

**A Review of Unreported to Reported Catch Ratios for Bottomfish Resources in the
Main Hawaiian Islands**

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Abstract

This working paper reviewed unreported to reported catch ratios for bottomfish resources in the Main Hawaiian Islands (MHI) using published information on estimates of unreported catch as well as using other sources. The ratios were used to develop estimates of unreported Hawaiian bottomfish catch in the MHI during the years 1948 – 2010 for use in stock assessment sensitivity analyses. Four alternative unreported catch history scenarios were developed to characterize the uncertainty in the available information about unreported catch. For each scenario, unreported catch (C_U) was estimated from reported catch (C_R) and the ratio of unreported to reported catch U derived from the literature as $C_U = U * C_R$. Total catch (C_T) was then estimated as $C_U + C_R$. The resulting averages of the annual ratios of unreported to reported catches (C_U/C_R) were 2.5, 1.83, 0.20, and 0.00 under catch scenarios I – IV, respectively. The resulting averages of the annual percentages of unreported to total catches (C_U/C_T) were 71%, 65%, 17%, and 0% under catch scenarios I – IV respectively. These four catch scenarios for the Deep7 bottomfish complex were used as data inputs for the Deep7 bottomfish stock assessment (Brodziak et al., 2011).

Introduction

This working paper reviewed unreported to reported catch ratios for bottomfish resources in the Main Hawaiian Islands (MHI) using published information on estimates of unreported catch as well as using other sources. The ratios were used to develop estimates of unreported Hawaiian bottomfish catch in the MHI during the years 1948 – 2010 for use in the Deep7 bottomfish complex stock assessment (Brodziak et al., 2011).

A Western Pacific Stock Assessment Review (WPSAR 1)¹ of the 2008 Hawaiian bottomfish stock assessment update (Brodziak et al., 2009) identified non-commercial catch histories as one of the issues that was recommended to be addressed in future stock assessments. Under State of Hawaii fishing regulations² the “never-sold” qualifier is what determines whether a fisherman is considered recreational or commercial:

“Individuals or vessels engaged in taking, selling or offering for sale any marine life for commercial purposes (including charter fishing services) must obtain a Commercial Marine License... ‘Commercial purpose’ means the taking of marine life for profit or gain, or as a means of livelihood, when the marine life is taken in or outside of the State, and when the marine life is sold, offered for sale, landed, or transported for sale anywhere in the State. Every commercial marine licensee

¹ Report on the Western Pacific Stock Assessment Review 1 Hawaii Deep Slope Bottomfish (WSPAR 1). Prepared for The Center for Independent Experts
By Dr. Kevin Stokes.
http://www.pifsc.noaa.gov/do/peer_reviews/StockAssessmentofHawaiiDeep-slopeBottomfish.php (Posted July 27, 2010, and accessed on 2/04/2011)

² http://hawaii.gov/dlnr/dar/fishing_commercial.html (Accessed on 2/04/2011)

shall furnish to the Department of Land and Natural Resources a monthly report with respect to marine life taken and any bait used.”

However, recreational catch in the Hawaiian bottomfish fishery is not reported and commercial catches in the Hawaiian bottomfish fishery may be under-reported (e.g., Pooley 1993; Haight et al., 1993; Smith, 1993; Zeller et al., 2008).

This working paper responds to the WPSAR 1 review by developing four alternative scenarios to characterize the uncertainty in the available information about unreported catch: Scenario I) A high level of unreported catch; Scenario II) A moderately high level of unreported catch; Scenario III) A low level of unreported catch; and Scenario IV) A negligible level of unreported catch. For each scenario, unreported catch (C_U) was estimated from reported catch (C_R) and the ratio of unreported to reported catch U derived from the literature as $C_U = U * C_R$. Total catch (C_T) was then estimated as $C_U + C_R$.

The ratios of unreported to reported catch (U) were derived from published information on estimates of unreported catch from Zeller et al. (2008) and Hamm and Lum (1992) as well as using other sources of data provided to the Pacific Islands Fisheries Science Center (PIFSC) or Western Pacific Fisheries Management Council (WPFMC) (Zeller et al., 2005; 2007; Martell et al., 2006; Lamson et al., 2007). Each source was reviewed here, specifying the basic methods used in each study and clarifying which sources generated original data (i.e., from surveys). Information sources that were not commonly available (i.e., Lamson et al., 2007) were included as appendices to this document.

Unreported catch (C_U) was estimated for primary Hawaiian bottomfish species (Table 1) in the MHI during the years 1948 – 2010. The seven Hawaiian bottomfish species identified as the Hawaiian Islands Deep7 bottomfish complex were also identified (Table 1). Reported commercial catch (C_R) of primary Hawaiian bottomfish species (Table 1) in the MHI during the years 1948 – 2010 was provided from the current stock assessment of Hawaiian bottomfish (Brodziak et al., 2011). The methods used to obtain the data are the same as those used in the previous assessment (Brodziak et al., 2009) and are described in detail in the current assessment document (Brodziak et al., 2011). The annual time period in the assessment for reporting bottomfish catch was the fishing year from 1-July of the previous year through 30-June of the current year (Brodziak et al., 2011).

The list of primary bottomfish species included in recent Hawaiian bottomfish stock assessments (Moffitt et al., 2006; Brodziak et al., 2009) (Table 1) and utilized here to develop four alternative scenarios of unreported catches of primary Hawaiian bottomfish species is a subset of the list of Hawaiian Bottomfish Management Unit Species (BMUS) defined by the WPFMC (e.g., Anonymous 2006, see Table 1). In particular, taape (*Lutjanus kasmira*), which is an introduced species, and kahala (*Seriola dumerili*), a species commonly discarded due to the risk of ciguatera poisoning, were not part of the set of primary bottomfish species used for stock assessment. Sea mount bottomfish species were also excluded.

Methods

Literature Review

Review of Zeller et al. (2005; 2007; 2008)

Zeller et al. (2005; 2007) reconstructed total commercial catches and total recreational catches of Hawaiian coral reef and bottomfish fisheries during the years 1950 – 2002 in the MHI and Northwest Hawaiian Islands (NWHI). Commercial landings statistics were provided by the State of Hawaii Division of Aquatic Resources (HDAR) as a breakdown by taxon, year, and geographic area (MHI, NWHI). A reporting adjustment was applied to annual reported catches based on 12 estimated ratios for total commercial catch to reported commercial catch (R_c) derived based on a range of local information sources and local expert knowledge (Zeller et al., 2007 Appendix 1). The ratios were linearly interpolated for years with missing ratios and applied to reported commercial catches to derive estimates of total commercial catches (i.e., total commercial catches = reported commercial catches * R_c) (Zeller et al., 2005 Table 3.4.1; 2007 Table 1).

The reconstruction of the non-commercial (recreational) catches was based on an indirect approach via five estimated ratios of total catch to reported commercial catch (R_t) derived based on a range of local information sources and local expert knowledge (Zeller et al., 2007 Appendix 2). Between the years 1950 and 1990, the ratios were linearly interpolated for years with missing ratios. The 1990 ratio was carried forward to 2002 unaltered. These ratios were applied to the reported commercial catches for each year to derive total catches (i.e., total catches = reported commercial catches * R_t) (Zeller et al., 2005 Table 3.4.1; 2007 Table 1). Estimates of recreational catches were derived by subtracting total commercial catches from the total catches (i.e., recreational catches = total catches – total commercial catches).

Zeller et al. (2008) also utilized an independent survey data set, the NOAA Fisheries Hawaii Marine Recreational Fisheries Survey (HMRFS)¹ (e.g., Allen and Bartlett 2008), to extend their estimation of non-commercial catches for the years 2003 – 2005. However, Zeller et al. (2008) appeared to mirror the derivation developed by Martell et al. (2006 Table 18), which is described below.

The ratios of total catch to reported commercial catch (R_t) derived by Zeller et al. (2008) may overestimate unreported catches of Hawaiian bottomfish. The ratios were derived by Zeller et al. (2005; 2007; 2008) to reconstruct total catches for coral reef and bottomfish fisheries combined (i.e., all HDAR data excluding landings of algae, corals, freshwater species, and large pelagic species such as tuna and billfishes). However, most Hawaiian coral reef fish are caught within the coastal zone, either from shore or boats operating along the margins of coastal coral reefs, while most Hawaiian bottomfish are captured from vessels operating in deeper water. For these reasons, the proportion of recreational catch to commercial catch may be higher in Hawaiian coral reef fisheries than in Hawaiian bottomfish fisheries because recreational catch is not reported.

¹ (<http://www.st.nmfs.noaa.gov/st1/recreational/index.html>)

We utilized ratios of total catch to reported commercial catch (R_t) derived by Zeller et al. (2005; 2007; 2008) (Table 2) in Catch Scenario I. It is important to clarify that Zeller et al. (2005; 2007; 2008) did not generate original data (i.e., conduct surveys) to estimate R_t . Instead the ratios were derived based on a range of local information sources and local expert knowledge (Zeller et al., 2007 Appendices 1 and 2; Zeller et al., 2008).

Review of Hamm and Lum (1992)

Hamm and Lum (1992) reported on a survey of small-boat commercial and recreational fishing activity conducted on the island of Oahu from March 1990 through May 1991. The survey design involved interviews of commercial and recreational small boat operators and utilized a random stratified sampling design that included eight public marinas and launching ramps that comprised a large portion of the small-boat activity on Oahu. Data collection and initial data entry were conducted under the supervision of HDAR. Data verification, analysis, and reporting were conducted by the Western Pacific Fishery Information Network (WPACFIN). Survey data were expanded within survey strata to obtain expanded quarterly estimates (March, April, May; June, July, August; September, October, November; December, January, February) of island wide small-boat commercial and recreation fishing activity from March 1990 to February 1991.

Because the data represented only that portion of fishing activity occurring out of the eight sampled ports, Hamm and Lum (1992) considered their expanded estimates of commercial and recreational catch to be a conservative estimate of Island-wide activity. However, the sample sizes for both the number of bottomfish vessels interviewed and for the catches of Hawaiian bottomfish by species were relatively large. The survey methods also included a random stratified sampling design that was rigorously applied and well documented. As a result, the expanded estimates of small-boat commercial and recreational fishing activity were used by Martell et al. (2006) to estimate the ratios of recreational to commercial catch of Hawaiian bottomfish by species for the Hawaiian bottomfish fishery in 1990 (see below) and used here in Catch Scenario II.

Review of Martell et al. (2006)

Martell et al. (2006) reported on the available commercial catch statistics for the Hawaiian bottomfish fishery during the years 1948 – 2005 for use in stock assessment. Martell et al. (2006) reviewed and, in some cases, modified available ratio indicators relating likely unreported recreational catches to reported commercial catches for the Hawaiian bottomfish fishery.

For the years 1950 and 1980, Martell et al. (2006, see Table 14) estimated the ratios of likely recreational catch to commercial catch from the ratios derived by Zeller et al. (2005). However, the ratios derived by Martell et al. (2006) were identical to the ratios of total unreported catch to reported commercial catch (i.e., $U_t = R_t - 1$) derived here from Zeller et al. (2005) in 1950 (2.27) and 1980 (3) (Table 1). Therefore, for the purposes of this working paper, we assumed that the ratios 2.27 and 3 derived by Martell et al. (2006

Table 14) represented the ratios of total unreported catch to reported commercial catch (i.e., $U_{1950} = 2.27$ and $U_{1980} = 3$) (Table 1).

For the year 1990, Martell et al. (2006, see Table 18) derived the ratio of likely recreational catch to commercial catch from Hamm and Lum (1992) who reported that, on average, 34% of bottomfish catch in 1990 was “sold.” Martell et al. (2006) utilized this information to derive the ratio (1.94) of likely recreational catch to commercial catch as the proportion of “non-sold” catch (0.66) to “sold” catch (0.34). Estimates of “non-sold” catch from Hamm and Lum (1992) may overestimate the recreational catch component because they probably include both recreational catch and unreported commercial catch (Hamm and Lum 1992). As a result, we also interpreted the ratio 1.94 from Martell et al. (2006) as the ratio of total unreported catch to reported commercial catch (i.e., $U_t = 1.94$).

To account for species differences in unreported catch, Martell et al. (2006) used extrapolated catch data available in Hamm and Lum (1992) to allocate unreported recreational catch of Hawaiian bottomfish in 1990 to species. Martell et al. (2006) then used recreational catch data available from the HMRFS (e.g., Allen and Bartlett 2008) to scale unreported recreational catch to the MHI. Martell et al. (2006) then used their expanded estimates of unreported recreational catch (by species) in 1990 for the MHI to derive species specific ratios of unreported recreational catch to reported commercial catch for the Hawaiian bottomfish fishery in 1990 (Martell et al., 2006 Table 18). Because estimates of “sold” to “non-sold” catch from Hamm and Lum (1992) may overestimate the recreational catch component, the species specific ratios derived by Martell et al. (2006 Table 18) for 1990 were also interpreted here as ratios of total unreported catch to reported commercial catch by species (i.e., U_{1990}) (Table 3).

For the years 2004 and 2005, Martell et al. (2006, see Table 18) derived the ratios of likely recreational catch to commercial catch from unpublished information available from the HMRFS (e.g., Allen and Bartlett 2008) via ratio indicators relating likely recreational catches to reported commercial catches. Taxa that were individually listed in the HMRFS data were matched directly with Hawaiian bottomfish species. A proportional allocation approach was used to assign pooled taxa in the HMRFS to Hawaiian bottomfish by species for taxa that were not individually listed. Pooled taxa in the HMRFS data were allocated to species in proportion to their species composition as reported in HMRFS data, or, if that was not available, then in proportion to their species composition in the commercial catch data (Martell et al., 2006).

The ratios derived by Martell et al., (2006, see Table 18) for 2004 and 2005 based on HMRFS data may underestimate total unreported catches because they do not include unreported commercial catch. Martell et al. (2006) also noted that the HMRFS may not have adequately sampled Hawaiian bottomfish catches. For the purposes of this working paper, however, the ratios relating likely recreational catches to reported commercial catches for 2004 and 2005 (Martell et al., 2006, see Table 18) were also interpreted here to represent ratios of total unreported catch to reported commercial catch by species in 2004 (i.e., U_{2004}) and 2005 (i.e., U_{2005}) (Table 3).

We utilized ratios of likely recreational catch to reported commercial catch derived by Martell et al. (2006, see Table 18) for the years 1990, 2004 and 2005 as estimates of total unreported catch to reported commercial (U_{1990} , U_{2004} , and U_{2005}) for Catch Scenario II (Table 3). It is important to clarify that the 1990, 2004, and 2005 ratios were all based on survey data as described above.

Review of Lamson et al. (2007)

Lamson et al. (2007) reported on a recall survey mailed in August, 2005, to all 3,678 fishermen registered with the State of Hawaii HDAR bottomfish registry. The survey was a joint effort between HDAR, the WPFMC, the NMFS PIFSC, and the NMFS Pacific Islands Regional Office (PIRO). The purpose of the survey was to better understand the activities of MHI bottomfish fishermen and their attitudes toward a range of management alternatives. The recall survey bracketed the fishermen's activity over the last six months of 2004 and the first six months of 2005 (the 2005 fishing year) and contained a number of questions related to fishing activity. However, Lamson et al. (2007) noted that the survey design and implementation were developed over a short period of time in response to pressing management concerns and without the opportunity for pre-testing and that, as a result, some survey questions may have been ambiguous and may have skewed response accuracy.

A total of 802 completed surveys (22%) were returned and used for the analyses conducted by Lamson et al. (2007). Summary statistics for total catch and catch by species were determined using surveys of active fishermen with non-blank answers. Fishermen were asked to report catch landings of each of the Deep 7 species, as well as uku (*Aprion virescens*). Summaries of total catch statistics included Deep 7 species + uku. Summaries of "Deep 7" excluded uku.

Fishermen were considered commercial for the purposes of the analyses conducted by Lamson et al. (2007) if they answered yes to a question which asked "Do you ever sell any bottomfish you catch?" Commercial bottomfish fishermen had a significantly higher total catch rate (median 182.5 lbs/day) compared to recreational bottomfish fishermen (median 42 lbs/day) despite the fact that 57% of the self-declared commercial fishermen said they sell their catch only to cover expenses. Commercial fishermen also had significantly more hydraulic and electric reels, as well as GPS plotters. However, catch rates were not significantly tied to any gear type.

The survey data was used by Lamson et al. (2007) to extrapolate catch rates (lbs/year) for all Deep 7 species in the entire pool of 3,678 registered bottomfish fishermen by sector (commercial or recreational) based on their self-declared status (Lamson et al., 2007):

"Ratios of commercial: recreational fishermen were established using self-declared status from all returned surveys as well as just the active fishermen. The difference between these two ratios provided a probable range of active and inactive, commercial and recreational bottomfishermen within the main Hawaiian

Islands. These ratios were then used to extrapolate catch rates from the entire pool of 3,678 registered bottomfishers. Mean annual catch per commercial and recreational fishermen were artificially inflated because the top twelve active fishermen caught 46% of the total catch... Therefore, medians were used to extrapolate catch range values. Total annual catch (for the Deep 7 species) was calculated by multiplying the range of number of fishers by the median annual catch for recreational and commercial fishermen.”

The median annual catch of MHI Deep 7 species per fishermen from the survey was 182.5 lbs for commercial fishermen and 42 lbs for recreational fishermen (Table 4). The extrapolated number of active commercial fishermen in the Hawaiian bottomfish fishery during the 2005 fishing year ranged from 680 to 758.5 (Table 4). The extrapolated number of active recreational fishermen in the Hawaiian bottomfish fishery during the 2005 fishing year ranged from 594 to 673 (Table 4). The extrapolated Deep 7 catch by sector in the Hawaiian bottomfish fishery, estimated as median unextrapolated annual catch per fishermen * extrapolated number of active fishermen by sector (Lamson et al., 2007) ranged from 124,100 to 138,426 lbs for commercial fishermen and ranged from 24,948 to 28,266 lbs for recreational fishers (Table 4).

We utilized the range of extrapolated Deep 7 catch by sector from the survey conducted by Lamson et al. (2007) (Table 4) to estimate the ratio of recreational catch to commercial catch for the Hawaiian bottomfish fishery during the 2005 fishing year (July 2004 – June 2005) for Catch Scenarios II and III (see below).

We also utilized the unextrapolated mean annual catch (lbs) per fisherman by sector (recreational and commercial) from Lamson et al. (2007) (Table 5) to derive ratios of total unreported catch to reported commercial catch by species for the MHI Deep 7 species for Catch Scenario II (see below).

Catch Scenario Results

Scenario I) High Level of Unreported Catch

A scenario with a high level of unreported catch was developed from ratios of total catch to reported commercial catch (R_t) derived by Zeller et al. (2005; 2007; 2008) for the years 1950, 1980, 1985, 1988, and 1990 (Table 2). The R_t ratios were transformed here to represent ratios of total unreported catch to reported commercial catch (i.e., $U_t = R_t - 1$). The 1950 U_t ratio was carried backward to 1948 unaltered, and the 1990 U_t ratio was carried forward to 2010 unaltered. The final ratios of unreported to reported catch (U) for Catch Scenario I were calculated as the smoothed 5-year average of the annual U_t ratios for the years 1948 to 2010 (Table A.2).

Reported commercial catch (C_R) for primary Hawaiian bottomfish species in the MHI is provided in Table A.1. Unreported catch (C_U) was estimated from reported catch (C_R) and the ratio of unreported to reported catch U for Catch Scenario I as $C_U = U * C_R$ (Table

A.2). Total catch was estimated as $C_R + C_U$ (Table A.3, Figure B.1). Under Catch Scenario I, the average annual unreported catch was 2.5 times higher than reported catch ($C_U/C_R = 2.5$), and the average annual unreported catch was 71% of total catch ($C_U/C_T = 0.71$) (Table 8, Figures 1 and 2).

Scenario II) Baseline Catch Scenario Used for the Deep7 Bottomfish Stock Assessment

This scenario used what was judged to be the best available direct quantitative information on unreported to reported catch ratios for individual species to estimate the unreported catches of Deep7 bottomfish for the stock assessment. This scenario produced a moderately high level of unreported catch was developed from the ratios derived by Martell et al (2006) for the years 1990, 2004, and 2005 (Table 3), and from survey data described in Lamson et al. (2007) for the year 2005 (Tables 4 and 5). The process of estimating the unreported to reported catch ratios by species can be divided into three primary steps described below.

First,, we utilized the ratio indicators relating likely recreational catches to reported commercial catches derived by Martell et al. (2006) for 2004 and 2005 (Table 3) to represent ratios of total unreported catch to reported commercial catch by species in 2004 and 2005 (Table 6A). Martell et al. (2006) noted that the HMRFS may not have adequately sampled bottomfish catches in 2004 and 2005. The 2004 and 2005 ratios of recreational to commercial catch derived by Martell et al. (2006) were also highly variable. For example, the ratio of recreational to commercial catch for hapuupuu was 0.42 in 2004 and 0.99 in 2005 (Table 6A). Variability in the ratios may have resulted from an inadequate sample size and, as a result, may not have reflected actual changes in the ratios between years. In order to account for the high interannual variability, we utilized an average estimate of the ratios of recreational to commercial catches from the HMRFS data in 2004 and 2005 (Table 6A). Ratios for miscellaneous ulua and yellowtail kalekale were not derived by Martell et al. (2006). The ratio for miscellaneous ulua (8.85) was calculated here as the average of the other ulua species including butaguchi (1.42), black ulua (0.25), and white ulua (24.88) (Table 6A). A ratio for yellowtail kalekale could not be inferred here from the HMRFS based on the available data in Martell et al. (2006) (Table 6A).

Second, we utilized the range of extrapolated Deep 7 catch by sector from the survey conducted by Lamson et al. (2007) (Table 4) to estimate the ratio of recreational catch to commercial catch for the Hawaiian bottomfish fishery during the 2005 fishing year (July 2004 – June 2005) (Table 6B). A minimum estimate of the ratio of recreational catch to commercial catch was estimated as the ratio of minimum extrapolated recreational catch (24,948 lbs) to maximum extrapolated commercial catch (138,426 lbs) (Table 4). A maximum estimate of the ratio of recreational catch to commercial catch was estimated as the ratio of maximum extrapolated recreational catch (28,266 lbs) to minimum extrapolated commercial catch (124,100 lbs) (Table 4). The ratio of recreational catch to commercial catch for Deep 7 species (0.20) was estimates as the average of minimum

estimate (0.18) and the maximum estimate (0.23) (Table 4). We utilized the ratio of recreational catch to reported commercial catch (0.20) derived from Lamson et al. (2007) (Table 4) to represent the ratios of total unreported catch to reported commercial catch in 2005 for primary bottomfish species other than Deep 7 species (Table 6B).

Lamson et al. (2007) found that the composition of Deep 7 species catches differed significantly between recreational and commercial fishermen in their survey. A logistic regression with commercial status as the response variable and species as predictor showed that significantly more ehu, onaga, opakapaka, and uku were caught by commercial than recreational fishermen (Lamson et al., 2007 Figure 4). As a result, it may be important to account for differences in the species compositions of recreational and commercial catches when estimating the ratio of recreational catch from reported commercial catch. As a result, for Deep 7 species, we used the species composition of unextrapolated recreational and commercial catches available from Lamson et al. (2007) (Table 5) to compute the observed data-weighted average ratio of recreational catch to commercial catch (i.e., recreational catch = proportion recreational * U_{t_avg} * 1/(proportion commercial)* reported commercial catch. For example, for hapuupuu, recreational catch was estimated as $0.07*0.20*1/0.03*$ reported commercial catch. The ratio of recreational catch to reported commercial catch was then $0.07*0.20*1/0.03 = (0.07/0.03)*.20 = 2.33*.20 = 0.48$ (Table 6B). The ratio of recreational catch to commercial catch for Deep 7 species derived here based on Lamson et al. (2007) may underestimate total unreported catches for Deep 7 species because Lamson et al. (2007) did not include unreported commercial catches in their survey. However, for the purposes of this working paper, we interpreted the ratios of recreational to commercial catch based on Lamson et al. (2007) as total unreported catch to reported commercial.

Third, a final set of ratios of recreational catch to commercial catch (Table 6C) was estimated as the average of the annual ratios derived by Martell et al. (2006) from HMRFS data (Table 6A) and the ratios derived here from Lamson et al. (2007) (Table 6B). The average was used because of uncertainty in both the ratios derived by Martell et al. (2006) and the ratios derived here based on Lamson et al. (2007). The averages of the annual ratios were used here to represent ratios of total unreported catch to reported commercial catch by species for primary Hawaiian bottomfish species during 2004 and 2005 (i.e., $U_{2004-2005}$) (Table 6C).

For 1990, we used the ratios derived by Martell et al. (2006) based on a preliminary small-boat survey conducted by Hamm and Lum (1992) (Table 3) except that Ulua Misc. (4.52) and Yellowtail Kalekale (0.20) (Table 6D) were set to the weighted average ratios derived above from HMRFS Lamson et al. (2007) (Table 6C). The 1990 ratios were used here to represent ratios of total unreported catch to reported commercial catch by species for primary Hawaiian bottomfish species during 1990 (i.e., U_{1990}) (Table 6D).

The 1990 ratios (U_{1990}) were carried backward to 1948 and forward to 1999 unaltered. The 2004-2005 ratios ($U_{2004-2005}$) were carried backward to 2000 and forward to 2010 unaltered. The final ratios of unreported to reported catch (U) for Catch Scenario II were calculated as the smoothed 5-year average of the annual U_t ratios for the years 1948 to

2010 (Table 7). Reported commercial catch (C_R) for primary Hawaiian bottomfish species in the MHI is provided in Table A.1. Unreported catch (C_U) for Catch Scenario II was estimated from reported catch (C_R) and the ratio of unreported to reported catch U for Catch Scenario II as $C_U = U * C_R$ (Table A.4). Total catch was estimated as $C_R + C_U$ (Table A.5, Figure B.2). Under Catch Scenario II, the average annual unreported catch was 1.83 times higher than reported catch ($C_U/C_R = 1.83$), and the average annual unreported catch was 65% of total catch ($C_U/C_T = 0.65$) (Table 9, Figures 1 and 2).

Scenario III) Low Level of Unreported Catch

An alternative unreported catch scenario with a low level of unreported catch was developed from ratios of recreational to commercial catches aggregated across species and derived here based on survey data described by Lamson et al. (2007) (Table 4). All primary bottomfish were assumed to have a ratio of recreational to commercial catch to equal to (20%) (Table 4). Reported commercial catch (C_R) for primary Hawaiian bottomfish species in the MHI is provided in Table A.1. Unreported catch (C_U) for Catch Scenario III was estimated from reported catch (C_R) as $C_U = 0.20 * C_R$ (Table A.4). Total catch was estimated as $C_R + C_U$ (Table A.6, Figure B.3). Under Catch Scenario III, the average annual unreported catch was 20% of reported catch ($C_U/C_R = 0.20$), and the average unreported catch was 17% of total catch ($C_U/C_T = 0.17$) (Table 10, Figures 1 and 2).

Scenario IV) Negligible Level of Unreported Catch.

The scenario with a negligible level of unreported catch was developed by assuming that there were no unreported catches. Total catch was estimated as reported commercial catches (Table A.1). This catch scenario was identical to that used in the 2008 assessment update (Brodziak et al., 2009) and in the 2006 assessment (Moffitt et al., 2006). Under Catch Scenario IV, there was no unreported catch ($C_U/C_R = C_U/C_T = 0$) (Table 11, Figures 1 and 2).

Additional documentation of the estimation of unreported primary bottomfish catches by catch scenario appears in the Appendices. Catch tables for scenarios I – IV are listed in Appendix A, and catch figures for scenarios I – IV are presented in Appendix B. Proportions of estimated total catches of primary bottomfish in the MHI under catch scenario I-IV are shown in Figure B.4.

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Table 1. Primary bottomfish and Deep 7 species included in recent Hawaiian bottomfish stock assessments (Moffitt et al., 2006; Brodziak et al., 2009)¹ and utilized here to develop four alternative scenarios of unreported catches of primary Hawaiian bottomfish species.

Common Name	Local Name	Scientific Name	Deep 7 Species	Primary Bottomfish Species
Pink snapper	Opakapaka	<i>Pristipomoides filamentosus</i>	X	X
Longtail snapper	Onaga	<i>Etelis coruscans</i>	X	X
Squirrelfish snapper	Ehu	<i>Etelis carbunculus</i>	X	X
Sea bass	Hapuupuu	<i>Epinephelus quernus</i>	X	X
Grey jobfish	Uku	<i>Aprion virescens</i>		X
Snapper	Gindai	<i>Pristipomoides zonatus</i>	X	X
Snapper	Kalekale	<i>Pristipomoides seiboldii</i>	X	X
Blue stripe snapper	Taape	<i>Lutjanus kasmira</i>		
Yellowtail snapper	Yellowtail kalekale	<i>Pristipomoides auricilla</i>		X
Silver jaw jobfish	Lehi	<i>Aphareus rutilans</i>	X	X
Amberjack	Kahala	<i>Seriola dumerili</i>		
Thick lipped trevally	Butaguchi	<i>Pseudocaranx dentex</i>		X
Giant trevally	White ulua	<i>Caranx ignobilis</i>		X
Black jack	Black ulua	<i>Caranx lugubris</i>		X

¹ The list of primary bottomfish species used in the 2006 Hawaiian bottomfish stock assessment and the 2008 stock assessment update (Table 1) is a subset of the list of Hawaiian Bottomfish Management Unit Species (BMUS) defined by the WPFMC (e.g., Anonymous 2006, see Table 1). In particular, taape (*Lutjanus kasmira*), which is an introduced species, and kahala (*Seriola dumerili*), a species commonly discarded due to the risk of ciguatera poisoning, were not part of the set of primary bottomfish species used for stock assessment. Sea mount bottomfish species were also excluded.

Table 2. Ratios of total catch to reported commercial catch (Rt) derived by Zeller et al. (2005; 2007; 2008), transformed here to represent estimates of total unreported catch to reported commercial catch (i.e., $U_t = R_t - 1$), and used here in Catch Scenario I.

Year	Ratios of Total Catch to Reported Commercial Catch (Rt)	Ratios of Unreported Catch to Reported Commercial Catch (Ut)
1950	3.27	2.27
1980	4	3
1985	4	3
1988	4	3
1990	3.5	2.5
1991	-	-
1992	-	-
1993	-	-
1996	-	-
2000	-	-
2001	-	-
2002	3.5	2.5

Table 3. Ratios of likely recreational catch to reported commercial catch for bottomfish in the MHI for the years 1990, 2004, and 2005 derived by Martell et al. (2006 Table 18) from HMRFS data (e.g., Allen and Bartlett 2008), and used here as estimates of total unreported catch to reported commercial (Ut) for Catch Scenario II.

Taxa	Ratios of Likely Recreational Catch to Reported Commercial Catch				
	Primary Bottomfish	Deep 7	U1990	U2004	U2005
Hapuupuu	X	X	1.02	0.42	0.99
Kahala			5.22	4.69	0
Kalekale	X	X	0.03	0	0
Opakapaka	X	X	2.87	5.95	1.64
Uku	X		2.27	2.49	4.51
Ehu	X	X	1.11	0	0
Onaga	X	X	0.73	0	0
Black ulua	X		1.24	0.15	0.35
Lehi	X	X	0.04	0	0
Gindai	X	X	0.15	0	0
Taape			15.63	0.55	3.33
Butaguchi	X		1.29	1.43	1.40
White ulua	X		2.41	28.51	21.24

Table 4. Median unextrapolated annual catch (lbs) of MHI Deep 7 species per fishermen during the 2005 fishing year by sector (commercial and recreational), extrapolated number of active fishermen by sector, and extrapolated Deep 7 catch by sector from a recall mail survey conducted by Lamson et al. (2007); Average ratio of recreational to commercial catch of Deep 7 species during the 2005 fishing year (0.20) estimated here from survey data in Lamson et al. (2007) and used here as an estimate of total unreported catch to reported commercial (U_{2005}) for Catch Scenarios II and III.

	Commercial (If sold at least once)		Recreational (If never sold)	
Median annual catch per fisher in 2005 from survey (lbs MHI Deep 7)	182.5		42	
Range	Minimum	Maximum	Minimum	Maximum
Estimated number of active fishermen in 2005 from survey	680	758.5	594	673
Extrapolated total annual catch in 2005 from survey (lbs MHI Deep 7)	124,100	138,426	24,948	28,266
	Rec. Min./ Com. Max.	Rec. Max./ Com. Min.		
2005 Rec./Com. Ratios (Min. and Max.) from survey	0.18	0.23		
	U_{2005}			
2005 Rec./Com. Ratios (Average) from survey	0.20			

Table 5. Unextrapolated mean annual catch (lbs) for the MHI Deep 7 species per fisherman by sector (commercial and recreational) during the 2005 fishing year from a recall mail survey conducted by Lamson et al. (2007), and used here to derive ratios of total unreported catch to reported commercial for Deep 7 species (U_{2005}) for Catch Scenario II.

	Commercial (if sold at least once)		Recreational (if never sold)	
	Survey n = 151		Survey n = 124	
Deep 7 Taxa	Lbs	Proportion Commercial	Lbs	Proportion Recreational
Hapuupuu	28.73	0.03	5.07	0.07
Kalekale	35.62	0.04	7.56	0.11
Opakapaka	442.88	0.49	25.11	0.36
Ehu	79.59	0.09	15.39	0.22
Onaga	280.62	0.31	10.58	0.15
Lehi	26.59	0.03	2.22	0.03
Gindai	9.16	0.01	3.85	0.06
Total	903.19	1.00	69.78	1

Table 6. Ratios of recreational catch to commercial catch used here to derive ratios of total unreported catch to reported commercial catch ($U_{2004-2005}$ and U_{1990}) for catch scenario II.

A. 2004 and 2005 Ratios of Recreational : Commercial Catch Derived by Martell et al. (2006) Based on Surveys Conducted by HMRFS													
	Hapuupuu*	Kalekale*	Opakapaka*	Uku	Ehu*	Onaga*	Ulua Misc	Lehi*	Gindai*	Butaguchi	Black Ulua	White Ulua	Yellowtail Kalekale
2004 Rec. / Com. Ratios	0.42	0	5.95	2.49	0	0		0	0	1.43	0.15	28.51	
2005 Rec. / Com. Ratios	0.99	0	1.64	4.51	0	0		0	0	1.40	0.35	21.24	
Average of 2004 and 2005 Rec./Com. Ratios	0.71	0.00	3.80	3.50	0.00	0.00	8.85	0.00	0.00	1.42	0.25	24.88	
B. 2004 Ratios of Recreational : Commercial Catch Derived here Based on Surveys Described by Lamson et al. (2007)													
	Hapuupuu*	Kalekale*	Opakapaka*	Uku	Ehu*	Onaga*	Ulua Misc	Lehi*	Gindai*	Butaguchi	Black Ulua	White Ulua	Yellowtail Kalekale
Recreational Proportion (July 2004 – June 2005)	0.07	0.11	0.36		0.22	0.15		0.03	0.06				
Commercial Proportion (July 2004 – June 2005)	0.03	0.04	0.49		0.09	0.31		0.03	0.01				
Recreational to Commercial Ratios (July 2004 – June 2005)	2.33	2.75	0.73		2.44	0.48		1.00	6.00				
Recreational to Commercial Ratios *0.20 (July 2004 – June 2005)	0.48	0.56	0.15	0.20	0.50	0.10	0.20	0.20	1.23	0.20	0.20	0.20	0.20
C. 2004-2005 Averaged Ratios of Recreational : Commercial Catch by Survey Type ($U_{2004-2005}$)													
	Hapuupuu*	Kalekale*	Opakapaka*	Uku	Ehu*	Onaga*	Ulua Misc	Lehi*	Gindai*	Butaguchi	Black Ulua	White Ulua	Yellowtail Kalekale
Average of Rec. / Com. Ratios $U_{2004-2005}$	0.59	0.28	1.97	1.85	0.25	0.05	4.52	0.10	0.61	0.81	0.23	12.54	0.20
D. 1990 Ratios of Recreational : Commercial Catch Derived by Martell et al. (2006) Based on Surveys Conducted by Hamm and Lum (1992) (U_{1990})													
	Hapuupuu*	Kalekale*	Opakapaka*	Uku	Ehu*	Onaga*	Ulua Misc	Lehi*	Gindai*	Butaguchi	Black Ulua	White Ulua	Yellowtail Kalekale
1990 Rec. / Com. Ratios U_{1990}	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20

Table 7. Smoothed 5-year average of the ratios of total unreported catch to reported commercial catch for primary Hawaiian bottomfish during the years 1948 – 2010 under catch scenario II; Deep 7 species are indicated by an *.

Fishing Year	Hapuupuu*	Kalekale*	Opakapaka*	Uku	Ehu*	Onaga*	Ulua Misc	Lehi*	Gindai*	Butaguchi	Black Ulua	White Ulua	Yellowtail Kalekale
1948	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1949	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1950	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1951	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1952	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1953	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1954	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1955	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1956	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1957	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1958	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1959	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1960	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1961	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1962	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1963	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1964	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1965	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1966	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1967	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1968	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1969	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1970	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1971	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1972	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1973	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1974	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1975	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1976	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1977	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1978	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1979	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20

Table 7. Continued.

Fishing Year	Hapuupuu*	Kalekale*	Opakapaka*	Uku	Ehu*	Onaga*	Ulua Misc	Lehi*	Gindai*	Butaguchi	Black Ulua	White Ulua	Yellowtail Kalekale
1980	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1981	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1982	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1983	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1984	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1985	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1986	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1987	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1988	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1989	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1990	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1991	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1992	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1993	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1994	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1995	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1996	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1997	1.02	0.03	2.87	2.27	1.11	0.73	4.52	0.04	0.15	1.29	1.24	2.41	0.20
1998	0.93	0.08	2.69	2.19	0.94	0.59	4.52	0.05	0.24	1.19	1.04	4.44	0.20
1999	0.85	0.13	2.51	2.10	0.77	0.46	4.52	0.06	0.34	1.10	0.83	6.46	0.20
2000	0.76	0.18	2.33	2.02	0.59	0.32	4.52	0.08	0.43	1.00	0.63	8.49	0.20
2001	0.68	0.23	2.15	1.93	0.42	0.19	4.52	0.09	0.52	0.90	0.43	10.51	0.20
2002	0.59	0.28	1.97	1.85	0.25	0.05	4.52	0.10	0.61	0.81	0.23	12.54	0.20
2003	0.59	0.28	1.97	1.85	0.25	0.05	4.52	0.10	0.61	0.81	0.23	12.54	0.20
2004	0.59	0.28	1.97	1.85	0.25	0.05	4.52	0.10	0.61	0.81	0.23	12.54	0.20
2005	0.59	0.28	1.97	1.85	0.25	0.05	4.52	0.10	0.61	0.81	0.23	12.54	0.20
2006	0.59	0.28	1.97	1.85	0.25	0.05	4.52	0.10	0.61	0.81	0.23	12.54	0.20
2007	0.59	0.28	1.97	1.85	0.25	0.05	4.52	0.10	0.61	0.81	0.23	12.54	0.20
2008	0.59	0.28	1.97	1.85	0.25	0.05	4.52	0.10	0.61	0.81	0.23	12.54	0.20
2009	0.59	0.28	1.97	1.85	0.25	0.05	4.52	0.10	0.61	0.81	0.23	12.54	0.20
2010	0.59	0.28	1.97	1.85	0.25	0.05	4.52	0.10	0.61	0.81	0.23	12.54	0.20

Table 8. Summary of primary bottomfish catches and unreported catch ratios in the MHI from 1948 – 2010 estimated under catch scenario I.

Fishing Year	Reported Catch (1000 lbs)	Unreported Catch (1000 lbs)	Total Catch (1000 lbs)	Unreported to Reported Catch Ratio (C_U/C_R)	Percent Unreported Catch (C_U/C_T)
1948	353	800	1,153	2.27	69%
1949	596	1,353	1,949	2.27	69%
1950	492	1,117	1,609	2.27	69%
1951	480	1,090	1,570	2.27	69%
1952	473	1,074	1,547	2.27	69%
1953	440	999	1,439	2.27	69%
1954	405	919	1,323	2.27	69%
1955	342	777	1,120	2.27	69%
1956	455	1,033	1,488	2.27	69%
1957	479	1,087	1,566	2.27	69%
1958	350	794	1,144	2.27	69%
1959	342	777	1,120	2.27	69%
1960	252	571	823	2.27	69%
1961	220	499	719	2.27	69%
1962	279	634	914	2.27	69%
1963	336	763	1,100	2.27	69%
1964	339	769	1,108	2.27	69%
1965	358	814	1,172	2.27	69%
1966	276	626	901	2.27	69%
1967	370	841	1,211	2.27	69%
1968	299	679	978	2.27	69%
1969	299	680	979	2.27	69%
1970	259	587	846	2.27	69%
1971	223	507	730	2.27	69%
1972	328	745	1,073	2.27	69%
1973	251	570	821	2.27	69%
1974	353	801	1,154	2.27	69%
1975	349	793	1,142	2.27	69%
1976	404	917	1,321	2.27	69%
1977	405	920	1,326	2.27	69%
1978	473	1,144	1,617	2.42	71%
1979	444	1,138	1,582	2.56	72%
1980	380	1,030	1,410	2.71	73%
1981	498	1,420	1,918	2.85	74%
1982	504	1,513	2,017	3.00	75%
1983	626	1,878	2,504	3.00	75%
1984	610	1,830	2,441	3.00	75%
1985	686	2,058	2,744	3.00	75%
1986	662	1,985	2,647	3.00	75%
1987	775	2,326	3,101	3.00	75%
1988	847	2,456	3,302	2.90	74%
1989	1,027	2,876	3,904	2.80	74%
1990	696	1,879	2,574	2.70	73%
1991	536	1,393	1,929	2.60	72%
1992	523	1,307	1,830	2.50	71%
1993	379	947	1,325	2.50	71%
1994	427	1,067	1,493	2.50	71%
1995	483	1,208	1,691	2.50	71%
1996	396	989	1,385	2.50	71%
1997	417	1,043	1,460	2.50	71%
1998	404	1,009	1,413	2.50	71%
1999	330	824	1,154	2.50	71%
2000	430	1,074	1,504	2.50	71%
2001	362	906	1,268	2.50	71%
2002	307	766	1,073	2.50	71%
2003	307	768	1,075	2.50	71%
2004	282	705	986	2.50	71%
2005	338	845	1,183	2.50	71%
2006	263	659	922	2.50	71%
2007	311	777	1,088	2.50	71%
2008	301	754	1,055	2.50	71%
2009	351	878	1,229	2.50	71%
2010	340	849	1,189	2.50	71%
Average 2008-2010	331	827	1,157	2.50	71%

Table 9. Summary of primary bottomfish catches and unreported catch ratios in the MHI from 1948 – 2010 estimated under catch scenario II.

Fishing Year	Reported Catch (1000 lbs)	Unreported Catch (1000 lbs)	Total Catch (1000 lbs)	Unreported to Reported Catch Ratio (C_U/C_R)	Percent Unreported Catch (C_U/C_T)
1948	353	844	1,196	2.39	71%
1949	596	1,436	2,032	2.41	71%
1950	492	1,170	1,662	2.38	70%
1951	480	1,090	1,570	2.27	69%
1952	473	1,067	1,540	2.25	69%
1953	440	1,024	1,464	2.33	70%
1954	405	871	1,276	2.15	68%
1955	342	713	1,055	2.08	68%
1956	455	1,027	1,482	2.26	69%
1957	479	1,039	1,518	2.17	68%
1958	350	794	1,144	2.27	69%
1959	342	755	1,098	2.20	69%
1960	252	563	814	2.24	69%
1961	220	506	726	2.30	70%
1962	279	624	904	2.23	69%
1963	336	758	1,094	2.25	69%
1964	339	771	1,110	2.27	69%
1965	358	834	1,192	2.33	70%
1966	276	603	879	2.19	69%
1967	370	904	1,275	2.44	71%
1968	299	680	979	2.27	69%
1969	299	745	1,044	2.49	71%
1970	259	612	871	2.37	70%
1971	223	520	743	2.33	70%
1972	328	744	1,073	2.27	69%
1973	251	591	843	2.35	70%
1974	353	869	1,222	2.46	71%
1975	349	821	1,170	2.35	70%
1976	404	921	1,325	2.28	70%
1977	405	923	1,328	2.28	69%
1978	473	1,097	1,570	2.32	70%
1979	444	1,098	1,542	2.47	71%
1980	380	964	1,345	2.54	72%
1981	498	1,282	1,779	2.58	72%
1982	504	1,182	1,687	2.34	70%
1983	626	1,479	2,105	2.36	70%
1984	610	1,416	2,026	2.32	70%
1985	686	1,345	2,031	1.96	66%
1986	662	1,189	1,850	1.80	64%
1987	775	1,502	2,278	1.94	66%
1988	847	1,830	2,676	2.16	68%
1989	1,027	2,358	3,385	2.30	70%
1990	696	1,485	2,180	2.13	68%
1991	536	1,151	1,687	2.15	68%
1992	523	1,111	1,634	2.13	68%
1993	379	838	1,216	2.21	69%
1994	427	927	1,354	2.17	68%
1995	483	1,041	1,524	2.15	68%
1996	396	871	1,266	2.20	69%
1997	417	897	1,314	2.15	68%
1998	404	826	1,230	2.05	67%
1999	330	647	976	1.96	66%
2000	430	756	1,185	1.76	64%
2001	362	613	975	1.69	63%
2002	307	494	800	1.61	62%
2003	307	497	804	1.62	62%
2004	282	463	745	1.64	62%
2005	338	555	893	1.64	62%
2006	263	408	671	1.55	61%
2007	311	613	924	1.97	66%
2008	301	600	901	1.99	67%
2009	351	590	941	1.68	63%
2010	340	619	958	1.82	65%
Average 2008-2010	331	603	934	1.83	65%

Table 10. Summary of primary bottomfish catches and unreported catch ratios in the MHI from 1948 – 2010 estimated under catch scenario III.

Fishing Year	Reported Catch (1000 lbs)	Unreported Catch (1000 lbs)	Total Catch (1000 lbs)	Unreported to Reported Catch Ratio (C_U/C_R)	Percent Unreported Catch (C_U/C_T)
1948	353	71	423	0.20	17%
1949	596	119	715	0.20	17%
1950	492	98	591	0.20	17%
1951	480	96	576	0.20	17%
1952	473	95	568	0.20	17%
1953	440	88	528	0.20	17%
1954	405	81	486	0.20	17%
1955	342	68	411	0.20	17%
1956	455	91	546	0.20	17%
1957	479	96	575	0.20	17%
1958	350	70	420	0.20	17%
1959	342	68	411	0.20	17%
1960	252	50	302	0.20	17%
1961	220	44	264	0.20	17%
1962	279	56	335	0.20	17%
1963	336	67	404	0.20	17%
1964	339	68	407	0.20	17%
1965	358	72	430	0.20	17%
1966	276	55	331	0.20	17%
1967	370	74	444	0.20	17%
1968	299	60	359	0.20	17%
1969	299	60	359	0.20	17%
1970	259	52	310	0.20	17%
1971	223	45	268	0.20	17%
1972	328	66	394	0.20	17%
1973	251	50	301	0.20	17%
1974	353	71	423	0.20	17%
1975	349	70	419	0.20	17%
1976	404	81	485	0.20	17%
1977	405	81	487	0.20	17%
1978	473	95	568	0.20	17%
1979	444	89	533	0.20	17%
1980	380	76	456	0.20	17%
1981	498	100	597	0.20	17%
1982	504	101	605	0.20	17%
1983	626	125	751	0.20	17%
1984	610	122	732	0.20	17%
1985	686	137	823	0.20	17%
1986	662	132	794	0.20	17%
1987	775	155	930	0.20	17%
1988	847	169	1,016	0.20	17%
1989	1,027	205	1,233	0.20	17%
1990	696	139	835	0.20	17%
1991	536	107	643	0.20	17%
1992	523	105	627	0.20	17%
1993	379	76	454	0.20	17%
1994	427	85	512	0.20	17%
1995	483	97	580	0.20	17%
1996	396	79	475	0.20	17%
1997	417	83	501	0.20	17%
1998	404	81	484	0.20	17%
1999	330	66	396	0.20	17%
2000	430	86	516	0.20	17%
2001	362	72	435	0.20	17%
2002	307	61	368	0.20	17%
2003	307	61	369	0.20	17%
2004	282	56	338	0.20	17%
2005	338	68	406	0.20	17%
2006	263	53	316	0.20	17%
2007	311	62	373	0.20	17%
2008	301	60	362	0.20	17%
2009	351	70	421	0.20	17%
2010	340	68	408	0.20	17%
Average 2008-2010	331	66	397	0.20	17%

Table 11. Summary of primary bottomfish catches and unreported catch ratios in the MHI from 1948 – 2010 estimated under catch scenario IV.

Fishing Year	Reported Catch (1000 lbs)	Unreported Catch (1000 lbs)	Total Catch (1000 lbs)	Unreported to Reported Catch Ratio (C_U/C_R)	Percent Unreported Catch (C_U/C_T)
1948	353	0	353	0.00	0%
1949	596	0	596	0.00	0%
1950	492	0	492	0.00	0%
1951	480	0	480	0.00	0%
1952	473	0	473	0.00	0%
1953	440	0	440	0.00	0%
1954	405	0	405	0.00	0%
1955	342	0	342	0.00	0%
1956	455	0	455	0.00	0%
1957	479	0	479	0.00	0%
1958	350	0	350	0.00	0%
1959	342	0	342	0.00	0%
1960	252	0	252	0.00	0%
1961	220	0	220	0.00	0%
1962	279	0	279	0.00	0%
1963	336	0	336	0.00	0%
1964	339	0	339	0.00	0%
1965	358	0	358	0.00	0%
1966	276	0	276	0.00	0%
1967	370	0	370	0.00	0%
1968	299	0	299	0.00	0%
1969	299	0	299	0.00	0%
1970	259	0	259	0.00	0%
1971	223	0	223	0.00	0%
1972	328	0	328	0.00	0%
1973	251	0	251	0.00	0%
1974	353	0	353	0.00	0%
1975	349	0	349	0.00	0%
1976	404	0	404	0.00	0%
1977	405	0	405	0.00	0%
1978	473	0	473	0.00	0%
1979	444	0	444	0.00	0%
1980	380	0	380	0.00	0%
1981	498	0	498	0.00	0%
1982	504	0	504	0.00	0%
1983	626	0	626	0.00	0%
1984	610	0	610	0.00	0%
1985	686	0	686	0.00	0%
1986	662	0	662	0.00	0%
1987	775	0	775	0.00	0%
1988	847	0	847	0.00	0%
1989	1,027	0	1,027	0.00	0%
1990	696	0	696	0.00	0%
1991	536	0	536	0.00	0%
1992	523	0	523	0.00	0%
1993	379	0	379	0.00	0%
1994	427	0	427	0.00	0%
1995	483	0	483	0.00	0%
1996	396	0	396	0.00	0%
1997	417	0	417	0.00	0%
1998	404	0	404	0.00	0%
1999	330	0	330	0.00	0%
2000	430	0	430	0.00	0%
2001	362	0	362	0.00	0%
2002	307	0	307	0.00	0%
2003	307	0	307	0.00	0%
2004	282	0	282	0.00	0%
2005	338	0	338	0.00	0%
2006	263	0	263	0.00	0%
2007	311	0	311	0.00	0%
2008	301	0	301	0.00	0%
2009	351	0	351	0.00	0%
2010	340	0	340	0.00	0%
Average 2008-2010	331	0	331	0.00	0%

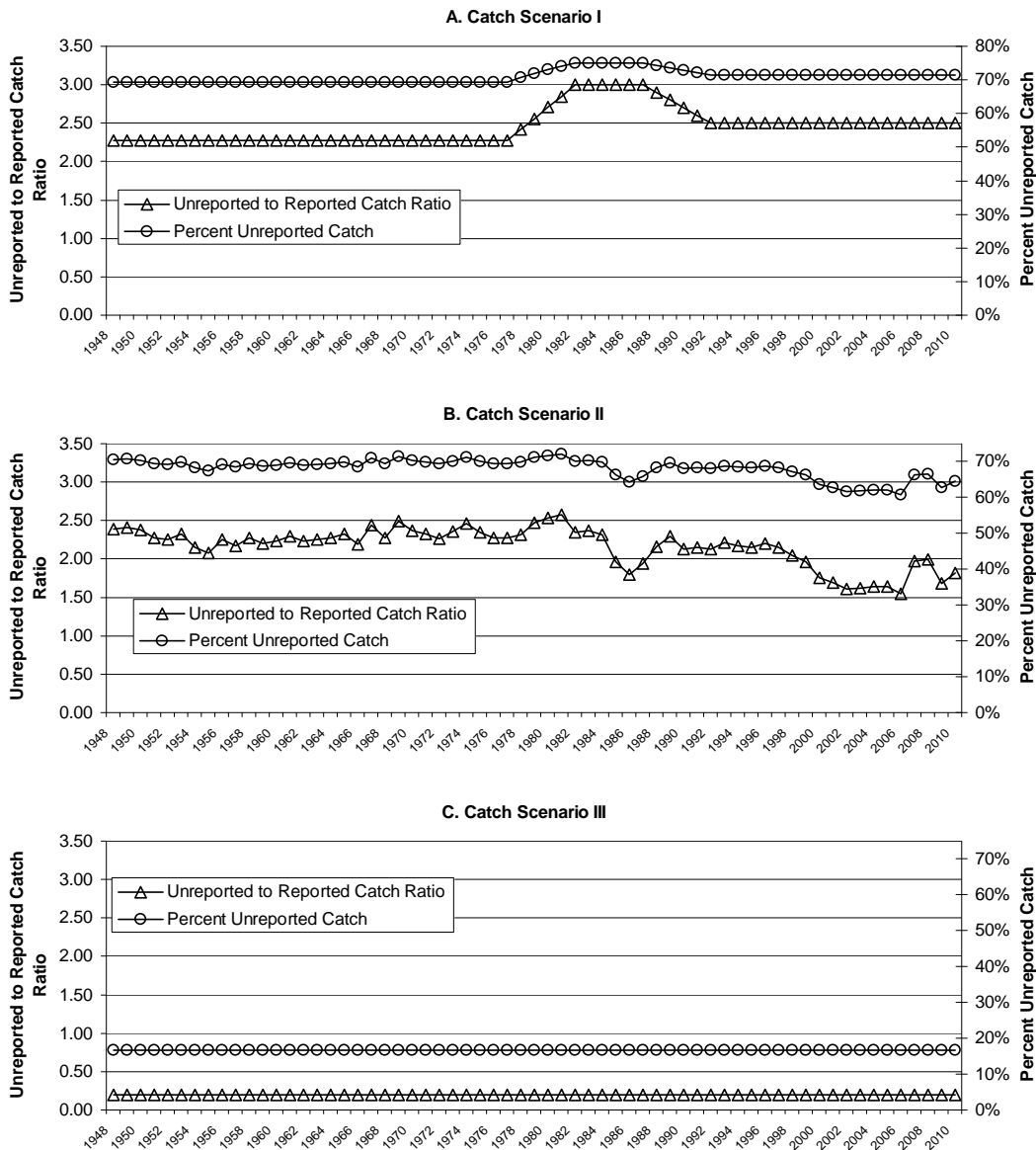


Figure 1. Summary of primary bottomfish unreported catch ratios in the MHI from 1948 – 2010 estimated under catch scenarios I – III; Catch Scenario IV assumed there was no unreported catch.

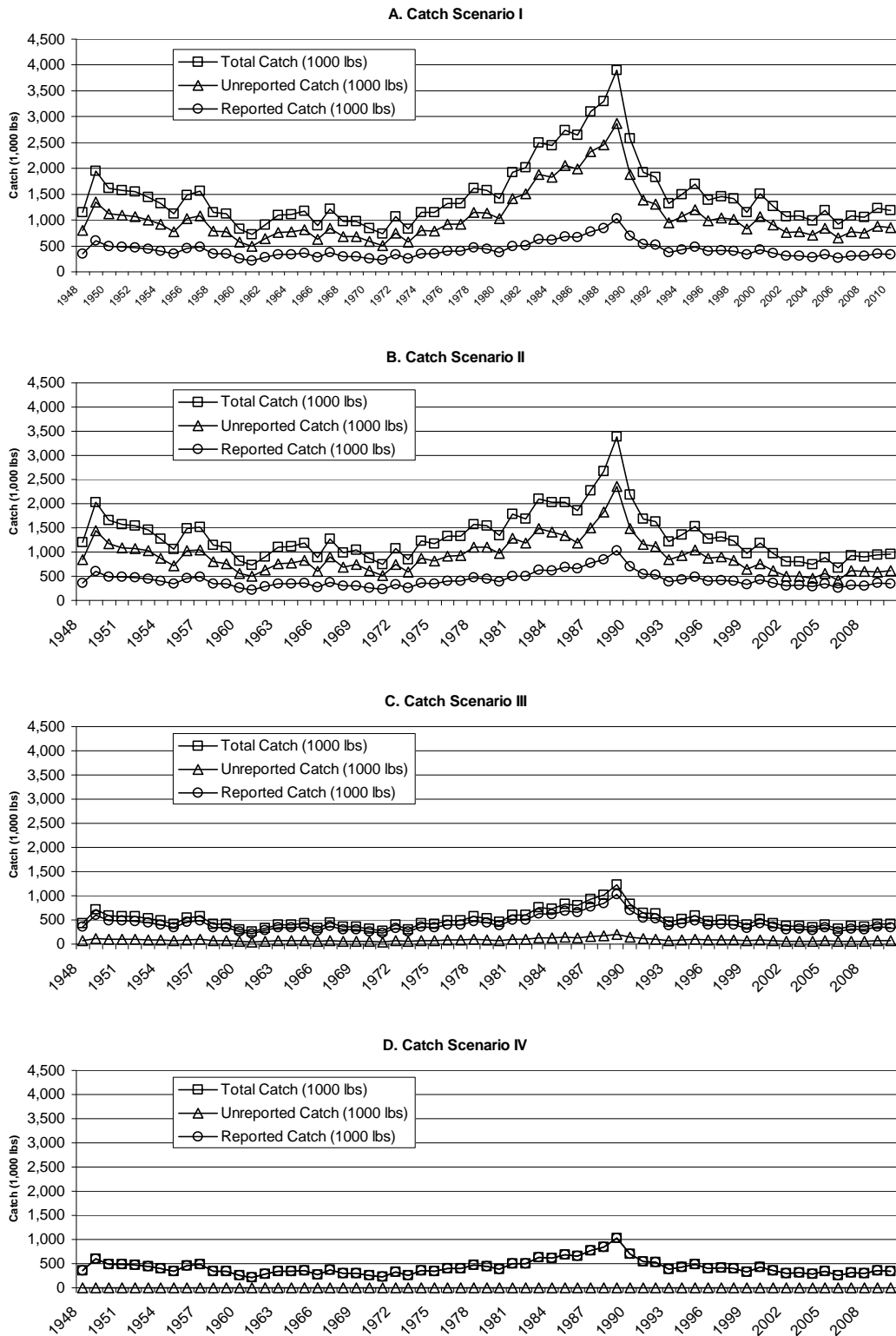


Figure 2. Summary of primary bottomfish catches in the MHI from 1948 – 2010 estimated under catch scenarios I – IV.

Appendix A. Catch Tables

Table A.1. Reported commercial catch (lbs) of primary bottomfish in the MHI by species from 1948 – 2010 from HDAR¹.

Fishing Year	Hapuupuu*	Kalekale*	Opakapaka*	Uku	Ehu*	Onaga*	Ulua Misc	Lehi*	Gindai*	Butaguchi	Black Ulua	White Ulua	Yellowtail Kalekale	Total
1948	9,928	14,355	75,458	58,695	59,070	32,773	86,950	15,170	217					352,616
1949	29,545	36,763	111,955	77,169	103,362	66,566	164,617	5,695	209					595,881
1950	18,619	29,176	113,681	70,359	75,304	61,166	118,384	4,641	770					492,100
1951	22,404	32,091	133,028	51,692	66,010	72,679	97,333	2,833	2,050					480,120
1952	32,554	45,666	139,668	48,142	54,430	45,625	94,521	9,584	2,899					473,089
1953	23,039	32,508	108,562	78,242	50,410	49,899	92,377	2,897	2,000					439,934
1954	16,682	40,183	103,998	59,844	40,765	65,531	71,870	3,885	1,876					404,634
1955	18,389	28,534	80,601	69,701	30,136	61,707	49,634	1,138	2,636					342,476
1956	27,319	32,441	110,206	77,416	40,069	69,438	90,730	3,833	3,721					455,173
1957	18,090	29,581	147,674	84,066	37,167	84,578	66,640	8,748	2,208					478,752
1958	20,887	17,481	93,922	76,121	26,836	52,232	57,809	2,414	2,020					349,722
1959	16,746	19,414	92,171	67,481	23,064	65,626	54,374	2,124	1,492					342,492
1960	12,886	19,312	70,573	43,916	19,449	39,379	43,333	1,604	1,195					251,647
1961	7,185	19,614	56,196	41,425	13,015	36,620	44,518	951	418					219,942
1962	10,538	17,598	84,570	54,400	16,435	51,087	42,260	1,773	838					279,499
1963	13,253	18,489	97,072	64,652	23,928	60,776	54,671	2,678	782					336,301
1964	11,247	23,491	95,232	80,791	24,717	47,129	53,016	987	2,314					338,924
1965	12,914	14,752	106,333	68,642	21,493	69,214	62,910	1,272	957					358,487
1966	11,863	13,553	71,407	46,823	18,144	64,061	46,900	2,008	832					275,591
1967	12,373	9,599	123,002	64,215	18,402	68,442	71,219	2,376	769					370,397
1968	11,308	6,896	84,483	52,362	19,879	69,504	51,622	2,215	754					299,023
1969	10,897	4,157	85,944	54,139	16,168	53,935	67,746	5,924	470					299,380
1970	19,850	5,132	69,690	49,794	15,870	43,540	50,686	2,676	1,437					258,675
1971	14,479	4,337	59,121	48,418	15,303	39,270	39,692	1,806	873					223,299
1972	17,985	8,203	118,706	54,139	21,377	58,924	43,143	4,430	1,245					328,152
1973	14,845	5,106	93,356	46,578	14,561	35,620	35,372	4,522	1,263					251,223
1974	14,625	4,862	135,213	72,955	21,117	43,607	54,115	4,876	1,467					352,837
1975	23,201	5,961	116,184	75,490	21,919	45,054	51,771	8,392	1,403					349,375
1976	22,399	7,907	105,489	69,102	31,279	80,234	76,156	10,335	1,209					404,110
1977	30,461	8,598	106,338	47,241	35,907	84,753	83,337	7,270	1,555					405,460
1978	28,719	9,826	154,642	95,086	35,704	66,505	70,503	9,791	2,553					473,329
1979	29,556	7,754	146,011	82,757	22,491	53,027	87,475	12,124	2,883					444,078
1980	17,732	7,047	151,057	64,219	16,996	31,344	71,610	17,828	2,389					380,222

*Deep 7 species.

¹ Reported commercial catch of the primary Hawaiian bottomfish species in the MHI during the years 1948 – 2010 was provided from data used in the current stock assessment of the Hawaiian bottomfish (Brodziak et al., 2011). The methods used to obtain the data are the same as those used in the previous assessment (Brodziak et al., 1999) and are described in detail in the current assessment document (Brodziak et al., 2011).

Table A.1. Continued.

Fishing Year	Hapuupuu*	Kalekale*	Opakapaka*	Uku	Ehu*	Onaga*	Ulua Misc	Lehi*	Gindai*	Butaguchi	Black Ulua	White Ulua	Yellowtail Kalekale	Total
1981	16,963	8,178	197,367	95,038	21,151	42,869	94,250	19,924	1,854					497,594
1982	21,680	8,050	177,728	92,896	24,436	65,945	78,682	29,982	1,615	1,463		1,845		504,322
1983	32,752	15,002	230,425	113,858	28,025	72,801	92,382	28,477	2,678	1,081		8,438		625,919
1984	29,731	13,421	159,352	143,029	36,160	86,599	97,964	16,543	3,565	1,733	47	22,005		610,149
1985	33,219	22,693	203,672	96,025	44,030	173,871	65,254	25,552	4,602	4,746	111	12,179		685,954
1986	26,541	25,409	181,382	67,680	61,887	196,513	52,620	27,706	3,756	7,214	916	10,052		661,676
1987	32,283	28,399	267,383	87,432	49,185	175,563	56,473	38,696	3,283	22,684	378	13,550		775,309
1988	10,411	18,169	301,907	185,549	42,058	157,161	73,189	38,239	2,063	6,019	223	11,753		846,741
1989	13,587	11,087	308,235	313,640	38,474	145,405	115,335	45,299	1,681	7,086	461	26,991		1,027,281
1990	14,173	15,486	210,366	134,539	37,630	141,548	81,519	34,944	2,785	8,703	228	13,868		695,789
1991	14,916	18,284	135,857	112,329	30,806	102,908	73,597	18,970	3,524	11,479	84	13,143		535,897
1992	15,254	28,047	173,122	93,561	31,907	91,813	58,025	17,254	5,120	1,619		7,185		522,907
1993	13,268	16,956	138,624	65,925	23,926	52,634	43,043	11,177	3,765	6,281	161	2,939		378,699
1994	10,353	17,894	173,718	77,510	23,238	68,453	33,955	11,631	3,978	2,762	23	3,151		426,666
1995	19,481	21,796	198,166	71,141	27,225	73,607	41,342	14,379	4,451	8,407	382	2,640		483,017
1996	10,332	20,270	145,802	46,954	29,125	69,633	51,523	10,419	3,185	2,519	76	5,827		395,663
1997	14,059	22,800	160,493	69,408	26,127	61,339	37,917	11,822	3,044	6,371	119	3,778		417,276
1998	12,686	24,432	149,681	56,658	26,364	70,849	44,244	9,386	3,357	2,467	328	3,224		403,676
1999	9,906	11,071	103,810	77,120	19,532	59,403	32,813	8,754	2,328	1,905	81	3,072		329,794
2000	13,148	15,863	167,036	93,725	26,713	72,639	20,498	11,185	3,165	2,576		3,233		429,778
2001	15,465	15,298	125,005	68,170	26,474	63,017	27,150	11,508	3,649	1,998	145	4,519	5	362,403
2002	9,034	10,298	105,143	62,084	16,958	59,999	22,658	11,715	2,434	1,978	329	3,918	1	306,548
2003	9,441	12,010	127,685	43,722	16,254	68,487	7,740	8,553	2,131	1,989	527	8,654		307,193
2004	7,924	8,040	88,023	58,894	19,181	75,954	2,383	4,919	2,080	790	1,499	12,107	18	281,811
2005	10,402	7,831	104,365	75,478	22,575	89,774	2,018	6,898	2,006	1,985	558	14,190	38	338,118
2006	7,258	5,503	75,981	62,110	18,891	74,466	441	6,308	1,608	537	367	9,955	44	263,469
2007	7,537	6,147	92,398	64,588	19,463	85,517	740	8,383	2,305	177	457	23,151	1	310,864
2008	6,579	5,532	96,215	83,632	18,234	55,745	482	11,043	2,828	1,743	604	18,811		301,447
2009	7,878	9,583	133,374	82,282	24,474	59,242	265	16,771	3,598	676	659	12,200	21	351,023
2010	8,189	8,151	106,368	104,860	24,195	57,564	2,758	6,117	2,746	759	3,332	14,582	20	339,640

Table A.2. Catch Scenario I: Estimated unreported catch (lbs) of primary bottomfish in the MHI by species from 1948 – 2010 using the smoothed 5-year moving average of the ratios of total unreported catch to reported commercial catch (Ut) derived for Catch Scenario I (Table 3); Deep 7 species are indicated by an *.

Ut	5-year avg.	Fishing Year	Hapuupuu*	Kalekale*	Opakapaka*	Uku	Ehu*	Onaga*	Ulua Misc	Lehi*	Gindai*	Butaguchi	Black Ulua	White Ulua	Yellowtail Kalekale	Total
2.27	2.27	1948	22,537	32,586	171,290	133,238	134,089	74,395	197,377	34,436	493	0	0	0	0	800,438
2.27	2.27	1949	67,067	83,452	254,138	175,174	234,632	151,105	373,681	12,928	474	0	0	0	0	1,352,650
2.27	2.27	1950	42,265	66,230	258,056	159,715	170,940	138,847	268,732	10,535	1,748	0	0	0	0	1,117,067
2.27	2.27	1951	50,857	72,847	301,974	117,341	149,843	164,981	220,946	6,431	4,654	0	0	0	0	1,089,872
2.27	2.27	1952	73,898	103,662	317,046	109,282	123,556	103,569	214,563	21,756	6,581	0	0	0	0	1,073,912
2.27	2.27	1953	52,299	73,793	246,436	177,609	114,431	113,271	209,696	6,576	4,540	0	0	0	0	998,650
2.27	2.27	1954	37,868	91,215	236,075	135,846	92,537	148,755	163,145	8,819	4,259	0	0	0	0	918,519
2.27	2.27	1955	41,743	64,772	182,964	158,221	68,409	140,075	112,669	2,583	5,984	0	0	0	0	777,421
2.27	2.27	1956	62,014	73,641	250,168	175,734	90,957	157,624	205,957	8,701	8,447	0	0	0	0	1,033,243
2.27	2.27	1957	41,064	67,149	335,220	190,830	84,369	191,992	151,273	19,858	5,012	0	0	0	0	1,086,767
2.27	2.27	1958	47,413	39,682	213,203	172,795	60,918	118,567	131,226	5,480	4,585	0	0	0	0	793,869
2.27	2.27	1959	38,013	44,070	209,228	153,182	52,355	148,971	123,429	4,821	3,387	0	0	0	0	777,457
2.27	2.27	1960	29,251	43,838	160,201	99,689	44,149	89,390	98,366	3,641	2,713	0	0	0	0	571,239
2.27	2.27	1961	16,310	44,524	127,565	94,035	29,544	83,127	101,056	2,159	949	0	0	0	0	499,268
2.27	2.27	1962	23,921	39,947	191,974	123,488	37,307	115,967	95,930	4,025	1,902	0	0	0	0	634,463
2.27	2.27	1963	30,084	41,970	220,353	146,760	54,317	137,962	124,103	6,079	1,775	0	0	0	0	763,403
2.27	2.27	1964	25,531	53,325	216,177	183,396	56,108	106,983	120,346	2,240	5,253	0	0	0	0	769,357
2.27	2.27	1965	29,315	33,487	241,376	155,817	48,789	157,116	142,806	2,887	2,172	0	0	0	0	813,765
2.27	2.27	1966	26,929	30,765	162,094	106,288	41,187	145,418	106,463	4,558	1,889	0	0	0	0	625,592
2.27	2.27	1967	28,087	21,790	279,215	145,768	41,773	155,363	161,667	5,394	1,746	0	0	0	0	840,801
2.27	2.27	1968	25,669	15,654	191,776	118,862	45,125	157,774	117,182	5,028	1,712	0	0	0	0	678,782
2.27	2.27	1969	24,736	9,436	195,093	122,896	36,701	122,432	153,783	13,447	1,067	0	0	0	0	679,593
2.27	2.27	1970	45,060	11,650	158,196	113,032	36,025	98,836	115,057	6,075	3,262	0	0	0	0	587,192
2.27	2.27	1971	32,867	9,845	134,205	109,909	34,738	89,143	90,101	4,100	1,982	0	0	0	0	506,889
2.27	2.27	1972	40,826	18,621	269,463	122,896	48,526	133,757	97,935	10,056	2,826	0	0	0	0	744,905
2.27	2.27	1973	33,698	11,591	211,918	105,732	33,053	80,857	80,294	10,265	2,867	0	0	0	0	570,276
2.27	2.27	1974	33,199	11,037	306,934	165,608	47,936	98,988	122,841	11,069	3,330	0	0	0	0	800,940
2.27	2.27	1975	52,666	13,531	263,738	171,362	49,756	102,273	117,520	19,050	3,185	0	0	0	0	793,081
2.27	2.27	1976	50,846	17,949	239,460	156,862	71,003	182,131	172,874	23,460	2,744	0	0	0	0	917,330
2.27	2.27	1977	69,146	19,517	241,387	107,237	81,509	192,389	189,175	16,503	3,530	0	0	0	0	920,394
2.27	2.42	1978	69,385	23,740	373,615	229,728	86,261	160,676	170,335	23,655	6,168	0	0	0	0	1,143,563
2.27	2.56	1979	75,722	19,866	374,080	212,023	57,622	135,855	224,111	31,062	7,386	0	0	0	0	1,137,728
3	2.71	1980	48,018	19,083	409,062	173,905	46,025	84,880	193,920	48,278	6,469	0	0	0	0	1,029,641

Table A.2. Continued.

Ut	5- year avg.	Fishing Year	Hapuupuu*	Kalekale*	Opakapaka*	Uku	Ehu*	Onaga*	Ulua Misc	Lehi*	Gindai*	Butaguchi	Black Ulua	White Ulua	Yellowtail Kalekale	Total
3	2.85	1981	48,412	23,340	563,285	271,238	60,365	122,348	268,990	56,863	5,291	0	0	0	0	1,420,133
3	3.00	1982	65,040	24,150	533,184	278,688	73,308	197,835	236,046	89,946	4,845	4,389	0	5,535	0	1,512,966
3	3.00	1983	98,256	45,006	691,275	341,574	84,075	218,403	277,146	85,431	8,034	3,243	0	25,314	0	1,877,757
3	3.00	1984	89,193	40,263	478,056	429,087	108,480	259,797	293,892	49,629	10,695	5,199	141	66,015	0	1,830,447
3	3.00	1985	99,657	68,079	611,016	288,075	132,090	521,613	195,762	76,656	13,806	14,238	333	36,537	0	2,057,862
3	3.00	1986	79,623	76,227	544,146	203,040	185,661	589,539	157,860	83,118	11,268	21,642	2,748	30,156	0	1,985,028
3	3.00	1987	96,849	85,197	802,149	262,296	147,555	526,689	169,419	116,088	9,849	68,052	1,134	40,650	0	2,325,927
3	2.90	1988	30,192	52,690	875,530	538,092	121,968	455,767	212,248	110,893	5,983	17,455	647	34,084	0	2,455,549
3	2.80	1989	38,044	31,044	863,058	878,192	107,727	407,134	322,938	126,837	4,707	19,841	1,291	75,575	0	2,876,387
2.5	2.70	1990	38,267	41,812	567,988	363,255	101,601	382,180	220,101	94,349	7,520	23,498	616	37,444	0	1,878,630
2.5	2.60	1991	38,782	47,538	353,228	292,055	80,096	267,561	191,352	49,322	9,162	29,845	218	34,172	0	1,393,332
2.5	2.50	1992	38,135	70,118	432,805	233,903	79,768	229,533	145,063	43,135	12,800	4,048	0	17,963	0	1,307,268
2.5	2.50	1993	33,170	42,390	346,560	164,813	59,815	131,585	107,608	27,943	9,413	15,703	403	7,348	0	946,748
2.5	2.50	1994	25,883	44,735	434,295	193,775	58,095	171,133	84,888	29,078	9,945	6,905	58	7,878	0	1,066,665
2.5	2.50	1995	48,703	54,490	495,415	177,853	68,063	184,018	103,355	35,948	11,128	21,018	955	6,600	0	1,207,543
2.5	2.50	1996	25,830	50,675	364,505	117,384	72,812	174,083	128,808	26,047	7,961	6,298	190	14,566	0	989,158
2.5	2.50	1997	35,146	57,000	401,232	173,520	65,317	153,349	94,792	29,556	7,609	15,928	298	9,444	0	1,043,189
2.5	2.50	1998	31,716	61,080	374,203	141,645	65,910	177,122	110,610	23,466	8,393	6,168	820	8,060	0	1,009,191
2.5	2.50	1999	24,765	27,677	259,524	192,799	48,831	148,508	82,033	21,884	5,821	4,763	203	7,680	0	824,484
2.5	2.50	2000	32,869	39,657	417,590	234,311	66,782	181,597	51,245	27,961	7,913	6,440	0	8,081	0	1,074,446
2.5	2.50	2001	38,663	38,244	312,513	170,426	66,185	157,541	67,875	28,771	9,123	4,996	361	11,298	13	906,007
2.5	2.50	2002	22,585	25,745	262,858	155,210	42,394	149,997	56,644	29,288	6,084	4,945	823	9,795	3	766,369
2.5	2.50	2003	23,602	30,025	319,211	109,306	40,636	171,218	19,349	21,383	5,329	4,973	1,318	21,635	0	767,983
2.5	2.50	2004	19,811	20,100	220,058	147,235	47,952	189,886	5,956	12,296	5,200	1,976	3,748	30,267	45	704,528
2.5	2.50	2005	26,005	19,578	260,912	188,695	56,437	224,435	5,046	17,246	5,014	4,963	1,394	35,476	95	845,294
2.5	2.50	2006	18,145	13,757	189,953	155,275	47,228	186,164	1,103	15,769	4,019	1,343	919	24,888	109	658,671
2.5	2.50	2007	18,841	15,368	230,996	161,471	48,657	213,793	1,850	20,959	5,762	442	1,142	57,877	3	777,161
2.5	2.50	2008	16,447	13,830	240,538	209,080	45,585	139,363	1,205	27,607	7,070	4,358	1,509	47,027	0	753,619
2.5	2.50	2009	19,696	23,958	333,436	205,706	61,186	148,106	663	41,927	8,994	1,690	1,646	30,501	51	877,558
2.5	2.50	2010	20,474	20,376	265,919	262,151	60,487	143,909	6,895	15,292	6,866	1,898	8,330	36,456	51	849,101

Table A.3. Catch Scenario I: Estimated total catch (lbs) of primary bottomfish in the MHI by species from 1948 – 2010 computed as reported commercial catch (Table A.1) plus estimated unreported catch (Table A.2) under Catch Scenario I; Deep 7 species are indicated by an *.

Fishing Year	Hapuupuu*	Kalekale*	Opakapaka*	Uku	Ehu*	Onaga*	Ulua Misc	Lehi*	Gindai*	Butaguchi	Black Ulua	White Ulua	Yellowtail Kalekale	Total
1948	32,465	46,941	246,748	191,933	193,159	107,168	284,327	49,606	710	0	0	0	0	1,153,054
1949	96,612	120,215	366,093	252,343	337,994	217,671	538,298	18,623	683	0	0	0	0	1,948,531
1950	60,884	95,406	371,737	230,074	246,244	200,013	387,116	15,176	2,518	0	0	0	0	1,609,167
1951	73,261	104,938	435,002	169,033	215,853	237,660	318,279	9,264	6,704	0	0	0	0	1,569,992
1952	106,452	149,328	456,714	157,424	177,986	149,194	309,084	31,340	9,480	0	0	0	0	1,547,001
1953	75,338	106,301	354,998	255,851	164,841	163,170	302,073	9,473	6,540	0	0	0	0	1,438,584
1954	54,550	131,398	340,073	195,690	133,302	214,286	235,015	12,704	6,135	0	0	0	0	1,323,153
1955	60,132	93,306	263,565	227,922	98,545	201,782	162,303	3,721	8,620	0	0	0	0	1,119,897
1956	89,333	106,082	360,374	253,150	131,026	227,062	296,687	12,534	12,168	0	0	0	0	1,488,416
1957	59,154	96,730	482,894	274,896	121,536	276,570	217,913	28,606	7,220	0	0	0	0	1,565,519
1958	68,300	57,163	307,125	248,916	87,754	170,799	189,035	7,894	6,605	0	0	0	0	1,143,591
1959	54,759	63,484	301,399	220,663	75,419	214,597	177,803	6,945	4,879	0	0	0	0	1,119,949
1960	42,137	63,150	230,774	143,605	63,598	128,769	141,699	5,245	3,908	0	0	0	0	822,886
1961	23,495	64,138	183,761	135,460	42,559	119,747	145,574	3,110	1,367	0	0	0	0	719,210
1962	34,459	57,545	276,544	177,888	53,742	167,054	138,190	5,798	2,740	0	0	0	0	913,962
1963	43,337	60,459	317,425	211,412	78,245	198,738	178,774	8,757	2,557	0	0	0	0	1,099,704
1964	36,778	76,816	311,409	264,187	80,825	154,112	173,362	3,227	7,567	0	0	0	0	1,108,281
1965	42,229	48,239	347,709	224,459	70,282	226,330	205,716	4,159	3,129	0	0	0	0	1,172,252
1966	38,792	44,318	233,501	153,111	59,331	209,479	153,363	6,566	2,721	0	0	0	0	901,183
1967	40,460	31,389	402,217	209,983	60,175	223,805	232,886	7,770	2,515	0	0	0	0	1,211,198
1968	36,977	22,550	276,259	171,224	65,004	227,278	168,804	7,243	2,466	0	0	0	0	977,805
1969	35,633	13,593	281,037	177,035	52,869	176,367	221,529	19,371	1,537	0	0	0	0	978,973
1970	64,910	16,782	227,886	162,826	51,895	142,376	165,743	8,751	4,699	0	0	0	0	845,867
1971	47,346	14,182	193,326	158,327	50,041	128,413	129,793	5,906	2,855	0	0	0	0	730,188
1972	58,811	26,824	388,169	177,035	69,903	192,681	141,078	14,486	4,071	0	0	0	0	1,073,057
1973	48,543	16,697	305,274	152,310	47,614	116,477	115,666	14,787	4,130	0	0	0	0	821,499
1974	47,824	15,899	442,147	238,563	69,053	142,595	176,956	15,945	4,797	0	0	0	0	1,153,777
1975	75,867	19,492	379,922	246,852	71,675	147,327	169,291	27,442	4,588	0	0	0	0	1,142,456
1976	73,245	25,856	344,949	225,964	102,282	262,365	249,030	33,795	3,953	0	0	0	0	1,321,440
1977	99,607	28,115	347,725	154,478	117,416	277,142	272,512	23,773	5,085	0	0	0	0	1,325,854
1978	98,104	33,566	528,257	324,814	121,965	227,181	240,838	33,446	8,721	0	0	0	0	1,616,892
1979	105,278	27,620	520,091	294,780	80,113	188,882	311,586	43,186	10,269	0	0	0	0	1,581,806
1980	65,750	26,130	560,119	238,124	63,021	116,224	265,530	66,106	8,858	0	0	0	0	1,409,863

Table A.3. Continued.

Fishing Year	Hapuupuu*	Kalekale*	Opakapaka*	Uku	Ehu*	Onaga*	Ulua Misc	Lehi*	Gindai*	Butaguchi	Black Ulua	White Ulua	Yellowtail Kalekale	Total
1981	65,375	31,518	760,652	366,276	81,516	165,217	363,240	76,787	7,145	0	0	0	0	1,917,727
1982	86,720	32,200	710,912	371,584	97,744	263,780	314,728	119,928	6,460	5,852	0	7,380	0	2,017,288
1983	131,008	60,008	921,700	455,432	112,100	291,204	369,528	113,908	10,712	4,324	0	33,752	0	2,503,676
1984	118,924	53,684	637,408	572,116	144,640	346,396	391,856	66,172	14,260	6,932	188	88,020	0	2,440,596
1985	132,876	90,772	814,688	384,100	176,120	695,484	261,016	102,208	18,408	18,984	444	48,716	0	2,743,816
1986	106,164	101,636	725,528	270,720	247,548	786,052	210,480	110,824	15,024	28,856	3,664	40,208	0	2,646,704
1987	129,132	113,596	1,069,532	349,728	196,740	702,252	225,892	154,784	13,132	90,736	1,512	54,200	0	3,101,236
1988	40,603	70,859	1,177,437	723,641	164,026	612,928	285,437	149,132	8,046	23,474	870	45,837	0	3,302,290
1989	51,631	42,131	1,171,293	1,191,832	146,201	552,539	438,273	172,136	6,388	26,927	1,752	102,566	0	3,903,668
1990	52,440	57,298	778,354	497,794	139,231	523,728	301,620	129,293	10,305	32,201	844	51,312	0	2,574,419
1991	53,698	65,822	489,085	404,384	110,902	370,469	264,949	68,292	12,686	41,324	302	47,315	0	1,929,229
1992	53,389	98,165	605,927	327,464	111,675	321,346	203,088	60,389	17,920	5,667	0	25,148	0	1,830,175
1993	46,438	59,346	485,184	230,738	83,741	184,219	150,651	39,120	13,178	21,984	564	10,287	0	1,325,447
1994	36,236	62,629	608,013	271,285	81,333	239,586	118,843	40,709	13,923	9,667	81	11,029	0	1,493,331
1995	68,184	76,286	693,581	248,994	95,288	257,625	144,697	50,327	15,579	29,425	1,337	9,240	0	1,690,560
1996	36,162	70,945	510,306	164,337	101,937	243,716	180,331	36,465	11,146	8,817	266	20,393	0	1,384,821
1997	49,205	79,799	561,725	242,928	91,444	214,688	132,709	41,378	10,652	22,299	417	13,221	0	1,460,465
1998	44,402	85,511	523,884	198,303	92,274	247,970	154,854	32,852	11,751	8,635	1,148	11,284	0	1,412,867
1999	34,670	38,747	363,333	269,919	68,363	207,911	114,846	30,638	8,149	6,669	284	10,751	0	1,154,278
2000	46,016	55,520	584,626	328,036	93,494	254,235	71,743	39,146	11,078	9,016	0	11,314	0	1,504,224
2001	54,128	53,542	437,518	238,596	92,658	220,558	95,025	40,279	12,772	6,994	506	15,817	18	1,268,409
2002	31,619	36,043	368,001	217,294	59,351	209,996	79,301	41,003	8,517	6,923	1,152	13,713	4	1,072,917
2003	33,042	42,035	446,896	153,028	56,890	239,705	27,089	29,936	7,460	6,962	1,845	30,289	0	1,075,176
2004	27,735	28,140	308,081	206,129	67,132	265,840	8,339	17,215	7,279	2,766	5,247	42,373	63	986,339
2005	36,406	27,409	365,276	264,173	79,012	314,209	7,064	24,144	7,020	6,948	1,951	49,666	133	1,183,411
2006	25,402	19,260	265,935	217,385	66,119	260,630	1,544	22,077	5,627	1,881	1,286	34,843	152	922,140
2007	26,378	21,515	323,394	226,059	68,120	299,311	2,589	29,342	8,067	618	1,599	81,028	4	1,088,025
2008	23,026	19,362	336,753	292,712	63,819	195,109	1,687	38,650	9,898	6,101	2,112	65,838	0	1,055,066
2009	27,574	33,541	466,810	287,988	85,660	207,348	928	58,697	12,592	2,366	2,305	42,701	72	1,228,581
2010	28,663	28,527	372,287	367,011	84,681	201,473	9,652	21,409	9,612	2,657	11,661	51,038	71	1,188,741

Table A.4. Catch Scenario II: Estimated unreported catch (lbs) of primary bottomfish in the MHI by species from 1948 – 2010 using the smoothed 5-year moving average of the ratios of total unreported catch to reported commercial catch derived for Catch Scenario II (Table 7); Deep 7 species are indicated by an *.

Fishing Year	Hapuupuu*	Kalekale*	Opakapaka*	Uku	Ehu*	Onaga*	Ulua Misc	Lehi*	Gindai*	Butaguchi	Black Ulua	White Ulua	Yellowtail Kalekale	Total
1948	10,127	431	216,564	133,238	65,568	23,924	393,304	607	33	0	0	0	0	843,794
1949	30,136	1,103	321,311	175,174	114,732	48,593	744,618	228	31	0	0	0	0	1,435,925
1950	18,991	875	326,264	159,715	83,587	44,651	535,490	186	116	0	0	0	0	1,169,876
1951	22,852	963	381,790	117,341	73,271	53,056	440,270	113	308	0	0	0	0	1,089,963
1952	33,205	1,370	400,847	109,282	60,417	33,306	427,550	383	435	0	0	0	0	1,066,796
1953	23,500	975	311,573	177,609	55,955	36,426	417,852	116	300	0	0	0	0	1,024,307
1954	17,016	1,205	298,474	135,846	45,249	47,838	325,092	155	281	0	0	0	0	871,157
1955	18,757	856	231,325	158,221	33,451	45,046	224,511	46	395	0	0	0	0	712,608
1956	27,865	973	316,291	175,734	44,477	50,690	410,402	153	558	0	0	0	0	1,027,144
1957	18,452	887	423,824	190,830	41,255	61,742	301,435	350	331	0	0	0	0	1,039,107
1958	21,305	524	269,556	172,795	29,788	38,129	261,489	97	303	0	0	0	0	793,986
1959	17,081	582	264,531	153,182	25,601	47,907	245,952	85	224	0	0	0	0	755,144
1960	13,144	579	202,545	99,689	21,588	28,747	196,010	64	179	0	0	0	0	562,545
1961	7,329	588	161,283	94,035	14,447	26,733	201,370	38	63	0	0	0	0	505,884
1962	10,749	528	242,716	123,488	18,243	37,294	191,156	71	126	0	0	0	0	624,370
1963	13,518	555	278,597	146,760	26,560	44,366	247,295	107	117	0	0	0	0	757,876
1964	11,472	705	273,316	183,396	27,436	34,404	239,809	39	347	0	0	0	0	770,924
1965	13,172	443	305,176	155,817	23,857	50,526	284,563	51	144	0	0	0	0	833,749
1966	12,100	407	204,938	106,288	20,140	46,765	212,144	80	125	0	0	0	0	602,987
1967	12,620	288	353,016	145,768	20,426	49,963	322,147	95	115	0	0	0	0	904,439
1968	11,534	207	242,466	118,862	22,066	50,738	233,504	89	113	0	0	0	0	679,578
1969	11,115	125	246,659	122,896	17,946	39,373	306,438	237	71	0	0	0	0	744,859
1970	20,247	154	200,010	113,032	17,616	31,784	229,270	107	216	0	0	0	0	612,436
1971	14,769	130	169,677	109,909	16,986	28,667	179,540	72	131	0	0	0	0	519,882
1972	18,345	246	340,686	122,896	23,728	43,015	195,150	177	187	0	0	0	0	744,430
1973	15,142	153	267,932	105,732	16,163	26,003	159,999	181	189	0	0	0	0	591,494
1974	14,918	146	388,061	165,608	23,440	31,833	244,780	195	220	0	0	0	0	869,201
1975	23,665	179	333,448	171,362	24,330	32,889	234,177	336	210	0	0	0	0	820,597
1976	22,847	237	302,753	156,862	34,720	58,571	344,479	413	181	0	0	0	0	921,063
1977	31,070	258	305,190	107,237	39,857	61,870	376,961	291	233	0	0	0	0	922,967
1978	29,293	295	443,823	215,845	39,631	48,549	318,909	392	383	0	0	0	0	1,097,119
1979	30,147	233	419,052	187,858	24,965	38,710	395,679	485	432	0	0	0	0	1,097,560

Table A.4. Continued.

Fishing Year	Hapuupuu*	Kalekale*	Opakapaka*	Uku	Ehu*	Onaga*	Ulua Misc	Lehi*	Gindai*	Butaguchi	Black Ulua	White Ulua	Yellowtail Kalekale	Total
1980	18,087	211	433,534	145,777	18,866	22,881	323,916	713	358	0	0	0	0	964,343
1981	17,302	245	566,443	215,736	23,478	31,294	426,324	797	278	0	0	0	0	1,281,898
1982	22,114	242	510,079	210,874	27,124	48,140	355,905	1,199	242	1,887	0	4,446	0	1,182,252
1983	33,407	450	661,320	258,458	31,108	53,145	417,875	1,139	402	1,394	0	20,336	0	1,479,032
1984	30,326	403	457,340	324,676	40,138	63,217	443,124	662	535	2,236	58	53,032	0	1,415,745
1985	33,883	681	584,539	217,977	48,873	126,926	295,166	1,022	690	6,122	138	29,351	0	1,345,368
1986	27,072	762	520,566	153,634	68,695	143,454	238,018	1,108	563	9,306	1,136	24,225	0	1,188,540
1987	32,929	852	767,389	198,471	54,595	128,161	255,446	1,548	492	29,262	469	32,656	0	1,502,270
1988	10,619	545	866,473	421,196	46,684	114,728	331,058	1,530	309	7,765	277	28,325	0	1,829,509
1989	13,859	333	884,634	711,963	42,706	106,146	521,699	1,812	252	9,141	572	65,048	0	2,358,164
1990	14,456	465	603,750	305,404	41,769	103,330	368,738	1,398	418	11,227	283	33,422	0	1,484,659
1991	15,214	549	389,910	254,987	34,195	75,123	332,904	759	529	14,808	104	31,675	0	1,150,755
1992	15,559	841	496,860	212,383	35,417	67,023	262,466	690	768	2,089	0	17,316	0	1,111,413
1993	13,533	509	397,851	149,650	26,558	38,423	194,698	447	565	8,102	200	7,083	0	837,618
1994	10,560	537	498,571	175,948	25,794	49,971	153,590	465	597	3,563	29	7,594	0	927,217
1995	19,871	654	568,736	161,490	30,220	53,733	187,004	575	668	10,845	474	6,362	0	1,040,631
1996	10,539	608	418,451	106,584	32,329	50,832	233,056	417	478	3,250	94	14,042	0	870,679
1997	14,340	684	460,614	157,556	29,001	44,778	171,511	473	457	8,219	148	9,104	0	896,883
1998	11,851	1,958	402,717	123,854	24,727	42,076	200,130	492	814	2,944	340	14,300	0	826,204
1999	8,403	1,443	260,666	162,105	14,958	27,192	148,424	568	780	2,090	68	19,847	0	646,544
2000	10,024	2,863	389,446	189,136	15,860	23,364	92,719	864	1,353	2,577	0	27,433	0	755,639
2001	10,463	3,528	269,012	131,842	11,163	11,691	122,809	1,032	1,898	1,806	62	47,504	1	612,810
2002	5,337	2,891	207,396	114,855	4,232	2,964	102,487	1,196	1,491	1,597	74	49,122	0	493,643
2003	5,577	3,372	251,859	80,886	4,057	3,383	35,009	873	1,306	1,606	119	108,498	0	496,545
2004	4,681	2,257	173,626	108,954	4,787	3,752	10,777	502	1,274	638	337	151,788	4	463,378
2005	6,145	2,199	205,860	139,634	5,634	4,435	9,129	704	1,229	1,603	125	177,912	8	554,617
2006	4,287	1,545	149,874	114,904	4,715	3,679	1,995	644	985	434	83	124,812	9	407,964
2007	4,452	1,726	182,257	119,489	4,857	4,225	3,346	856	1,412	143	103	290,254	0	613,120
2008	3,886	1,553	189,785	154,719	4,551	2,754	2,180	1,127	1,732	1,407	136	235,840	0	599,673
2009	4,654	2,691	263,082	152,222	6,108	2,927	1,200	1,712	2,204	546	148	152,960	4	590,458
2010	4,838	2,288	209,811	193,991	6,038	2,844	12,474	625	1,682	613	750	182,824	4	618,783

Table A.5. Catch Scenario II: Estimated total catch (lbs) of primary bottomfish in the MHI by species from 1948 – 2010 computed as reported commercial catch (Table A.1) plus estimated unreported catch (Table A.4) under Catch Scenario II; Deep 7 species are indicated by an *.

Fishing Year	Hapuupuu*	Kalekale*	Opakapaka*	Uku	Ehu*	Onaga*	Ulua Misc	Lehi*	Gindai*	Butaguchi	Black Ulua	White Ulua	Yellowtail Kalekale	Total
1948	20,055	14,786	292,022	191,933	124,638	56,697	480,254	15,777	250	0	0	0	0	1,196,410
1949	59,681	37,866	433,266	252,343	218,094	115,159	909,235	5,923	240	0	0	0	0	2,031,806
1950	37,610	30,051	439,945	230,074	158,891	105,817	653,874	4,827	886	0	0	0	0	1,661,976
1951	45,256	33,054	514,818	169,033	139,281	125,735	537,603	2,946	2,358	0	0	0	0	1,570,083
1952	65,759	47,036	540,515	157,424	114,847	78,931	522,071	9,967	3,334	0	0	0	0	1,539,885
1953	46,539	33,483	420,135	255,851	106,365	86,325	510,229	3,013	2,300	0	0	0	0	1,464,241
1954	33,698	41,388	402,472	195,690	86,014	113,369	396,962	4,040	2,157	0	0	0	0	1,275,791
1955	37,146	29,390	311,926	227,922	63,587	106,753	274,145	1,184	3,031	0	0	0	0	1,055,084
1956	55,184	33,414	426,497	253,150	84,546	120,128	501,132	3,986	4,279	0	0	0	0	1,482,317
1957	36,542	30,468	571,498	274,896	78,422	146,320	368,075	9,098	2,539	0	0	0	0	1,517,859
1958	42,192	18,005	363,478	248,916	56,624	90,361	319,298	2,511	2,323	0	0	0	0	1,143,708
1959	33,827	19,996	356,702	220,663	48,665	113,533	300,326	2,209	1,716	0	0	0	0	1,097,636
1960	26,030	19,891	273,118	143,605	41,037	68,126	239,343	1,668	1,374	0	0	0	0	814,192
1961	14,514	20,202	217,479	135,460	27,462	63,353	245,888	989	481	0	0	0	0	725,826
1962	21,287	18,126	327,286	177,888	34,678	88,381	233,416	1,844	964	0	0	0	0	903,869
1963	26,771	19,044	375,669	211,412	50,488	105,142	301,966	2,785	899	0	0	0	0	1,094,177
1964	22,719	24,196	368,548	264,187	52,153	81,533	292,825	1,026	2,661	0	0	0	0	1,109,848
1965	26,086	15,195	411,509	224,459	45,350	119,740	347,473	1,323	1,101	0	0	0	0	1,192,236
1966	23,963	13,960	276,345	153,111	38,284	110,826	259,044	2,088	957	0	0	0	0	878,578
1967	24,993	9,887	476,018	209,983	38,828	118,405	393,366	2,471	884	0	0	0	0	1,274,836
1968	22,842	7,103	326,949	171,224	41,945	120,242	285,126	2,304	867	0	0	0	0	978,601
1969	22,012	4,282	332,603	177,035	34,114	93,308	374,184	6,161	541	0	0	0	0	1,044,239
1970	40,097	5,286	269,700	162,826	33,486	75,324	279,956	2,783	1,653	0	0	0	0	871,111
1971	29,248	4,467	228,798	158,327	32,289	67,937	219,232	1,878	1,004	0	0	0	0	743,181
1972	36,330	8,449	459,392	177,035	45,105	101,939	238,293	4,607	1,432	0	0	0	0	1,072,582
1973	29,987	5,259	361,288	152,310	30,724	61,623	195,371	4,703	1,452	0	0	0	0	842,717
1974	29,543	5,008	523,274	238,563	44,557	75,440	298,895	5,071	1,687	0	0	0	0	1,222,038
1975	46,866	6,140	449,632	246,852	46,249	77,943	285,948	8,728	1,613	0	0	0	0	1,169,972
1976	45,246	8,144	408,242	225,964	65,999	138,805	420,635	10,748	1,390	0	0	0	0	1,325,173
1977	61,531	8,856	411,528	154,478	75,764	146,623	460,298	7,561	1,788	0	0	0	0	1,328,427
1978	58,012	10,121	598,465	310,931	75,335	115,054	389,412	10,183	2,936	0	0	0	0	1,570,448
1979	59,703	7,987	565,063	270,615	47,456	91,737	483,154	12,609	3,315	0	0	0	0	1,541,638

Table A.5. Continued.

Fishing Year	Hapuupuu*	Kalekale*	Opakapaka*	Uku	Ehu*	Onaga*	Ulua Misc	Lehi*	Gindai*	Butaguchi	Black Ulua	White Ulua	Yellowtail Kalekale	Total
1980	35,819	7,258	584,591	209,996	35,862	54,225	395,526	18,541	2,747	0	0	0	0	1,344,565
1981	34,265	8,423	763,810	310,774	44,629	74,163	520,574	20,721	2,132	0	0	0	0	1,779,492
1982	43,794	8,292	687,807	303,770	51,560	114,085	434,587	31,181	1,857	3,350	0	6,291	0	1,686,574
1983	66,159	15,452	891,745	372,316	59,133	125,946	510,257	29,616	3,080	2,475	0	28,774	0	2,104,951
1984	60,057	13,824	616,692	467,705	76,298	149,816	541,088	17,205	4,100	3,969	105	75,037	0	2,025,894
1985	67,102	23,374	788,211	314,002	92,903	300,797	360,420	26,574	5,292	10,868	249	41,530	0	2,031,322
1986	53,613	26,171	701,948	221,314	130,582	339,967	290,638	28,814	4,319	16,520	2,052	34,277	0	1,850,216
1987	65,212	29,251	1,034,772	285,903	103,780	303,724	311,919	40,244	3,775	51,946	847	46,206	0	2,277,579
1988	21,030	18,714	1,168,380	606,745	88,742	271,889	404,247	39,769	2,372	13,784	500	40,078	0	2,676,250
1989	27,446	11,420	1,192,869	1,025,603	81,180	251,551	637,034	47,111	1,933	16,227	1,033	92,039	0	3,385,445
1990	28,629	15,951	814,116	439,943	79,399	244,878	450,257	36,342	3,203	19,930	511	47,290	0	2,180,448
1991	30,130	18,833	525,767	367,316	65,001	178,031	406,501	19,729	4,053	26,287	188	44,818	0	1,686,652
1992	30,813	28,888	669,982	305,944	67,324	158,836	320,491	17,944	5,888	3,708	0	24,501	0	1,634,320
1993	26,801	17,465	536,475	215,575	50,484	91,057	237,741	11,624	4,330	14,383	361	10,022	0	1,216,317
1994	20,913	18,431	672,289	253,458	49,032	118,424	187,545	12,096	4,575	6,325	52	10,745	0	1,353,883
1995	39,352	22,450	766,902	232,631	57,445	127,340	228,346	14,954	5,119	19,252	856	9,002	0	1,523,648
1996	20,871	20,878	564,253	153,538	61,454	120,465	284,579	10,835	3,662	5,769	170	19,868	0	1,266,342
1997	28,398	23,484	621,107	226,964	55,128	106,117	209,428	12,295	3,500	14,590	267	12,881	0	1,314,159
1998	24,537	26,390	552,398	180,512	51,091	112,924	244,374	9,878	4,172	5,412	668	17,524	0	1,229,881
1999	18,309	12,513	364,476	239,225	34,491	86,595	181,237	9,321	3,108	3,995	149	22,919	0	976,338
2000	23,172	18,726	556,482	282,861	42,573	96,002	113,217	12,049	4,518	5,153	0	30,665	0	1,185,417
2001	25,929	18,825	394,017	200,012	37,637	74,707	149,959	12,540	5,547	3,805	206	52,023	6	975,213
2002	14,371	13,189	312,539	176,939	21,190	62,963	125,145	12,911	3,924	3,575	403	53,040	1	800,191
2003	15,017	15,382	379,544	124,609	20,311	71,871	42,748	9,426	3,437	3,595	646	117,152	0	803,738
2004	12,606	10,297	261,649	167,848	23,968	79,707	13,159	5,421	3,354	1,428	1,837	163,894	22	745,189
2005	16,546	10,030	310,225	215,112	28,209	94,209	11,147	7,602	3,234	3,588	683	192,103	46	892,735
2006	11,545	7,048	225,855	177,014	23,606	78,144	2,436	6,952	2,593	971	450	134,767	52	671,433
2007	11,989	7,873	274,655	184,077	24,320	89,742	4,086	9,239	3,717	319	560	313,405	1	923,984
2008	10,465	7,085	286,000	238,351	22,785	58,499	2,662	12,170	4,560	3,150	739	254,651	0	901,120
2009	12,532	12,274	396,457	234,505	30,582	62,169	1,465	18,483	5,801	1,222	807	165,160	25	941,481
2010	13,027	10,439	316,179	298,852	30,233	60,407	15,232	6,741	4,429	1,372	4,081	197,407	24	958,424

Table A.6. Catch Scenario III: Estimated unreported catch (lbs) of primary bottomfish in the MHI by species from 1948 – 2010 using the ratios of total unreported catch to reported commercial catch derived for catch scenario III (0.20, Table 4); Deep 7 species are indicated by an *.

Fishing Year	Hapuupuu*	Kalekale*	Opakapaka*	Uku	Ehu*	Onaga*	Ulua Misc	Lehi*	Gindai*	Butaguchi	Black Ulua	White Ulua	Yellowtail Kalekale	Total
1948	1,986	2,871	15,092	11,739	11,814	6,555	17,390	3,034	43	0	0	0	0	70,523
1949	5,909	7,353	22,391	15,434	20,672	13,313	32,923	1,139	42	0	0	0	0	119,176
1950	3,724	5,835	22,736	14,072	15,061	12,233	23,677	928	154	0	0	0	0	98,420
1951	4,481	6,418	26,606	10,338	13,202	14,536	19,467	567	410	0	0	0	0	96,024
1952	6,511	9,133	27,934	9,628	10,886	9,125	18,904	1,917	580	0	0	0	0	94,618
1953	4,608	6,502	21,712	15,648	10,082	9,980	18,475	579	400	0	0	0	0	87,987
1954	3,336	8,037	20,800	11,969	8,153	13,106	14,374	777	375	0	0	0	0	80,927
1955	3,678	5,707	16,120	13,940	6,027	12,341	9,927	228	527	0	0	0	0	68,495
1956	5,464	6,488	22,041	15,483	8,014	13,888	18,146	767	744	0	0	0	0	91,035
1957	3,618	5,916	29,535	16,813	7,433	16,916	13,328	1,750	442	0	0	0	0	95,750
1958	4,177	3,496	18,784	15,224	5,367	10,446	11,562	483	404	0	0	0	0	69,944
1959	3,349	3,883	18,434	13,496	4,613	13,125	10,875	425	298	0	0	0	0	68,498
1960	2,577	3,862	14,115	8,783	3,890	7,876	8,667	321	239	0	0	0	0	50,329
1961	1,437	3,923	11,239	8,285	2,603	7,324	8,904	190	84	0	0	0	0	43,988
1962	2,108	3,520	16,914	10,880	3,287	10,217	8,452	355	168	0	0	0	0	55,900
1963	2,651	3,698	19,414	12,930	4,786	12,155	10,934	536	156	0	0	0	0	67,260
1964	2,249	4,698	19,046	16,158	4,943	9,426	10,603	197	463	0	0	0	0	67,785
1965	2,583	2,950	21,267	13,728	4,299	13,843	12,582	254	191	0	0	0	0	71,697
1966	2,373	2,711	14,281	9,365	3,629	12,812	9,380	402	166	0	0	0	0	55,118
1967	2,475	1,920	24,600	12,843	3,680	13,688	14,244	475	154	0	0	0	0	74,079
1968	2,262	1,379	16,897	10,472	3,976	13,901	10,324	443	151	0	0	0	0	59,805
1969	2,179	831	17,189	10,828	3,234	10,787	13,549	1,185	94	0	0	0	0	59,876
1970	3,970	1,026	13,938	9,959	3,174	8,708	10,137	535	287	0	0	0	0	51,735
1971	2,896	867	11,824	9,684	3,061	7,854	7,938	361	175	0	0	0	0	44,660
1972	3,597	1,641	23,741	10,828	4,275	11,785	8,629	886	249	0	0	0	0	65,630
1973	2,969	1,021	18,671	9,316	2,912	7,124	7,074	904	253	0	0	0	0	50,245
1974	2,925	972	27,043	14,591	4,223	8,721	10,823	975	293	0	0	0	0	70,567
1975	4,640	1,192	23,237	15,098	4,384	9,011	10,354	1,678	281	0	0	0	0	69,875
1976	4,480	1,581	21,098	13,820	6,256	16,047	15,231	2,067	242	0	0	0	0	80,822
1977	6,092	1,720	21,268	9,448	7,181	16,951	16,667	1,454	311	0	0	0	0	81,092
1978	5,744	1,965	30,928	19,017	7,141	13,301	14,101	1,958	511	0	0	0	0	94,666
1979	5,911	1,551	29,202	16,551	4,498	10,605	17,495	2,425	577	0	0	0	0	88,816

Table A.6. Continued.

Fishing Year	Hapuupuu*	Kalekale*	Opakapaka*	Uku	Ehu*	Onaga*	Ulua Misc	Lehi*	Gindai*	Butaguchi	Black Ulua	White Ulua	Yellowtail Kalekale	Total
1980	3,546	1,409	30,211	12,844	3,399	6,269	14,322	3,566	478	0	0	0	0	76,044
1981	3,393	1,636	39,473	19,008	4,230	8,574	18,850	3,985	371	0	0	0	0	99,519
1982	4,336	1,610	35,546	18,579	4,887	13,189	15,736	5,996	323	293	0	369	0	100,864
1983	6,550	3,000	46,085	22,772	5,605	14,560	18,476	5,695	536	216	0	1,688	0	125,184
1984	5,946	2,684	31,870	28,606	7,232	17,320	19,593	3,309	713	347	9	4,401	0	122,030
1985	6,644	4,539	40,734	19,205	8,806	34,774	13,051	5,110	920	949	22	2,436	0	137,191
1986	5,308	5,082	36,276	13,536	12,377	39,303	10,524	5,541	751	1,443	183	2,010	0	132,335
1987	6,457	5,680	53,477	17,486	9,837	35,113	11,295	7,739	657	4,537	76	2,710	0	155,062
1988	2,082	3,634	60,381	37,110	8,412	31,432	14,638	7,648	413	1,204	45	2,351	0	169,348
1989	2,717	2,217	61,647	62,728	7,695	29,081	23,067	9,060	336	1,417	92	5,398	0	205,456
1990	2,835	3,097	42,073	26,908	7,526	28,310	16,304	6,989	557	1,741	46	2,774	0	139,158
1991	2,983	3,657	27,171	22,466	6,161	20,582	14,719	3,794	705	2,296	17	2,629	0	107,179
1992	3,051	5,609	34,624	18,712	6,381	18,363	11,605	3,451	1,024	324	0	1,437	0	104,581
1993	2,654	3,391	27,725	13,185	4,785	10,527	8,609	2,235	753	1,256	32	588	0	75,740
1994	2,071	3,579	34,744	15,502	4,648	13,691	6,791	2,326	796	552	5	630	0	85,333
1995	3,896	4,359	39,633	14,228	5,445	14,721	8,268	2,876	890	1,681	76	528	0	96,603
1996	2,066	4,054	29,160	9,391	5,825	13,927	10,305	2,084	637	504	15	1,165	0	79,133
1997	2,812	4,560	32,099	13,882	5,225	12,268	7,583	2,364	609	1,274	24	756	0	83,455
1998	2,537	4,886	29,936	11,332	5,273	14,170	8,849	1,877	671	493	66	645	0	80,735
1999	1,981	2,214	20,762	15,424	3,906	11,881	6,563	1,751	466	381	16	614	0	65,959
2000	2,630	3,173	33,407	18,745	5,343	14,528	4,100	2,237	633	515	0	647	0	85,956
2001	3,093	3,060	25,001	13,634	5,295	12,603	5,430	2,302	730	400	29	904	1	72,481
2002	1,807	2,060	21,029	12,417	3,392	12,000	4,532	2,343	487	396	66	784	0	61,310
2003	1,888	2,402	25,537	8,744	3,251	13,697	1,548	1,711	426	398	105	1,731	0	61,439
2004	1,585	1,608	17,605	11,779	3,836	15,191	477	984	416	158	300	2,421	4	56,362
2005	2,080	1,566	20,873	15,096	4,515	17,955	404	1,380	401	397	112	2,838	8	67,624
2006	1,452	1,101	15,196	12,422	3,778	14,893	88	1,262	322	107	73	1,991	9	52,694
2007	1,507	1,229	18,480	12,918	3,893	17,103	148	1,677	461	35	91	4,630	0	62,173
2008	1,316	1,106	19,243	16,726	3,647	11,149	96	2,209	566	349	121	3,762	0	60,289
2009	1,576	1,917	26,675	16,456	4,895	11,848	53	3,354	720	135	132	2,440	4	70,205
2010	1,638	1,630	21,274	20,972	4,839	11,513	552	1,223	549	152	666	2,916	4	67,928

Table A.7. Catch Scenario III: Estimated total catch (lbs) of primary bottomfish in the MHI by species from 1948 – 2010 computed as reported commercial catch (Table A.1) plus estimated unreported catch (Table A.6) under Catch Scenario III; Deep 7 species are indicated by an *.

Fishing Year	Hapuupuu*	Kalekale*	Opakapaka*	Uku	Ehu*	Onaga*	Ulua Misc	Lehi*	Gindai*	Butaguchi	Black Ulua	White Ulua	Yellowtail Kalekale	Total
1948	11,914	17,226	90,550	70,434	70,884	39,328	104,340	18,204	260	0	0	0	0	423,139
1949	35,454	44,116	134,346	92,603	124,034	79,879	197,540	6,834	251	0	0	0	0	715,057
1950	22,343	35,011	136,417	84,431	90,365	73,399	142,061	5,569	924	0	0	0	0	590,520
1951	26,885	38,509	159,634	62,030	79,212	87,215	116,800	3,400	2,460	0	0	0	0	576,144
1952	39,065	54,799	167,602	57,770	65,316	54,750	113,425	11,501	3,479	0	0	0	0	567,707
1953	27,647	39,010	130,274	93,890	60,492	59,879	110,852	3,476	2,400	0	0	0	0	527,921
1954	20,018	48,220	124,798	71,813	48,918	78,637	86,244	4,662	2,251	0	0	0	0	485,561
1955	22,067	34,241	96,721	83,641	36,163	74,048	59,561	1,366	3,163	0	0	0	0	410,971
1956	32,783	38,929	132,247	92,899	48,083	83,326	108,876	4,600	4,465	0	0	0	0	546,208
1957	21,708	35,497	177,209	100,879	44,600	101,494	79,968	10,498	2,650	0	0	0	0	574,502
1958	25,064	20,977	112,706	91,345	32,203	62,678	69,371	2,897	2,424	0	0	0	0	419,666
1959	20,095	23,297	110,605	80,977	27,677	78,751	65,249	2,549	1,790	0	0	0	0	410,990
1960	15,463	23,174	84,688	52,699	23,339	47,255	52,000	1,925	1,434	0	0	0	0	301,976
1961	8,622	23,537	67,435	49,710	15,618	43,944	53,422	1,141	502	0	0	0	0	263,930
1962	12,646	21,118	101,484	65,280	19,722	61,304	50,712	2,128	1,006	0	0	0	0	335,399
1963	15,904	22,187	116,486	77,582	28,714	72,931	65,605	3,214	938	0	0	0	0	403,561
1964	13,496	28,189	114,278	96,949	29,660	56,555	63,619	1,184	2,777	0	0	0	0	406,709
1965	15,497	17,702	127,600	82,370	25,792	83,057	75,492	1,526	1,148	0	0	0	0	430,184
1966	14,236	16,264	85,688	56,188	21,773	76,873	56,280	2,410	998	0	0	0	0	330,709
1967	14,848	11,519	147,602	77,058	22,082	82,130	85,463	2,851	923	0	0	0	0	444,476
1968	13,570	8,275	101,380	62,834	23,855	83,405	61,946	2,658	905	0	0	0	0	358,828
1969	13,076	4,988	103,133	64,967	19,402	64,722	81,295	7,109	564	0	0	0	0	359,256
1970	23,820	6,158	83,628	59,753	19,044	52,248	60,823	3,211	1,724	0	0	0	0	310,410
1971	17,375	5,204	70,945	58,102	18,364	47,124	47,630	2,167	1,048	0	0	0	0	267,959
1972	21,582	9,844	142,447	64,967	25,652	70,709	51,772	5,316	1,494	0	0	0	0	393,782
1973	17,814	6,127	112,027	55,894	17,473	42,744	42,446	5,426	1,516	0	0	0	0	301,468
1974	17,550	5,834	162,256	87,546	25,340	52,328	64,938	5,851	1,760	0	0	0	0	423,404
1975	27,841	7,153	139,421	90,588	26,303	54,065	62,125	10,070	1,684	0	0	0	0	419,250
1976	26,879	9,488	126,587	82,922	37,535	96,281	91,387	12,402	1,451	0	0	0	0	484,932
1977	36,553	10,318	127,606	56,689	43,088	101,704	100,004	8,724	1,866	0	0	0	0	486,552
1978	34,463	11,791	185,570	114,103	42,845	79,806	84,604	11,749	3,064	0	0	0	0	567,995
1979	35,467	9,305	175,213	99,308	26,989	63,632	104,970	14,549	3,460	0	0	0	0	532,894

Table A.7. Continued.

Fishing Year	Hapuupuu*	Kalekale*	Opakapaka*	Uku	Ehu*	Onaga*	Ulua Misc	Lehi*	Gindai*	Butaguchi	Black Ulua	White Ulua	Yellowtail Kalekale	Total
1980	21,278	8,456	181,268	77,063	20,395	37,613	85,932	21,394	2,867	0	0	0	0	456,266
1981	20,356	9,814	236,840	114,046	25,381	51,443	113,100	23,909	2,225	0	0	0	0	597,113
1982	26,016	9,660	213,274	111,475	29,323	79,134	94,418	35,978	1,938	1,756	0	2,214	0	605,186
1983	39,302	18,002	276,510	136,630	33,630	87,361	110,858	34,172	3,214	1,297	0	10,126	0	751,103
1984	35,677	16,105	191,222	171,635	43,392	103,919	117,557	19,852	4,278	2,080	56	26,406	0	732,179
1985	39,863	27,232	244,406	115,230	52,836	208,645	78,305	30,662	5,522	5,695	133	14,615	0	823,145
1986	31,849	30,491	217,658	81,216	74,264	235,816	63,144	33,247	4,507	8,657	1,099	12,062	0	794,011
1987	38,740	34,079	320,860	104,918	59,022	210,676	67,768	46,435	3,940	27,221	454	16,260	0	930,371
1988	12,493	21,803	362,288	222,659	50,470	188,593	87,827	45,887	2,476	7,223	268	14,104	0	1,016,089
1989	16,304	13,304	369,882	376,368	46,169	174,486	138,402	54,359	2,017	8,503	553	32,389	0	1,232,737
1990	17,008	18,583	252,439	161,447	45,156	169,858	97,823	41,933	3,342	10,444	274	16,642	0	834,947
1991	17,899	21,941	163,028	134,795	36,967	123,490	88,316	22,764	4,229	13,775	101	15,772	0	643,076
1992	18,305	33,656	207,746	112,273	38,288	110,176	69,630	20,705	6,144	1,943	0	8,622	0	627,488
1993	15,922	20,347	166,349	79,110	28,711	63,161	51,652	13,412	4,518	7,537	193	3,527	0	454,439
1994	12,424	21,473	208,462	93,012	27,886	82,144	40,746	13,957	4,774	3,314	28	3,781	0	511,999
1995	23,377	26,155	237,799	85,369	32,670	88,328	49,610	17,255	5,341	10,088	458	3,168	0	579,620
1996	12,399	24,324	174,962	56,344	34,950	83,560	61,828	12,502	3,821	3,023	91	6,992	0	474,796
1997	16,870	27,360	192,591	83,290	31,352	73,607	45,500	14,187	3,652	7,645	143	4,533	0	500,731
1998	15,224	29,318	179,617	67,990	31,637	85,018	53,093	11,264	4,029	2,961	394	3,869	0	484,412
1999	11,887	13,285	124,571	92,544	23,439	71,284	39,376	10,504	2,794	2,286	97	3,686	0	395,752
2000	15,777	19,035	200,443	112,469	32,055	87,166	24,598	13,421	3,798	3,091	0	3,879	0	515,734
2001	18,558	18,357	150,006	81,804	31,769	75,620	32,580	13,810	4,379	2,398	173	5,423	6	434,883
2002	10,841	12,358	126,172	74,501	20,349	71,999	27,189	14,058	2,920	2,374	395	4,702	1	367,857
2003	11,329	14,412	153,221	52,467	19,505	82,185	9,288	10,264	2,558	2,387	632	10,385	0	368,632
2004	9,509	9,648	105,628	70,673	23,017	91,145	2,859	5,902	2,496	948	1,799	14,528	22	338,173
2005	12,482	9,397	125,238	90,574	27,090	107,729	2,422	8,278	2,407	2,382	669	17,028	46	405,741
2006	8,709	6,603	91,178	74,532	22,669	89,359	529	7,569	1,929	645	441	11,946	52	316,162
2007	9,044	7,377	110,878	77,506	23,355	102,621	888	10,060	2,766	212	548	27,781	1	373,037
2008	7,895	6,638	115,458	100,359	21,881	66,894	578	13,251	3,394	2,092	724	22,573	0	361,737
2009	9,454	11,500	160,049	98,739	29,369	71,091	318	20,125	4,317	811	790	14,640	25	421,228
2010	9,827	9,781	127,641	125,832	29,034	69,076	3,309	7,340	3,296	911	3,998	17,499	24	407,568

Appendix B. Catch Figures

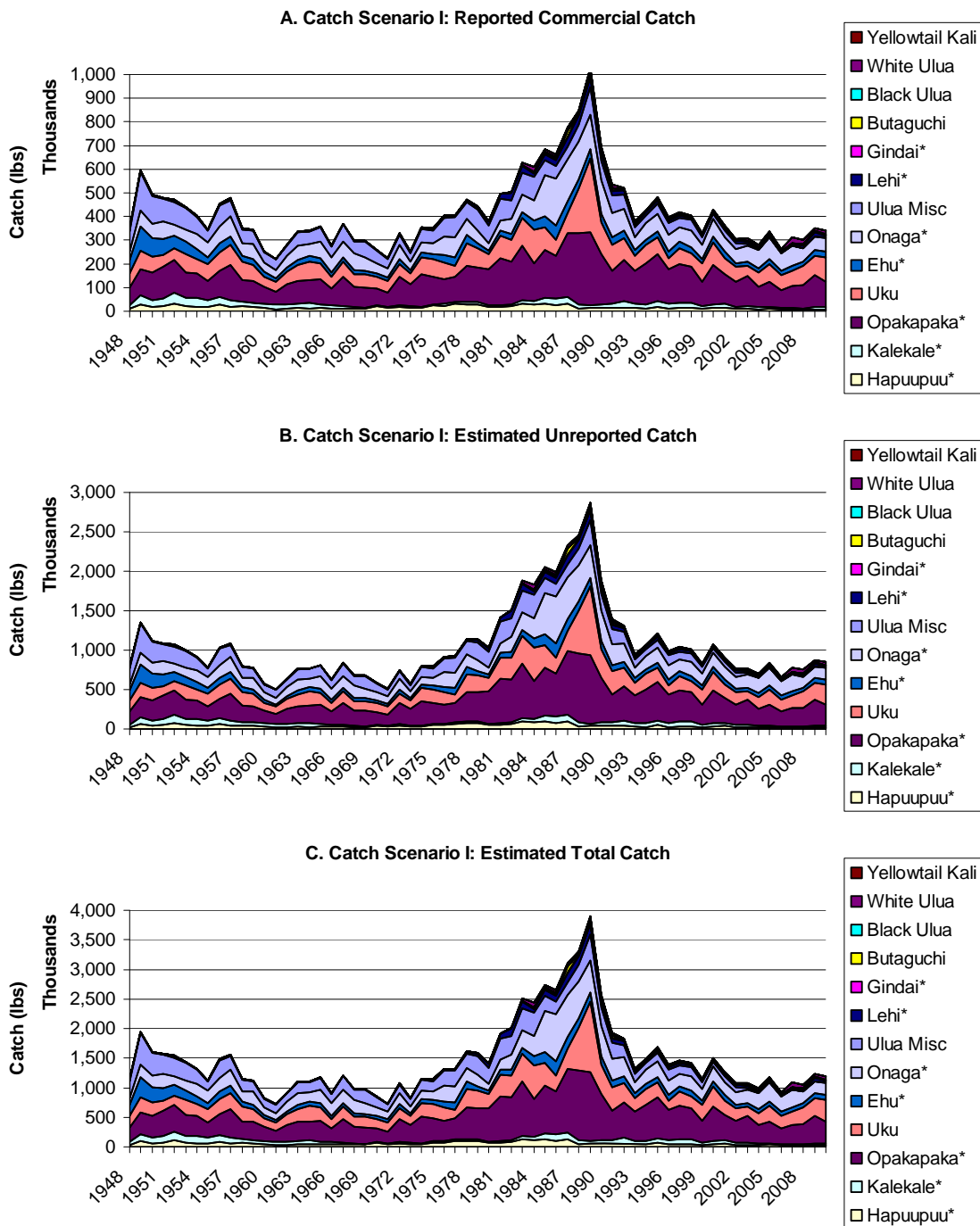


Figure B.1. Catches of primary bottomfish in the MHI under Catch Scenario I: Reported commercial catch (Panel A), estimated unreported catch (Panel B), and estimated total catch (Panel C); Deep 7 species are indicated by an *.

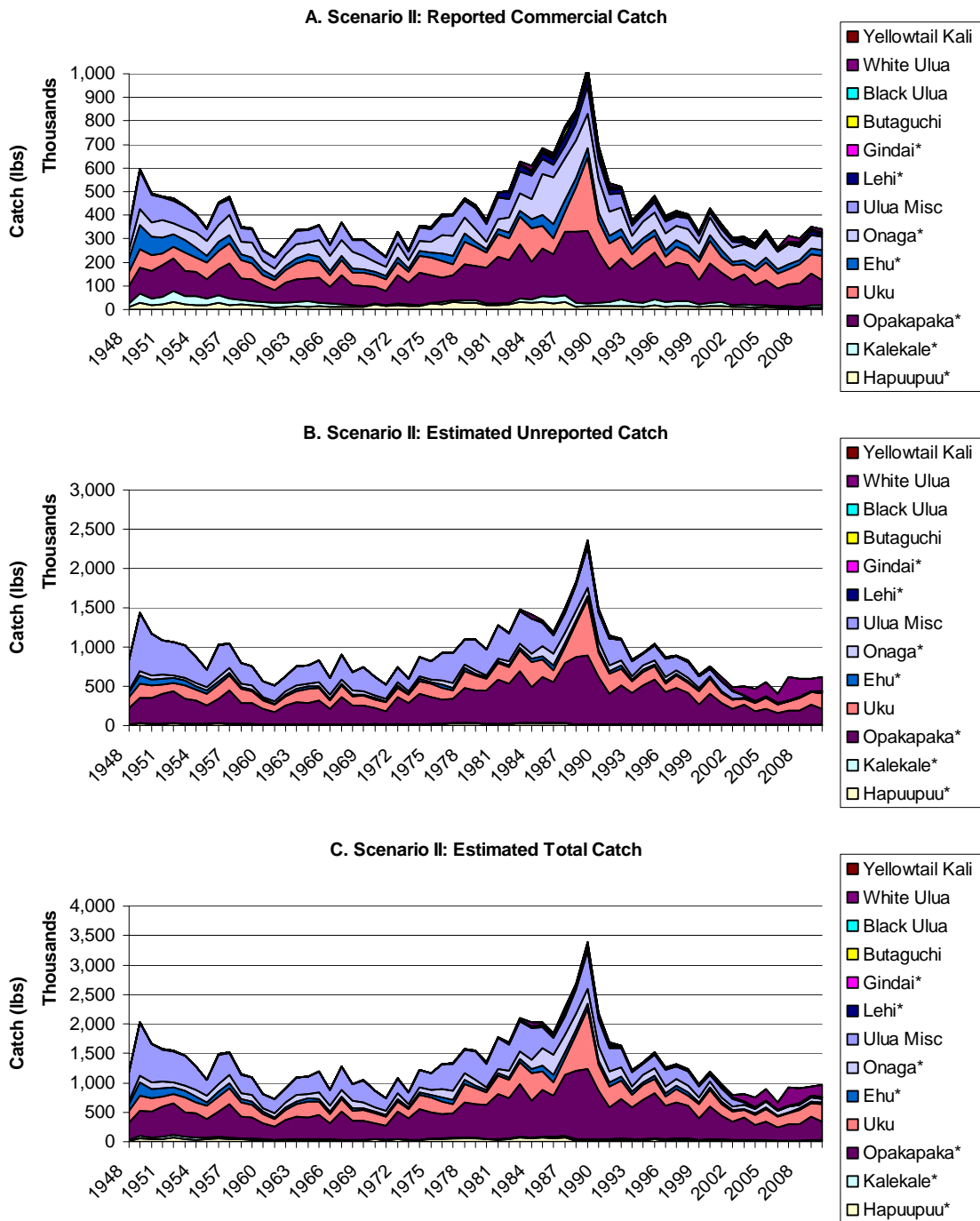


Figure B.2. Catches of primary bottomfish in the MHI under Catch Scenario II: Reported commercial catch (Panel A), estimated unreported catch (Panel B), and estimated total catch (Panel C); Deep 7 species are indicated by an *.

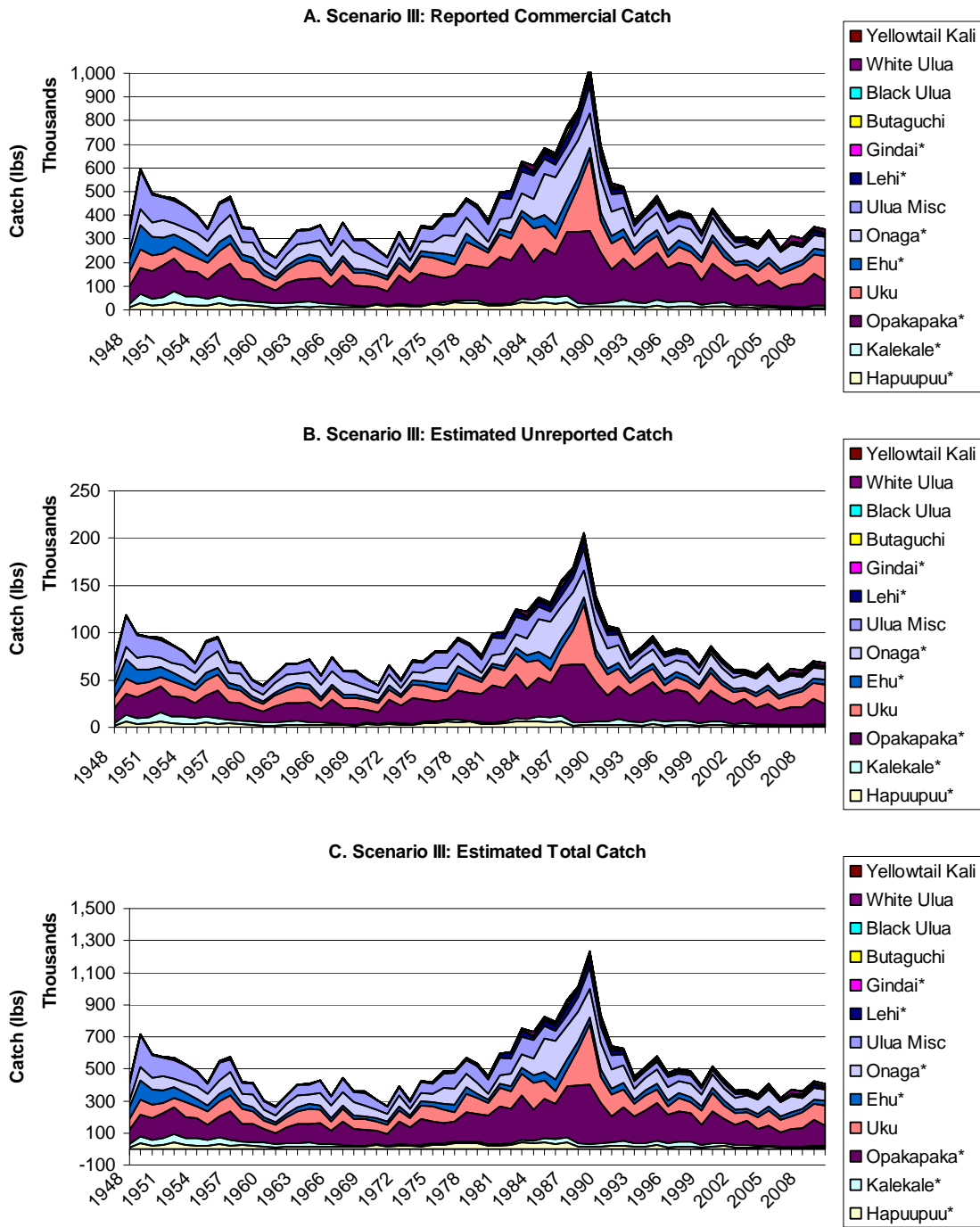


Figure B.3. Catches of primary bottomfish in the MHI under Catch Scenario III: Reported commercial catch (Panel A), estimated unreported catch (Panel B), and estimated total catch (Panel C); Deep 7 species are indicated by an *.

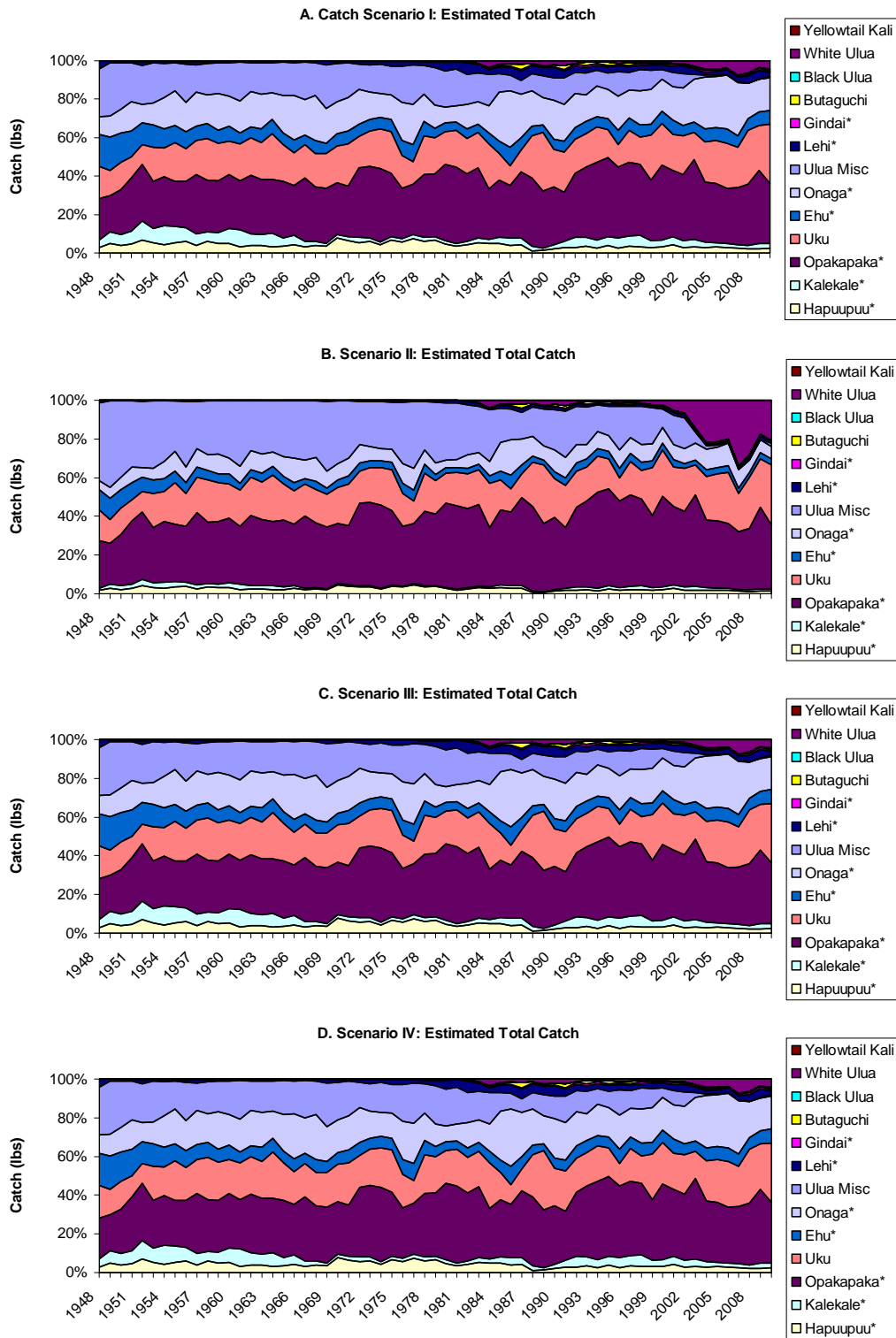


Figure B.4. Proportions of estimated total catches of Primary bottomfish in the MHI under Catch Scenario I (Panel A), Catch Scenario II (Panel B), Catch Scenario III (Panel C), and Catch Scenario IV (Panel D).

APPENDIX C

Lamson, M. R., B. McNaughton, and C. J. Severance. 2007. Analysis and expansion of the 2005 Hawaii State/Western Pacific Regional Fishery Council Bottomfish Fishermen Survey. 16 p. Submitted to the Western Pacific Regional Fishery Management Council on 29 May 2007.

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ANALYSIS AND EXPANSION OF THE 2005 HAWAI'I STATE/WESTERN PACIFIC REGIONAL FISHERY COUNCIL BOTTOMFISH FISHERMEN SURVEY

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INTRODUCTION

In the main Hawaiian Islands (MHI), participation in the deep-slope bottomfish fishery grew rapidly through the late 70s and early 80s. The increase in bottomfishing vessels peaked in 1985, with about 800 commercial vessels reporting bottomfish landings. Since then, vessel participation has steadily declined to about 300 vessels in 2004. The fishery targets certain deep water snappers and groupers that are generally known to be slow growing and long-lived species. Assessing the status of bottomfish abundance and monitoring the behavior of these deep water species are extremely difficult because of the depth at which these species live. Most of these species live at depths between 50 to 150 fathoms (300 to 900 feet). Fishermen often target these valuable species in waters up to 1,000 feet.

The Western Pacific Regional Fishery Management Council (Council) has monitored the status of Hawai'i's bottomfish stocks through its Bottomfish Plan Team since the late 1980s. These bottomfishes are considered to be part of an archipelagic-wide stock and are generally managed as a multi-species complex. The seven main bottomfish species are often referred to as "the Deep 7" and include: ehu (*Etelis carbunculus*), gindai (*Pristipomoides zonatus*), kalekale (*Pristipomoides sieboldii*), hapuupuu (*Epinephelus quernus*), onaga (*Etelis corsucans*), opakapaka (*Pristipomoides filamentosus*) and lehi (*Aphareus rutilans*).

Throughout the 90s, the Council advised the State of Hawai'i Division of Aquatic Resources (HDAR) of ongoing local depletion of certain important bottomfish species, mainly onaga and ehu, in the MHI. The Council then encouraged the State, who was the lead management agency in the MHI for bottomfish, to take action to address the local depletion issue. In 1998, the State responded by creating 19 Bottomfish Restricted Fishing Areas (BRFAs) around the MHI, establishing a free bottomfish fishermen's registry by boat, and implementing a recreational bag limit. At that time it was believed that 80% of the prime bottomfishing grounds were in waters under State jurisdiction, 0 to 3 miles offshore. Subsequent State and Federal bathymetric mapping research has more recently shown that a higher percentage (about 50%) of deep-slope bottomfish habitat is located within Federal waters. Using the improved bathymetric mapping information, the State has recently revised their BRFAs.

In 2005, new overfishing and overfished control rules were implemented through an amendment to the Bottomfish Fishery Management Plan (FMP). These new rules resulted from the reauthorization of the Magnuson Fishery and Conservation Act in 1996 that requires U.S. fisheries to be annually evaluated based on maximum sustainable yield. As a result of the new

control rules, on May 27th, 2005, the National Marine Fishery Service (NMFS) notified the Council that overfishing of Hawai'i bottomfish was occurring. The overfishing determination led to a cooperative effort between the State and Council to develop a coordinated management plan to address this issue. While commercial fishermen are required to report their effort and catch through the existing HDAR commercial marine licensing program, recreational catch and effort information remain largely unknown. The State, Council and NMFS developed and fielded a survey to better understand the activities of MHI bottomfish fishermen and their attitudes toward a range of management alternatives (Appendix A). The survey results were used to supplement the existing commercial data and to help inform future bottomfish fishery management plan amendments and regulations. Further analysis and expansion of the survey results, the methodology applied, and a discussion of the survey data are presented in this paper.

There is no reliable assessment of recreational fishing mortality on the Hawai'i bottomfish stock because recreational fishermen have not historically been required to submit fish catch reports. The national Marine Recreational Fisheries Statistical Survey (MRFSS) is unable to capture reliable catch or effort information from the recreational bottomfishing sector. This remains an important and large information gap for fishery managers; especially considering that Hawai'i recreational fishery participants may number in the thousands as compared to the 300 licensed commercial fishermen who sold bottomfish in 2004 (Moffitt et al. 2006). Two independent stock assessment reviews conducted on the Hawai'i bottomfish fishery in 2004 and 2006 have noted the importance of including recreational fishery information into future bottomfish stock assessments. Both reviews identified fishing mortality from recreational bottomfishing sector as something that needs to be fully assessed and accounted for in the stock assessment.

In August 2005, this survey was mailed to 3,678 fishermen who were registered with the State bottomfish registry. A preliminary analysis was done on an incomplete sample of respondents focusing only on certain survey questions. Further analysis of completed survey results could provide an important tool for estimating the relative scale of Hawai'i noncommercial bottomfish catch because a significant number of surveyed fishermen were recreational bottomfishermen. The survey also provides self-report information on basic bottomfishery participant characteristics and preferences, as well as fishing patterns and demographics. Some general characteristics of the fishery have been known but until now they have not been systematically documented.

As the FMP Amendment and an Environmental Impact Statement for the MHI bottomfishery management were being developed and reviewed, the most recent stock assessment by the Pacific Islands Fisheries Science Center (PIFSC) was released showing the need for a greater reduction in fishing mortality from 15% to 24% (Moffitt, Powerpoint presentation 4/18/2007). An increase in mortality reduction of bottomfishes will likely result in greater social and economic impacts on the bottomfishing community and associated businesses. The results of this survey will aid fishery managers in better understanding the potential consequences of the management alternatives being considered.

METHODOLOGY

Field Survey: The survey was a joint effort between the State of Hawai'i Division of Aquatic Resources, the Council, the National Marine Fisheries Service Pacific Islands Fisheries Science Center (PIFSC), and the Pacific Islands Regional Office (PIRO). The survey used the pre-

existing list of State registered bottomfish fishermen, which numbered 3,678 at the time of the survey. The survey was mailed out to all registered bottomfishers, and 802 completed surveys were returned (a 22% return rate) and used for this analysis. The recall survey bracketed the fishermen's activity over last six months of 2004 and first six months of 2005 (July 2004 – June 2005) and had a number of questions related to fishing activity. A copy of the survey may be found in Appendix A. The survey design and implementation was developed over a short time period without an opportunity for pre-testing and thus may have resulted in some ambiguous questions that may have skewed response accuracy. Because of the emergency nature of the overfishing determination and proposed Council action, a preliminary analysis was done on a partial sample of the returned surveys using a cut-off date of September 15, 2005. That analysis included a sample of 722 completed surveys (a rough return rate of 20%), and a wrong address rate of 14%.

For this report, all 802 surveys were re-entered to ensure accuracy in the statistics. For this subsequent analysis and expansion, responses that were partially completed, wrongly filled out, or left blank for the questions of interest were dropped from the final analyses. In addition, 112 out of 802 returned surveys (14%), and 67 out of 295 surveys of active fishermen (23%) had at least one key-punch error from the original data input. The minimum number of errors found on a survey was one, while the maximum number was 11 errors. A sample size of approximately 292 active fishermen was fielded from the returned surveys. However, sample size varies from test to test according to the number of blank or wrong responses for each question.

Data Analysis: All statistical analyses were performed using S-PLUS[®] 7.0 for Windows. All relevant data columns were reviewed for normality. No transformations were necessary so the data was processed raw. Fishermen were considered to be commercial if they answered yes to question #21, which asked, "Do you ever sell any bottomfish you catch?" (Appendix A). However, 52% of the 155 self-declared commercial bottomfishers said they do not consider themselves truly commercial (question #24, Appendix A). In addition, 57% of these same 155 fishermen said they sell their catch only to cover expenses (question #23, Appendix A). Because both catch in pounds (lbs) and catch in number of fish were reported, a comparison of the correlation between these two catch formats was completed to see if one could be used as a proxy for the other.

Is there a difference between commercial and recreational bottomfishing annual catch rates in the MHI? The summary statistics for total catch and catch by species were determined using surveys from active fishermen with non-blank catch answers. Fishermen were asked to report catch landings for each of the Deep 7 species, as well as uku (*Aprion virescens*). From this point forward, "total catch" (of all bottomfishes) implies all eight species, whereas "Deep 7" always excludes uku. A Welch Modified t-Test was run to determine if there were any significant differences between the means of individual catch rates by lbs and by number of fish caught between recreational and commercial fishers for both total catch and catch of Deep 7 species. A One-way Type III ANOVA was also used to compare total bottomfish catch per total days fished to commercial status. This test normalizes the fact that commercial fishermen typically fish more days than recreational fishermen. To compare whether or not the days of the week fished by commercial versus recreational fishermen were significantly different, a logistic regression with commercial status as the response and days of the week fished as the predictor variables was run. This test was selected because the response and the predictor variables were binary and the data was unbalanced. The same model was run to determine if the number of commercial

and recreational fishermen on the water differed significantly over the months of the year, between gear types, and between the species being targeted. A chi-squared test was run to test whether a fisherman's commercial status determined if they fished more often for cultural reasons. Differences in age and area fished between recreational and commercial fishermen were not assessed in this study.

Does catch rate differ significantly between self-declared ethnic affiliations? Ethnicities were determined from question #25 of the survey instrument which asked fishers to select “the ethnic and cultural traditions you most strongly identify and affiliate with” (Appendix A). Ethnicities were grouped into four major divisions including Asian, Caucasian, Hawaiian, and other. Other included Pacific Islanders, Portuguese, and anyone who had two or more ethnic ties. We ran a type III One-way ANOVA to examine whether a fisher's ethnicity has any predictive power over how much fish is caught (by lbs and by number of fish caught) per trip.

What factors best predict the total bottomfish catch and catch by species? To examine this question, a series of generalized linear regression models (GLMs) were run to determine which particular factors were significant. All variables were unbalanced, limiting the use of an ANOVA. Response variables included catch in pounds of each of the Deep 7 species plus uku, as well as the total catch in lbs (of all bottomfishes). Contributing factors including ethnicity (categorical), commercial status (categorical), number of days fished (continuous), total catch of other species (continuous), and the degree to which the fishermen targeted bottomfish for cultural events (categorical). This later predictor variable, cultural frequency, was determined from question #26 which asked fishers the frequency they go bottomfishing to provide fish for cultural or ethnic ceremonies, parties, and similar events (Appendix A). Total catch minus the catch of targeted species was included as a factor in order to account for the correlation between total catch and catch by species per fisherman. If this factor was not significant, then the test would indicate that a particular species may have been targeted independently of the others. For most linear models, t-values at or greater than 1.75 were considered significant, and are comparable to a p-value < 0.05. In addition, step-wise Akaike Information Criteria (AIC) was used to select the “best” model for predicting total catch rates using the factors available to us from the survey questions.

What is the range of total catch based on this survey? Ratios of commercial: recreational fishermen were established using self-declared status from all returned surveys as well as just the active fishermen. The difference between these two ratios provided a probable range of active and inactive, commercial and recreational bottomfishermen within the main Hawaiian Islands. These ratios were then used to extrapolate catch rates from the entire pool of 3,678 registered bottomfishers. Mean annual catch per commercial and recreational fishermen were artificially inflated because the top twelve active fishermen caught 46% of the total catch (see the strong left-skew in Figure 7). Therefore, medians were used to extrapolate catch range values. Total annual catch (for the Deep 7 species) was calculated by multiplying the range of number of fishers by the median annual catch for recreational and commercial fishermen.

RESULTS

Is there a difference between commercial and recreational bottomfishing annual catch rates in the MHI? Both catch in pounds and catch by number of fish of all bottomfishes differ significantly between recreational and commercial fishermen (Welch Modified Two-Sample t-

Test: [pounds: $t = 5.88$, $df = 162.75$, $p\text{-value} = 0$]; [number of fish: $t = 5.64$, $df = 182.34$, $p\text{-value} = 0$]. See Figure 1 for the total bottomfish catch means by weight and by number of fish caught for both recreational and commercial fishermen.

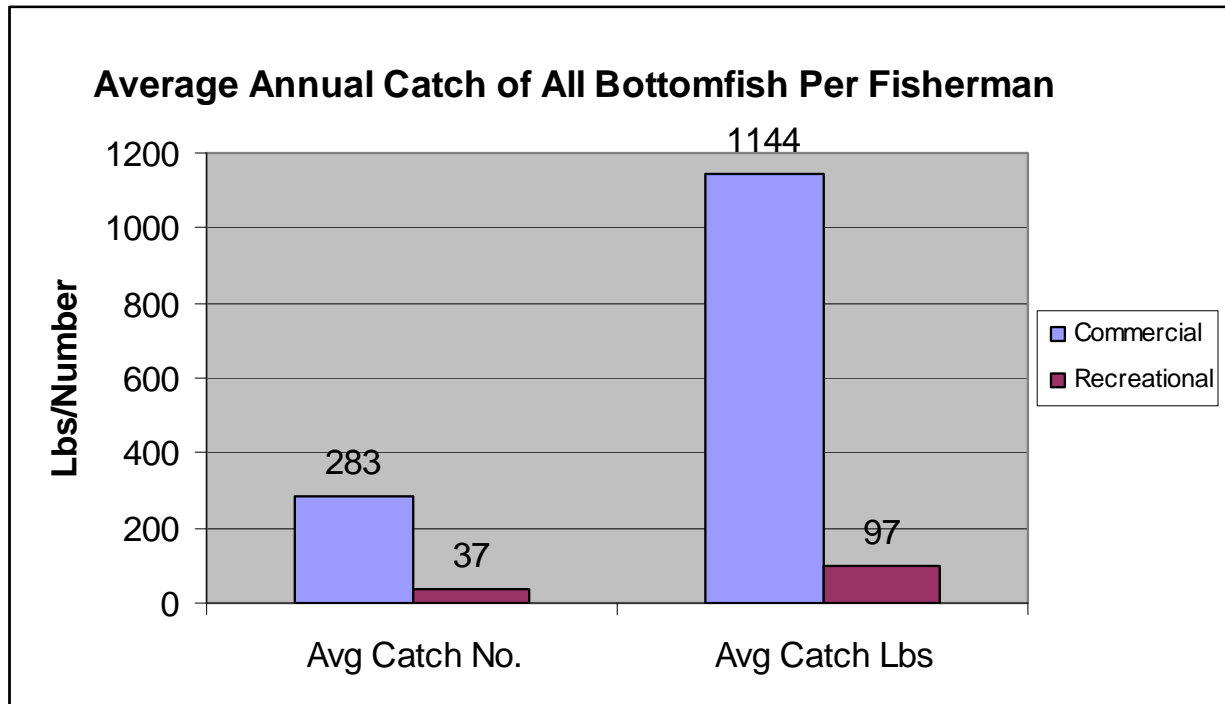


Figure 1: Average annual catch of all bottomfish per fisherman by weight (lbs.) and number of fish for July 2004 - June 2005.

A one-way ANOVA comparing catch in pounds of bottomfish per bottomfishing day was also highly significant with $F = 26.23$ and $p\text{-value} < 0.001$. Commercial bottomfishermen catch a mean of 57 lbs per bottomfishing day, compared to a recreational bottomfisher’s daily catch mean of 15 lbs per day (total catch). For the Deep 7 species on average, a commercial fisherman catches 902.92 lbs/250 fish per year, whereas a recreational fisher catches only 69.78 lbs/31 fish. The median value for these same Deep 7 fishes is 182.50 lbs for commercial and 42 lbs for recreational fishers. The correlation $r\text{-value}$ of 0.76 implied a degree of collinearity between catch in pounds versus number of fish caught, and we used catch in lbs as the appropriate variable for all subsequent tests. See Table 1 below for further breakdown of average annual commercial and recreational catch per fisherman by species.

(numbers are annual averages per fisher unless specified)	Commercial	Recreational
Sample size (N)	Fishers: 151	Fishers: 124
Ehu	Pounds: 79.59 Fish No: 39.64	Pounds: 15.39 Fish No: 7.65
Gindai	Pounds: 9.16 Fish No: 3.94	Pounds: 3.85 Fish No: 2.16
Hapuupuu	Pounds: 28.73 Fish No: 4.57	Pounds: 5.07 Fish No: 1.26

Kalekale	Pounds: 35.62 Fish No: 23.02	Pounds: 7.56 Fish No: 6.11
Lehi	Pounds: 26.59 Fish No: 2.46	Pounds: 2.22 Fish No: 0.36
Onaga	Pounds: 280.62 Fish No: 54.43	Pounds: 10.58 Fish No: 3.72
Opakapaka	Pounds: 442.88 Fish No: 121.83	Pounds: 25.11 Fish No: 10.12
Uku	Pounds: 240.85 Fish No: 33.25	Pounds: 26.78 Fish No: 5.82
Total catch Deep 7	Pounds: 902.92 Fish No: 249.89	Pounds: 69.78 Fish No: 31.39
Total catch with Uku	Pounds: 1143.77 Fish No: 283.14	Pounds: 96.56 Fish No: 37.21
Total catch per day	Pounds: 57	Pounds: 15
Median Deep 7	Pounds: 182.50	Pounds: 42
# of Days Fished	Days: 27.18	Days: 13.99

Table 1: Mean annual catch per fisherman by sector unless otherwise specified.

The mean total number of days fished (from July 2004 – June 2005) is also significantly different for commercial fishermen (27.18d) than it is for recreational fishermen (13.99d) (Welch Modified Two-Sample t-Test: $t = -2.19$, $df = 80.86$, $p\text{-value} = 0.0314$). The days of the week fished were statistically different between recreational and commercial fishermen. The binomial logistic regression model shows that commercial fishermen fished significantly more on Wed, Thur, and Fri than recreational fishermen (Figure 2). T-values were 1.760, 2.913, 2.722 respectively. Mondays and Sundays had the lowest t-values at 0.213, 0.130 respectively. There were no significant correlations between days of the week so the assumptions of the model were met.

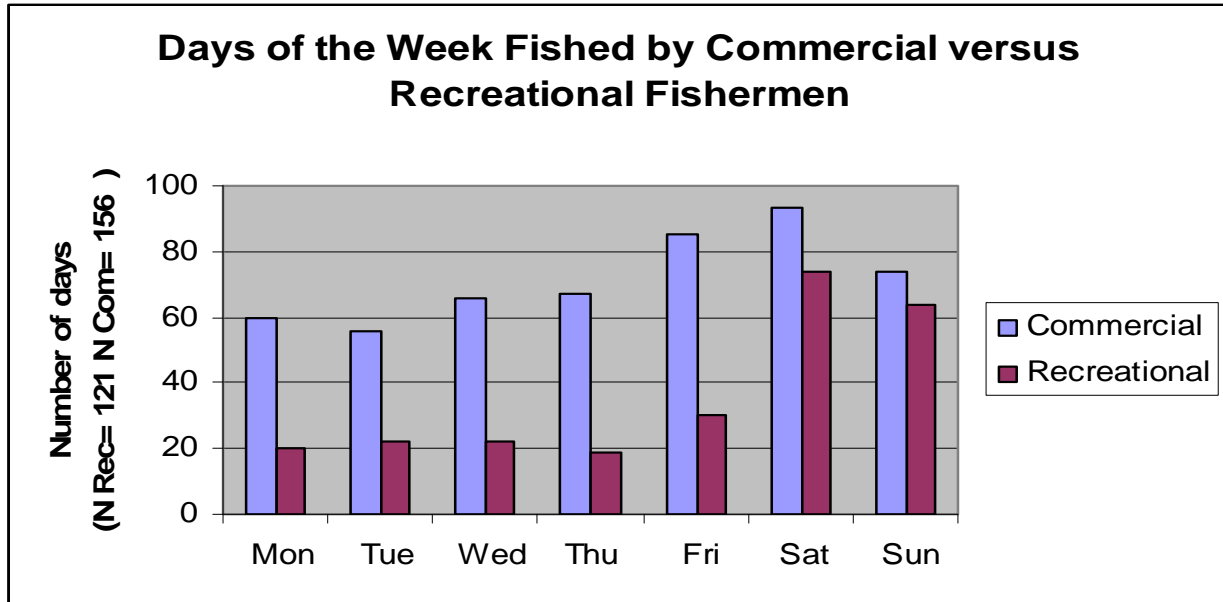


Figure 2: Days of the week fished by number of commercial vs. recreational bottomfish fishermen.

The binomial model of months fished by commercial versus recreational showed January and December, the two most important months for bottomfishing, were statistically different in terms of numbers of recreational versus commercial fishermen. T statistics for those months were 2.235 and 1.753 respectively. The lowest t-values were in July (0.002), August (0.105) and September (0.086) where bottomfishing is at its lowest (Figure 3).

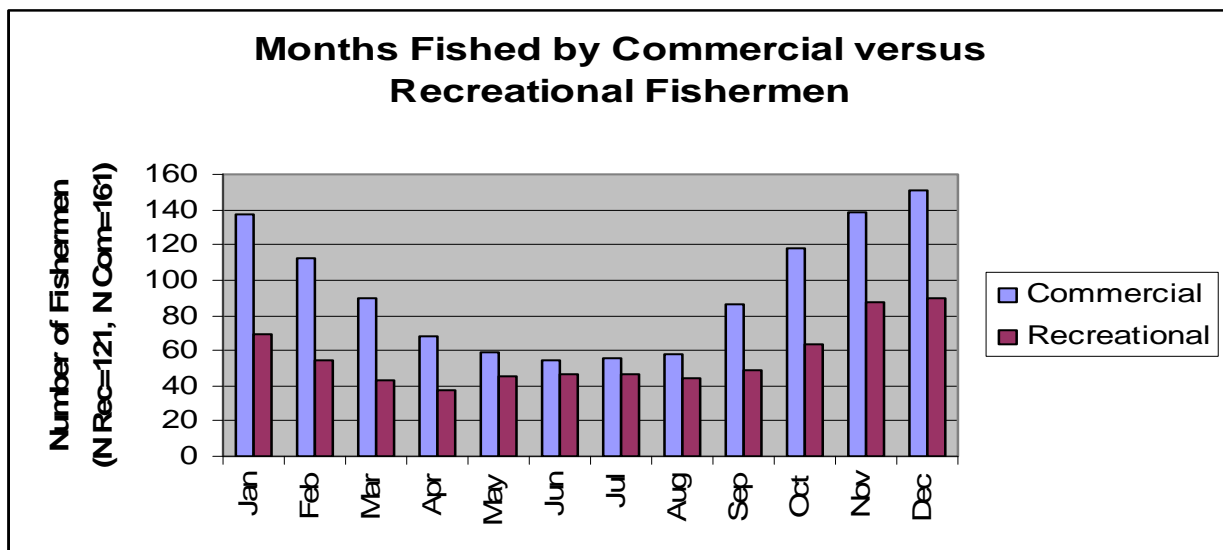


Figure 3: Months fished by number of commercial versus recreation fishermen (July 2004 to June 2005).

A generalized binomial model of species targeted versus the fisherman’s commercial status shows that ehu, onaga, opakapaka, and uku are statistically significant with t-values of -1.584, -2.452, -3.206, and -1.773 respectively. On average, much more of these fish are caught by commercial than recreational fishermen (Figure 4). Also, these four species (ehu, onaga, opakapaka, and uku) make up the largest yield in terms of overall catch.

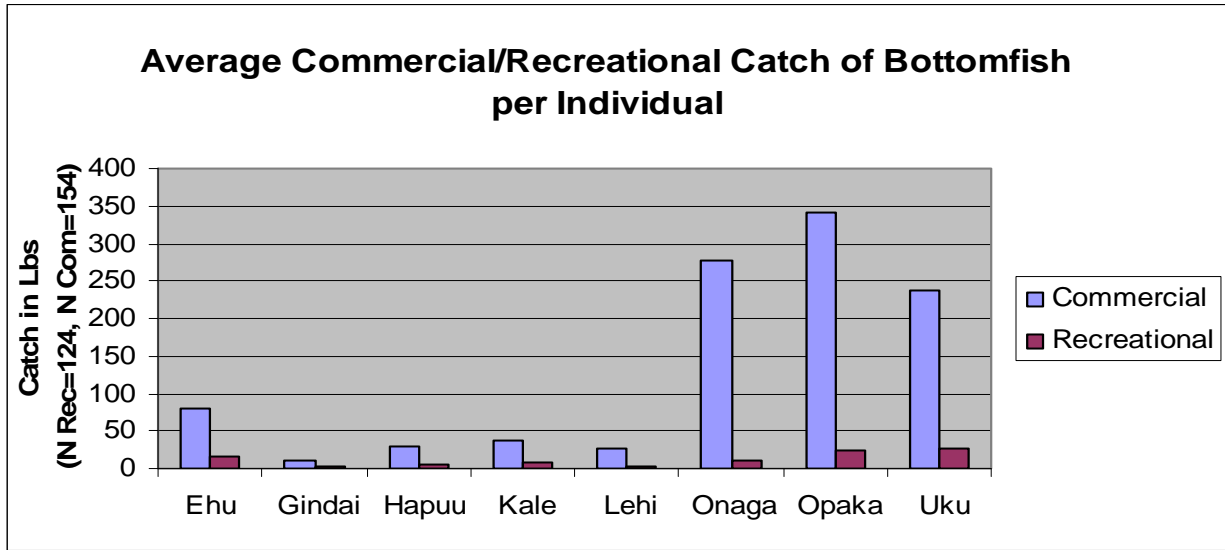


Figure 4: Average annual catch of each species by commercial and recreational fishermen.

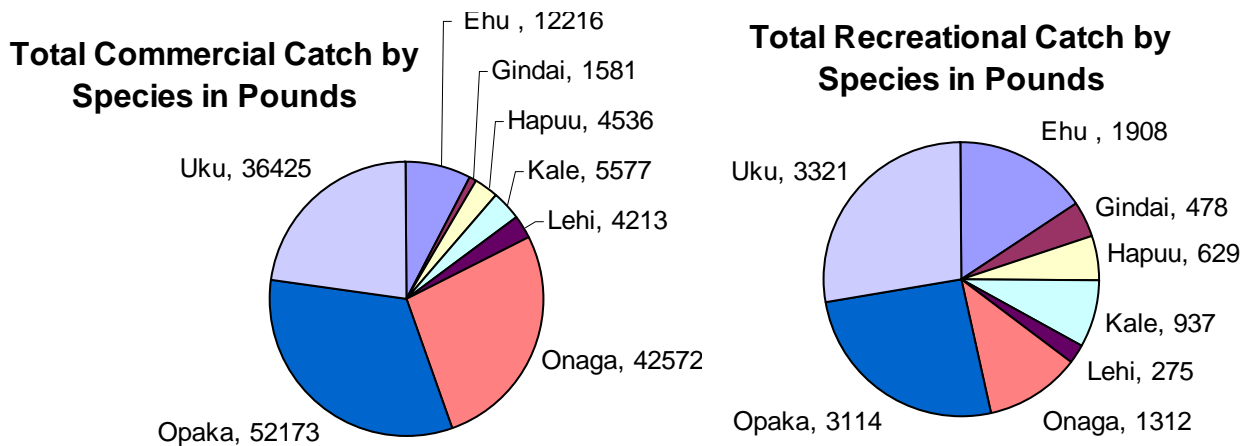
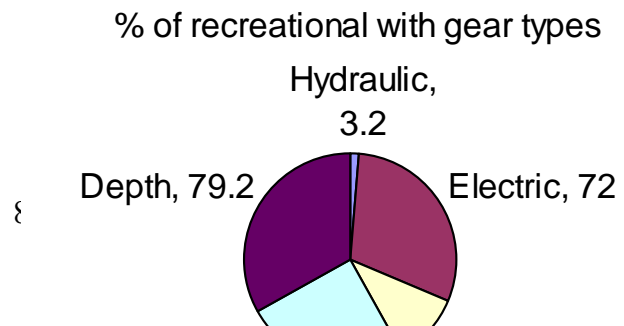


Figure 5: Distribution of catch by species for recreational and commercial fishermen.

A generalized binomial model of gear versus the fisher’s commercial status shows significant differences. Commercial fishermen had significantly more hydraulic and electric reels as well as GPS with p-values of 0.004, 0.05, and 0.033 accordingly. However catch rates were not significantly tied to any gear types. Hydraulic gear does approach significance (t-value = 2.35, p-value = 0.1). GPS plotters were also approaching significance with a t-value = 1.81. See Figure 6 below for a graph depicting the differences in gear types between commercial and recreational fishers.



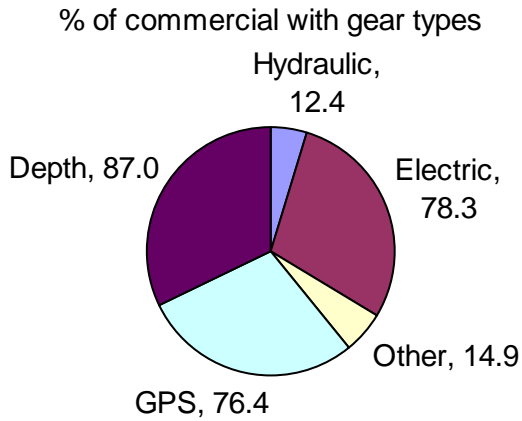


Figure 6: Shows the percentage of active fishermen using each gear type.

A chi-squared test run to determine if commercial status influenced fishing activity for cultural reasons was highly significant (p-value = 0). Recreational fishermen fished much more often for these cultural purposes. A list of all cultural needs and ceremonies pertaining to bottomfishing reported on the open-ended question (#26) appears in Appendix B.

Does catch rate differ significantly between self-declared ethnic affiliations? Sample sizes of ethnicities were Asian (168), Caucasian (31), Hawaiian (30), and other (58). Our one-way ANOVA did not show any statistical differences between overall catch in numbers or catch in lbs to ethnicity. For catch by number of fish caught ($F_{(3/280)} = 0.76$, p-value = 0.513) and for pounds caught ($F_{(3/280)} = 0.65$, p-value = 0.580).

What factors best predict the total bottomfish catch and catch by species? Multiple generalized linear models (GLMs) showed no correlation between ethnicity and total catch or catch composition (Table 2). The number of days fished, commercial status, and total catch minus the targeted species (ie. total catch of all other species besides the species of interest) were all fairly consistent predictors of the total species catch.

Y Variable	Significant X variables	T-Value
Catch lbs	Commercial Status	4.4806593
	# of Days Fished	3.5302833
Ehu	Total catch-Ehu	6.8768993
	Frequency 3	2.3625920
Gindai	Total catch-Gindai	2.3114861
Hapuupuu	Commercial Status	2.0430346
	# of Days Fished	1.9107005
	Total catch-Hapuupuu	2.2769875
Kalekale	Total catch-Kalekale	6.2324274
Lehi	Commercial Status	1.9824564
	Total catch-Lehi	2.2875796
Onaga	Commercial Status	1.7560569
	# of Days Fished	2.7648554
	Total catch-Onaga	3.4089525
	Frequency 1	1.8358639
Opakapaka	# of Days Fished	2.8505228
	Total catch-Opakapaka	1.9407904
Uku	# of Days Fished	5.6748180
	Frequency 1	-1.9157887

Frequency 3	-1.6786624
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Table 2: Significant t-values for linear regressions.

The frequency variables are directly related to question #26 on the survey (see Appendix A), which asks how frequently the fisher provides fish for cultural or family events. They correspond to a significant difference between the reference category of never bottomfishing for cultural events, and fishing once a year (Frequency 1), or fishing more than several times a year (Frequency 3). The frequency variables listed in Table 2 showed some significant correlations with the species caught. This is true for ehu, onaga, and uku. In addition, uku is the single bottomfish species where the total catch of all other species does not predict its catch ($t = 0.167$). In other words, catch rates for Deep 7 bottomfish species do not predict catch rates for uku.

The full model using all available variables was: Total catch in lbs = Days Fished + Ethnicity + Cultural Frequency + Commercial Status + Catch (fish) Number + all possible interactions between these factors. AIC selected the “best fitting” (generalized linear) model as: Catch Lbs ~ Commercial + Ethnicity + Days + Cultural Frequency + Catch Number + Days: Cultural Frequency + Commercial: Catch Number + Ethnicity: Catch Number + Days: Catch Number + Cultural Frequency: Catch Number [Family = poisson, AIC = 3654.07, residuals deviance: df = 134,896.2:238. Other specific details for this GLM are listed below in Table 3, any variable whose partial p-value is < 0.05 is considered significant.

Predictor Variable	F-statistic value (df)	Partial p-value
Commercial	F-stat (1/260) = 178.1968	p = 0.000
Ethnicity	F-stat (3/257) = 3.0604	p = 0.029
Days	F-stat (1/256) = 43.025	p = 0.000
Cultural Frequency	F-stat (4/252) = 1.0688	p = 0.373
Catch No.	F-stat (1/251) = 205.6303	p = 0.000
Days: Cultural Frequency	F-stat (4/247) = 9.6004	p = 0.000
Commercial: Catch No.	F-stat (1/246) = 2.5525	p = 0.111
Ethnicity: Catch No.	F-stat (3/243) = 3.9887	p = 0.008
Days: Catch No.	F-stat (1/242) = 0.2007	p = 0.654
Cultural Frequency: Catch No.	F-stat (4/238) = 1.3346	p = 0.258

Table 3: “Best fitting” (GLM) model factor details for catch in pounds.

What is the range of total catch based on this survey? Figure 7 shows the shows the scatter and the strong left skew of total annual catch of all bottomfish species reported in the survey.

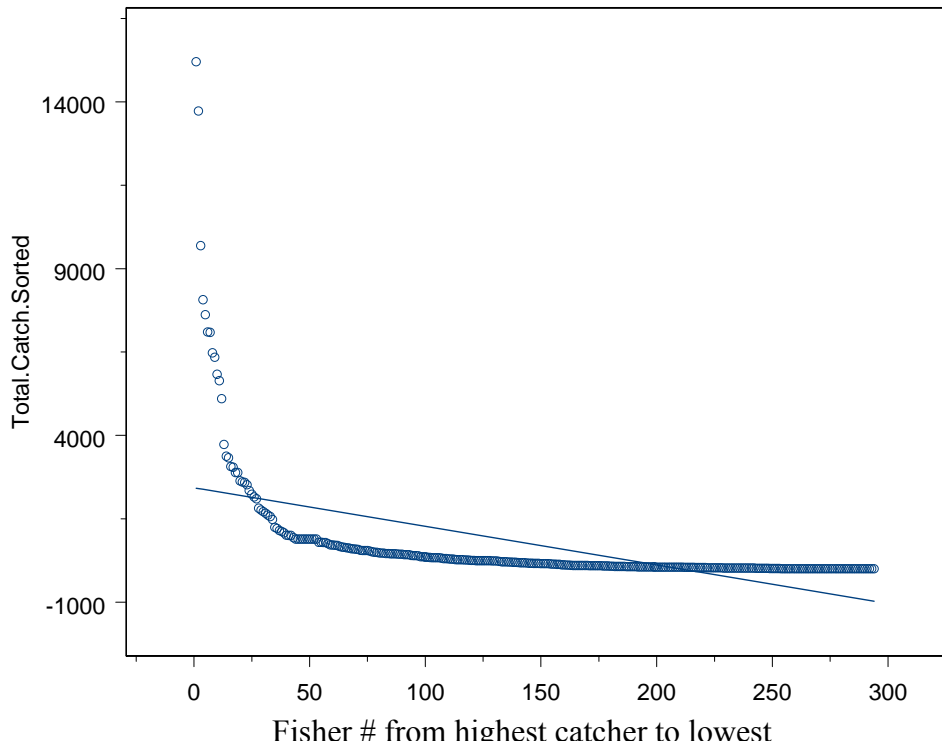


Figure 7: Scatterplot of Total Annual Reported Catch per Fisherman.

Only the top twelve bottomfishers caught over 4,000 lbs/year total catch (Figure 7). These dozen catch landings inflated the mean annual catches, and therefore median annual catch per fisherman values were used to extrapolate mean annual catch ranges of the Deep 7 species. The final extrapolations for Deep 7 species in the MHI are listed in Table 4 below.

(For Deep 7 only)	Commercial	Recreational
Median Annual Catch per Fisherman	182.50 lbs	42 lbs
Range of Active Fishermen	680 - 758.5 fishers	594 – 673 fishers
Extrapolated Total Annual Catch	124,100 – 138,426 lbs	24,948 – 28,266 lbs

Table 4: Total annual catch extrapolations by sector.

DISCUSSION

The survey results suggest that many differences exist between recreational and commercial bottomfishing. Some of these differences have been confirmed statistically by the tests above. On average, commercial fishermen appear to catch more total bottomfish than recreational fishermen. Also, these data show that the number of commercial bottomfishers exceeds the number of recreational fishers by 128% (N = 295). However, the database of State registered bottomfishermen was not updated for addresses or fishing activity. A more precise ratio of recreational to commercial fishermen could be obtained through a current updated State boat registry, especially if it included crew members. Defining commercial status becomes increasingly more difficult when self-declared “commercial” fishermen are only fishing part-time or to cover expenses.

Regardless, commercial bottomfishery participants have a significantly higher total catch rate (mean of 57 pounds per day) as compared to recreational bottomfishers (15 pounds per day).

This, combined with their greater number of trips, means that commercial fishermen catch more pounds of bottomfish per year (median of 182.50 lbs) than recreational fishermen (median of 42 lbs).

As expected, commercial fishermen fish more often during the weekdays than recreational fishermen. However, it is interesting to note that the number of commercial fishermen fishing on Mondays was not statistically greater than recreational fishermen. It is also interesting that commercial fisherman express a much higher interest in bottomfishing during the winter season than recreational fishers. While recreational fishing for bottomfishing does peak in the winter there is also a smaller peak in summer (Figure 3).

The average annual commercial catch per person of onaga, opakapaka, ehu, and uku are all significantly greater than the annual recreational averages. This is not surprising as onaga, opakapaka, and ehu are three of the most targeted and highest valued species. It is also worthwhile to mention that uku was the only species surveyed whose catch was not significantly related to the total catch of the other bottomfish species. This suggests that uku is being targeted separately possibly for cultural reasons (see discussion of Table 2) or for their life history patterns (shallower dwelling habitats). Additionally, uku may be targeted by a variety of techniques (which do not require an electric or hydraulic reel) such as spearfishing, slow trolling, drifting over banks, or jigging.

Commercial fishermen had significantly more hydraulic and electric reels, as well as GPS plotters. However, catch rates were not significantly tied to any gear types. A further analysis would be to test the significance of gear type on each particular species catch.

It appears that ethnicity alone does not dictate a bottomfisher's success (ANOVA results on ethnicity). However, the "best-fitting" GLM suggests that ethnicity may influence catch rate when included with all the other predictor variables and possible interactions (Table 2). Findings indicate that ehu, onaga, and uku are all species that may be caught more often by all fishers for cultural and family purposes. However, these data also show that no particular ethnic group targets any specific species. A chi-squared test revealed that recreational fishermen fish significantly more for cultural needs than commercial fishermen.

The survey confirms that the number of days fished and commercial status of the fisherman are both good predictors for catch in pounds of most individual species. Results from the "best-fitting" model also suggest that ethnicity and cultural frequency (fishing for cultural events), along with interactions between days fished and cultural frequency, days fished and number of fish caught, commercial status and number of fish caught, ethnicity and number of fish caught, as well as cultural frequency and number of fish caught, are also significant factors in predicting total catch in pounds (Table 3). However, this model is highly overdispersed and is not a good fit of the total catch data (residuals deviance: $df > 2$; Quinn & Keough 2002), and may be very incomplete. Weather conditions, boat type, experience level, and several other factors not included in this model could also severely affect catch rates.

These data show that recreational fishermen do catch a considerable portion of bottomfish in the main Hawaiian Islands. However, it is worthwhile to mention that total commercial catch is significantly larger than total recreational catch for this survey sample. Recreational bottomfish catch is 17% of the total catch extrapolation made from this survey and should be accounted for

in future management decisions. HDAR records show a reported commercial catch of 240,151 lbs of Deep 7 species for the 2004 bottomfishing season (HDAR 2004). Our report's maximum catch extrapolations for Deep 7 species estimate a total catch rate of 166,692 lbs per year in the MHI (28,266 lbs/year recreational and 138,426 lbs/year commercial). This suggests that the extrapolations made from the fielded survey may be underestimating the total catch. However, we used medians to extrapolate annual catches for both commercial and recreational fishers. Mean catch may be more representative of annual recreational catch because recreational fishers do not show the same skew as commercial fishers. If we instead use mean catch for recreational fishers (69lbs/fisherman) our estimate would bump up to a range of 40,986 - 46,437 lbs/year. If this estimate is accurate, recreational fishermen could catch up to 25 % of the total main Hawaiian Islands Deep 7 bottomfish landings.

Despite these inconsistencies, the estimates in this report are still not far off the HDAR bottomfisher summary reports. This analysis would be complemented by comparing the reported commercial catch for same bracketed time period from the State's commercial data. Additional surveys would be more credible if an up-to-date recreational bottomfish registry was maintained and recreational fishermen were required to keep accurate catch records. The results of this survey could also be compared to any bottomfish catch extrapolations from the Hawai'i Marine Recreational Fishing Survey Project (HMRFS) data bank. Further analysis of this survey could include variables on fisherman age, area fished, and whether each fisherman fished near the State's restricted areas.

Scientists and managers are currently seeking at least a 24% reduction in the mortality of Deep 7 bottomfishes. Incorporating the impact of recreational bottomfishing into the management equation will be critical. This reanalysis and expansion of the original survey has provided important information on both sectors of the fishery and gives an objective comparison between them. It is hoped that this analysis will be of value in the continuing effort to manage this fishery in sustainable ways that limit negative cultural and economic impacts.

This survey questioned (#27) how important it is that fishers' children or family members will be able to target and catch bottomfish into the future (Appendix A). Of the 158 fishermen who answered this question, the majority of them felt that bottomfishing into the future was very important to them (93 fishers, 59%); 50 fishers (32%) believed that it was somewhat important; and few said that it was not at all important (15 fishers, 9%). In order to ensure conservation of the main Hawaiian Islands bottomfish fishery into the future, fishermen, scientists, and policy-makers alike must work together to reach this common goal.

ACKNOWLEDGEMENTS

Many thanks to the 802 bottomfishermen who took the time to respond to the survey. To Tony Beeching, who conducted the original preliminary analysis. Also to Patrick Hart for reviewing the original draft of the paper. Partial funding was provided to Megan Lamson as an EPSCoR MSTCBES Graduate Scholar. Both Megan Lamson and Blake McNaughton are graduate students within the Tropical Conservation Biology and Environmental Science (TCBES) M.S. Program at the University of Hawai'i at Hilo.

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APPENDICES

A. Survey Instrument

B. Cultural Needs Reported

(Attach Survey Instrument Here)

Appendix B. Cultural Needs Report

Question #26 on the survey instrument (Appendix A) asks fishermen whether they provide bottomfish for cultural or family events. They are asked to check the box that shows the types of celebrations or events (as shown below):

New Years celebration Family gathering Other (please specify): _____

Of the 431 individuals who answered this question, 233 (54%) checked that they fished for New Years, 241 (56%) fished for family gathering purposes, and 82 (19%) fished for other celebrations or events. Any written answers provided in the open-ended question about “other” cultural events are provided in the table below (with frequencies listed beside them).

Other events (N=82)

Home use (18)
Christmas (15)
Parties (15)
Weddings (15)
Birthdays other* (10)
1st birthdays (5)
Funerals (4)
Graduation (3)
Holidays (3)
Religious/Church events (3)
Thanksgiving (3)
Yakudoshi (2)
Chinese New Year (1)
Kanreki (1)
Luau (1)

* includes all birthdays (except 1st birthdays and Kanreki).