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STATUS OF STOCKS OF LOBSTERS IN THE NORTHWESTERN HAWAIIAN ISLANDS, 1987

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INTRODUCTION

This is the third annual status of lobster stocks report. The report uses both research sampling and commercial logbook data to examine changes in the stocks of slipper lobster, Scyllarides squammosus, and spiny lobster, Panulirus marginatus, and to make inferences about the current level of catch and effort relative to optimal levels. This year's report uses tail width measurements, rather than carapace length as in previous reports, and introduces a dynamic production model as a tool to forecast future fishery yields.

COMMERCIAL LOGBOOK DATA

The commercial logbooks do not distinguish between fishing effort targeting slipper lobsters and spiny lobsters and, instead, report total fishing effort. Thus, catch and effort relationships based on logbook data can only be constructed for the two species combined. In 1987, trapping effort in the lobster fishery was 60% of the 1986 effort. Even with this reduction in effort, catch per unit of effort (CPUE) declined in 1987 from 1986 levels for all 12 banks fished in both years (Table 1). The 1987 CPUE's

Table 1.--Absolute and relative catch per unit effort (CPUE) for spiny and slipper lobsters in 1986-87, based on commercial logbook data.

Location	CPUE			1987/86 CPUE by species	
	1987	1986	1987/1986	Spiny	Slipper
Nihoa Island	0.46	1.22	0.38	0.84	0.29
Necker Island	0.98	1.22	0.80	0.65	1.13
French Frigate Shoals	0.74	1.47	0.50	0.32	1.00
Brooks Banks	([a])	([a])	0.43	1.06	0.29
St. Rogatien Bank	0.59	1.51	0.39	0.42	0.35
Gardner Pinnacles	0.87	1.07	0.81	0.65	0.96
Raita Bank	0.66	1.21	0.55	0.42	0.63
Maro Reef	1.44	1.80	0.80	0.96	0.68
Northampton Seamounts	([a])	([a])	0.51	0.21	0.53
Pioneer Seamount	([a])	([a])	0.74	--	0.74
Lisianski Island	([a])	([a])	0.35	1.08	0.52
Pearl and Hermes Reef	([a])	([a])	0.56	3.38	0.28
Total	1.08	1.53	0.71	0.72	0.69

[a]Fewer than three vessels fished these banks, so confidentiality regulations prohibit the publishing of CPUE.

for the three banks Necker Island, Gardner Pinnacles, and Maro Reef, which have been fished since the beginning of the fishery, were at 80% of their 1986 levels while the 1987 CPUE's for other banks, many which were fished heavily only in 1985 and 1986, were reduced to 35-71% of their 1986 CPUE's (Table 1). For all 12 of these banks combined, the 1987 CPUE declined to 71% of the 1986 level, with the 1987 CPUE's for spiny and slipper lobsters declining 72 and 69%, respectively, of their 1986 levels (Table 1).

The catch and effort relationships for three banks and the entire Northwestern Hawaiian Islands (NWHI) are given in Figures 1A-D. These catch and effort relationships all have a pattern of increasing catch with increasing effort in 1984 and 1985, followed by declining or constant catch with further increases in effort in 1986. Finally in 1987, as effort was reduced to 1984 or 1985 levels, the catches fell well below the corresponding 1984 or 1985 catches (Figs. 1A-D).

RESEARCH SAMPLING DATA

In July 1987, standardized research sampling was conducted at Necker Island and Maro Reef, which were the same sites sampled in 1977 and 1986, by using wire mesh traps for spiny lobsters and plastic traps for slipper lobsters. Sampling data indicate that when tail width frequencies are used instead of carapace length frequencies, sampling structure differs very little between males and females for both spiny and slipper lobsters. Thus, frequency distributions of tail width for the population of spiny and slipper lobsters were constructed by combining both sexes. Spiny lobster frequency distributions were computed with the CPUE by tail width class for the combined male and female samples at Necker Island and Maro Reef (Figs. 2, 3). At both Necker Island and Maro Reef, the CPUE of lobsters above the minimum size (5.0-cm tail width) declined dramatically since 1977 while the CPUE of lobsters below 5.0 cm, representing the new recruits to the fishery, remained unchanged (Figs. 2, 3). There was a small increase in CPUE in 1987 over 1986 for lobsters around the 5.0-cm tail width size, suggesting somewhat better recruitment in 1987 than 1986 (Figs. 2, 3). The right-hand descending side of the 1987 CPUE distributions shows more downward curvature at Necker Island than Maro Reef (Figs. 2, 3), indicating that the fishing mortality is higher at Necker Island than Maro Reef.

The standardized sampling for slipper lobsters consists of only 2 yr of relatively small samples, but a tail width frequency distribution for these 2 yr combined shows similar size structure for both Necker Island and Maro Reef and evidence of recruitment below the new minimum size (5.6-cm tail width) (Fig. 4).

Although recruitment appears good for both slipper and spiny lobsters at Necker Island and Maro Reef, frequency distributions of tail width for spiny lobsters collected in November 1986 at Maro Reef and Raita Bank by a National Marine Fisheries Service observer onboard a commercial vessel show a low abundance of sublegal lobsters at Raita Bank (Fig. 5). This low abundance of sublegal lobsters in the sample, together with the large decline in landings of legal lobsters at Raita in 1987, may mean that Raita

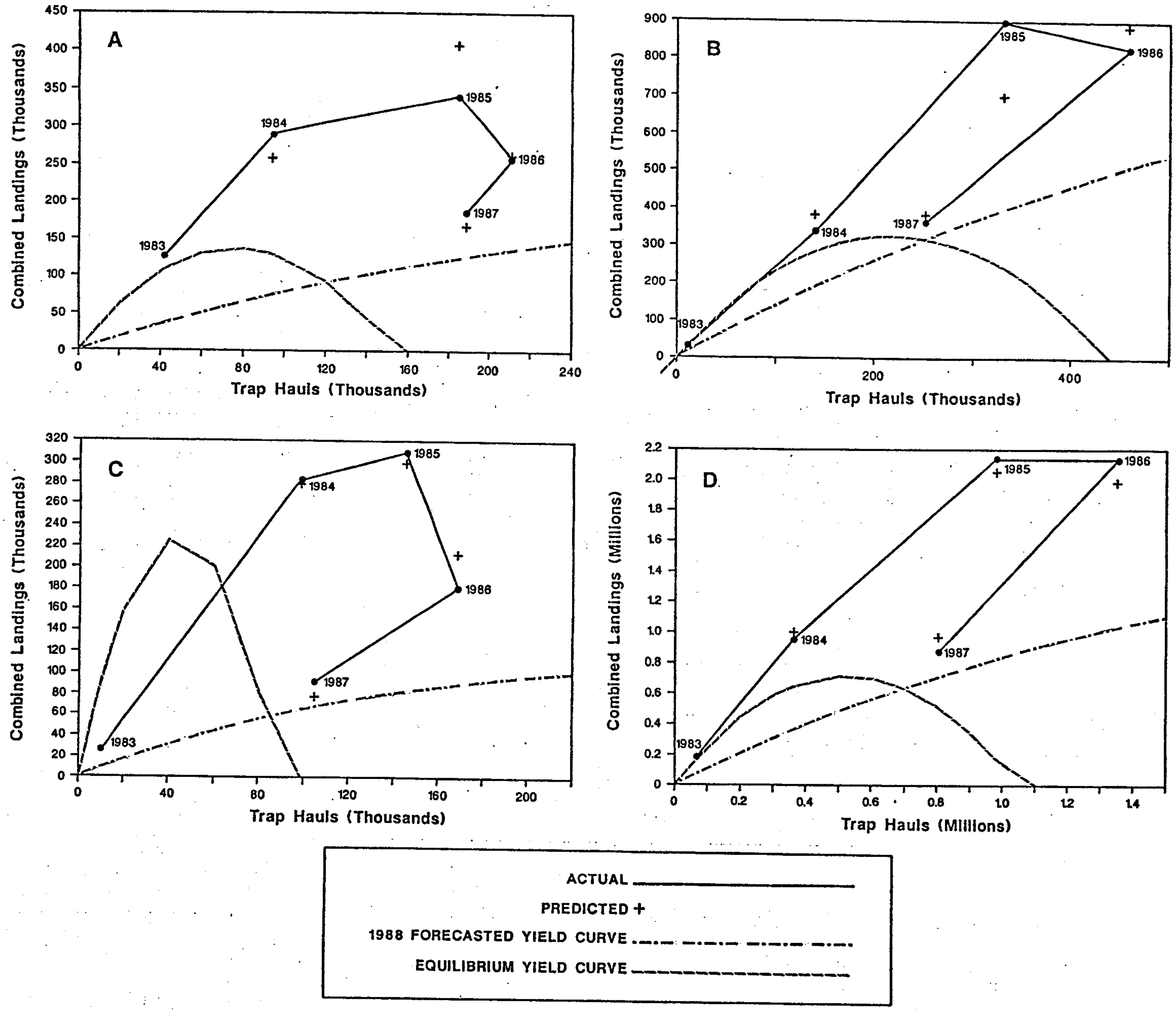

Figure 1.--The actual, predicted, 1988 forecast, and equilibrium combined landings for spiny and slipper lobsters, by trap hauls, at (A) Necker Island, (B) Maro Reef, (C) Gardner Pinnacles, and (D) the entire Northwestern Hawaiian Islands in 1983-87.

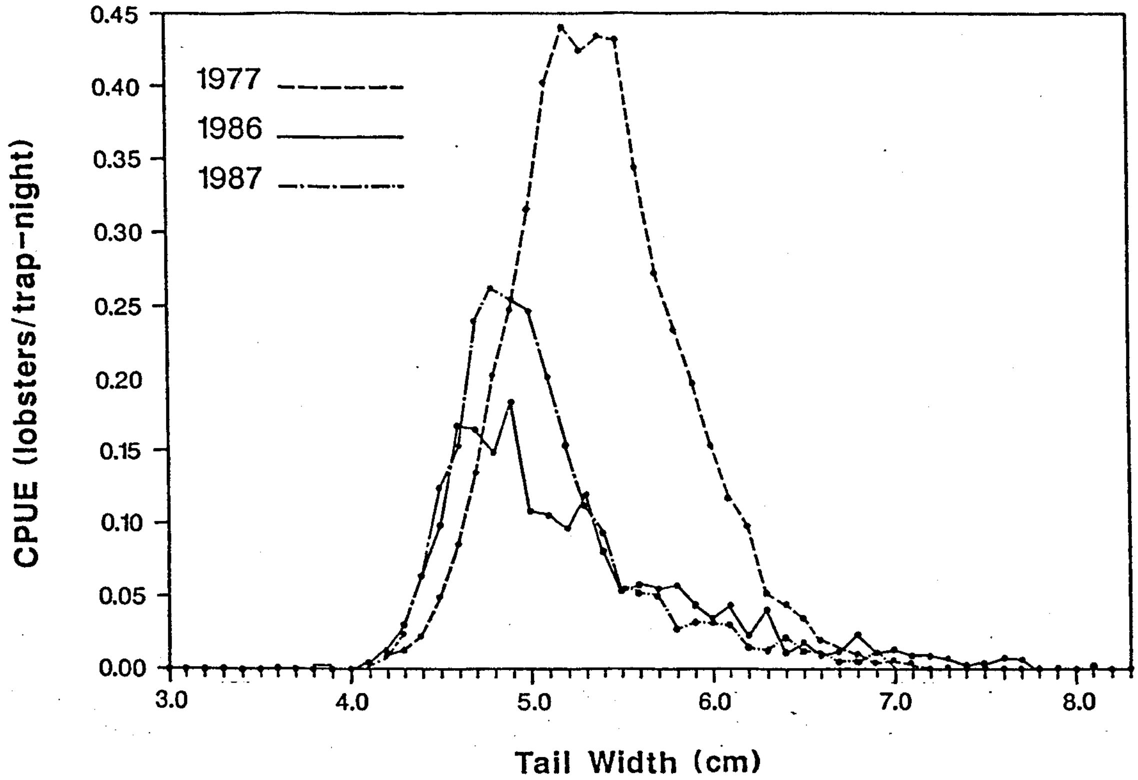

Figure 2.--The catch per unit of effort (CPUE) by tail width size classes for spiny lobsters at Necker Island in 1977, 1986, and 1987.

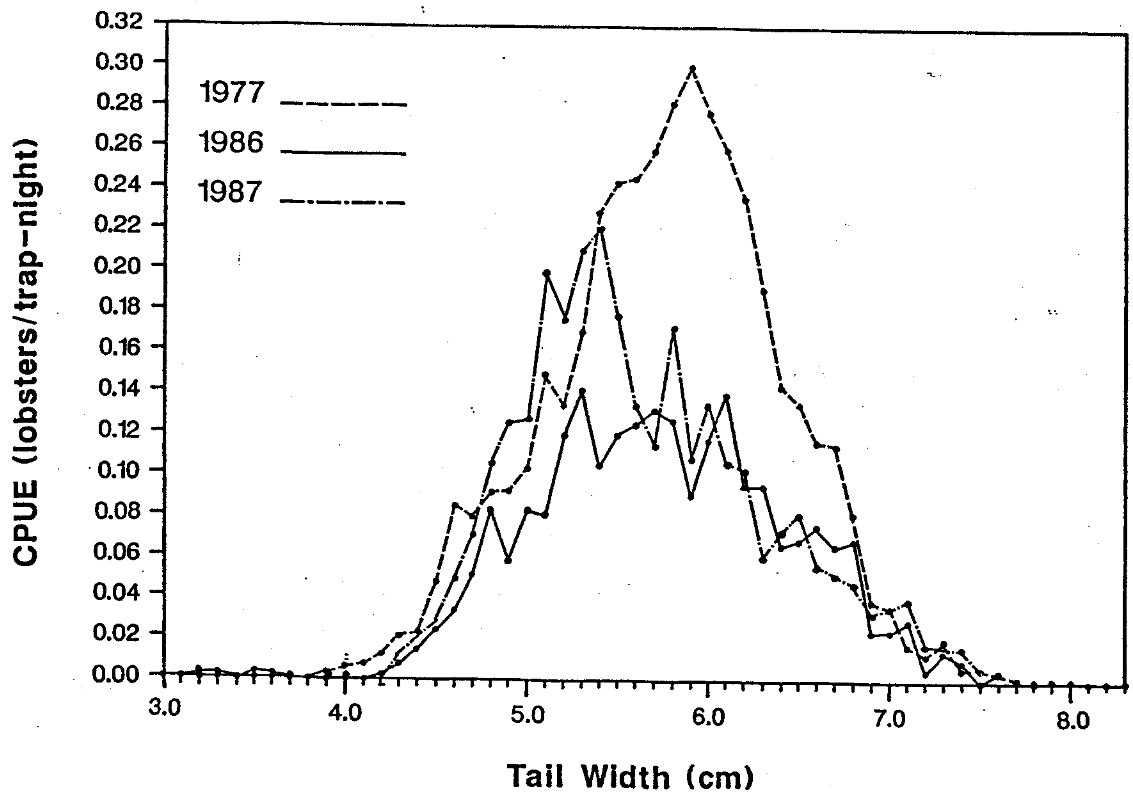

Figure 3.--The catch per unit of effort (CPUE) by tail width size classes for spiny lobsters at Maro Reef in 1977, 1986, and 1987.

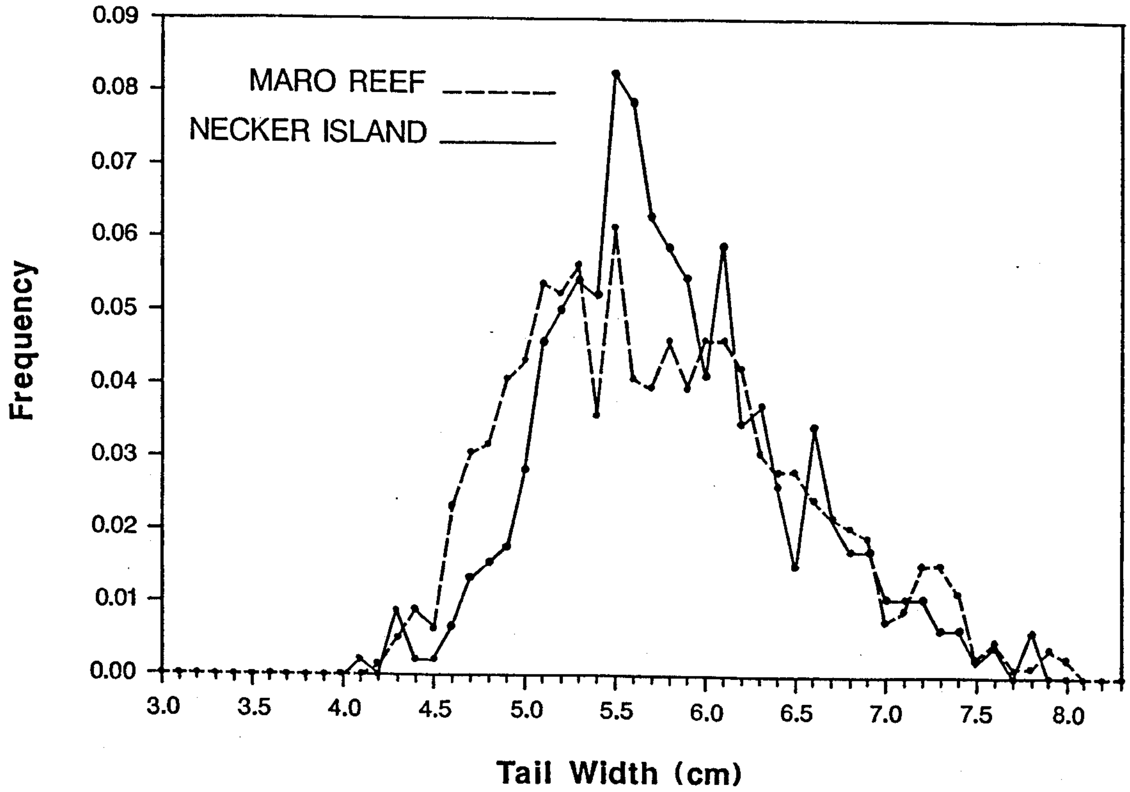

Figure 4.--The frequency by tail width size classes for slipper lobsters at Maro Reef and Necker Island for 1986 and 1987 combined.

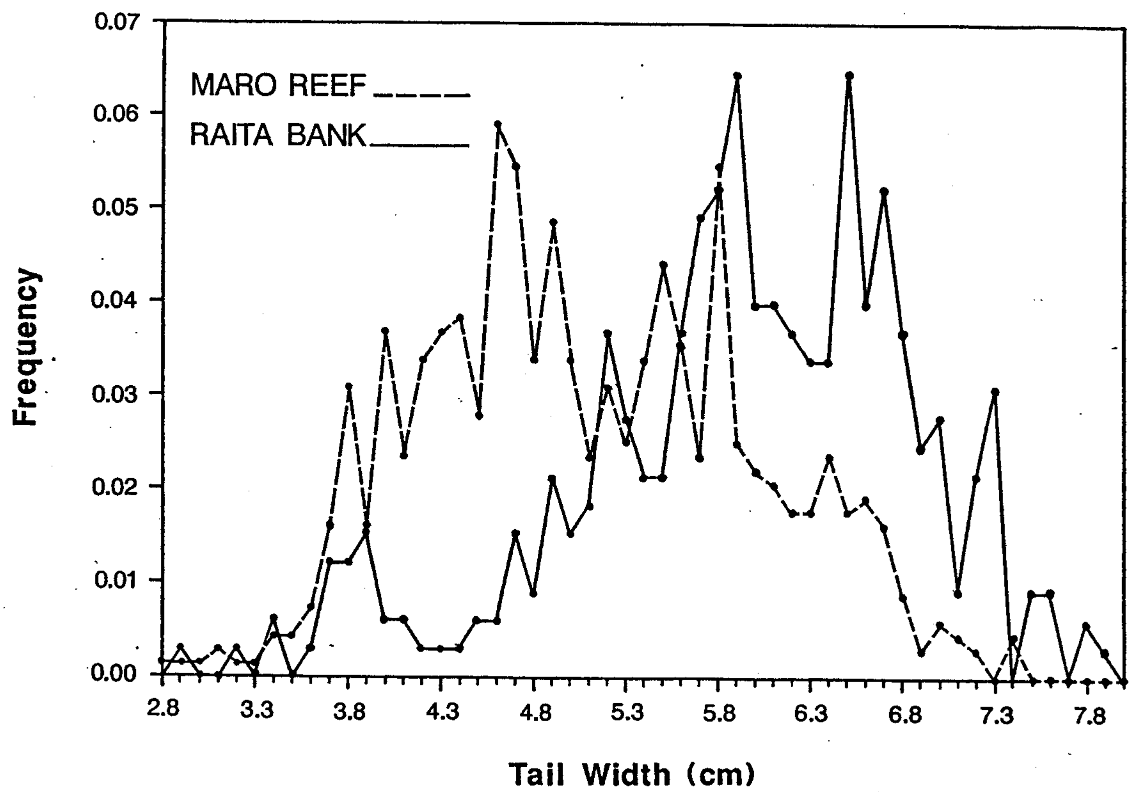

Figure 5.--The frequency by tail width size classes for spiny lobsters at Maro Reef and Raita Bank for November 1986.

Bank has relatively weak recruitment and, hence, will not be as productive for spiny lobsters as the 1985 and 1986 catches suggested.

The annual lobster research cruises collect data on the proportion of female lobsters with external eggs by tail width class, which is used to estimate the tail width at which the females first produce eggs. In 1987 for spiny lobsters, tail widths were estimated at 4.2 and 4.6 cm at Necker Island and Maro Reef, respectively (Table 2), whereas for slipper lobsters, they were estimated at 5.2 and 5.7 cm for Necker Island and Maro Reef, respectively (Table 3). The tail width at the onset of egg production at both Necker Island and Maro Reef in 1987 are statistically less than the 1977 sizes (Table 2). This decline may represent a population response to maintain reproductive capacity in the presence of exploitation.

Table 2.--Tail width at the onset of egg production for spiny lobsters. (Standard error is in parentheses.)

Location	Tail width (cm) by year		
	1977	1985-86	1987
Necker Island	4.6 (0.10)	4.0 (0.07)*	4.2 (0.07)
Maro Reef	5.1 (0.15)	4.8 (0.13)	4.6 (0.05)

*Statistically less than the 1977 value (_P_ = 0.05).

Table 3.--Tail width at the onset of egg production for slipper lobsters. (Standard error is in parentheses.)

Location	Tail width (cm) in 1986-87
Necker Island	5.2 (0.47)
Maro Reef	5.7 (0.16)

Based on the standardized trapping, size-frequency distribution, and tail width at the onset of egg production, a CPUE for reproductive females was computed and used as an index of spawning stock biomass (Table 4). The spiny lobster spawning stock biomasses in 1987 were estimated at 33 and 81% of the 1977 levels at Necker Island and Maro Reef, respectively (Table 4). The relatively high value at Maro Reef reflects the decrease in the size at onset of egg production and the relatively high research CPUE. In future years, the spawning stock biomass of slipper lobsters relative to the 1986-87 sample will be computed. Changes in the relative slipper spawning stock biomass will be closely monitored, given that the size of the onset of egg production is currently close to the minimum size of 5.6 cm.

Table 4.--Female spawning stock biomass (kg/trap-night) for spiny lobsters.

Location	Biomass by year				
	1977	1986	1987	1986/1987	1987/1977
Necker Island	2.45	0.86	0.83	1.04	0.33
Maro Reef	2.14	1.26	1.74	0.72	0.81

DYNAMIC PRODUCTION MODEL

The historical catch and effort relationships show that the fishery has not yet achieved equilibrium levels. Traditional equilibrium production models may greatly overestimate the fishery production. A dynamic production model (Schnute 1977), which is not based on the assumption that catches represent equilibrium levels, was fit to the combined legal spiny and slipper lobster landing and effort data from 1983 to 1987 for Necker Island, Maro Reef, Gardner Pinnacles, and the entire NWHI. A system of four simultaneous equations was used to estimate the model parameters, one equation per area. Three parameters were estimated for each area, but one of the three, the instantaneous rate of stock increase, was assumed to be the same for all four areas and, hence, estimated jointly by all four areas. The estimated annual catches, given annual effort over the period 1983-87, are plotted on Figures 1A-D. An indication of the fit of the dynamic model to the lobster fishery at each area can be obtained by comparing the estimated and actual catches. Based on the estimated dynamic production model, a forecast of the 1988 catch as a function of effort is plotted on Figures 1A-D.

The forecasted catch curves predict, for example, that, if the 1988 effort is equal to the 1987 effort, the 1988 catch will be lower than the 1987 catch for all four areas. Under the new minimum tail width regulation for slipper lobsters, which went into effect January 1988, only an estimated 86% of the 1987 landings would be legal in 1988. The 1988 forecasts include this reduction of landings based on the new slipper minimum size. The greatest declines are predicted to occur at Necker Island and Gardner Pinnacles where, assuming no change in effort, the 1988 catch will only be 69 and 74%, respectively, of the 1987 levels. For Maro Reef and the entire NWHI, the 1988 catches are forecasted to be 84 and 81% of the 1987 catches for the same level of effort; hence for these areas, the declines are due almost entirely to the loss in landings of small slipper lobsters as a result of the new minimum size regulation. The estimated dynamic production model also estimates the long-term equilibrium production curve, assuming that the recruitment to each area comes from spawning stock in that area (Figs. 1A-D). This assumption probably holds for the entire NWHI, but it is not known whether this assumption is correct for the other banks. Because this is the first time this dynamic model has been applied to the NWHI lobster fishery and the application is based on only 5 yr of data, the results of the model should be viewed cautiously.

DISCUSSION AND CONCLUSIONS

When CPUE declines substantially without an increase in effort, one of the first concerns is whether this decline is due to recruitment failure. At Necker Island and Maro Reef, where we have CPUE frequency data for spiny lobsters, the relative abundance of small lobsters has not changed since 1977, and hence, there has not been a recruitment failure for spiny lobsters at these banks. The slipper lobsters only have been fished heavily since 1985, and recruitment to the fishery in 1987 likely depends on the spawning stock prior to 1985. Thus, recruitment overfishing is not responsible for the decline in slipper stocks either. The same argument can be used to rule out recruitment overfishing at banks such as Brooks, Raita, and St. Rogatien, which were fished heavily only since 1985. It can be concluded that the decline in CPUE from 1986 to 1987 is due to the reduction of the population of legal lobsters as a result of heavy fishing pressure in 1986. To put it another way, the level of fishing effort in 1986--1,352,559 trap hauls--was excessive to sustain the 1986 combined legal spiny and slipper CPUE of 1.57.

Although the decline in CPUE for slipper lobsters was anticipated because of the recently heavy fishing pressure, the magnitude of the decline in CPUE of both slipper and spiny lobsters at some of the banks such as St. Rogatien, Raita, and Brooks, which contributed substantially to the 1986 landings, was more than expected. It is possible that these banks have much lower rates of recruitment than Necker Island and Maro Reef and, hence, lower long-term productivity. The tail width frequency distribution at Raita Bank supports this hypothesis (Fig. 5). Further, the sublegal CPUE's reported from the logbooks in 1987, which serve as measures of recruitment, are 0.11 and 0.02 for St. Rogatien and Raita, respectively, compared to 0.48 and 0.35 for Necker Island and Maro Reef (Clarke et al. 1988[1]).

The dynamic production model forecasts that, if effort in 1988 is unchanged from 1987, catches will be lower than 1987 levels--from 84% of the 1987 level for the entire NWHI to 69% of the 1987 level for Necker Island. The model also predicts a long-term or equilibrium maximum sustainable yield of 716,000 slipper and spiny lobsters combined, which will be achieved with an effort of about 500,000 trap hauls.

LITERATURE CITED

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