

The Fishery for Nehu, *Stolephorus purpureus*, a Live Bait Used for Skipjack Tuna, *Katsuwonus pelamis*, Fishing in Hawaii

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ABSTRACT

With increasing interest in the baitfish resources and their capacity to support local skipjack tuna, *Katsuwonus pelamis*, fisheries, we need to evaluate their distribution and relative abundance. This paper describes the trends in production of nehu, *Stolephorus purpureus*, an anchovy used as live bait in the fishery for skipjack tuna in Hawaiian waters.

Kaneohe Bay and Pearl Harbor, two of the most important baiting sites in the Hawaiian Islands, produce 71% of the bait. Another important site on Oahu, particularly for night baiting, is Kalihi-Keehi Lagoon.

Day baiting produced 79% whereas night baiting produced 21% of the State's nehu catch. Catches and baiting effort showed a downward trend in the day fishery and an upward trend in the night fishery in 1961-65. In 1966-72, however, catches and baiting effort increased steadily in the day fishery whereas they declined in the night fishery.

INTRODUCTION

The Hawaiian pole-and-line fishery for skipjack tuna, *Katsuwonus pelamis*, is dependent on a steady supply of live bait. Essentially, two separate fisheries are involved. The first is for live bait which is caught with nets in shallow waters of bays and harbors. The second is for skipjack tuna and other tunas which are caught in offshore waters with pole and line after the fish are attracted to the boat with live bait. Thus, live bait is essential in the Hawaiian skipjack tuna fishery, and fishermen spend a good part of their time catching it. This report presents and analyzes the bait catch statistics associated with the Hawaiian skipjack tuna fishery for the years 1960 to 1972. It supplements a previous report on the Hawaiian skipjack tuna fishery by Yamashita (1958).

SPECIES UTILIZED

Basically, almost any small fish in sufficient numbers can be used as live bait, but their effectiveness varies from species to species. By far, Hawaiian skipjack tuna fishermen prefer the nehu, *Stolephorus purpureus*, a small (40-60 mm), fragile anchovy that schools over sand and mud bottoms in harbors and bays throughout the Hawaiian Islands. It apparently possesses most of the qualities of a good baitfish. Captured both day and night, nehu constitutes roughly 97% of the bait caught in Hawaiian waters. Most of the remainder is made up of silverside or iao, *Pranesus pinguis*, and small round hering or piha, *Spratelloides delicatulus*.

BAITING LOCALITIES

Within the Hawaiian Islands there are several baiting grounds; they are listed below, by islands.

Island	Baiting grounds
Oahu	Kaneohe Bay Pearl Harbor Kalihi-Keehi Lagoon Honolulu Harbor Ala Wai Canal Kewalo Basin Waialua Bay including Haleiwa
Maui	Maalaea Bay region including Kihei Lahaina Kahului including NASKA (formerly Naval Air Station, Kahului)
Hawaii	Hilo Harbor Kawaihae Mahukona Kailua-Kona
Kauai	Port Allen Hanalei Nawiliwili Hanapepe
Molokai	Kaunakakai
Lanai	—

Oahu has the most important bait resource. Roughly 79% of the State's bait production comes from Oahu's baiting grounds (Fig. 1). Two of them, Kaneohe Bay on the windward side and Pearl Harbor on the leeward side of Oahu, are the major sources of bait, providing about

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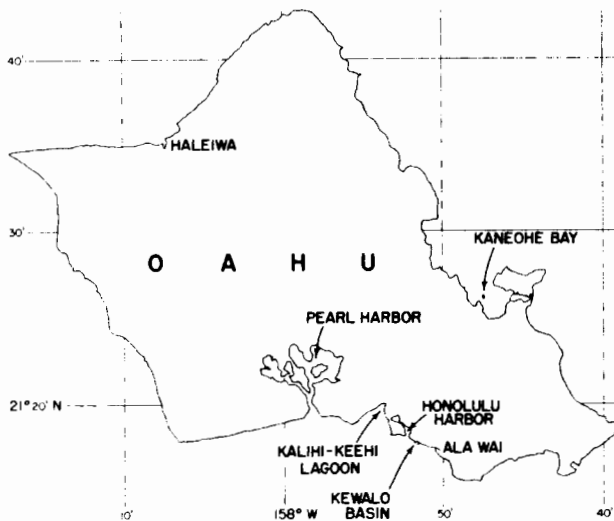


Figure 1.—Baiting areas on Oahu.

71% of the State's production. A third site of some importance, particularly for night baiting, is Kalihi-Keehi Lagoon. Generally, Oahu-based vessels do their "baiting" (catching of bait) on Oahu although they may also bait at Kauai, Maui, Molokai, and Lanai. Maui-based vessels usually bait on Maui, Oahu, Molokai, and Lanai, but rarely venture to Kauai. Hawaii-based vessels are generally restricted to grounds off their island. They capture a large proportion of their live bait at night as Hilo Harbor is fringed by a predominantly rocky shoreline that is not suitable for day seining.

METHODS OF CAPTURE

Bait is caught by two methods in the Hawaiian Islands. Day baiting usually starts at dawn and ends when enough bait for a day's fishing has been caught. If day baiting is unproductive, night baiting is attempted and, if little or no night bait is caught, day baiting is resumed the next morning.

Day Baiting

Day baiting may last for 1.5 to 7 h but usually lasts about 3 h (Uchida and Sumida 1971). The fishermen use an outboard-powered skiff loaded with a surround net measuring roughly 156 m (80 fathoms) long and 7 m (4 fathoms) deep (June 1951). They scout the shallow waters of bays and harbors. When a school of baitfish is located, the net is set from the skiff as the skiff encircles the school. The net is then partially "dried up" to form a bag to hold the school. To keep mortalities to a minimum, the fishermen "swim" the net-enclosed baitfish to the vessel. Once alongside the vessel, the fishermen, using 23-liter capacity (about 6 gal) stainless steel buckets, brail the fish from the net into the baitwells. Each scoop of the bucket contains both water and baitfish to minimize injury to the baitfish. The amount of baitfish in a bucket varies considerably. Yamashita

(1958) estimated the amount of nehu in a bucket to be about 3.2 kg (7 lb), but recent estimates (Hida and Wetherall 1977) indicate that the actual weight of the baitfish in a bucket may be about 22-24 kg (10-11 lb). Usually, several sets are required to obtain enough bait to justify tuna fishing. Uchida and Sumida (1971) estimated from data collected in June-August 1967 that the average is about three sets although as many as nine sets in a single day may not be uncommon.

Night Baiting

For night baiting, lift nets which measure about 27-46 m (15-25 fathoms) long and 22 m (12 fathoms) deep are used (June 1951). Night baiting does not involve active scouting for schools of baitfish. Rather, a submerged light is used to take advantage of the fact that nehu are attracted to light. After dark, the vessel is anchored or moored and a light is suspended several feet below the water surface from a 6-m (20-ft) pole which is lashed to the vessel's portside. Just before daybreak, a rheostat dims the light causing the baitfish to concentrate. The net is set around the tightly schooled baitfish from a skiff and the captured bait is transferred to the baitwells. Uchida and Sumida (1971) found that night-baiting operations from setting the light to drying up the net, usually lasted 8 h. Usually one set is made per night.

CATCH, EFFORT, AND CATCH PER EFFORT

The bait reports, turned in by the fishermen to the Hawaii Division of Fish and Game, were summarized by baiting locality and by time of baiting (day or night). Reports which showed nehu catches but gave no indication of day or night baiting, and those which indicated the capture of baitfish other than nehu, were included only in statewide summaries. In the following sections, I discuss bait production in the day and night fisheries.

STATEWIDE PRODUCTION

Statewide catch statistics of baitfish, combined for all species, baiting grounds, and times of capture, are plotted in Figure 2. With the exception of 1960, when the baitfish catch amounted to 22,849 buckets, catches in 1961-72 have never fallen below 30,000 buckets annually and in some years they have been well over 35,000 buckets. The peak in bait production occurred in 1971 when 42,098 buckets were caught.

Baiting effort tended to drift upward in 1960-65 and downward in 1966-72. Actually the uncorrected effort presented in Figure 2 includes both day and night effort and does not take into account the curtailment of night-baiting operations after 1965 concurrent with increases in day-baiting operations. As I will discuss in later sections, 1 day of baiting will usually produce a catch which is much greater than that obtained by night baiting. The

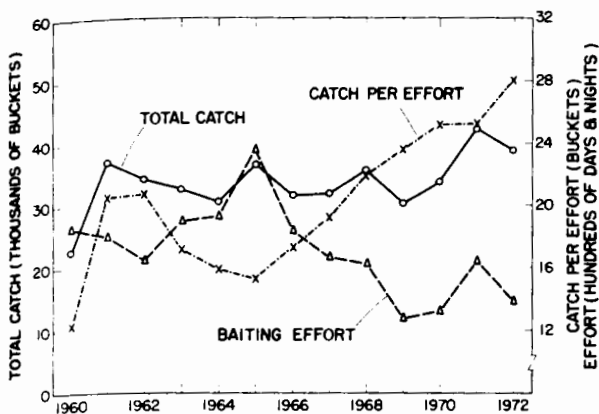


Figure 2.—Catch, baiting effort, and catch per effort in the fishery for live bait in Hawaii, 1960-72.

progressive increase in catch per effort in 1965-72, therefore, results from an increase in day baiting and a decrease in night baiting.

DAY-BAIT PRODUCTION

The statewide production of day bait averaged 25,338 buckets in 1960-72. In 1960, production reached 15,735 buckets with 1,001 days of baiting effort. Figure 3A shows that although production rose in 1961, day effort started on a downward trend that also carried production to lower levels. An upturn in production occurred in 1965, but day effort did not begin its upward climb until 1968, when it reached 1,055 days. The result was that production climbed to 30,148 buckets. Poor tuna fishing in 1969 dropped baiting intensity to 870 days and production to 25,650 buckets. In 1970, an upward trend started that was to carry day effort well over 1,000 days and production to exceptionally high levels, particularly in 1971 when 1,334 days of baiting produced 38,786 buckets.

In terms of apparent abundance, as measured by catch per day baited (C/D), only 15.7 buckets/day were taken in 1960 (Fig. 3A). The C/D rose sharply thereafter to 28.6 buckets in 1962, then declined to 23.8 buckets in 1964-65. In 1966-67, however, an upswing occurred and in recent years, catches have been nearly 30 buckets/day. The peak in the index was reached in 1972 when 31.2 buckets of bait were caught per day's baiting. The overall average for the 13-yr period was 27.1 buckets/day of baiting.

Among the State's baiting grounds, Pearl Harbor was the most productive for day-baiting operations. In general, both bait production and baiting intensity at Pearl Harbor show an upward trend (Fig. 3B). Production averaged 10,127 buckets annually and accounted for 40% of the statewide average catches. Annual catches ranged from a low of 3,517 buckets in 1960 to a high in 1971 of 18,992 buckets.

Day effort expended at Pearl Harbor paralleled the annual catches. It ranged from a low of 244 days in 1962 to a high of 687 days in 1971. The average over 13 yr was 396 days or roughly 42% of the average annual day-baiting effort statewide.

The abundance index for Pearl Harbor showed very little variation and no distinct trend over the years (Fig. 3B). Abundance was lowest in 1960 when only 13.5 buckets/day were caught. The indices in 1961-72 fluctuated within a fairly narrow range between 23.4 and 28.1 buckets. The average C/D in 13 yr was 25.6 buckets.

Kaneohe Bay, the second major ground for day bait, produced an average annual catch of 8,783 buckets of nehu. This catch represented about 35% of the day bait caught annually in the State. The annual catches tended to decline in 1960-64 (Fig. 3C). But the upward trend which started in 1965 carried production to well over 10,000 buckets in 1966-72. Production, at a low of 2,116 buckets in 1964, increased over sevenfold to a peak of 15,709 buckets in 1970.

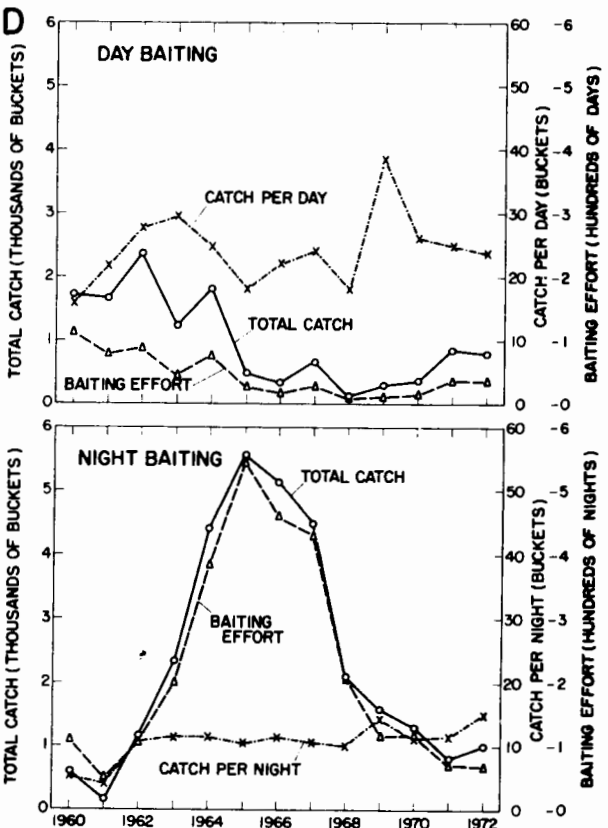
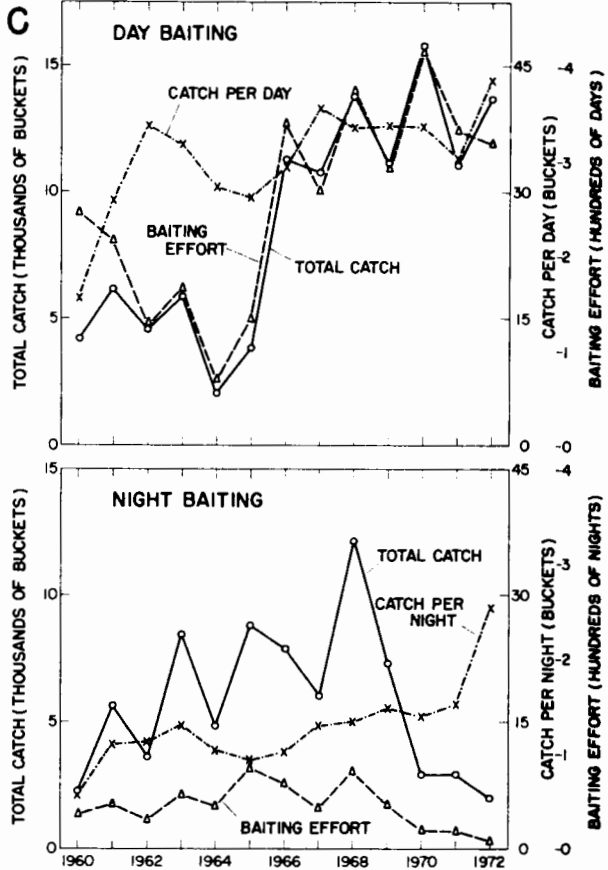
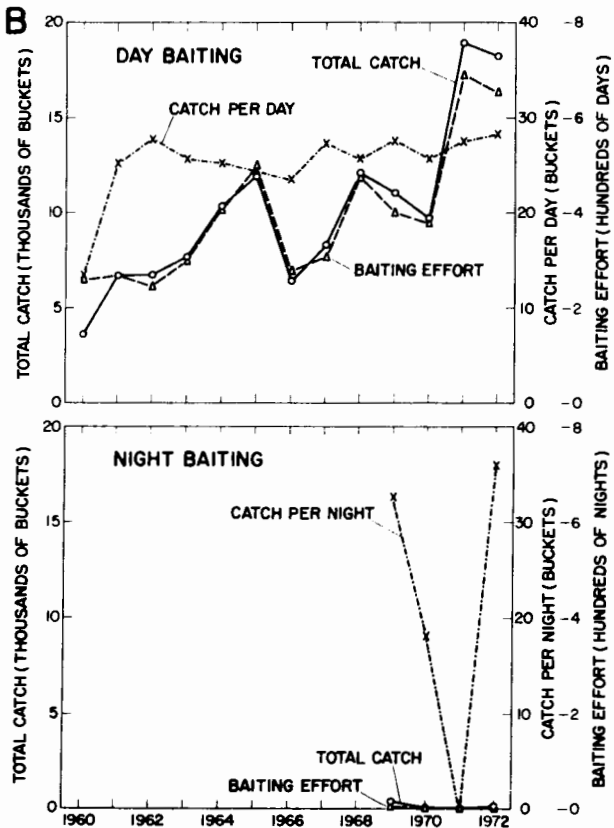
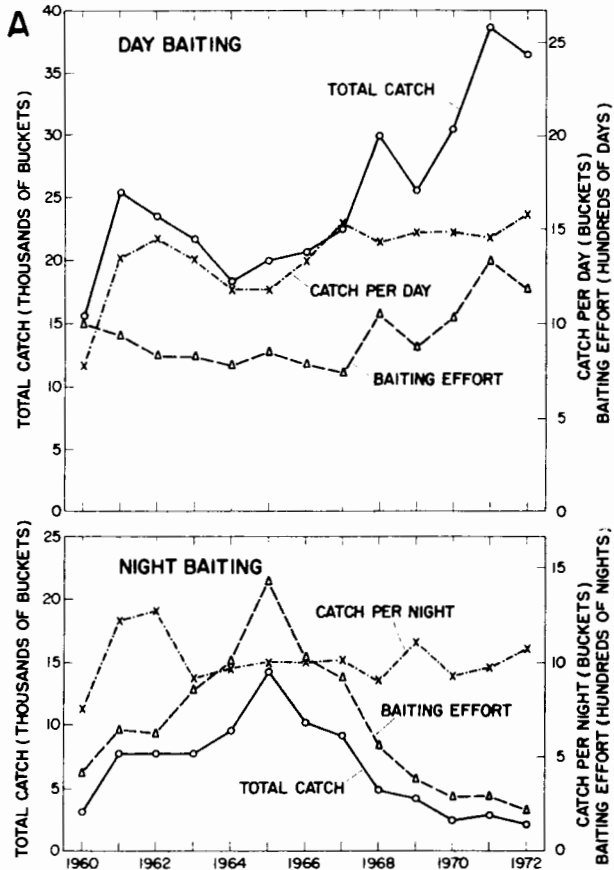
The effort expended in day baiting at Kaneohe Bay also varied widely. The progressive decline in baiting intensity in 1960-64 was reversed in 1965-72 (Fig. 3C). The low production in 1964 resulted from baiting effort of only 69 baiting days whereas the high production of 1970 resulted from expending 418 days on baiting. Over the 13-yr period, an average of 253 baiting days were expended at Kaneohe Bay, representing 27% of the statewide day-baiting effort.

The apparent abundance of nehu at Kaneohe Bay was lowest in 1960 when only 17.3 buckets/day were taken. The abundance index in the following year increased to 28.7 buckets and has not fallen below this level since (Fig. 3C). An estimate of 43.3 buckets/day in 1972 was the highest level attained by the index. The 1960-72 average was 34.7 buckets/day. This was roughly a third higher than the average calculated for Pearl Harbor.

Catches of day bait from Kalihi-Keeki Lagoon and Honolulu Harbor were small. Kalihi-Keeki Lagoon had an annual production which averaged 968 buckets and represented about 4% of the statewide day-bait catches. Both the catches and baiting effort in the day fisheries showed a downward trend (Fig. 3D). Day catches from Honolulu Harbor averaged 259 buckets/yr and accounted for only about 1% of the State's total. Catch and day-baiting effort fluctuated widely over the years but the trend in these indices was upward (Fig. 3E). From all other baiting areas, summarized under "Other Areas," production averaged 5,200 buckets/yr and represented about 20% of the State's production. The trend in catch and day-baiting effort was downward in 1961-67 and upward in 1968-72 (Fig. 3F).

NIGHT-BAIT PRODUCTION

From the annual catch statistics for night bait, it is evident that the catches, plotted over the years 1960-72, follow a bell-shaped curve with relatively low production in 1960-63, fairly high production in the mid-1960's, and back to low production in 1968-72 (Fig. 3A). Statewide data on night baiting show that in 1960, 3,069 buckets of nehu were caught in 408 nights of baiting. Production and baiting intensity rose to progressively higher levels until 1965 when 1,424 nights of baiting produced a peak catch of 14,251 buckets of nehu. A



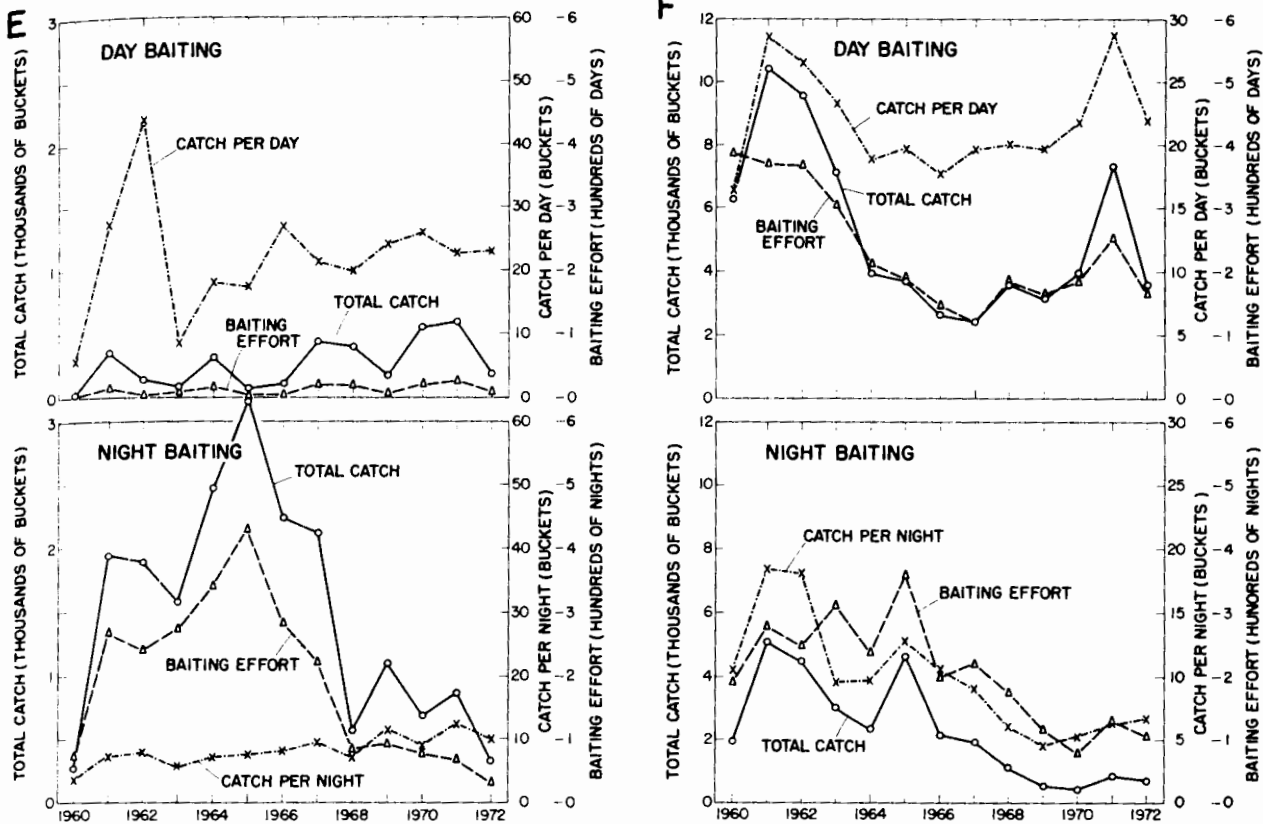


Figure 3.—Catch, baiting effort, and catch per effort in the day and night fisheries for nehu, in Hawaii, 1960-72. A. Total catch in Hawaii, 1960-72. B. Pearl Harbor. C. Kaneohe Bay. D. Kalihi-Keeki Lagoon. E. Honolulu Harbor. F. Other areas in Hawaii.

downward trend in night baiting started the following year and by 1972, only 2,187 buckets were produced in 206 nights of baiting. The average annual production and baiting intensity were 6,648 buckets and 659 nights, respectively.

Among the grounds contributing to night-bait production, Kalihi-Keeki Lagoon was by far the most important. In 1960-65, production rose sharply from a low of 188 buckets in 46 nights of baiting in 1961 to a high of 5,570 buckets in 547 nights in 1965 (Fig. 3D). A decline, starting in 1966, resulting from a change in emphasis to less night baiting and more day baiting, carried production progressively lower in subsequent years. The average annual production, representing about 35% of the statewide night catches, was 2,347 buckets. An average of 220 nights expended at Kalihi-Keeki Lagoon annually accounted for about 33% of the statewide night effort.

Estimates of nehu abundance at Kalihi-Keeki Lagoon were low in 1960-61, falling below six buckets per night in both years (Fig. 3D). Catch per night calculated for 1962-72 was 10 buckets or more and reached a peak of 15.0 buckets in 1972. The average for the 13-yr period was 10.7 buckets.

Second in importance in night-bait production was Honolulu Harbor. The night-bait catch from here was lowest in 1960 when 259 buckets were caught in 72 nights of baiting. An increase in night-baiting intensity in sub-

sequent years was reflected in progressively higher catches. In 1965 the production reached 3,175 buckets, a 12-fold increase (Fig. 3E). A steady decline in night-baiting intensity carried production progressively lower and by 1972, 30 nights devoted to night baiting produced only 303 buckets. The average annual catch was 1,464 buckets representing 22% of the statewide night production. Night effort at Honolulu Harbor amounted to 190 nights or 29% of the statewide night effort.

The abundance of nehu caught per night averaged 7.7 buckets in 1960-72. Whereas the abundance index was 9.5 buckets or less in 1960-68, it was higher in 1969 and in 1971-72. The peak of 12.4 buckets was attained in 1971 (Fig. 3E).

Among the remaining areas, several were relatively good for night baiting. Kaneohe Bay produced an average annual catch of 575 buckets or roughly 9% of the statewide night catches. Grounds at Hawaii and Kauai, included in the statistics for "Other Areas," were also moderately good for night baiting.

SUMMARY

The purpose of this report was to examine the trends in the production of nehu, *Stolephorus purpureus*, a live bait used for skipjack tuna fishing in Hawaiian waters. Briefly, the results showed that nehu constitutes roughly

97% of the bait caught in the Hawaiian Islands. Kaneohe Bay and Pearl Harbor, both of which are important baiting sites on Oahu, produce 71% of the bait. Another important site on Oahu, particularly for night baiting, is Kalihi-Keeki Lagoon.

Statewide, annual bait production in 1960-72 fluctuated between 22,849 and 42,098 buckets and averaged 33,658 buckets. Baiting effort varied from 1,271 days and nights in 1960 to 2,365 days and nights in 1965 and averaged 1,713 days and nights. Catch per effort fluctuated widely from 12.3 buckets in 1960 to 28.0 buckets in 1972 and averaged 19.6 buckets.

Day baiting produced 79% whereas night baiting produced 21% of the State's production. In 1960-72, day-bait production averaged 25,338 buckets, day effort averaged 936 days, and catch per day amounted to 27.1 buckets. The average annual production from night baiting was 6,648 buckets, whereas night effort averaged 659 nights. The catch per night was 10.1 buckets in 1960-72.

In general, catches and baiting effort in the day fishery for nehu showed a downward trend in 1961-65 and an

upward trend in 1966-72. On the other hand, catches and baiting effort in the night fishery showed an upward trend from 1960 to 1965 then declined steadily in 1966-72.

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