concentrations of demersal fish such as rockfish, whiting and possibly Pacific cod. Layers of this type were observed to rise from the bottom at night and to ascend toward the surface.

(2) Open ocean layers - 4 sound scattering layers in addition to the surface layer were distinguished but not all were necessarily present at the same time.

(i) The first layer when present lay between 75 and 130 m, generally at about 90 m. This layer was the least intense and the most intermittent of the four.

(ii) The second layer was generally centred at about 185 m, but varied between 145 and 220 m. This layer was generally but not always present and was considerably less intense than the main layer.

(iii) The third or main layer varied in depth between 220-330 m and usually lay at about 275 m. It was the most intense and persistent layer.

(iv) The fourth layer lay between 330-400 m. It was generally faint and rather intermittent.

At dusk the main layer in particular rose toward the surface, passing through the upper layers, and often splitting into 3 sections. It tended to fade out at about 75-90 m. At dawn the layer reformed and sank. It was not clear whether the second layer also moved upwards at dusk. Part may have been carried up with the main layer but part was not affected. Two observations on the behaviour of the deep layer were made. In some instances there were suggestions of vertical movement.

II. Catches

A. Coastal banks

(1) Catches from the Goose Island and Middle Banks were very small, consisting usually of no more than a few fish.

(2) Bottom catches, mainly sandlance (Ammodytes hexapterus), and some herring (Clupea pallasii) were larger than midwater or surface catches, mainly salmon (Oncorhynchus spp.).

B. Gullies

(1) Catches from the gullies around the banks were the largest made, due to the numbers of rockfish (mainly Sebastodes alutus) and whiting (Theragra chalcogramma) taken.

(2) In the gullies, the bottom catches were the largest, the surface catches the smallest. Rockfish and whiting dominated in both bottom and midwater catches; salmon, turbot (Atheresthes stomias) and blackcod (Anoplopoma fimbria) in the surface catches.

(3) Bottom and near-surface catches during the night were larger than those during the day. However in midwater for some reason not at present understood more whiting and rockfish (S. alutus, S. flavidus, and S. entomelas) were caught during the day than at night, and hence day catches were larger. In the surface catches, more salmon were taken at night than during the day. Turbot and blackcod were the dominant species in the surface catches at night. The great proportion of turbot taken occurred in these catches.

* C. Queen Charlotte Islands inlets

Here aside from one large catch of herring, small flatfish of various species were the dominant group. Because of the numbers involved and the short time available these flatfish were only roughly sorted and not counted. Eelpouts (family Zoarcidae) were also numerous. However no attempt was made to sort or identify them. The most interesting feature of a number of the inlet catches was the presence of numbers of 0-group rockfish, mainly ocean perch (S. alutus).

D. Open ocean catches

(1) The species composition of open ocean catches from the continental slope and borderland differed markedly from those from inshore localities. Lanternfish were the most common group, next came the viperfish, Chauliodus macouni, and then the argentinids. The lanternfish were mainly of two species, Hierops thompsoni and Diaphus theta, two other species, Lampanyctus leucopsarus and Tarletonbeania crenularis were fairly numerous. Three other species of Lampanyctus and one of Tarletonbeania occurred occasionally. Six species of argentinid were taken, Bathylagus pacificus and B. milleri were the two most common. Rockfish were occasionally taken even in hauls 730-825 m in 2380 m of water. They were mainly Sebastodes aleutianus.

(2) Tables IV and V show the catches per hour of the more common species by day and night in relation to the sound scattering layers and to depth. The depth distribution of the various species is discussed in more detail in another report (Taylor, 1967b, MS) and are only presented in summary form there.

(i) More of the lanternfish H. thompsoni and D. theta were caught in the main sound scattering layers than above or below it. The latter species, however, was also numerous in catches from below the main layer. Most of the Lampanyctus leucopsarus were caught below the main layer. The viperfish, Chauliodus macouni, and the argentinids were also more numerous below the main layer than in or above it.

(ii) Diurnal migration, although shown by nearly all species, was more pronounced in some than in others. Night catches from below 185 m tended to be smaller than day catches, while those from above 185 m tended to be larger. In the daytime the largest catches of Diaphus theta were made between 365 and 455 m, at night between 140 and 185 m. In the daytime Hierops thompsoni was apparently most numerous between 185 and 275 m, at night catches were smaller and no pronounced concentrations encountered. Lampanyctus leucopsarus was most numerous in the daytime deep hauls below 455 m. At night there was evidence of a vertical migration extending into the upper 185 m of water. The viperfish (Chauliodus macouni) was most numerous in catches from 365 m or deeper. At night more were taken in the upper 365 m than in the daytime. Argentinids were more numerous in the hauls deeper than 455 m than in shallower hauls.

E. Catches from the vicinity of seamounts

The catches from near the Dellwood Hills were typical of other open ocean catches, as were the catches from deep water near the Bowie

Seamount. The echosounder showed the presence of large schools of fish on or near the bottom on the Bowie Seamount itself. However, the very rough bottom with numerous high peaks effectively prevented trawling on or near the bottom. Attempts were made but were largely unsuccessful. Handline fishing with large jigs took several halibut from 20-90 kg each and numerous large rockfish (Sebastodes ruberrimus, S. paucispinus, S. aleutianus, and S. helvomaculatus).

III. Unusual species and range extensions

A total of 90 species in 39 families were caught. Of these, 8 have not been recorded previously off British Columbia, and 5 have been recorded only once before. The 8 new B.C. records are: Sagamichthys abei, Lampanyctus nannochir, Notolepis rissoi rissoi, Scopelosaurus harryi, Borodulina infans, Serrivomer jesperseni, Oneirodes acanthias and Chaenophryne cf. parviconus. Second records for B.C. are: Bathylagus ochotensis, Nansenia candida, Caristius macropus, Oneirodes eschrichti-group and Paricelinus hopliticus.

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Table I. The location, date, time and other pertinent information on each haul made during G.B. Reed midwater trawl cruises 64-6, June 8-23, 1964, 64-12, October 25-November 15, 1964, and 65-7, July 8-18, 1965, south and west of the Queen Charlotte Islands.

Haul No.	Locality	Position Lat. N.	Position Long. W.	Date	Time of setting (PST)	Duration (min)	Net used	Depth of water (m)	Depth of net (m)	Net in relation to target	Catch[a] (kg or no.)
Cruise 64-6											
1	SE edge Goose Is. bank	51°26'	128°52'	9/6/64	1030	105	Engel	157-187	40-68 77-104	In and above midwater schools	(984)
2	SE edge Goose Is. bank	51°26'	128°52'	9/6/64	1400	40	Engel	198-205	9-37[b]	In and above near bottom schools	(379)
3	SE edge Goose Is. bank	51°26'	128°50'	9/6/64	2107	45	Engel	163-168	18-64	In and below surface layer	(27)
4	Goose Is. bank	51°34'	129°15'	10/6/64	1125	45	Engel	44-51	9-37	In surface layer	Trace
5	Goose Is. bank	51°32'	129°15'	10/6/64	1345	45	Engel	48-51	0-27	Schools very sparse	Trace
6	Goose Is. bank	51°35'	129°18'	10/6/64	2115	35	Engel	57	9-45	In surface layer	(23)
7	SE edge Goose Is. bank	51°21.5'	129°20'	11/6/64	2033	45	Engel	156-190	73-101	Above midwater schools	(27)
8	SE edge Goose Is. bank	51°21'	129°16'	11/6/64	2203	47	Engel	183-205	9-37	In surface layer	(23)
9	SW edge Goose Is. bank	51°36'	129°33'	12/6/64	1145	45	Engel	59-81	9-37	Above bottom schools	(14)
10	SW edge Goose Is. bank	51°35'	129°30'	12/6/64	1345	30	Engel	59-62	9-37	In surface layer	(2)
11	Gully-Goose Is.-Middle Bk.	51°45'	129°45'	12/6/64	1948	45	Engel	273-307	92-119	In midwater schools	(20)
12	Middle Bank	52°00'	129°56'	13/6/64	1215	45	Engel	117-121	18-45	In diffuse bottom schools	Trace
13	Middle Bank	51°59'	129°56'	13/6/64	1340	45	Engel	108-121	18-73	In and below surface layer	0
14	Middle Bank	51°57'	129°43'	13/6/64	1825	45	Engel	128	37-64	Midwater schools very sparse	(5)
15	30-40 miles SE Cape St. James	51°41'	130°15'	14/6/64	1145	45	Engel	275-476	110-137	Above main layer	0
16	30-40 miles SE Cape St. James	51°39'	130°17'	14/6/64	1305	45	Engel	485-695	174-201	In main layer	(5)
17	30-40 miles SE Cape St. James	51°38'	130°05'	14/6/64	1702	46	Engel	329	156-201	In main layer	(1)
18	30-40 miles SE Cape St. James	51°33'	130°15'	14/6/64	1938	37	Engel	860-988	37-64	Below surface layer	0

continued ...

Table I (continued)

Haul No.	Locality	Position		Date	Time of setting (PST)	Duration (min)	Net used	Depth of water (m)	Depth of net (m)	Net in relation to target	Catch[a] (kg or no.)
		Lat. N.	Long. W.								
19	30-40 miles SE Cape St. James	51°34'	130°17'	14/6/64	2058	30	Engel	659-824	9-27	In surface layer	0
20	35 miles S × W Cape St. James	51°22'	131°10'	15/6/64	1200	60	Engel	?	238-284	In main layer	Trace
21	35 miles S × W Cape St. James	51°26'	131°09'	15/6/64	1410	115	Engel	288-2379	732-825	Below main layer	(45)
22	35 miles S × W Cape St. James	51°25'	131°04'	15/6/64	1950	45	Engel	2,214-2,244	183-229	In to below main layer	Trace
23	35 miles S × W Cape St. James	51°26'	131°06'	15/6/64	2115	30	Engel	2,244	9-37	In surface layer	Trace
24	Gully off Hakai Passage	51°39.5'	128°23.5'	16/6/64	1140	45	Engel	139	0-27	In and above bottom schools	(312)
25	Gully off Hakai Passage	51°45'	128°27'	16/6/64	1230	45	Engel	135-139	9-37	In surface layer	(+)
26	Gully off Hakai Passage	51°42'	128°15'	16/6/64	1520	42	Engel	121	55-82	In midwater schools	(295)
27	Gully off Hakai Passage	51°39'	128°32'	16/6/64	1903	47	Engel	139	0-27	In bottom schools	(1,933)
28	Gully off Hakai Passage	51°41'	128°18'	16/6/64	2126	30	Engel	128-139	0-27	In surface layer	(51)
29	SW Goose Is. bk.	51°57'	128°39'	18/6/64	1145	57	Engel	139-150	0-27	In occasional bottom schools	(119)
30	SW Goose Is. bk.	51°55'	128°38'	18/6/64	1330	45	Engel	88-150	9-37	In surface layer	Trace
31	SW Goose Is. bk.	51°59'	128°39'	18/6/64	1942	46	Engel	157-159	101-128	In midwater schools	(82)
32	SW Goose Is. bk.	51°57'	128°36'	18/6/64	2125	30	Engel	157	9-37	In surface layer	(38)
33	Gully-Goose Is.-Middle Bank	51°57'	129°24'	19/6/64	1130	50	Engel	209-214	9-27	In midwater schools	(265)
34	Gully-Goose Is.-Middle Bank	51°54'	129°24'	19/6/64	1305	50	Engel	210-216	9-37	In surface layer	(+)
35	SW corner Goose Is. bank	51°47'	129°22'	19/6/64	2005	45	Engel	159-178	64-92	In diffuse midwater schools	(9)
36	SW corner Goose Is. bank	51°50'	129°21'	19/6/64	2130	45	Engel	123-152	9-37	In surface layer	(43)
37	50 miles S × E Cape St. James	51°17'	130°10'	20/6/64	1200	50	Engel	640-677	238-265	In main layer	(9)
38	50 miles S × E Cape St. James	51°16'	130°07'	20/6/64	1635	35	Engel	695-915	9-37	In surface layer	(6)

continued ...

Table I (continued)

Haul No.	Locality	Position		Date	Time of setting (PST)	Duration (min)	Net used	Depth of water (m)	Depth of net (m)	Net in relation to target	Catch[a] (kg or no.)
		Lat. N.	Long. W.								
39	50 miles S × E Cape St. James	51°16'	130°09'	20/6/64	1811	46	Engel	915-979	174-210	In main layer	(86)
40	50 miles S × E Cape St. James	51°16'	130°07'	20/6/64	2122	45	Engel	860-1,190	101-128	In diffuse 2nd layer	(6)
41	Dellwood Hills	50°43'	130°50'	21/6/64	1135	45	Engel	1,052-1,464	210-229	In main layer	(5)
42	Dellwood Hills	50°40'	130°50'	21/6/64	1320	30	Engel	769-1,373	156-183	Above main layer	(1)
43	Dellwood Hills	50°43.5'	130°51'	21/6/64	1438	38	Engel	878-1,061	27-55	In surface layer	0
44	50 miles S × W Cape St. James	51°07'	131°04'	22/6/64	1130	45	Engel	2,379	229-256	In main layer	(9)
45	50 miles S × W Cape St. James	51°04.5'	131°06'	22/6/64	1415	45	Engel	2,425	156-183	Above main layer	(1)
46	50 miles S × W Cape St. James	51°08'	130°58'	22/6/64	2039	49	Engel	2,288-2,378	110-174	In main layer	(2)
47	70 miles S × E Cape St. James	51°05'	129°48.5'	23/6/64	1205	50	Engel	695-860	210-238	In main layer	(9)
Cruise 64-12											
1	SE edge, Goose Is. bank	51°26'	129°00'	27/10/64	1649	61	Engel	117	?	?	Trace
2	40 miles S × E Cape St. James	51°21.8'	130°23.5'	28/10/64	1817	30	Engel	1,409-1,556	?	?	(23)
3	16 miles W, Cape St. James	51°59.6'	131°22'	29/10/64	1327	46	Engel	1,830	178-199	In main layer	(4)
4	16 miles W, Cape St. James	51°53.3'	131°19'	29/10/64	1505	46	Engel	1,830	110	Above main layer	Trace
5	16 miles W, Cape St. James	51°56'	131°24.6'	29/10/64	2047	45	Engel	1,921	139-187	In main layer	(4)
6	16 miles W, Cape St. James	51°57'	131°27'	29/10/64	2212	45	Engel	1,830	92-137	Just above main layer	(9)
7	Dixon Entrance	54°11.5'	132°16'	7/11/64	1909	31	Engel	110-121	0-27	In and above bottom schools	(36)
8	Dixon Entrance	54°11.5'	132°19'	7/11/64	2021	31	Engel	121-124	5-22	In surface layer	(9)
9	Port Chanal	53°36'	132°55'	8/11/64	1520	15	Gulf shrimp	128	128	-	(227)
10	Port Chanal	53°36'	132°54'	8/11/64	1614	12	Gulf shrimp	117	117	-	(136)

continued ...

Table I (continued)

Haul No.	Locality	Position		Date	Time of setting (PST)	Duration (min)	Net used	Depth of water (m)	Depth of net (m)	Net in relation to target	Catch[a] (kg or no.)
		Lat. N.	Long. W.								
11	Port Chanal	53°36.5'	132°55.5'	9/11/64	0920	26	Engel	97-128	0-37	In and above bottom schools	(834)
12	Marble Island	53°10'	132°41.4'	10/11/64	1055	9	Engel	172-183	0-37	In and above bottom schools	Trace
13	Skidegate Channel	52°00'	132°00'	10/11/64	1432	16	Gulf shrimp	128-135	128-135	-	(363)
14	Skidegate Channel	52°00'	132°00'	11/11/64	0905	27	Gulf shrimp	124-146	9-27	Above bottom	0
15	Skidegate Channel	52°00'	132°00'	11/11/64	0958	27	Gulf shrimp	121-146	9-18	Above bottom	0
16	Marble Island	53°10'	132°41.4'	11/11/64	1225	7	Gulf shrimp	183	5-11	Above bottom	0
17	Fairfax Inlet (Tasu Sound)	52°00'	132°00'	12/11/64	1110	16	Gulf shrimp	128-181	128-181	-	(908)
18	Gowgaia Bay	52°00'	131°00'	13/11/64	1348	12	Gulf shrimp	55-81	55-81	-	(363)
19	Gowgaia Bay	52°00'	131°00'	13/11/64	1438	14	Gulf shrimp	40-55	40-55	-	(545)
20	Gowgaia Bay	52°00'	131°00'	13/11/64	1537	15	Gulf shrimp	55-77	55-77	-	(363)
21	Houston Steward Channel	52°00'	131°00'	14/11/64	1600	5	Gulf shrimp	38-51	38-51	-	(36)
Cruise 65-7											
1	35 miles SW Cape St. James	51°32'	131°42'	8/7/65	1240	33	No. 2 Engel	2,470	68-73	Above upper layer	4
2	35 miles SW Cape St. James	51°33'	131°35'	8/7/65	1418	32	No. 2 Engel	2,470	245-293	Above main layer	180
3	35 miles SW Cape St. James	51°35'	131°41'	8/7/65	1638	30	No. 2 Engel	2,379	157-194	In 2nd layer	3
4	35 miles SW Cape St. James	51°36'	131°40'	8/7/65	1830	30	No. 2 Engel	2,379	92-110	Between upper and 2nd layers	1
5	35 miles SW Cape St. James	51°36'	131°41'	8/7/65	2105	30	No. 2 Engel	2,379	128-143	In 2nd layer	133
6	35 miles SW Cape St. James	51°32'	131°44'	9/7/65	1147	48	No. 2 Engel	2,333	340-392	Below main layer	759
7	35 miles SW Cape St. James	51°31'	131°39'	9/7/65	1352	48	No. 2 Engel	2,288	238-293	In main layer	1,038

continued ...

Table I (continued)

Haul No.	Locality	Position		Date	Time of setting (PST)	Duration (min)	Net used	Depth of water (m)	Depth of net (m)	Net in relation to target	Catch[a] (kg or no.)
		Lat. N.	Long. W.								
8	35 miles SW Cape St. James	51°28'	131°34'	9/7/65	1638	30	No. 2 Engel	2,379	183-201	Above main layer	17
9	35 miles SW Cape St. James	51°30'	131°36'	9/7/65	1824	30	No. 2 Engel	2,288	146	In 2nd layer	7
10	35 miles SW Cape St. James	51°30'	131°34'	9/7/65	2022	29	No. 2 Engel	2,196	154-183	In main layer	364
11	35 miles SW Cape St. James	51°29.5'	131°03'	9/7/65	2146	30	No. 2 Engel	2,196	275-311	Below main layer	246
12	35 miles SW Tasu Sound	52°21'	133°12'	10/7/65	1337	52	No. 2 Engel	2,516	348-392	In main layer	1,023
13	50 miles SW Tasu Sound	52°18'	133°13'	10/7/65	1550	30	No. 2 Engel	2,745	275-285	In main layer	525
14	50 miles SW Tasu Sound	52°17'	133°11'	10/7/65	1728	30	No. 2 Engel	2,745	139-165	Above main layer	0
15	50 miles SW Tasu Sound	52°16'	133°12'	10/7/65	1840	30	No. 2 Engel	3,550	55-62	In upper layer	1
16	50 miles SW Tasu Sound	52°15'	133°10'	10/7/65	2032	30	No. 2 Engel	2,654	172-183	In main layer	36
17	50 miles SW Tasu Sound	52°17'	133°10'	10/7/65	2153	30	No. 2 Engel	2,654	256-275	Below main layer	208
18	50 miles SW Tasu Sound	52°11'	133°08'	11/7/65	1320	30	No. 2 Engel	2,654	366-406	Below main layer	91
19	50 miles SW Tasu Sound	52°11'	133°11'	11/7/65	1500	65	No. 2 Engel	2,654	572-597	Below deep layer	1,435
20	50 miles SW Tasu Sound	52°13'	133°12'	11/7/65	1734	30	No. 2 Engel	2,608	399-439	In deep layer	53
21	50 miles SW Tasu Sound	52°14'	133°12'	11/7/65	2013	30	No. 2 Engel	2,608	209-238	In main layer	81
22	50 miles SW Tasu Sound	52°15'	133°11'	11/7/65	2135	30	No. 2 Engel	2,608	99-121	In main layer	80
23	Bowie Seamount	53°18'	135°38'	13/7/65	1152	30	No. 2 Engel	468	73-92	Above upper layer	1
24	Bowie Seamount	53°18'	135°40'	13/7/65	1300.	30	No. 2 Engel	403	73-110	Above peak	36
25	Bowie Seamount	53°16'	135°40'	13/7/65	1437	42	No. 2 Engel	348	73-102	Above peak	--
26	Bowie Seamount	53°18'	135°37'	13/7/65	1728	30	No. 2 Engel	1,464	384-432	Below main layer	273

continued ...

Table I (continued)

Haul No.	Locality	Position		Date	Time of setting (PST)	Duration (min)	Net used	Depth of water (m)	Depth of net (m)	Net in relation to target	Catch[a] (kg or no.)
		Lat. N.	Long. W.								
27	Bowie Seamount	53°16'	135°34'	13/7/65	1858	32	No. 2 Engel	915	307-329	In main layer	223
28	Bowie Seamount	53°18'	135°41'	13/7/65	2152	20	No. 2 Engel	220	59-73	Above peak	46
29	Bowie Seamount	53°18'	135°38'	14/7/65	1642	10	No. 4 B-J	483	92-117	In 2nd layer	0
30	Bowie Seamount	53°18'	135°40'	14/7/65	1939	26	No. 4 B-J	128	55-92	In and above near bottom school	0
31	Bowie Seamount	53°18'	135°40'	14/7/65	2055	26	No. 4 B-J	137	58-99	Above bottom	0
32	50 miles SW Tasu Sound	52°20'	133°10.7'	18/7/65	1237	30	No. 4 B-J	2,654	329-366	Above main	32
33	50 miles SW Tasu Sound	52°18.3'	133°10.7'	18/7/65	1425	30	No. 4 B-J	2,654	220-256	In 2nd layer	60
34	50 miles SW Tasu Sound	52°19.5'	133°10.7'	18/7/65	1642	30	No. 4 B-J	2,654	44-73	Above upper layer	0
35	50 miles SW Tasu Sound	52°17'	133°10'	18/7/65	1753	30	No. 4 B-J	2,654	124-132	Between upper and 2nd layers	0

[a]Figures in parentheses are estimated weights of catches in kilograms; other figures are estimated size of catch in numbers of fish.

[b]Figures underlined represent distance from the bottom in metres; other figures represent depth below the surface in fathoms.

Table II. The species of fish caught on the G.B. Reed midwater trawl cruises 64-6, 64-12, and 65-7, the hauls in which each species occurred, and the number per haul[a].

Family	Species	Type of locality	Haul number with number, or weight in lb (underlined figures), of specimens in parentheses
Petromyzonidae	Entosphenus tridentatus	slope	A-39(1)
Squalidae	Squalus acanthias	bank, gullies, inlets	A-4(1), 8(1), 28(1); B-7(1), 17(3), 18(4), 19(3), 20(1); C-13(1)
Rajidae	Raja sp.	bank, inlets	B-9(1), 20(1)
Chimaeridae	Hydrolagus colliei	bank, inlets	A-9(1); B-7(7), 9(few), 13(65), 17(12), 19(4), 20(4), 21(19)
Clupeidae	Clupea pallasii	bank, gullies, inlets	A-6(8), 9(79), 28(24); B-9(18), 10(2), 11(1838), 12(14 J)[b], 20(298 J)
Searcidae	Sagamichthys abei (?)	borderland	C-13(1), 19(1)
Salmonidae	Oncorhynchus gorbuscha	bank, gully, borderland	A-6(17), 8(1), 25(1), 34(1), 36(6), 44(4)
	Oncorhynchus kisutch	bank, gully	A-10(1), 30(1), 34(1), 36(1); B-1(1)
	Oncorhynchus tshawytscha	bank, gully	A-1(2), 8(7), 9(1)
	Oncorhynchus keta	bank, gully	A-6(3), 26(2), 32(1)
	Oncorhynchus nerka	bank	A-10(1)
Osmeridae	Thaleichthys pacificus	gully	A-8(1), 28(1), 33(5); B-7(many juv.), 8(many juv., 9 adults)
Argentinidae	Leuroglossus stilbius	borderland	C-19(1)
	Bathylagus pacificus	borderland	A-21(117); C-19(95)
	Bathylagus milleri	borderland	A-21(2); C-11(7), 17(15), 19(99)
	Bathylagus ochotensis	borderland, slope	A-21(1), 40(3); B-2(9), 5(1), 6(1); C-11(3)
	Macropinna microstoma	borderland	A-21(3); C-19(2), 20(2)
	Nansenia candida	borderland, slope	A-21(1), 40(1); C-5(4), 6(5), 17(1), 19(6), 22(5)
	Nansenia sp.	borderland	C-3(2), 5(2), 6(16), 11(1), 19(14), 20(1)
	Argentinid sp.	borderland	C-20(1), 26(1), 32(5)
Gonostomatidae	Cyclothone pacifica (microdon)	borderland	A-21(9); C-5(1), 19(2)
Melanostomiatidae	Bathophilus flemingi	borderland	B-2(2); C-12(1), 28(1)
	Tactostoma macropus	slope, borderland	A-21(34), 40(1); B-2(17), 4(4), 5(10), 6(12); C-11(7), 17(17), 18(1), 19(26), 20(7), 28(2)
Malacosteidae	Aristostomias scintillans	borderland	A-21(1); B-2(23), 4(1), 5(1), 6(2); C-18(1), 19(5)
Chauliodontidae	Chauliodus macouni	slope, borderland, seamount	A-20(13), 21(66), 22(43), 23(11), 37(1), 39(2), 40(6), 41(10), 46(7), 47(4); B-5(13), 6(6); C-6(38), 7(55), 8(1), 10(8), 11(16), 12(25), 13(24), 17(11), 18(15), 19(79), 20(22), 21(8), 26(120), 27(30), 28(40), 32(2), 33(2)
Myctophidae	Hierops thompsoni	slope, borderland, seamount	A-16(2), 20(39), 21(11), 22(30), 23(1), 37(22), 39(7), 40(2), 41(156), 46(11), 47(6); B-3(10), 4(3); C-2(141), 3(1), 5(5), 6(57), 7(511), 10(38), 11(62), 12(78), 13(238), 16(2), 17(53), 18(10), 19(5), 20(2), 21(25), 32(5), 26(32), 27(165), 28(6), 29(series), 32(1), 33(32)

continued ...

Table II (continued)

Family	Species	Type of locality	Haul number with number, or weight in lb (underlined figures), of specimens in parentheses
Myctophidae (cont'd)	*Diaphus theta*	slope, borderland, seamount	A-20(4), 21(78), 22(63), 23(9), 37(98), 39(5), 40(180), 41(160), 46(26), 47(11); B-2(290), 3(138), 4(13), 5(104), 6(204); C-2(9), 5(94), 6(552), 7(352), 10(184), 11(49), 12(799), 13(158), 16(30), 17(31), 18(44), 19(8), 21(34), 22(28), 26(60), 27(16), 28(13), 32(14), 33(14)
	Tarletonbeania crenularis	slope, borderland	A-21(12), 22(9), 37(4), 40(2), 41(21), 47(1); B-2(24), 3(3), 4(2), 5(2), 6(22); C-5(3), 6(28), 7(8), 8(1), 10(5), 11(13), 12(75), 13(4), 17(1), 21(1), 22(1), 26(12), 27(11), 28(1), 29(2), 33(5)
	Tarletonbeania taylori	borderland	C-2(2), 5(1), 6(1), 16(1), 21(1)
	Tarletonbeania sp.	borderland	C-2(6), 5(2), 6(9), 7(8), 10(2), 11(4), 12(21), 13(2), 16(1), 17(1), 19(1), 20(1); B-3(1)
	Lampanyctus leucopsarus	slope, borderland	A-17(1), 20(51), 21(249), 22(15), 37(10), 39(45), 40(96), 41(34), 46(62), 47(5); B-2(80), 4(1), 5(92), 6(77); C-2(12), 5(18), 6(24), 7(84), 10(114), 11(49), 12(16), 13(92), 16(2), 17(53), 18(10), 19(1030), 20(5), 22(31), 26(46), 27(1), 28(6), 33(7)
	Lampanyctus ritteri	borderland	B-5(17), 6(4); C-12(3), 13(1), 17(10), 18(8), 19(1), 21(1), 28(6)
	Lampanyctus nannochir	borderland	C-11(1), C-19(43)
	Lampanyctus regalis	borderland	A-21(146); B-5(2), 6(8); C-5(1), 11(17), 12(2), 17(7), 19(17)
Scopelarchidae	*Neoscopelarchoides dentatus*	slope, borderland	A-21(4), 37(1), 39(1); C-2(1), 6(1), 11(2), 12(1), 13(1), 19(17), 20(8)
Paralepidae	*Lestidium ringens*	borderland	A-23(2), 41(1), 45(3); B-2(3); C-4(1), 5(1), 10(2), 11(1), 20(1), 22(1), 26(1)
	Notolepis rissoi rissoi	borderland	A-21(2), 44(1); C-10(1)
Scopelosauridae	*Scopelosaurus harryi* (?)	borderland	A-21(1); C-19(1)
Anotopteridae	*Anotopterus pharao*	borderland	C-19(1)
Nemichthyidae	*Nemichthys avocetta*	borderland	B-6(1)
	Borodulina infans	borderland	C-19(4)
	Borodulina gilli	borderland	C-11(1)
Serrivomeridae	*Serrivomer jesperseni*	borderland	A-21(1)
Merluccidae	*Merluccius productus*	gully, slope	A-33(1), 37(9), 47(9); B-17(78)
Gadidae	*Gadus macrocephalus*	gully, inlet	B-9(3), 20(57)
	Theragra chalcogramma	bank, gully	A-1(210), 2(23), 3(49), 5(1 J), 7(1), 12(10 J), 13(4 J), 24(552), 26(1 J), 27(316), 28(1), 29(23), 31(143), 35(17); B-7(13), 8(7), 9(4), 13(22), 18(many juv.), 20(many), 21(1)
Caristiidae	*Caristius macropus*	borderland	C-17(1)
Melamphaidae	*Poromitra rugosus*	borderland	A-21(176); C-19(8)
	Melamphaes lugubris	borderland	A-21(30); C-11(9), 17(6), 18(1), 19(8), 28(1)
Bothidae	*Citharichthys sordidus*	inlet	B-18(14)

continued ...

Table II (continued)

Family	Species	Type of locality	Haul number with number, or weight in lb (underlined figures), of specimens in parentheses
Pleuronectidae	Atheresthes stomias	bank, gully, slope, inlets	A-8(6), 10(1 L)[c], 12(15 L), 13(1 L), 16(28 L), 17(8 L), 18(41 L), 19(99), 24(3), 26(12 L), 28(66), 31(16), 32(63), 34(12), 36(71); B-7(10), 8(3), 9(many), 10(many), 13(257), 17(many), 18(8), 19(some), 20(some)
	Hippoglossus stenolepis	inlet, seamount	B-20(1). Bowie Seamount hook and line (5).
	Hippoglossoides elassodon	gully, inlets	A-26(2 J); B-9(many), 10(many), 17(many), 18(23), 19(many), 20(many)
	Lyopsetta exilis	inlets	B-9(many), 10(many), 17(many), 18(22), 19(many), 20(many)
	Parophrys vetulus	inlets	B-7(64), 8(1), 18(19)
	Lepidopsetta bilineata	inlets	B-18(106), 19(many), 20(many)
	Microstomus pacificus	borderland, inlets	A-21(1 L); B-6(1 L), 13(several), 18(7)
	Eopsetta jordani	inlets	B-7(1)
	Glyptocephalus zachirus	gully, inlets	B-7(3), 18(3), 19(few), 20(few)
	Platichthys stellatus	inlet	B-20(few)
	Unidentified	borderland	A-16(1 L)
Embiotocidae	Cymatogaster aggregatus	inlet	B-19(many)
Centrolophidae	Icichthys lockingtoni	borderland	A-23(1); C-1(1)
Zaproridae	Zaprora silenus	borderland	A-45(1)
Anoplopomatidae	Anoplopoma fimbria	banks, gully	A-6(1), 7(1), 8(7), 9(2), 24(1), 28(5), 31(2), 32(120), 36(1); B-1(1), 7(1), 8(1), 9(132), 10(61), 13(28), 17(5), 18(16), 19(15), 20(120)
Hexagrammidae	Hexagrammos stelleri	inlet	B-21(2)
	Ophiodon elongatus	slope, inlet	A-39(1 J); B-21(1)
Scorpaenidae	Sebastodes aleutianus	borderland, seamount	A-21(3); B-7(7 J), 9 + 10(29 J); C-6(2), 11(1), 13(1), 18(1), 19(2), 20(1), 24(1), 26(1), hook and line Bowie Seamount (some)
	Sebastodes alutus	gully, slope	A-1(1102), 2(474), 11(13), 16(5), 17(2), 24(57), 25(1), 27(1361), 29(129), 31(1), 33(321), 37(6), 39(26), 42(1), 47(3); B-9 + 10 (52 J), 13(40 + 2), 17(44 J), 18(336 J), 21(204 J)
	Sebastodes brevispinis	bank, gully	A-14(2), 27(34), 29(5), 31(12)
	Sebastodes elongatus	gully	A-33(2)
	Sebastodes entomelas	gully, slope, seamount	A-26(333), 32(1), 39(4); C-24(35), hook and line Bowie Seamount (some)
	Sebastodes flavidus	gully	A-1(177), 2(20), 3(3), 7(58), 8(1), 11(2), 24(31), 26(3), 27(107), 29(5), 31(1), 32(21), 33(1); B-13(2)
	Sebastodes ciliatus (?)	gully	A-2(1), 1(33)
	Sebastodes helvomaculatus	seamount	Bowie Seamount, hook and line (some)
	Sebastodes melanops	gully	A-28(2)
	Sebastodes paucispinis	gully, seamount	A-1(1), 27(3); B-13(224), 19(59 J). Bowie Seamount, hook and line (some)
	Sebastodes pinniger	gully	A-29(1)

continued ...

Table II (continued)

Family	Species	Type of locality	Haul number with number, or weight in lb (underlined figures), of specimens in parentheses
Scorpaenidae (cont'd)	Sebastodes proriger	gully	A-24(1), 27(652)
	Sebastodes ruberrimus	gully, inlet, seamount	B-8(1 J), 9(1); Bowie Seamount hook and line (some)
	Sebastodes zacentrus	gully	A-11(1), 33(48); B-9 + 10(2 J)
	Sebastodes crameri	inlets	B-9 + 10(5 J), 17(2), 20(2)
	Sebastodes sp. (juvenile)	gully, borderland	C-1(1 J), 2(9 J), 5 (1 J), 6(26 J), 7(14 J), 8(14 J), 9(7 J), 10(10 J), 11(1 J), 12(1 J), 13(2 J), 20(1 J)
Cottidae	Hemilepidotus hemilepidotus	gully, slope	A-20(1), 26(1), 34(1)
	Paricelinus hopliticus	bank	A-12(1)
	Icelinus tenuis	inlet	B-21(1)
	Malacocottus kincaidi	borderland	B-6(1); C-11(1)
	Psychrolutes paradoxus	gully	B-7(3)
Agonidae	Asterotheca infraspinata	gully, inlets	B-7(1), 17(many)
Liparidae	Liparis fucensis	slope	A-18(1)
Anarrhichadidae	Anarrhichthys ocellatus	borderland	A-20(2 J); C-1(1 J), 8(1 J), 12(1 J), 15(1 J), 17(1 J), 20(1 J), 23(1 J)
Zoarcidae	spp.	inlets	B-10(many), 17(many), 18(many), 19(few), 20(many)
Ammodytidae	Ammodytes hexapterus	bank, slope, gully	A-4(70 L), 9(293+), 10(many), 12(few), 13(4), 14(many), 16(few L), 17(1 L), 18(2), 19(1 L), 29(1), 30(75), 34(201+ L), 38(few), 40(2)
Oneirodidae	Chaenophryne cf parviconus	borderland	A-21(2)
	Oneirodes eschrichti-group	borderland	C-19(1)
	Oneirodes acanthias	borderland	C-19(1)

[a]Cruise number, haul number, and number of each species are shown as follows: cruise number by a letter, 64-6 by A, 64-12 by B, 65-7 by C, the haul number follows the letter representing the cruise, the figure in parentheses after the haul number represents the number of specimens of the particular species in that haul, if only the weight of the specimens is available it is shown as an italicized or underlined figure.

[b]J = Juvenile

[c]L = Larval form

Table III. The catch per hour (at a speed of 5.2 km/hr) of the more frequently caught species (or families) for each haul in relation to type of locality and general depth zone in coastal regions.

General depth	Day or night	Cruise & haul number	Squalus acanthias	Hydrolagus colliei	Clupea pallasii	Oncorhynchus keta	Oncorhynchus gorbuscha	Oncorhynchus kisutch	Oncorhynchus tshawytscha	Oncorhynchus nerka	Thaleichthys pacificus	Theragra chalcogrammus	Gadus macrocephalus	Atheresthes stomias	Other flatfish	Anoplopoma fimbria	Sebastodes alutus	Sebastodes flavidus	Sebastodes (other)	Cottidae	Ammodytes hexapterus	Zoarcidae	Other species
Bank - Engel net																							
Surface	Day	64-6-4	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	76L	..	..
		64-6-10	..	..	..	..	..	1	..	1	..	..	..	1L	..	..	..	..	..	..	many	..	..
		64-6-13	..	..	..	..	..	..	..	..	..	4	..	1L	..	..	..	..	..	..	4L	..	several
		64-12-1	..	..	..	..	..	1	..	..	..	..	..	..	..	1	..	..	1	..	..	..	..
Midwater	Night	64-6-6	..	..	12	4	25	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	2
		64-6-14	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	many	..	..
Bottom	Day	64-6-9	..	1	86	..	..	..	1	..	..	..	..	..	..	2	..	..	..	..	321+	..	..
		64-6-5	..	..	..	..	..	..	..	..	..	1J	..	..	..	..	..	..	..	..	..	..	..
		64-6-12	..	..	..	..	..	..	..	..	..	15J	..	23L	..	..	..	..	..	1	few	..	..
Gully - Engel net																							
Surface	Day	64-6-34	..	..	..	..	1	1	..	..	..	..	..	10L	..	..	..	..	..	1	178+L	..	..
		64-6-25	..	..	..	..	1	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..
		64-6-30	..	..	..	..	..	1J	..	..	..	..	..	..	..	..	..	..	..	..	77L	..	..
	Night	64-6-3	..	..	..	..	..	..	..	..	..	(30)	..	..	..	..	..	4	..	..	..	..	..
		64-6-8	1	..	..	..	1	..	8	..	1	..	..	7	..	8	..	1	..	..	..	..	..
		64-6-36	..	..	..	..	8	1	..	..	..	..	..	(33)	..	1	..	..	..	..	..	..	..
		64-6-28	2	..	40	..	..	..	..	..	2	2	..	(50)	..	(4)	..	..	3	..	..	..	..
		64-6-32	..	..	..	1	..	..	..	..	many	..	..	(42)	..	(79)	..	(14)	1	..	..	..	..
Midwater	Day	64-6-1	..	..	..	..	..	..	1	..	..	(49)	..	..	..	..	566	(41)	(8)	..	..	..	..
		64-6-11	..	..	..	..	..	..	..	..	..	..	..	..	..	..	11	2	2	..	..	..	..
		64-6-26	..	..	..	..	3	..	..	..	..	1	..	16	..	..	..	4	436	1	..	..	..
		64-6-31	..	..	..	..	..	..	..	..	..	(96)	..	(11)	..	(1)	1	1	(8)	..	..	..	..
	Night	64-6-7	..	..	..	..	..	..	..	..	..	1	..	..	3L	1	..	62	..	..	..	..	..
		64-6-35	..	..	..	..	..	..	..	..	..	(11)	..	..	..	..	..	..	..	..	..	..	..

Table III (cont'd.)

General depth	Day or night	Cruise & haul number	Squalus acanthias	Hydrolagus colliei	Clupea pallasii	Oncorhynchus keta	Oncorhynchus gorbuscha	Oncorhynchus kisutch	Oncorhynchus tshawytscha	Oncorhynchus nerka	Thaleichthys pacificus	Theragra chalcogrammus	Gadus macrocephalus	Atheresthes stomias	Other flatfish	Anoplopoma fimbria	Sebastodes alutus	Sebastodes flavidus	Sebastodes (other)	Cottidae	Ammodytes hexapterus	Zoarcicae	Other species
Bottom	Day	64-6-2	..	..	..	..	..	..	..	..	..	(18)	..	..	..	..	846	(16)	(2)	..	..	..	..
		64-6-33	..	..	..	..	..	..	..	..	7	..	..	..	..	..	458	1	(33)	..	..	..	1
		64-6-24	..	..	..	..	..	..	..	..	..	(378)	..	(2)	..	1	86	(21)	1	..	..	..	..
		64-6-29	..	..	..	..	..	..	..	..	..	(15)	..	..	..	..	159	6	7	..	1	..	..
		64-6-27	..	..	..	..	..	..	..	..	..	(218)	..	..	..	..	2067	(74)	(851)	..	..	..	..
Dixon Entrance - Engel net																							
Surface	Night	64-12-8	..	..	..	..	..	..	..	..	43	34	..	14	5	5	..	..	58	..	..	..	..
Bottom	Night	64-12-7	2	12	..	..	..	..	..	..	few	22	..	16	114	1	..	..	12J	5	..	..	2
Bowie Seamount - Engel net																							
Bottom	Day	65-7-24	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	74	..	..	..	..
		65-7-25	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	Night	65-7-28	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	178
Inlets - Engel net																							
Bottom	Day	64-12-11	..	..	(1620)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
		64-12-12	..	..	86	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bowie Seamount - No. 4 Barraclough- Johnson net																							
Bottom	Day	65-7-30	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
	Night	65-7-31	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Inlets - shrimp net																							
Midwater	Day	64-12-14	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
		64-12-15	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
		64-12-16	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table III (cont'd)

General depth	Day or night	Cruise & haul number	Squalus acanthias	Hydrolagus colliei	Clupea pallasii	Oncorhynchus keta	Oncorhynchus gorbuscha	Oncorhynchus kisutch	Oncorhynchus tshawytscha	Oncorhynchus nerka	Thaleichthys pacificus	Theragra chalcogrammus	Gadus macrocephalus	Atheresthes stomias	Other flatfish	Anoplopoma fimbria	Sebastodes alutus	Sebastodes flavidus	Sebastodes (other)	Cottidae	Ammodytes hexapterus	Zoarcidae	Other species
Bottom	Day	64-12-9	..	few	58	..	..	..	..	..	..	12	10	many small	many small	380	150J	..	3 + 104J	..	..	..	3
		64-12-10	..	..	14	..	..	..	..	..	..	..	..	-"-	-"-	220	..	..	..	..	..	many	..
		64-12-13	..	(155)	..	..	..	..	..	..	..	115	..	(613)	..	147	220	10	(534)	..	..	..	..
		64-12-17	17	67	..	..	..	..	..	..	..	(198)	..	many	many	28	..	..	11+ 246J	..	..	many	many
		64-12-18	28	..	..	..	..	..	..	..	..	many	..	56	1358	..	2352J	..	..	..	..	..	-"-
		64-12-19	18	24	..	..	..	..	..	..	..	..	..	some	many	90	..	..	354	..	..	..	few
		64-12-20	6	22	1669	..	..	..	..	..	many	319	..	some	many	672	..	..	11	..	..	..	many
		64-12-21	..	319	..	..	..	..	..	..	17	..	..	..	..	..	3427J	..	..	17	..	..	..

Table IV. Average numbers per hour of trawling at 5.2 km/hr of the more abundant species (or families) in various coastal localities.

			Herring	Salmon	Alaska pollock	Turbot	Other flatfish	Blackcod	Pacific ocean perch	Other rockfish	Sandlance	Other fish
Goose Island & Middle Bank	Surface	Day	..	1	1	1 L[1]	+[2]	+	..	+	20+L	several
	Midwater	Night	6	15	..	..	1	1	..	1	many L	..
	Bottom	Day	29	+	5J	8 L	..	1	..	..	107+L	1
Gullies	Surface	Day	..	1	..	3 L	..	..	+	..	86+L	+
		Night	8	3	6	26	..	38	..	4	..	1
	Midwater	Day	..	2	23	8	1 L	..	283	239	..	..
		Night	..	..	26	6	..	1	3	18	..	..
	Bottom	Day	..	..	98	+	..	+	387	29	+	..
		Night	..	..	208	..	..	..	2067	1047	..	..
McIntyre Bay	Surface	Night	..	..	34	14	5	5	..	5 J	..	43
	Bottom	Night	..	..	22	16	114	1	..	12 J	..	21
Inlets (Engel Net)	Bottom	Day	7167	..	..	..	..	..	..	..	..	..
(Shrimp Net)	Midwater	Day	..	..	..	..	..	..	..	..	..	..
(Shrimp Net)	Bottom	Day	226	..	42	many J	many J	237	39+ 754 J	29+ 62 J	..	.. many

[1]J = juvenile; L = larvae

[2]In many cases, catches reported as weights were converted to numbers using what information was available on average weights of the various species. All figures are rounded to the nearest whole number; a plus sign indicates less than 0.5 individual. The following average weights were used: herring 0.25 lb; pollock 2.3 lb; turbot 2.3 lb; blackcod 1.0 lb; other rockfish - Sebastodes brevispinus 5.0 lb; S. flavidus 3.5 lb; S. paucispinus 5.5 lb; S. entomelas (ciliatus?) 2.0 lb; S. zacentrus 1.0 lb.

Table V. The day and night average total catch per hour's fishing in relation to various scattering layers for each cruise.

	Cruise 64-6 June		Cruise 64-12 Oct.-Nov.		Cruise 65-7 July	
	Day	Night	Day	Night	Day	Night
Surface layer	+	99	-	807	-	-
Above 1st layer	-	-	-	-	3	-
Between 1st & 2nd layers	-	62	-	-	-	-
In 2nd layer	-	315	-	-	7	261
Above main (3rd) layer	3	-	30	366	137	-
In main layer	123	162	193	332	1,120	292
Below main layer	-	-	-	-	595	526
In deep (4th) layer	-	-	-	-	102	-
Below deep layer	494	-	-	-	1,404	-

Table VI. The catch per hour[1] of the more frequently caught species (or families) for each haul in relation to sound scattering layers and depth.

Position re sound scattering layer (Catches made by Engel trawl)	Depth range (m)	Cruise and haul no.	Day or night	Argentinid species	Tactostoma macropus	Chauliodus macouni	Hierops thompsoni	Diaphus theta	Tarletonbeania crenularis	Tarletonbeania taylori	Tarletonbeania sp.	Lampanyctus leucopsarus	Lampanyctus ritteri	Lampanyctus regalis	Lampanyctus nannochir*	Atheresthes stomias	Sebastodes alutus	Sebastodes sp.	Other species
In surface layer	0-45	64-6-38	D	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	0-45	64-6-43	D	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+
Above main layer	90-140	64-6-15	D	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	140-185	64-6-42	D	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..
	140-185	64-6-45	D	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	6
In main layer	140-185	64-6-17	D	..	..	..	..	..	..	..	..	1	..	..		10L[a]	3	..	1
	140-185	64-6-16	D	..	..	..	4	..	..	..	..	..	..	..		37L[a]	9	1	1
	185-230	64-6-39	D	..	..	3	8	6	..	..	..	50	..	..	..	..	18	3	3
	185-230	64-6-41	D	..	..	11	175	179	24	..	..	38	..	..	..	..	..	..	1
	185-230	64-6-47	D	..	..	6	10	20	1	..	..	9	..	..	..	..	6	..	16
	230-275	64-6-37	D	..	..	1	31	139	6	..	..	14	..	..	..	..	5	..	12
	230-275	64-6-44	D	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
	230-275	64-6-20	D	..	..	13	39	4	..	..	..	52	..	..	..	..	..	..	1
Below deep layer	640-730	64-6-21	D	67	18	34	6	41	6	..	..	131	..	77	..	..	..	2	112
Above main layer	90-140	64-12-4	D	..	5	..	4	16	3	..	..	1	..	..	..	..	..	..	1
In main layer	185-230	64-12-3	D	..	..	..	13	175	4	..	1	..	..	..	..	..	..	..	..
Above first layer	45-90	65-7-1	D	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2J[3]	2
	45-90	65-7-23	D	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2
In first layer	45-90	65-7-15	D	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2J
In second layer	90-140	65-7-4	D	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2
	140-185	65-7-3	D	4	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..
	140-185	65-7-9	D	..	..	..	..	..	..	..	..	..	..	..	..	..	..	15J	

Table VI (cont'd.)

Position re sound scattering layer	Depth range (m)	Cruise and haul no.	Day or night	Argentinid species	Tactostoma macropus	Chauliodus macouni	Hierops thompsoni	Diaphus theta	Tarletonbeania crenularis	Tarletonbeania taylori	Tarletonbeania sp.	Lampanyctus leucopsarus	Lampanyctus ritteri	Lampanyctus regalis	Lampanyctus nannochir	Atheresthes stomias	Sebastodes alutus	Sebastodes sp.	Other species
Above main layer	140-185	65-7-14	D	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	185-230	65-7-8	D	..	..	2	..	..	2	..	..	..	..	..	..	..	..	31J	2
	230-275	65-7-2	D	..	..	..	293	19	..	4	12	24	..	..	..	..	..	19J	2
In main layer	230-275	65-7-7	D	..	..	77	724	493	11	..	11	118	..	..	..	..	..	19J	..
	230-275	65-7-13	D	..	..	66	652	433	11	..	5	252	3	..	..	..	..	5J+3	8
	275-320	65-7-27	D	..	..	54	297	29	20	..	..	2	..	..	..	..	..	..	..
	320-365	65-7-12	D	..	..	29	91	930	87	..	24	18	3	..	2	..	..	1J	4
Below main layer	320-365	65-7-6	D	27	..	49	75	725	37	17	12	32	..	..	..	..	..	34J+2	1
	365-410	65-7-18	D	30	2	32	21	93	..	..	..	21	17	..	..	..	..	2	4
	410-455	65-7-26	D	2	..	242	65	121	24	..	..	93	..	..	..	..	..	2	2
In deep layer	410-455	65-7-20	D	8	13	42	4	..	..	..	2	10	..	..	..	..	..	2J+2	19
Below deep layer	500-595	65-7-19	D	217	26	78	5	8	..	..	1	1026	1	17	40	..	..	2	24
In surface layer	0-45	64-6-19	N	..	..	..	..	..	..	..	..	..	..	..	..	162L	..	..	3
	0-45	64-6-23	N	..	..	17	2	14	..	..	..	..	..	..	..	..	..	..	..
Between first and second layers	45-90	64-6-18	N	..	..	..	..	..	..	..	..	..	..	..	..	58L	..	..	4
In second layer	90-140	64-6-40	N	4	1	6	2	194	2	..	..	104	..	..	..	..	..	..	2
In main layer	140-185	64-6-46	N	..	..	10	17	..	..	..	..	95	..	..	..	..	..	..	..
	185-230	64-6-22	N	..	..	54	38	80	11	..	..	19	..	..	..	..	..	..	..
In surface layer	?	64-12-2	N	14	27	..	..	558	38	..	..	126	..	..	..	..	..	..	44
Above main layer	90-140	64-12-6	N	1	13	6	..	220	23	..	..	84	4	9	..	..	..	..	6
In main layer	140-185	64-12-5	N	1	13	17	..	139	3	..	..	123	23	12	..	..	..	..	1

Table VI (cont'd.)

Position re sound scattering layer	Depth range (m)	Cruise and haul no.	Day or night	Argentinid species	Tactostoma macropus	Chauliodus macouni	Hierops thompsoni	Diaphus theta	Tarletonbeania crenularis	Tarletonbeania taylori	Tarletonbeania sp.	Lampanyctus leucopsarus	Lampanyctus ritteri	Lampanyctus regalis	Lampanyctus nannochir	Atheresthes stomias	Sebastodes alutus	Sebastodes sp.	Other species
In second layer	90-140	65-7-5	N	12	..	..	10	184	6	2	4	35	..	2	..	..	..	2J	4
In main layer	90-140	65-7-22	N	9	..	14	9	49	2	..	..	55	..	..	..	..	..	..	2
	140-185	65-7-10	N	..	..	17	78	376	10	..	4	233	..	..	..	..	..	21J	6
	140-185	65-7-16	N	..	..	..	6	83	..	3	3	6	..	..	..	..	..	..	..
	185-230	65-7-21	N	..	..	45	56	76	2	2	..	2	..	..	..	..	..	..	..
Below main layer	230-275	65-7-17	N	40	42	28	132	78	2	..	2	132	25	18	..	..	..	..	20
	275-320	65-7-11	N	24	15	35	137	107	28	..	9	107	..	37	2	..	..	3J+2	26
(Catches made by No. 4 Barraclough-Johnson net)																			
Above first layer	45-90	65-7-34	D	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Between first and second layers	90-140	65-7-35	D	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
In second layer	90-140	65-7-29	D	..	..	..	Series	..	10	..	..	..	..	..	..	..	..	..	..
Above main layer	275-365	65-7-32	D	10	..	4	2	28	..	..	..	..	..	..	..	..	..	..	..
In second layer	185-275	65-7-33	N	..	..	3	55	24	9	..	..	12	..	..	..	..	..	..	..

[1]At a speed of 5.2 km/hr.

[2]L = larval form.

[3]J = juvenile.

[4]Lampanyctus nannochir may be synonymous with L. leucopsarus.

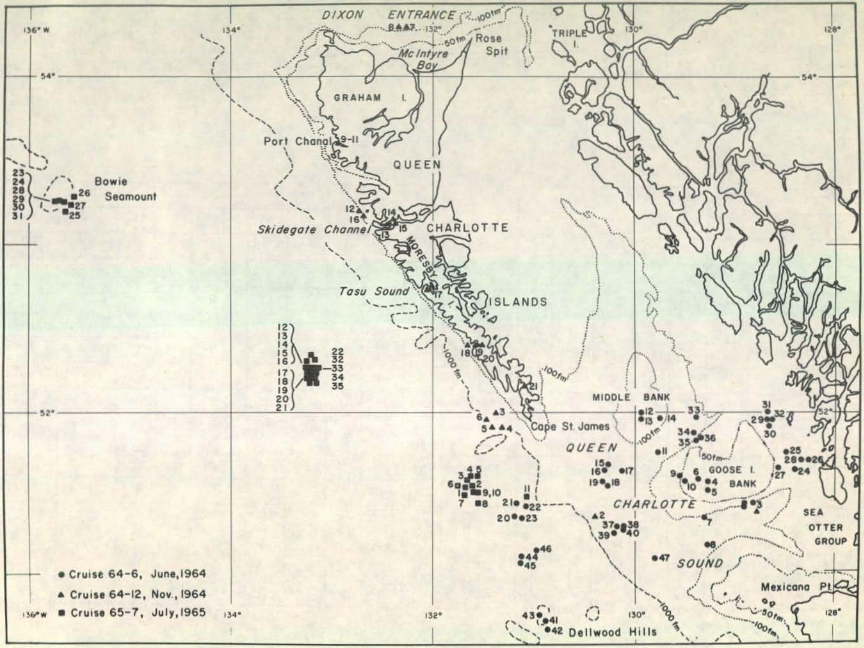

Fig. 1. Map of the northern and central British Columbia coastline showing the location of each tow and place names referred to in the text.

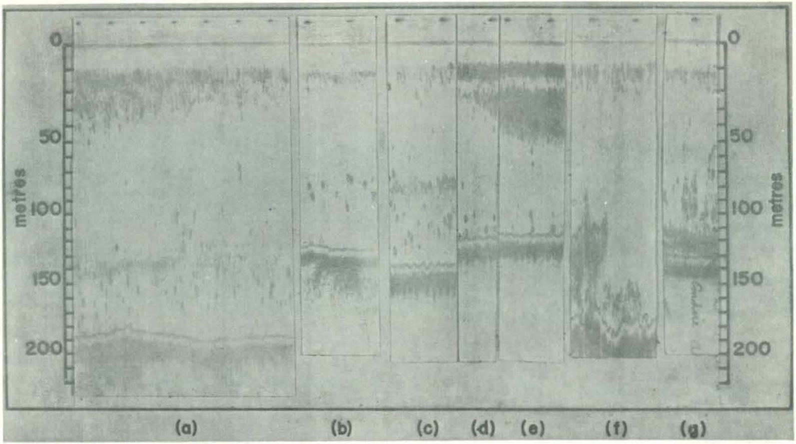

Fig. 2. Examples of surface and near-bottom scattering layers: (a) double and single surface layer, diffuse type of bottom layer; scattered dash-like echoes; (b) poorly developed surface layer of inlet (Skidegate Channel); (c-e) rapid intensification of surface layer; (f) typical diffuse school (herring); (g) aggregation of dash-like echoes to form layer.

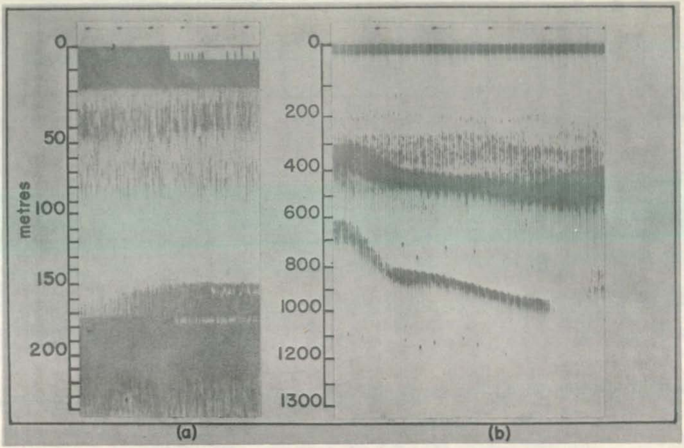

Fig. 3. Examples of scattering layers on Bowie Seamount, July 1965:
(a) intensive surface layer and bottom layer at 166 m
(b) extensive bottom layer in 278-425 m

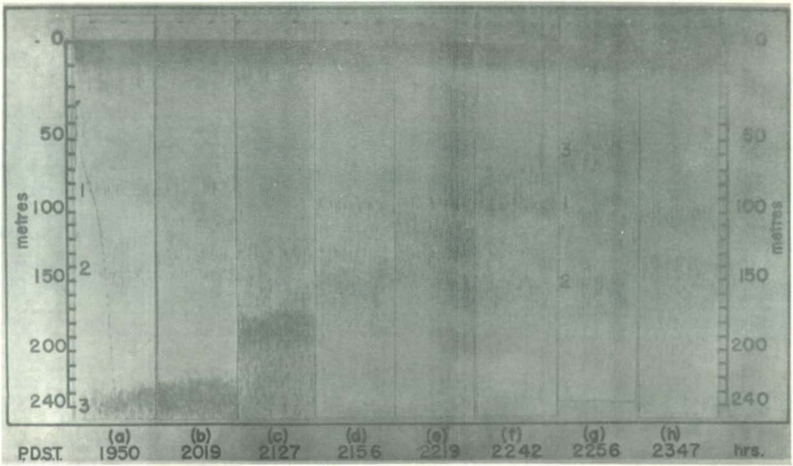

Fig. 4. Ascent of scattering layer, July 9, 1965. The third layer rose from 222 m (a), crossing the second at 130 m (d,e) and first at 92 m (e,f), fading out above 56 m (h). The first and second layers maintained approximately their original positions. The second layer split (a,b), part rising to 111 m before fading out. Intensity of third layer decreased and of first and second layers increased.

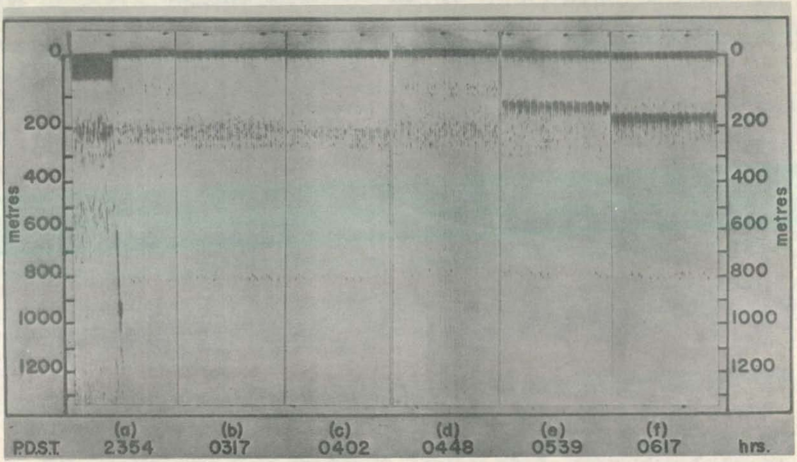

Fig. 5. Descent of scattering layer, July 11, 1965. Part of third layer remained at about 222 m throughout the night (a-e). Migratory part faded in at about 92 m (d), intensified and decreased rapidly (e,f). Note change of depth scale from 0-240 m to 0-1300 m in (a).