ɔnomics and Hawaii's
sh. Rev. 55(2):93–101.
ıii's marine fisheries:
rm trends, and recent
ish. Rev. 55(2):7–19.
ıe ecological basis of
ıgement. *In* D. Pauly
ors), Theory and man-
isheries, p. 167–194.
9.
The ecology of patch
ɔical Pacific atoll: re-
community structure
redators. Ph.D. Diss.,
lu, 321 p.
cological perspective
ı the main Hawaiian
v. 55(2):34–49.
Uchiyama (Editors).
the Northwestern Ha-
ep. Commer., NOAA
FC-38, 142 p.

Hawaii's Marine Fisheries: Some History, Long-term Trends, and Recent Developments

SAMUEL G. POOLEY

Introduction

Recently Hawaii's commercial marine fishery has experienced a period of rapid growth and structural change, and its characteristics are quite different from what they were a decade ago. Some of these changes are the result of governmental and private-sector decisions on fishery development in Hawaii, but many have occurred because of increasingly competitive pressures, particularly as they have affected mainland U.S. commercial fishing fleets. Further changes are anticipated as diverse fishing interests (including both large-scale and small-scale commercial, indigenous, and recreational fishing interests, as well as nonconsumptive marine resource interests) are worked out in fishery, marine, and coastal zone management processes. This paper concentrates on the economic development of the offshore commercial fishery, and places somewhat greater emphasis on the large-scale fisheries. Biological and management features of Hawaii's marine fisheries are considered in other papers in this number (Mar. Fish. Rev. 55(2)).

Samuel G. Pooley is with the Honolulu Laboratory, Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA, 2570 Dole Street, Honolulu, HI 96822-2396.

ABSTRACT — This paper provides an overview of Hawaii's marine fisheries from 1948 to the present. After three decades of decline following a brief period of growth at the conclusion to World War II, Hawaii's commercial fisheries began a decade of sustained development in the 1980's. At the same time, fisheries management issues became more significant as different segments of the fishery came into more direct competition. This paper provides new estimates of commercial landings for the 1977–90 period, and summarizes limited information on recreational and subsistence fisheries in the 1980's. It also provides some historical context which may be useful in evaluating fishery development and management options.

Hawaii's marine fisheries can be divided into three geographical areas (Fig. 1):

1) The inhabited main Hawaiian Islands (MHI), with their surrounding reefs and offshore banks (the island of Hawaii to Niihau and Kauai);

2) The Northwestern Hawaiian Islands (NWHI), a 1,200 mile string of basically uninhabited reefs, shoals, and islets ranging west northwest from the main Hawaiian Islands (i.e., west of Niihau and Kauai);

3) The mid-North Pacific Ocean, ranging from lat. 40°N to the Equator, and from long.145°W to long. 175°E.

Hawaii's fishing fleets can also be divided into three somewhat overlapping or interconnected segments:

1) Large-scale commercial fishing.

Although termed "large-scale" in Hawaii, by mainland U.S. and foreign fishing fleet standards almost all the vessels in this segment would be considered small. Most "large-scale" commercial fishing vessels in Hawaii are less than 100 feet in overall length. These include the older aku boats (pole-and-line sampans[1] fishing for skipjack tuna[2]) (Table 1) and tuna longline sampans (also wooden but of a different design), as well as modern tuna and swordfish longline vessels, distant-wa-

Table 1.—List of common and scientific names of frequently caught commercial species in Hawaii.

Common name	Scientific name
Bottomfish	
Snappers	
Onaga	*Etelis coruscans*
Opakapaka	*Pristipomoides filamentosus*
Ehu	*E. carbunculus*
Kalekale	*P. seiboldii*
Gindai	*P. zonatus*
Uku	*Aprion virescens*
Lehi	*Aphareus rutilans*
Yellowtail kalekale	*P. auricilla*
Taape	*Lutjanus kasmira*
Grouper	
Hapuupuu	*Epinephelus quernus*
Jacks	
White ulua	*Caranx ignobilis*
Black ulua	*C. lugubris*
Butaguchi	*Pseudocaranx dentex*
Kahala	*Seriola dumerili*
Other	
Lobster	
Spiny	*Panulirus marginatus*
Slipper	*Scyllarides squammosus*
Pelagic Management Unit Species	
Blue marlin	*Makaira mazara*
Striped marlin	*Tetrapturus audax*
Broadbill swordfish	*Xiphias gladius*
Shortbill spearfish	*T. angustirostris*
Black marlin	*M. indica*
Indo-Pacific sailfish	*Istiophorus platypterus*
Mahimahi	*Coryphaena hippurus*
Ono (wahoo)	*Acanthocybium solandri*
Blue shark	*Prionace glauca*
Mako shark (short-fin)	*Isurus oxyrinchus*
Mako shark (long-fin)	*I. paucus*
Oceanic whitetip shark	*Carcharhinus longimanus*
Thresher shark	*Alopias superciliosus*
Tiger shark	*Galeocerdo cuvieri*
Tunas	
Bigeye Tuna	*Thunnus obesus*
Yellowfin tuna	*T. albacares*
Albacore	*T. alalunga*
Skipjack tuna (Aku)	*Katsuwonus pelamis*
Kawakawa	*Euthynnus affinis*
Frigate tunas	*Auxis* spp.

[1]The term "sampan" in Hawaii refers primarily to wooden-hulled fishing craft of a design introduced by Japanese fishermen in the early 1900's. The vessels range from 35 to 75 feet with a flared bow, a low stern, and a deep profile to maintain seaworthiness in Hawaii's rough waters.

[2]Hawaii common names for commercial marine fish and shellfish species are used throughout this paper. Scientific names and corresponding Hawaii, names are found in Table 1.

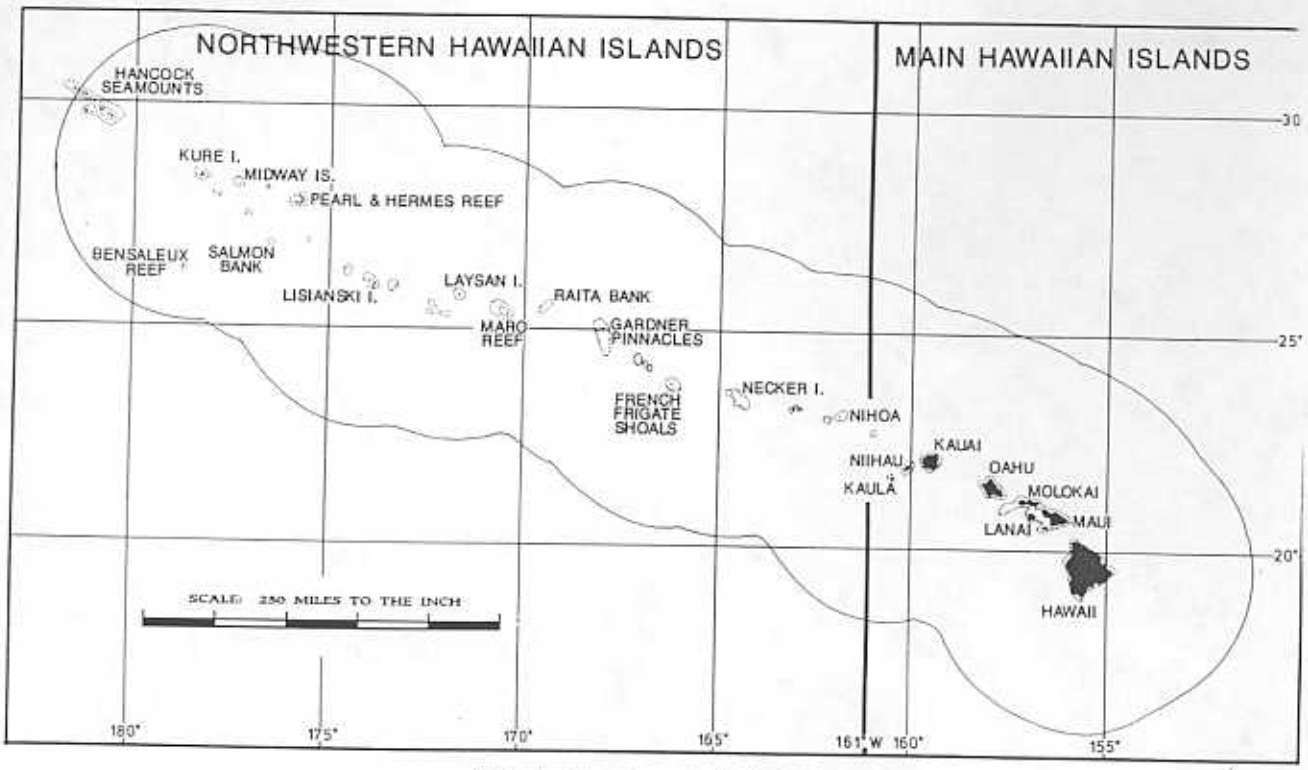


Figure 1.—Hawaii map, including NWHI.

ter albacore trollers, and multipurpose vessels which fish for bottomfish (deepwater snappers, groupers, and jacks) and spiny and slipper lobster in the NWHI. These vessels can operate as far as 1,000 nautical miles from Hawaii throughout the mid-North Pacific, and some span the South Pacific. Most operate within 200 miles of the MHI or within the NWHI.

2) Small-scale commercial fishing.

The vessels in this segment include a wide variety of trailered and moored boats between 12 and 45 feet in length. These vessels primarily use trolling and handline techniques, although some traps and surrounding nets are used. The target species include tunas, billfish, mahimahi, ono (wahoo), bottomfish for the trollers and handliners; bottomfish, reef fish, and crustaceans for the trap vessels; and small midwater scads (known locally as akule and opelu) for the surrounding-net fishery. These vessels operate almost exclusively in the MHI.

3) Small-scale recreational, part-time commercial, and subsistence fishing.

This segment includes the same kind of vessels as found in the small-scale commercial fleet, as well as some very small boats (including surf boards and sail boards), charter fishing boats and dive fishing boats. Although charter fishing is a commercial operation, its clients are oriented toward recreational opportunities and thus it is distinguished from commercial fishing. The target species for this segment of the fishery are more varied than those of the commercial segments, and include a variety of reef species, as well as the more familiar tunas, billfish, mahimahi and ono (wahoo), bottomfish, and crustaceans. The fishing methods used are also considerably more varied.

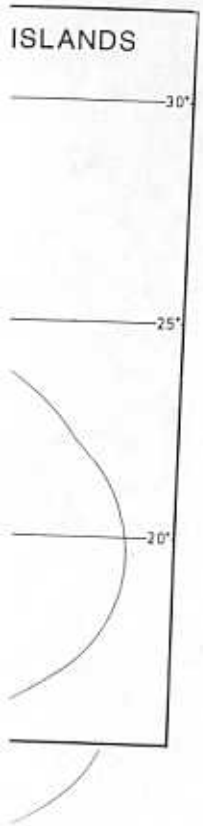
The issue of categorizing Hawaii's small-boat fisheries is a difficult one, and is discussed later in this paper. For the moment we would categorize this segment as one where the fishery has limited fishing power and its fishermen have mixed motivations in terms of fishing activity.

Hawaii's Traditional Commercial Marine Fisheries

Shortly after Statehood, a U.S. Department of Interior, Bureau of Commercial Fisheries proposal labeled the Hawaii fishery as "dying" (Iversen[3]). Hawaii's major commercial fisheries had been dominated by traditional practices that reflected Hawaii's Japanese immigrant heritage and its impact on the local fishery and seafood markets. The predominant commercial fishery was aku (skipjack tuna), which was caught by a live-bait, pole-and-line wooden sampan fleet, known as aku boats (Fig. 2), and which was landed primarily for canning. In 1960, over 60% of Hawaii's total recorded commercial fishery landings (by weight) was aku, and the percentage remained over 50% until 1970.

By the mid-1970's the number of aku boats and their companion sam-

[3]R. T. B. Iversen, 45-626 Halekou Place, Kaneohe, HI 96744. Personal commun., 1991.



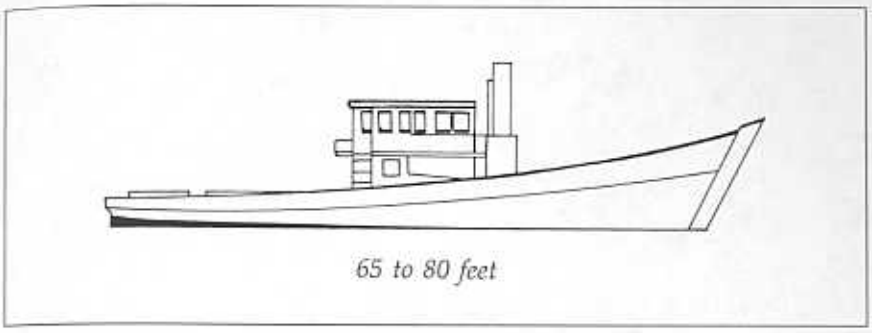


Figure 2.—Drawing of typical Hawaii aku (skipjack tuna pole-and-line) boat.

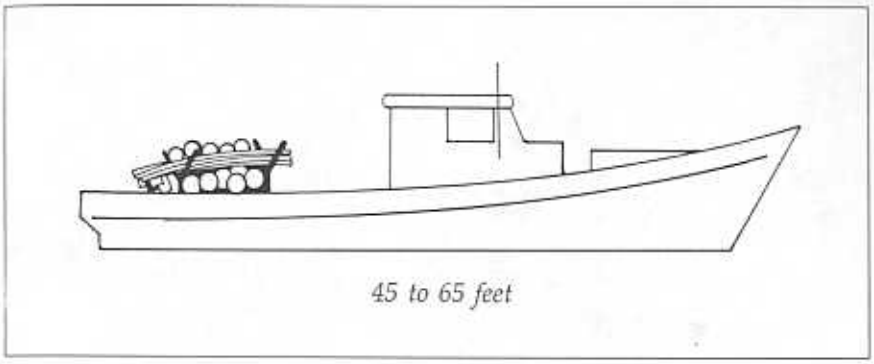


Figure 3.—Drawing of typical Hawaii flagline (longline sampan) boat.

Table 2.—Hawaii commercial fisheries, 1990. NMFS estimates based on logbooks and shoreside monitoring. MHI = main Hawaiian Islands; NWHI = Northwestern Hawaiian Islands.

Fleet	Weight (1,000 lb.) Caught	Weight (1,000 lb.) Sold	Thousand dollars
Longline	13,090	12,200	$28,800
Troll and handline pelagics	4,460	4,050	6,980
Aku boat	1,005	1,005	1,838
MHI bottomfish	830	810	3,300
NWHI bottomfish	420	400	1,070
NWHI lobster	949	949	4,887
Other	1,700	1,594	3,513
Total	22,454	21,008	50,388

pans, the longline tuna boats (known locally as flagline boats, Fig. 3), had decreased substantially, and the condition of many of the boats was poor. Fishing remained close to the main Hawaiian islands, although some older bottomfish boats fished the NWHI. Volume of fish in the fresh fish market had declined, and few improvements in marketing were apparent. Most fresh seafood appeared to be consumed in the home, and ethnic identification with particular species was very strong. Nearshore reef and schooling fish were still relatively abundant, but Hawaii's commercial fishery reached its nadir in 1975.[4]

Figures 4 and 5 provide estimates of Hawaii's long-term commercial fishing landings and revenue.[5] Revenues throughout this paper are inflation-adjusted values to a 1990 base year. Figures on landings and revenue for the period 1948–76 are based entirely on the Hawaii Division of Aquatic Resources (HDAR) commercial fishing landings reports. Figures for the period 1986–90 are based largely on NMFS estimates of Hawaii's commercial landings and on our own wholesale market monitoring program. The period 1977–85 is a combination of the HDAR data with NMFS estimates of particular gear types (longline and NWHI lobster).[6] Table 2 provides a breakdown of the NMFS data for 1990 by gear type.

Figure 4 differentiates the aku boat fishery (skipjack tuna) from the rest of the fishery (identified as "non-aku") because the aku fleet has been the source of most annual variation in landings. The average annual variation in detrended aku landings was 164% (compared with 27% for non-aku landings) in the period 1948–90.[7] Any analysis of the overall Hawaii commercial fishery over time must differentiate the overall trend from these fluctuations in the aku fishery.

Aku landings declined through the mid-1970's to the closing of the cannery in 1984, and then continued to fall through 1990. Aku landings fell as a percentage of total landings (by weight) from over 70% in the 1960's to less than 20% in the last five years of the 1980's, and to only 4.5% in 1990. However aku revenue has not fallen as appreciably because of the higher market price of fresh aku (compared with the cannery price in the pre-1985 period).

Major Developments Since the Mid-1970's

The nature and value of Hawaii's present day fisheries and seafood industry have changed dramatically since the 1970's. The commercial fishery has more than doubled in inflation-adjusted ex-vessel value since 1970 to $50 million in 1990 and $60 million in 1991. The seafood market is probably worth over $100 million (including imported seafood), there is a $10-15 million char-

[4]In terms of inflation-adjusted revenue. The lowest landings were in 1969 using NMFS estimates, but 1975 was the second lowest year.

[5]Estimates are required because official records of commercial fisheries landings were not comprehensive in some years during that period.

[6]Appendix A, available from the author, provides additional detail on the NMFS estimates for the period 1979-90, as well as time-series for individual gear types (aku boat, longline, NWHI lobster, NWHI bottomfish, main Hawaiian Islands, and other gears) from 1948 to 90.

[7]Detrending is a simple statistical procedure to remove the long-term change (growth or decline) in a time series. The resulting figures then reflect more accurately the shorter-term variation, in this case, the year-to-year variation, in the 1948 to 1990 time period.

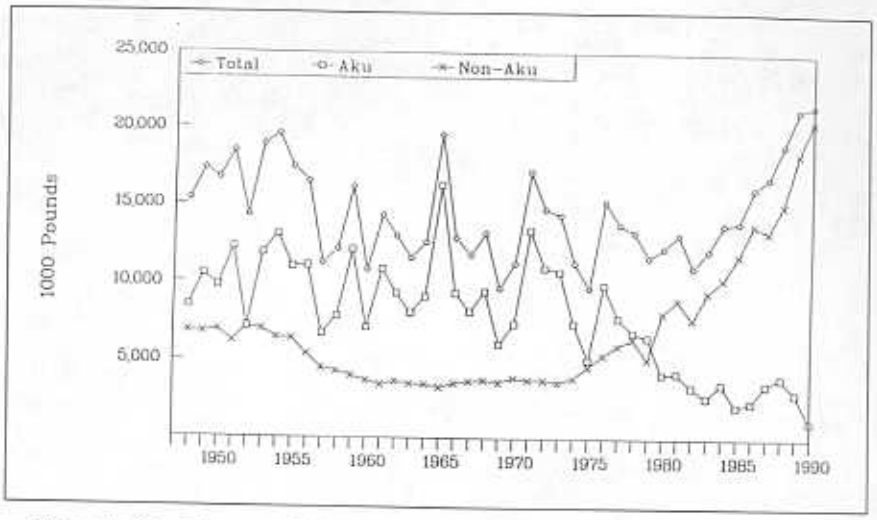


Figure 4.—Hawaii commercial fishery landings (pounds), 1948-90. NMFS estimates, total, aku (skipjack tuna), and all other species.

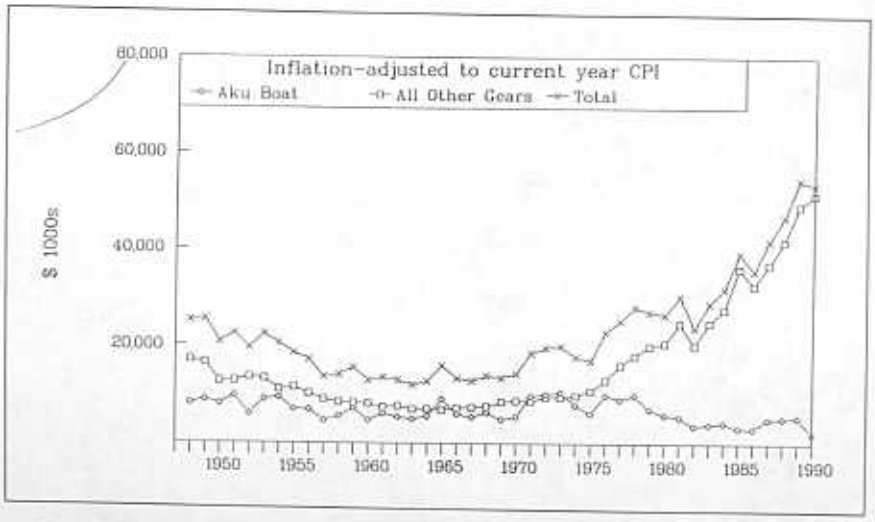


Figure 5.—Hawaii commercial fishery revenue, 1948-90. NMFS estimates, total, aku boat (pole-n-line skipjack tuna), and all other gears. Revenue adjusted for inflation to 1990 U.S. $ base.

ter boat industry, probably an equivalently valued tournament fishery, and there is a recreational and subsistence marine fishery with direct expenditures of $24 million.[8] Figure 6 displays our estimate of the Hawaii seafood market supply in 1990, with 20 million pounds ($50 million) from commercial fishing, 9 million pounds from recreational fishing, 15 million pounds ($30 million) from foreign imports, 24 million pounds ($45 million) from the mainland U.S., and 3.5 million pounds ($10 million) exported.[9]

Perhaps the most notable long-term trend in Hawaii's overall commercial fishery is the dramatic increase in inflation-adjusted ex-vessel revenue in the 1980's (Fig. 5). The increase in revenue (240%), which is reflected in the increased value of the marketing sector, is even greater than the increase in pounds landed (200%), although less than the increase in non-aku landings (300%). The increase in average aggregate price reflects a substantially growing demand, particularly in the restaurant and export (U.S. mainland and foreign) markets, more than matching the increased supply for most species during the period.

There are many elements to these recent changes in Hawaii's seafood industry. Perhaps the first harbinger of change was the arrival of albacore trollers from the west coast en route to newly discovered fishing grounds north of Midway Islands late in the 1970's. This caused a new perspective on the nature of Hawaii's role in the Pacific-wide fishery and led to some substantial changes on the Honolulu waterfront. Not the least of these changes was the technological demonstration effect of the mere presence of these distant-water, highly mobile vessels[10]. In 1985, there were 75 albacore trollers in the U.S. North Pacific fishery (Hawaii Division of Aquatic Resources, 1986). Landings peaked at 3.8 million pounds, but because of logistics, the closure of the Honolulu cannery, and the changing world tuna market, Hawaii did not become the tuna processing and transshipment center that was anticipated. Eventually less than 20 albacore vessels chose to make Honolulu their home port.

Also in the 1980's, the Northwestern Hawaiian Islands spiny lobster fishery began to bloom. The NWHI possess a large EEZ but have relatively limited fishing grounds for nonpelagic species. During a cooperative research effort of the NMFS, HDAR, University of Hawaii, and U.S. Fish and Wildlife Service in the 1970's (Grigg and Tanoue,

[8]The definition and determination of "value" for recreational and subsistence fisheries is a complex methodological issue. Direct comparison of the expressed dollar values of commercial vs. recreational fisheries is generally not appropriate; see Edwards (1990) for a primer on these issues. Meyer (footnote 20) estimated the nonmarket value of small-boat noncommercial fishing in Hawaii at $200 million, using hedonic valuation methods, compared to actual direct expenditures of $24 million.

[9]Hawaii's seafood marketing sector is described in: J. C. Cooper and S. G. Pooley. 1982. Total seafood volume in Hawaii's wholesale fish markets. Southwest Fish. Cent. Admin. Rep.H-82-15, 12 p.; J. C. Cooper and S. G. Pooley. 1983. Characteristics of Hawaii's wholesale seafood market. Southwest Fish. Cent. Admin. Rep. H-83-22, 33 p.; W. K. Higuchi and S. G. Pooley. 1985. Hawaii's retail seafood volume. Southwest Fish. Cent. Admin. Rep. H-85-06, 16 p.; and MacDonald and Deese (1988).

[10]The demonstration effect relects indirect learning initiated by the presence of a new technology or methodology, usually introduced into a culture or a society from outside.

·f the marketing
than the increase
%), although less
on-aku landings
in average ag-
a substantially
ticularly in the
(U.S. mainland
ıore than match-
ly for most spe-

ments to these
ıii's seafood in-
st harbinger of
f albacore troll-
ıst en route to
g grounds north
in the 1970's.
·pective on the
in the Pacific-
some substan-
ɔnolulu water-
these changes
demonstration
·ence of these
·bile vessels[10].
albacore troll-
'acific fishery
Aquatic Re-
: peaked at 3.8
ause of logis-
Honolulu can-
ɔrld tuna mar-
ome the tuna
pment center
'entually less
hose to make

e Northwest-
y lobster fish-
WHI possess
ively limited
lagic species.
arch effort of
ersity of Ha-
Wildlife Ser-
and Tanoue,

Admin. Rep.H-
S. G. Pooley,
ii's wholesale
Cent. Admin.
uchi and S. G.
afood volume.
Rep. H-85-06,
: (1988).
indirect learn-
: new technol-
oduced into a

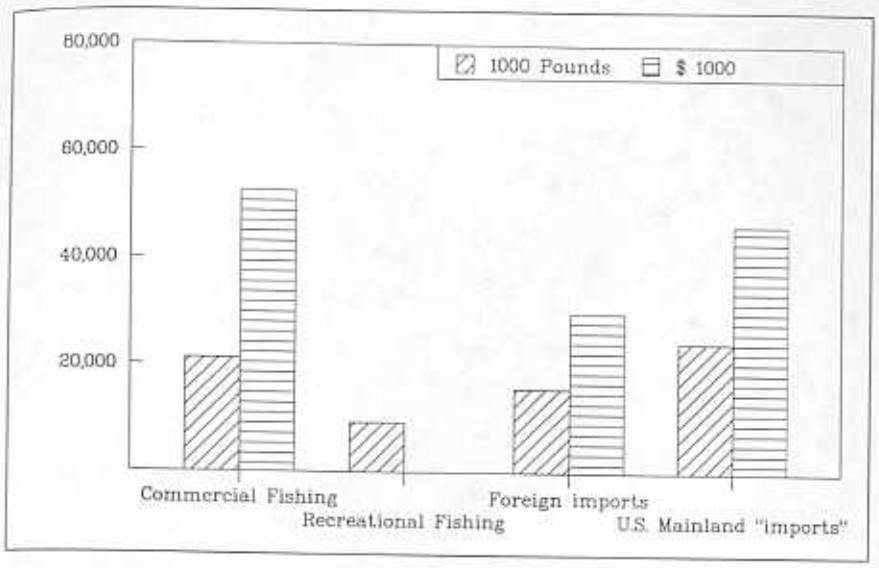


Figure 6.—Hawaii seafood market shares, 1990. NMFS estimates.

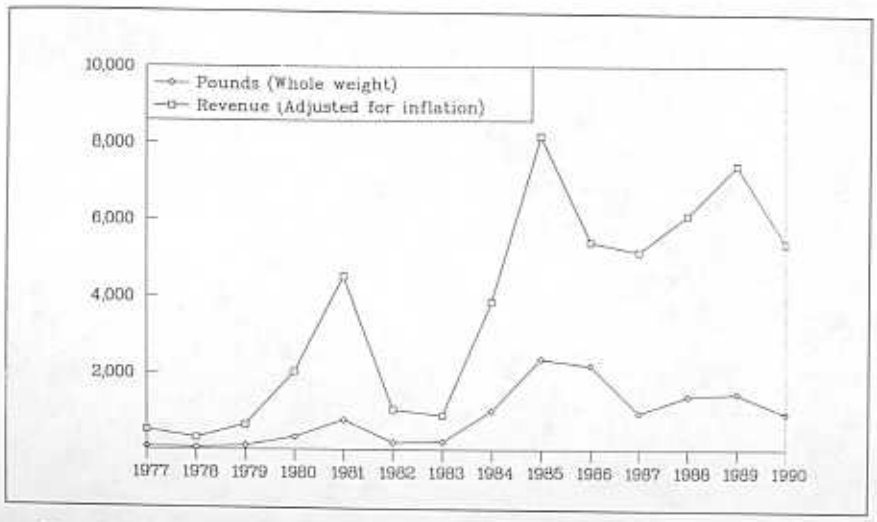


Figure 7.—NWHI lobster landings, pounds and revenue, 1977-90. NMFS estimates and figures. Revenue adjusted for inflation to 1990 U.S. $ base.

1984), scientists discovered substantial quantities of spiny lobster in the NWHI. By the mid-1980's, with the additional discovery of slipper lobster, NWHI lobster was one of Hawaii's largest fisheries in terms of ex-vessel revenue (Fig. 7). To develop the lob-ster fishery, new fishermen and new ɔoats came to Hawaii, primarily from the Pacific Northwest (Fig. 8). Large vessels, some over 100 feet in length, with advanced technology freezing and processing equipment, entered the fishery. New traps were introduced from California which made fishing not only more efficient but also allowed the slipper lobster to be caught commercially.

Although the first lobsters were sold locally as a live product, soon almost all were produced as a frozen tail product and sold to mainland U.S. buyers. This was the first premium product of Hawaii's new commercial fisheries, with prices ranging up to $13.50 per pound for the tails. However, neither the albacore nor the lobster fishery changed the basic structure of the Hawaii fresh fish market.

The NWHI also proved to be a good location for bottom fishing (mechanized "handline" fishing for snappers, groupers, and jacks), which required a medium-scale modern fishing vessel (Fig. 9) similar to those used in the lobster and albacore fisheries. The expanding supply of pink and red snappers (opakapaka and onaga) locally made possible the expansion of the restaurant market by allowing a regular and consistent supply of relatively fresh fish (Fig. 10). At the same time, the restaurant market for fresh mahimahi also expanded, providing a new source of income for local trollers (Takenaka et al.[11]). Local wholesale dealers were able to promote fresh local mahimahi as a substitute for some of the large imports of frozen mahimahi. Since both bottom fish and mahimahi were landed fresh and sold primarily at the Honolulu auction, this marked an important change in the local fishery and reinvigorated the local fresh fish market.

With a much larger restaurant market in Honolulu, bottomfish fishermen from the main Hawaiian Islands were able to obtain premium prices for their considerably fresher catch, and thus were motivated to increase their landings (Fig. 11). Finally, some wholesale seafood dealers began sending opakapaka and mahimahi to the mainland, establishing a distinctively Hawaiian seafood presence linked to Hawaii's tourism market.

In the late 1970's and early 1980's the traditional Hawaiian tuna handline fisheries, known as ika shibi (Ikehara[12]) and palu ahi, revived owing to fuel-efficient small-scale vessels (Fig. 12). These fisheries, which targeted yellowfin and bigeye tuna (both known locally as ahi, along with albacore), were centered on the Big Island (Hawaii), but much of the product at the time was shipped to Honolulu for the restaurant market. This was a useful de-

[11]B. Takenaka, L. Toricer, S. G. Pooley, and J. C. Cooper. 1984. Recent trends in the commercial fishery and marketing of mahimahi and ono in Hawaii. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Southwest Fish. Cent., Honolulu Lab., Southwest Fish. Cent. Admin. Rep. H-84-9, 20 p.

[12]W. Ikehara. 1981. A survey of the ika-shibi fishery in the state of Hawaii, 1980. U.S. Dep. Commer., NOAA, Natl. Mar.Fish. Serv., Southwest Fish. Cent., Honolulu Lab., Southwest Fish. Cent. Admin Rep. H-82-4C, 11 p.

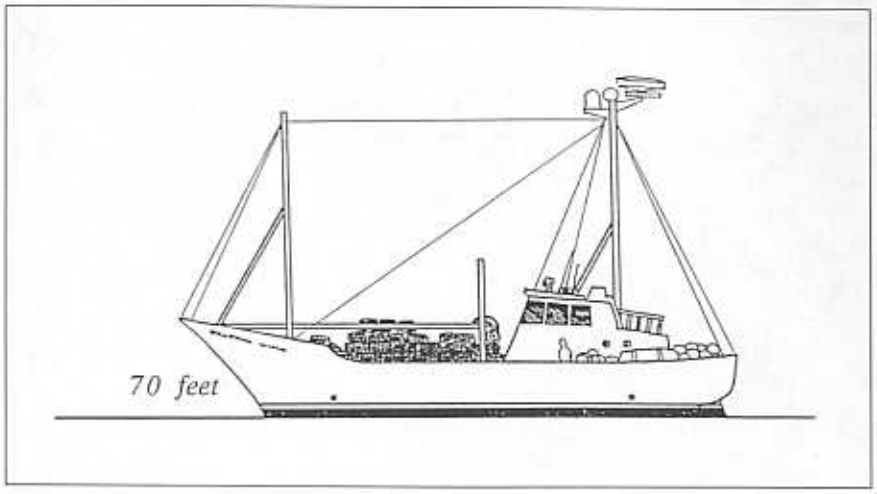


Figure 8.—Drawing of typical NWHI lobster boat.

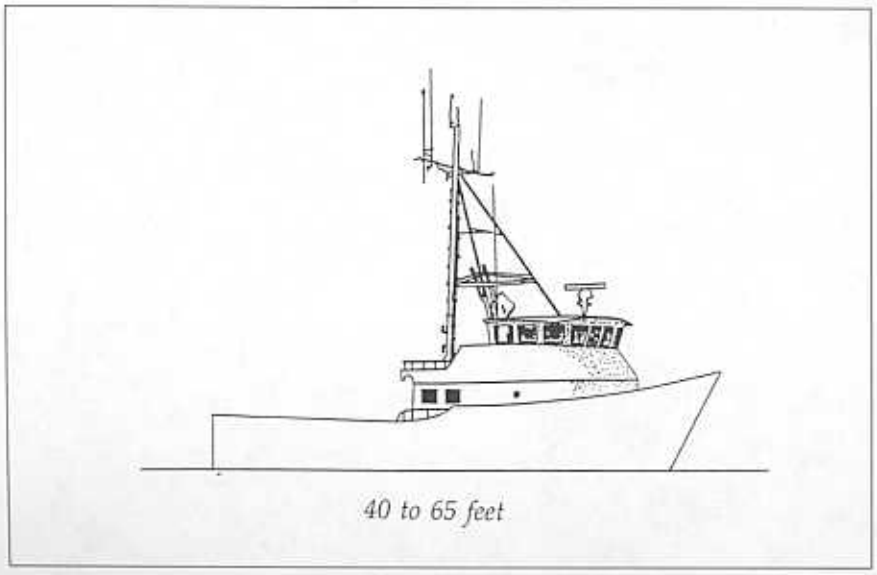


Figure 9.—Drawing of typical NWHI bottomfish boat.

velopment for the neighbor islands whose commercial fishery appeared to be left behind by the growth of the large-scale fishing fleets based in Honolulu. Today, there are strong local markets for fresh fish on the neighbor islands, associated with the expansion of the tourist trade on those islands, and there is considerable "export" of fresh fish to the U.S. mainland. However, access by handline boats to the higher value-added market has been limited on account of a phenomenon known as the "burnt tuna phenomenon," a condition in which the meat of handline and troll caught yellowfin tuna is metabolically degraded during fishing when not offset by rapid icing. Nonetheless, landings of tuna and other pelagics (primarily billfish, mahimahi, and ono) by troll, handline, and miscellaneous gears (i.e., excluding longline and aku boat) increased by elevenfold from 1970 to 1990 (Fig. 13).

In 1984 the tuna cannery Hawaiian Tuna Packers closed, coinciding with a period of substantial reorganization in the multinational canned tuna industry. As a result, the aku boat fleet declined from 12 active boats in 1979 (Hudgins, 1980) to just 7 active boats in 1986, selling solely to the fresh market (Boggs and Pooley, 1987; Pooley et al.[13]). Attempting to expand that market was a major project of State government in the 1980's (MacDonald et al., 1991), but current conditions in the fishery suggest that an entirely new start will be required, including a solution to the perceived bait problem and limitations on market penetration (primarily due to limited shelf life), if the potential yield of the skipjack resource is to be achieved in the future (Boggs and Pooley, 1987). Landings in the past five years have averaged less than 5 million pounds, with only 4 full-time aku boats active in the fishery.

By the mid-1980's, the export market for Hawaii's fresh bigeye tuna rose dramatically, largely as a result of marketing efforts by major wholesale dealers and the favorable exchange rate between the dollar and the yen. This marked the early resurgence of Hawaii's traditional longline tuna fleet, which produces a superior-grade tuna for sashimi (raw tuna). In the late 1980's, both NWHI bottomfish and lobster boats began facing lower catch rates and increased regulation, so that a number of these vessels began to transfer to the longline fishery.

In the early 1980's, perhaps as few as 15 vessels were fishing with longline gear in Hawaii. Today, over 150 vessels are in the longline fleet. Most of the vessels are newer and larger. Whereas the older sampans are about 45 feet, the new steel-hulled vessels range from 65 to 115 feet (Fig. 14). Many of the older vessels have new owners and have been refurbished. The longline crews have been trying a number of different fishing strategies, from fishing as far as 1,200 miles from Honolulu to fishing right off the reef,[14]

[13]S. G. Pooley, S. Teramoto, and A. C. Todoki. 1988. Hawaii's aku fishery in 1986 and 1987. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Southwest Fish. Cent. Admin. Rep. H-88-16, 15 p.

[14]Fishing off the reef provides a major fisheries management controversy. The Western Pacific Fishery Management Council has closed the waters around the main Hawaiian Islands to

Continued

the aku boat flee
:tive boats in 1979
just 7 active boats
ly to the fresh mar-
›ley, 1987; Pooley
g to expand that
r project of State
)80's (MacDonald
rent conditions in
ıat an entirely new
, including a solu-
bait problem and
t penetration (pri-
l shelf life), if the
skipjack resource
:he future (Boggs
ındings in the past
aged less than 5
only 4 full-time
e fishery.
, the export mar-
bigeye tuna rose
ıs a result of mar-
r wholesale deal-
e exchange rate
ıd the yen. This
resurgence of
ngline tuna fleet,
erior-grade tuna
ıa). In the late
bottomfish and
:ing lower catch
gulation, so that
:ssels began to
fishery.
perhaps as few
ıg with longline
, over 150 ves-
: fleet. Most of
er and larger.
ıpans are about
-hulled vessels
feet (Fig. 14).
sels have new
:furbished. The
n trying a num-
trategies, from
niles from Ho-
off the reef,[14]

and A. C. Todoki.
1986 and 1987.
Natl. Mar. Fish.
Admin. Rep. H-

a major fisheries
: Western Pacific
l has closed the
vaiian Islands to

Continued

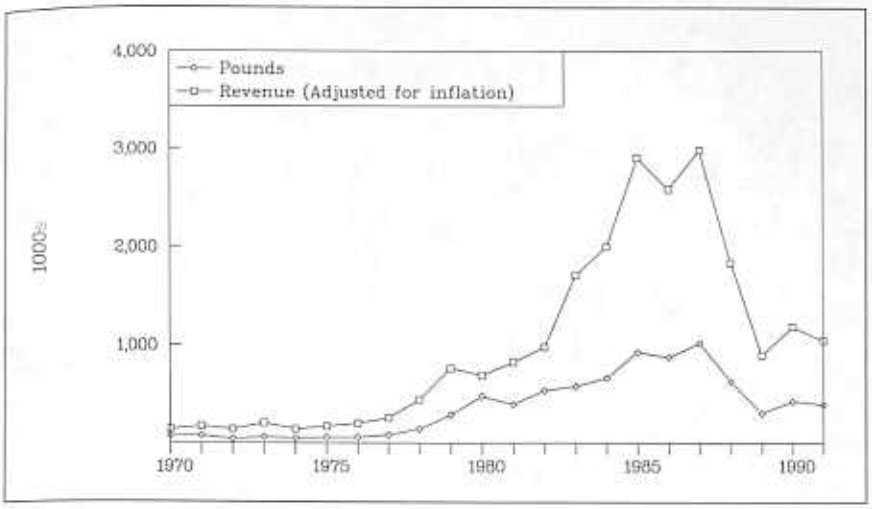


Figure 10.—NWHI bottomfish landings, pounds and revenue, 1970-91. NMFS estimates. Revenue adjusted for inflation to 1990 U.S. $ base.

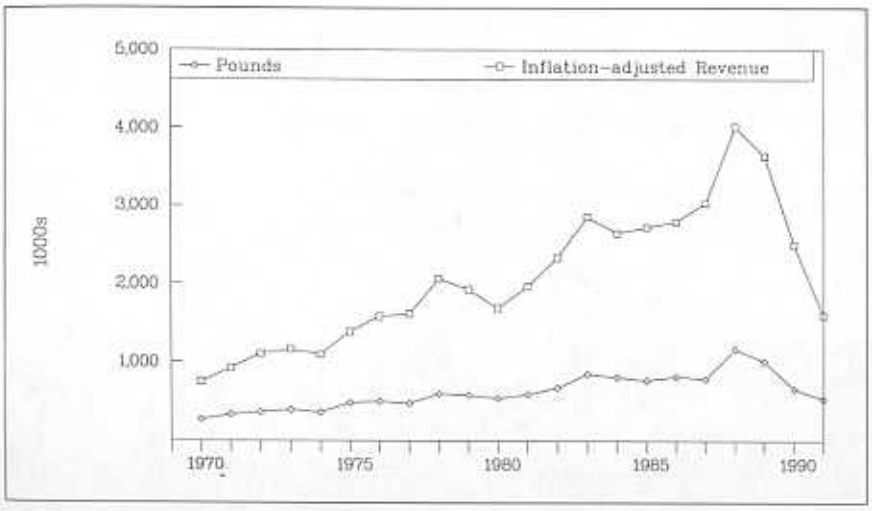


Figure 11.—MHI bottomfish landings, pounds and revenue, 1970-91. NMFS estimates. Revenue adjusted for inflation to 1990 U.S. $ base.

from fishing for the high-valued bigeye tuna to fishing for the lower-valued but more abundant yellowfin tuna, to long-distance fishing for swordfish destined for export to the east coast. The new vessels deployed a new gear which has now become the predomi-ıant gear throughout the Hawaiian longline fishery, the more efficient monofilament mainlines stored on reels, frequently set by powered line throwers (Kawamoto et al.[15]). The growth of the longline fishery is depicted in Figure 15.

Hawaii's market for fresh tuna (and other pelagics such as mahimahi) is now highly competitive, with competition in supply from Florida to Australia. The local fish market must now compete with the Tskuji market in Tokyo for the raw product, and local consumers must compete with the local restaurant trade and the export market.

If we take a brief look in retrospect, in 1979 the Hawaii Fisheries Development Plan predicted commercial fisheries growth to 50 million pounds in 1990 and 85 million pounds in the year 2000 (Department of Land and Natural Resources, 1979b). As one of the Plan's co-authors, I would say we failed to anticipate the likelihood and potential consequences of the collapse of U.S. production of canned tuna (the closure of the California and Hawaii canneries, and the emphasis on purse-seine tuna processing at the American Samoa and Puerto Rico canneries), and thus our forecasts for skipjack and albacore tuna landings were far afield. We also expected a rapid development of the oceanic shrimp fishery, but ultimately the resource did not support large-scale development (Tagami and Ralston[16]). But for ahi, NWHI lobster and bottomfish, the projections for growth have been quite reasonable. The prospects for further development in pelagics remain strong, although development must now be tempered by fisheries management considerations.[17]

Fleets and Current Landings

Hawaii's commercial fishery exceeds $50 million in ex-vessel revenues, from 22 million pounds of landings in 1990. The longline tuna

longline fishing and has imposed a moratorium on new entry into the Hawaii-based longline fishery from 1991 through 1994 (Amendments 2, 4, and 5 to the Fishery Management Plan for the Pelagic Fisheries of the Western Pacific Region, Western Pacific Regional Fishery Management Council, Honolulu, Hawaii 1986, as amended in 1991.)

[15]K. E. Kawamoto, R. Y. Ito, R. P. Clarke, and A. Chun. 1989. Status of the Hawaiian tuna longline fishery 1987-88. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Southwest Fish. Cent., Honolulu Lab., Southwest Fish. Cent. Admin. Rep. H-89-10, 33 p.

[16]D. T. Tagami and S. Ralston. 1988. An assessment of exploitable biomass and projection of maximum sustainable yield for *Heterocarpus laevigatus* (shrimp) in the Hawaiian Islands. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Southwest Fish. Cent., Honolulu Lab., Southwest Fish. Cent. Admin. Rep. H-88-14, 22 p.

[17]The relationship, or lack thereof, of fishery development and fishery management has been a difficult one. The Western Pacific Fishery Management Council initially tried to bridge the gap, but it had few resources which could be placed on fishery development issues. Within the State of Hawaii government, the two functions exist in different departments, while within NMFS, fishery development functions have been phased out since the late 1970's except for awards to private sector projects (the Saltonstall-Kennedy grants). Most State of Hawaii fishery

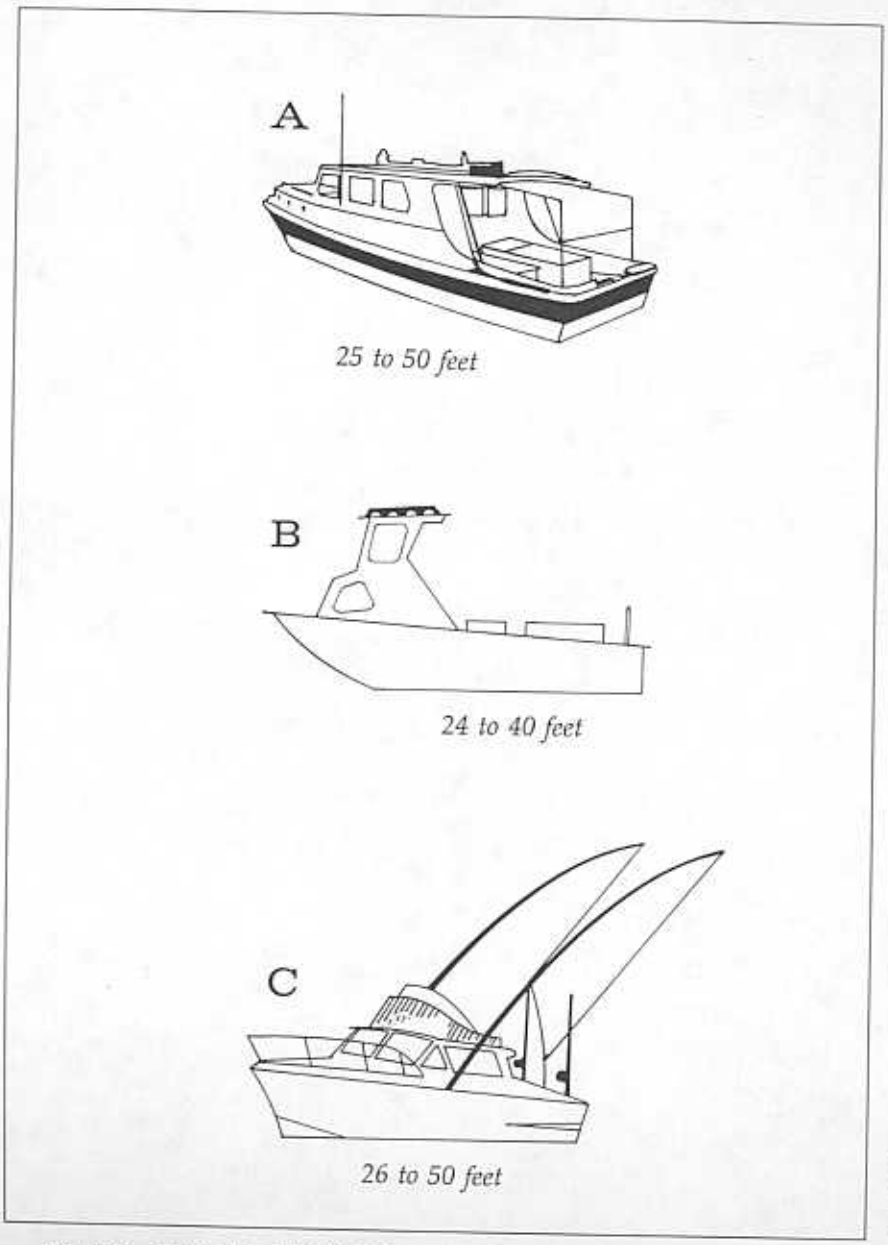


Figure 12.—Drawing of typical MHI (A) bottomfish, (B) pelagic handline, and (C) trolling boats.

fishery is the largest commercial fishery in Hawaii, valued at $29 million. The smaller-scale troll and handline fisheries for tuna and mixed pelagics, such as mahimahi, are next in value, at $7 million, while lobster, aku (skipjack tuna), and bottomfish (snappers, groupers, and jacks) are the other major commercial fisheries (Table 2).

While there were 15,000 boats registered (or documented) in Hawaii in the 1980's, only from 7,500 to 5,000 were used for fishing (Skillman and Louie[18], Sumida, et al.[19]; Meyer Resources Inc.[20]). Less than 2,000 vessels are presently registered for commercial fishing and, while there are less than 3,500 people holding commercial fishing licenses (issued to individuals), most commercial fishing license holders make minimal record of landings. There are perhaps only 750-500 boats that could be considered full-time commercial and charter-boat fishing operations. Almost all the fishing boats in Hawaii are less than 100 feet overall; only a portion of the longline fleet is longer than 75 feet.

This mixture of small and medium-sized fishing vessels has been relatively beneficial for Hawaii's fisheries (Pooley[21]). Large vessels can easily overharvest many of the nonpelagic resources while having a hard time making ends meet over the long run in such limited fisheries[22]. Many of the medium-sized vessels have the advanced technology and mobility to make switching between fisheries a viable business strategy[23], while at the same time not having a strongly negative impact on the small-scale commercial and recreational fishermen. Indeed, it was believed that Hawaii's offshore pelagic fisheries, which are substantially less susceptible to overfishing by small and medium-sized

Continued

[17] *Continued*
conservation activities are oriented toward nearshore fisheries. The State's 1985 fishery development plan added an emphasis toward the noncommercial sectors Hawaii's fishery and warned: "Fisheries development can only be promoted for those fishery resources that can withstand increased fishing pressure without damaging the integrity of the resource. . . ." (Hawaii Division of Aquatic Resources, 1986).

[18] R. A. Skillman and D. K. H. Louie. 1984. Inventory of U.S. vessels in the central and western Pacific: Phase 2—verification and classification. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Southwest Fish. Cent., Honolulu Lab., Southwest Fish. Cent. Admin. Rep. H-84-12, 21 p.

[19] R. F. Sumida, B. M. Ito, and J. P. Draper. 1985. Inventory and uses of vessels in Hawaii, 1984. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Southwest Fish. Cent., Honolulu Lab., nontechnical report.

[20] Meyer Resources Inc. (P. A. Meyer.) 1987. A report on resident fishing in the Hawaiian islands. (A project to determine the economic value of recreational fishing in Hawaii.) U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Southwest Fish. Cent., Honolulu Lab., Southwest Fish. Cent. Admin. Rep. H-87-8C, 74 p.

[21] S. G. Pooley. 1985. The hopelessness of the invisible hand: small versus large fishing vessels in Hawaii. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Honolulu Lab., Southwest Fish. Cent. Admin. Rep. H-85-02, 16 p.

[22] For example, Clarke and Pooley (1988) found that mid-sized vessels (65 feet overall length) were the most profitable in the NWHI lobster fishery, while the larger vessels (greater than 75 feet in overall length) were not profitable. However, the larger lobster vessels have participated in the NWHI lobster fishery and have a dramatic impact on available stocks of lobsters.

[23] A strategy increasingly constrained by the implementation of limited entry in Hawaii's major commercial fisheries.

:nses (issued to in-
nmercial fishing li-
minimal record of
perhaps only 750-
be considered full-
and charter-boat
Almost all the fish-
are less than 100
a portion of the
:er than 75 feet.
nall and medium-
has been relatively
waii's fisheries
essels can easily
f the nonpelagic
ing a hard time
er the long run in
s[22]. Many of the
ls have the ad-
and mobility to
:en fisheries a vi-
[23], while at the
a strongly nega-
mall-scale com-
onal fishermen.
:d that Hawaii's
:ries, which are
eptible to over-
medium-sized

. H. Louie. 1984.
in the central and
rification and clas-
ier., NOAA, Natl.
Fish. Cent., Hono-
Cent. Admin. Rep.

and J. P. Draper.
vessels in Hawaii,
OAA, Natl. Mar.
. Cent., Honolulu

. Meyer.) 1987. A
the Hawaiian is-
ne the economic
in Hawaii.) U.S.
Mar. Fish. Serv.,
u Lab., Southwest
8C, 74 p.

pelessness of the
arge fishing ves-
ommer., NOAA,
ulu Lab., South-
H-85-02, 16 p.

ley (1988) found
t overall length)
e NWHI lobster
:ls (greater than
not profitable.
essels have par-
ishery and have
ocks of lobsters.

strained by the
ry in Hawaii's

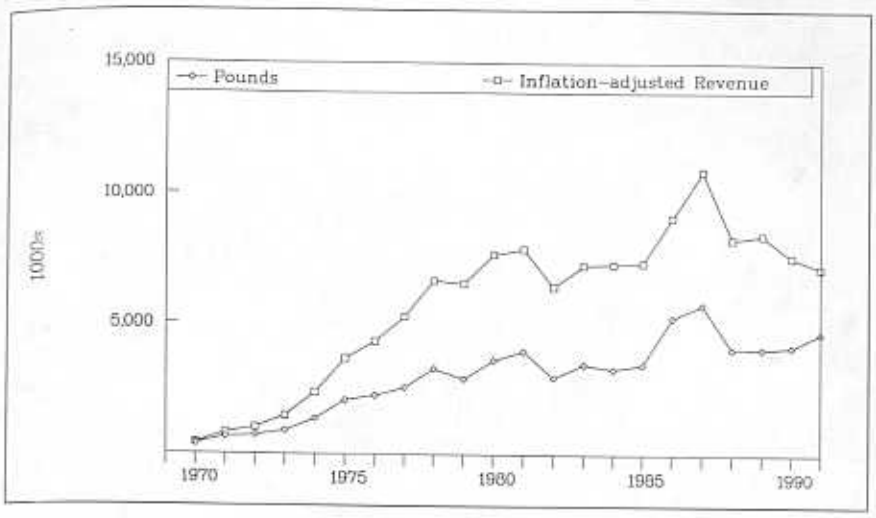


Figure 13.—MHI pelagic landings, pounds and revenue, 1970-91. NMFS estimates. Revenue adjusted for inflation to 1990 U.S. $ base.

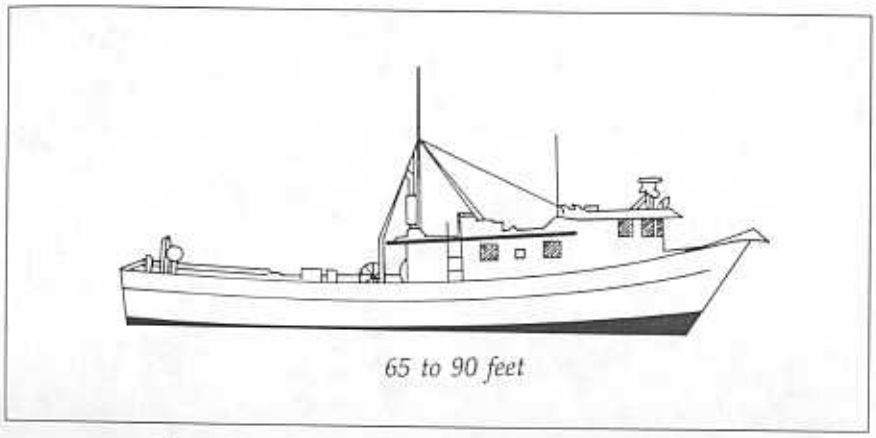


Figure 14.—Drawing of typical modern Hawaii longline boat.

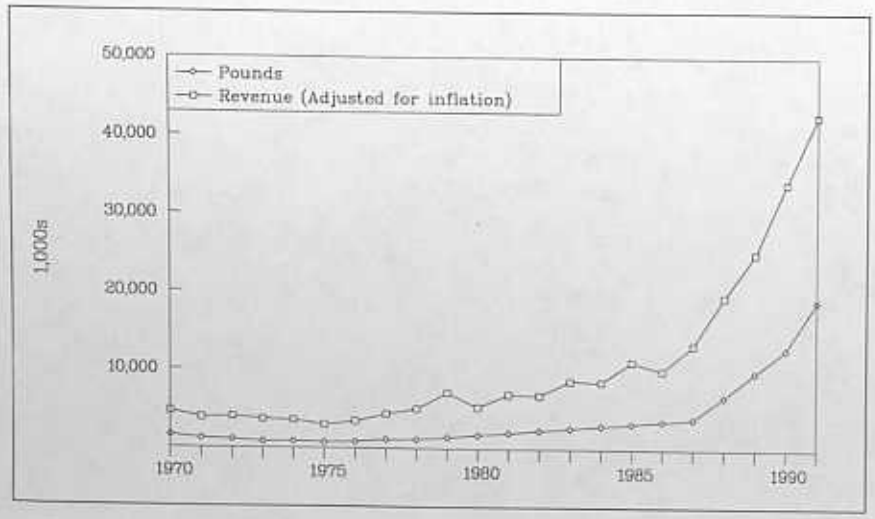


Figure 15.—Hawaii longline landings and revenue, 1970-91. NMFS estimates. Revenue adjusted for inflation to 1990 U.S. $ base.

fishing vessels, would be an attractive avenue for future growth. Unfortunately the recent development of the longline fishery has been less benign, with substantial disputes amongst participants (Pooley, 1990).

The structure of Hawaii's seafood markets has encouraged value-added fisheries development (i.e., the production of a higher quality and higher-priced product through improved handling and marketing and the increased utilization of lower valued species), but with some definite side effects for Hawaii consumers (i.e., higher prices and lower availability). Whereas many mainland U.S. fisheries are "industrial-strength" with poor reputations for quality, low fresh fish prices, and poor incomes for fishermen, in Hawaii the combination of auctions and direct purchases from outside sources has meant a consistently high-quality product. However, fresh fish prices have risen considerably since 1970, even adjusted for the general rate of consumer price inflation (Fig. 16). This has been prompted by the explosion of restaurant demand, where fresh mahimahi can be found on local restaurant menus from Moiliili to Kaanapali, and on the U.S. mainland from Seattle to Des Moines to Boston. For local consumers, the loss of the aku (skipjack tuna) fleet has produced higher retail prices for fresh tuna. Our analysis of the price structure of Hawaii fresh fish prices (Pooley, 1987; Pooley[24, 25]) indicates that the market provides strong quality premiums and is thus a competitive forum for most major fishery producers. However, as the export market develops from the sashimi "niche" to the swordfish "segment," transshipping operations are increasing. This reduces the "local content" of Hawaii's fishery landings, at some detriment to Hawaii's economy and to local consumers.

[24]S. G. Pooley. 1986. Competitive markets and bilateral exchange: the wholesale seafood market in Hawaii. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Southwest Fish. Cent., Honolulu Lab., Southwest Fish. Cent. Admin. Rep. H-86-08, 14 p.

[25]S. G. Pooley. 1991. Revised market analysis: Hawaii yellowfin tuna. NMFS Southwest Fish. Cent., Honolulu Lab. manuscr. 003-91H-MRF.

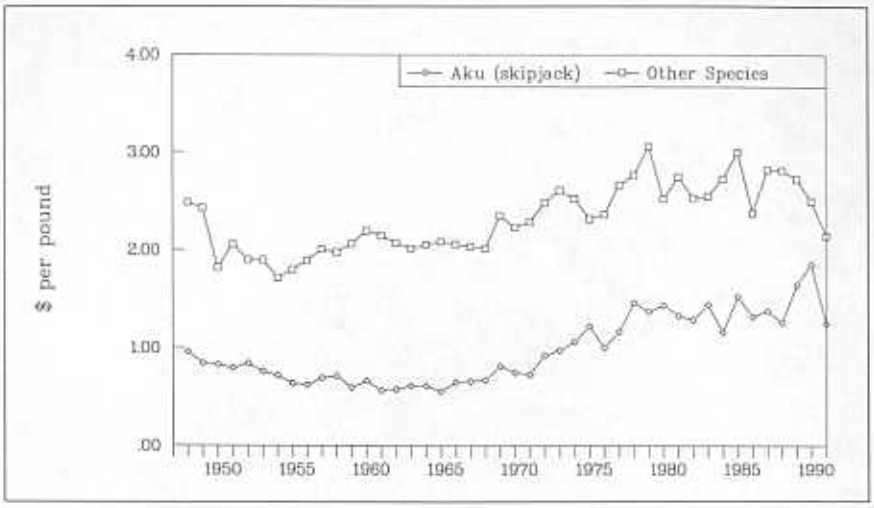


Figure 16.—Hawaii commercial fishery ex-vessel prices, 1948-91. U.S. $ per pound (whole weight). NMFS estimates, aku (skipjack tuna) and all other species. Prices adjusted for inflation to 1990 U.S. $ base.

Recreational Fisheries

The distinction between "recreational" and "commercial" marine fishing in Hawaii's small boat fleets is extremely tenuous. As opposed to most mainland U.S. states, there is relatively easy access to most fishing locations by most residents of Hawaii. Furthermore, and perhaps most important, Hawaii's seafood market is not as centralized and industrialized as mainland fisheries, so that it has always been feasible for small-scale fishermen to sell any or all of their catch for a respectable price. Many people sell a portion of their catch to offset fishing costs, while division of the catch amongst family and friends is also a common practice and indeed in some circles, an important cultural and social obligation. Many people who might be considered "commercial" fishermen in fact hold a full-time or part-time job which provides more income than fishing. Furthermore, charter-fishing boat captains generally retain their catch for sale in the local market, unless explicit arrangements are made to the contrary.[26] Even the catch at major sports fishing tournaments is frequently sold by the charter captains. Not only are there overlapping structural factors in commercial and recreational fishing, but the legalistic differentiation is not particularly helpful. People who catch and sell at least a part of their catch are required to have a State of Hawaii commercial fishing license. However these licenses cost only $25 ($50 to nonresidents), and there is no marine recreational fishing license. Furthermore, there is no active dealer-reporting system, and Federal fisheries management has yet to require permits for the small-boat bottomfish and pelagic fleets.

Because of the lack of information on the small-boat fisheries, a number of survey approaches have been taken to estimate the extent of Hawaii's "recreational" fisheries. The most comprehensive was the NMFS Marine Recreational Fishing Statistical Survey (1979–81) which was a combined telephone and creel intercept survey.[27] The intercept included all modes of marine fishing: shoreline; piers and jetties, private vessel; and charter boat. The telephone and intercepts were fielded by a local company under contract to NMFS headquarters (with minimal actual involvement by NMFS staff in Hawaii), but the statistical expansions were undertaken by a firm on the mainland and delivered only to NMFS headquarters. For reasons not entirely understood, the expansions provided inconsistent estimates of various species and the results were never published. However, if we assume the major source of error was in individual species extrapolation, rather than in total participation and total or aggregate landings, then the following results can be derived.

The 1980 estimates of participation were 2.1 million fishing trips (620,000 by private boats and 88,000 by charter boats, the remainder being shoreside fishing) taken by 235,200 residents and 82,200 visitors (tourists). This amounted to 24% of the de facto resident population. The estimated weight of "recreational" fish caught was 4.4 million pounds, of which 94% was from boat fishing.[28]

In 1984, the Honolulu Laboratory, NMFS, and the Division of Aquatic Resources, State of Hawaii, conducted a survey of vessel owners registered with the State of Hawaii's Department of Transportation[29] (Skillman and Louie[30]; Sumida et al.[31]). Of the respondents who indicated they fished during the year, 70% said they never sold any of their catch, and only 16% sold at least half their catch.[32]

[26]Reporting of catch by charter boats to the Hawaii Division of Aquatic Resources was formalized in 1985. Prior to that, some charter boats reported their catch, and others did not. Charter boats are not explicitly differentiated in the State commercial fish catch reports, although the commercial fishing license identifies these vessels.

[27]Data and methodology for the NMFS Marine Recreational Fishing Statistical Survey in the western Pacific were never published officially. These interpretations are based on project documents obtained by the Honolulu Laboratory several years after the survey was completed.

[28]These estimates were based on samples taken from the 8,033 people who were "intercepted" (sampled) in Hawaii. "Recreational" was not well defined, but is believed to indicate the fish weighed at the sample location were not to be sold. The expansion was based on 4,593 telephone interviews to Hawaii households, of which 15% contained people who went fishing.

[29]Of the approximately 14,500 vessels registered in 1984 with the State Department of Transportation (or documented with the Coast Guard in Hawaii), 12,578 were deemed to have fishing vessel characteristics (cruise liners were excluded, for example). Sixty percent of the questionnaires were completed, with 5,496 vessel owners reporting their vessel was used for fishing. No examination of the nonrespondents was made, so it is not known to what extent returns on this survey were self-selected from fishing vessel owners or not. Presumably 9,200 vessels (60% of the initial population of vessels) could have been used for fishing, but we have tended to use the lower figure as more realistic on the expectation that many people who did not use their boat for fishing would not bother to answer and return a survey oriented

Continued

minimal actual in-
S staff in Hawaii),
pansions were un-
on the mainland
NMFS headquar-
ot entirely under-
s provided incon-
arious species and
r published. How-
ie major source of
il species extrapo-
total participation
te landings, then
can be derived.
s of participation
ng trips (620,000
38,000 by charter
being shoreside
200 residents and
tourists). This
the de facto resi-
estimated weight
caught was 4.4
which 94% was

lulu Laboratory,
sion of Aquatic
awaii, conducted
wners registered
aii's Department
(Skillman and
l.[31]). Of the re-
ted they fished
said they never
, and only 16%
catch.[32]

d on samples taken
were "intercepted"
reational" was not
to indicate the fish
tion were not to be
sed on 4,593 tele-
aii households, of
who went fishing.
500 vessels regis-
ate Department of
ted with the Coast
re deemed to have
(cruise liners were
xty percent of the
ed, with 5,496 ves-
essel was used for
he nonrespondents
wn to what extent
self-selected from
Presumably 9,200
opulation of ves-
or fishing, but we
er figure as more
that many people
fishing would not
a survey oriented
Continued

In 1987 the Hawaii Division of Aquatic Resources surveyed its license holders on a number of issues. Although the response rate was low (30% of the 2,529 license holders responded), the survey appears to confirm the impression that most "commercial" fishing license holders in Hawaii do not make their livelihood from fishing: 80% or more of the respondents on each island indicated they earned less than 51% of their gross income from fishing.

Karl Samples, University of Hawaii, prepared a series of studies on charter boat fishing during the early 1980's for NMFS. Samples found that the charter boat fleet consisted of 119 boats in 1982 (Samples et al.[33]). These vessels are almost entirely 2–6 passenger vessels where half-day and whole-day charters are sold to the group, rather than to individuals (as in U.S. mainland "head" and "party" boats). This fleet generated 73,780 passenger trips with a direct income of $8.1 million[34]. Total fish catch by the charter boat fleet was 2.2 million pounds. It was also estimated that charter boat patrons spent $39 million directly related to charter fishing as a vacation or leisure activity (Samples and Schug[35]).

The only major study of the economics of recreational fishing in Hawaii was undertaken by Meyer Resources Inc.[20] for NMFS. This study used a variation of the contingent (nonmarket) valuation technique on focus groups composed of recreational fishing clubs in Hawaii. Meyer estimated that there were 6,684 small boats used for "resident" fishing (defined as: "persons who are not making their primary living from commercial fishing," Meyer[20], p. 1) in Hawaii, with direct expenditures of $24 million. Total catch by these vessels was 21 million pounds, of which 47% was sold. The remainder was used for home consumption (23%), given away to friends and family (21%), or otherwise used. Using contingent valuation techniques, Meyer estimated that the nonmarket value of these fishing trips to Hawaii resident fishermen was $239 million.[36]

Finally, in 1990 and early 1991 the State of Hawaii, with the assistance of NMFS, conducted a survey of small boat launch sites and harbors on Oahu (the island on which Honolulu and 80% of the population is situated) to understand better offshore fishing by recreational and subsistence fishermen. The results from this survey may provide a stronger basis for estimating current recreational and part-time commercial fishing activity (Hamm and Lum[37]).

Recent Issues

Naturally, the transition from the old style to the new in Hawaii's offshore fisheries has not occurred without biological, economic, and social impacts. Hawaii's commercial and recreational fisheries are no longer what they were, and the relationship between Hawaii's people and the sea has changed. We have already mentioned the change in availability and price of locally caught fish for Hawaii's resident consumers, but there have been changes in the water and on the docks too.

Recognition that nearshore fish resources have diminished (as well as consumer fears concerning ciguatera toxins), combined with the rise in tourism-related ocean recreation, means that there will be more pressure for nearshore marine environment management, with a premium on nonconsumptive uses of marine resources. A number of State of Hawaii initiatives have focused on this recognition, including the Main Hawaiian Islands - Marine Resources Investigation (Pooley[38] and Hawaii Division of Aquatic Resources, 1988), and there has been a broad strategic planning approach to coastal zone management and development (Hawaii Ocean and Marine Resources Council, 1991). Furthermore, rights of native Hawaiians to fishery resources are being explored, primarily through the offices of the Western Pacific Fishery Management Council (Iversen et al., 1989), and these will undoubtedly affect the ultimate resolution to fishery management issues. How Hawaii balances all of these interests may be a major political issue for the 1990's.

There are also some direct competitive pressures accompanying the rapid growth of the longline fishery. The Western Pacific Regional Fishery Management Council (Council) is the center of commercial fisheries management in Hawaii, whereas the state government is concentrating on nearshore fishing issues. The early years of the Council involved laying out a fishery management structure with relatively little emphasis on the distributive issues which were central on the

[29] *Continued*
towards fishing. We also noted through inspection of the respondents that most of the full-time commercial fishing boats also did not respond.

[30] R. A. Skillman and D. K. H. Louie. 1984. Inventory of U.S. vessels in the central and western Pacific: Phase 2—verification and classification. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Southwest Fish. Cent. Admin. Rep. H-84-12, 21 p.

[31] R. F. Sumida, B. M. Ito, and J. D Draper. 1985. Inventory and uses of vessels in Hawaii, 1984. NMFS Southwest Fish. Cent., Honolulu Lab., nontechnical rep.

[32] Only 3% of the respondents said they made half their income from fishing, suggesting that the survey returns were biased toward small-scale recreational fishermen.

[33] K. C. Samples, J. N. Kusakabe, and J. T. Sproul. 1984. A description and economic appraisal of charter boat fishing in Hawaii. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Southwest Fish. Cent., Honolulu Lab., Southwest Fish. Cent. Admin. Rep. H-84-6C, 130 p.

[34] Income from charter fees was approximately $5.8 million while income from selling fish was $2.3 million.

[35] K. C. Samples and D. M. Schug. 1985. Charter fishing patrons in Hawaii: a study of their demographics, motivations, expenditures and

[35] *Continued*
fishing values. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Southwest Fish. Cent., Honolulu Lab., Southwest Fish. Cent. Admin. Rep. H-85-8C, 95 p.

[36] Nonmarket value means in this case what the participants thought their fishing "experience" was worth in market terms. Frequently this is termed "willingness to pay," as in "How much would you be willing to pay to continue fishing ...?" although that is not the precise approach used by Meyer.

[37] D. C. Hamm and H. K. Lum. 1992. Preliminary results of the Hawaii small-boat fisheries survey. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Southwest Fish. Cent., Honolulu Lab., Southwest Fish. Cent. Admin. Rep. H-92-08, 35 p.

[38] S. G. Pooley (Editor). 1988. Recommendations for a five-year scientific investigation on the marine resources and environment of the main Hawaiian islands. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Southwest Fish. Cent., Honolulu Lab., Southwest Fish. Cent. Admin. Rep. H-88-2, 22 p.

U.S. mainland. The NWHI lobster and bottomfish fishery management plans (FMP's) addressed limited fisheries with limited interaction with other fisheries. The pelagic species FMP's orientation was simply toward displacing foreign longline fishing in the Council areas. However, with the growth of the domestic longline fishery in the late 1980's, the Council was suddenly faced with competing domestic issues.

Resolving these pressures has involved a real trade-off between the cost of regulation, in terms of the cost of biological and economic research and in terms of changes in life-styles, and the potential benefits of well-managed natural resources. People who go fishing are frequently very independent, more so than most. All one needs to do is examine the vastness and isolation of their working environment. They are also our most accessible observers of oceanographic conditions and marine biology. It seems that more needs to be done to encourage their community of interests with the rest of Hawaii's ocean and coastal users.

Foreign and U.S. mainland fisheries and markets are also influencing Hawaii's marine fisheries either through biological resource pressure and environmental effects which have led to displaced fleets or changes in market conditions, or through more direct changes in seafood markets. Foreign longline and baitboat fisheries for tuna have fished the central Pacific for decades. Although foreign longline vessels are effectively precluded from fishing within 200 miles of Hawaii (including the NWHI), the tuna and billfish stocks they seek probably are sufficiently migratory to hypothesize an interaction between their distant-water capture and fishing conditions in Hawaii. Furthermore, a number of local entrepreneurs have been exploring the importation of fresh fish directly into Honolulu from foreign longline vessels fishing just outside the U.S. Exclusive Economic Zone. The U.S. purse seine tuna fleet has expanded dramatically into the South Pacific, and the U.S. albacore trollers are now fishing the South Pacific, both using American Samoa as a base. Guam and the Northern Mariana Islands are also used as transshipment centers for purse seine and longline fisheries. The apparent closing down of the Japanese, South Korean, and Taiwanese drift gillnet fleets fishing for squid and albacore tuna, due to their impact on sea birds and marine mammals, may affect both the commercial fisheries of the central Pacific and seafood markets. In addition, there are the potential impacts of ocean mining and other nonfishery related marine developments.

Ironically, perhaps one of the most important economic components of Hawaii's commercial fishing industry is not fishing at all; it is the resupply operations for the hundreds of foreign fishing boats and refrigerated transports which stop in Honolulu harbor for supplies. The direct economic impact of these vessels is $46 million annually (Hudgins and Iversen, 1990). The whole question of harbor infrastructure has been a thorny one even before the original fisheries development plan (Department of Land and Natural Resources, 1979b). Similarly, the relationship between fisheries development and fisheries management and between fisheries and other coastal zone activities (cf. Department of Land and Natural Resources, 1979a) are central to Hawaii's political agenda in the 1990's.

Commercial fishing and the expenditures of the recreational and subsistence fisheries do not comprise a large industry in Hawaii, not even as a percentage of the overall ocean sector, although they are larger than many sectors of diversified agriculture and manufacturing. But fishing has a number of important linkages to Hawaii's current industrial and commercial structure and to Hawaii's cultural heritage. The commercial, recreational, and subsistence fisheries of Hawaii are important barometers of conditions in the ocean environment. Those of us whose job it is to monitor the marine fisheries and to conduct applied research on those fisheries are constantly fascinated by the variation which is displayed. The purpose of this paper has been to provide a better historical framework with which policymakers and the public can assess Hawaii's marine fisheries.

Literature Cited

Boggs, C. H., and S. G. Pooley. 1987. Force of change in Hawaii's aku (skipjack tuna) industry, 1986. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-072, 70 p.

Clarke, R. P., and S. G. Pooley. 1988. An economic analysis of NWHI lobster fishing vessel performance. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., NOAA-TM-NMFS-SWFC-106.

Department of Land and Natural Resources. 1979a. Hawaii coastal zone fisheries management study. State of Hawaii. Honolulu, Hawaii, 48 p.

_____. 1979b. Hawaii fisheries development plan. State of Hawaii. Honolulu, Hawaii, 297 p.

Edwards, S. F. 1990. An economics guide to allocation of fish stocks between commercial and recreational fisheries. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 94, 29 p.

Grigg, R. W., and K. Y. Tanoue. 1984. Proceedings of the second symposium on resource investigations in the Northwestern Hawaiian Islands. Sea Grant Miscellaneous Report UNIHI-SEAGRANT-MR-84-01.

Harman, R. F., and A. Z. Katekaru. 1988. 1987 Hawaii commercial fishing survey. State of Hawaii Department of Land & Natural Resources. Honolulu, Hawaii.

Hawaii Division of Aquatic Resources. 1986. Hawaii fisheries plan, 1985. State of Hawaii Department of Land & Natural Resources. Honolulu, Hawaii.

_____. 1988. Main Hawaiian Islands marine resources investigation—1988 survey. State of Hawaii Department of Land & Natural Resources. Honolulu, Hawaii.

Hawaii Ocean and Marine Resources Council. 1991. Hawaii ocean resources management plan. State of Hawaii Department of Business and Economic Development. Honolulu, Hawaii.

Hudgins, L. L. 1980. Economic model of fisheries market with endogenous supply: the Hawaii skipjack tuna case. Ph.D. dissertation. Department of Economics, Univ. of Hawaii, 114 p.

_____ and R. T. B. Iversen. 1990. Foreign flag fishing vessel expenditures in the Port of Honolulu, 1986-88. Report prepared for the State of Hawaii Department of Business, Economic Development and Tourism. Honolulu, Hawaii, 26 p.

_____ and S. G. Pooley. 1987. Growth and contraction of domestic fisheries: Hawaii's tuna industry in the 1980s. *In* D. J. Doulman (editor), Tuna Issues and Perspectives in the Pacific Islands Region. Honolulu: East-West Center Press, 225 p.

Iversen, R., T. Dye, and L. M. B. Paul. 1989. Rights of native Hawaiian fishermen with specific regard to harvesting bottomfish in the Northwestern Hawaiian Islands and with regard to harvesting of bottomfish, crustaceans, precious corals, and open-ocean fish in offshore areas surrounding the entire Hawaiian island chain. A contract report prepared for the Western Pacific Regional Fishery Management Council, Honolulu, Hawaii. 2 vols; vol. 1, 59 p, vol. 2, 143 p.

MacDonald, C. D., and H. E. Deese. 1988. Opportunities for development: a growth scenario and situation analysis of Hawaii ocean industries. Oceans '88, Proceedings of the 13th annual Oceans conference, Vo

re Cited

'ooley. 1987. Forces
i's aku (skipjack tuna)
Dep. Commer., NOAA
-SWFC-072, 70 p.
Pooley. 1988. An eco-
'HI lobster fishing ves-
J.S. Dep. Commer.,
sh. Serv., NOAA-TM-

d Natural Resources.
al zone fisheries man-
of Hawaii. Honolulu,

/aii fisheries develop-
awaii. Honolulu, Ha-

economics guide to
ks between commer-
fisheries. U.S. Dep.
:h. Rep. NMFS 94,

Tanoue. 1984. Pro-
l symposium on re-
n the Northwestern
Grant Miscellaneous
ANT-MR-84-01.
. Katekaru. 1988.
:ial fishing survey,
ent of Land & Natu-
, Hawaii.
juatic Resources.
s plan, 1985. State
of Land & Natural
awaii.
awaiian Islands ma-
:ion—1988 survey,
:nt of Land & Natu-
Hawaii.
Resources Coun-
resources manage-
aii Department of
Development. Ho-

nomic model of a
dogenous supply:
:ase. Ph.D. disser-
onomics, Univ. of

-sen. 1990. For-
:penditures in the
. Report prepared
partment of Busi-
ent and Tourism,

. 1987. Growth
iestic fisheries:
he 1980s. *In* D. J.
ues and Perspec-
s Region. Hono-
ss, 225 p.
B. Paul. 1989.
fishermen with
ig bottomfish in
Islands and with
tomfish, crusta-
open-ocean fish
g the entire Ha-
ract report pre-
: Regional Fish-
nolulu, Hawaii.
13 p.
Deese. 1988.
it: a growth sce-
s of Hawaii's
8. Proceedings
nference, Vol-

ume 3. Marine Technology Society and IEEE, Washington, D.C., approx. 10 p.

_____, H. E. Deese, and E. Corbin. 1991. Seafood marketing: innovative support for fisheries management in Hawaii. MTS '91 Proceedings. Marine Technology Society, Washington, D.C., p. 113-120.

Pooley, S. G. 1987. Demand considerations in fisheries management—Hawaii's market for bottom fish. *In* J. J. Polovina and S. Ralston (editors), Tropical snappers and groupers: Biology and fisheries management, p. 605-638. Westview Press, Boulder, Colo.

_____. 1990. Hawaii longline fishing controversy. Southwest Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, P.O. Box 271, La Jolla, CA 92038. Tuna Newsletter 97:3–6.

Samuel G. Pooley, 1993. Hawaii's marine fisheries: some history, long-term trends, and recent developments. Marine Fisheries Review 55(2), 1993.

Appendix A: NMFS estimation procedure for Hawaii commercial fishery landings figures, 1948-90

The purpose of this Appendix is to explain the procedures used to create estimates of total and major components of Hawaii commercial fishery landings for the period 1948 - 1990 as a supplement to existing State of Hawaii figures.[1] Figure A.1 provides a time-series illustration of the differences between HDAR figures and NMFS estimates from 1970-1990 in terms of pounds caught (landed for NMFS data) and revenue.

The only long-term comprehensive time-series of Hawaii fisheries data is compiled by the State of Hawaii Division of Aquatic Resources (HDAR) from the catch reports turned in monthly by commercial fishing licensees. This time-series remains the best source of disaggregated (i.e., catch and effort by species, gear type, area fished, and date[2]) information on most of Hawaii's commercial fisheries. Although this time-series has always been hampered by the exclusion of catch landed by recreational fisheries (and until recently by unsold landings by commercial fishers) and by the suspicion that not all small-scale commercial operators reported their landings, it is believed to have been a consistent time-series from 1948-1978. Unfortunately in 1979 the time-series deteriorated because of new and severe under-reporting by Hawaii longliners, and subsequently because of under-reporting by a number of other large-scale commercial operators, such as NWHI bottomfish and lobster vessels. This problem is believed to have occurred because of a dispute between some vessel operators and HDAR concerning reporting responsibilities under the U.S. MFCMA (Magnuson act) and because of reorganization of State of Hawaii fisheries responsibilities which separated their statistical unit from their enforcement unit.

Since then there have been a number of efforts by HDAR to improve reporting, and the situation has improved in recent years. Ironically, however, these efforts probably mean that the degree of under-reporting over the period 1979-1990 has been inconsistent

---

[1] Some figures in this Appendix have been updated since the publication date of the original article.

[2] "Date" in HDAR commercial fish catch reports may indicate date-of-landing for single or multi-day trips or actual date of catch. It is not necessarily a reliable indicator of the number of trips or the number of days fishing.

(the gravest problem in time-series analysis). Therefore, examination of recent changes in Hawaii's commercial fisheries using only HDAR data is risky.

The problem is summarized by Appendix Table A.1 which compares HDAR figures and NMFS estimates[3] for 1990. NMFS estimates of total Hawaii commercial fishery landings for 1990 (21.5 and 21.6 million pounds) exceeded HDAR figures (17.4 million pounds) by 24%. The largest difference is the longline fleet, which despite improved coverage by HDAR in 1990 still showed the NMFS estimates (12.8 million pounds) to be 38% larger than the HDAR figure (9.3 million pounds). In this case, NMFS sampled locations receiving at least 80% of the landings, so we believe the NMFS estimates are quite accurate and the difference between the NMFS estimates and the HDAR figures truly reflects under-recording in the HDAR figures. There is also a substantial difference between HDAR and NMFS figures for the NWHI lobster fishery: HDAR reported lobster weights are only 33% of NMFS figures (round weights estimated from actual Federal logbook numbers and revenue reports of product form weights).[4] The other major difference is in NWHI bottomfish landings, with NMFS estimates exceeding HDAR figures by 35%. Differences between HDAR figures and NMFS estimates for other domestic Hawaii commercial fisheries are smaller or negligible in 1990, although there are other significant differences in other years during the 1978-90 period.[5]

The ability of the NMFS Honolulu Laboratory to calculate estimates of Hawaii fisheries independently of the HDAR commercial fish catch reporting system derives from Federal regulation and associated monitoring of three major commercial fisheries in Hawaii: NWHI lobster and bottomfish, and the longline fishery. However, until

---

[3] For the period 1984-1990 there are two different NMFS estimates: an annual estimate based as much as possible on NMFS shoreside sampling and Federal logbooks, and the time-series estimate used in the Marine Fisheries Review paper. The time-series estimates use HDAR data for a greater number of component series. Both NMFS estimates are reported in Table A-1.

[4] The source of this difference probably is that vessels report landed product weight to HDAR, while reporting actual number of lobsters caught to NMFS. We use a conversion factor of approximately 3 to convert frozen tail weights to round weights. Using an equivalent expansion, the HDAR adjusted figure for 1990 would be 826,000 pounds, 87% of the NMFS estimate. This appears quite reasonable, given the HDAR revenue figures for lobster landings, which are 83% of the NMFS reported revenues.

[5] It is possible that there is under-reporting for some of these fisheries even when the NMFS estimate is close to the HDAR figure.

late 1990, only the NWHI lobster fishery had a mandated Federal data collection system (logbooks). Monitoring the NWHI bottomfish and the longline fisheries relied on informal NMFS wholesale market monitoring and HDAR catch reports.

In 1986 the NMFS Honolulu Laboratory took over a wholesale market monitoring program initiated by the Western Pacific Regional Fishery Management Council in 1984. In 1989 HDAR personnel began to share in this monitoring function with NMFS. The wholesale market monitoring program covered the major landings of NWHI bottomfish from its inception in 1984, as well as a large proportion of MHI bottomfish, troll, handline, and longline landings of pelagic management species beginning in 1986, and tuna species in 1987. The purpose of this monitoring program was two-fold: to provide scientific measurements of the species composition and size distribution of local landings, and to provide up-to-date estimates of landings from the Federally-regulated fisheries. The NMFS Honolulu Laboratory's Fishery Monitoring & Economics Program (FMEP) prepares preliminary estimates of annual landings which usually are available by June 1 of the following year, and if necessary, in-year estimates are generated.

In 1991 NMFS changed its procedures for shoreside monitoring considerably due to the implementation of Federal log books in the longline fishery and changes in the structure of the fresh fish market in Hawaii. The result is renewed reliance on HDAR data for the MHI bottomfish and pelagic (including tuna) fisheries. This changes some of our ideas on how best to provide a consistent time-series of commercial fish landings, but these changes are not covered in this appendix. They are described in the FMEP 1992 annual reports on the pelagic and bottomfish fisheries (Ito, 1992 and Kawamoto, 1992).

The NMFS wholesale market monitoring program is a voluntary (i.e., not mandated by Federal regulation) sample of sales at a number of sites around Hawaii. We believe it provides an excellent sample of longline landings, and a good sample of NWHI bottomfish landings (except for Kauai landings from the NWHI)[6]. We also sample Oahu and Big Island landings of bottomfish and pelagic species (including tunas) by the small boat fleet, but this sampling does not thoroughly monitor landings from Kauai, Maui, or Molokai. Site expansion factors (the percentage of domestic landing sites covered by NMFS monitoring) are based on a 1979-81 survey of wholesale seafood dealers in Hawaii, adjusted to reflect recent information on changing market channels. Site expansion factors are gear specific: factors range from 1.1 for some gears in the early years

---

[6] The NMFS estimates for NWHI bottomfish include HDAR data on trips not sampled by NMFS.

to 2.0 for other gears.[7] However, since 1981 we have not been able to undertake a complete stratified sample of all of Hawaii's fresh seafood buyers to test the reliability of our expansion factors.

Initially we prepared our own estimates of troll-handline pelagics and MHI bottomfish landings, based on our shoreside monitoring samples. However we did not maintain the early sampling intensity, and the structure of the market for these landings changed, so that our samples became inconsistent over their very short time period (1984-1992). As a result, we decided to rely on HDAR data for time-series presentations and analyses of these fisheries, even though there may be under-reporting.

We also sampled the Honolulu-based aku boat fleet on a regular basis, primarily to provide information on bait use and size composition information on skipjack tuna landings. The difference between our estimates of aku landings in 1990 (1.005 million pounds) and HDAR figures (1.116 million pounds) is negligible. Our estimate of "Other" landings uses HDAR data for fisheries not sampled by NMFS. The largest individual components of "Other" are the akule and opelu fisheries (small coastal pelagic species) which landed approximately 1 million pounds in 1990. "Other" also includes crustaceans (aside from the NWHI lobster), mollusks, coral, and reef fish.

Figures A.2-A.4 illustrate the time-series differences from 1970-90 for longline, NWHI bottomfish, and NWHI lobster landings.

NMFS Estimates

Our estimation procedure involves adjusting or replacing individual gear and/or species and/or area figures from HDAR (as compiled by NMFS from HDAR computer tapes) using the NMFS data and estimates where available throughout the period. This procedure is composed of five elements (Figure A.5 summarizes the estimation procedure and indicates which tables document the alternative time-series components).

1. HDAR aku boat data, 1948-90. (Table A.2)

2. NMFS longline landings estimates: (Table A.3)

   - HDAR data from 1948-78

---

[7] There is also an expansion for the number of days sampled at each site. The expansion ranges from 0% for logbooks and one invoice system to 100% (doubling) for some market samples. Market samples ranged from 100% coverage to 50% coverage during the period (1984-1990). Since 1990 the market sampling rate has declined to 17% at our primary site in 1993.

- linear adjustment (described below) of HDAR longline landings data for 1979-86 when NMFS monitoring data were not available

- NMFS estimates from 1987-90

3. NMFS NWHI bottomfish landings estimates for 1984-90, and a linear adjustment of HDAR NWHI bottomfish landings data for 1979-83. (Table A.4).

4. NMFS NWHI lobster landings data for 1977-90, and HDAR NWHI lobster landings data for 1948-76. (Table A.5).

5. HDAR data for 1948-90 for the remaining gears, species, and locations. This includes all troll and handline pelagics and MHI bottomfish (Table A.6), and other gear types and species (Table A.2). These data are not adjusted for under-reporting or any deviation from the NMFS estimates for MHI landings from 1987-90.

Table A.7 reports the total landings and revenue from HDAR figures and NMFS estimates (1948-90). Revenue was estimated using NMFS revenue figures or prices for NMFS logbook or shoreside monitoring figures for Hawaii longline and NWHI bottomfish and lobster landings. For NMFS estimates based on HDAR figures (e.g., longline from 1979-86 and NWHI bottomfish from 1979-83, HDAR prices were applied to the NMFS landings estimates. For the other time series (e.g., aku boat and "other"), HDAR revenue figures were used.

Linear extrapolation procedure

The adjustment of HDAR longline data for 1979-86 is a linear extrapolation from the HDAR 1978 longline figure to the 1987 NMFS longline estimate. We investigated a number of alternative methods for filling in the longline landings for 1979-86. These included a "variable" adjustment based on deviations from the trend and an annual linear extrapolation increment multiplied by the ratio of current year HDAR longline landings to the 1979-86 average. These alternatives assumed that the HDAR longline landings figures for 1979-86 were reliable indications in variability in longline landings, even if improperly scaled. However detailed examination of the 1979-86 HDAR figures suggest this is not the case, and that the HDAR figures provide no reliable information on longline landings in that period. Thus a simple linear extrapolation from 1978 to 1987 is considered the most reliable method.

The linear extrapolation was also applied to NWHI bottomfish landings for the period 1979-83.

Figures

Figure A.1. Hawaii commercial fishery landings, 1970-1990. HDAR figures and NMFS estimates, 1,000 Pounds Caught (HDAR) and Landed (NMFS) and ex-vessel revenue, $1,000.

Figure A.__. HDAR figures and NMFS estimates, 1970-90. 1,000 Pounds Caught (HDAR) and Landed (NMFS) and ex-vessel revenue, $1,000.

-2 Hawaii longline fishery.

-3 NWHI bottomfish fishery.

-4 NWHI lobster fishery (including expanded estimate of HDAR landings to revised whole weight figures).

Figure A.5. NMFS estimation procedure for Hawaii commercial fishery landings, 1948-90.

Tables

Table A.1.: HDAR figures and NMFS estimates for Hawaii commercial fish landings, 1990.

Table A.2: HDAR Aku Boat (Pole-and-line Skipjack tuna vessels) and "Other" species-gear landings, 1948-90.

Table A.3.: Hawaii longline landings, 1948-90.

Table A.4.: NWHI bottomfish landings, 1948-90.

Table A.5.: NWHI lobster landings, 1970-90.

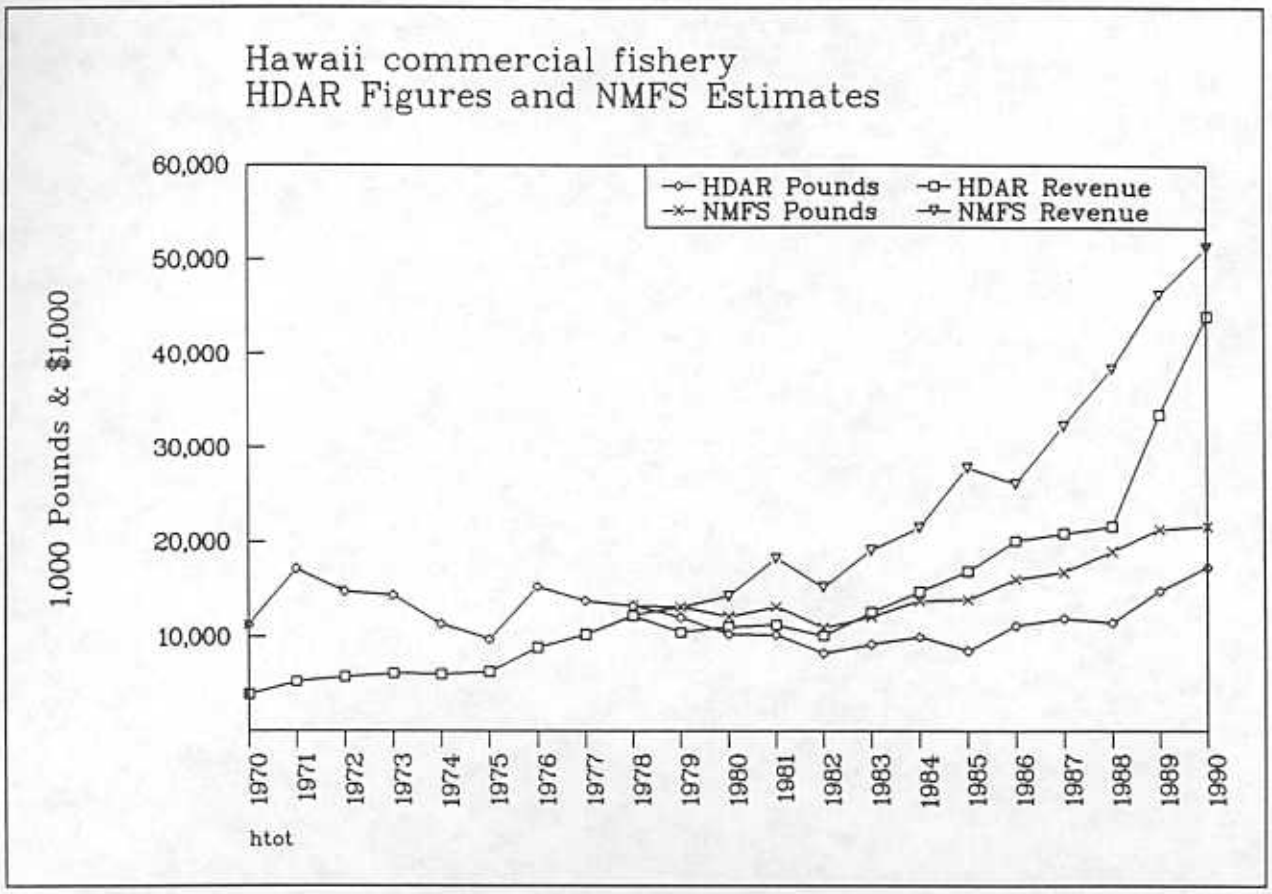
Table A.6.: MHI bottomfish and troll-handline pelagic landings, 1948-90.

Table A.7.: Total Hawaii commercial fish landings, 1948-90.

{Tables printed in hcnt91c}

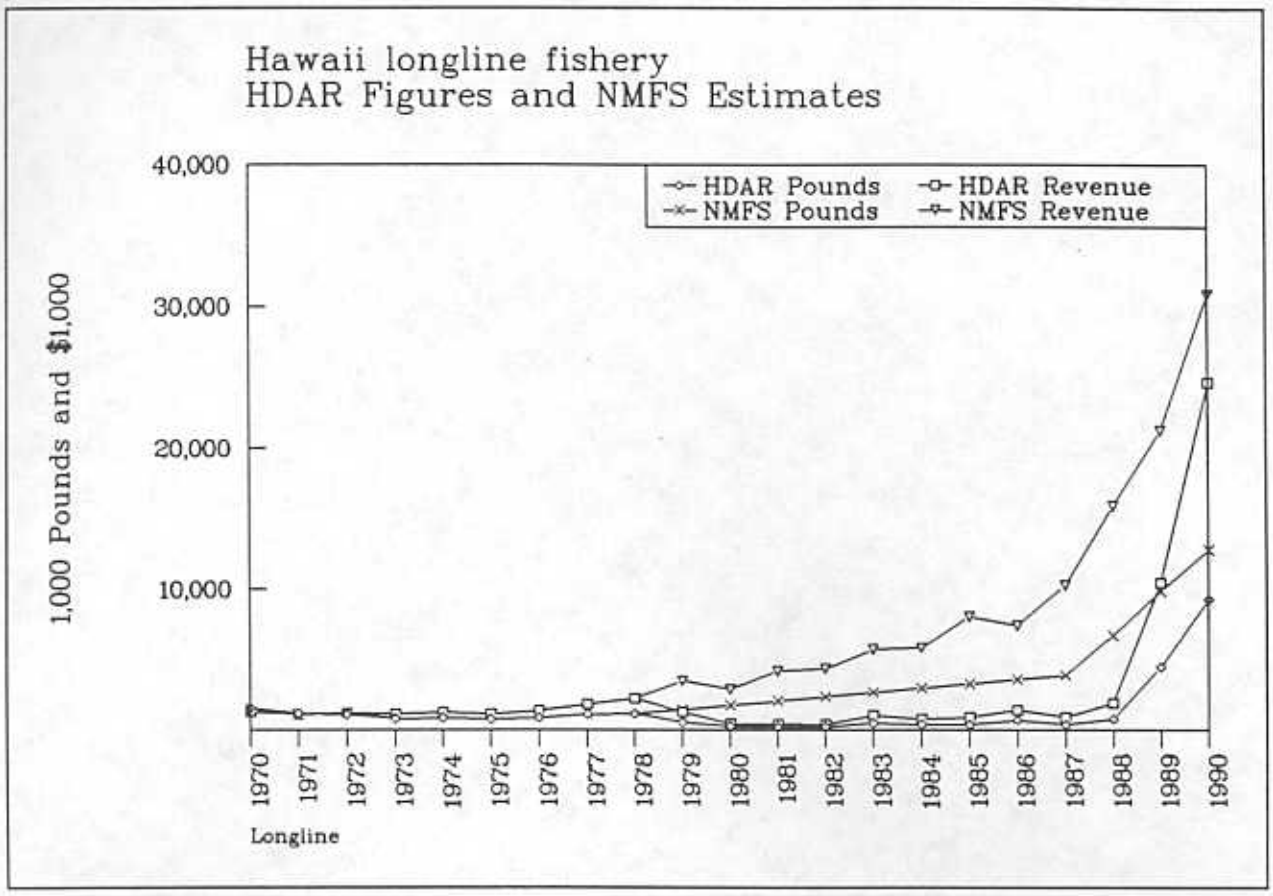
d:\fmpi\hcnt91b
August 31, 1993

Figure A.1. Hawaii commercial fishery, 1970-1990. HDAR figures and NMFS estimates, 1,000 pounds caught (HDAR) and landed (NMFS) and ex-vessel revenue, $1,000.



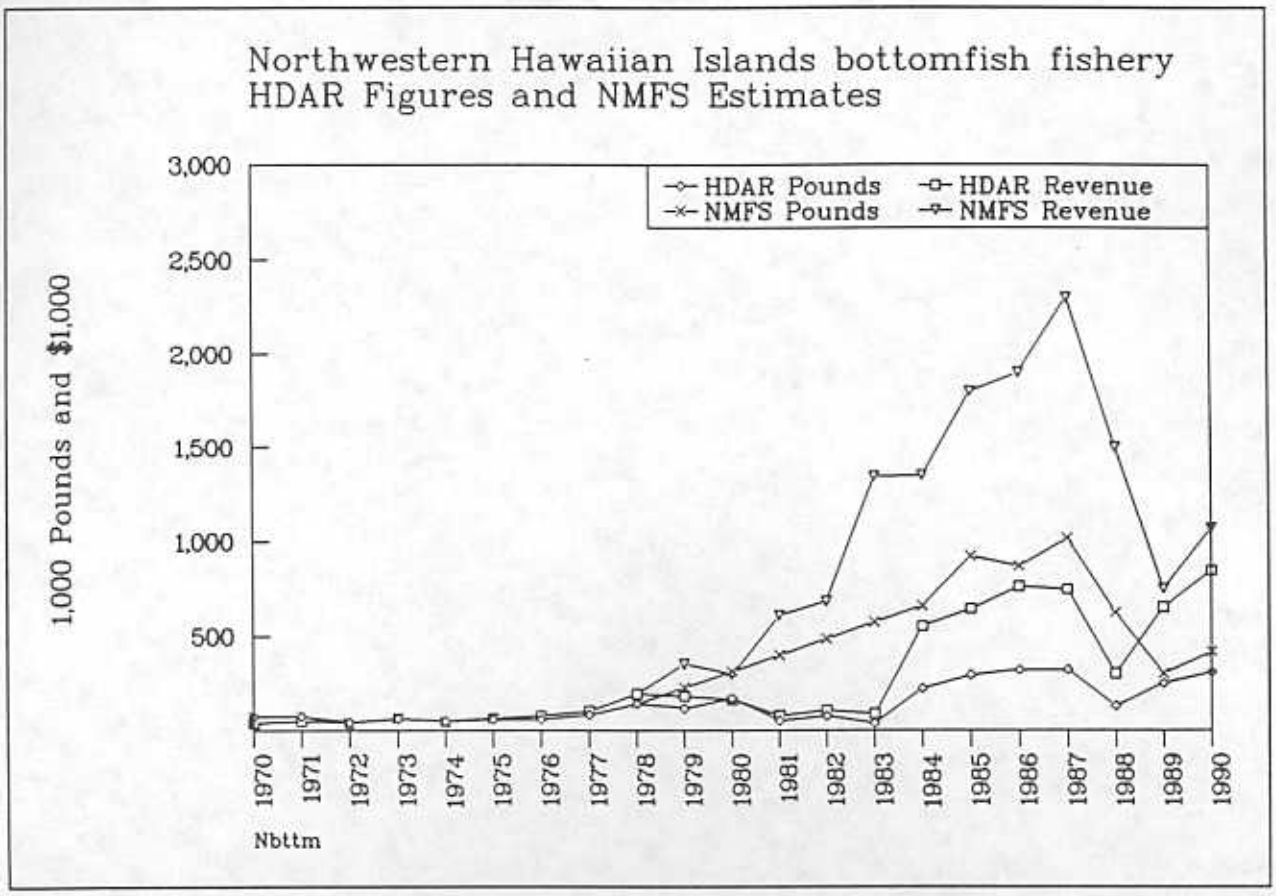
Data Source: HTOT.CAL 8/24/93

Figure A.2. Hawaii longline fishery, 1970-90. HDAR figures and NMFS estimates. 1,000 pounds caught (HDAR) and landed (NMFS) and ex-vessel revenue, $1,000.



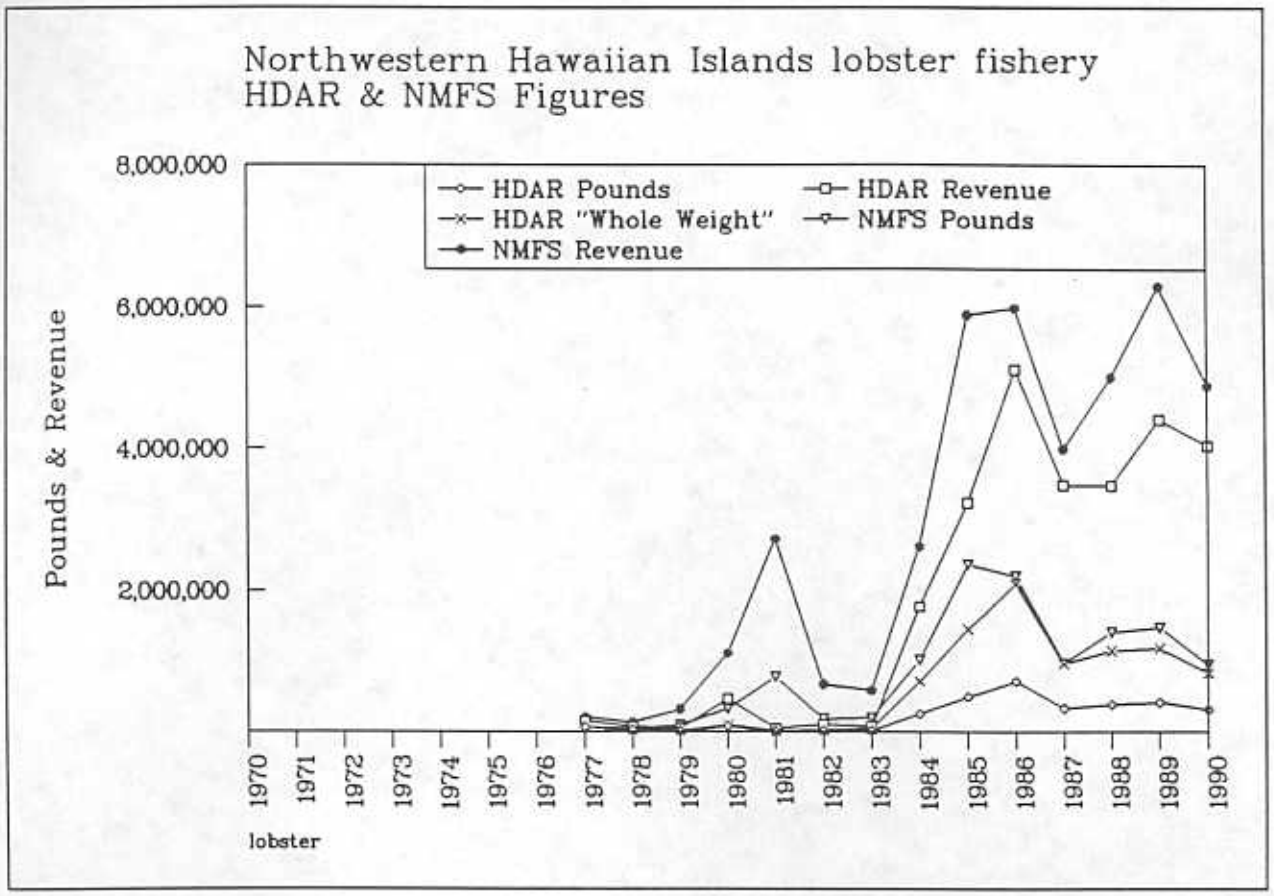
Data Source: LONGLINE.CAL 8/24/93

Figure A.3. NWHI bottomfish fishery, 1970-90. HDAR figures and NMFS estimates, 1,000 pounds caught (HDAR) and landed (NMFS) and ex-vessel revenue, $1,000.



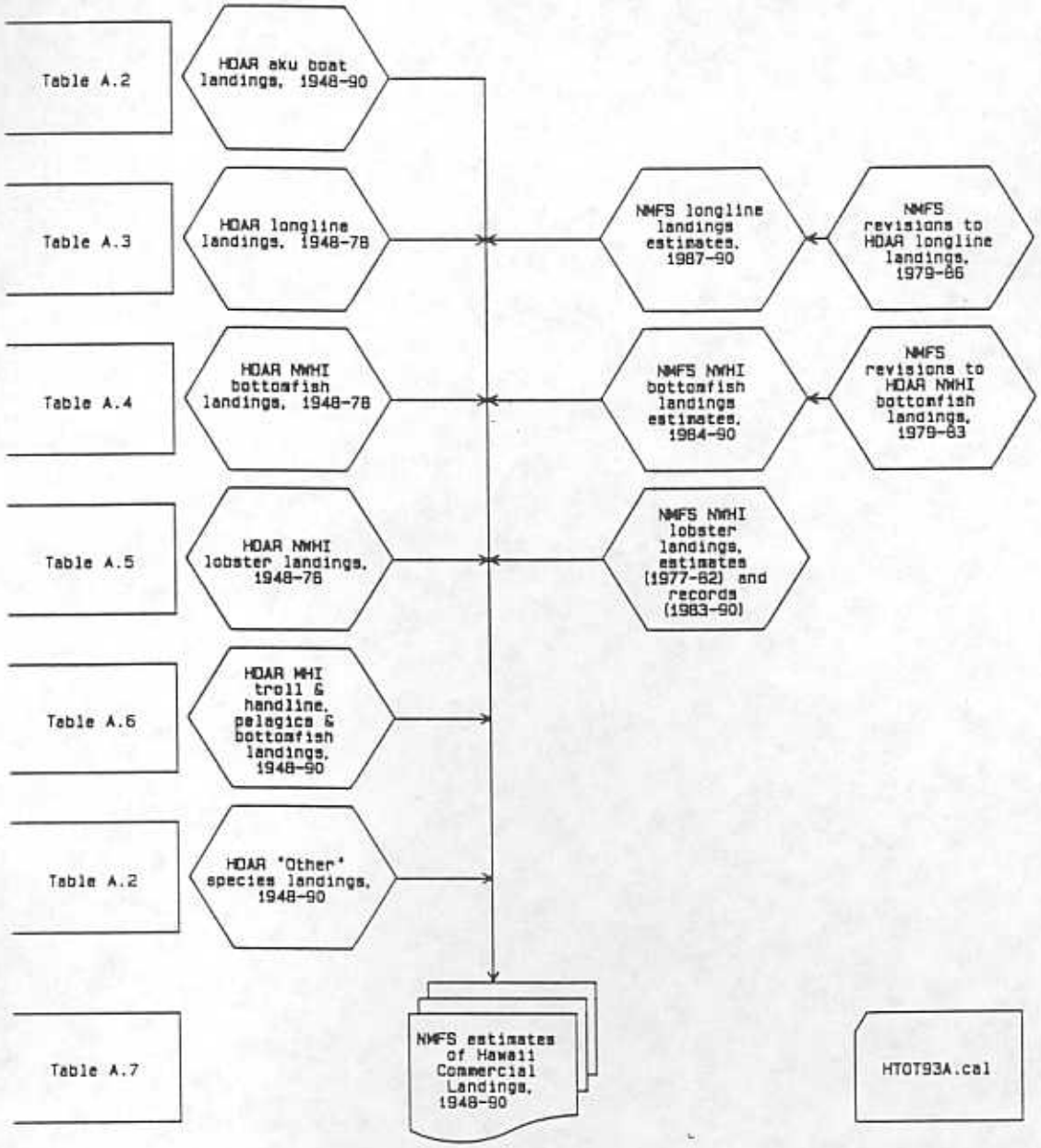
Data Source: NBTTM.CAL 8/24/93

Figure A.4. NWHI lobster fishery, 1970-90.
HDAR and NMFS figures, including expanded estimate of HDAR landings to revised whole weight figures, pounds caught and ex-vessel revenue.



Data Source: LOBSTER.CAL 8/25/93

Figure A.5. NMFS estimation procedure for Hawaii commercial fishery landings, 1948-90.



Htot93a 8/31/93

Table A.1.: HDAR figures and NMFS estimates for Hawaii commercial fish landings, 1990, 1,000 Pounds Caught (HDAR) or Landed (NMFS).

	HDAR	NMFS^1 (one-year)	NMFS^2 (time-series)
Aku Boat	1,116	1,005	1,116 (HDAR)
Longline	9,266	12,790	12,790 (NMFS^1)
NWHI Bottomfish	312	421	421 (NMFS^1)
NWHI Lobster	313	949	949 (NMFS^1)
MHI Bottomfish	661	792	661 (HDAR)
MHI Pelagics[1]	4,128	4,013	4,128 (HDAR)
Other[2]	1,562	1,562 (HDAR)	1,562 (HDAR)
TOTAL*	17,356	21,532	21,626
TOTAL^2	17,869		
... Lobster whole weight[3]			

* Columns may not sum precisely due to rounding.

HDAR figures are reported pounds caught (calculated by NMFS through the GAS computer program)

NMFS estimates of landings are based on logbooks and shoreside sampling, expanded to fishery-wide estimates.

NMFS^1 are individual gear estimates which may exist for only a few years for some components.

---

[1] Troll-handline-other gears (not aku boat or longline)

[2] "Other" are all gear types, species, and area combinations <u>not</u> individually identified in this Appendix. These include lobster and shrimp fisheries in the MHI, akule and opelu landings, and reef fish, inter. alia.

[3] HDAR figures on lobster landings (presumed to be lobster <u>tails</u>) expanded to an estimate of whole weight equivalency.

NMFS^2 are estimates available over a longer time frame which were used in developing the NMFS long-term time-series. They include either the NMFS^1 estimate <u>or</u> the HDAR figures throughout the time period.

Data source: hn90z \fmep\data 9/30/91

Table A.2: HDAR Aku Boat (Pole-and-line skipjack tuna vessels) and HDAR "Other"[4] landings, 1948-90.

1,000 Pounds Caught & $1,000 ex-vessel revenue

	HDAR(GAS) Aku Boat Lbs	HDAR Revenue	HDAR "Other"	HDAR Revenue
1948	8,496	1,375	2,021	965
1949	10,541	1,477	1,902	965
1950	9,788	1,293	1,213	599
1951	12,264	1,650	1,172	596
1952	7,181	1,054	1,544	541
1953	11,914	1,589	1,077	590
1954	13,104	1,667	1,161	638
1955	11,020	1,266	1,304	591
1956	11,120	1,265	1,113	528
1957	6,765	884	930	484
1958	7,856	1,105	984	492
1959	12,122	1,448	867	465
1960	7,138	975	1,000	541
1961	10,878	1,298	963	519
1962	9,349	1,168	1,059	514
1963	8,096	1,099	996	453
1964	9,134	1,243	910	439
1965	16,295	2,042	1,001	484
1966	9,339	1,406	1,227	558
1967	8,164	1,286	1,446	593
1968	9,463	1,574	1,560	643
1969	6,072	1,276	1,502	689
1970	7,386	1,497	1,632	765
1971	13,393	2,753	1,552	844
1972	11,001	2,949	1,578	954
1973	10,766	3,203	1,501	918
1974	7,427	2,676	1,324	898
1975	5,088	2,282	1,291	975
1976	9,896	3,827	1,738	1,323
1977	7,780	3,707	1,718	1,647
1978	6,849	4,358	1,254	1,538
1979	6,549	3,438	1,374	1,409
1980	4,194	3,199	1,432	1,720
1981	4,229	3,308	1,176	1,501
1982	3,342	2,331	1,013	1,579
1983	2,683	2,616	1,701	2,193
1984	3,527	2,889	1,555	2,080
1985	2,114	2,301	1,038	2,590
1986	2,351	2,271	1,063	1,822
1987	3,503	3,848	915	1,168
1988	3,943	4,267	1,065	1,656
1989	2,962	4,571	1,701	3,215
1990	1,116	1,873	1,561	3,495

Data Source: Htot93a.cal 8/23/93

---

[4] "Other" are all gear types, species, and area combinations not individually identified in this Appendix. These include lobster and shrimp fisheries in the MHI, akule and opelu landings, and reef fish, inter. alia.

Table A.3.: Hawaii longline landings, 1948-90.

1,000 Pounds Caught (HDAR) or Landed (NMFS) &
$1,000 ex-vessel revenue

	HDAR Pounds Caught	HDAR Revenue	NMFS Pounds Landed	NMFS Revenue
1948	3,476	1,375	3,476	1,375
1949	3,491	1,240	3,491	1,240
1950	3,859	1,057	3,859	1,057
1951	3,970	1,192	3,970	1,192
1952	4,290	1,352	4,290	1,352
1953	4,332	1,131	4,332	1,131
1954	4,448	1,033	4,448	1,033
1955	3,898	1,131	3,898	1,131
1956	3,443	1,003	3,443	1,003
1957	2,571	917	2,571	917
1958	2,645	915	2,645	915
1959	2,636	966	2,636	966
1960	2,173	905	2,173	905
1961	1,972	830	1,972	830
1962	2,022	872	2,022	872
1963	1,811	818	1,811	818
1964	1,883	857	1,883	857
1965	1,707	808	1,707	808
1966	1,655	844	1,655	844
1967	1,563	885	1,563	885
1968	1,353	901	1,353	901
1969	1,416	1,139	1,416	1,139
1970	1,541	1,261	1,541	1,261
1971	1,151	1,094	1,151	1,094
1972	1,055	1,173	1,055	1,173
1973	778	1,118	778	1,118
1974	830	1,210	830	1,210
1975	746	1,106	746	1,106
1976	838	1,338	838	1,338
1977	1,101	1,809	1,101	1,809
1978	1,125	2,216	1,125	2,216
1979	518	1,260	*1,432*	*3,485*
1980	252	418	*1,740*	*2,890*
1981	195	398	*2,047*	*4,179*
1982	207	383	*2,355*	*4,367*
1983	469	1,007	*2,663*	*5,723*
1984	375	737	*2,970*	*5,842*
1985	364	893	*3,278*	*8,035*
1986	679	1,402	*3,585*	*7,400*
1987	353	880	3,893	10,276
1988	760	1,895	6,733	15,922
1989	4,488	10,457	9,844	21,273
1990	9,266	24,661	12,790	30,845

NMFS figures printed in italics indicate years using the linear extrapolation procedure (see text). Subsequent years are independent NMFS estimates.

Data Source: Longline.cal \fmep\data 8/18/93

Table A.4.: NWHI bottomfish landings, 1948-90.

1,000 Pounds Caught (HDAR) or Landed (NMFS) &
$1,000 ex-vessel revenue

	HDAR Pounds Caught	HDAR Revenue	NMFS Pounds Landed	NMFS Revenue
1948	295	107	295	107
1949	316	115	316	115
1950	355	91	355	91
1951	369	120	369	120
1952	534	174	534	174
1953	465	139	465	139
1954	283	76	283	76
1955	334	102	334	102
1956	136	48	136	48
1957	93	36	93	36
1958	63	20	63	20
1959	68	26	68	26
1960	88	36	88	36
1961	76	30	76	30
1962	65	25	65	25
1963	92	34	92	34
1964	92	32	92	32
1965	51	18	51	18
1966	48	18	48	18
1967	33	14	33	14
1968	33	14	33	14
1969	40	15	40	15
1970	74	39	74	39
1971	75	50	75	50
1972	43	42	43	42
1973	62	63	62	63
1974	49	49	49	49
1975	59	64	59	64
1976	59	78	59	78
1977	83	104	83	104
1978	143	194	143	194
1979	118	183	*229*	*356*
1980	172	163	*316*	*299*
1981	52	79	*402*	*611*
1982	77	108	*488*	*685*
1983	38	89	*575*	*1,346*
1984	224	553	661	1,350
1985	296	645	922	1,800
1986	323	762	869	1,900
1987	324	747	1,015	2,300
1988	130	304	625	1,500
1989	251	653	303	750
1990	312	846	421	1,070

NMFS figures printed in italics indicate years using the linear extrapolation procedure (see text). Subsequent years are independent NMFS estimates.

Data Source: Nbttm.cal \fmep\data 8/18/93

Table A.5.: NWHI lobster landings, 1970-90.

Pounds Caught (HDAR) or Landed (NMFS) & $ ex-vessel revenue

YEAR	HDAR POUNDS	HDAR REVENUE	HDAR WHOLE[5]	NMFS POUNDS	HDAR REVENUE
1970	0				
1971	0				
1972	0				
1973	0				
1974	0				
1975	0				
1976	0				
1977	69,549	157,872	69,549	72,000	209,000
1978	27,039	80,745	27,039	45,000	135,000
1979	14,787	54,631	14,787	100,000	320,000
1980	83,330	466,189	97,592	328,000	1,114,000
1981	6,874	48,148	9,713	780,000	2,730,000
1982	14,940	109,142	26,604	187,000	673,000
1983	17,409	77,195	41,905	203,000	591,000
1984	258,070	1,772,911	717,750	1,017,000	2,624,000
1985	499,203	3,240,327	1,451,039	2,368,000	5,887,000
1986	714,483	5,110,936	2,091,587	2,202,000	3,982,000
1987	333,816	3,486,462	960,795	969,000	3,988,000
1988	388,479	3,473,085	1,146,184	1,405,000	5,000,000
1989	415,527	4,403,521	1,246,581	1,470,000	6,291,000
1990	312,706	4,038,158	826,010	949,000	4,887,000

Data Source: Lobster.cal \fmep\data 8/17/93

[5] Estimated whole weight if reported landings represent product weight (adjusted annually by NMFS percent total landings in frozen tail product form).

Table A.6.: MHI bottomfish and troll-handline pelagic landings, 1948-90. (HDAR commercial catch reports.)

1,000 Pounds Caught & $1,000 ex-vessel revenue

	Bottomfish		Troll-Handline Pelagics	
	Pounds	Revenue	Pounds	Revenue
1948	763	348	297	83
1949	753	334	332	88
1950	550	213	976	59
1951	525	212	183	47
1952	544	244	247	60
1953	495	231	646	250
1954	424	191	161	34
1955	414	198	449	49
1956	512	244	217	51
1957	465	223	453	48
1958	462	220	156	37
1959	335	186	132	30
1960	313	164	150	40
1961	308	158	148	37
1962	374	195	154	41
1963	442	219	171	40
1964	423	212	167	41
1965	354	195	170	41
1966	411	219	198	54
1967	393	229	226	59
1968	605	251	195	64
1969	379	262	273	95
1970	270	214	379	115
1971	335	262	654	229
1972	364	324	710	297
1973	392	355	885	448
1974	364	372	1,347	796
1975	485	513	2,060	1,348
1976	499	615	2,241	1,677
1977	479	660	2,548	2,153
1978	597	906	3,272	2,921
1979	580	940	2,889	3,192
1980	541	919	3,592	4,180
1981	591	1,183	3,947	4,749
1982	673	1,492	2,941	4,103
1983	847	1,882	3,442	4,772
1984	803	1,797	3,257	4,949
1985	765	1,954	3,439	5,275
1986	811	2,052	5,232	6,681
1987	784	2,345	5,737	8,397
1988	1,165	3,288	4,038	6,761
1989	1,007	3,090	4,046	7,148
1990	661	2,265	4,128	6,874

Data Source: Htot93a.cal 8/23/93

Table A.7.: Total Hawaii commercial fish landings, 1948-90.

1,000 Pounds Caught (HDAR) or Landed (NMFS) &
$1,000 ex-vessel revenue

YEAR	HDAR[6] Pounds	HDAR Revenue	NMFS Pounds	NMFS Revenue
1948	15,349	4,253	15,349	4,253
1949	17,334	4,220	17,334	4,220
1950	16,740	3,312	16,740	3,312
1951	18,482	3,817	18,482	3,817
1952	14,340	3,425	14,340	3,425
1953	18,929	3,931	18,929	3,931
1954	19,580	3,639	19,580	3,639
1955	17,420	3,337	17,420	3,337
1956	16,541	3,139	16,541	3,139
1957	11,276	2,592	11,276	2,592
1958	12,166	2,789	12,166	2,789
1959	16,160	3,121	16,160	3,121
1960	10,863	2,660	10,863	2,660
1961	14,345	2,873	14,345	2,873
1962	13,023	2,815	13,023	2,815
1963	11,608	2,663	11,608	2,663
1964	12,609	2,824	12,609	2,824
1965	19,578	3,588	19,578	3,588
1966	12,879	3,098	12,879	3,098
1967	11,825	3,065	11,825	3,065
1968	13,208	3,446	13,208	3,446
1969	9,682	3,476	9,682	3,476
1970	11,282	3,891	11,282	3,891
1971	17,160	5,232	17,160	5,232
1972	14,752	5,739	14,752	5,739
1973	14,384	6,105	14,384	6,105
1974	11,341	6,001	11,341	6,001
1975	9,729	6,288	9,729	6,288
1976	15,272	8,858	15,272	8,858
1977	13,778	10,238	13,780	10,289
1978	13,266	12,214	13,284	12,268
1979	12,042	10,477	13,153	13,140
1980	10,266	11,065	12,142	14,321
1981	10,197	11,266	13,173	18,260
1982	8,267	10,105	10,999	15,230
1983	9,197	12,636	12,113	19,123
1984	9,999	14,778	13,791	21,531
1985	8,515	16,898	13,923	27,842
1986	11,174	20,101	16,113	26,107
1987	11,950	20,871	16,816	32,322
1988	11,490	21,645	18,975	38,394
1989	14,870	33,538	21,332	46,338
1990	17,356	44,051	21,625	51,308

Data Source: Htot93a.cal 8/18/93

---

6 Compiled by NMFS using the GAS computer program.