EXPLORATORY BOTTOM TRAWLING IN HAWAIIAN WATERS

by

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ABSTRACT

The exploratory bottom trawling cruises were made in Hawaiian waters on the Bureau of Commercial Fisheries research vessel TOWNSEND CROMWELL between October 1967 and May 1968. The cruises were conducted in cooperation with the Hawaii Institute of Marine Biology, University of Hawaii.

An area totaling 4,974 sq km was covered during the exploratory surveys. Approximately 42 percent of this area or 2,106 sq km was judged to be trawlable; 2,281 sq km were untrawlable and 587 sq km were marginally trawlable. A relatively large uninterrupted area of trawlable bottom was found north of Maui.

One hundred and nineteen trawl drags were made on the cruises primarily using the Gulf of Mexico-type flat shrimp trawls of various sizes.

The species with the greatest commercial potential caught during the surveys was a penaeid shrimp, *Penaeus marginatus*. Relatively good catches of this shrimp were made in depths between 97 and 234 m around Molokai and in an area off the north coast of Oahu.

INTRODUCTION

Oceanic islands, such as the main Hawaiian Islands, are characterized by having narrow shelves, which have been appropriately called insular shelves in contrast to continental shelves. The insular shelves surrounding the main Hawaiian Islands can be traced to 549 m (300 fm.), although most of the shelves extend to depths less than 91 m (50 fm.) (Shepard, 1948, p. 141-142). Depths of 1,826 m (1,000 fm.) can be found as close as 11 km from shore (Fig. 1). Thus, a priori, a large demersal resource would not be expected in Hawaiian waters, based simply on the extent of the shelf around the islands.

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In an early investigation of the demersal resources of the Hawaiian Islands, a study of the fauna to a depth of 1,826 m was conducted from March to August 1902 on the ALBATROSS, research vessel of the U.S. Fish Commission (Gilbert, 1905). This survey covered an area around Hawaii bounded by lat. 18° to 26° N., long. 156° to 172° W. Most of the published records of deep-water fishes and invertebrates from Hawaii are based on specimens caught on the ALBATROSS survey. Although several species of potential commercial importance were discovered on that survey, none was taken in significant quantities. The types of gear used on the ALBATROSS included tangles, dredges, and beam trawls, which probably were not very efficient by today's standards. The ALBATROSS also lacked modern depth-sounding equipment, which is almost a necessity for efficient trawling.

Between October 1967 to May 1968 the Bureau of Commercial Fisheries Biological Laboratory, Honolulu, Hawaii, in cooperation with the Institute of Marine Biology, University of Hawaii, conducted a series of three exploratory bottom trawling cruises on the Bureau's vessel, the TOWNSEND CROMWELL, in Hawaiian waters. The purpose of the cruises was to investigate the demersal fish and invertebrate resources around the Hawaiian Islands down to a depth of 914 m (500 fm) using more efficient trawling gear than that used on the ALBATROSS.

Very little bottom trawling has been done in areas similar to the Hawaiian Islands. The results obtained on our cruises will provide information on conditions that can be expected in trawling around oceanic islands elsewhere. This report will discuss catches of the species with possible commercial potential.

GEAR AND METHODS

Prior to our surveys, very little information existed on bottom conditions around the Hawaiian Islands with respect to bottom trawling. The strategy adopted in conducting our surveys was to first locate the most promising areas on the basis of depth data and bottom notations on navigational charts, and then conduct detailed echo-sounding transects in these areas. Bottom grab samples were taken to confirm trawlable bottom as indicated by the echograms. The surveys were restricted to depths of 914 m (500 fm) or less.

The primary sampling gear was the Gulf of Mexico-type, flat, shrimp trawl (Bullis, 1951, p. 8). The size of the trawls (length of the head rope) ranged from 6.70 m (22 ft.) to 16.76 m (55 ft.). The trawl was connected to a single towing warp by a bridle 46 m long. Doors (otter boards) of various sizes included the Gulf of Mexico-type, wooden, chain doors measuring up to 1.52 by 0.76 m. Most of the drags were made with a pair of aluminum "V" doors measuring 0.96 by 1.83 m. Also used were a 21.34 m (70 ft.) Gulf of Mexico-type, semiballoon, shrimp trawl (Greenwood, 1959, p. 4) and a 400-mesh, eastern, otter trawl (Greenwood, 1958, p. 12). The otter trawl was used with two towing warps and a pair of aluminum doors measuring 1.52 by 2.44 m (5 by 8 ft.).

For single-warp dragging, the trawl was towed from the starboard side of the vessel off a hydrographic boom. For double-warp dragging, two gallows on the starboard side were used. The trawl was set out at a speed of 4 to 6 knots and the cable was released at a rate of 18 to 45 m per minute. The-depth-to-cable-out (scope) ratios ranged from 1.9 to 4.2. The trawl was fished for 13 minutes to 4 hours (time trawl was on bottom). Trawling speed usually ranged between 1.0 and 4.7 knots.

TRAWLING AREAS AND CATCH

The area of the bottom to a depth of 914 m round the Hawaiian Islands is estimated to be approximately 44,076 sq km. An area totaling 4,974 sq km was surveyed during the exploratory surveys (Fig. 1). Of the area surveyed, 2,106 sq km (42.3 percent) were considered to be trawlable, 587 sq km were marginally trawlable, and 2,281 sq km were untrawlable.

The largest uninterrupted expanse of trawlable bottom, comprising about 1,063 sq km, was found north of the island of Maui. The bottom here sloped gently from about 274 to 523 m. Drags as long as 4 hours were made in this area.

Trawlable bottom was found around Molokai off the northwest, west and south coasts, and also in Pailolo Channel, between Molokai and Maui. South of Oahu, an area totaling 429 sq km and a small area comprising 14 sq km north of the island were found to be trawlable. Patches of trawlable ground were also found in Kealaikahiki Channel between Lanai and Kahoolawe. The waters around the island of Hawaii were a disappointment, for only small areas of trawlable bottom were found there. Furthermore, off the north coast of Hawaii sugar cane debris on the bottom tended to clog the trawls. The sugar cane debris also hampered the sorting of the catch.

A total of 119 trawl drags was made around the islands. Ten of the drags were unsuccessful owing to torn nets and loss of gear. A summary of the trawl drags in the various areas is found in Table I.

For the development of a commercial fishery a penaeid shrimp, *Penaeus marginatus*, was the most promising species caught during the exploratory cruises. This shrimp was known to occur in Hawaiian waters from the explorations of the ALBATROSS in 1902 (Rathbun, 1906, p. 902) but only small numbers were taken on that survey. *P. marginatus* compares favorably in size with the penaeid shrimps of the major fisheries in the southeastern United States. The larger females number 18 to 20 to 1 kg (8 or 9 to 1 pound), heads on.

The distribution of *P. marginatus* on trawlable bottom around the Hawaiian Islands is shown in Figure 2. The shrimp were caught in depths between 27 and 234 m on sandy and sand-mud substrate. The catch ranged from less than 0.45 to 16.10 kg per drag. Good catches were made off the west and in Pailolo Channel. Good catches were also made off the north coast of Oahu. The area north of Oahu has some rough spots on the bottom, however, and must be considered marginally trawlable since two nets were damaged on the exploratory drags made here.

Adequate data are not available to make seasonal comparisons of *P. marginatus* catch rates. Comparisons of day and night catches can be made, however. Off the north and west coasts of Molokai and off the north coast of Oahu, the night catches were almost always better than the day catches. The depth in these areas ranged from 97 to 183 m. In Pailolo Channel, where the depth ranged from 183 to 254 m, however, little or no difference between the day and night catches was evident (Fig. 3). Springer and Bullis (1952) made similar observations on the brown shrimp (*Penaeus aztecus*) in the Gulf of Mexico. They noted that this species is generally taken at night but that differences in the catch rates were not as well defined in the deeper parts of the shrimp's range.

Other potentially valuable species caught in the shrimp trawls included several species of small (20 cm) deep water flatfishes belonging to the family Bothidae and Pleuronectidae. The catches of individual species of these flatfishes were small but, collectively, up to 13.61 kg per drag were taken. The flatfishes were widely distributed around the Hawaiian Islands (Fig. 4). The best catches were made in Pailolo Channel. Also caught were small numbers (up to 14 per drag) of spiny lobster (*Panulirus japonicus*) and portunid crab (*Portunus sanguinolentus*); the latter caught at a maximum rate of 30 per drag. The lobster and crab were taken primarily on sandy bottom in depths to about 128 m off Molokai, Oahu and Lanai. These lobster and crab command premium prices in the markets in Hawaii.

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Table I

Distribution of trawl drags around the Hawaiian Islands

Area	Number of drags	Average depth range (m)
Oahu		
Off north coast	6	97-113
Off south coast	3	594-640
Maui		
Off north coast	17	48-523
Hawaii		
Off coast of Kawaihae	5	260-356
Off north coast	6	229-869
Molokai		
Off north coast	7	110-137
Off west coast	13	181-183
Off south coast	3	265-274
Penguin Bank	3	62-66
Pailolo Channel between Molokai and Maui	29	183-254
Kealaikahiki Channel between Lanai and Kahoolawe	27	97-427

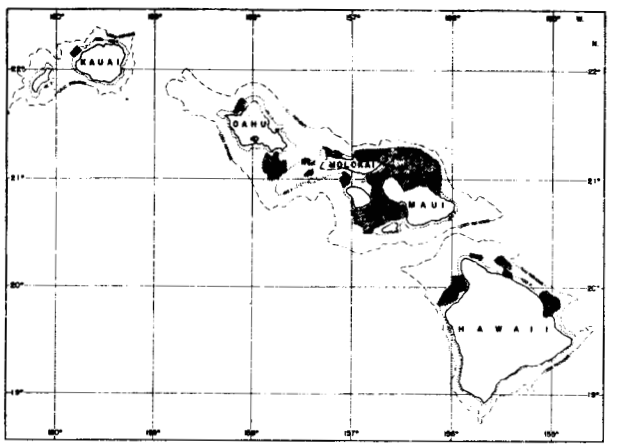

Fig. 1 The main Hawaiian Islands, showing the 1,826-m (1,000-fm.) and 183-m (100-fm.) depth contours. The crosshatch shows the areas surveyed.

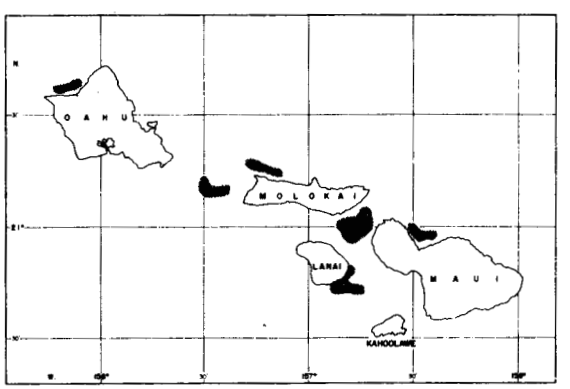

Fig. 2 The distribution of Penaeus marginatus on trawlable bottom around the Hawaiian Islands.

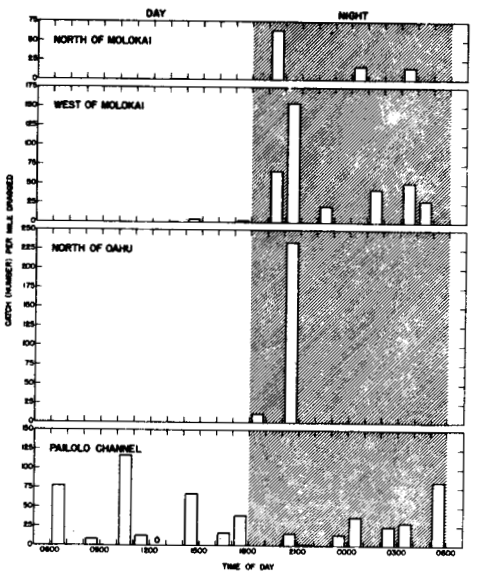

Fig. 3 Day-night variation in catches of Penaeus marginatus.

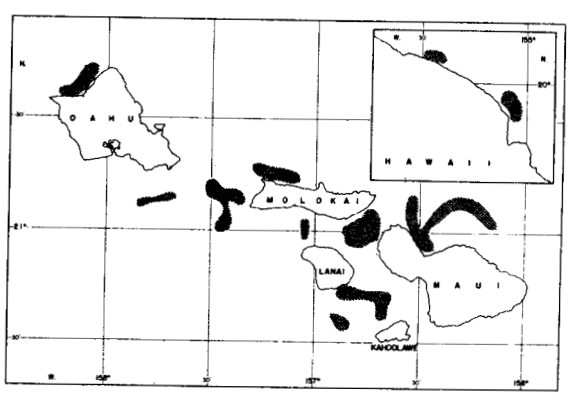

Fig. 4. The distribution of flatfish catches around the Hawaiian Islands.