SOUTHWEST FISHERIES CENTER
HONOLULU LABORATORY
NATIONAL MARINE FISHERIES SERVICE
P.O. BOX 3830
HONOLULU, HI 96812

file copy

April 1986

ANNUAL REPORT OF THE 1985 WESTERN PACIFIC LOBSTER FISHERY

Prepared by

Robert A. Skillman
Southwest Fisheries Center Honolulu Laboratory
National Marine Fisheries Service, NOAA
Honolulu, Hawaii 96822-2396

and

Peter A. Milone and H. E. Witham
Southwest Region
National Marine Fisheries Service, NOAA
Honolulu, Hawaii 96822-2396

for

Western Pacific Regional Fishery Management Council

NOT FOR PUBLICATION

ADMINISTRATIVE REPORT H-86-6

Southwest Fisheries Center Administrative Report H-86-6

ANNUAL REPORT OF THE 1985 WESTERN PACIFIC LOBSTER FISHERY

Prepared by

Robert A. Skillman
Southwest Fisheries Center Honolulu Laboratory
National Marine Fisheries Service, NOAA
Honolulu, Hawaii 96822-2396

and

Peter A. Milone and H. E. Witham
Southwest Region
National Marine Fisheries Service, NOAA
Honolulu, Hawaii 96822-2396

for

Western Pacific Regional Fishery Management Council

April 1986

STATUS OF THE FISHERY

Introduction

This is the third annual report on the lobster fisheries managed under a fishery management plan prepared by the Western Pacific Regional Fishery Management Council (Council) since the plan came into effect in March 1983. The report provides the technical information stipulated in the Final Combined Fishery Management Plan, Environmental Impact Statement, Regulatory Analysis and Draft Regulations for Spiny Lobster Fishery (dated April 1982; page 163; hereafter referred to as the FMP).

There are three management areas for this fishery: Permit area 1, the Northwestern Hawaiian Islands (NWHI), permit area 2, the main Hawaiian Islands, and permit area 3, the islands of the territories of American Samoa and Guam. No permits were issued for area 3, and only three vessels were issued permits to fish in permit area 2 in 1985. Since the majority of the fishing took place in the NWHI, the bulk of the material presented in this report will relate to that segment of the fishery and results of fishing in the main Hawaiian Islands will be mentioned as appropriate. However, total statistics are provided for the entire fishery.

The fishery initially targeted on the spiny lobster, Panulirus marginatus, which is sometimes called the red or the two-spined lobster. The more inshore spiny lobster species, P. penicillatus, which is sometimes called the green or four-spined lobster, rarely enters the catch of the present fishery. Most fishermen differentiate between these species on the daily catch and effort logbook, but not on the processing and sales (trip) report. The fishery has recently been targeting on slipper lobster of which Scyllarides squammosus is the most common species taken. The larger, ridge-backed slipper lobster, S. haanii, is sometimes caught in fair numbers and the Chinese slipper lobster, Parribacus antarticus, is a rare component of the catch. For the most part, these species are not differentiated on either the logbook or the sales reports.

Current Events

Changes in the fishery in 1985 were evolutionary rather than new; however, this does not lessen the significance of the changes in landings, catch, catch rate, and species mixture. These events will be described in the individual sections that follow. However, one event is significant in that it has not occurred in a number of years.

When the fishery first started, only live lobsters were landed and marketing of this product seriously limited the development of the fishery. When the industry began landing primarily frozen tails, however, marketing no longer seriously restricted the development of the industry, although some suggest that the cyclical nature of the development of this fishery was dictated by economics rather than by the limited resource. With respect to marketability, spiny lobster tails from Hawaii are reported to rank between those from Australia and Brazil. In 1985, spiny lobster prices on the world market started strongly, but declined in the latter

part of the year. As a consequence of this general decline in prices, fishermen began reporting difficulty in receiving their set-back price from wholesalers and processors. Projections made in the following section on landings indicate that at the end of 1985 fishermen had in cold storage more unsold frozen tails representing an equivalent whole lobster weight greater than the total lobster catch for any year before 1980. Demand for frozen slipper lobster tails was reportedly good, resulting in a stable or slightly increasing price.

Landings or Sales

The source of the annual landings or sales statistics for lobsters in the NWHI fishery has varied over the history of the commercial fishery, which started in 1977. Estimates for 1977-79 were derived from confidential information voluntarily supplied by the pioneers of the industry to the National Marine Fisheries Service (NMFS), Southwest Fisheries Center (SWFC) and incorporated into the FMP source document. Landings data from 1980 to 1982, when the FMP was being prepared, were obtained by the SWFC by direct interview at the time of offloading. Lastly, data from March 1983 through 1985 were derived from the lobster processing and sales report, which the fishermen are required to submit. The statistics for 1983 and 1984 have been revised and presented in a different format from that of previous years (Tables 1 and 2). Since sales for 1983 were reported starting in March when the FMP came into effect, the reported statistics were expanded proportionally to represent 12 months. The weight estimates are in terms of whole lobster weight, and price was estimated based on estimated whole animal weight and estimated revenue. In lieu of any statistics, reported tail weight for slipper lobster was converted to whole weight using the percentage for spiny lobster (tail weight equals 35.6% of whole weight). Since people believe that the recovery ratio for slipper is not as good as that for spiny lobster, the estimated whole animal weights for slipper lobster are probably conservative.

Fishermen are required to report the sales of only spiny lobster by product type on the processing and sales report; hence, the report form does not contain any specific reference to a species name. Because this is a multispecies fishery, most fishermen have in fact reported the sales of spiny and slipper lobster combined (particularly for frozen tails); some report only spiny lobster sales, and in 1985 some fishermen began reporting the sale of spiny and slipper lobster separately at the request of the NMFS, Southwest Region (SWR). In addition, the SWFC has been able to obtain 1984 statistics broken down by species and product type from some fishermen. Thus, the reported sales data for 1984 and 1985 of frozen spiny and slipper lobster tails have been allocated to each species-product type according to the proportions of those vessels reporting them separately. Also, since sales reports were received for 34 out of 38 trips in 1984 and 53 out of 62 in 1985, the statistics in Tables 1 and 2 have been expanded to represent complete reporting by assuming direct proportionality (i.e., by multiplying by 38/34 and 62/53, respectively).

Based on the annual landings or sales statistics (Table 1), the spiny lobster fishery has oscillated dramatically in its short history (Fig. 1).

Starting off rather slowly with only 30 metric tons (MT) (72,000 lb) of spiny lobster landed in 1977, the fishery increased until 350 MT (780,000 lb) were landed in 1981. The landings declined considerably for the following 2 years, and then a new high was established in 1984 when nearly 360 MT (796,000 lb) of landings were reported. This level was exceeded in 1985 when landings of 500 MT (1,095,000 lb) were reported.

In 1984 when slipper lobster sales were first reported, estimated sales of slipper lobster equaled 147 MT (325,000 lb) while in 1985 the estimated sales increased to 320 MT (704,000 lb). The 1984 level of slipper lobster sales is comparable to the estimated landings for spiny lobster in 1980 and the 1985 level approaches the 1981 and 1984 sales for spiny lobster.

The primary product produced by the fishery continued to be frozen tails. For spiny lobster, estimated frozen tail sales in weight accounted for 91.6% and live and frozen whole products accounted for 7.7 and 0.7%, respectively. For slipper lobster, frozen tails accounted for 99.7% while the frozen whole product accounted for 0.3%.

The simple projections described above have another aspect; at the end of 1985 fishermen had more unsold frozen lobster tail in cold storage (representing an equivalent whole animal weight) than the fishery harvested in any year before 1980. Specifically based on the above projections, there were in terms of whole animal weight nearly 60 MT (137,000 lb) of spiny lobster and 40 MT (88,000 lb) of slipper lobster for a total of some 100 MT (225,000 lb).

Revenue and Economics

Estimated revenues in this fishery follow much the same oscillatory pattern as the estimated sales in weight (Fig. 1), but they also indicate how much the value of this fishery has grown over the years (Table 2 and Fig. 2). Spiny lobster revenue of $3,478,000 in 1985 sets a new high and while that in 1984 at $2,346,000 ranks third just behind 1981. Slipper lobster revenue increased substantially from $588,000 in 1984 to $1,306,000 in 1985. Thus, although sales of slipper lobster were not reported in earlier years, it is clear that slipper lobster has been and remains the secondary generator of revenue in the fishery. The total exvessel revenue in 1984 ($2,934,000) and 1985 ($4,784,000) places this fishery among the four highest valued commercial fisheries in Hawaii, along with those for large tunas, skipjack tuna, and bottom fishes.

In the early years of the fishery, live lobsters were the sole product of the fishery and generated all of the income (Table 2 and Fig. 3). During the period when the FMP was being prepared (1980-82), the industry began processing the catch and marketing frozen tails; however, precise sales information is not available, including data by product type. Since the FMP came into effect and more detailed data became available, frozen lobster tails have made up the largest proportion of the sales.

The price per pound data in Table 1 vary according to the mixture of product types as well as temporally. For the period 1980-82, the price

data may not be very accurate because data on landings and associated revenue or prices were not available by product type. Because all of the frozen product was either exported or transshipped to mainland destinations thereby rendering price data not readily available, the price estimates presented in the table were based to a large extent on the sales price for live spiny lobster in Hawaii. Thus, the revenue during this period is most likely overestimated, but the extent of the bias depends on the proportion of lobster tails and the difference in prices among product types. The price per pound for live spiny lobster and frozen lobster tails has increased fairly steadily (Table 2), but the price of whole spiny lobster has been essentially steady in 1983-85.

Although only a limited amount of data are available on the sale of different product forms by species, it is possible to examine the relationship among weight, number of frozen tails, and revenue per trip and average size. For slipper lobster (7 data points in 1984 and 19 in 1985), it can be seen that the average annual weight (sales), number (catch), and revenue per trip for frozen tails increased from 1984 to 1985 (Fig. 4), but the variance also increased, probably due to more vessels participating in the fishery and to greater diversity in vessel size. The price also increased from 1984 to 1985, but, in contrast, the variance was higher in 1984. This might be due to the buyers becoming more familiar with this relatively new or uncommon product. In contrast to these statistics, the estimated average size of slipper lobsters changed little from 1984 to 1985, and the variance was very small. When a multiple linear regression was attempted with price as a function of weight, revenue, number and average size in 1985, none of these potentially explanatory variables had a sufficiently high test score ($F_{1,17,alpha=0.1}=3.03$) to enter the equation. That is, ther was no significant statistical relationship between price of frozen slipper lobster tails and these potential explanatory variables in the available 1985 data.

For spiny lobster (5 data points in 1984 and 15 in 1985), the average landings in weight and catch in number per trip as well as average size in pounds per lobster differed little from 1984 to 1985 (Fig. 5). The amount of variation in the data was about the same from year to year, but was quite large for weight and number. However, revenue per trip and price in dollars per pound increased from 1984 to 1985, and the variation in the data was quite large. When a multiple linear regression was attempted for spiny lobster again using 1985 data, no significant relationship could be found at the low testing level used ($F_{1,13,alpha=0.1}=3.14$) for price as a function of the same potential explanatory variables as those used for slipper lobster.

Catch

Catch statistics are derived from logbooks submitted by the fishermen on the form "Daily Lobster Catch Report per Statistical Area;" submission of these logbooks is mandatory. Since this is an annual report on the fishery, all summaries in this and the following sections are by date of landing. The catch figures for 1984 have been revised from the 1984 annual report after a computer programming error was found.

Catches for the fishery conservation zone around the main Hawaiian Islands were first reported in 1984 when one vessel made one trip (Table 3), and then again in 1985 when two vessels made three trips. Catches were small in both years.

The total 1984 catch of legal spiny lobster was 4.2 times that for 1983 and the total 1985 catch was 6.1 times the 1983 catch and 1.4 times the 1984 catch. The total 1984 total catch of slipper lobster was 11.1 times that in 1983, and the total 1985 catch was 46.5 times that in 1983 and 4.2 times that in 1984. Since some fishermen report only total catch of slipper lobster without separating those kept for sale, returned because they were berried, or too small to keep, only reported total catch statistics are given in this report.

The catch of sublegal, berried, and total spiny lobster follow similar trends to those for legal lobster.

In 1983, the fishery was conducted around three islands; Gardner Pinnacles was added to the old stand-bys, Necker Island and Maro Reef. In 1984, three additional islands were fished as well as the main Hawaiian Islands. In 1985, 13 islands were fished, which includes about all of the fishable banks in the NWHI, as well as, again, some trial fishing in the main Hawaiian Islands.

In 1983, the ranking of islands by the size of catches for spiny and slipper lobster was Necker, Maro, and Gardner. In 1984, these same three islands were again the most important, but their ranking varied with species, namely Maro, Necker, and Gardner for legal spiny lobster and Gardner, Maro, and Necker for slipper lobster. In 1985, the ranking of the islands changed again, and an area fished for the first time, St. Rogatien Bank, ranked in the top three. Specifically, the most important islands for legal spiny lobster catches were Maro, St. Rogatien, and Necker, and for total spiny lobster they were Maro, Necker, and St. Rogatien. For slipper lobster the most important islands were Maro, Gardner, and St. Rogatien.

The proportion of the various species and species categories in the annual catch statistics has changed considerably over the past 3 years (Fig. 6). In 1983, the catch of legal spiny lobster made up a major portion of the catch (64.6%) of all lobsters caught and sublegal spiny lobster accounted for the second largest proportion (20.8%). Slipper lobster accounted for only 10.5% of the reported catch. In 1984, the total catch of legal spiny lobster still made up a majority of the catch, but the percentage had fallen to 52.8%. The reported catch of total slipper lobster had become second highest (22.5%). In 1985, there were dramatic changes in proportions: No species or species category made up a majority of the catch and total slipper lobster made up the largest portion of the catch at 45.4%. The catch of legal spiny lobster fell to 36.5% of the total.

The proportion of total slipper and total spiny lobster categories in the total catch of all lobster has also varied considerably by year and by island within year (Table 4). In 1983, total spiny lobster catch made up the highest proportion by far at all three islands fished (Gardner, Maro,

and Necker). This was true also in 1984, but the proportion of slipper lobster increased at these same three islands and showed relatively high levels on some of the new islands added to the fishery. In 1985, a marked change occurred in the fishery, i.e., total spiny lobster just maintained a majority in the cumulative catch for all islands and lost its majority on some islands, including the major fishing grounds, Maro Reef and Gardner Pinnacles.

A comparison of the reported catch from logbooks (in number) from log books with the estimated weight sold statistics derived from the processing and sales report at the end of the Landings chapter suggests that there is a discrepancy between these statistics (Fig. 7). If the catch statistics are accepted as being relatively unbiased with regard to trend, then estimated sales of spiny lobster were overestimated and slipper lobsters under estimated. At least three sources of error are possible. First, those vessels not reporting the sale of frozen spiny and slipper lobster tails separately have catches of these two species in different proportions than those that have report them separately. Second, those vessel trips for which sales reports have not yet been received have sales of a different magnitude than those for which reports have been received. And third, these two errors may have different relative magnitudes in different years.

Fishing Effort and Catch Per Unit Effort

Although the number of fishing vessels and trips is not useful as a measure of fishing effort from a population dynamics viewpoint, it is instructive to review the trend of these statistics (Table 1). In 1977, 5 vessels entered the fishery and made 14 trips during which the operators explored different fishing areas on Necker Island, experimented with different gear configurations, and performed many other activities involved in establishing a new fishery. The number of vessels declined to two or three vessels from 1978 to 1980 although the number of trips did not differ by much. In 1981 a high of 10 vessels and 25 trips was recorded, but participation declined again until 1983 when only four vessels made 19 fishing trips. Participation increased strongly in 1984 and then again in 1985 when 16 vessels made 62 fishing trips. (There was one additional fishing trip not included in the statistics because of the quality of the fishing effort statistics.)

Thus, participation is this fishery could be described as being cyclical.

Seasonally, the number of boats landing has also followed a cyclical pattern, a low number of landings in January followed by an increasing number until early spring (Fig. 8). After a sharp decrease, the number of vessel landings increases through late summer, and then after a moderate decline vessel landings increase in December as most of the fishermen try to be in port over the holidays. The distribution of trap-nights fished follows a similar pattern, but shows a declining trend through the summer followed by high's in October and December (Fig. 9).

The number of days fished and the number of trap-nights fished are measures of fishing effort more closely related to fishing mortality, particularly the latter, and thus generally of use in stock assessment. Monthly statistics on trap-nights are described above (Table 5 and Fig. 9), and data on variation by island and year are presented in Table 6. The number of fishing days in 1984 was 3.0 times that in 1983 and in 1985 was 6.0 times that in 1983 and 2.0 times that in 1984. The number of trap-nights fished in 1984 was 4.9 times that in 1983 and in 1985 was 14.2 times that in 1983 and 2.9 times that in 1984. Thus, the amount of fishing effort expended in the fishery increased markedly in 1984 after the fishery came under management in 1983, and this trend continued, although not as strongly, in 1985. It should be pointed out that the fishing power of the traps has not remained constant since 1983 due to changes in gear and fishing strategy. The commercial fishing vessels used wire mesh, wooden slat, and black plastic traps in 1983, black plastic traps with standard and short entrance cones in 1984, and long coned black plastic traps in 1985. In addition, the vessel operators can target on spiny or slipper lobster by changing the depth and bottom fished. Thus, the fishing effort statistics may not be useful for assessment purposes.

The length of fishing trips has been increasing since the fishery came under management in 1983. In the first year under management, average trip length (excluding travel time) was 14.4 days, and in 1984 and 1985 the average rose to 22.2 and 27.0 days, respectively.

For the main Hawaiian Islands, only 2 days of fishing and 50 trap-nights were reported in 1984 and none was reported in 1983. In 1985, fishing effort increased to 32 days and 7,160 trap-nights, which represents only 1.9% and 0.7% of the total fishing effort expended in the fishery, respectively.

The number of days and trap-nights fished has varied considerably by island from year to year. For days fished, the fishing grounds at Necker Island, Maro Reef, and Gardner Pinnacles received the greatest amount of fishing effort in all 3 years since management regulations went into effect. In 1983 and 1984, the descending order of the islands with respect to number of fishing days was as listed above, and in 1985 Maro Reef displaced Necker Island as the most heavily fished island. With respect to trap-nights fished, the islands receiving the greatest amount of fishing effort, in descending order, were Necker, Maro, and Gardner in 1983, Maro, Gardner, and Necker in 1984, and Maro, Necker, and St. Rogatien in 1985. Thus, with respect to fishing effort, Necker Island has been either the most important fishing ground or within the top three since the fishery started in 1977.

The annual catch rate in terms of catch per trap-night (Table 6 and Fig. 10) for legal spiny lobster has declined from 2.05 in 1983 to 1.17 in 1984 to 0.88 in 1985. Polovina[1] indicates that the catch rates for

---

[1]Polovina, J. J. 1985. Status of stocks of spiny lobsters at Necker Island and Maro Reef, 1985. Southwest Fish. Cent., Natl. Mar. Fish. Serv., NOAA, Admin. Rep. H-85-12, 11 p.

the wire mesh and the black plastic trap with standard length entrance cones are comparable for legal spiny lobster. Catch rate for sublegal spiny lobster stayed about the same from 1983 to 1984 (around 0.6), but declined to 0.32 in 1985, and the catch rate for berried spiny lobster fluctuated, showing no upward or downward trend. Results from Polovina indicate that the black plastic traps catch more sublegal spiny lobster than the wire mesh traps. For slipper lobster, the catch rate increased from 0.33 per trap-night in 1983 to 0.75 in 1984 and to 1.09 in 1985. And, Polovina found that the black plastic trap with standard entrance cones caught four times as many slipper lobsters as the wire mesh traps, which is greater than the ratio of 1985 to 1983 catch rate. Changes in the fishing power of the traps and in the catch rates suggest that the relative abundance of legal and sublegal spiny lobster has declined since the management plan came into force and that for slipper lobster has remained about the same. Although it has been suggested that this might be due to a switch in species dominance on the grounds due to overfishing of one species, the rapidity of the change indicates that changing fishing strategy would probably be a more likely cause. Indeed, fishermen have said that weather conditions contributed to their movement out of shallower spiny lobster grounds and into deeper slipper lobster grounds. However, changing fishing strategy is hard to evaluate. If fishermen began targeting more on slipper lobster at the expense of spiny lobster, then this could account for some of the decline in spiny lobster catch rate. It would also account for some of the increase in slipper lobster catch rate; however, slipper lobster catch rate did not increase as much as expected from 1983 to 1985 based on differential catching power of wire and black plastic traps with standard length entrance cones. In addition, fishermen say that traps equipped with long entrance cones outfish traps with standard cones for both species of lobsters. Thus, it could be argued that the indices of relative abundance (catch per trap-night) for spiny and slipper lobsters have both declined.

Catch rate of legal spiny lobster has changed considerably at the three islands that have been heavily fished from 1983 to 1985. The catch rate at Necker has gone down from 2.34 in 1983 to 2.16 in 1984 and 0.88 in 1985, and has gone through a similar change at Gardner (1.83, 1.71, and 0.59). At Maro the catch rate increased from 1.38 in 1983 to 1.75 in 1984, but declined to 0.97 in 1985. Catch rates for sublegal and berried spiny lobster have been quite low on all islands except for sublegal lobsters at Necker. In this case, the catch rate increased from 1.01 in 1983 to 2.12 in 1984, but declined to 1.01 again in 1985. The change from 1983 to 1984 could be due to changing to black plastic traps from wire mesh traps, but the change in 1985 is probably real. In 1983 and 1984, the catch rate of slipper lobster did not exceed that of spiny lobster at any of the islands fished. However, in 1985 the catch rate of slipper lobster exceeded that of spiny lobster at Brooks Bank, Gardner Pinnacles, Lisianski Island, Maro Reef, and Northampton Seamounts, and at Gardner and Maro this represents a reversal from previous years.

The monthly catch rate statistics show quite a diverse pattern within and among the species categories (Fig. 11). Superficially, it appears that every year is unique. For the catch rate of legal spiny lobster, there

seems to be little similarity among the years, and there is no obvious seasonal trend. For sublegal spiny lobster, two things stand out. First, high and low catch rates seem to alternate through the years, and second, catch rates were usually high in July and September of 1983 and 1984, respectively, which could suggest the entry of large numbers of prerecruits onto the fishing grounds. For berried spiny lobsters, the 3 years again do not have very similar trends, and, at this level of examination, there is little indication of any seasonality. For slipper lobsters, there is again little similarity among the 3 years and no consistent seasonal cycle of catch rate.

Changes in the Fishery

Changes in species composition, size composition (legal and sublegal differences), and proportion of berried lobster in the catches can be determined from the logbook data provided by the fishermen (Table 7). The proportion of total spiny lobster to total slipper lobster in the catch has declined from predominately spiny lobster in 1983 to a level approaching par in 1985. This change is made up not only by the addition of fishing grounds on which slipper lobster catches predominated, but also to the declining importance of spiny lobster on fishing grounds used by the fishery for a number of years. Much the same trend is apparent if the proportion of legal spiny lobster to total slipper lobster caught is examined (the second column in Table 7). In 1985, spiny lobster catches in order of importance predominated at Necker Island, St. Rogatien Bank, Pearl and Hermes Reef, Kure Atoll, Nihoa, Raita Bank and French Frigate Shoals. Slipper lobster catches in order of importance predominated at Maro Reef, Gardner Pinnacles, Brooks Bank, Northampton Seamounts, and Lisianski Island; before 1985 spiny lobster catches were more important at Gardner Pinnacles and Maro Reef.

Within the spiny lobster annual catch (Table 7, the last three columns), legal lobsters make up the largest proportion although the magnitude of the ratio has declined from 0.722 in 1983 to 0.669 in 1985. The proportion of sublegal lobsters increased slightly in 1984 and then remained stable and the proportion of berried spiny lobster has increased slightly over the 3 years. The proportions of legal and sublegal spiny lobster at some of the islands differ considerably from the average annual statistics given above. Necker Island has always had a lower proportion of legal spiny lobsters, and by 1985 sublegal lobsters predominated in the catch for the first time. Unusually high proportions of berried spiny lobster were caught at Nihoa in 1984 and at Lisianski Island in 1985.

The average size of spiny lobster in the fishery increased from 9.3 cm carapace length (CL) (6.1 cm TW3) in 1983 to 9.5 cm CL (6.2 cm TW3) in 1984 and then declined to 8.8 cm CL (5.8 cm TW3) in 1985. However, 1983 measurements came only from live animals originating from Necker Island whereas measurements were from live lobsters and frozen tails from three islands in 1984 and five islands in 1985.

The monthly data on the proportion of total spiny to total slipper lobster and legal spiny to total slipper lobster (Table 8) show that the proportion of spiny lobsters in the catch declined markedly between 1983

and 1984 and then declined further in 1985 (Fig. 12). Thus, the major change in fishing strategy, i.e., targeting more on slipper lobsters, actually occurred in 1984 while the impact of this change on catch rate and species composition was not recognized until 1985. For spiny lobster overall, the proportion of legal lobsters is greater than that of sublegal spiny lobsters and the latter is greater than that of berried lobsters. There is substantial monthly variability, but no apparent seasonality in these ratios.

Council Action

During 1985 the Council initiated two emergency regulations. The first of these became effective on 25 April 1985 and consisted of the following provisions: 1) eliminated the use of carapace length to define a legal spiny lobster and substituted a tail width measurement instead, 2) established a new site for measuring tail width, 3) defined the minimum size as 4.8 cm TW3, and 4) eliminated the allowance for retaining undersized lobster tails. It is possible for emergency regulations to stay in effect for two consecutive 90-day periods; this emergency action expired on 22 October 1985.

The second emergency regulation became effective on 1 October 1985 and placed a moratorium on the entry of new boats into the NWHI fishery and restricted boats in the fishery from carrying more lobster traps than recorded on their current permit application. This emergency regulation expired in January 1986.

The Council prepared a third amendment to the plan in October 1985, and this amendment proposed to formally incorporate the elements of the first emergency action into the FMP. No decision had been made by the end of 1985 to implement the amendment.

Research

New tail width measurement.--There are a number of enforcement problems associated with the tail width measurement defined in the initial regulations (this measurement shall be called TW1) as well as the minimum size being defined in terms of carapace length for whole lobsters and tail width for frozen tails. Specifically, these problems involve ice or frozen meat covering the tail width measuring site or the shell at the measuring site being broken, and the technical difficulty of determining whether not more than 15% of the landings of frozen tails from a vessel fall below 5.0 cm TW1 (being equivalent to 7.7 cm CL) but above 4.5 cm TW1. Because of this, the SWR requested that the SWFC establish a new tail width measurement and a minimum size equivalent to 7.7 cm CL.

In consultation with the SWR enforcement officers, a new site posterior to the original site was proposed. This new measurement (TW2) could be described as the minimum distance across the tail measured between the first and second abdominal segments. While data were being collected on a cruise of the NOAA ship Townsend Cromwell in October 1984, it was found that the thick templates used by the industry to determine minimum size would not fit into the pits at the distal ends of the measuring site.

Thus, the enforcement officers and Council staff proposed an alternative measurement site (TW3) in nearly the same area that could be described as the maximum distance measured across the tail between the first and second tail segments. Because of the change in measurement site and because of the desirability of collecting samples from as many fishing areas as possible under commercial fishing conditions, observers were place on two commercial fishing vessels in late April, May, and June 1985.

Since the determination of the 7.7 cm CL minimum size was based on female spiny lobster, a functional regression relating TW3 to CL for females was determined:[2]

$$TW3 = 4.2169 + 0.6265 * CL \quad .$$

This equation provides a TW3 estimate of 5.2 cm at 7.7 cm CL. For comparative purposes, relationships for males and both sexes combined were calculated:

$$TW3 = 8.8631 + 0.5325 * CL \text{ for males and}$$

$$TW3 = 6.0863 + 0.5856 * CL \text{ for both sexes.}$$

During subsequent discussions at Council meetings, industry members indicated that the 5.2 cm TW3 size would preclude them from harvesting lobsters that they had been legally harvesting under current regulations, namely the 15% tolerance falling between 5.0 and 4.5 cm TW1, and they argued that these small sized lobsters are needed to leverage the sale of their entire load. The SWFC initially recommended adopting 5.2 cm TW3 as the minimum size, and the Crustacean Plan Development Team and the Scientific and Statistical Committee recommended 5.1 cm TW3 as an acceptable compromise. The Council decided to adopt 4.8 cm TW3 as the minimum size for spiny lobster, and an emergency regulation to that effect was put into place for 90 days on 15 April 1985.

For comparative purposes, equivalent estimates for CL, tail weight in grams and ounces for males and females, TW2 and TW3 using female data, and TW3 using data from both sexes are presented in Table 9.

Escape vent research.--The SWFC began conducting research on escape vents in 1984 for the following reasons: 1) sublegal spiny lobsters make up a large proportion of the catch in the NWHI fishery, 2) handling of these lobsters is suspected to cause substantial mortality on released animals based on observations in this fishery (Gooding 1985), and 3) such handling has been shown to cause decreased growth and increased mortality in the western Australian fishery (Brown and Caputi 1983). Laboratory and

---

[2]Skillman, Robert A. Estimation of minimum tail width size for legal spiny lobster in the Northwestern Hawaiian Islands fishery. Manuscr. in prep. Southwest Fish. Cent., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396.

field research in 1984 on the NOAA ship Townsend Cromwell showed that escape vents result in a significantly smaller catch of sublegal spiny lobsters while the catch of legal lobsters at least stayed the same. When catch rates were higher than the generally low catch rates obtained on the two cruises, then catches of legal spiny lobster were higher in vented traps than in control traps with no vents, but this was not statistically significant. Also, a response surface statistical model was developed that allows accurate estimation of the escape vent height depending on the minimum lobster size chosen for management.

As expected during the early stages of designing these experiments, the field experiments indicated that slipper lobster escapement was significant from traps with vents. Hence, the SWFC extended the experiments to address this problem. Laboratory trials in 1985 indicated that escape vents located on the upper edge of the side panels resulted in significantly less escapement of slipper lobsters than did vents located either in the typical location on the lower edge of the side panels as used in other fisheries and in the SWFC's 1984 trials, or on the top panel of the black plastic lobster pots. During the field trials in November and December 1985, it was found that the catch of slipper lobsters in traps with vents located on the upper edge of the side panels was 31% of the catch by the control trap. Although this is better than the 20% figure for vents located along the lower edge, it is less than expected. The length measurements taken on the cruise indicated, as would be expected, that the escape vents allow the escapement of the smaller slipper lobsters. Since many of these lobsters are in fact returned by fishermen, estimation of the effectiveness of the vents relative to slipper lobster escapement will have to await the estimation of a preliminary minimum size based on yield-per-recruit analysis and assessment of spawning stock biomass dynamics. Catches of legal spiny lobster by the traps equipped with vents located along the upper edge was 21% greater than the nonvented traps, and the traps with vents in the lower location had catches 15% greater than the control traps. The catch per trap-night for the high vented traps on this cruise was 2.93 for legal spiny and 1.28 for non-berried slipper lobster. These results compare favorably with industry results during the same period on the same grounds; in fact, they are higher.

Stock assessment.--The catch rate (catch per trap-night) of spiny lobster for the entire fishery in 1985 was down 50% from 1984 and 57% from 1983, and the trends were similar at Necker Island (59 and 62%) and Gardner Pinnacles (65 and 68%), from 1985 to 1984 and then 1983 (Table 6). At Maro Reef, the 1985 catch rate was down 45% from 1984 and 30% down from 1983 (i.e., 1984 catch rate was greater than in 1983). However, while this was occurring, the catch rate of slipper lobster was increasing: The 1985 catch rate was 145% of that in 1984 and 330% of that in 1983 for the entire fishery. For the three islands that were in the fishery from 1983 to 1985, comparable percentages are 121 and 591% for Gardner Pinnacles, 246 and 259% for Maro Reef, and 92 and 252% for Necker Island. Thus, catch rate of spiny lobster has declined since 1983 and that for slipper lobster has increased. Although changes in fishing power of the traps relative to both species led to the conclusion that the relative stock abundance of spiny lobster has gone down and probably that of slipper lobster too, it is, nonetheless,

not clear whether they can be used for stock assessment purposes because these catch rates may not necessarily accurately measure stock abundance.

In addition to problems of changes in fishing power of the traps, this is now clearly a multispecies fishery, and the effort statistics have not been allocated to that directed toward each species as would be necessary if the catch per unit effort statistics were to accurately measure abundance. Although fishermen can target on spiny or slipper lobster by changing the depth at which they fish and by setting in different habitats, it is not readily clear how to separate the effort statistics post facto based on the statistics submitted to the NMFS. It could be argued that there would have been little incentive for the industry to develop their ability to fish on slipper lobster if the catch rate of spiny lobster had not been falling.

All that can be said at this point using catch per unit effort statistics for legal lobsters, is that stock density of both species probably has declined, but no statement can be made about the health of the stock without further study.

Since the overall proportion of sublegal spiny lobster in the catch has not changed appreciably since 1983, it would appear that there is no gross evidence of reduced recruitment into the fishery (Table 7). On the three islands fished during these 3 years (Gardner, Maro, and Necker), the proportion of sublegal lobsters has actually increased, but the proportion of legal spiny lobsters in the catch has likewise declined. Thus, although use of proportions of legal and sublegal spiny lobsters in the catch is a rather crude means of looking at recruitment, no radical changes in recruitment seems to have taken place in the fishery.

The proportion of berried spiny lobster has increased since 1983. Although some of this increase is due to the decreased catch of legal spiny lobsters, the statistics indicate that mating has not been impaired. There is one area of concern, namely Necker Island, where the proportion of berried lobsters decreased from 1984 to 1985. However, the large proportion of sublegal lobsters in the catch at Necker could contribute to this result.

In August 1985, the SWFC conducted a stock assessment research cruise at Necker Island, Maro Reef, and Laysan Island by resampling the same 0.1° square quadrants sampled in 1977 and by using the same two-chambered wire mesh trap as well as the new back plastic trap for comparison. The results from the wire traps suggest that the standing stock of the spiny lobster population that can be trapped has been reduced to 40% of its unexploited level at Necker Island, 63% at Maro Reef, and 62% at Laysan Island (see footnote 1). The reduction at Laysan is not statistically significant due to high variance and that at Necker cannot be tested because only two quadrants were sampled. Slipper lobster stocks appear unchanged, but the catch rates of the wire traps were quite low. When the catch was divided into legal (>7.7 cm CL) and sublegal (7.0-7.7 cm CL) size classes, greater reduced levels were seen in legal animals (26, 51, and 75% of pre-exploitation levels at Necker, Maro, and Laysan) than for sublegal lobsters (74, 92, and 71%, respectively). Again, only the Maro estimate for legal lobsters was significant, and none of the estimated reductions for sublegal lobsters

was significant. If the reduction of sublegal lobsters at Necker were true, then it could be caused by retention of animals below the legal limit but included within the 15% tolerance zone, mortality due to handling, or reduced recruitment. Using the Beverton and Holt yield equation and estimates of growth and mortality based on work on inshore stocks and assuming the existing level of fishing mortality, Polovina estimated for Necker Island that a reduction in tail width from 5.1 to 4.8 cm TW3 would reduce the spawning stock biomass to 70% of its level under the 5.1 cm tail size (or 25% from the 1977 level). If the level of recruitment is not reduced, then yield would increase by 15%. For Maro Reef, it was estimated that spawning stock biomass would be reduced to 86% of the level under the 5.1 cm regulation (or 52% of the 1977 level), and yield would increase by 7%, if recruitment were not reduced. Polovina concluded that reduction of the tail width size from 5.1 to 4.8 cm at Maro Reef and most other islands and banks showing similar population structure would not be detrimental to the stocks and could increase yield. He cautioned that as the size of the harvestable population declined, the proportion of sublegal lobsters entering the traps would increase and be subjected to increased mortality, which could then lead to a situation that is now seen at Necker Island. Other researchers at the Honolulu Laboratory cautioned that there is a four year lag in possible effects of fishing on recruitment and that the effects of increased fishing in 1981 may just now becoming apparent.

Other.--Three papers on recruitment and queuing behavior of spiny lobster and the occurrence of the Chinese slipper lobster were published in 1984, but not mentioned in the 1984 annual report (MacDonald 1984; MacDonald et al. 1984; Morin and MacDonald 1984). In addition three papers on recruitment and recreational fishing have been submitted for publication, but were not available for review.[3,4,5]

Endangered Species Interactions

The daily logbooks provide for reporting of interactions with monk seals and turtles in the lobster fishery. Out of 1,653 fishing days, fishermen reported seeing monk seals in the statistical area being fished on 61 days and in the vicinity of the fishing gear on 29 days (Table 10). They also reported observing monk seals preying on released lobsters on 6 days. Most of the observations in statistical areas came from Necker Island followed by St. Rogatien Bank and Gardner Pinnacles. Surprisingly

---

[3]MacDonald, C. D. Oceanogragphic climate and Hawaiian spiny lobster larval recruitment. Proc. of the Hawaiian Ocean Experiment Workshop, University of Hawaii, Honolulu, Hawaii, January 21-24, 1985.

[4]MacDonald, C. D. Puerulus recruitment in the Hawaiian spiny lobster Panulirus marginatus. Proceedings of the International Workshop on Lobster Recruitment, Canada Department of Fisheries and Oceans, New Brunswick, Canada, June 30-July 5, 1985. Can. J. Fish. Aquat. Sci.

[5]MacDonald, C. D., and T. Thompson. Characteristics of a recreational fishery for spiny lobsters at the Midway Islands. N. Am. J. Fish. Manage.

few observations were reported at Maro Reef given the amount of fishing effort there. Turtles were reported in the statistical area being fished and in the vicinity of the gear on only 3 days.

Recommendations

The SWFC makes the following recommendations regarding research and management of the NWHI lobster fishery.

1. Conduct annual stock assessment cruises to the NWHI to assess the stocks of spiny and slipper lobsters.

2. Implement a requirement for use of escape vents in lobster traps to promote the escapement of sublegal spiny and slipper lobsters.

3. Implement management regulations for slipper lobster, including initially a minimum tail width.

4. Improve the assessments of maximum sustainable yield and standing stock biomass for spiny and slipper lobster.

5. Require reporting the sales of slipper lobsters by product type.

6. Require reporting of sublegal and berried slipper lobster catches in addition to the catch of legal animals.

7. Improve the size composition coverage of lobster landings by establishing a sampling program for transshipped frozen tails.

8. Improve the collection of socio-economic data by improving the permit application form and by other means.

9. Place an observer on a commercial vessel at least once a year to collect size measurements from the catches and verify estimates of sublegal and berried lobsters.

ADMINISTRATIVE AND ENFORCEMENT ACTIVITIES

The year 1985 marked the third year of enforcement of regulations since implementation of the spiny lobster management plan in March 1983. During 1985 a record number of vessels were issued permits for the spiny lobster fishery, however, the total number of vessels which actually participated in the fishery was significantly lower than the number actually permitted. With record landings of spiny and slipper lobster in 1985, NMFS enforcement officers also reported a sharp increase in violations. The majority of violations were for the retention of sublegal spiny lobsters.

The enforceability of spiny lobster regulations continued to pose a problem in 1985, and enforcement officers continued their effort in trying to gain compliance with the regulations through a program of education.

Enforcement of a minimum size limit for spiny lobsters without any tolerance for the take of sublegal lobsters was carried out over a 6-month period in 1985 through enactment of an emergency regulation.

Permits to Fish

A record 45 vessels were issued permits to fish for lobsters in 1985. This compares with 19 permits issued in 1984 and 14 issued in 1983. Total trap carrying capacity for permitted vessels in 1985 was 31,150. Of the 45 vessels issued permits only 3 requested permits to fish in the FCZ around the main Hawaiian Islands. All the others were permitted for the NWHI. Despite the record number of permits issued in 1985 only 16 of the 45 permitted vessels actually participated in the fishery. This represents an increase of 5 vessels from the 11 vessels which actively fished in 1984. The 16 active vessels carried a total of 12,250 traps. This represents a marked increase from 5,240 traps carried by the active fleet in 1984 and 1,200 traps used by the active fleet in 1983 (Table 11).

A moratorium on the issuance of new permits and a limit on the number of traps carried by permitted vessels were put into effect by emergency regulations requested by the Council. The moratorium was in effect from 1 October 1985 to 30 December 1985.

Enforcement Activities and Violations

In 1985, NMFS enforcement agents inspected 34 landings of lobsters, all in Honolulu. In addition, U.S. Coast Guard patrol vessels boarded seven lobster vessels at sea. A total of 22 violations were reported for which agents issued 16 Enforcement Action Reports and 6 verbal warnings. This compares to a total of eight violations reported in 1984. Of the 22 violations reported, 12 involved the retention of sublegal lobsters (3 of which also involved the retention of berried lobsters), 3 vessels were cited for failure to keep accurate logbooks, 3 were cited for failure to report their Honolulu arrival time 24 h in advance, 3 were cited for fishing without a license, and one vessel was cited for failure to report its sale of lobster. A summary of 1985 enforcement actions is contained in Table 12.

Enforcement Problems

As in 1984 the major problem confronting enforcement of the spiny lobster regulations was the unenforceability of the 15% tolerance for sublegal lobsters. The inability to obtain a random sample from a vessel's catch and the impracticality of measuring the entire catch of lobsters on a vessel precluded effective enforcement of a minimum size limit in the fishery for much of the year.

However, from 25 April to 22 October 1985, emergency regulations were in effect which eliminated the 15% tolerance for sublegal lobsters and established a single minimum size tail width measurement of 4.8 cm for spiny lobsters. This action greatly simplified enforcement of the minimum size limit and appeared to generate a more conscientious effort by lobster

fishermen to comply with the regulations. Permanent elimination of the 15% tolerance for sublegal lobsters under Amendment 3 to the lobster FMP will significantly improve the lobster enforcement program.

The requirement that fishermen maintain complete and accurate fishing logs continues to be a difficult one to enforce. It is believed that the majority of fishermen estimate their daily catch of sublegal and berried lobsters. Without a means of cross-checking logbook records only the most flagrant and erroneous logging violations can be detected.

The 24-h advance notice requirement before landing spiny lobsters also continues to pose problems. The NMFS enforcement agents have worked closely with Coast Guard communications personnel to improve the communication links between vessels at sea and NMFS enforcement staff.

As participation and competition in the lobster fishery grows, an increase in gear conflict is likely in the limited areas targeted by lobster fishermen. Several past incidents and complaints make evident this possibility. In view of this potential problem, consideration should be given to requirements for owner markings on lobster gear and installation of rot out panels to prevent any possibility of ghost fishing.

Recommendations:

1. The SWR recommends that the Council restructure the spiny lobster FMP as a framework plan to allow more timely response to changes in the fishery. A framework approach will give the Council greater flexibility in managing the fishery without having to promulgate emergency regulations or rely on the lengthy plan amendment process.

2. The SWR recommends that the Council proceed as quickly as possible to implement an escape gap requirement for traps used in the fishery to allow escapement or sublegal spiny lobsters while allowing retention of slipper lobsters.

3. The SWR supports the Council's decision to assess the need for management measures for slipper lobsters which emerged as a significant component of the catch in 1985.

4. With the stated intent of the CNMI to participate fully in Council activities, the SWR recommends that the Council begin to consider revisions to the FMP which will encompass spiny lobster management needs in the FCZ of the CNMI. Council discussion of these matters should begin only when representatives of the CNMI take their seats on the Council.

SUMMARY

1. Most of the fishing regulated by the lobster fishery management plan took place in the Northwestern Hawaiian Islands; there were a few exploratory cruises to the main Hawaiian Islands, and there was no fishing in American Samoa or Guam.

2. In 1985 estimated sales (expanded from reported values) reached a record high for spiny and slipper lobster in the fishery: 500 MT (1,095,000 lb) of spiny lobster valued at $3,478,000 and 320 MT (704,000 lb) of slipper lobster valued at $1,306,000.

3. Likewise, catch reported on logbooks for spiny and slipper lobster was the highest recorded since the fishery came under management in March 1983. The reported spiny lobster catch of 956,042 legal animals was 6.1 times that in 1983, and the reported slipper lobster catch of 1,189,842 was 46.5 times that in 1983.

4. The fishery expanded to include 13 different fishing grounds in the Northwestern Hawaiian Islands.

5. The three most important fishing grounds, in descending order, for spiny lobster catch were Maro Reef, St. Rogatien Bank (first year in the fishery), and Necker Island; for slipper lobster the order was Maro, Gardner, and St. Rogatien.

6. For the first time, the catch of legal spiny lobster did not account for a majority of the reported catch; in fact, the slipper lobster catch accounted for 45.4% and legal spiny lobster 36.5% of the total lobster catch.

7. The greatest number of vessels (16), trips (62), days fished (1653), and trap-nights fished (1,089,462) were recorded this year, although the largest change occurred between 1983 and 1984.

8. In terms of the number of trap-nights fished, the top three fishing grounds were Maro Reef, Necker Island, and St. Rogatien Bank. In terms of number of days fished, Gardner Pinnacles replaced St. Rogatien for third place.

9. Catch rate for legal spiny lobster declined from 2.05 lobsters per trap-night in 1983 to 1.17 in 1984 and 0.88 in 1985 and that for sublegal spiny lobster declined from 0.66 lobsters per trap-night in 1983 to 0.63 in 1984 to 0.32 in 1985. The trends were similar on the three traditional fishing grounds, namely Necker, Maro, and Gardner. Catch rate for total slipper lobster increased from 0.33 per trap-night in 1983 to 0.75 in 1984 and 1.09 in 1985.

10. For the first time, overall catch rate of slipper lobster (1.09 per trap-night) exceeded that of legal spiny lobster (0.88). Catch rate of slipper lobster exceeded that of spiny lobster on Brooks Bank, Gardner Pinnacles, Lisianski Island, Maro Reef, and Northampton Seamounts, and on Gardner and Maro this represents a reversal from previous years.

11. For the first time on any fishing ground, the proportion of sublegal spiny lobsters in the catch exceeded that of legal lobsters, and this occurred on Necker Island.

12. Escape vent research has shown that vented traps catch more legal spiny lobster and fewer sublegal lobster than non-vented traps, especially when the two vents are located on the upper edge of the side panels. High vented traps caught more slipper lobster than low vented traps, but fewer than non-vented traps.

13. The standing stock of the harvestable population of spiny lobster (legal under the original FMP) at Necker Island was estimated to be at 26% of its unexploited level and at 57% of its unexploited level at Maro Reef. This suggests that Maro Reef population was probably harvested at about the level of maximum sustainable yield and that at Necker Island has been reduced below the level of maximum sustainable yield.

14. The estimated standing stock of sublegal spiny lobster has been reduced to 74% of its unexploited level at Necker Island, 92% at Maro Reef, and 71% at Laysan Island, but none of the reductions is statistically significant. If the reduction at Necker were real and caused by decreased recruitment or fishing mortality, then the reduction represents a loss to the fishery. This situation could also result on other islands if mortality increases and sublegal lobsters become an increasing proportion of the catch.

15. A Beverton and Holt model analysis indicates that reducing the minimum size from 5.1 to 4.8 cm TW3 at Maro Reef (and by inference most other islands in the fishery) would reduce the spawning stock biomass to about 52% of its unexploited level, which based on the fact that maximum production occurs at a 50% reduction of the fishable stock under the Schaefer production model, is probably sufficient to prevent recruitment overfishing, and it would marginally increase yield. At Necker Island, the spawning stock biomass is already below 50% of its unexploited level, and reducing the minimum size from 5.1 to 4.8 cm TW3 would further reduce the stock.

16. A record 45 vessels were issued permits to fish for lobsters in 1985.
17. A total of 22 violations were reported for which agents issued 16 Enforcement Action Reports and 6 verbal warnings.

LITERATURE CITED

BROWN, R. S., and N. CAPUTI.
1983. Factors affecting the recapture of undersize western rock lobster Panulirus cygnus George returned by fishermen to the sea. Fish. Res. 2:103-128.

GOODING, R. M.
1985. Predation on released spiny lobster, Panulirus marginatus, during tests in the Northwestern Hawaiian Islands. Mar. Fish. Rev. 47(1):27-35.

MACDONALD, C. D.
1984. Studies on recruitment in the Hawaiian spiny lobster, Panulirus marginatus. In R. W. Grigg and K. Y. Tanoue (editors), Proceedings of the Second Symposium on Resource Investigations in the Northwestern Hawaiian Islands, Vol. I, May 25-27, 1983, University of Hawaii, Honolulu, Hawaii, p. 199-220. UNIHI-SEAGRANT-MR-84-01.

MACDONALD, C. D., S. C. JAZWINSKI, and J. H. PRESCOTT.
1984. Queuing behavior of the Hawaiian spiny lobster Panulirus marginatus. Bull. Mar. Sci. 35:111-114.

MORIN, T. D., and C. D. MACDONALD.
1984. Occurrence of the slipper lobster Scyllarides haanii in the Hawaiian Archipelago. Proc. Biol. Soc. Wash. 97:404-407.

UCHIDA, R. N., J. H. UCHIYAMA, D. T. TAGAMI, and P. S. SHIOTA.
1980. Biology, distribution, and estimates of apparent abundance of the spiny lobster, Panulirus marginatus (Quoy and Gaimard), in waters of the Northwestern Hawaiian Islands: Part II. Size distribution, legal to sublegal ratio, sex ratio, reproductive cycle, and morphometric characteristics. In R. W. Grigg and R. T. Pfund (editors), Proceeding of the Symposium on Status of Resource Investigations in the Northwestern Hawaiian Islands, April 24-25, 1980, University of Hawaii, Honolulu, Hawaii, p. 131-142. Sea Grant Misc. Rep. UNIHI-SEAGRANT-MR-80-04.

Table 1.--Estimated annual sales of spiny and slipper lobster. Ex-vessel price is in dollars per pound and ex-vessel revenue is in dollars. Weight is in terms of whole animals as is ex-vessel price. See text for source of data.

	Spiny lobster				Slipper lobster					
Year	Pounds	Metric tons	Price	Revenue	Pounds	Metric tons	Price	Revenue	No. of vessels	No. of trips
1977	72,000	30	2.90	209,000	--	--	--	--	5	14
1978	45,000	20	3.00	135,000	--	--	--	--	2	12
1979	100,000	50	3.20	320,000	--	--	--	--	2	6
1980	328,000	150	3.40	1,115,000	--	--	--	--	3	12
1981	780,000	350	3.50	2,730,000	--	--	--	--	10	25
1982	187,000	80	3.60	673,000	--	--	--	--	7	19
1983	203,000	90	2.91	591,000	--	--	--	--	4	19
1984	796,000	360	2.68	2,346,000	325,000	150	1.78	588,000	11	38
1985	1,095,000	500	2.91	3,478,000	704,000	320	1.87	1,306,000	16	62

Table 2.--Estimated annual sales of spiny and slipper lobster by product type. Ex-vessel price is in dollars per pound and ex-vessel revenue is in dollars.

Year	Product	Type	Spiny lobster				Slipper lobster				No. of vessels	No. of trips
			Pounds	MT	Price	Revenue	Pounds	MT	Price	Revenue		
1977	Live		72,000	33	2.90	208,800	--	--	--	--	5	14
1978	live		45,000	20	3.00	135,000	--	--	--	--	2	12
1979	Live		100,000	45	3.20	320,000	--	--	--	--	2	6
1980	Not available											
1981	Not available											
1982	Not available											
1983	Live		25,000	11	4.46	111,600	--	--	--	--	4	12
	Frozen	Whole	15	0	4.00	60	--	--	--	--	1	1
	Frozen	Tails	51,400	23	7.41	380,800	--	--	--	--	2	7
1984	Live		33,500	15	5.13	171,800	--	--	--	--	7	9
	Frozen	Whole	7,500	3	4.10	25,700	100	0	3.00	400	3	6
	Frozen	Tails	239,500	109	7.23	1,901,700	26,700	12	5.00	133,500	10	31
1985	Live		32,100	15	4.69	150,300	--	--	--	--	7	20
	Frozen	Whole	3,100	1	4.08	12,800	700	0	2.73	1,900	3	9
	Frozen	Tails	383,500	174	7.93	3,361,600	254,100	115	5.24	1,323,000	15	56

Table 3.--Annual catch in numbers of spiny lobster, Panulirus marginatus, slipper lobsters, Scyllarides sp., and kona crab, Ranina ranina, by vessels in the Northwestern Hawaiian Island fishery. FFF = French Frigate Shoals; LI = Lisianski Island; NH = Northampton Seamount; PH = Pearl and Hermes Reef; SR = St. Rogatien; MHI = Main Hawaiian Island.

Year	Area	No. of vessels	No. trip	Legal spiny	Sublegal spiny	Berried spiny	Total spiny	Total slipper	Kona crab
1983	Gardner	1	2	23,686	1,206	364	25,256	2,888	0
	Maro	1	1	27,210	1,426	638	29,274	8,990	0
	Necker	4	18	111,710	48,148	8,710	168,668	13,732	3
	Total	4	19	157,606	50,780	9,712	218,198	25,610	3
1984	FFS	1	1	266	42	23	331	166	0
	Gardner	5	10	174,274	9,059	5,836	189,169	109,264	192
	Maro	3	7	250,489	20,789	16,329	287,607	83,855	0
	Necker	10	24	210,494	206,919	40,765	458,178	77,401	355
	Nihoa	3	8	24,174	1,531	11,213	36,918	12,993	202
	Raita	2	3	7,586	137	84	7,807	1,134	0
	MHI	1	1	9	2	1	12	2	0
	Total	11	38	667,292	238,479	74,251	980,022	284,815	749
1985	Brooks	3	5	21,486	5,669	4,865	32,020	55,843	1
	FFS	3	4	10,011	2,462	1,172	13,645	5,306	10
	Gardner	8	13	96,484	15,354	10,289	122,127	212,528	141
	Kure	4	5	14,159	1,057	2,021	17,237	7,396	283
	LI	3	3	36	10	14	60	840	0
	Maro	7	18	359,949	53,874	41,200	455,023	538,288	33
	Necker	12	35	185,654	212,970	32,440	431,064	154,464	140
	Nihoa	2	5	7,949	478	699	9,126	6,530	5
	NH	3	3	110	8	16	134	1,417	0
	PH	4	6	49,960	9,659	2,252	61,871	40,466	11
	Raita	4	5	9,583	644	295	10,522	5,468	0
	SR	4	7	200,054	42,308	33,954	276,316	161,030	2
	Other (1)	2	2	186	9	0	195	25	0
	MHI	2	3	421	109	186	716	241	9
	Total	16	62	956,042	344,611	129,403	1,430,056	1,189,842	635

Table 4.--Percent of total slipper and spiny lobster in the total catch of all lobster, by island and year.

Year	Area	Total spiny lobster	Total slipper lobster
1983	Gardner	89.7	10.3
	Maro	73.0	27.0
	Necker	92.5	7.5
	Total	89.5	10.5
1984	French Frigate Shoals	66.6	33.4
	Gardner	63.4	36.6
	Maro	77.4	22.6
	Necker	85.5	14.5
	Nihoa	74.0	26.0
	Raita	87.3	12.7
	Main Hawaiian Islands	85.7	14.3
	Total	77.5	22.5
1985	Brooks Banks	36.4	63.6
	French Frigate Shoals	72.0	28.0
	Gardner	36.5	63.5
	Kure	70.0	30.0
	Lisianski	6.7	93.3
	Maro	45.8	54.2
	Necker	73.6	26.4
	Nihoa	58.3	41.7
	Northampton	8.6	91.4
	Pearl and Hermes Reef	60.5	39.5
	Raita	65.8	34.2
	St. Rogatien	63.2	36.8
	Other (1)	88.6	11.4
	Main Hawaiian Islands	74.8	25.2
	Total	54.6	45.4

Table 5.--Monthly catch (in number) per trap-night of spiny lobster, slipper lobster, and kona crab by vessels in the Northwestern Hawaiian Islands. Derived from FMP-required "Daily Catch Report Per Statistical Area."

Year	Month	No. of areas	No. of trap-nights	Catch per trap-night					
				Legal spiny lobster	Sublegal spiny lobster	Berried spiny lobster	Total spiny lobster	Total slipper lobster	Kona crab
1983	Mar.	1	960	2.19	1.04	0.39	3.61	0.25	0.00
	Apr.	1	8,091	1.46	0.27	0.11	1.84	0.16	0.00
	May	1	1,120	2.23	0.85	0.64	3.72	0.46	0.00
	June	1	5,205	1.83	0.76	0.16	2.75	0.42	0.00
	July	1	800	2.74	3.46	0.46	6.67	0.31	0.00
	Aug.	2	14,579	1.72	0.23	0.10	2.06	0.15	0.00
	Sept.	1	2,300	2.42	1.46	0.36	4.24	0.18	0.00
	Oct.	1	12,000	2.52	0.23	0.12	2.88	0.42	0.00
	Nov.	3	25,252	1.57	0.67	0.04	2.29	0.49	0.00
	Dec.	1	6,550	4.39	2.04	0.26	6.69	0.19	0.00
	Annual	3	76,857	2.05	0.66	0.13	2.84	0.33	0.00
1984	Jan.	0	--	--	--	--	--	--	--
	Feb.	2	12,768	1.16	0.74	0.06	1.96	0.36	0.00
	Mar.	3	14,658	2.73	1.22	0.18	4.13	1.09	0.00
	Apr.	4	53,167	1.79	0.16	0.15	2.10	0.75	0.00
	May	0	--	--	--	--	--	--	--
	June	2	10,360	1.76	1.73	0.65	4.14	0.57	0.00
	July	2	10,090	0.96	0.04	0.63	1.63	0.35	0.00
	Aug.	5	66,526	2.29	0.71	0.17	3.17	0.50	0.00
	Sept.	2	14,181	2.01	2.90	0.19	5.11	1.04	0.00
	Oct.	2	20,180	2.15	0.37	0.10	2.62	0.69	0.00
	Nov.	4	40,810	1.85	0.63	0.13	2.61	1.03	0.00
	Dec.	6	134,700	1.41	0.47	0.21	2.08	0.83	0.00
	Annual	7	377,440	1.77	0.63	0.20	2.60	0.75	0.00
1985	Jan.	3	18,106	0.80	0.23	0.09	1.12	0.31	0.00
	Feb.	3	27,652	0.76	1.02	0.17	1.96	0.65	0.00
	Mar.	6	55,312	0.80	0.55	0.07	1.42	0.87	0.00
	Apr.	10	141,393	0.41	0.12	0.03	0.56	1.41	0.00
	May	9	51,867	0.59	0.54	0.09	1.23	1.84	0.00
	June	5	119,655	0.74	0.30	0.11	1.16	2.60	0.00
	July	4	111,000	1.23	0.18	0.18	1.59	1.11	0.00
	Aug.	10	98,867	1.08	0.40	0.18	1.66	0.64	0.00
	Sept.	9	51,877	1.48	0.63	0.19	2.29	0.35	0.00
	Oct.	9	174,214	1.12	0.26	0.18	1.56	0.77	0.00
	Nov.	4	34,703	0.98	0.14	0.08	1.20	0.67	0.00
	Dec.	8	204,816	0.74	0.29	0.07	1.09	0.73	0.00
	Annual	18	1,089,462	0.88	0.32	0.12	1.31	1.09	0.00

Table 6.--Annual fishing effort and catch per trap-night for spiny lobster, slipper lobster, and kona crab by vessels in the Northwestern Hawaiian Islands by area. Derived from FMP required "Daily Lobster Catch Report per Statistical Area."

Year	Area	No. of days	No. of trap-nights	Catch per trap-night					
				Legal spiny lobster	Sublegal spiny lobster	Berried spiny lobster	Total spiny lobster	Total slipper lobster	Kona crab
1983	Gardner	29	12,916	1.83	0.09	0.03	1.96	0.22	0.00
	Maro	36	16,150	1.38	0.09	0.04	1.50	0.56	0.00
	Necker	209	47,791	2.34	1.01	0.18	3.53	0.29	0.00
	Total	274	76,857	2.05	0.66	0.13	2.84	0.33	0.00
1984	Gardner	192	102,099	1.71	0.09	0.06	1.85	1.07	0.00
	Maro	247	142,973	1.75	0.15	0.11	2.01	0.59	0.00
	Necker	294	97,509	2.16	2.12	0.42	4.70	0.79	0.00
	Nihoa	73	23,871	0.01	0.06	0.47	1.55	0.54	0.01
	Others (2)	14	10,938	0.72	0.02	0.01	0.74	0.12	0.00
	MHI	2	50	0.18	0.04	0.02	0.24	0.04	0.00
	Total	822	377,440	1.17	0.63	0.20	2.60	0.75	0.00
1985	Brooks	40	30,428	0.71	0.19	0.16	1.05	1.84	0.00
	French Frigate	28	15,026	0.67	0.16	0.08	0.91	0.35	0.00
	Gardner	245	163,038	0.59	0.09	0.06	0.75	1.30	0.00
	Kure	25	15,728	0.90	0.07	0.13	1.10	0.47	0.02
	Lisianski	3	1,265	0.03	0.01	0.01	0.05	0.66	0.00
	Maro	467	371,854	0.97	0.14	0.11	1.22	1.45	0.00
	Necker	435	211,243	0.88	1.01	0.15	2.04	0.73	0.00
	Nihoa	28	13,405	0.59	0.04	0.05	0.68	0.49	0.00
	Northampton	3	1,330	0.08	0.01	0.01	0.10	1.07	0.00
	Pearl and Hermes	104	65,907	0.76	0.15	0.03	0.94	0.61	0.00
	Raita	28	11,869	0.81	0.05	0.02	0.89	0.46	0.00
	St. Rogatien	213	180,711	1.11	0.23	0.19	1.53	0.89	0.00
	Other (1)	2	498	0.37	0.02	0.00	0.39	0.05	0.00
	MHI	32	7,160						
	Overall	1,653	1,089,462	0.88	0.32	0.12	1.31	1.09	0.00

Table 7.--Composition of the catch in terms of various species and catch categories by island within year.

Year	Area	Total spiny to total slipper	Legal spiny to legal slipper	Legal to total spiny	Sublegal to total spiny	Berried to total spiny
1983	Gardner	8.75	8.20	0.938	0.048	0.014
	Maro	3.26	3.03	0.929	0.049	0.022
	Necker	12.28	8.14	0.662	0.285	0.052
	Total	8.52	6.14	0.722	0.233	0.045
1984	French Frigate	1.99	1.60	0.804	0.127	0.069
	Gardner	1.73	1.59	0.921	0.048	0.031
	Maro	3.43	2.99	0.871	0.072	0.057
	Necker	5.92	2.72	0.459	0.452	0.089
	Nihoa	2.84	1.86	0.655	0.041	0.304
	Raita	6.88	6.69	0.972	0.018	0.011
	MHI	6.00	4.50	0.750	0.167	0.083
	Total	3.44	2.34	0.681	0.243	0.076
1985	Brooks	0.57	0.38	0.671	0.177	0.152
	French Frigate	2.57	1.89	0.734	0.180	0.086
	Gardner	0.57	0.45	0.790	0.126	0.084
	Kure	2.33	1.91	0.821	0.061	0.117
	Lisianski	0.07	0.04	0.600	0.167	0.233
	Maro	0.85	0.67	0.791	0.118	0.091
	Necker	2.79	1.20	0.431	0.494	0.075
	Nihoa	1.40	1.22	0.871	0.052	0.077
	Northampton	0.09	0.08	0.821	0.060	0.119
	Pearl and Hermes	1.53	1.24	0.807	0.156	0.036
	Raita	1.92	1.75	0.911	0.061	0.028
	St. Rogatien	1.72	1.24	0.724	0.153	0.123
	Other (1)	7.80	7.44	0.954	0.046	0.000
	MHI	2.97	1.75	0.588	0.152	0.260
	Total	1.20	0.80	0.669	0.241	0.090

Table 8.--Composition of the catch in terms of various species and catch categories by month within year.

Year	Month	Total spiny to total slipper	Legal spiny to legal slipper	Legal to total spiny	Sublegal to total spiny	Berried to total spiny
1983	3	14.458	8.750	0.605	0.288	0.107
	4	11.239	8.902	0.792	0.149	0.059
	5	8.035	4.821	0.600	0.229	0.171
	6	6.614	4.405	0.666	0.276	0.058
	7	21.792	8.939	0.410	0.519	0.071
	8	14.102	11.789	0.836	0.113	0.048
	9	24.025	13.704	0.570	0.345	0.085
	10	6.844	6.001	0.877	0.080	0.043
	11	4.714	3.240	0.687	0.294	0.018
	12	34.579	22.690	0.656	0.305	0.039
1984	[1]1	--	--	--	--	--
	2	5.452	3.226	0.512	0.378	0.031
	3	3.744	2.491	0.660	0.296	0.044
	4	2.808	2.395	0.853	0.078	0.069
	[1]5	--	--	--	--	--
	6	7.238	3.082	0.426	0.418	0.156
	7	4.633	2.727	0.589	0.027	0.385
	8	6.341	4.575	0.721	0.224	0.054
	9	4.982	1.962	0.394	0.568	0.038
	10	3.805	3.124	0.821	0.140	0.039
	11	2.544	1.802	0.709	0.240	0.051
	12	2.525	1.706	0.676	0.224	0.101
1985	1	3.616	2.584	0.715	0.208	0.077
	2	3.017	1.173	0.389	0.523	0.088
	3	1.632	0.920	0.564	0.384	0.052
	4	0.393	0.287	0.730	0.215	0.055
	5	0.667	0.323	0.484	0.439	0.077
	6	0.444	0.284	0.639	0.263	0.098
	7	1.430	1.106	0.773	0.111	0.116
	8	2.604	1.692	0.649	0.241	0.109
	9	6.559	4.223	0.644	0.273	0.083
	10	2.019	1.444	0.715	0.168	0.117
	11	1.809	1.478	0.817	0.118	0.064
	12	1.494	1.012	0.678	0.262	0.060

[1]No landings.

Table 9.--Equivalent estimates of TW1, TW2, TW3, and tail weight versus carapace length (CL) for spiny lobster. Tail width estimates were derived from Skillman (see text footnote 2) while tail weight estimates were derived from Uchida et al. (1980).

CL CM	TW1-ADJ Necker female	Tail weight male		Tail weight female		TW2 female	TW3 female	TW3 M and F
		grams	ounces	grams	ounces	cm	cm	cm
8.25	5.3	152	5.3	189	6.6	5.4	5.6	5.4
8.1	5.3	146	5.1	180	6.3	5.3	5.5	5.4
8.0	5.2	142	5.0	174	6.1	5.3	5.4	5.3
7.9	5.1	138	4.8	168	5.9	5.2	5.4	5.2
7.8	5.1	134	4.7	162	5.7	5.2	5.3	5.2
7.7	5.0	130	4.6	156	5.5	5.1	5.2	5.1
7.6	5.0	127	4.4	151	5.3	5.0	5.2	5.1
7.5	4.9	123	4.3	145	5.1	5.0	5.1	5.0
7.4	4.8	119	4.1	140	4.9	4.9	5.1	4.9
7.3	4.8	116	4.0	135	4.7	4.9	5.0	4.9
7.2	4.7	112	3.9	130	4.5	4.8	4.9	4.8
7.1	4.7	109	3.8	125	4.4	4.7	4.9	4.8
7.0	4.6	105	3.7	120	4.2	4.7	4.8	4.7
6.9	4.5	102	3.6	115	4.0	4.6	4.7	4.6
6.8	4.5	99	3.4	111	3.9	4.6	4.7	4.6
6.7	4.4	95	3.3	106	3.7	4.5	4.6	4.5
6.6	4.4	92	3.2	102	3.6	4.4	4.6	4.5
6.5	4.3	89	3.1	98	3.4	4.4	4.5	4.4
6.4	4.2	86	3.0	94	3.3	4.3	4.4	4.4
6.3	4.2	83	2.9	90	3.1	4.3	4.4	4.3
6.2	4.1	80	2.8	86	3.0	4.2	4.3	4.2
6.1	4.1	77	2.7	82	2.9	4.1	4.2	4.2
6.0	4.0	74	2.6	78	2.7	4.1	4.2	4.1

Table 10.--Reported interactions with endangered species in the Northwestern Hawaiian Islands lobster fishery.

Island	Individuals			
	1	2	3	4
Monk seals observed in statistical area				
Brooks	2			
French Frigate	5			
Gardner	5			
Lisianski	1			
Maro	2			
Necker	33	2	0	3
Northampton	1			
St. Rogatien	7			
Monk seals observed in vicinity of fishing gear				
Brooks	6			
French Frigate	4			
Gardner	13			
Maro	1			
Necker	7			
St. Rogatien	8	3		
Monk seals observed preying on released lobster				
French Frigate	3			
St. Rogatien	3			
Turtles observed in statistical area				
French Frigate	2			
Necker	1			
Turtles observed in vicinity of fishing gear				
Necker	3			

Table 11.--Permit and vessel activity in spiny lobster fishery.

	Permits issued	Active vessels	Trap carrying capacity of active vessels	Average trap carrying capacity of active vessels
1983	14	4	1,200	300
1984	19	11	5,240	476
1985	45	16	12,250	703

Table 12.--Violations of spiny lobster regulations 1985. CG = Coast Guard, and EAR = Enforcement Action Report.

	Violation	Action
1.	Failure to report 24 h in advance	EAR issued
2.	Fail to report sale of lobster	EAR issued
3.	Retention of 13 shorts, 8 berried	EAR issued
4.	Retention of 50 shorts	EAR issued
5.	Retention of 19 shorts	EAR issued
6.	Retention of 1 short, 1 berried	Verbal warning
7.	Fail to keep accurate logs	Verbal warning
8.	Fail to keep accurate logs	Verbal warning
9.	Fish without license	EAR issued
10.	Fish without license (CG case)	EAR issued
11.	Fish without license (CG case)	EAR issued
12.	Retention of 4 shorts (CG case)	EAR issued
13.	Retention of 5 shorts (CG case)	EAR issued
14.	Retention of 10 shorts (CG case)	EAR issued
15.	Retention of 69 shorts	EAR issued
16.	Retention of 19 shorts	EAR issued
17.	Fail to report 24 h in advance	EAR issued
18.	Fail to keep accurate logs	EAR issued
19.	Retention of 2 shorts	Verbal warning
20.	Fail to report 24 h in advance	Verbal warning
21.	Retention of 4 shorts	Verbal warning
22.	Retention of shorts and berried	EAR issued

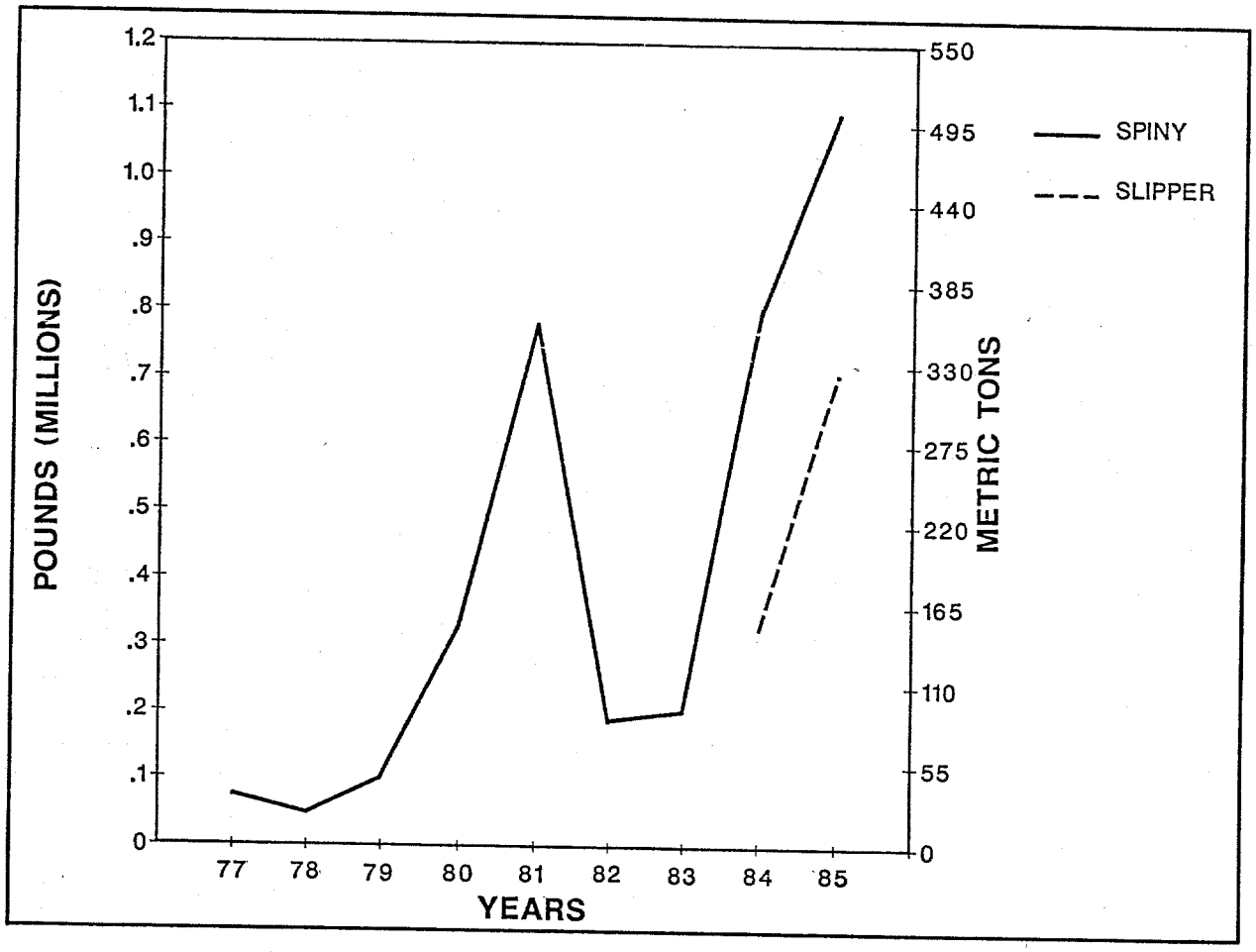

Figure 1.--Estimated annual landings/sales of spiny and slipper lobster in the Northwestern Hawaiian Islands fishery, 1977-85.

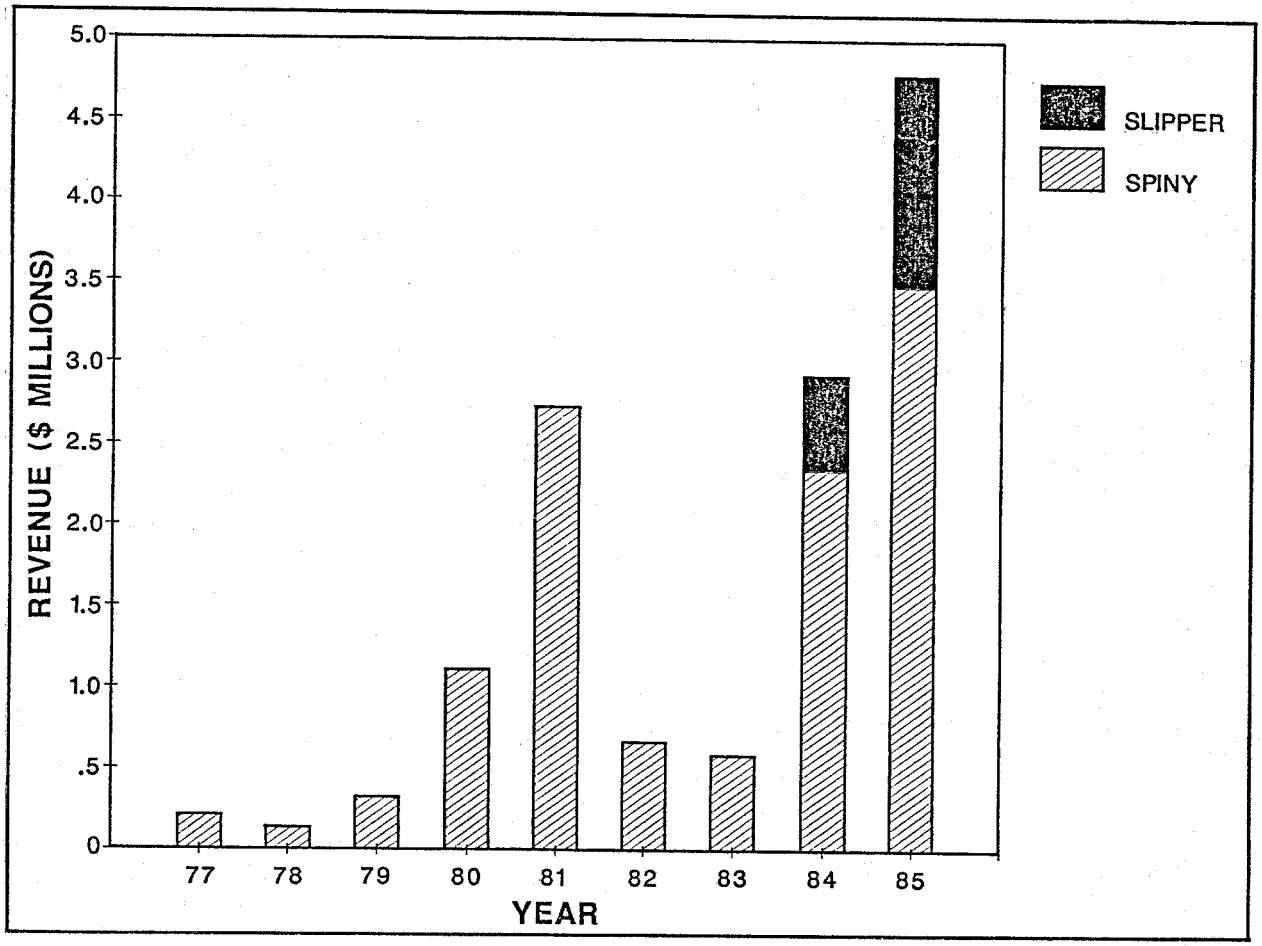

Figure 2.--Revenue for spiny and slipper lobster in the Northwestern Hawaiian Islands fishery for 1977-85.

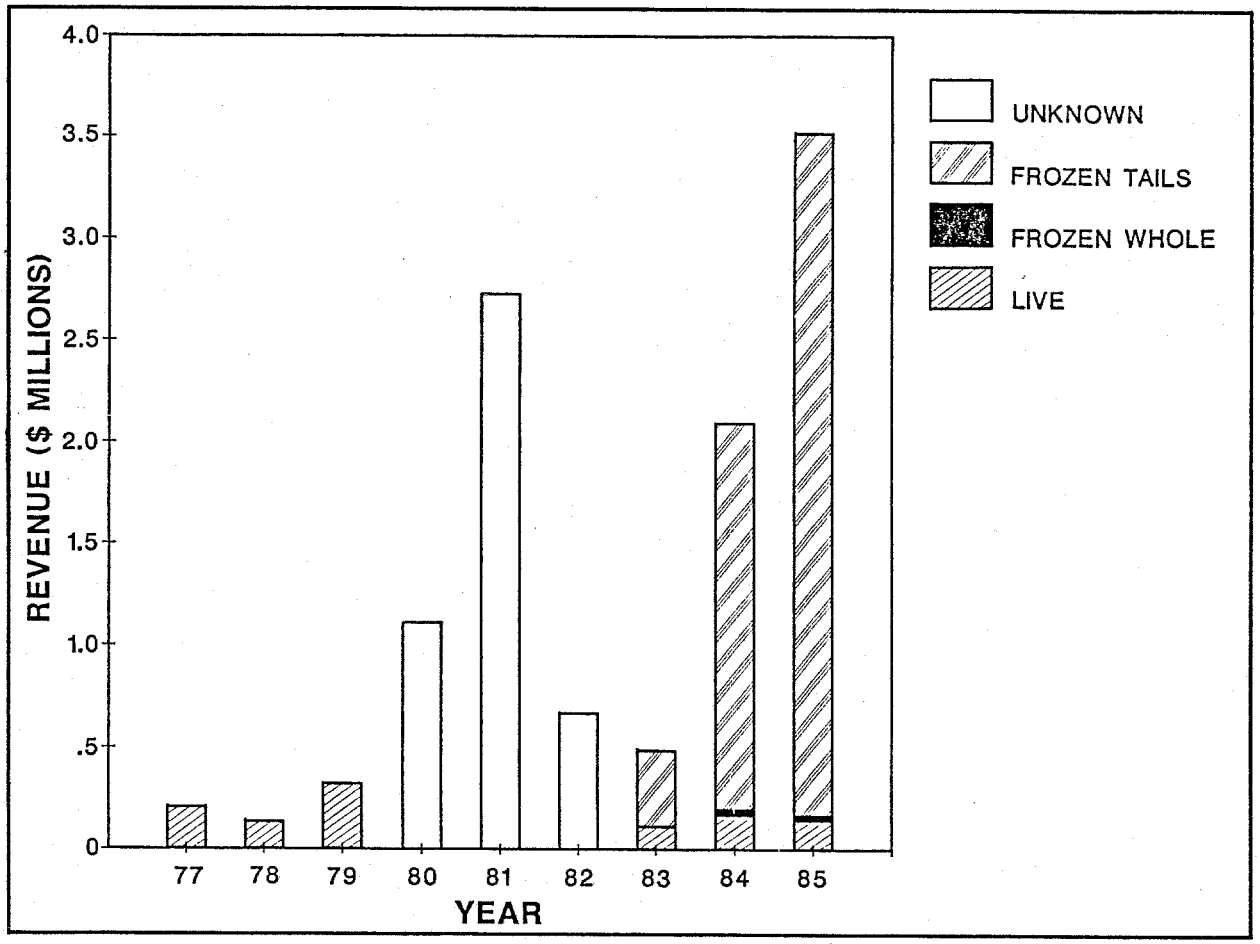

Figure 3.--Revenue of spiny lobster by product type in the Northwestern Hawaiian Islands fishery for 1977-85.

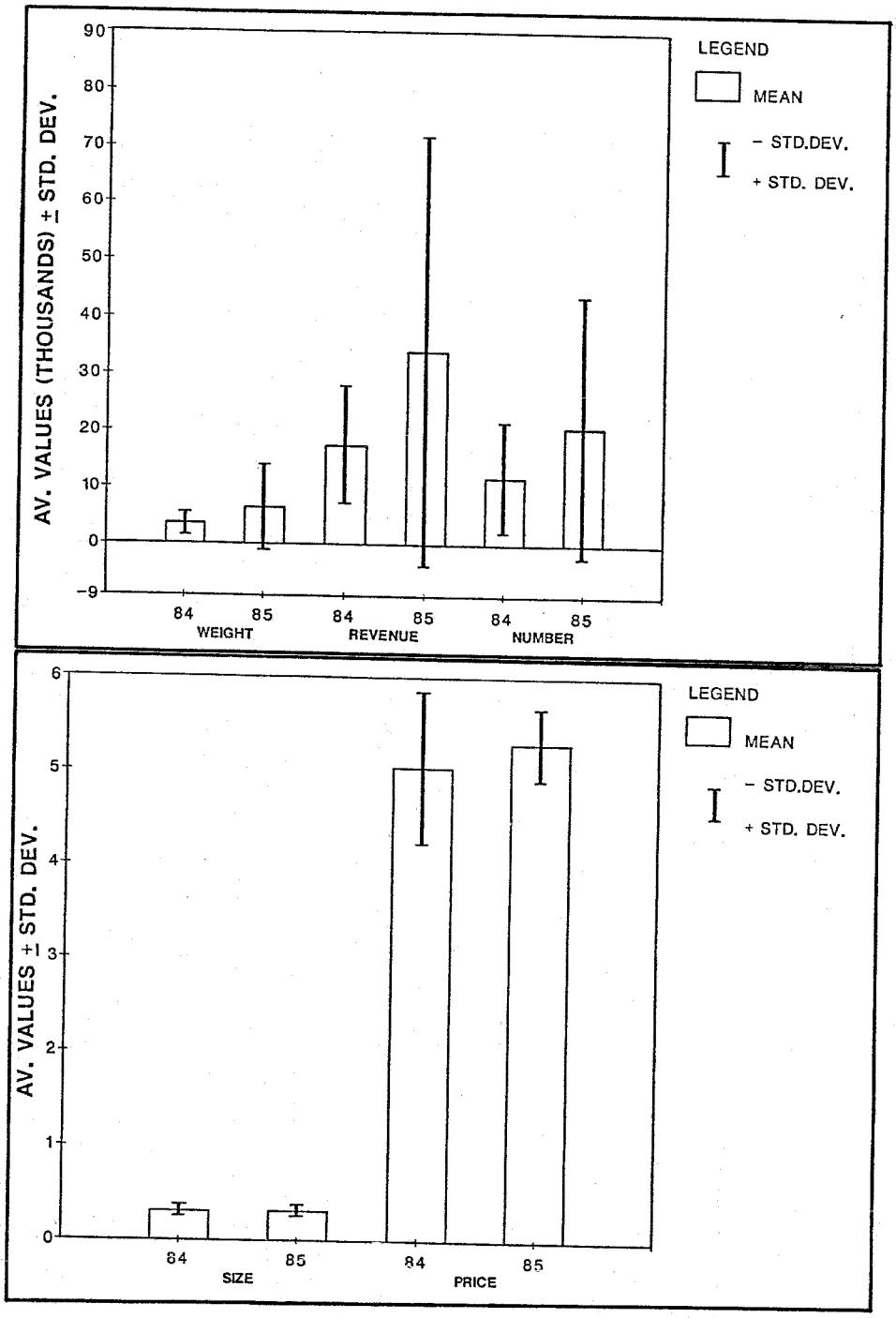

Figure 4.--Average annual landing statistics for slipper lobster frozen tails for 1984 (N = 7) and 1985 (N = 19). A: Weight (lb/trip), revenue ($/trip), number (pieces/trip). B: Size (lb/piece) and price ($/lb).

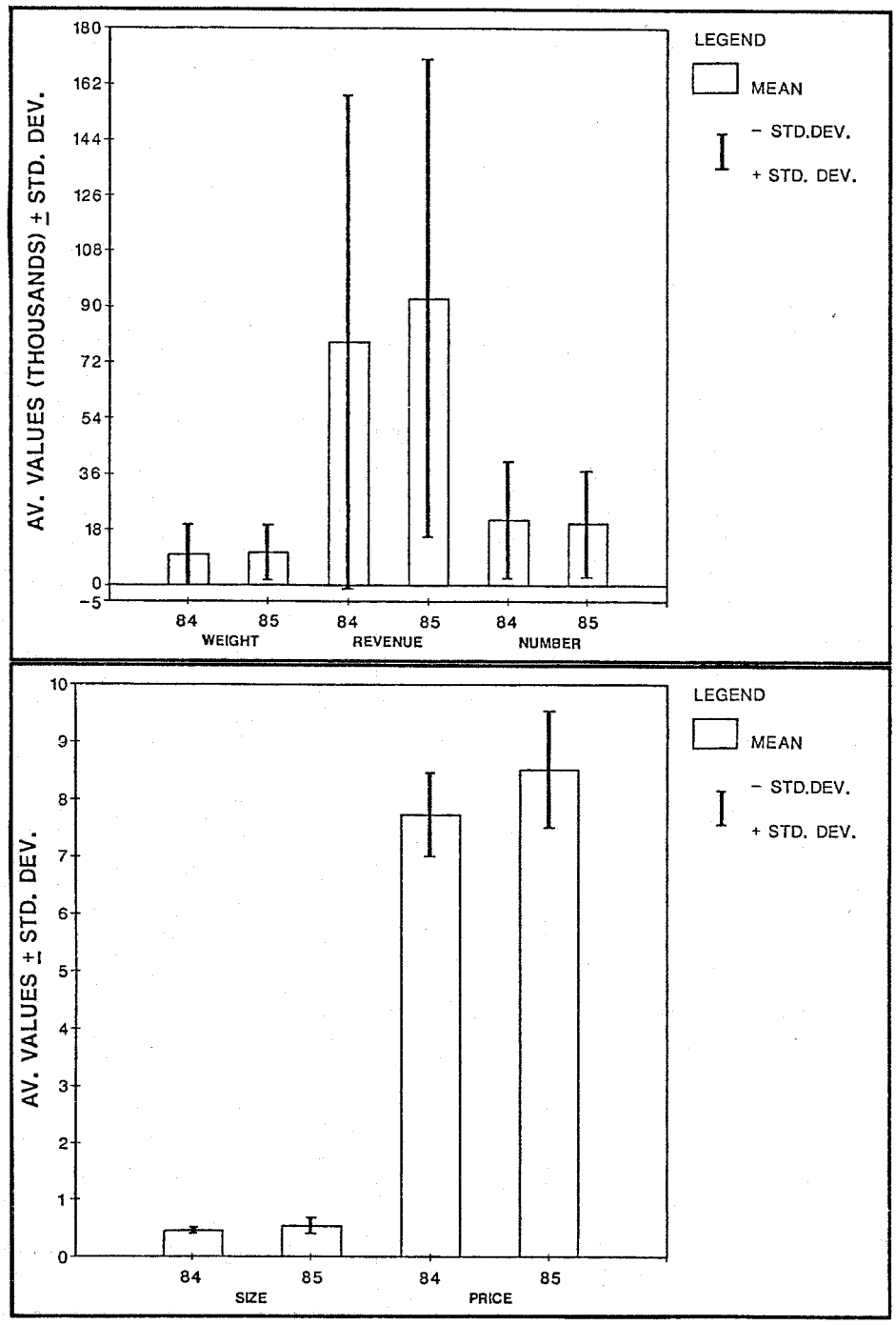

Figure 5.--Average annual landing statistics for spiny lobster frozen tails for 1984 (N = 5) and 1985 (N = 15). A: Weight (lb/trip), revenue ($/trip), number (pieces/trip). B: Size (wt/piece) and price ($/lb).

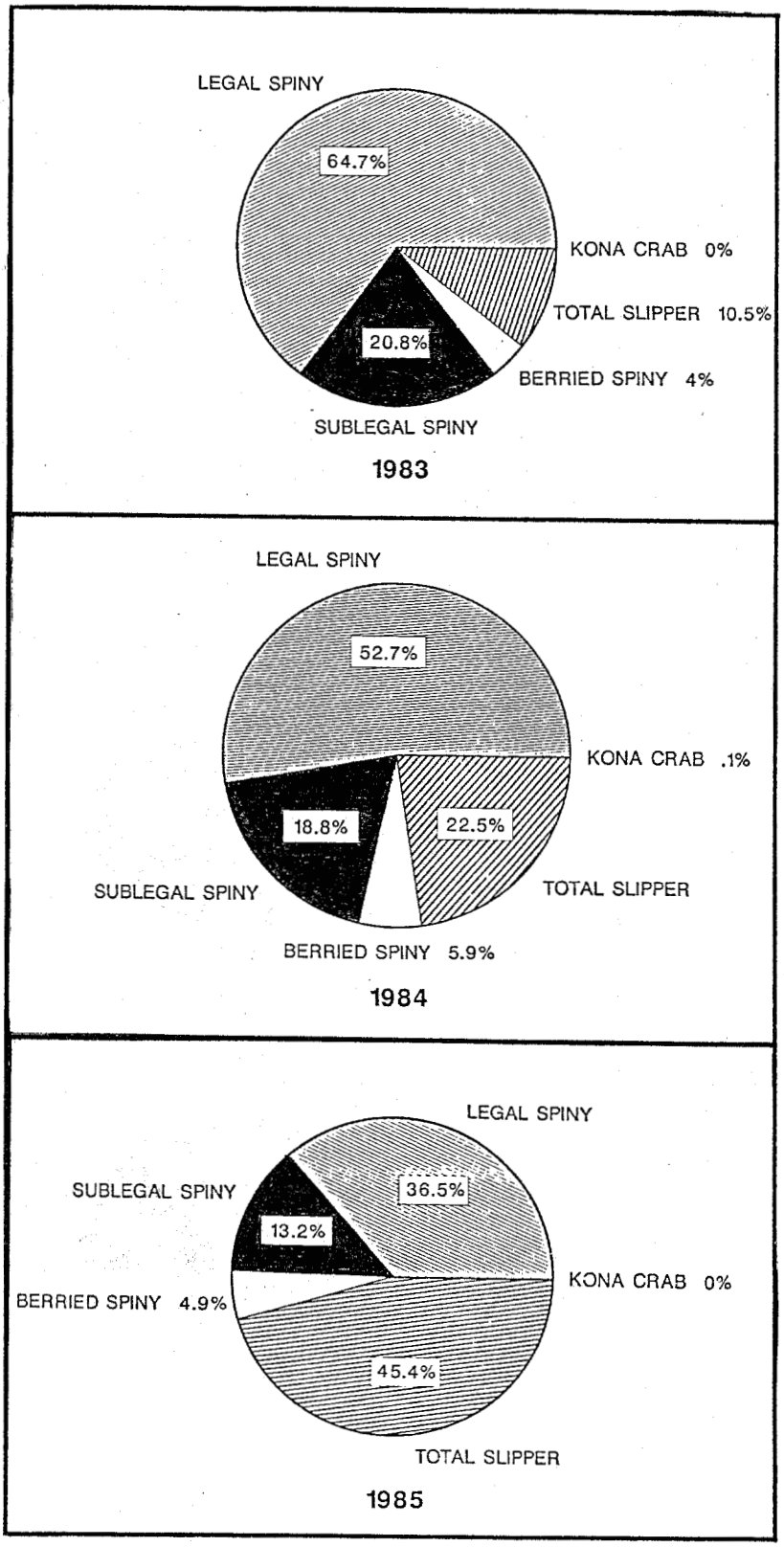

Figure 6.--Percent of the Northwestern Hawaiian Islands catch by species category for 1983-85.

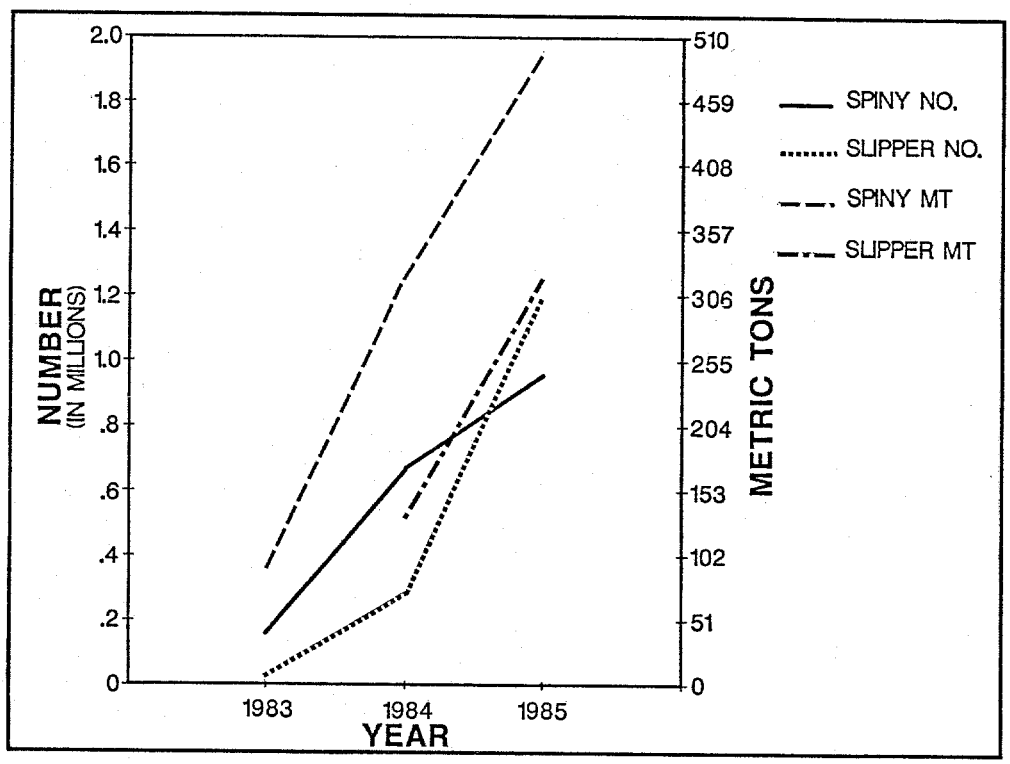

Figure 7.--Comparison of the reported number of legal spiny and total slipper lobster with the estimated sales of the same species.

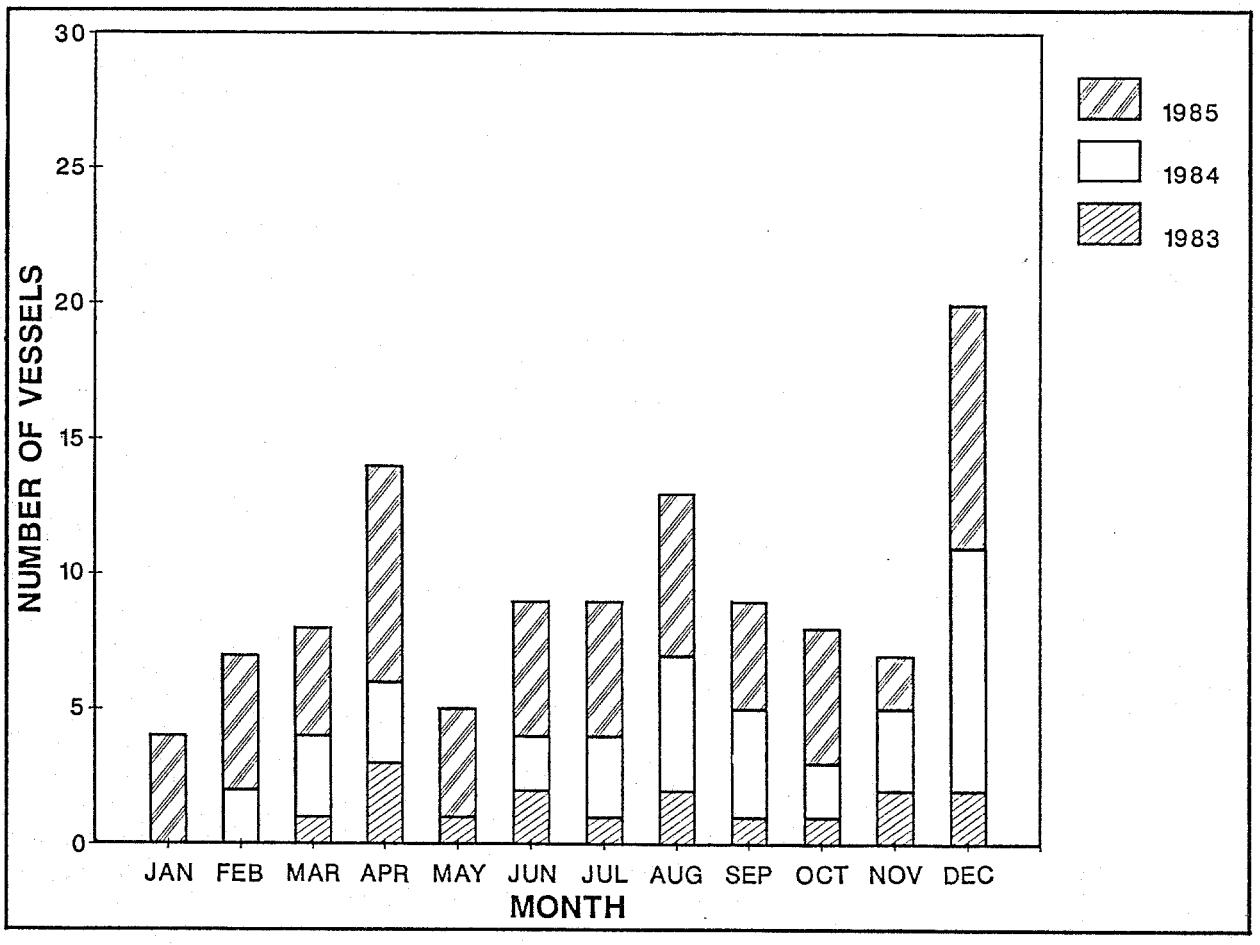

Figure 8.--The number of vessels landings seasonally for the Northwestern Hawaiian Islands fishery in 1983-85.

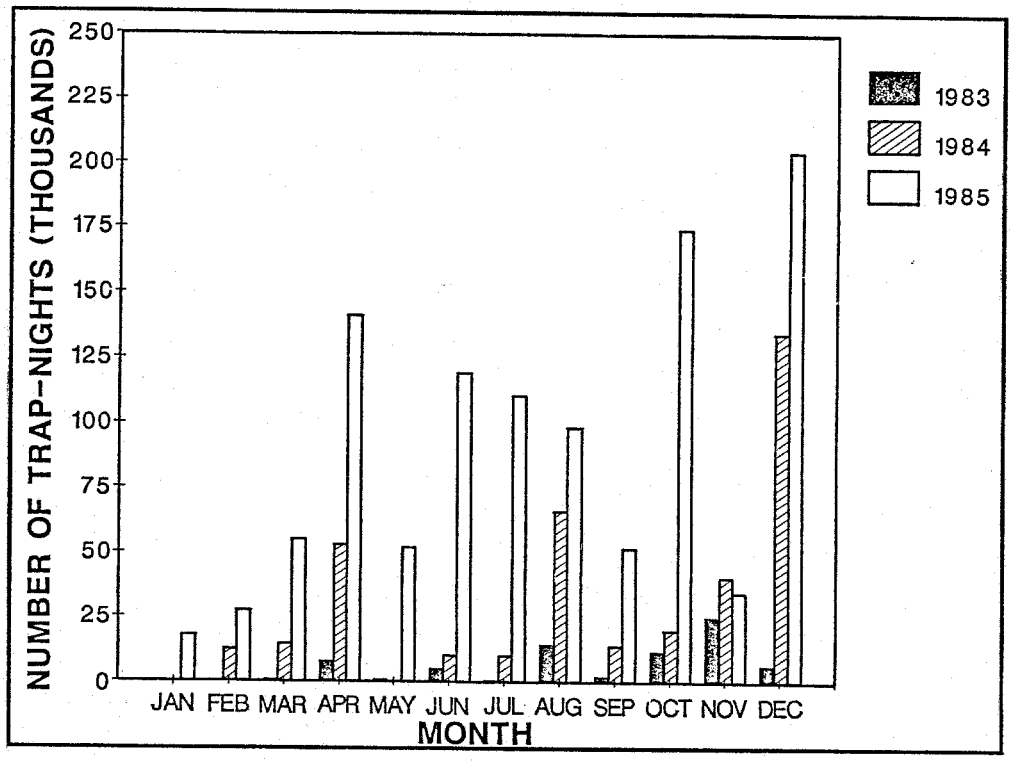

Figure 9.--The number of trap-nights fished seasonally for the Northwestern Hawaiian Islands fishery in 1983-85.

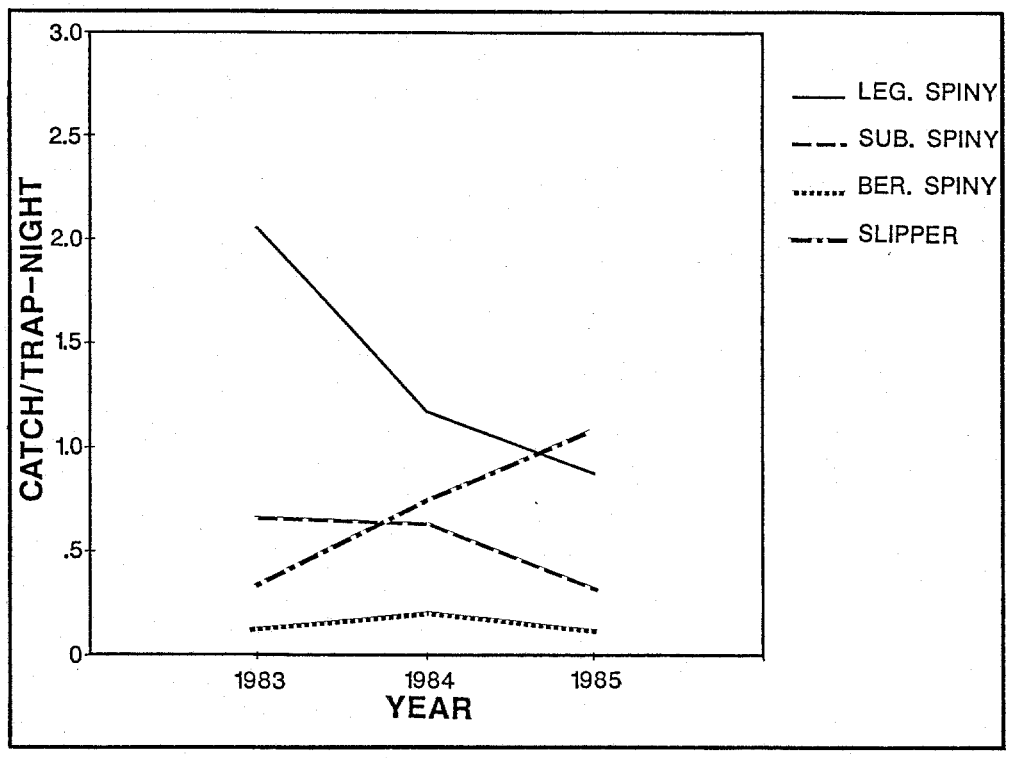

Figure 10.--Annual catch rate for legal, sublegal, and berried spiny lobster and total slipper lobster in the Northwestern Hawaiian Islands fishery.

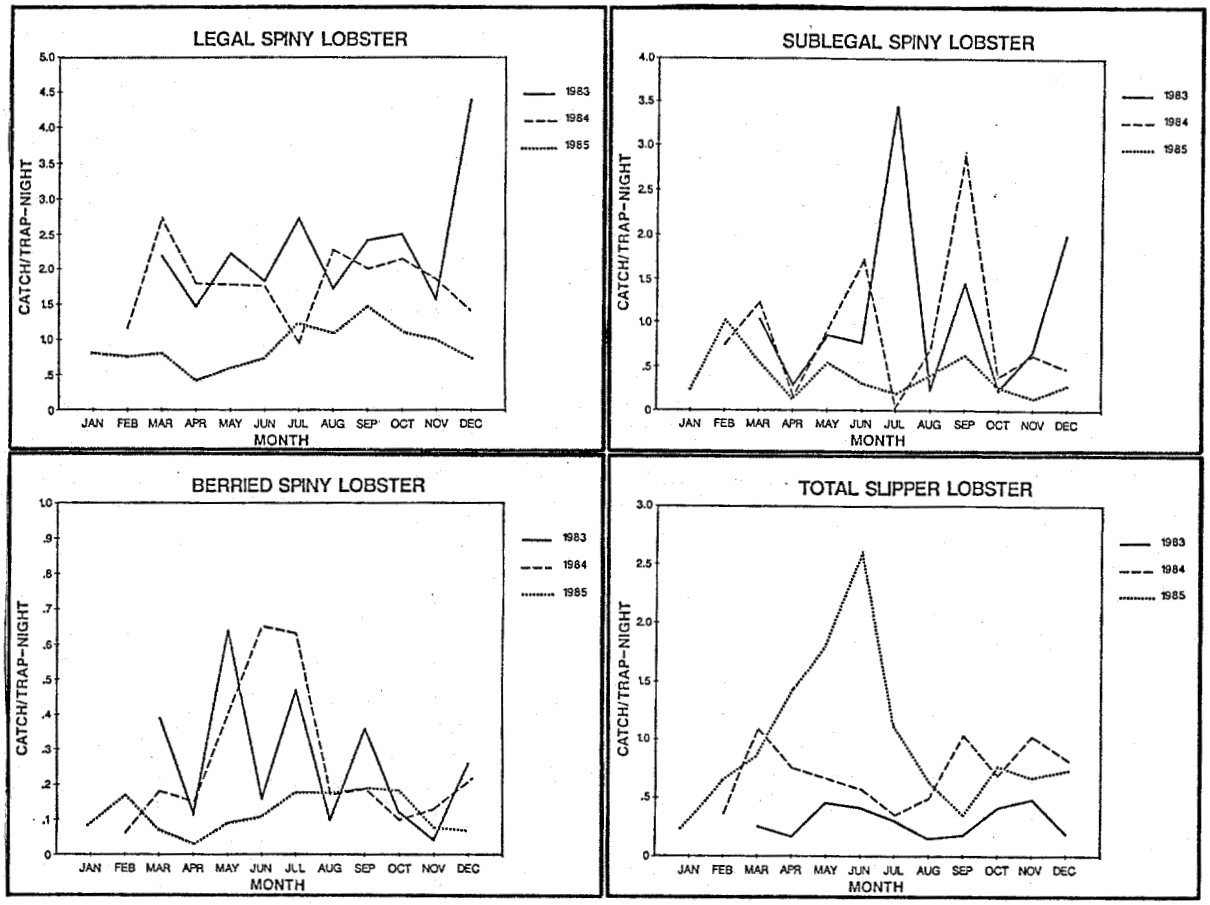

Figure 11.--Monthly catch rate for legal, sublegal, and berried spiny lobster and slipper lobster for 1983-85 in the Northwestern Hawaiian Islands fishery.

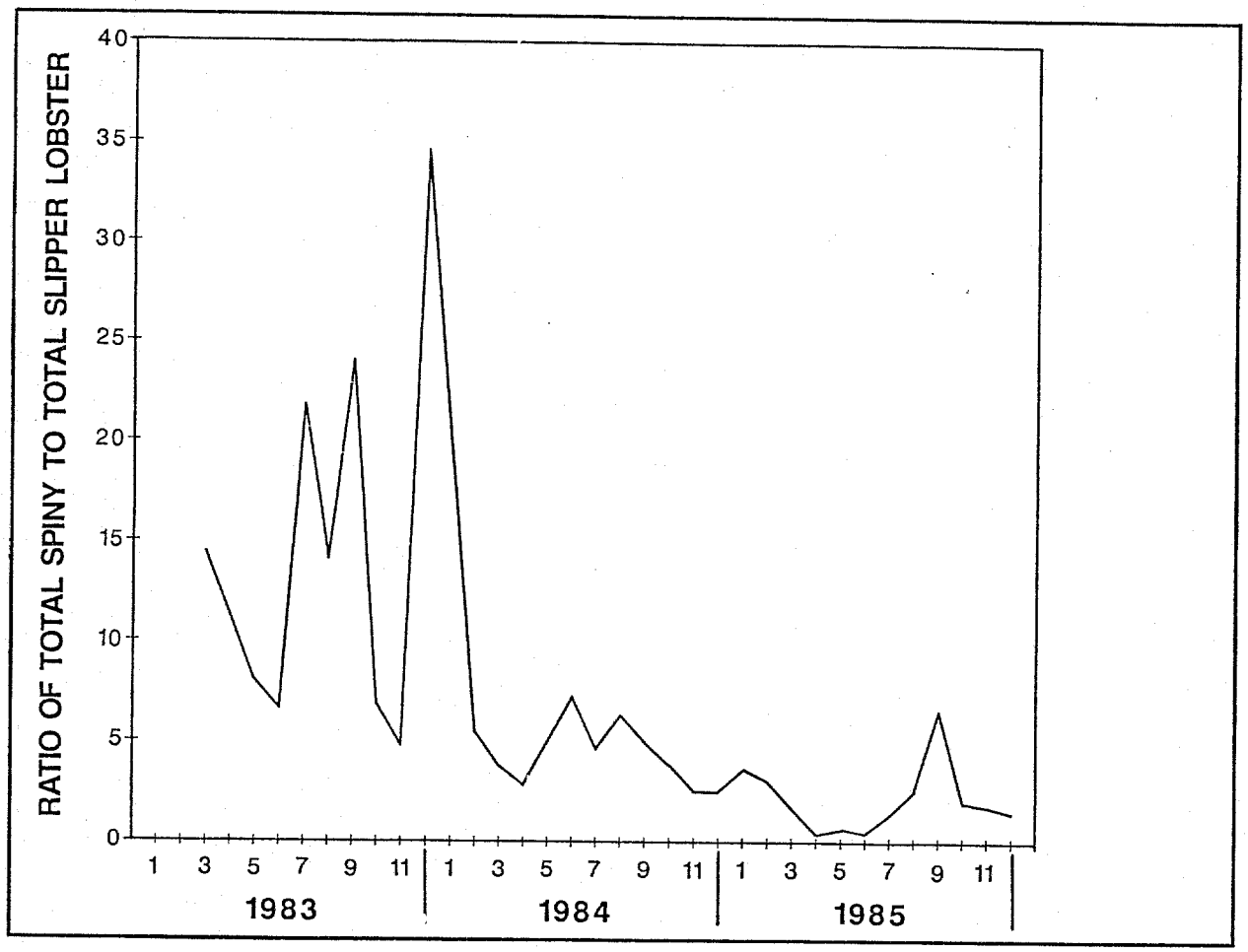

Figure 12.--Monthly ratio of total spiny to total spiny lobster catch for 1983-85.