The Lobster and Shrimp Fisheries in Hawaii

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The Lobster Fishery

Introduction

The commercial lobster fishery in Hawaii is a trap fishery which harvests several lobster species in the Northwestern Hawaiian Islands (NWHI)—an isolated range of islands, islets, banks, and reefs extending 1,500 n.mi. northwest, from Nihoa Island to Kure Atoll (Fig. 1). The fishery targets two species: the endemic spiny lobster *Panulirus marginatus* (Quoy and Gaimard, 1825) and the common slipper lobster *Scyllarides squammosus* (Milne-Edwards, 1837) (Fig. 2,3). Two other species—the ridgeback slipper lobster *S. haanii* (de Haan, 1841) (Morin and MacDonald, 1984) and the Chinese slipper lobster *Parribacus antarcticus* (Lund, 1793)—are caught incidentally in low abundance.

Lobster concentrations in the NWHI were documented by research cruises in 1976, and commercial trapping began in 1977 (Uchida and Tagami, 1984). Since 1983, the lobster fleet has ranged from 9 to 16 vessels (15 to 35 m long), each averaging 3 trips per year. A typical vessels sets about 800 traps per day and remains at sea almost 2 months per trip. The NWHI lobster fishery is Hawaii's most valuable demersal fishery; in recent years, annual landings have averaged about 600 metric tons (t) (1 million lobsters), valued at about $6 million U.S. ex-vessel (Fig. 4). Since 1988, about 80% of the landings have been spiny lobster (Polovina[1]).

A commercial shellfish trap made by Fathoms Plus[2] is used by all the fishermen. This is a dome-shaped, single-chambered trap made of molded black polyethylene which measures 980 × 770 × 295 mm, with a mesh size of 45 × 45 mm (inside dimensions). Each trap has two entrance cones located on opposite sides. Each trap also has two escape vent panels each consisting of four 67 mm diameter circular vents located on opposite sides to facilitate the escapement of sublegal lobsters (lobsters under minimum legal harvest size). The traps are typically baited with chopped mackerel (*Scomber* sp.) and fished in strings of several hundred traps per string most frequently set in depths from 20 to 70 m.

Synopsis of the Fishery

The historical landings from the lobster fishery exhibit a classical trend of a developing fishery with a period of low catches at the beginning of the fishery (1977–83) followed by a rapid increase in landings as more vessels entered the fishery and markets were developed (1984–86) and most recently a decline in landings as the population is reduced by overfishing (1987–91) (Fig. 4). In the early years of the fishery (1977–84) and since 1988, landings have been about 80% spiny and 20% slipper lobsters. However, for a three-year period from 1985 to 1987 the fishery targeted and largely depleted a previously lightly exploited population of slipper lobsters.

Stock assessment has used the annual catch of spiny and slipper lobsters and trapping effort data from the commercial logbooks since 1983 (Table 1).

Table 1.—Annual landings of spiny and slipper lobsters (in 1,000's), trapping effort (in 1,000's trap-hauls), and the percentage of spiny lobster in the landings, 1983–90.[1]

Year	Spiny lobster	Slipper lobster	Total lobsters	Trapping effort	CPUE	Spiny lobster %
1983[2]	158	18	176	64	2.75	90
1984	677	207	884	371	2.38	78
1985	1022	900	1922	1041	1.83	53
1986	843	851	1694	1293	1.31	50
1987	393	352	745	806	0.92	53
1988	888	174	1062	840	1.26	84
1989	944	222	1166	1069	1.09	81
1990	591	187	778	1182	0.66	76
1991[3]	131	35	166	292	0.56	79

[1] Data were provided to the Honolulu Laboratory, National Marine Fisheries Service, as required by the Crustacean Fishery Management Plan of the Western Pacific Regional Fishery Management Council.
[2] April-December 1983.
[3] January-May, November-December 1991.

[1]J. J. Polvina. 1991. Status of lobster stocks in the Northwestern Hawaiian Islands, 1990. U.S. Dep. Commer., Natl. Mar. Fish. Serv., Southwest Fish. Sci. Cent. Admin. Rep. H-91-04, 16 p.
[2]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

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ABSTRACT — A description of the lobster and deepwater shrimp fisheries in Hawaii, addressing harvest levels, biology, and research, is presented. Both fisheries are trap fisheries. The lobster fishery is a limited entry fishery with 1991 landings of 200 metric tons. The shrimp fishery is unregulated, with very sporadic effort, and annual landings below 200 metric tons.

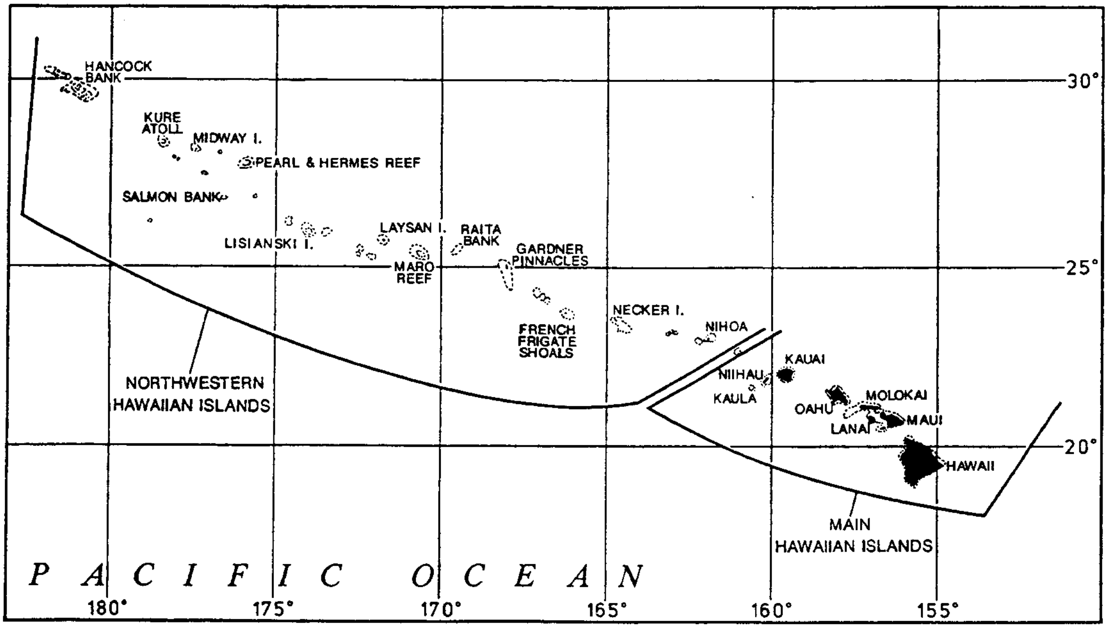

Figure 1.—The Hawaiian Archipelago, including the Northwestern Hawaiian Islands.

Both spiny and slipper lobsters may be caught in the same trap but fishermen can alter the proportion of each species by selecting the trapping area and depth. Logbooks record only the number of traps hauled and do not specify when effort targets spiny or slipper lobster. Since 1983 when logbook reporting was in effect, the combined catch per unit effort (CPUE) for legal slipper and spiny lobsters has declined from 2.75 to 0.56 lobster per trap-haul (Fig. 4).

Stock assessment of the lobster resource is hindered by the relatively short catch and effort time series and our inability to age lobsters. A dynamic production model, fit to the combined spiny and slipper lobster catch and effort data for the entire NWHI, estimates an equilibrium production curve with a maximum sustainable yield of 900,000 lobsters/year from a fishing effort of 740,000 trap-hauls, resulting in a CPUE of 1.22 lobsters/trap-haul (Polovina[1]). A CPUE time-series model estimates the annual instantaneous natural mortality (M) at 0.7/year and catchability (q) at 1.0×10^{-6} (Polovina[1]). Thus the 1990 fishing effort of 1.2 million trap-hauls corresponds to a fishing mortality (F) of 1.2/year or 1.7 times M. Based on the minimum harvest sizes and this level of fishing mortality, the spawning stock biomass per recruit is estimated at 40% of the level in the absence of fishing.

Both the level of fishing mortality relative to natural mortality and the relative spawning biomass suggest that fishing effort alone was not sufficient to cause the decline in CPUE observed in 1990 and 1991. Current research suggests this decline is the result of poor recruitment (due to oceanographic conditions) at some banks which resulted in a concentration of fishing effort at the remaining banks where recruitment was strong.

Research

After the initial research cruises documented lobster concentrations in the NWHI in 1976, research focused on the biology of the spiny lobster *Panulirus marginatus*. Tagging studies at Kure Atoll and French Frigate Shoals estimated a von Bertalanffy growth curve for growth (in carapace length) to have a parameter K of 0.31/year with an asymptotic carapace length of 13.2 cm, a mean natural mortality estimate of 0.37/year, and estimates for the ages at the onset of sexual maturity of 2.7 and 1.7 years for males and females, respectively (MacDonald, 1984). Trapping surveys mapped the spatial distribution of *P. marginatus* in the NWHI and indicated that the highest catch rates ranged from depths of 55–73 m in the southeastern portion of the NWHI to 19–54 m in the northwestern portion of the Hawaiian Archipelago (Uchida and Tagami, 1984). The settlement of post-larval lobster, puerulus, were monitored at Kure Atoll, French Frigate Shoals, and Oahu with surface collectors (MacDonald, 1984). Puerulus settlement appeared seasonal at the ends of the Hawaiian Archipelago; the greatest settlement occurred in the summer at Kure Atoll and in the winter at Oahu while at French Frigate Shoals, more centrally located, settlement appeared more uniformly throughout the year (MacDonald, 1986).

Research conducted during 1984–87 developed escape vents to reduce the catch and hence mortality of sub-

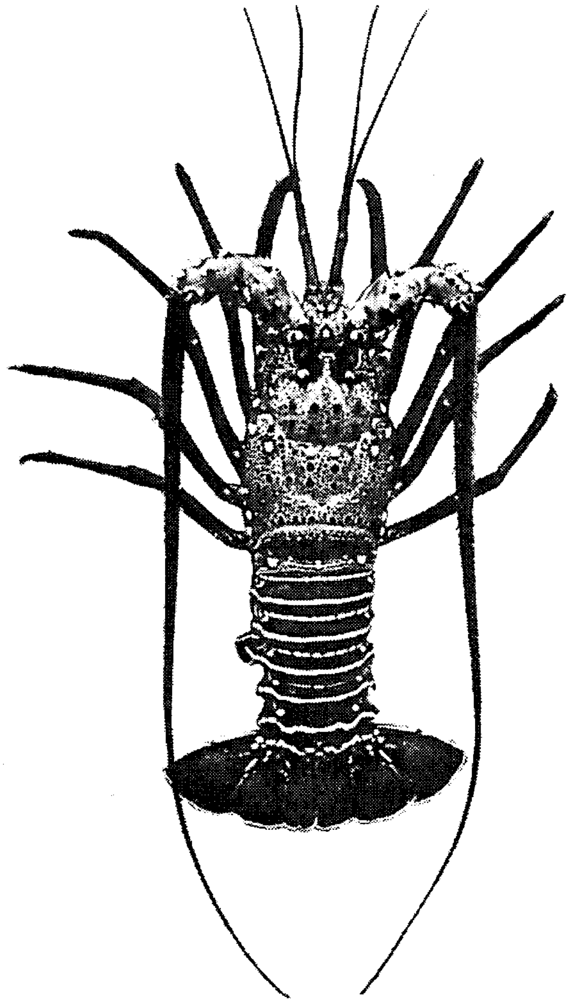

Figure 2.—The spiny lobster, *Panulirus marginatus*.

legal spiny lobster (<50 mm tail width) and sublegal slipper lobster (<56 mm tail width) without reducing legal catches. A circular vent design takes advantage of the different morphology of the spiny and slipper lobsters to allow escapement at different tail sizes for each species. Specifically, research found that traps equipped with two vent panels consisting of four 67 mm diameter circles placed at the bottom of the trap caught 83% and 93% fewer sublegal spiny and slipper lobsters than did nonvented control traps, without significantly reducing legal catches of either species (Everson et al., In press).

An estimated 2,000 plastic traps are lost annually in the NWHI. Concern has been raised that lobsters entering those lost traps may be unable to exit and therefore die. Recent field and tank studies have investigated whether lobsters can escape unbaited lobster traps. The results indicate that lobsters using the traps for shelter are able to exit, and no mortality due to the retention of slipper or spiny lobster in traps was observed (Parrish and Kazama, 1992).

Ongoing research is directed toward understanding the factors responsible for observed spatial and temporal variation in adult lobster abundance within the Hawaiian Archipelago. Results from larval tows and studies on local oceanography suggest that long-term differences in lobster densities between banks in the NWHI are not due to local larval densities but to differences in the amount of relief provided by the benthic habitat on the banks.

Temporal variation in spiny lobster stocks at the two most productive banks in the fishery, Maro Reef and Necker Island, has been studied with both commercial and research data. Research and commercial trapping data both show a wide variation in recruitment to the fishery for spiny lobster at Maro Reef relative to Necker Island, 360 n.mi. to the southeast. A high correlation is observed between recruitment to the fishery at Maro Reef and the relative sea level between French Frigate Shoals and Midway Island four years earlier. Geosat altimeter data indicate that the variation in relative sea level between French Frigate Shoals and Midway is linked to the El Niño Southern Oscillation (ENSO). The mechanisms responsible for the apparent link between sea level and lobster recruitment are not known and are the subject of current research. However, the sea level index may prove to be a useful forecast of recruitment to the fishery at Maro Reef four years later (Polovina and Mitchum, 1992).

One economic study (Clarke and Pooley, 1988) has examined the return on investment as a function of vessel size. The most profitable vessels in the fleet are the midsize vessels. These vessels are 20–30 m long, have 5–9 crew members, and are able to set 600–820 traps per day. Larger vessels face cost constraints while smaller vessels face operational problems.

Management

The fishery has been managed under Federal jurisdiction with a fishery

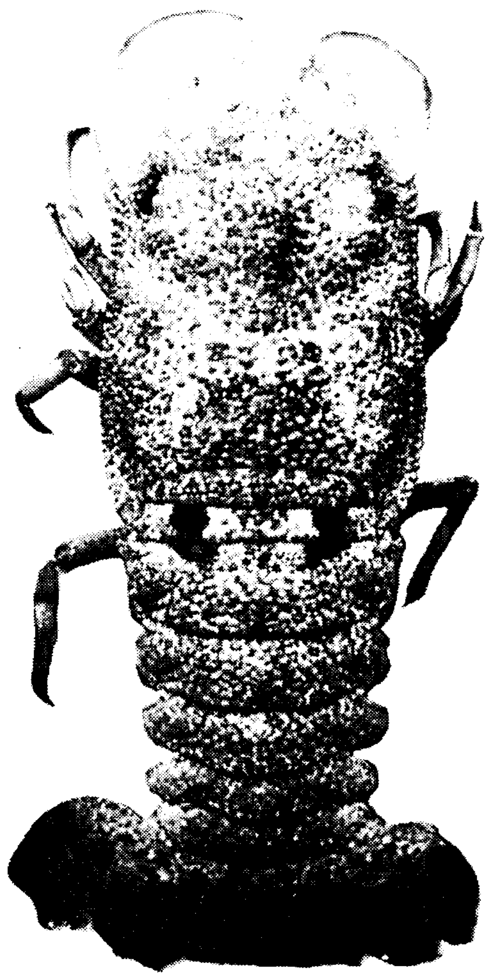

Figure 3.—The slipper lobster, *Scyllarides squammosus*.

management plan (FMP) administered by the Western Pacific Regional Fishery Management Council (WPRFMC) since 1983. Currently the plan prohibits the harvest of slipper lobster (*S. squammosus*) with a tail width of <56 mm and spiny lobster (*P. marginatus*) with a tail width of <50 mm, prohibits the retention of egg-bearing females, requires that all traps have escape vents to reduce handling and release-induced mortality on sublegal lobsters, and mandates that vessels submit logbooks recording daily catch and trapping effort. A decline in CPUE from 1.25 lobster per trap-haul in 1988 to 0.6 in 1990 as well as concerns that vessels from other fisheries in worse condition were considering entering the lobster fishery, motivated the fishermen to work with the WPRFMC to develop a limited entry and harvest quota plan. Further, to protect the spawning biomass of the stock while the plan was being developed the WPRFMC passed emergency regulations to close the fishery for 6 months (May through October, 1991). In March 1992, the lobster FMP was amended to include provisions for a limited entry system for a maximum of 15 vessels, an annual fleet harvest quota, and a closed season from January through June to protect the spawning biomass before the summer spawning. The quota is set to achieve an average CPUE over the fishing season of 1.0 lobster per trap-haul. A preseason quota is set using an estimate of the population size at the end of the previous fishing season and estimates of natural mortality and recruitment. A final quota is set after the first month of fishing based on the CPUE during that month. Information from research surveys can also be used in the quota calculations. Currently, fishermen and managers are considering whether an individual quota would be an improvement over the current fleet quota.

The lobster fishery has sufficient management regulations, which if applied correctly, should make the fishery sustainable and economically profitable. However, environmental factors may result in both considerable annual as well as decadal-scale variation in the exploitable lobster population and hence landings.

The Shrimp Fishery

Deepwater pandalid shrimp are found in some abundance throughout the tropical and subtropical Pacific (King, 1984; Moffitt and Polovina, 1987). In Hawaii, research trapping showed that *Heterocarpus laevigatus* (Fig. 5) and the smaller and more shallow dwelling species, *H. ensifer*, could be readily caught in the depth range 350–825 m in baited traps (Struhsaker and Aasted, 1974). During the past decade there have been two periods when the resource, particularly the more valuable species *H. laevigatus*, has been the target of fishing. In the early 1980's a small trap fishery was initiated around the main Hawaiian Islands. The vessels typically used large, pyramid-shaped traps with a volume of almost 2 m^3, and a large vessel might set up to 50 traps a day (Tagami and Barrows,

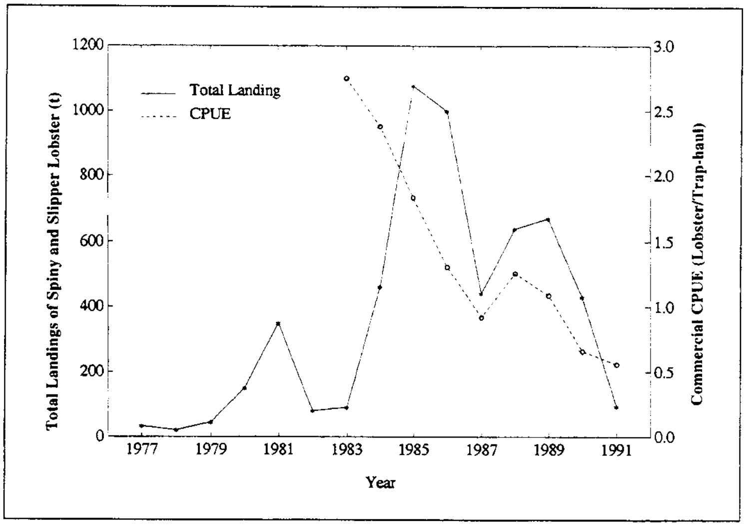

Figure 4.—Total lobster landings and commercial catch per unit effort (CPUE) from the lobster fishery in the Northwestern Hawaiian Islands. Data since 1983 are based on vessel logbooks required under the fishery management plan.

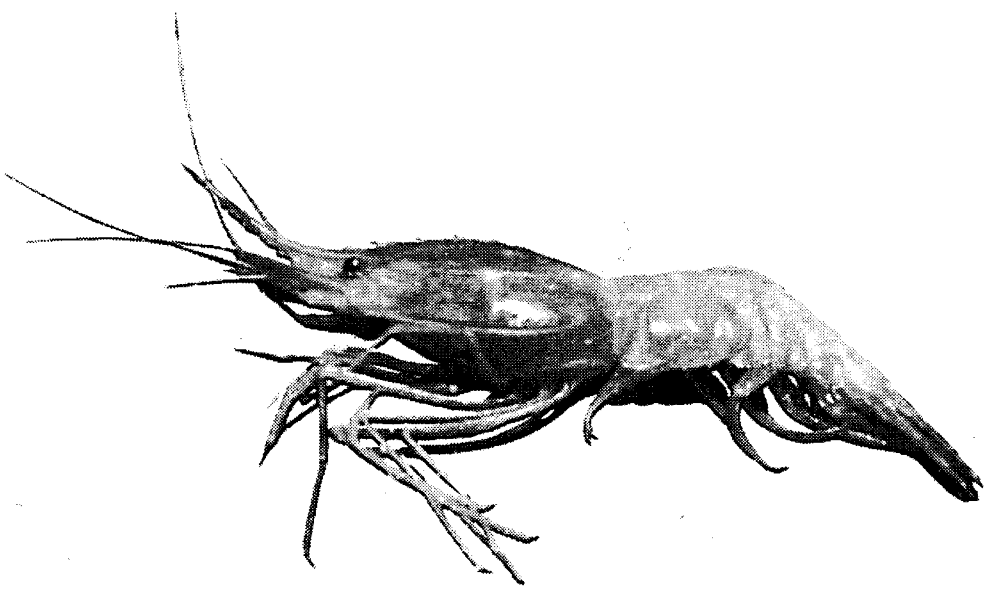

Figure 5.—The deepwater shrimp, *Heterocarpus laevigatus*.

1988). Landings from this fishery peaked in 1984 at over 190 metric tons of *H. laevigatus* with an ex-vessel value of $1.5 million ($7.85/kg) from 7 vessels, 23–40 m in length (Ralston and Tagami, 1992). However by the late 1980's most of the vessels had left the fishery as declining catch rates and the high cost of the deep trapping made the fishery unprofitable. There was a resurgence in the fishery in 1990, when landings of over 100 t were reported, primarily the result of intensive fishing by a single vessel but this level of production was not sustainable at a profitable CPUE[3]. Currently there are no management regulations for this resource.

Recent research has conducted submersible surveys of shrimp densities on different habitats and estimated shrimp biomass from an intensive trapping depletion study (Moffitt and Parrish, 1992; Ralston and Tagami, 1992). The submersible surveys observed that *H. ensifer* tended to group around large anemones and other benthic relief over an otherwise flat, sandy bottom and were very active in the presence of a baited trap (Gooding et. al., 1988; Moffitt and Parrish, 1992). However, *H. laevigatus* were solitary and showed little activity around baited traps. Greater densities of *H. laevigatus* were observed on volcanic than on coralline substrata (Moffitt and Parrish, 1992). The depletion study based on intensive trapping estimated a catchability coefficient which when applied to trapping data around the main Hawaiian Islands estimated an exploitable biomass of *H. laevigatus* of 271 t (Ralston and Tagami, 1992).

While the deepwater shrimp resource may support a very limited local fishery or perhaps periodic heavy pulse fishing, it is unlikely to be the object of heavy sustained exploitation. Initial high catch rates appear to drop rapidly, gear loss is appreciable and costly due to the trapping depths, and markets are not well established.

[3]Commercial Landings, State of Hawaii, Division of Land and Natural Resources, Division of Aquatic Resources, 1990.

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