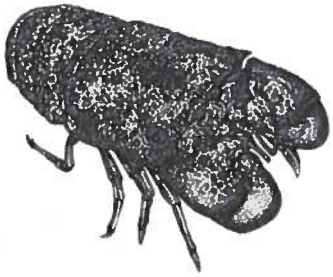
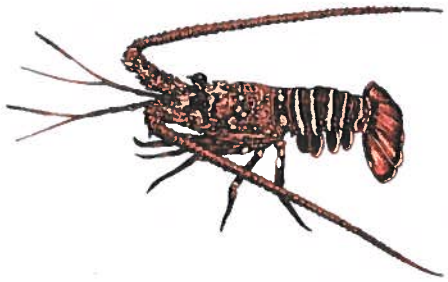
Main Hawaiian Island Lobsters: Commercial Catch and Dealer Data Analysis (1984-2004)



Scaly Slipper Lobster
ula-pāpapa
Scyllarides squammosus



Red Spiny Lobster
ula
Panulirus marginatus

A report prepared for

The Western Pacific Regional Fishery Management Council

and

The State of Hawaii
Department of Land and Natural Resources
Division of Aquatic Resources

Prepared by

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Cover art: Waikiki aquarium website

Executive Summary

The State of Hawaii, Department of Land and Natural Resources (DLNR) through the Division of Aquatic Resources (DAR), manages Hawaii's marine resources for the people of Hawaii. This study analyzes 21 years (1984-2004) of data from fisherman catch and dealer sales reports to provide a current assessment of the lobster resources of the main Hawaiian Islands (MHI) and its associated commercial fishery.

The current study was conducted for several reasons. First, no one had done a thorough analysis of the commercial fishery data since 1968. Second, the information would give insight regarding the development and evolution of the fishery. Third, this study could provide some insight into the status of stocks. Fourth, there had been no effort to compare reported catch data with dealer data for correlations between reported landings and dealer sales, particularly after changes in catch report forms and a concurrent education and outreach initiative were implemented by DAR in 2002.

During the years this study covers, the fishery as a whole reported relatively stable landings, but exhibited dramatic shifts in preferred gear type, market patterns and island-specific production. Statewide annual commercial landings ranged between 7,000 and 12,000 pounds with the exception of a three-year low of 2,000-3,000 pounds from 1993-1995. Maui fishers accounted for 61% of the 185,263 pounds of commercial catch reported from 1984-2004. Oahu and Hawaii fishers reported 16 and 17%, respectively, while Kauai fishers accounted for only 6% of the total landings.[1] Maui's contribution increased to 85% of the landings during the last five years.

Spiny lobsters consist of almost 90% of the reported catch, while slipper lobsters account for just over 10%. Improved species identification in the catch and dealer data from the last two years of the study indicate that the green spiny lobster is the predominant catch from Maui and Kauai (93%), while the red spiny lobster dominates the catch from Hawaii and Oahu (90%). A huge

[1] Due to State of Hawaii data confidentiality laws, the limited size of Kauai commercial lobster fishery inhibits the reporting of results for most of Kauai's regional analyses.

drop-off in reported slipper lobster landings was also observed in the last two years, totaling only 0.25% of the landings.

A dramatic shift in gear preference occurred around 1994. Between 1984 and 1993, trap harvest accounted for twice as many landings (59%) as the next most productive gear type, hand harvest (27%). Between 1994 and 2004, hand harvest represented 79% of the reported landings, and accounted for 91% of landings between 2001 and 2004. Lobster nets were employed most frequently on Oahu, accounting for 23% of Oahu's landings, but only 5-10% of the landings from the other islands.

During the years of its greatest use (1984-1993), trap harvest catch per unit effort (CPUE) averaged 20-40 pounds landed per day. Hand and net harvest displayed similar CPUE values during this same period. Catch rates for all three primary gear types were at 21-year lows in 1993, averaging less than 20 pounds per day. As hand harvest became the preferred gear type (1994-2004), its mean CPUE on Maui gradually improved from 10 pounds per day in 1993, to peak at 60 pounds per day in 2002. Hand harvest catch rates on Oahu and Hawaii remained relatively constant over the 21-year period, averaging 10-20 and 20-30 pounds per day, respectively.

Mean weight for spiny lobsters remained fairly constant over the 21 years, fluctuating between 2.0-2.5 pounds on Hawaii and Maui, and 1.5-2.5 pounds on Oahu. There appears to be a gradual decrease in mean weight on Maui since 1995, while on Oahu mean weight has been steadily increasing since 1990. Based on limited data from 2002-2004, green and red spiny lobsters harvested in this fishery have a similar mean weight of 2.15 pounds in all island areas. Mean weight for slipper lobsters was slightly smaller than for spiny lobsters, fluctuating between 1.5-2.0 pounds over the time-series, but exhibiting no upward or downward trend.

A few individuals dominated the fishery. Twenty fishers were responsible for 52% of the 185,263 pounds of reported landings, while over 500 registered fishers harvested the remaining catch. The small-scale fisher earns only a few hundred dollars in a given year from their lobster sales. The twenty primary fishers, most active for about six years of the 21-year study, report

between $5,000 and $10,000 each year in lobster income. The market exhibited even greater consolidation, with a single dealer from each island region dominating the market. At least for Maui and Kauai, these virtual monopolies appeared to have a beneficial impact on their regional fishery, by increasing the demand for lobsters and offering $2.50-$5.00 more per pound than on Hawaii and Oahu. This, in turn, appeared to generate more participation and total landings. The 21-year statewide mean price per pound, adjusted to 2004 value, was $10.72.

Dealer data captured less of the commercial fishery activity, with fishers reporting selling 150,000 pounds of lobsters and dealers reporting only 100,000 in sales. The total value of dealer sales was lower by a comparable value, approximately $30,000 less annually. Dealer reports also captured fewer total active fishers, reporting sales from 340 different fishers in the 21-year period, whereas 537 fishers reported selling their catch to licensed dealers. A much closer correlation between catch and dealer data sets began in 1999 and continued until 2002, with total annual reported pounds sold and value of sales within 8% for the two data sets. Catch reports were revised in 2002, no longer requiring fishers to report sales data, which eliminated the ability to cross-check future landings and sales figures.

In the early years of the time-series, data fields from both catch and dealer reports were not always completed. Catch reports did not specify the number of lobsters caught in 20% of the entries, which limited the ability to analyze mean weight in some instances. Catch reports improved to 100% completion in 2002 with the initiation of the revised report forms. Dealer reports only reported the number of lobsters in 40% of the entries. In addition, 23% of the dealers did not report the value of the sale, which limited determining price per pound. Prior to 1990, dealers almost never distinguished between spiny and slipper lobsters. Dealer reports improved gradually beginning in 1996, and by 2002 were nearly 100% complete. In addition, both dealer and catch reports began identifying lobsters to species in 2002, with nearly 100% compliance by 2003.

Based on this 21-year summary of the available data, the MHI lobster fishery does not appear to be experiencing overfishing. The fishery has adapted to new harvest methods and responded to an expanding market with stable trends in total landings and mean weight, and stable or

increasing trends in CPUE for hand harvest, the currently preferred gear method. While analyses of these indicators were sometimes limited due to poor species identification or small data sets, revised reporting forms and increased reporting compliance by the fishery in the later years of this study should provide the type of data for better fishery analyses in the future.

Recommendations. The primary conclusion of this study is that the commercial lobster fishery is small, thus making the data set small. The available data were insufficient to provide a credible assessment of the resource. The following recommendations are intended to provide mechanisms for data improvement which will lead to a better insight into the status of the resource.

1. A series of interviews should be conducted with the twenty highliners to obtain more detailed information, not requested on the original catch report forms, that could provide further insight into the changes in the fishery discussed in this report.
2. Interviews should be conducted with both fishers and buyers on Maui to better understand the economic forces driving this market and track changes in CPUE and fishing pressure in response to it. The fishery and market data should continue to be monitored.
3. Because effort data were recorded in trip-days prior to 2002 and in man-hours after 2002 , a wide range of fishers should be interviewed to derive a formula to estimate historical man hours per day and allow for comparisons with current and future data.
4. The DAR should evaluate mechanisms of obtaining additional information about catch and effort from the non-commercial sector of this fishery.
5. DAR should make an effort to obtain better mean weight data, by making sure fishers report weight and numbers accurately and keep track of population size structure.
6. Given the new fishing report forms implemented in 2002, a study should be conducted in seven years with data from 2002-2012, to determine whether the new requirements generate data that are accurate and complete enough to provide insight into the status of the resource.

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I. Introduction

The State of Hawaii, Department of Land and Natural Resources (DLNR) through its Division of Aquatic Resources (DAR), manages Hawaii's marine resources for the people of Hawaii. The state has collected commercial lobster landings data in some form since the early 1900s. Today, all commercial fishers who sell any part of their catch are required to obtain a commercial marine license (CML, also known as a commercial fishing license) and submit fishing reports within ten days after the end of each month until the license expires (HRS §189-2 & 3). While not officially licensed by DAR, primary commercial marine dealers (i.e., businesses that buy locally caught seafood directly from licensed commercial fishers) are also required to submit monthly commercial marine dealer reports by the tenth day of the following month (HRS §189-10). Primary businesses include restaurants, fish markets, grocery stores, wholesalers, and fish peddlers. Appendix I provides sample report forms. These two data sets are the primary sources for the analyses presented.

In 1948, the DAR began processing commercial fishing reports. These catch reports initially only required fishers to report monthly totals of pounds sold and value of catch sold for each species and gear method. Over the years the report was refined, increasing the level of detail in effort data from fisher-months to fisher-days, specifying area fished, and requiring numbers in addition to pounds landed. Revisions in 2002 increased the level of detail in effort data to fisher-hours, as well as required better description of the gear employed and species caught.

Recreational fishermen, conversely, are not licensed by the state, and as such, catch reports have never been required for the recreational fishery (those who do not sell any of their catch). There are no reliable statewide estimates of the number of fishers, level of effort or pounds landed for this sector. Morris (1968), and later McGinnis (1972), estimated recreational catch to be "equivalent to the commercial fishery catches," although neither report describes the method of determination.

A thorough review of the literature determined that the lobster fishery in the main Hawaiian Islands (MHI) has been characterized in only one previous study (Morris 1968), with a follow-up

document a few years later that provided several management recommendations (McGinnis 1972). As with the current study, these two reports were conducted for and in consultation with the State Department of Land and Natural Resources (DLNR). Morris' study, a Master's thesis from the University of Hawaii Zoology department, was prompted by a substantial decline in landings between 1948 and 1965. Landings dropped to approximately 20 % of the peak by 1965, falling from more than 45,000 pounds to just over 8,000 pounds per year. The study analyzed catch reports, interviewed the five highest producers statewide, and conducted a tagging study in Maunalua Bay, Oahu. The study concluded that data collected for the fishery were insufficient for a proper stock assessment, and recommended that fishers be required to describe more accurately the level of effort. Morris' study supplied much of the rationale for the McGinnis report, which, in conjunction with a laboratory growth study, provided management recommendations for the lobster fishery, including minimum size limits, closed seasons and restrictions on the condition of harvested lobsters. Other reports listed in the references are taxonomic, behavioral or ecological in nature, and do not directly address the fishery.

The current study is the first detailed investigation of the fishery, its market and the lobster resource in nearly 40 years. This study analyzes 21 years (1984-2004) of data from fisherman catch and dealer sales reports to provide a current assessment of the lobster resources of the MHI and its associated commercial fishery. Until this report, there have been no analyses of the commercial dealer data for lobsters. The current study was conducted for several reasons. First, no one had done a thorough analysis of the commercial fishery data since 1968. Second, the information would give insight regarding the development and evolution of the fishery. Third, this study was developed in hopes that it might provide some insight into the status of stocks. Fourth, there had been no effort to compare reported catch data with dealer data for correlations between reported landings and dealer sales, particularly after changes in catch report forms and a concurrent education and outreach initiative were implemented by DAR in 2002.

II. Methods

A. Description of commercial catch report and dealer report data sets

The DAR Statistical Unit (SU) receives information from commercial fishers and dealers of marine life throughout the state. The SU and neighbor island DAR licensing offices are the primary liaisons with licensees, providing assistance with regulations and data reporting. The SU receives monthly catch and dealer reports from fishers and dealers, respectively, and checks them for completeness. Because of their interaction with commercial fishers and dealers, the SU and neighbor island staff are integral in the level of compliance, accuracy and completeness of data collected. Appendix III details the variation in accuracy and completeness of the data sets between regions.

In 1948, the DAR began processing commercial fishing reports and storing these records into database files for data analysis. All catch reports have been quality controlled and transferred to electronic files by DAR SU, which were subsequently provided to the authors. The catch report data set consists of 6,633 entries. Prior to 1999, dealer reports were submitted to DAR and transferred to microfiche reels.

The fish dealer reporting system was implemented in 1999. Since then, the reports have been collected and processed by DAR's SU, which applies quality control procedures and stores the data in computer database files. The authors inspected over 50,000 reports for entries of lobster sales for the years 1983 through 1999. For each identified lobster sale, all information recorded on the report was transcribed and added to the database of the fish dealer reporting system for use in this and future reports. All data were subsequently quality controlled, removing entries of lobsters caught in the Northwestern Hawaiian Islands, and those where pounds sold could not be determined. The latter accounted for fewer than 20 deletions. These data were combined with the existing electronic data set for analysis. The dealer report data set consists of 3,740 entries. These two data sets were the basis of the analyses for this report.

Catch data

The majority of the catch data analyzed in this report (1983-2002) was derived from data submitted on the 'Fish Catch Report' (Appendix I). Commercial fishers are required to provide entries for each day fished in a given month. Data from these reports used in this study include: area fished (based on statistical charts and consolidated into four regions for this report), fishing method used (gear type in this report), name of the species, number caught, pounds caught, pounds sold, value of pounds sold (value in this report) and to whom the catch was sold. By default, each entry correlated to one trip or one day of effort. If they did not fish during the month, they must submit the report marking a 'did not fish' box. Despite this requirement, no zero-catch 'skunk trips' occurred in the database.

In 2002, DAR revised this form (see 'Fishing Report' in Appendix I). The new form requires greater detail documenting effort, including hours fished per method, and length of net or number of traps deployed. DAR also began working with fishers to differentiate between green and red spiny lobsters (*Panulirus penicillatus* and *P. marginatus*, respectively) and between the common and ridgeback slipper lobsters (*Scyllarides squammosus* and *S. haanii*, respectively). After 2002, fishers were not required to provide sales data.

Dealer data

The majority of dealer data analyzed in this report was derived from data submitted on the 'Commercial Marine Dealer's Report on Purchases of Marine Life' (Appendix I). Dealers are required to provide separate entries for each species in a given sale. Data from these reports used in this study include day of sale, from whom bought, species, pounds bought, number bought and amount paid (value in this report). If a dealer bought no marine life in a given month, they must submit the report marking a 'did not purchase' box. Additional dealer data was obtained from 'Commercial Marine Licensee Retail Sales Report' (see Appendix I), which is required of commercial fishers who sell their catch directly to the public.

Dealer data rarely distinguished between lobster species prior to 1990, generally reporting the sale merely as "lobsters." After 1990, dealers began distinguishing slipper from spiny lobsters, and after 2002, many have distinguished between green and red spiny lobsters.

B. Analysis

Data was organized and analyzed by Fiscal Year (1 July – 30 June). Thus, for figures, tables and text in this report, 1984 means July 1983 – June 1984. The two data sets were analyzed in three stages. First, each data set was analyzed in a multi-tiered manner. Data was separated by region as follows; Kauai (including Niihau and Kaula Rock), Oahu, Maui (including Molokai, Lanai, Kahoolawe and Penguin Bank), and Hawaii. Data was further separated by five gear types (hand harvest, lobster trap, lobster net, fish trap, gill net) and a miscellaneous category. These data were analyzed as a whole (the entire 21-year period), by year, and by month for;

- total landings and effort (in trips, generally measured in days)
- mean CPUE, in both pounds and pieces per trip
- mean weight
- mean price per pound
- total value of the fishery per month
- number of fishers

Catch data are organized based on the fishing area entered on the catch reports and not the port of landing. Thus, lobsters reported caught in the waters surrounding Hawaii (i.e., statistical areas 100 to 128, see Appendix II) are attributed to the island of Hawaii. Lobsters reported caught in the waters surrounding Maui County (i.e., statistical areas 300 to 331) are attributed to the Maui region. Lobsters reported caught in the waters surrounding Oahu (i.e., statistical areas 400 to 429) are attributed to Oahu. Lobsters reported caught in the waters surrounding Kauai County (i.e., statistical areas 500 to 528) are attributed to the Kauai region.

CPUE is defined as pounds per trip, with a trip equal to one day, although assumption of the catch report data set is discussed above. In addition, fishers were always required to report 'did not catch trips'. The original forms accommodated for such data entries, however most fishers reported only trips with catch activity or recorded only the portion of the catch that was sold. In effect, the fish catch report took on the appearance of a trip sales report rather than a true fishing report with total catch and fishing effort information. Value is provided both as unadjusted and

inflation-adjusted to 2004 dollars, based on the Hawaii Bureau of Labor Statistics Consumer Price Index (CPI).

Appendix IV provides the number of data entries and the number of fishers representing these data by year and by month for each of the 24 sub-categories (i.e., four regions and six gear categories). The number of data entries in each sub-category illustrates the robustness within each analysis, and the number of fishers determines whether the data are confidential based on State Statute. If the data represent fewer than three fishers, the results are confidential and cannot be presented in this report. In short, this led to both a paucity of data and significant confidentiality concerns for all island areas except Maui.

Catch data were sorted by fisher, and separated into "highliners" and remaining fishers. For this report, a highliner is any fisher who landed more than 2,000 pounds over the 21-year period. Twenty fishers match this definition. For consistency, the top twenty buyers, based on total pounds bought, were also profiled, providing insight to socio-economic trends in the fishery. Highliner data were analyzed similarly to the multi-tired analysis described above.

Through 2002, fishers were required to report the number of pounds sold and the value of the total sale. This allowed for numerous comparisons between the catch and dealer data sets. Comparative analyses include pounds sold, value of lobsters sold and number of active fishers, providing insight into the extent data were not being captured by either reporting scheme. Comparisons between mean price and mean weight were also conducted.

While the two data sets provide some measure of corroboration, the results of the resource analyses were primarily obtained through the catch data, while dealer data was better for analyzing the socio-economics of the fishery. Statewide and regional analyses are presented, as both are important in the understanding of overall and island-unique characteristics of the resource, the fishery and the market. Results are presented in two sections; resource analysis and fishery analysis.

C. Statistical Methods

Statistical methods were not necessary to summarize most of the data. Total pounds landed and sold, total value of lobster and total effort are reported as raw numbers. Price per pound, CPUE and mean weight are reported as averages with standard deviations. Detailed statistics are available in Appendix V.

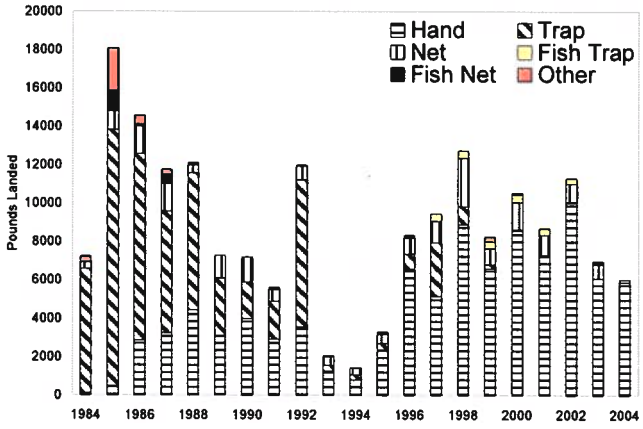
III. Results

A. Resource Analyses

Resource analyses are those analyses that attempt to determine the status of the resource, including stock size, size/age structure, and species breakdown. Because habitat type and fishing pressure vary across the four island areas, regional and island-wide analyses were conducted to characterize the resource, as data permitted. To present a complete representation, the same analyses were conducted for both catch and dealer data when appropriate, allowing comparison of the two data sets. Based on the available data, results of pounds landed, gear type, catch per unit effort (CPUE), mean weight, and species composition are presented.

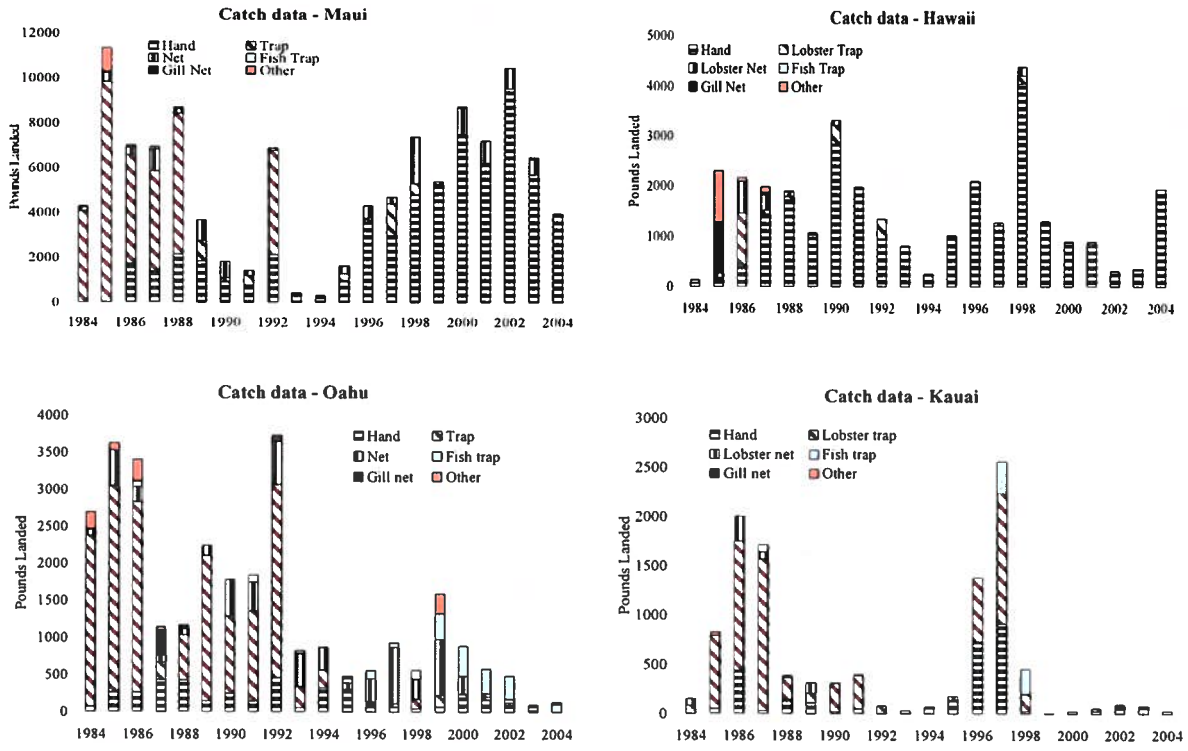
Total catch data reported landings, including sold and unsold catch, were 185,263 pounds for the 21-year time series. Landings peaked at 18,099 in 1985, but have been relatively stable overall (Figure 1). Most years' landings fell between 7,000 and 12,000 pounds. Very low catch was reported for a three-year period between 1993 and 1995, when catch per unit effort (CPUE, in pounds per trip) was near 20-year lows for the three primary gears (Figure 4). Landings rebounded in 1996 and remained stable for seven years, but have declined roughly 33% for the last two years. Dealer data reports only pounds bought, thus does not provide comparable data for this analysis.

Figure 1. Pounds landed by gear type, catch data - all islands



Most of the effort and landings are from Maui, which has maintained a strong commercial lobster fishery throughout the time-series. Maui's 112,870 pounds, caught by 224 fishers, comprise 61% of the total commercial landings taken in the MHI. Although lobster trap fishing was the primary method before 1993, this method was virtually replaced by hand harvest from that year forward (Figure 2). On Hawaii, 124 different fishers reported 31,697 pounds in landings during the 21-year period, comprising 17% of the statewide total. Figure 2 illustrates the dominance of hand harvest on Hawaii, accounting for four of every five trips.

Figure 2. Pounds landed by gear type, catch data – regional (y-axis varies)

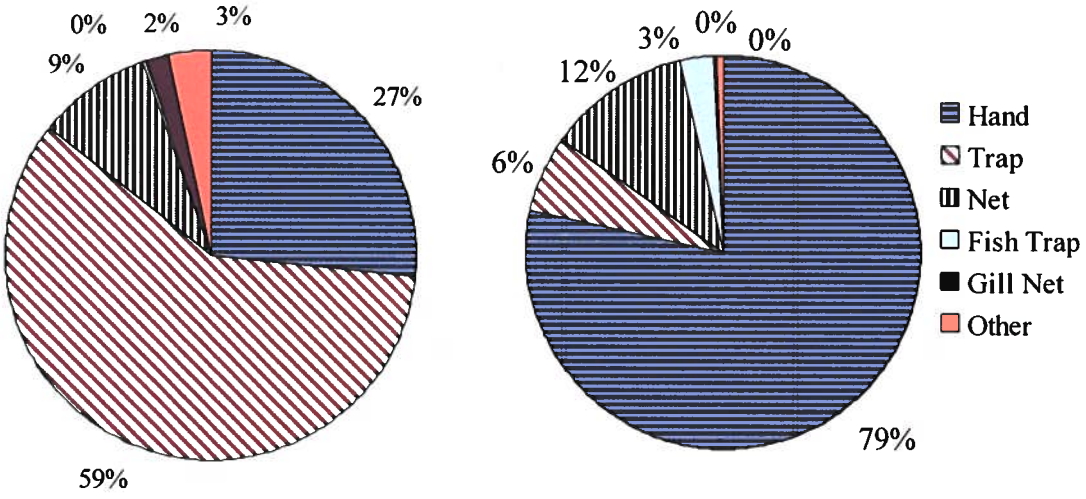


Oahu's reported landings totaled 29,609 pounds, constituting 16% of the commercial fishery. Oahu was found to be the only region where hand harvest is not the preferred fishing method. As seen with Maui, lobster traps were the dominant gear type before 1993. However, trap use on Oahu did not fade as abruptly, and was never replaced completely by hand harvesting. A total of 133 fishers reported landings on Oahu, averaging 14 active fishers each year and constituting a substantial turnover from year to year. Kauai reported the lowest catch of lobster by island

throughout the time-series (11,087 pounds), contributing only 6% to the total commercial landings. Gear preference on Kauai appeared to be evenly split between hand harvest and lobster traps. Due to low participation on Kauai (maximum of eight fishers in one year), large changes in catch rate or pounds landed could occur only when one or two fishers left or entered the fishery. These changes may also have occurred due to changes in the demand for local lobster or in the activities of highliners.

As described above, the preferred gear type changed during the course of the analysis period. There was a relatively sudden switch during the early 1990s. Between 1983 and 1993, trap harvest accounted for twice as many landings as the next most productive gear type, hand harvest. Between 1994 and 2004, hand harvest was responsible for 79% of reported landings, accounting for over 91% of landings for the years 2001-2004.

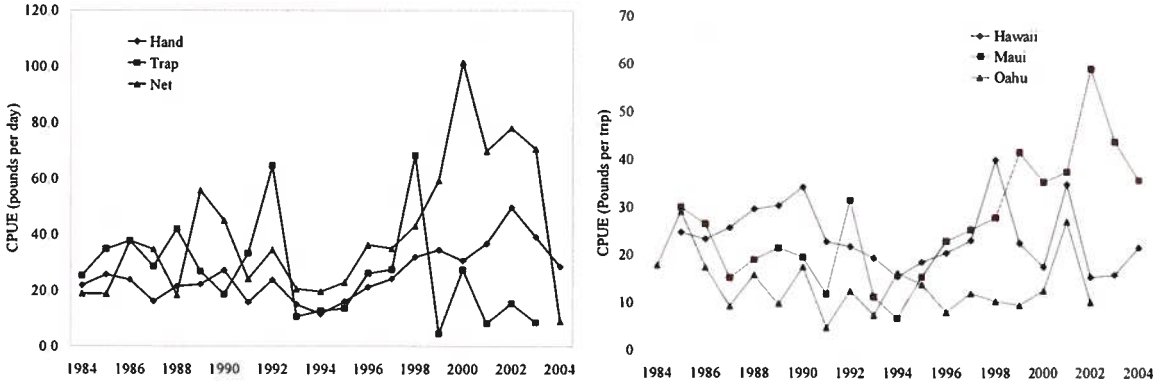
Figure 3. Percent of landings in pounds by gear type: 1984-1993 and 1994-2004



Hand harvest, lobster traps, and lobster nets accounted for 95.4% of all landings in the 21-year period (51.0, 34.2, and 10.3%, respectively). Of these gear types, hand harvest displayed the most consistency in CPUE, with average annual maximum, minimum and 21-year average values of 49.7, 11.6, and 25.6 pounds per day. With the exception of two peak years (1992 and 1998), trap harvest CPUE shows a steady decline and has had the lowest averages of the three

primary gears for the past six years. Lobster net CPUE has fluctuated considerably over the 21-year period, with maximum and minimum annual averages of 101.5 and 9.0 pounds per day.

Figure 4. CPUE, primary gears - all islands and CPUE, hand harvest – regional



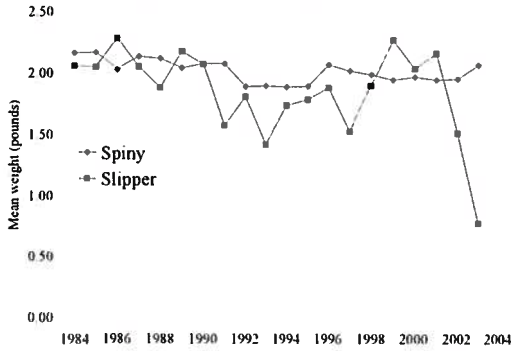
Insufficient data and confidentiality issues prohibited regional CPUE analysis except for hand harvest. For this same reason, no Kauai data could be presented. The regional breakdown shows relative consistency between islands, with similar peaks and troughs throughout the time-series. Oahu fishers consistently reported the lowest hand harvest CPUE, while CPUE of Maui fishers surpassed the island of Hawaii over the last six years of the data set.

Mean weight for spiny lobsters was relatively constant over the 21-year period, with yearly island-wide averages between 1.89-2.16 pounds per lobster (Figure 5.a). The annual standard deviation was also constant, between 0.38-0.57, averaging 0.5 pounds (See Appendix V). Even after excluding data for 2003 for which there were only three entries, slipper lobster mean weight and standard deviation showed greater fluctuation (1.42-2.29). This fluctuation seen in the slipper lobster data is likely due to the relative size of the data sets, as there are nearly eight times more data points for spiny lobsters than for slipper lobsters. Due to data limitations, regional analysis was feasible only for Hawaii, Maui and Oahu for spiny lobsters (Fig. 5.b-d), and was not feasible for slipper lobsters. All regional mean weight results were very similar to the island-wide pattern, although standard deviation did increase for Hawaii and Oahu due to the size of the data set (Appendix V). There appears to be a gradual decrease in mean weight on Maui since

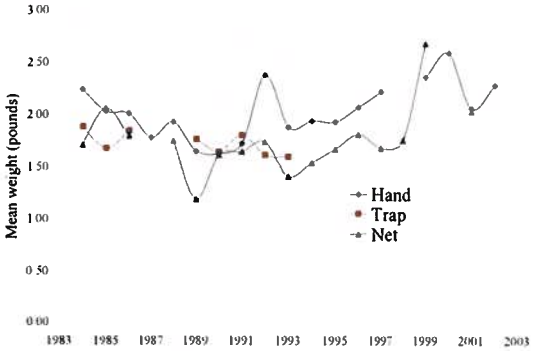
1995, while on Oahu mean weight has been steadily increasing since 1990 (10-15% over ten years). There does not appear to be any pattern to size selectivity with respect to gear type.

Figure 5. Mean weight, catch data – all islands and dealer data for Maui

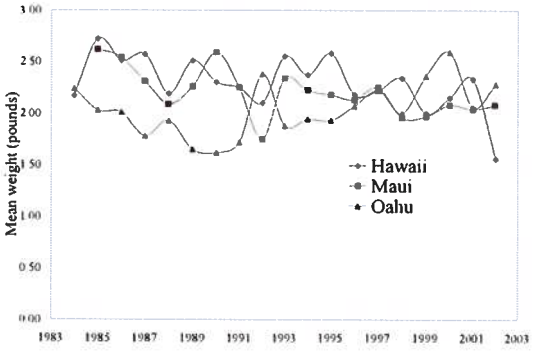
5a. Slipper and spinys, all available data



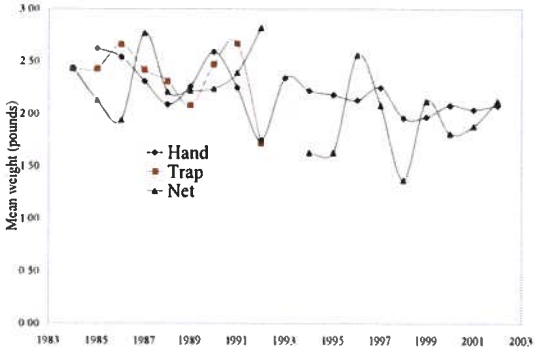
5b. Spiny lobsters, Oahu, by gear



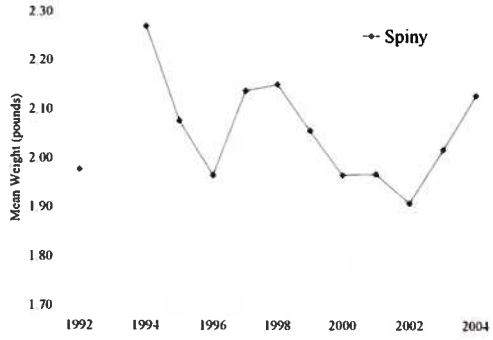
5c. Spiny lobsters, regional, by hand



5d. Spiny lobsters, Maui, by gear



5.e Spiny lobsters, Maui, all dealer data



Of the 3,738 entries for the dealer data, 2,387 data points (64%) were discarded due to lack of information or because species was identified only as lobster (4.6%). Of the remaining data, only

the subset of Maui spiny lobsters was large enough to permit analysis (Fig. 5.e). There are 27 data points for the five years from 1992-1996, including no data for 1993 (i.e., $n < 7$ per year). From 1997-2003, an average of 118 data points per year illustrates much better record keeping from this point forward (only 10 data points for 2004 is due to dealers differentiating between green and red spiny lobsters; see below). The data appear to show a downward trend in the size of lobsters from 1997 to 2002, rebounding in the two last years. Annual standard deviation averaged 0.40 pounds (see Appendix V for details). In 2004, mean weight of green and red spiny lobsters on Maui was 2.06 and 2.23 pounds, respectively.

Beginning in 2002, DAR worked with licensees to more accurately describe the species caught. Previously, fishers commonly reported either slipper or spiny lobster. Species composition changed dramatically with the implementation of this new requirement. Prior to 2003, spiny and slipper lobsters consisted of 90 and 10% of the catch, respectively. As shown in Table 1, after

Table 1. Species composition before and after reporting change, Oct. 2002

Catch Data

1984-2002			2003-2004		
Species	Pounds	Percent	Species	Pounds	Percent
Green Spiny	0	0.00%	Green Spiny	8,477	65.07%
Red Spiny	0	0.00%	Red Spiny	2,845	21.84%
Ridgeback	0	0.00%	Ridgeback	44	0.34%
Slipper	17,885	10.38%	Slipper	32	0.25%
Spiny	154,350	89.62%	Spiny	1,630	12.51%
Total	172,235		Total	13,028	

DealerData

1984-2002			2003-2004		
Species	Pounds	Percent	Species	Pounds	Percent
Green Spiny	211	0.24%	Green Spiny	4,364	38.78%
Red Spiny	588	0.66%	Red Spiny	715	6.35%
Ridgeback	0	0.00%	Ridgeback	0	0.00%
Slipper	3,072	3.47%	Slipper	49	0.44%
Spiny	46,941	52.96%	Spiny	6,125	54.43%
Lobsters	37,821	42.67%	Lobsters	0	0.00%
Total	88,633		Total	11,253	

2002, virtually no slipper lobster were reported caught. Catch data after 2002 showed that green spiny lobsters were caught three to one over red spiny lobsters. Dealer data was less specific

prior to 2003, often reporting "lobsters" for the species. Of the entries that did distinguish between slipper and spiny lobsters, dealer data showed a lower percentage of slipper lobster moving through the market (6% vs. 10.4% for catch data). With 87% of the catch data identified to species after 2002, green spiny lobsters made up 75% of the catch. With only 45% of the sales identified to species, dealer data after 2002 shows that 86% of the market is green spiny lobsters. Spiny lobster dominated the catch for all four island regions, although this was more pronounced for Hawaii (98% spiny lobsters landed) than for Kauai (58% spiny lobsters landed). Both Maui and Oahu caught 91% spiny lobsters. While green spiny lobsters account for 75% of the total reported catch after 2002, this is not homogeneous across the islands. In 2003-2004, Maui reported 78% of total landings, which were primarily green spiny lobsters. Hawaii reported 20% of total landings, which were primarily red spiny lobsters. Oahu and Kauai's total combined landings contributed only 1.67% of the total catch with Oahu reporting solely red spiny lobsters and Kauai reporting solely green spiny lobsters.

Table 2. Species composition by island, 2003-2004

	Hawaii	Kauai	Maui	Oahu	Total
Green Spiny	10.37%	100.00%	92.69%	0.00%	74.87%
Red Spiny	89.63%	0.00%	7.31%	100.00%	25.13%

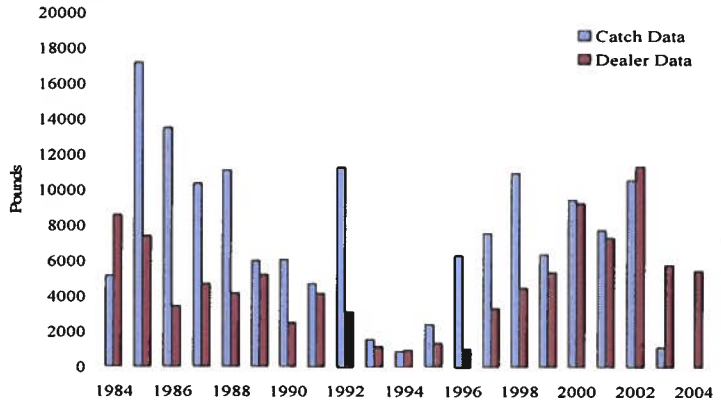
B. Fishery Analysis

Fishery analyses are those analyses that address the socio-economic aspects of the fishery, characterizing the interaction of commercial fishers and the market. This includes the number of active fishers, their level of involvement in the fishery and exit and entry patterns. Market factors include total pounds of lobster bought or sold, the mean price per pound, and the value of the fishery as a whole and per individual. Of primary interest in these analyses is the relative monopolization of both the commercial harvest and the retail market. As with the resource analysis, market variations among the four island areas warrants regional analyses, as data permits. Catch and dealer data are analyzed side by side, when appropriate.

From the catch reports, fishers reported selling 150,434 pounds (81% of their catch) of lobster from 1984-2002. After 2002, fishers were not required to report what they sell, so this cannot be interpreted. Hawaii fishers retained the most lobsters and Kauai fishers the least, at 22.6 and

15.6%, respectively. Over the same period, dealers reported purchasing 100,085 pounds of lobster, including 11,253 pounds of lobster in 2003-2004.

Figure 6. Reported sales, catch and dealer data – all islands



Prior to 1998, only two years with substantial catches (1989 and 1991) had similar quantities bought and sold. From 1984-1998, dealer reports heavily underreported total sales, averaging 50% fewer pounds reported bought than fishers reported selling. Starting in 1999, dealer report sales averaged within 8% of fisher reports, excluding the last two years for reasons stated above. Dealer reports also appeared to underreport the number of active commercial fishers (Figure 7), capturing only 63% (340 of 537) of the number of fishers reporting selling catch in the same period. As with sales data, there is a closer correlation between the two data sets in the last few years of the time-series. Annual participation ranged from 27 fishers (14 for dealer data), to 74 fishers (46), averaging 53 (30) over the time-series. Catch and dealer lows and peaks did not occur in the same years, with the dealer low value corresponding to one of the highest recorded fisher participation years (1990).

Figure 7. Active fishers, catch and dealer data – all islands

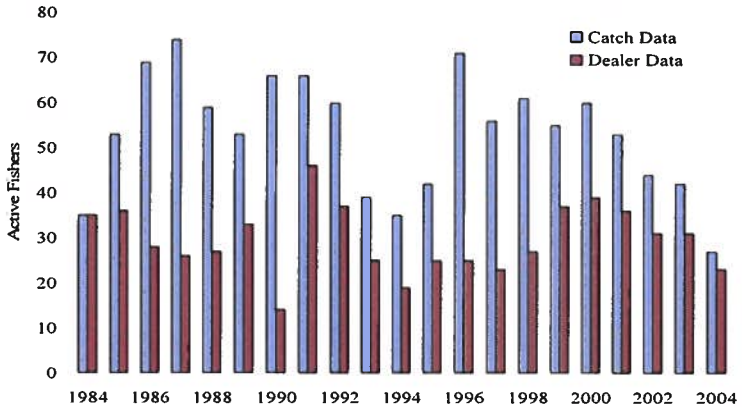


Table 3 shows that the discrepancy in active fishers occurs across all regions, with the closest correlation on Kauai (73%) and the poorest on Oahu (54%). Table 3 also illustrates that the regional landings and participation are well correlated. Kauai has the lowest landings (6% of the catch), and the fewest fishers (9% of the licensees), while Maui has the greatest landings (61% of the catch) and the most fishers (45% of the licensees).

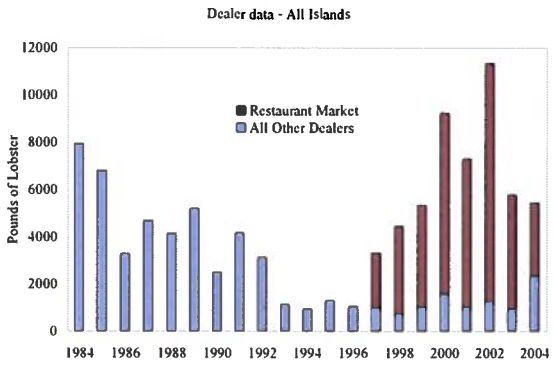
Table 3. Dealers and fishers – regional breakdown

	Hawaii	Kauai	Maui	Oahu	Total
Dealers	18	20	48	14	108
Fishers - dealer data	80	33	155	72	340
Fishers - catch data	124	45	224	133	526

Table 3 also provides the regional distribution in number of dealers that recorded at least one lobster sale over the 21 years. Many of these dealers bought only small quantities of lobster either for a short time or very sporadically over the time-series. Of the 100,085 pounds bought statewide, ten buyers bought 76,023 pounds (76%). Of the four regions, dealer activity appeared most evenly balanced on Hawaii and most consolidated on Maui. Most dealers, large and small, operated throughout the time-series on Oahu and Hawaii. On Maui and Kauai, increased or emerging activity from higher volume dealers appeared to squeeze some of the smaller dealers out of the business.

Figure 8 shows how this market dominance affects the entire fishery. From 1984-2004, dealers bought an average of 4,700 pounds of lobster per year. The highest amount of lobster bought (11,357 pounds) occurred in 2002, while the lowest (953 pounds) occurred in 1994. Due to the emergence of a high value tourist restaurant market in the mid-1990s, the volume of sales increased dramatically. Disregarding the sales of this new market, the largest lobster sales occurred in 1984. A steady decline in sales occurred from 1984 (7,944 pounds) to 1992 (952 pounds) and remained low for the remainder of the time-series. The post-1992 average was only 1,186 pounds.

Figure 8. Pounds of lobster bought per year

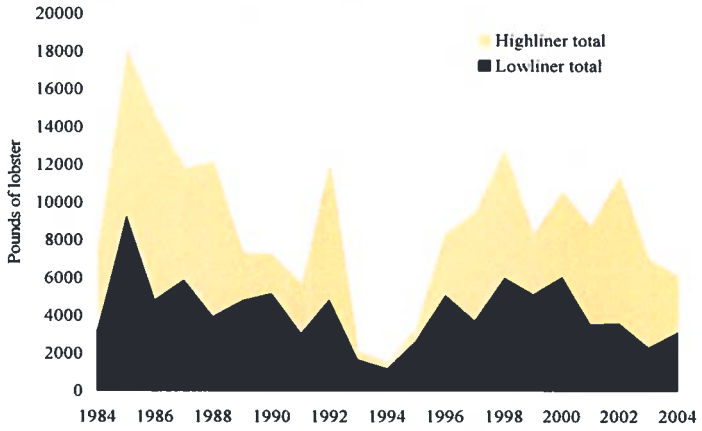


Catch dominance occurred as well, with the twenty highliners landing 52.5% (96,218 pounds) of the total reported catch. The majority of the fishery is comprised of very part-time fishers, where 70% caught fewer than 100 pounds over the entire 21 years. Even among the highliners, based on confidential data for individual years of participation and total landings, only five or six appeared to generate a substantial portion of their income in any given year from this fishery.

A few highliners were responsible for most (31-63%) of the landings, both on a statewide and island-specific basis.

Figure 9 shows that despite their considerably larger share of the catch, trends in highliner catch was reasonably well correlated with that of the remainder of the fishery. As highliners become more active, increasing their effort and subsequently their landings, the smaller volume fishers respond similarly.

Figure 9. Landings of the top 20 and bottom 517 licensees



Although these twenty highliners accounted for more than 50% of the total reported commercial catch of lobster in the MHI, very few fished more than a few years of the 20-year span. Participation ranged from one to sixteen years, and averaged six years, over the 21-year period. Only one highliner employed lobster nets (in addition to traps), one employed four gear types, and the remaining highliners split evenly between hand and trap fishing (Table 4).

Table 4. Summary of highliner activity

	Fishers	Pounds	Trips (in days)	Average CPUE*	CPUE* std dev
Hand Harvest	9	46,133	1283	49.6	24.6
Trap Harvest	9	42,542	1105	97.2	101.2

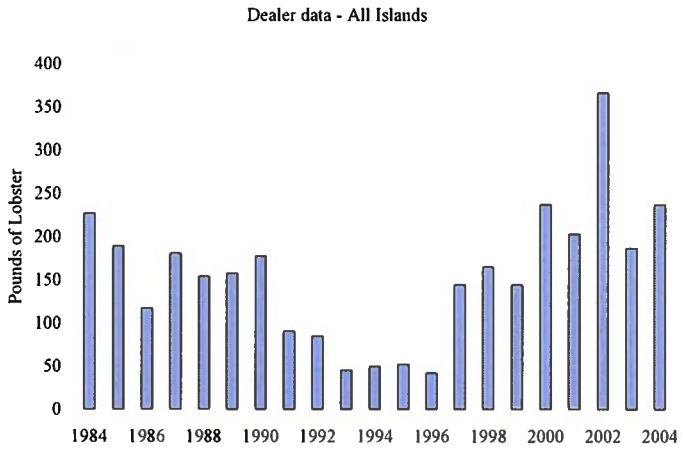
* CPUE in pounds per day

The CPUE reported in Table 4 is an average of the 18 individual CPUE values, with standard deviation related to differences between fishers. On a fishery-wide scale, CPUE rates are much closer between hand and trap harvest (36.0 and 38.5 pounds per trip, respectively). This anomaly is the result of a few very successful trap fishers conducted brief pulse fisheries for periods ranging from a few weeks to two months, while the more consistent trap fishers had more modest CPUE rates.

Figure 10 provides average annual sales per fisher, providing a perspective on how the level of individual involvement changed over the years. During the period from 1984-1990, the average

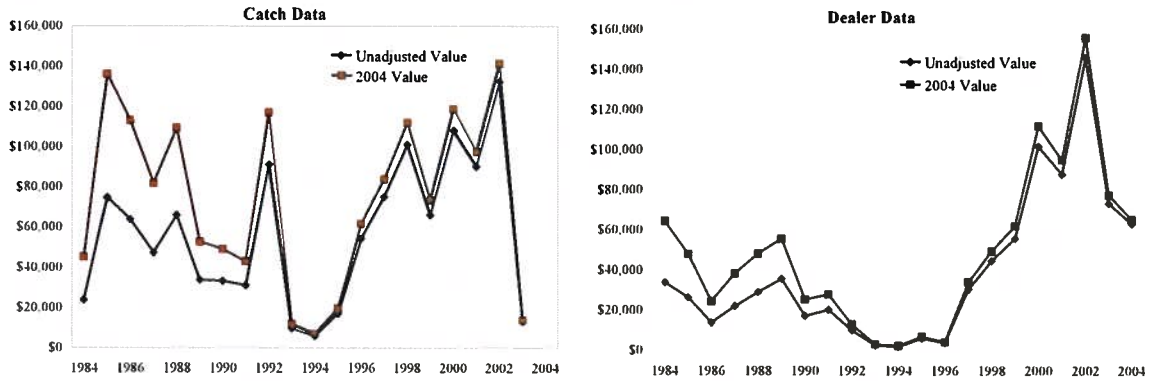
fisher sold 170 lbs per year; between 1990-1996, he sold 61 pounds per year and from 1996-2004, individuals averaged sales of 211 pounds per year.

Figure 10. Pounds of lobster bought per fisher per year.



Based on catch report data, inflation-adjusted (Consumer Price Index, Bureau of Labor Statistics) to 2004 values, the MHI commercial fishery average revenues are $81,775 per year. This average does not include 1984, which may be an incomplete data set, or 2003 and 2004 revenues, because fishers were not required to include sales data in their reports after 2002. The value of all sales from dealer reports after 2002 was approximately $142,250, which increases the total value of the fishery for the 21-year period (in 2004 dollars) to $1,614,000.

Figure 11. Catch and dealer data reported revenues



Through 1998, total dealer reported revenues averaged roughly $30,000 less per year than total catch revenues (Fig. 11). For three years (1999-2001), revenues between the data sets were very similar, with dealer data reporting around $5,000 per year under catch data. With value data dropped from the list of reporting requirements in 2002, these data can no longer be compared.

Table 5 provides a regional breakdown of the basic economic information. Because of the relatively higher price for lobster, Maui commands 69% of the value of the fishery for 61% of the reported sales. A more detailed discussion of price based on catch records is provided below.

Table 5. Value of the fishery, catch data – regional

	Lbs. sold	Value[1]	Mean price[1]
Hawaii	24,539	$218,665	$8.91
Kauai	9,578	$80,965	$8.45
Maui	92,127	$1,118,435	$12.14
Oahu	24,190	$193,935	$8.02
All	150,434	$1,612,000	$10.72

[1] Data are inflation-adjusted to 2004 values

The price per pound data set is not consistent throughout the time-series. Data are robust enough for spiny lobster price analysis for 29 years across the four regions, but only 11 years for slipper lobsters. While it is important to analyze the data both by species and by region due to very different market forces, this often leads to both a small data set and one that can be skewed by the impact of a single dealer. For example, on the island of Hawaii, only three sales contained information on price per pound for slipper lobsters over the entire 21 years of data and in one year, a single dealer bought all spiny lobsters, resulting in a $0.01 standard deviation for price per pound. This presents a false picture of the fishery. Nevertheless, Figure 12 and Table 6 provide regional and species-specific price data. Average values and annual standard deviation are found in Appendix V. The data show a seller's market on Kauai in the late 1980s, with a mean price over $15.00 a pound. A seller's market emerged on Maui in 1997, with both slipper and spiny lobsters price near $12.50 a pound. Price on all other island areas has been relatively steady at around $8.00 a pound.

Figure 12. Inflation-adjusted (2004) price per pound

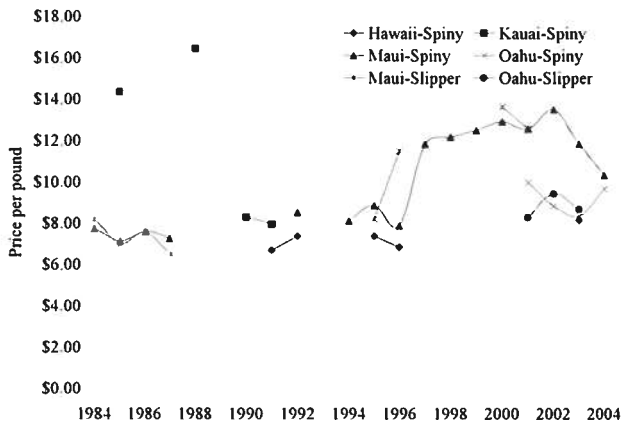


Table 6. Mean price per pound

Region	Price per Lb
Spiny Lobsters	
Hawaii	$7.28
Kauai	$11.75
Maui	$10.03
Oahu	$9.18
Slipper Lobsters	
Maui	$9.37
Oahu	$8.78

IV. Discussion

With the exception of a few individual fishermen, the MHI commercial lobster fishery appears to be a part-time or opportunistic fishery. This is reflected in the large number of participants, with over 500 people reporting catch over the 21-year period, and small total landings, with most licensees reporting fewer than 100 pounds for the entire time-series. Due to the size of the fishery, the catch and dealer data sets are relatively small, which proved to be problematic in many analyses. With regards to the status of the resource, the catch data set was more useful. With regards to the status of the fishery and the market, the dealer data set proved more useful. Total landings, value and participation were compared between the two data sets to determine how well each data set captured the amount of activity occurring. Revisions made by the DAR in the catch reporting form in 2002 no longer require fishers to report sales data, eliminated the possibility of cross-checking future landings and sales figures. New requirements in effort reporting and species identification, and improved communication between DAR staff and fishery participants should enhance future CPUE and mean weight analyses. Finally, due to the potential for commercial underreporting and because the size of the recreational fishery is unknown the available data sets do not capture all fishing activity. Therefore, total pressure on the resource cannot accurately be determined.

A. Status of the MHI lobster resource and limitations in its evaluation

The analysis of fishery data is the primary means of assessing the status of fisheries resources, as data are usually available in a reasonably consistent time-series format and are generated at a low cost relative to field studies or other assessment methods. The state of Hawaii, through the Department of Land and Natural Resource's Division of Aquatic Resources (DAR), requires that commercial fishers complete daily entries in monthly catch reports that include total pounds and numbers of lobster landed, and the level of effort in trip-days[2] by area fished, gear type employed and species caught. This provides the means of assessing trends in abundance and status of the resource, based on trends in pounds landed, catch per unit effort (CPUE), and mean weight. Monthly dealer reports require fish dealers to provide pounds and number of lobsters bought by

[2] As mentioned earlier, changes in reporting requirements in 2002 improved the detail for effort data.

species for each sale, providing comparative data for trends in mean weight. Analyses of these catch and dealer data sets from the MHI commercial lobster fishery were limited by rough estimates of effort and landed weight, imprecise species identification, and by the limited number of data points available for some of the island or gear-specific analyses. The data also appear heavily influenced by socio-economic factors that can obscure trends in the status of the resource. For example, a single highliner operating for a few weeks in one region could double the annual landings. In addition, changes in market demand in a region appeared to cause an increase in participation and subsequently landings. This demand influence may also have increased daily effort, which could not be determined solely through an analysis of the data. The absence of recreational harvest data, which has been estimate d to represent as much as 50% of the total catch (Morris 1968), confounds interpretation of the amount of pressure, total productivity, and a thorough assessment of the resource.

Total Landings

Over the 21-year time series, landings have been relatively stable with the exception of a three-year low from 1993-1995. On average, annual statewide landings have ranged between 7,000 – 12,000 pounds. The low period saw between 2,000 – 3,000 pounds landed annually. While fewer fishers were active during this period, the data alone do not provide an understanding as to why this dip occurred. Maui, with over 60% of the total landings, overwhelms trends on other islands when analyzing on a statewide basis. Oahu, as with the other regions, had relatively high landings through 1992 but has not reported increased landings since the three-year trough. Nearly 80% of Oahu's 29,609 pounds of commercial landings occurred before 1993. As will be discussed later, this may relate to the persistence of net fishing on Oahu, a low number of active fishers and the lack of a premium lobster market. Kauai, because it is a very small fishery (11,087 total pounds) appears to be primarily influence by pulse fishing of highliners. When no highliners are active in Kauai, the region lands less than 500 pounds annually. The islands of Hawaii and Maui display relatively consistent participation throughout the time-series, even though Hawaii's landings were one-third that of Maui.

As is discussed above, highliners have a dramatic influence on total pounds landed annually. Subsequently, trends in total landings may not to be a good indicator of the status of the

resource. Exit and entry patterns of the twenty profiled highliners were not consistent over the course of the study, and do not appear to be correlated to fluctuations in abundance, as seen in the average mean weight (see below). Without conducting individual interviews, it is not possible to determine the rationale of these exit and entry patterns.

Theoretically, catch and dealer reports[3] should produce the same statistics for total pounds sold, value of the fishery and number of active participants, providing a mechanism for cross-checking the level of reporting occurring in the commercial lobster fishery. This was not the case as island-wide totals of catch data were 50% greater for comparable indicators over the time-series, although these values became more similar during the last few years. Thus there is likely underreporting within both data sets. This idea, though difficult to prove, comes from managers who have been working for many years with the industry and are aware of reluctance from some fishers and dealers to report these transactions to the state (D. Hamm, pers. comm.).

Gear type preference

The three primary gear types, hand harvest, lobster traps and lobster nets, were not employed uniformly across regions or across the time-series. Nets caught approximately 10% of the total landings, and were employed most regularly on Oahu (23%). Nets were used just 10% on Maui and 5% on Hawaii and Kauai. Net use did not change temporally, with the exception that Oahu fishers were less active overall after 1993. For Maui, Oahu and Kauai, trap harvest was the preferred gear type from 1984 – 1992, and constituted 59% of the statewide landings during this period. After 1992, Maui fishers switched almost exclusively to hand harvest. With the lack of landings on Oahu and the small-scale and pulse fishery of Kauai, hand harvest represented 79% of the landings from 1993 – 2004. Increased landings on Maui toward the end of the data set increased this to 91% from 2001-2004. Throughout the time-series, Hawaii fishers preferred hand harvest, which constituted over 80% of their total landings.

The reason for this change in preferred gear may have been foreseen over thirty years ago. In his 1968 report, Morris attributed declines in trap CPUE to theft by divers, causing fishermen to

[3] Through 2002, prior to changes in the catch report form.

alter their fishing methods or drop out of the fishery. These actions were not attributed to any changes in the resource. In the report, Morris (1968) stated

> "It appears that commercial trap fishing along the leeward side will eventually disappear if divers continue stealing the catches and the traps. Fishing for lobsters on the leeward side will probably be done entirely by divers unless some method is developed that will permit deep water trapping and recovery, or laws enacted to protect trap fishermen from vandalism."

Catch per unit effort, mean weight and species composition

CPUE appears to be generally correlated with landings patterns, which may provide some insight into resource status. Unfortunately, gear preference varied so dramatically across the time-series, that this correlation is suspect. While all gear types appeared to experience their lowest catch rates at the same time the fishery landed a quarter of its annual average (1993-1995), gear preference changed during this time. Was the drop in trap CPUE due to a lack of effort, the retirement of a few skilled trap fishers, or as Morris suspects, the increase in hand harvest fishers. What is certain is that hand harvest CPUE, especially on Maui, increased dramatically from the time it became the preferred gear type. Hand CPUE increased an average of 20% each year from 1994-2002. Lobster net use is characterized by pulse fishing, which provides a very poor data set, causing huge variation in CPUE.

This fluctuation in CPUE could also be a result of both relatively low effort and high variation in gear design. Lobster nets account for an average of only 24 trips per year; four fold fewer entries than trap harvest and seven fold fewer than hand harvest. Morris (1968) noted that lobster net CPUE is directly proportional to the area of net deployed. A one hundred foot long piece of net will captured twice the number of lobsters that a fifty foot net of the same width. While this is logical, length of net will inevitably vary between fishers and possibly for a single fisher (e.g, part of the net is damaged and cut out) at any given time. Yet, this information was not required in catch reports until 2002. Unknown variation in effort must also occur with lobster trap harvest, where the number of traps hauled on a given day was also not included in the effort, and hand harvest, which can have high variability in both actual effort (time under water) and skill level.

All of these variables are captured in the new catch reports, which will allow for better accuracy in future analyses. While fishers are required by the DAR to report days fished when no lobsters were caught, there were none of these entries in the data set. In addition, highliner CPUE is generally much greater than CPUE for the occasional fisherman, who may be catching lobsters incidentally to other activities. Without comprehensive interviews with a number of highliners and occasional fishermen, these data have limitations in determining the status of the resource. For this reason, Morris (1968) analyzed only individual highliner CPUE (with associated interviews) to provide insight into the status of the resource.

Because of the complications with correlating abundance with either total landings or CPUE (as described above), mean weight is the final available indicator from the available data that may offer some insight into the status of the resource. Overall, the mean weight of spiny lobster from the catch was relatively stable at 2.0-2.5 pounds per lobster, with a gradual increase in mean weight on Oahu (10% in ten years) and decrease in mean weight on Maui (12% in ten years) over the second half of the time series. Slipper lobster mean weight fluctuated between 1.5 and 2.0 pounds over the 21 years with no noticeable trend in size. This stable trend in mean weight over the 21-year period suggests that the resource may be adapted to the existing pressure. Still, the slight drop in size on Maui and increase in size on Oahu has occurred concurrently with an increase and decrease in effort on those islands, respectively.

However, the capacity of this indicator to shed light on the status of the resource is limited for the following reasons. First, because DAR requires that both fishers and dealers give only estimates of in mean weight of an entire lot, variations in lobster size are immediately lost in the data, especially with large catches. This, in conjunction with an overall small data set, allows only for analysis of variation in mean weight from year to year. Analysis of size structure, in which the frequency of individual sizes occurred, would provide much greater insight into the status of the resource. Second, due to the small data set, this analysis could not be completed by gear type and species for every island, a problem due to differences in gear size selectivity. Dealer data shows greater fluctuation (due to a much smaller data set available), but an overall larger size for spiny lobsters. This may be a product of fishers retaining smaller lobsters for home consumption (fishers report retaining 20% of their catch), because they will get more

money for the larger ones. Nevertheless, a study should be conducted that will provide better mean weight data, as the value of this information remains limited.

Most of the available data do not differentiate lobsters by species. Prior to 1990, dealers only reported purchasing "lobsters," after which they differentiated between spiny and slipper lobsters. In 2002, reporting again improved to differentiate green and red spiny lobsters. Thus, data prior to 1990 do not allow for even basic understanding of the species composition by island. The data from 2002 does indicate strong differences in species composition by island, with Maui and Kauai reporting primarily green spiny lobsters, and Oahu and Hawaii reporting primarily red spiny lobsters. Green spiny lobsters are known to inhabit shallower waters than the red spiny lobsters, and trends in catch by gear type were observed, with trap fishers generally reported red spiny lobsters, and hand harvest fishers reporting green spiny lobsters, although this conclusion was based on limited reporting. This report was not able to definitively conclude as to why each region exhibited a dominance of one species in the landings.

B. Status of the MHI commercial lobster fishery

Although not useful for resource assessment, dealer data set was much better suited to provide insight into the status of the fishery. As was the case with the fishery in the 1950s and 1960s, a few fishers dominate the commercial landings. While 80% of the fishery occurred on Oahu in the first study (Morris 1968), likely due to consumer demand and availability of small boat ramps (traps were the preferred gear), 61% of the fishery occurred on Maui in this study, with hand harvest the dominant harvest method. Year-round calm waters on Maui's South and West coasts and a new consumer demand fueled by the high-priced restaurant market are probably the driving factors in today's fishery.

The fishery experienced a dip in catch and effort in the early 1990s, possibly due to disruptions in people's lives and ecological impacts caused by Hurricane Iniki in September 1992. This coincided with a rapid change in preferred gear type (trap to hand harvest) which still exists in 2004. The data cannot explain if or how these two factors are related. Because landings are well correlated to highliner entry-exit patterns, fewer active highliners during these years may have

contributed to the depressed level of landings. While in most years six to nine highliners were active, fewer than six were active between 1993-1995. Whether highliners chose not to fish because the catch was down, or for some other reason, cannot be known from the catch and dealer reports alone.

By the end of 2004, it appears that the commercial lobster fisheries on Kauai and Oahu have been reduced to negligible catch and effort. Kauai fishers reported an average of 53 pounds per year from 2000-2004, while Oahu fishers reported 435 pounds per year in the same period. The possible reasons for this sustained inactivity in the commercial fishery are numerous, including a strong economy altering fishers' motives from the need for additional income into personal consumption, the lack of a market and/or low price on Kauai and Oahu, or a lack of highliners operating from these islands. Conversely, the fishery on Hawaii has remained consistent while landings on Maui tripled from 1995-2002. The number of highliners operating on Maui has remained between five and seven per year since 1996, which is a higher number of active highliners than at any time previously. This sustained high effort is almost certainly due to the high price offered and high volume bought in recent years. The sustained lower level of landings seen on Hawaii may be because this region has a relatively high number of consistently active fishers for the amount of pounds landed and no dominant buyer affecting the market.

As seen in the Morris' study, the market is the driving force in the total landings reported in the MHI lobster fishery. Kauai experienced higher catch and participation rates when the price for lobsters increased to $15.00 a pound, in order to supply the restaurant market. When this market disappeared in 1987, the commercial fishery became sporadic and operated at very low levels. The onset of an emerging restaurant-driven market on Maui in 1996 has increased the mean price by $2.50-5.00 over that on the other islands. In addition, without the influence of this market, landings could be at historic lows both on Maui and statewide.

Almost all of the licensees sell only a few lobsters, generating no more than a few hundred dollars in a given year. A few fishers have earned $20,000 - $30,000 in a single year, but these fishers have only remained in the fishery for one to three years. The average highliner was active

for about six years, reporting $5,000 - $10,000 a year in income from lobster sales. This indicates that most participants in this fishery are part-time.

C. Status of the market

Most of the lobsters (72%) were bought on Maui. Kauai buyers bought 11% of the lobsters, 80% of which were bought between 1987 and 1991. Oahu and Hawaii dealers bought 10% and 7%, respectively. Sales are more skewed in recent years, with Maui dealers responsible for 87% since 2002. The market is dominated by a few buyers. Of the 100,085 pounds of reported sales from dealer data, 76% came from 10 buyers. The amount of the regional market each of these buyers captured ranged from 32% to 91%. For those dominant dealers that were not active throughout the time-series, their entry and exit caused very large changes in participation and total landings from that region. Hotels and restaurants have dominated the Kauai and Maui markets, while seafood stores and grocery chains have dominated the Oahu and Hawaii markets.

D. Reporting improvements over time

While accuracy and completeness of catch and dealer reports are ultimately a function of the individual, with some participants always doing a thorough job and others always doing the minimum, data quality did appear to improve over time, with substantial improvements in dealer report completeness beginning in 1996 and fisher report completeness improving in 2002. Dealers only sporadically reported the number of pieces prior to 1996 and had a lower rate of compliance in reporting the sale price (i.e., value). By 2000, reporting of these data was near 100%. Dealers provided better species descriptions (i.e., green and red spiny lobsters) in 2003, while fishers began differentiating the species in their catch reports in 2002. This is likely the result of education and outreach by DAR with fishermen and dealers in recent years. In addition, as was discussed previously, correlation between dealer and catch reports became much closer starting in 1996. In addition to these increases in accuracy and thoroughness in reporting, DAR instituted changes to the catch report form, which will hopefully result in improvements in determining effort level for all gear types. This will hopefully clarify many of the concerns addressed in this study in future analyses.

V. Recommendations

The primary conclusion of this study is that the commercial lobster fishery is small, thus making the data set small. If the trips were spread out evenly throughout the time-series, analyses would be based on an average of less than one trip per day for the entire state. Of these, one trip per week would report catching only one or two lobsters. Data that were available to review for this study are insufficient to be used for assessment of the fishery status. The following recommendations utilize the subsets of greatest activity (e.g., highliners account for 52% of the total landings; Maui accounts for 60% of the total landings; hand harvest accounts for 90% of the recent landings), and are intended to provide a basis for data improvement which will eventually make possible better insight into the status of the resource.

1. Twenty licensees caught 52% of the entire catch. This small set of fishers had an overwhelming impact on all analyses conducted in this study. A series of interviews should be conducted with these twenty highliners to obtain more detailed information, not requested on the original catch report forms, that could provide further insight into the changes in the fishery discussed in this report. Data analyses of individual fishers have already been conducted under this contract and should be employed during the interview to better understand catch methods and improve estimates of CPUE. Additionally, an attempt to include fishers operating in the 1980s, when trap fishing was the preferred method, may gain insight as to why the fishery changed suddenly.

2. In the last five years of this study (2000-2004), Maui fishers accounted for 85% of the total landings. In this time, there have been large increases in total active fishers, effort per fisher, and price per pound on the island of Maui. Interviews should be conducted of both fishers and buyers on Maui to better understand the economic forces impacting this fishery. It is also possible that some recreational fishers switched to selling their catch when prices increased on Maui. This hypothesis, which could provide insight into the recreational fishery, should be pursued with Maui fishers who entered the fishery after 1996. In addition, due to the rapid increase in fishing pressure on Maui, this sector of the fishery and its associated market data should be closely monitored.

3. Because the fishery has switched primarily to the highly variable method of hand harvest in 1994, and data prior to 2002 recorded effort in trip-days instead of hours, CPUE results for this method are dubious. In addition, fishers are now required to report effort in hours. Because of these two issues, a wide range of fishers who employ hand harvest methods should be interviewed to derive a formula to estimate historical man hours per day and allow for comparisons with current and future data.

4. While Morris (1968) and McInnis (1972) estimated the size of the recreational lobster catch to be approximately equal to that of the commercial catch, there are no records as to how this determination was made. The DAR should evaluate mechanisms available for obtaining additional information about catch and effort for the non-commercial sector of this fishery. As a beginning, interviews with a variety of individuals identified from the commercial sector could be considered.

5. Because mean weight, as an indicator of the status of the resource, is less dependent on effort, market influences, and the impact of incomplete reporting, it may be the most reliable measure of the health of the stocks. For this reason, DAR should make an effort to obtain more complete mean weight data, by making sure fishers report weight and numbers accurately and keep track of population size structure. To be most useful, this would need to be a long term commitment.

6. Given the new fishing report forms implemented in 2002, a study should be conducted in seven years with data from 2002-2012, to determine whether the new requirements generate data that are accurate and complete enough to provide insight into the status of the resource.

VI. References

A thorough search of the literature for information relevant to Hawaiian Island lobsters and the MHI lobster fishery turned up eight government reports, four student theses or dissertations from the University of Hawaii, one book, three presented papers, and five journal articles for a total of twenty one publications.

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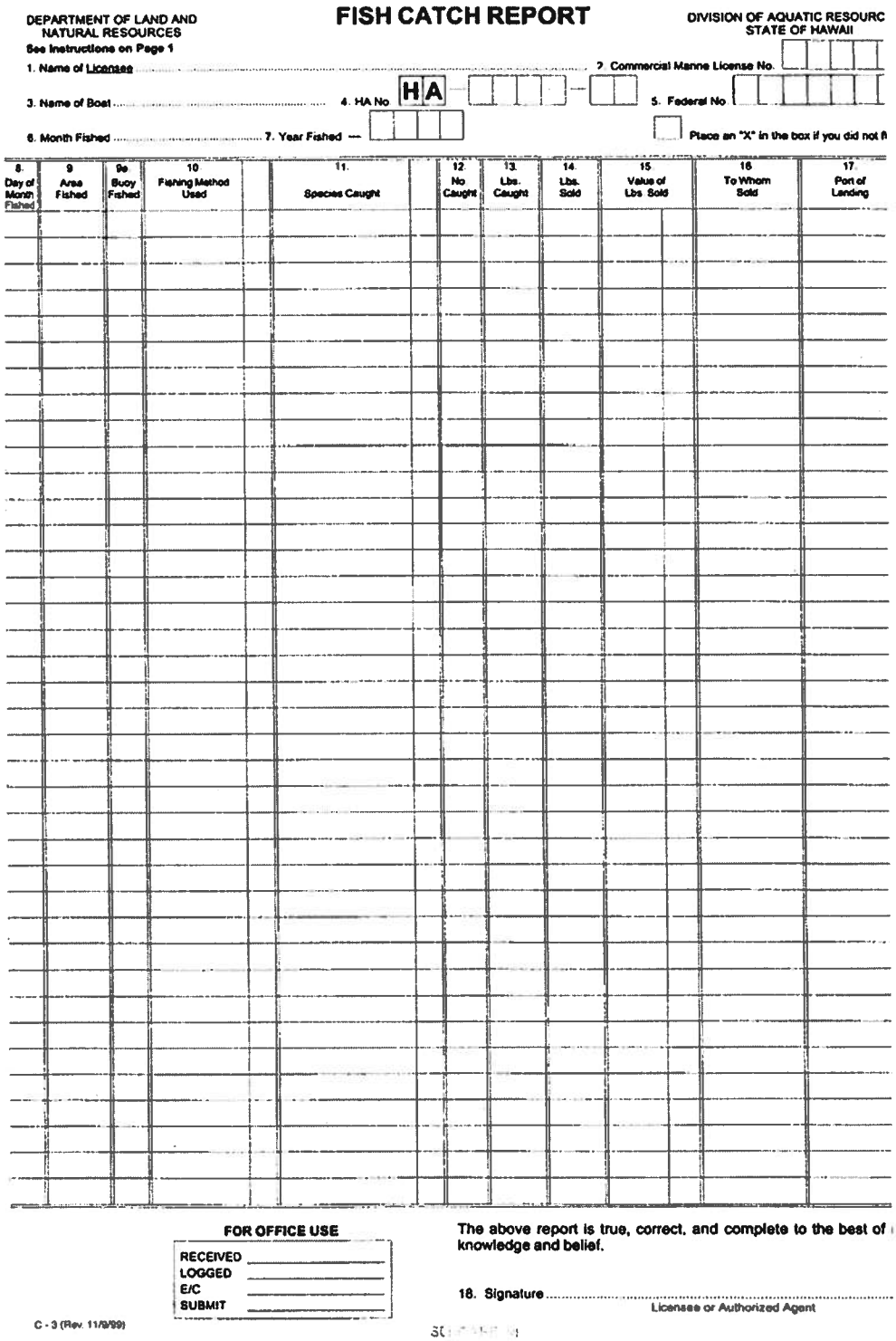
Appendix I

Division of Aquatic Resources Fishing and Dealer Report Forms



DEPARTMENT OF LAND AND NATURAL RESOURCES

FISH CATCH REPORT

DIVISION OF AQUATIC RESOURC
STATE OF HAWAII

See Instructions on Page 1

1. Name of Licensee

2. Commercial Marine License No.

3. Name of Boat

4. HA No HA

5. Federal No

6. Month Fished

7. Year Fished —

Place an "X" in the box if you did not fi

8. Day of Month Fished	9 Area Fished	9a Buoy Fished	10 Fishing Method Used	11. Species Caught	12. No Caught	13. Lbs. Caught	14. Lbs. Sold	15 Value of Lbs Sold	16 To Whom Sold	17. Port of Landing

FOR OFFICE USE

RECEIVED

LOGGED

E/C

SUBMIT

The above report is true, correct, and complete to the best of knowledge and belief.

18. Signature

Licensee or Authorized Agent

C - 3 (Rev. 11/9/99)

(Please Print)

Fishing Report

FOR OFFICE USE	
U/S	
K/D	

Licensee Name ______________________ Commercial Marine License No. [ ][ ][ ][ ][ ]

Vessel Name ______________________ HA No. [ ][ ][ ][ ] - [ ][ ] USCG No. [ ][ ][ ][ ][ ][ ][ ]

Month & Year Fished ______________________ [2][0][ ][ ]
Month Year

FISHING EFFORT									SPECIES	CATCH		L/R	
Day Fished	Charter Trips "X"	Buoy or Area Fished	Specific Fishing Method (See Methods List)	Hours Fished Per Method/ Area	Number of Net Sets	Number of Fishing Lines, Traps or Net Length in Feet	No Catch "X"	Port of Landing	Specific Species Name (See Species List)	Number Landed	Pounds Landed	Number of Lost and Released Fish L = Lost R = Released	
												L	R

Number Lost to Predators: SHARKS ________ UNKNOWN ________ OTHER ______________________ / ________
Number Number Predator Name Number

Comments to DAR: ______________________

Division of Aquatic Resources, Department of Land and Natural Resources, State of Hawaii

FR REV 6/2003

Page ______ of ______

SEND THIS COPY

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES

COMMERCIAL MARINE DEALER'S REPORT ON PURCHASES OF MARINE LIFE

1. Fish Dealer ______________________ 3. Phone ______________ 4. Page No. _____ of _____ pages

2. Business Address ______________________ 5. Month ______________________ 6. Year ______

____

______________________ 7. ☐ Place an "X" in the box if you did not purchase any marine life.

8. DAY	9. FROM WHOM BOUGHT	10. COMMERCIAL MARINE LIC. NO	11. SPECIES	12. LBS BOUGHT	13. NO. BOUGHT	14. AMOUNT PAID

The above report is true, correct, and complete to the best of my knowledge and belief.

15. Date ______________ 16. Signature ______________________
COMMERCIAL MARINE DEALER OR AUTHORIZED AGENT

NOTE: The law requires this report to be filed on or before the tenth day following the report month.

Mail Yellow Copy to: DIVISION OF AQUATIC RESOURCES

SEND THIS COPY

FOR OFFICE USE
LOGGED ______
EDITED ______
CODED ______
SUBMIT ______

(Please Print)

Commercial Marine Licensee Retail Sales Report

FOR OFFICE USE
R/L _____
K/D _____

Licensee Name _____ Commercial Marine License No. | | | | | |

Month and Year of Sales _____ (Month) 20 | | (Year)

Day Sold	Species Name	Condition Sold (See Instructions)	Number Sold	Pounds Sold	Value of Pounds Sold	

CMLRSR 8/2002 Division of Aquatic Resources, Department of Land and Natural Resources, State of Hawaii

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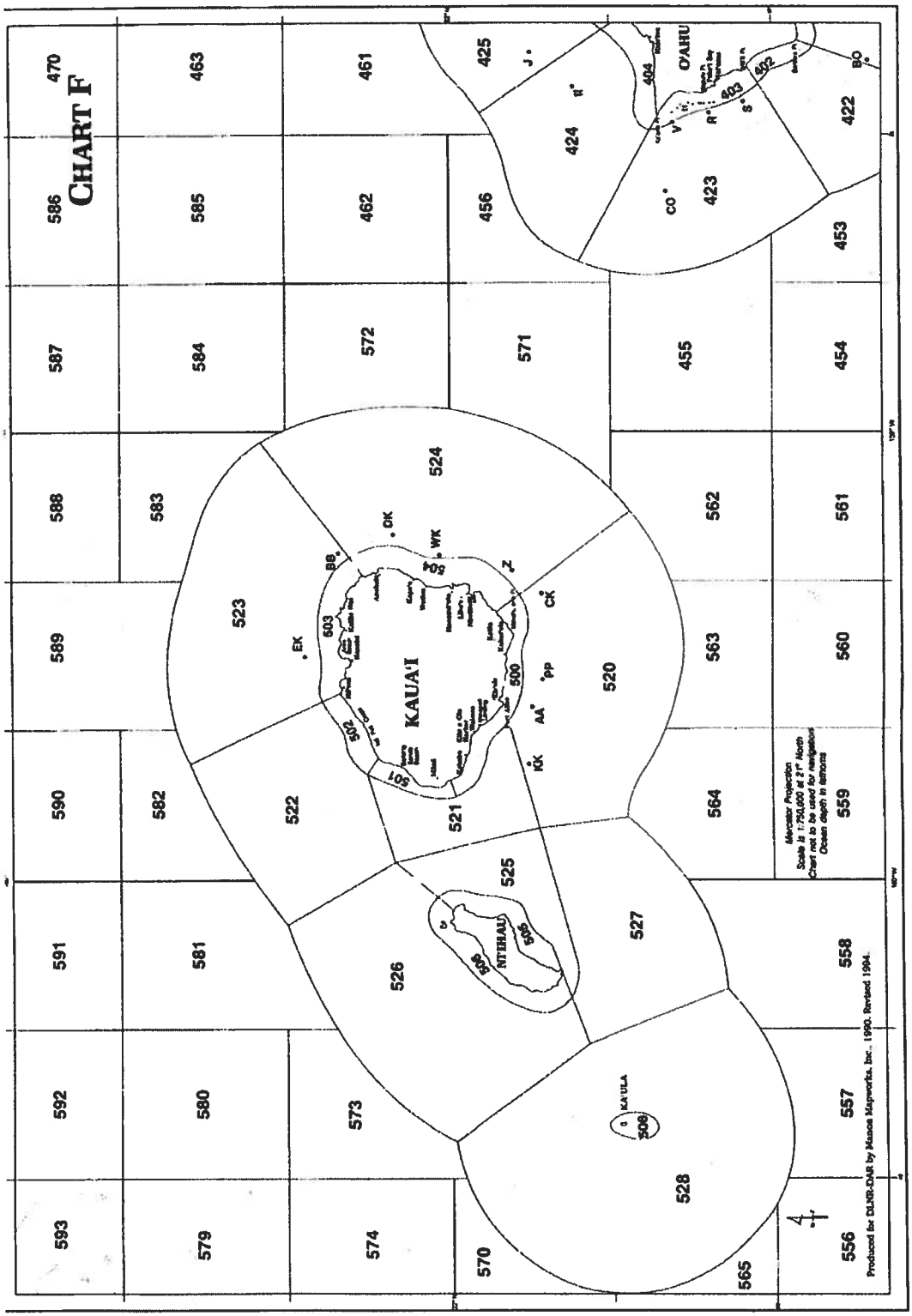
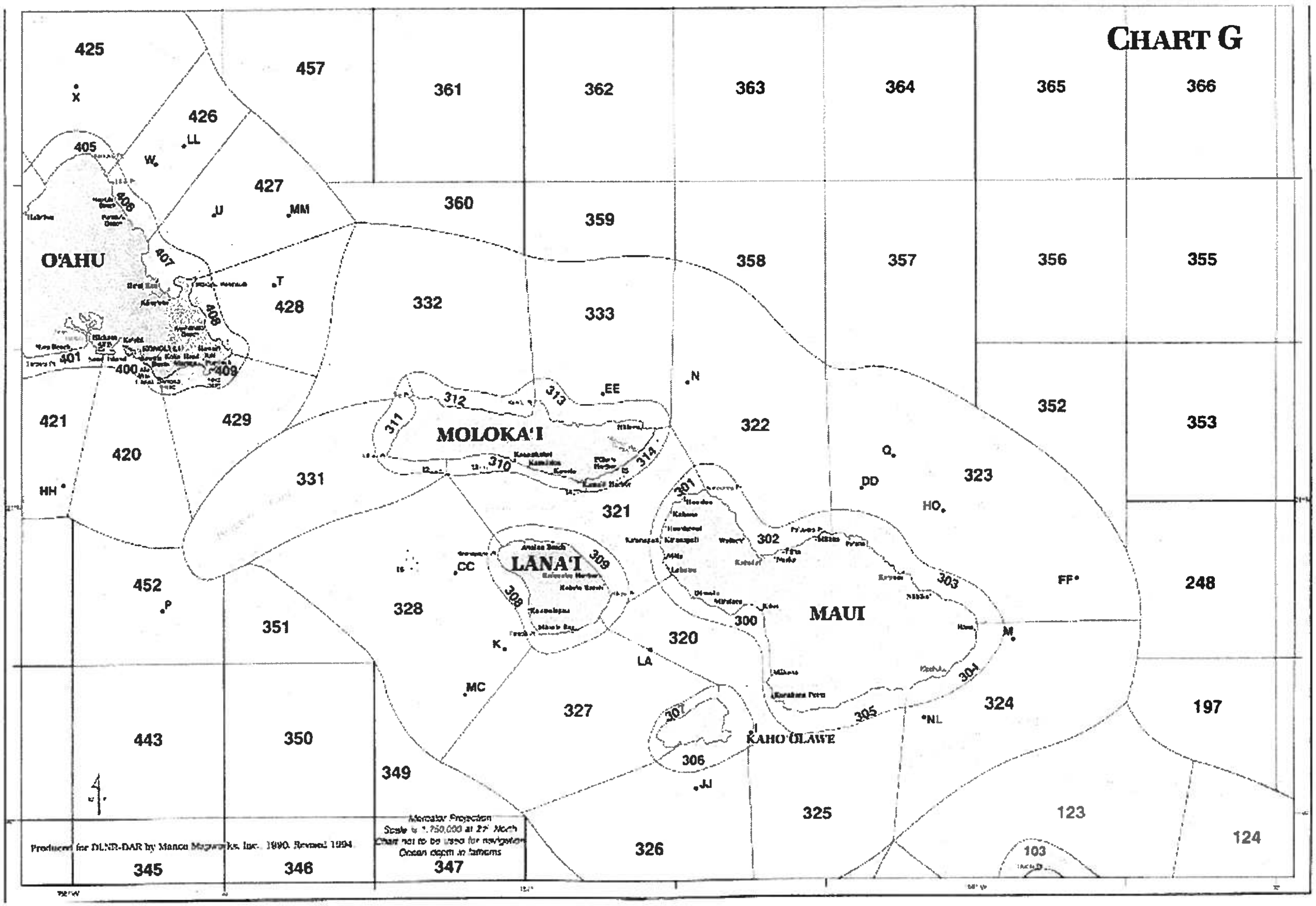
Appendix II

State of Hawaii Statistical Charts

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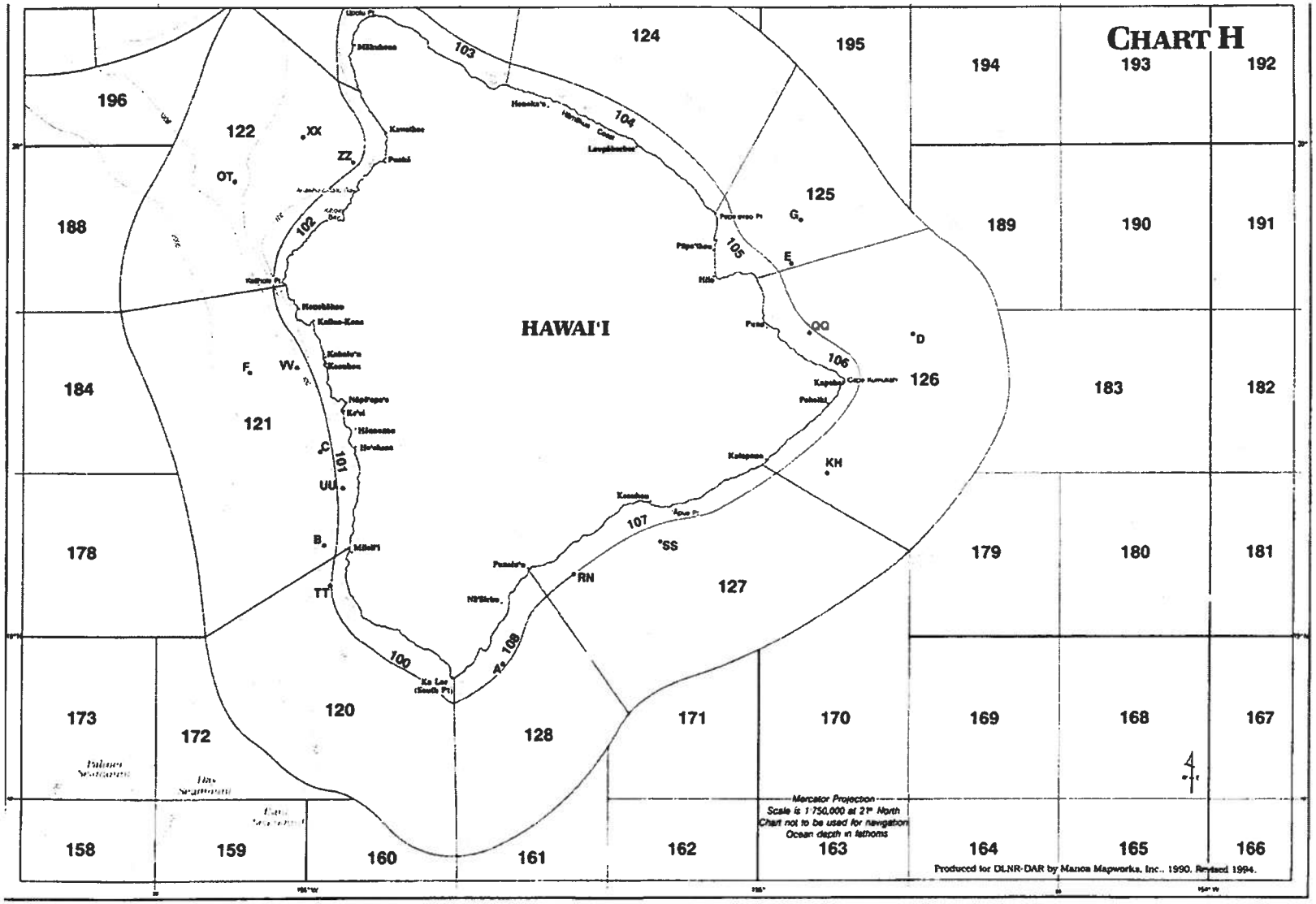
Mercator Projection
Scale is 1:750,000 at 21° North
Chart not to be used for navigation
Ocean depth in fathoms
Produced for DLNR-DAR by Manoa Mapworks, Inc., 1990, Revised 1994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Mercator Projection
Scale is 1:750,000 at 21° North
Chart not to be used for navigation
Ocean depth in fathoms
Produced for DLNR-DAR by Manoa Mapworks, Inc., 1990. Revised 1994.

Appendix III

Summary of Catch and Dealer Data Reporting Quality

Prior to conducting catch and dealer data analyses, quality control was performed on each data set. This aided in organization of the data, determination of the amount of available data for each analysis and comparison of the level of completeness between the two sets.

As described in the methods section, the data fields from the report forms used in these analyses are;

Catch Data

- Day fished
- Area fished (sorted by region)
- Gear type
- Species caught
- Number caught
- Pounds caught
- Pounds sold
- Value (Value of pounds sold)

Dealer Data

- Day of sale
- Species
- Pounds bought
- Number bought
- (Value) Amount paid

These data field titles can be seen on the report forms found in Appendix I and definitions of these can be found in the glossary in Appendix VI.

1. Data Completeness –Catch Data

Although the DAR has required since 1989 that fishers provide effort information for days with no fish caught ("skunk trips"), there were no zero catch entries in the data set. The number of unreported "skunk trips" would have a direct effect on total effort, and subsequently, average CPUE.

The following section breaks down the data completeness per entry for the whole data set and by island region.

Area fished
Of 6,656 entries, 6,633 (99.7%) had realistic entries for area fished. Twelve entries did not report area fished, and were removed from the data set. This accounted for 876 pounds of lobster. Eleven entries reported area 99999, which does not exist. This accounted for 10,136 pounds of lobster. It was assumed that these entries were from NWHI lobster permittees, and were also removed from the list.

Gear type

On the catch forms, gear type is listed as "fishing method used." Eighteen categories of gear were reported within the data set (see Appendix V for full breakdown). Within these categories is "other." 96 entries (1.5%) were reported as other. Entering other in this field did not eliminate it from any analyses.

Species caught

Fishermen were not requested to differentiate between green and red spiny lobsters until October 2002. Reports prior to 2002 differentiate only between "spiny lobster" (5546 entries), "slipper lobster" (723 entries), and ridgeback "*haanii*" (14 entries). In 2003, there was 77.3% compliance with reporting exact species (i.e., green or red spiny lobster vs. spiny lobster). Compliance improved to 100% in 2004.

Table 1. Accuracy in reporting species composition

1984-2002			2003-2004		
Species	Pounds	Percent	Species	Pounds	Percent
Green Spiny	0	0.00%	Green Spiny	8,477	65.07%
Red Spiny	0	0.00%	Red Spiny	2,845	21.84%
Ridgeback	0	0.00%	Ridgeback	44	0.34%
Slipper	17,885	10.38%	Slipper	32	0.25%
Spiny	154,350	89.62%	Spiny	1,630	12.51%
Total	172,235		Total	13,028	

Number caught

Throughout the islands, 80% of the entries included number caught. Number caught is most important for mean weight data analyses. As can be seen in the table, this impacted analyses on Oahu most. The Kauai data set was already too small for regional mean weight analysis.

Table 2. Completeness – number caught

	Reports with data	Total reports	Percent complete
Hawaii	1,041	1,237	84.2%
Maui	3,077	3,429	89.7%
Oahu	897	1,572	57.1%
Kauai	294	395	74.4%
All Islands	5,309	6,633	80.0%

Pounds caught
The highest compliance rate in catch reports was for pounds caught, except for an anomaly with the ridgeback slipper lobster *S. haanii*. Of fourteen total entries, seven (50%) did not include pounds landed. This accounted for seven of the eight entries for which pounds landed was not recorded.

Table 3. Completeness – pounds caught

	Reports with data	Total reports	Percent complete
Hawaii	1,237	1,237	100%
Maui	3,429	3,429	100%
Oahu	1,564	1,572	99.5%
Kauai	395	395	100%
All Islands	6,625	6,633	99.9%

Pounds sold
Determining data completeness for pounds sold is not possible, as a blank column may mean that catch was not sold. Based on this assumption, 34,829 of 185,263 pounds caught (18.8 %) were not sold. After 2002, new reporting requirements did not require sales data on catch reports. These two years account for one-third of the unsold catch.

Table 4. Percent of catch not reported sold

	Reports with data	Total reports	Percent reported	Pounds not sold
Hawaii	914	1,237	73.9%	7158
Maui	2,506	3,429	73.1%	20743
Oahu	1,311	1,572	83.4%	5419
Kauai	280	395	70.9%	1509
All Islands	5,011	6,633	75.5%	34829

Value
Values were reported for all records in which "pounds sold" data were reported. This implies 100% compliance, as long as the amount of "pounds sold" is accurate.

2. Data Completeness – Dealer Data

Species
Reporting of species purchased improved over the period of time covered by this data set. From 1984 – 2004, the proportion of dealers reporting only "lobster" in a given year (without clarification) ranged from 0% to 100%. Of the 3740 entries, 1668 reported "lobster" in the species name column. However, only 271 of these entries occurred after 1990. Only two "lobster" entries occurred after 2000.

Pounds bought

Pounds bought was near 100% complete with only 28 entries from the data set not including pounds bought.

	Reports with data	Total reports	Percent complete
Hawaii	296	297	99.7%
Maui	1,959	1,983	98.8%
Oahu	812	815	99.6%
Kauai	521	521	100%
All Islands	3,588	3,616	99.2%

Number bought

Throughout the islands, only 41% of the entries included number caught. Number caught is most important for mean weight analyses. As can be seen in this table, and is reflected in the main report, mean weight from dealer data could only be determined for the island of Maui. Subsets of data for the other regions were too small to permit analysis.

Table 5. Completeness – number bought

	Reports with data	Total reports	Percent complete
Hawaii	155	297	52.2%
Maui	1,086	1,983	54.8%
Oahu	197	815	24.2%
Kauai	47	521	9.0%
All Islands	1,485	3,740	41.1%

Value

On the dealer forms, value is listed as "amount paid." Value is important for average price analysis and total value of the fishery. Oahu dealers had very poor completion of value data, causing the data set to be too small for average price analysis. Data sets from Kauai and Hawaii were already too small for dealer data average price analysis.

Table 6. Completeness - value

	Reports with data	Total reports	Percent complete
Hawaii	230	297	77.4%
Maui	1,898	1,983	95.7%
Oahu	236	815	29.0%
Kauai	516	521	99.0%
All Islands	2,880	3,616	79.6%

3. Accuracy

Mean weight is not reported directly by the fisher, but is calculated from the pounds caught and number caught fields. Some licensees estimate the total pounds, while others appear to obtain the information from dealers at time of sale. While we were unable to truly know how accurately fishermen estimated the weight of their catch, all entries were estimated to whole pounds. Thus, weight estimates for smaller catches (i.e., one to two lobsters) may have been as much as 25 to 50 % off. A catch of 1-2 lobsters was typical for the majority of fishermen. Therefore, this affected the data significantly. Of 6,633 records, 2,588 (40%) reported catching three or fewer lobsters. In addition, as seen in Table 8, it was apparent that some fishers did not accurately record the number of lobsters caught.

Table 7. Quality control – mean weight (catch data)

	Low mean weight	High mean weight
Hawaii	0.33	14.0
Maui	0.27	25.0
Oahu	0.17	30.5
Kauai	0.50	16.0

The majority of buyers and all fishers also rounded the weight of lobster purchased to the nearest pound. While some buyers purchase substantial quantities from individuals, most purchase small quantities on a regular basis. This causes similar inaccuracies to those described for the catch report data. Nevertheless, because dealers are likely more concerned with exact weight as this indicates how much they must pay the fisher, mean weight values should be more accurate from dealer data. Unfortunately, as was discussed above in the dealer completeness section, dealers were less concerned with recording the number of lobsters bought, making this data set very small (1,485 points for all islands and all species across the time-series). This equates to an average of less than 10 data points each year from the islands of Hawaii, Oahu and Kauai. Subsequently, only Maui dealer data was used for mean weight analysis.

Average Price

Average price is provided in dollars per pound, and is obtained from the value and pounds sold fields. Table 8 shows the range of price obtained on each island and the average price over the 20-year period.

Table 8. Quality control – price* (catch data)

	Low price	High price	Average
Hawaii	$ 0.40	$14.87	$5.90
Maui	$ 0.60	$16.60	$8.41
Oahu	$ 0.40	$20.00	$6.28
Kauai	$ 1.22	$14.12	$6.54

*Data is not inflation-adjusted

4. Potential for double counting sales

The DLNR has a mandatory reporting requirement for any primary business that purchases locally caught seafood directly from licensed commercial fishermen for resale purposes to submit monthly dealer reports. Secondary businesses that purchase seafood from primary dealers are not required to submit dealer reports. Dealer reports that include purchases from other dealers caused difficulty during analysis, creating the possibility of double counting harvested lobsters. There were thirteen individuals who acted as dealers and were also listed as fishers to other dealers. Over 13,000 pounds of lobster sales were associated with these people. In one instance, a dealer reported three sales for 572 pounds, apparently bought from himself. These three sales were the largest individual sales of lobster, averaging 190.7 pounds per sale. These are not insignificant numbers, constituting 13.5% of reported sales. Nevertheless, it is not possible to determine if any of these reports are due to reselling lobsters or if the business acted as both a buyer and a fisher during the course of operations.

Appendix IV
Confidentiality Matrix

The following four tables illustrate the difficulty in analyzing catch data in a multi-tiered format. The number of data points (e) and fishers (f) reporting are listed for each tier (e.g., all hand harvest data for the Island of Hawaii by year). Analyses with fewer than three fishers are considered confidential and are highlighted. The number of data points available for each analysis provides an indication of the quality of the result. If a majority of the years are highlighted for a given tier, analyses could not be conducted.

Table 1. Island of Hawaii

	Gear					
Year	Hand (1)	Trap (2)	Net (3)	Fish trap (4)	Gill net (5)	All
1984						OK
1985	6e, 4f	6e, 3f	7e, 4f			OK
1986	19e, 7f	33e, 3f				OK
1987	56e, 15f		10e, 3f			OK
1988	58e, 12f		5e, 3f			OK
1989	34e, 9f					OK
1990	83e, 18f	26e, 3f				OK
1991	87e, 16f	0e, 0f				OK
1992	44e, 12f	11e, 3f				OK
1993	41e, 9f	4e, 2f				OK
1994	16e, 6f					OK
1995	54e, 11f					OK
1996	102e, 21f					OK
1997	53e, 14f					OK
1998	101e, 13f					OK
1999	58e, 10f					OK
2000	50e, 11f					OK
2001	25e, 10f					OK
2002	20e, 5f					OK
2003	21e, 8f					OK
2004	90e, 9f					OK
All	1020e,124f	108e,21f	49e,16f		16e, 7f	1237e

	Gear					
Month	Hand (1)	Trap (2)	Net (3)	Fish trap (4)	Gill net (5)	All
September	164e, 56f	5e, 4f	4e, 4f			OK
October	145e, 44f	10e, 4f				OK
November	122e, 36f	9e, 3f	5e, 3f			OK
December	126e, 41f	23e, 4f	8e, 3f,			OK
January	123e, 40f	18e, 4e				OK
February	99e, 27f	6e, 4f	11e, 4f			OK
March	97e, 34f	13e, 4f	5e, 3f		7e, 6f	OK
April	110e, 33f	8e, 4f	8e, 6f			OK
May	31e, 17f	16e, 4f				OK
All	1020e, 124f	108e, 21f	49e, 16f		16e, 7f	1237e

*Shaded boxes with no values indicates confidential information

Table 2. Island of Maui

	Gear					
Year	Hand (1)	Trap (2)	Net (3)	Fish trap (4)	Gill net (5)	All
1984		150e, 5f	9e, 5f			162
1985		354e, 13f	26e, 3f		3e, 3f	420
1986	66e,10f	149e, 10f	16e, 12f			238
1987	91e, 14f	136e, 8f	19e, 4f		3e, 3f	262
1988	114e, 12f	113e, 5f	11e, 7f		7e, 3f	245
1989	85e, 9f	18e, 8f	13e, 5f			116
1990	46e, 13f	14e, 6f	21e, 9f			81
1991	65e, 15f	19e, 3f	10e, 7f			95
1992	68e, 12f	51e, 4f	6e, 4f			125
1993	36e, 9f					39
1994	27e, 10f					40
1995	64e, 8f		10e, 3f			91
1996	160e, 17f		9e, 3f			177
1997	118e, 15f	22e, 3f	6e, 4f			146
1998	173e, 22f		39e, 3f			219
1999	126e, 26f					134
2000	212e, 26f					229
2001	166e, 27f		10e, 3f			178
2002	161e, 25f					172
2003	130e, 19f		8e, 3f		9e, 3f	147
2004	110e, 14f					113
All	2019e,	1057e,	245e,		38e,	3429

	Gear					
Month	Hand (1)	Trap (2)	Net (3)	Fish trap (4)	Gill net (5)	All
September	416e, 81f	129e, 15f	110e, 30f		11e, 6f	
October	255e, 57f	117e, 15f	50e, 13f			
November	191e, 35f	122e, 20f	8e, 6f			
December	198e, 41f	100e, 14f	9e, 6f			
January	208e, 29f	163e, 19f	6e, 5f			
February	164e, 40f	106e, 12f	15e, 8f			
March	235e, 45f	111e, 14f	13e, 8f			
April	191e, 44f	130e, 13f	19e, 9f		7e, 4f	
May	57e, 14f	78e, 7f	15e, 10f		4e, 4f	
All	2019e,	1057e,	246e,			

*Shaded boxes with no values indicates confidential information

Table 3. Island of Oahu

	Gear						
Year	Hand	Trap	Net	Fish trap	Gill net	All	Other
1984		93/10	7/3			113/16	0/0
1985	9/3	124/7	19/4			223/17	5/4
1986	15/4	66/8	9/4			141/16	33/2
1987	47/6	27/5	6/4			95/18	2/1
1988	27/5	34/5				68/11	1/1
1989	15/4	81/7				99/13	0/0
1990	14/3	52/7				72/12	0/0
1991	31/8	30/6	14/4			76/18	0/0
1992	37/8	54/7	14/7			108/23	0/0
1993	7/4	24/5	20/5			53/14	2/2
1994	20/5	19/3	15/6			54/14	0/0
1995	20/6		6/3			52/11	0/0
1996	15/9		10/4	30/4		57/16	0/0
1997	6/5		19/6			40/12	0/0
1998	4/3		13/4	26/5		51/10	0/0
1999		13/3	11/7	27/5		78/14	20/1
2000	15/10		4/3	38/4		59/17	0/0
2001	6/4			38/4		55/9	4/1
2002	12/4			34/3		51/8	1/1
2003				13/4		18/7	1/1
2004							1/1
All						1571/132	

	Gear						
Month	Hand	Trap	Net	Fish trap	Gill net	All	Other
September	58/18	57/9	50/17	33/7		214/48	14/2
October	31/16	101/14	28/13	39/6		204/45	4/3
November	20/12	73/12	15/5	32/5		144/30	2/1
December	25/16	60/14	24/8	21/3		144/40	13/4
January	26/15	106/16	9/8	22/5		174/42	10/4
February	45/18	95/14	11/3	37/5		206/39	14/3
March	26/14	81/11	15/6	37/5	4/4	176/38	13/6
April	51/15	56/13	15/9	37/4	5/3	165/41	1/1
May	27/9	81/14	12/7			133/32	5/3
All	309	710	179	262	24	1572/132	

*Shaded boxes with no values indicates confidential information

Table 4. Island of Kauai

	Gear					
Year	Hand (1)	Trap (2)	Net (3)	Fish trap (4)	Gill net (5)	All
1984						11/3
1985	3/3					21/5
1986	21/4	9/3	7/3			37/8
1987						74/5
1988						25/4
1989						19/6
1990						15/4
1991						14/5
1992						
1993						
1994	7/3					7/3
1995	11/3					15/4
1996	34/7					52/9
1997	37/6					52/8
1998						23/3
1999						
2000						
2001						
2002	9/4					9/4
2003						
2004						
All	167/26	151/11	32/11			395/45

	Gear					
Month	Hand (1)	Trap (2)	Net (3)	Fish trap (4)	Gill net (5)	All
September	38/11	19/4				71/17
October	13/8	20/4	4/3			41/13
November		25/3				36/6
December	21/8	20/5	7/4			54/17
January	20/7	9/3	8/3			43/13
February	14/7	12/3				29/11
March	18/7	10/4	4/3			29/14
April	23/8	16/4				49/11
May	12/4	20/4				34/8
All	167/26	151/11	32/11			395/45

*Shaded boxes with no values indicates confidential information

Appendix V

Data Analysis Tables

Table 1. Mean weight, by species - all catch data

Mean Weight, Standard Deviation and Number of entries per species

Spiny Lobsters				Slipper Lobsters			
Year	Average	StDev	n	Year	Average	StDev	n
1984	2.16	0.52	148	1984	2.06	0.65	9
1985	2.16	0.50	293	1985	2.05	0.65	107
1986	2.03	0.55	187	1986	2.29	0.53	54
1987	2.13	0.51	300	1987	2.05	0.60	76
1988	2.12	0.50	280	1988	1.88	0.57	37
1989	2.04	0.50	146	1989	2.17	0.48	14
1990	2.08	0.56	196	1990	2.07	0.84	7
1991	2.08	0.57	174	1991	1.57	0.83	16
1992	1.89	0.38	213	1992	1.81	0.89	27
1993	1.89	0.52	92	1993	1.42	1.01	10
1994	1.89	0.55	82	1994	1.74	0.99	4
1995	1.89	0.47	140	1995	1.78	0.78	16
1996	2.07	0.50	305	1996	1.88	0.82	38
1997	2.02	0.52	247	1997	1.53	0.73	25
1998	1.99	0.52	293	1998	1.90	0.49	18
1999	1.94	0.50	199	1999	2.27	0.57	10
2000	1.97	0.45	281	2000	2.03	0.77	26
2001	1.94	0.44	225	2001	2.16	0.73	21
2002	1.95	0.39	210	2002	1.51	0.82	11
2003	2.06	0.41	36	2003	0.78	0.20	3

Source: Analysis xcel/Mean weight/Fig5a data

Data set was derived from catch data. Of the 6633 total data points, this subset does not include 1324 entries that did not report number of lobsters caught or 391 entries where the mean weight was greater than the published maximum weight (3 lbs for both species). There are 4576 total entries, of which 57% came from Maui landings, 19% from Hawaii, 18% from Oahu and 6% from Kauai.

Table 2. Mean weight for spiny lobsters by region and gear – catch data

Spiny lobster by hand - Hawaii

Year	ave. wt.	st. dev.	n (746)
1984	2.17	0.49	6
1985	2.72	0.89	9
1986	2.51	0.90	28
1987	2.57	0.66	62
1988	2.19	0.51	42
1989	2.51	1.07	71
1990	2.30	0.64	68
1991	2.25	0.82	50
1992	2.10	0.46	25
1993	2.55	0.81	15
1994	2.37	0.65	15
1995	2.58	0.83	53
1996	2.18	0.67	78
1997	2.22	0.75	50
1998	2.34	0.61	62
1999	2.00	0.93	54
2000	2.15	0.89	38
2001	2.33	1.32	11
2002	1.56	0.70	9

Spiny lobster by hand - Maui

Year	ave. wt.	st. dev.	n (1634)
1984	NA	NA	0
1985	2.62	1.05	12
1986	2.54	0.63	56
1987	2.31	0.77	69
1988	2.09	0.68	71
1989	2.26	0.52	73
1990	2.59	0.68	44
1991	2.25	0.70	50
1992	1.75	0.27	50
1993	2.34	0.85	23
1994	2.22	0.77	50
1995	2.18	0.44	126
1996	2.13	0.43	122
1997	2.25	0.65	126
1998	1.96	0.48	163
1999	1.97	0.50	162
2000	2.08	0.64	199
2001	2.04	0.49	132
2002	2.08	0.51	106

Spiny lobster by hand - Oahu

Year	ave. wt.	st. dev.	n (258)
1984	2.24	0.43	5
1985	2.03	0.55	8
1986	2.01	0.52	17
1987	1.78	0.45	36
1988	1.93	0.48	18
1989	1.65	0.35	28
1990	1.62	0.55	10
1991	1.72	0.66	24
1992	2.38	0.92	21
1993	1.88	0.68	13
1994	1.94	0.64	23
1995	1.93	0.70	13
1996	2.07	0.78	9
1997	2.22	0.83	6
1998	NA	NA	1
1999	2.36	0.82	6
2000	2.59	0.56	11
2001	2.06	0.65	4
2002	2.28	0.49	5

Spiny lobster by hand - Kauai

Year	ave. wt.	st. dev.	n (128)
1985	na	na	1
1986	1.54	0.50	15
1987	1.40	0.46	8
1988	1.66	0.58	3
1989	na	na	2
1990	2.22	0.25	4
1991	2.11	0.19	3
1992	na	na	1
1993	na	na	0
1994	1.86	0.35	5
1995	1.38	0.48	11
1996	1.67	0.27	33
1997	1.62	0.36	29
1998	na	na	1
1999	na	na	1
2000	na	na	2
2001	na	na	1
2002	1.92	0.41	6
2003	na	na	1

Spiny lobster by trap - Hawaii

Analysis not conducted.
Only 58 data points in 21 years

Spiny lobster by trap - Maui

Year	ave. wt.	st. dev.	n (676)
1984	2.43	0.52	220
1985	2.43	0.70	139
1986	2.66	0.76	86
1987	2.42	0.59	83
1988	2.31	0.62	77
1989	2.08	0.81	13
1990	2.47	0.93	10
1991	2.67	1.15	31
1992	1.72	0.17	17

* only 28 data points after 1992

Spiny lobster by trap - Oahu

Year	ave. wt.	st. dev.	n (202)
1984	1.88	0.39	51
1985	1.67	0.53	33
1986	1.84	0.40	19
1987	NA	NA	2
1988	NA	NA	1
1989	1.76	0.43	20
1990	1.64	0.24	13
1991	1.80	0.48	42
1992	1.61	0.26	10
1993	1.59	0.25	11

* only 16 data points after 1993

Spiny lobster by trap - Kauai

Analysis not conducted.
Only 23 data points in 21 years

Spiny lobster by net - Hawaii

Analysis not conducted.
Only 41 data points in 21 years

Spiny lobster by trap - Maui

Year	ave. wt.	st. dev.	n (175)
1984	2.44	0.43	25
1985	2.13	1.04	7
1986	1.94	0.66	2
1987	2.77	0.21	4
1988	2.21	0.71	22
1989	2.22	1.02	8
1990	2.24	1.02	5
1991	2.39	1.05	7
1992	2.82	1.04	4
1993	NA	NA	1
1994	1.63	0.34	7
1995	1.63	0.34	9
1996	2.56	0.87	9
1997	2.08	0.77	13
1998	1.37	0.26	14
1999	2.12	0.17	8
2000	1.81	0.38	12
2001	1.88	0.22	9
2002	2.12	0.25	9

Spiny lobster by net - Oahu

Year	ave. wt.	st. dev.	n (144)
1984	1.71	0.48	21
1985	2.06	0.36	5
1986	1.79	0.44	5
1987	NA	NA	1
1988	1.75	0.35	2
1989	1.19	0.14	3
1990	1.61	0.24	8
1991	1.64	0.61	3
1992	1.74	0.53	13
1993	1.41	0.17	15
1994	1.54	0.59	10
1995	1.67	0.64	9
1996	1.81	0.65	15
1997	1.68	0.52	16
1998	1.75	0.48	10
1999	2.68	0.76	4
2000	NA	NA	1
2001	2.03	0.50	2
2002	NA	NA	1

Spiny lobster by trap - Kauai

Analysis not conducted.
Only 12 data points in 21 years

Source: Analysis xcel/Mean weight/Fig5b-d data

Data set was derived from catch data, and includes only data for spiny lobsters that had both pounds and numbers landed. Subset is 3,963 of total 6,633 points (60%).

Table 3. Mean weight by species – dealer data

Annual Mean Weight by Species

Hawaii

Mean weight of slipper lobsters cannot be measured on Hawaii, there are only 2 data points over 21 yrs.

Spiny Lobster

Year	Mean Weight	Std Dev	
1990-1991	1.62	0.27	
1991-1992	1.48	0.40	
1994-1995	1.72	0.46	
1995-1996	1.60	0.33	
2002-2003	3.24*	1.25	*Includes lobsters weighing nearly 5 pounds

Kauai

Not enough data for meaningful analysis!

Maui

Mean weight of slipper lobsters cannot be measured on Maui, there are only 48 data points over 21 yrs.

Spiny Lobster

Year	Mean Weight	Std Dev
1991-1992	1.98	0.44
1993-1994	2.44	0.50
1994-1995	2.08	0.34
1995-1996	1.97	0.65
1996-1997	2.15	0.29
1997-1998	2.21	0.42
1998-1999	2.07	0.35
1999-2000	2.00	0.43
2000-2001	2.01	0.41
2001-2002	1.93	0.38
2002-2003	2.08	0.51
2003-2004	2.16	0.47

Oahu

Mean weight of slipper lobsters cannot be measured on Oahu, there are only 48 data points over 21 yrs.

Spiny Lobster

Year	Mean Weight	Std Dev
2000-2001	1.51	0.30
2001-2002	2.06	0.88
2002-2003	1.96	0.62
2003-2004	1.86	0.47

Table 4. Mean weight for red and green spiny lobsters, by region – catch data

Region	Species	Year	ave. wt.	st. dev.	n
Hawaii	RSL	2002	2.31	0.75	5
Hawaii	RSL	2003	2.12	0.85	43
Hawaii	RSL	2004	1.87	0.42	54
Maui	RSL	2002	2.38	0.22	6
Maui	RSL	2003	2.14	0.50	21
Maui	RSL	2004	2.84	0.23	2
Oahu	RSL	2003	2.14	0.50	11
Maui	GSL	2002	2.08	0.74	37
Maui	GSL	2003	2.15	0.47	106
Maui	GSL	2004	2.22	0.53	42

Table 5. Inflation-adjusted (2004) price per pound by region & species – dealer data

	Hawaii-Spiny		Kauai-Spiny		Maui-Spiny		Oahu-Spiny		Maui-Slipper		Oahu-Slipper	
	Price	StDev	Price	StDev	Price	StDev	Price	StDev	Price	StDev	Price	StDev
1984					$7.71	$0.93			$8.15	$1.24		
1985			$14.35	$2.72	$7.11	$0.15			$6.98	$0.58		
1986					$7.56	$0.23			$7.55	$0.36		
1987					$7.25	$1.36			$6.48	$0.50		
1988			$16.44	$0.03		$0.00						
1989						$0.00						
1990			$8.28	$0.00		$0.00						
1991	$6.69	$0.30	$7.94	$0.39		$0.00						
1992	$7.37	$0.02			$8.51	$0.70						
1993						$0.00						
1994					$8.11	$0.00						
1995	$7.37	$0.01			$8.84	$0.50			$8.19	$0.50		
1996	$6.83	$0.83			$7.88	$3.67			$11.48	$0.84		
1997					$11.79	$1.35						
1998					$12.16	$0.70						
1999					$12.49	$1.30						
2000					$12.88	$1.59			$13.61	$0.48		
2001					$12.55	$1.93	$9.96	$1.67	$12.55	$1.99	$8.27	$0.57
2002					$13.48	$1.36	$8.80	$1.74			$9.41	$1.54
2003	$8.14	$2.56			$11.83	$2.58	$8.34	$1.98			$8.67	$0.56
2004					$10.32	$2.76	$9.62	$0.96				
Average	$7.28		$11.75		$10.03		$9.18		$9.37		$8.78	

Source: Analysis xcel/CPI/DLR Price

Types of Gear:
Eighteen categories of gear were identified at least once in the catch reports. Of these, hand harvest account for 52.9% of all entries. Lobster traps account for 30.7% of the entries. Lobster net accounts for 7.7% of the entries. The remaining 8.8% of entries account for 11 of the gear types. It is possible that lobsters were an incidental catch to the target species for these entries.

Table 6. Number and percentage of trips by gear type

Gear Type	Entries	%age
diving	2968	44.57%
hand picked	421	6.32%
Spear fishing[1]	132	1.98%
		52.88%
Lobster trap	1152	17.30%
Trap (misc.)	890	13.37%
		30.67%
fish trap	306	4.60%
gill net	82	1.23%
		5.83%
Lobster net	431	6.47%
Net (misc.)	81	1.22%
		7.69%
Bullpen trap	3	0.05%
casting	14	0.21%
crab net	1	0.02%
crab trap	72	1.08%
deep-sea handline	2	0.03%
Inshore handline	6	0.09%
Other	96	1.44%
Seine net	1	0.02%
Throw net	1	0.02%
		2.94%

[1] By regulation, lobsters caught in the MHI may not be taken by spear, nor may anyone sell a mutilated or tailed lobster. It would inhibit the effectiveness of the prohibition on taking egg-bearing females or undersized lobsters, as the fisher would likely kill the lobster prior to determining its developmental state. Thus, we assume for these data that fishers landed lobster by hand without a spear incidentally during a spearfishing trip.

Appendix VI

Glossary

Area fished	A required field in catch reports, determined from 'Commercial Fisheries Statistical Chart.'
Catch data	Data derived from commercial fish catch reports, submitted by commercial fishers
Catch report	The State of Hawaii commercial fishing activity report form (see Appendix I)
Fish Dealer	Any person who sells or exchanges, or who is an agent in the transfer of marine life obtained directly from a commercial marine licensee who sells or exchanges marine life at retail.
Commercial Fisher	A person who has been issued a commercial marine license pursuant to HRS, Section 189-2.
CPUE	Catch per unit effort in units of pounds per day fished.
Dealer data	Data derived from sales of marine life caught in the state by a fisher to a fish dealer, submitted by dealers.
Dealer report	The State of Hawaii commercial dealer sales report form (see Appendix I)
Gear type	Fishing method used and reported in catch reports, includes the primary methods of hand harvest, lobster traps and lobster nets.
Hand harvest	Various methods of harvesting or "picking" marine life by hand. In the information included with the "Fishing Report" booklet provided to commercial fishers, specific categories and definitions are provided for when fishers are taking marine life by "dive," "spear fishing" and "handpicked."
Highliner	Any fisher who landed at least 2,000 pounds of lobsters over the 21-year time-series.
Lobster net	A net of cotton, linen or nylon of various lengths that is secured on hard substrate (usually overnight) and is sometimes baited with fish heads.

Lobster trap	A wire or plastic mesh trap, commonly rectangular in shape, with a funnel shaped mouth located at one or both ends. Weights are placed on the bottom of traps to prevent movement during deployment. Most traps are deployed from a boat.
Mean weight	Calculated from the reported weight of lobster purchased and the number reported.
Number caught	A data field on catch reports, denoting the number of lobsters landed in a trip.
Pounds bought	A data field on dealer reports denoting the total pounds in a given sale. In analyses, pounds bought always relates to dealer data.
Pounds caught	A data field on catch reports, denoting the total pounds of lobsters landed in a trip.
Pounds sold	A data field on catch reports, denoting the pounds of lobsters sold to a fish dealer (or directly to the public) from a single trip. In analyses, pounds bought always relates to catch data.
Price per pound	Calculated from the total value of lobsters purchased by the number of pounds. In analyses, price per pounds is used for both catch and dealer data.
Region	A means to organize and analyze the data. A Region includes the island and surrounding waters. Maui region includes Lanai, Molokai, Kahoolawe and Penguin Bank and Kauai includes Niihau and Kaula Rock. Hawaii and Oahu are the other regions used in this report.
Value	A data field on catch reports. On the dealer forms, value is listed as "amount paid," although for this report value is used for both catch and dealer data.