Southwest Fisheries Center Administrative Report H-89-3

STATUS OF LOBSTER STOCKS IN THE NORTHWESTERN HAWAIIAN ISLANDS, 1988

Jeffrey J. Polovina and Robert B. Moffitt
Southwest Fisheries Center Honolulu Laboratory
National Marine Fisheries Service, NOAA
Honolulu, Hawaii 96822-2396

February 1989

NOT FOR PUBLICATION

ABSTRACT

The commercial logbook catch and effort data from 1983 to 1988 are used to estimate the maximum sustainable yield for the combined slipper lobster, *Scyllarides squammosus*, and spiny lobster, *Panulirus marginatus*, stocks at 1,140,000 lobsters with a fishing effort of 848,000 trap hauls. The 1988 landings and effort fall within the confidence intervals for these estimates. A forecast curve for 1989 landings as a function of effort is estimated.

Research data indicate that adequate spawning stock biomass is protected by the minimum sizes and escape vents at the current level of fishing effort. Growth curves derived from tail width frequency data collected from 1986 to 1988 research cruises at Necker Island estimate that spiny and slipper lobsters attain their minimum legal tail widths of 50 and 56 mm at 3.1 and 3.3 years, respectively, after larval settlement.

INTRODUCTION

This is the fourth annual report on the status of lobster stocks in the Northwestern Hawaiian Islands. The report uses 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.

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. From 1983 to 1987, effort and landings of slipper and spiny lobsters followed a similar trend (Fig. 1). However, in 1988 when effort increased slightly from the 1987 level, landings of spiny lobsters increased dramatically while landings of slipper lobsters declined, and the combined lobster catch per unit effort (CPUE) increased by 16% from 1987 despite the exclusion of sublegal slipper lobsters in 1988 (Fig. 1; Table 1). Most striking is the increase in spiny lobster CPUE's at St. Rogatien Bank, Gardner Pinnacles, and Raita Bank from 1987 levels (Table 1). Fishermen report that the increase in spiny lobster CPUE and decrease in slipper lobster CPUE are due to targeting on spiny lobsters and do not necessarily reflect a decrease in slipper lobster population density.

The catch and effort relationships for the three main banks and for all the other banks combined are given in Figure 2. These catch and effort relationships 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. In 1987, as effort was reduced to 1984 or 1985 levels, the catches fell well below the corresponding 1984 and 1985 levels (Fig. 2). However, effort in 1988 increased at Maro Reef and Gardner Pinnacles, resulting in increased catches, and declined at Necker Island and at all the other banks combined, resulting in relatively constant catch levels (Fig. 2).

RESEARCH SAMPLING DATA

Standardized research sampling was conducted in June 1988 at Necker Island and Maro Reef, which were the same sites sampled in 1977, 1986, and 1987, by using wire mesh traps for spiny lobsters and, beginning in 1986, 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 distribution of tail width for the populations of spiny and slipper lobsters was constructed by combining both sexes. Size-frequency distribution of spiny lobster was computed with the CPUE by tail width class for the combined male and female samples at Necker

Island and Maro Reef (Fig. 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, whereas the CPUE of lobsters below 5.0 cm, representing the new recruits to the fishery, increased slightly (Fig. 3). The right-hand descending side of the 1986-88 CPUE distribution shows more downward curvature at Necker Island than Maro Reef (Fig. 3), suggesting that the fishing mortality is higher at Necker Island than Maro Reef.

The standardized sampling for slipper lobsters consists of only 3 years of relatively small samples, but the tail width frequency distribution shows no difference in size structure between 1987 and 1988 (Fig. 3).

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. Tail widths in 1988 were estimated at 3.9 and 4.8 cm for spiny lobsters (Table 2) and at 5.0 and 5.2 cm for slipper lobsters captured at Necker Island and Maro Reef, respectively (Table 3). It is interesting to note that the tail width at onset of egg production in slipper lobsters has declined just as was observed for spiny lobsters. This decline may represent a population's response to maintain reproduction capacity in the presence of exploitation.

Based on the standardized trapping, size-frequency distribution, and tail width at the onset of egg production, a CPUE for reproductive female spiny lobster was computed and used as an index of spawning stock biomass (Table 4). The spiny lobster spawning stock biomass in 1988 was estimated at 51 and 80% of the 1977 levels at Necker Island and Maro Reef, respectively (Table 4). The similarity between the 1986-87 and 1988 CPUE frequency distributions for slipper lobsters at both Necker Island and Maro Reef indicates that our sampling has not detected any change in slipper lobster spawning stock biomass.

Tail width frequency data from the research cruises at Necker Island in 1986-88 were used to estimate growth curves for slipper and spiny lobsters. Modal progression from the tail width frequencies was fit to a von Bertalanffy growth curve with the ELEFAN computer program to obtain preliminary estimates of parameters κ and L_{∞}. These estimated parameters produce growth curves estimating spiny and slipper lobsters attain their minimum legal sizes at 3.1 and 3.3 years, respectively, after larval settlement (Fig. 4).

DYNAMIC PRODUCTION MODEL

In 1987, a system of dynamic production models was fit to the combined lobster catch and effort data from 1983 to 1987 for Necker island, Maro Reef, Gardner Pinnacles, and the entire Northwestern Hawaiian Islands (NWHI). This model was used to forecast 1988 yield curves as a function of fishing effort. In 1987, the forecast model predicted 1988 catches would be lower than 1987 if effort was unchanged, partly due to the anticipated decline in slipper lobster landings resulting from the new minimum slipper lobster tail width regulation. However, as we have seen, the combined lobster CPUE increased, and the 1988 forecasted landings (given effort) underestimated the actual landings by 19% at Maro Reef, 52% at Necker, 111% at Gardner Pinnacles, and 44% for the entire NWHI (Table 5).

The same dynamic production model was fit with 1983-88 data for Necker Island, Maro Reef, Gardner Pinnacles, and for all other NWHI banks combined, to estimate the maximum sustainable yield (MSY) and corresponding effort and 1989 yield curves (Fig. 2). The MSY for the entire NWHI lobster fishery is estimated at 1,140,000 slipper and spiny lobsters with a corresponding fishing effort of 848,000 trap hauls. The 95% confidence intervals for the estimates of MSY and effort are 944,000-1,336,000 lobsters and 672,000-1,024,000 trap-hauls, respectively. The 1988 landings and effort were 1,057,600 lobsters and 889,000 trap hauls, respectively. If effort is unchanged in 1989, the 1989 landings are estimated to be 972,000 lobsters--just slightly below the 1988 landings.

DISCUSSION AND CONCLUSION

The 1988 lobster season was unusual because of the increase in spiny lobster CPUE. While the increase in spiny lobster landings is apparently due to targeting on spiny lobsters rather than a decline in slipper lobster population size, the cause of the increase in spiny CPUE is not known. The increase may be due to several factors: 1) an increase in catchability of spiny lobsters due to environmental factors, such as lower-than-average sea state and warmer-than-average sea temperature; 2) use of escape vents, which improve the survival of sublegal lobsters and increase catchability of legal lobsters; and 3) an increase in exploitable spiny lobster population size due to relatively low 1987 spiny lobster landings (less than one-half 1988 levels). If this latter factor is responsible, one might anticipate an increase in slipper lobster landings and CPUE in 1989, since both 1987 and 1988 slipper lobster landings have been low relative to 1985 and 1986 levels.

In conclusion, the biological condition of the lobster stocks appears good, and spawning biomass appears adequately protected by the minimum sizes and escape vents. The harvest and effort levels are within the confidence levels estimated for MSY and corresponding effort.

Table 1.--Absolute and relative catch per unit effort (CPUE) for spiny and slipper lobsters in 1986-88, based on commercial logbook data.[1] The 1988 CPUE is based on legal slipper and legal spiny lobsters; 1986-87 CPUE's are based on all slipper and legal spiny lobster catches.

	CPUE				1988/87 CPUE by species	
Location	1988	1987	1986	1988/1987	Spiny	Slipper
Necker Island	1.08	0.98	1.22	1.10	1.68	0.42
French Frigate Shoals	0.97	0.74	1.47	1.31	2.40	0.33
St. Rogatien Bank	1.46	0.59	1.51	2.47	3.64	0.65
Gardner Pinnacles	1.17	0.87	1.07	1.34	3.18	0.22
Raita Bank	0.86	0.66	1.21	1.30	3.25	0.46
Maro Reef	1.39	1.44	1.80	0.96	1.62	0.30
Total	1.25	1.08	1.53	1.16	2.14	0.34

[1]Clarke, R. P. Annual report of the 1988 western Pacific lobster fishery. Manuscr. in prep. Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396.

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

	Tail width (cm) by year			
Location	1977	1985-86	1987	1988
Necker Island	4.6 (0.10)	4.0 (0.07)*	4.2 (0.07)*	3.9 (0.10)*
Maro Reef	5.1 (0.15)	4.8 (0.13)	4.6 (0.05)*	4.8 (0.11)

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

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

Location	Tail width (cm) in 1986-87	1988
Necker Island	5.2 (0.47)	5.0 (0.34)
Maro Reef	5.7 (0.16)	5.2 (0.13)

Table 4.--An index of female spawning stock biomass (kilograms/trap night) for spiny lobsters.

	Index by year					
Location	1977	1986	1987	1988	1988/1987	1988/1977
Necker Island	2.45	0.86	0.83	1.24	1.49	0.51
Maro Reef	2.14	1.26	1.74	1.71	0.98	0.80

Table 5.--The 1988 combined legal spiny lobster and legal slipper lobster catches, together with predicted catches based on 1988 effort with 1983-87 catch data (landings in thousands of lobsters) (NWHI = Northwestern Hawaiian Islands).

Bank	Actual landings	Forecasted landings	Percent error
Gardner Pinnacles	173.6	82.4	-111
Maro Reef	531.8	447.0	-19
Necker Island	169.6	111.7	-52
All banks combined in the NWHI	1,057.6	735.5	-44

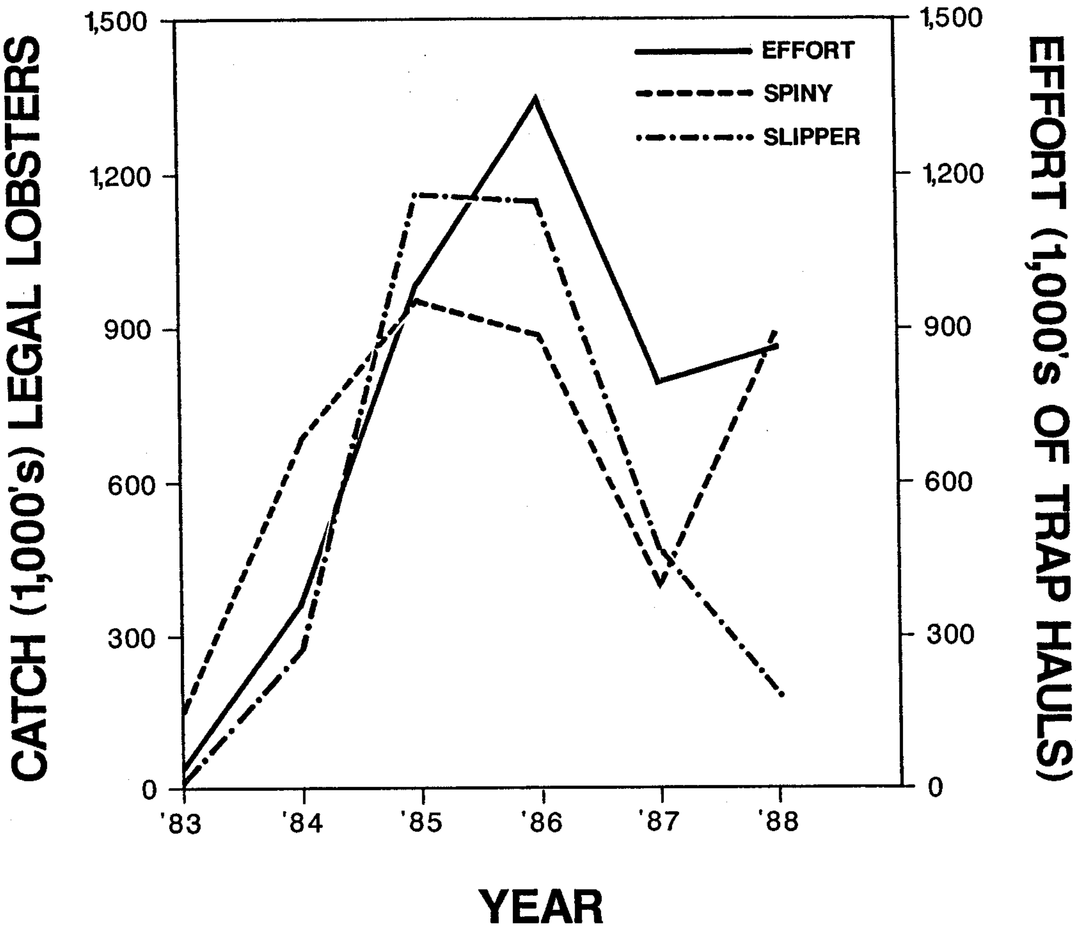
FIGURE CAPTIONS

Figure 1.--Catch and effort of slipper and spiny lobsters in the Northwestern Hawaiian Islands, 1983-88.

Figure 2.--The actual, estimated, and 1989 forecast for spiny and slipper lobsters, by trap hauls, at Necker Island, Maro Reef, Gardner Pinnacles, and all other banks combined in the Northwestern Hawaiian Islands in 1983-88.

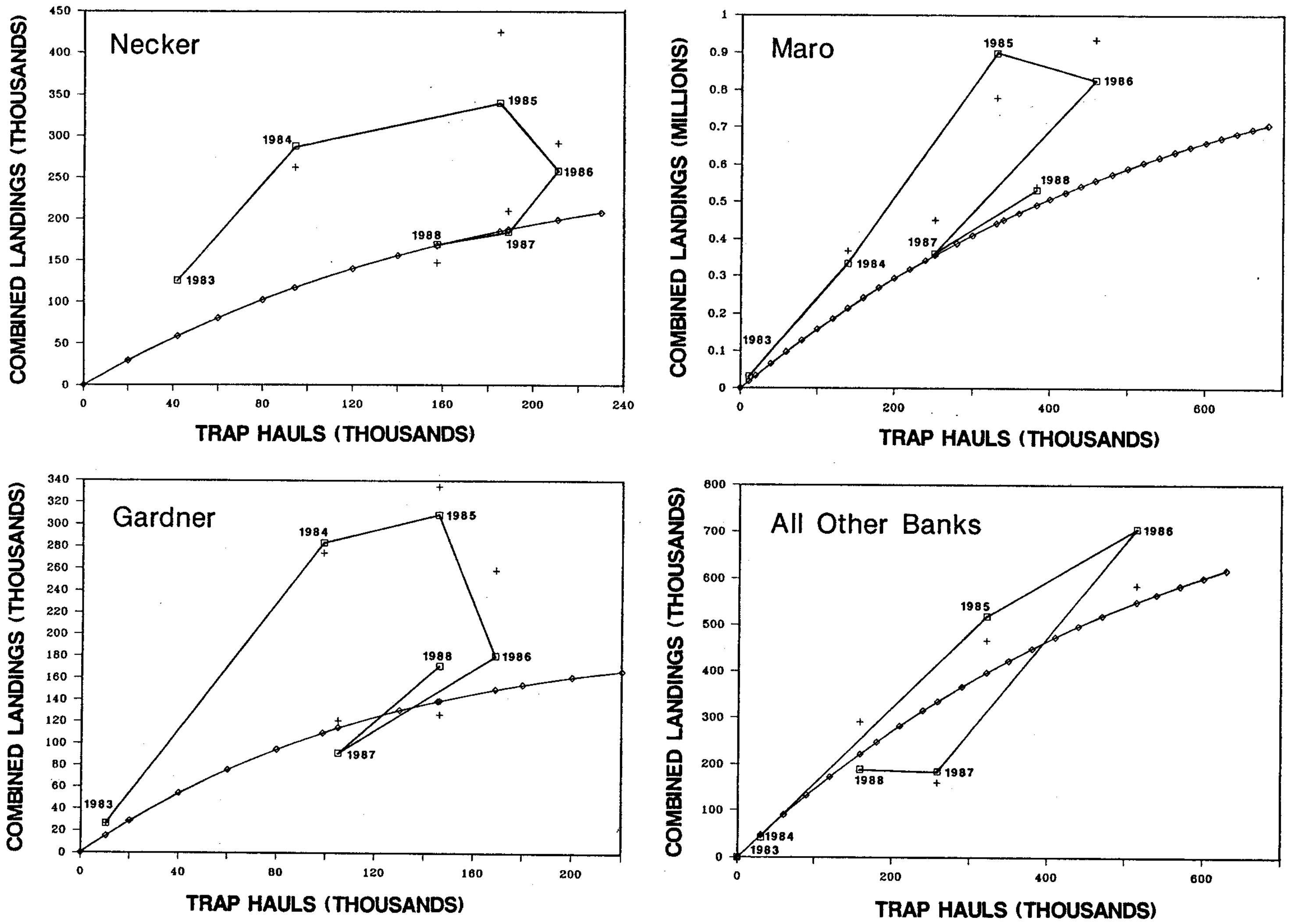
Figure 3.--The catch per unit effort (CPUE), by tail width size class, of slipper lobsters captured in plastic traps and of spiny lobsters captured in wire traps at Necker Island and Maro Reef in 1977 and 1986-88.

Figure 4.--Growth curves for slipper and spiny lobsters at Necker Island after larval settlement. Spiny and slipper lobsters' minimum tail widths are 50 and 56 mm, respectively.



CATCH (1,000's) LEGAL LOBSTERS
EFFORT (1,000's OF TRAP HAULS)
1,500
1,200
900
600
300
0
EFFORT
SPINY
SLIPPER
'83
'84
'85
'86
'87
'88
YEAR

FIGURE 1



□—□—□— = actual slipper and spiny lobster landings

+++++ = estimated landings from fit of production model

◇—◇—◇— = 1989 forecast of landings from production model

FIGURE 2

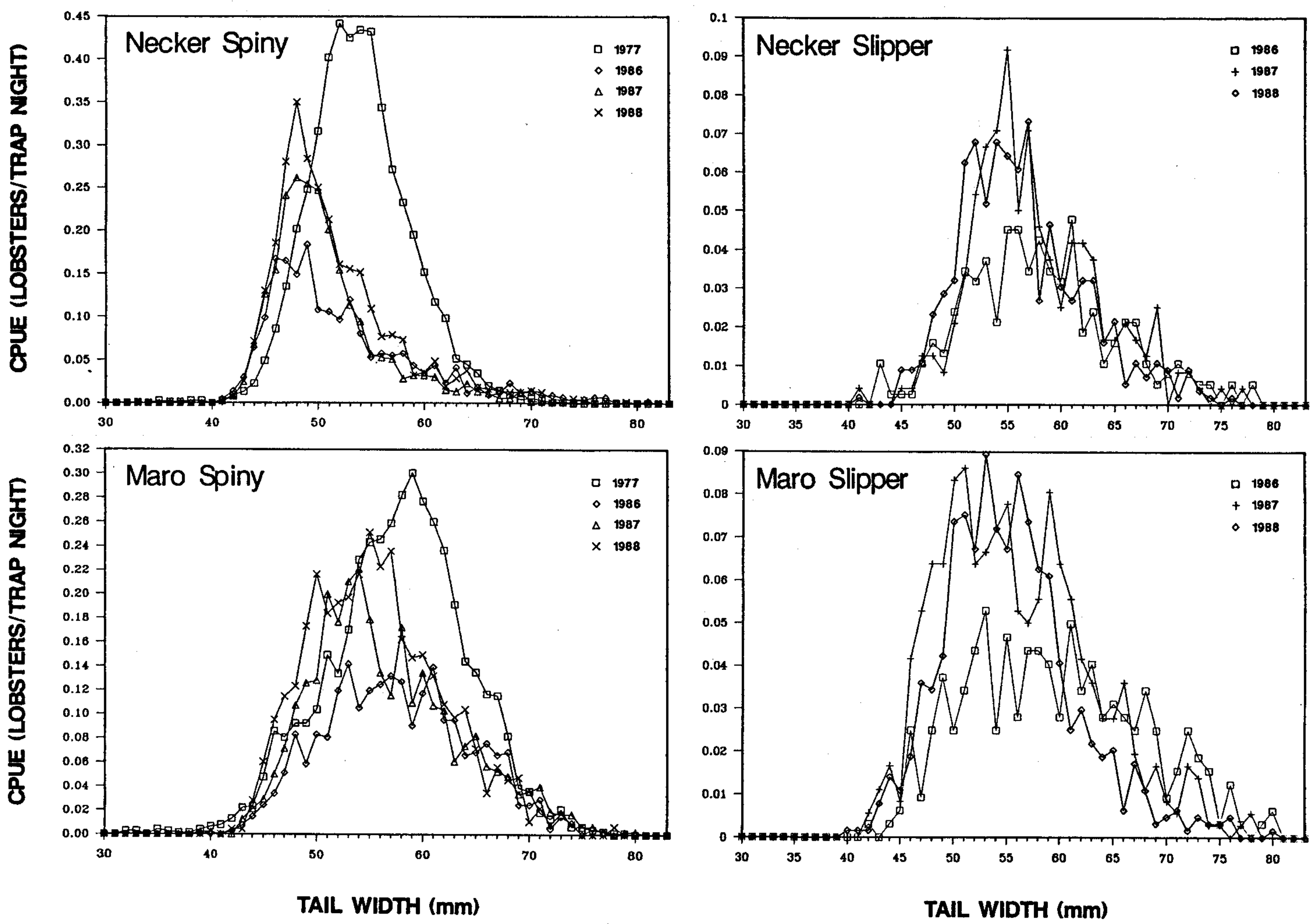

Necker Spiny
Necker Slipper
Maro Spiny
Maro Slipper
CPUE (LOBSTERS/TRAP NIGHT)
TAIL WIDTH (mm)
1977
1986
1987
1988

FIGURE 3

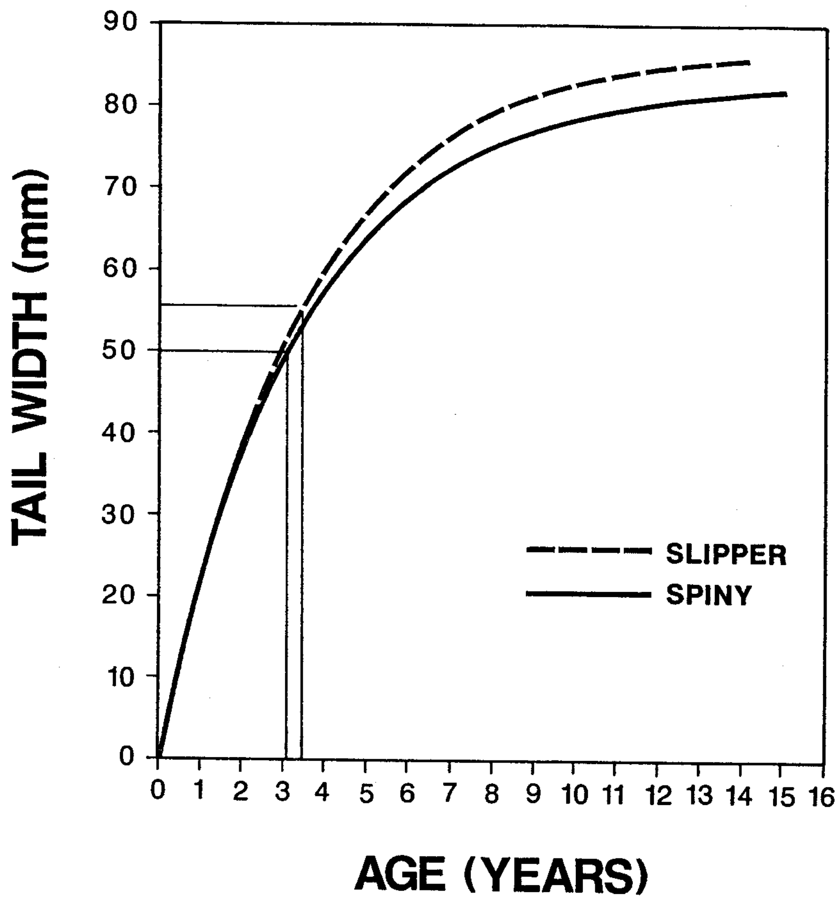

TAIL WIDTH (mm)
90
80
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
AGE (YEARS)
SLIPPER
SPINY

FIGURE 4