Re-specifying Acceptable Biological Catches for the Hawaii non-Deep 7 Bottomfish Management Unit Species

116th Meeting of the Scientific and Statistical Committee
June 17-19, 2014

The SSC's Task

At the 116th Meeting of the Scientific and Statistical Committee (SSC), SSC members are tasked to re-specify the Acceptable Biological Catch (ABC) for the Hawaii non-deep 7 bottomfish MUS. The initial specification completed in 2012, was only for one year. The catch time series was updated in 2012 with data up to 2011 and recalculated the potential ABC. The SSC set the ABC at 140,000 lbs based on the updated time series from the initial ABC of 135,000 lbs. This specification was good for 2 years (fishing year 2013 and 2014). ABC will need to be re-specified for the 2015 fishing year and may consider a multi-year specification similar to the coral reef management unit species. The SSC will review the updated catch data (up to 2013) that will be presented by Council staff. Staff will also present the methodology used by the SSC to calculate the 2012 specification (averaging results from methods: (1) the 75th percentile of the entire catch time series, (2) mean of the last 5 years, and (3) the catch associated with the 50% risk of overfishing for the non-deep 7 component derived from the MHI Deep 7 bottomfish stock assessment). The SSC may also consider setting the ABC using the Biomass-Augmented Catch-MSY approach (Sabater and Kleiber 2014). An MSY value of 265,000 lbs was generated for the non-deep 7 bottomfish stock complex. The P* analysis determined the appropriate risk of overfishing for the Hawaii non deep 7 bottomfish to be at 32% rounding down to 30% since the risk tables are in 5% increment. The corresponding catch level associated with this risk is 187,100 lbs.

The three options that the SSC will consider in specifying the ABC for fishing year 2015-2018 include:
Option 1 – No Action – Maintain the ABC at 140,000 lbs
Option 2 – Use of model average approach incorporating data up to 2013– will maintain ABC by 140,000 lbs
Option 3 – Use the Biomass-Augmented Catch-MSY approach to determine MSY and the results of the P* analysis to specify the ABC at 187,100 lbs

Background information

NMFS/Council Estimation of OFL

In 2011, NMFS Pacific Islands Fisheries Science Center completed a stock assessment for the Deep 7 bottomfish stock complex using data from 1949-2010 to produce projection results of a range of commercial catches of Deep 7 bottomfish that would produce probabilities of overfishing ranging from zero percent to 100 percent, and at five-percent intervals in fishing year 2011-12, and in 2012-13 (Brodziak et al., 2011, Table 17.1 and shown in Appendix 1). The 2010 stock assessment uses similar commercial fishery data as in the previous 2008 stock assessment that assessed the entire Hawaii multi-species bottomfish stock complex as a whole (Brodziak et al. 2009); however, the 2010 assessment includes a modified treatment of unreported catch and catch per unit of effort (CPUE) standardization, as well as new research information on the likely life history characteristics of Deep 7 bottomfish (A. Andrews, PIFSC, unpublished 2010 research).

According to the 2010 stock assessment, the Catch 2/CPUE 1 scenario combination represents the best approximation (with a 0.400 probability) of the true state of nature of the bottomfish fishery and Deep 7 bottomfish population dynamics. Under the Catch 2/CPUE 1 scenario combination, the long-term maximum sustainable yield (MSY) of the MHI Deep 7 bottomfish stock complex is estimated to be 417,000 lb. The assessment model also estimates that the commercial catch associated with a 50 percent probability of overfishing the MHI Deep 7 bottomfish complex in fishing year 2011-12 and again in fishing year 2012-13 is 383,000 lb. Therefore, while the long-term MSY for the Deep 7 bottomfish fishery is 417,000 lb, the overfishing limit (OFL) for the 2011-12 and 2012-13 fishing years is estimated to be 383,000 lb. The 2010 MHI Deep 7 bottomfish stock assessment does not include an evaluation of stock status or the risk of overfishing for any of the remaining BMUS in the MHI (hereinafter, the MHI non-Deep 7 bottomfish)[1]. Therefore, biological reference points, including estimates of MSY and OFL for the MHI non-Deep 7 bottomfish are unknown. However, the stock assessment projection results for the MHI Deep 7 bottomfish stock complex (Appendix 1) can be used to develop an OFL proxy for the MHI non-Deep 7 bottomfish stock complex, and a range of commercial non-Deep 7 bottomfish catches that would produce probabilities of overfishing ranging from zero percent to 100 percent. This approach relies on the assumption that population dynamics, catchability and other parameters of the non-Deep7 bottomfish are similar in relative scale to the Deep 7 bottomfish (Brodziak, pers. com. March 31, 2011). In general, MHI non-Deep 7 bottomfish are coral reef associated species and are more productive compared to MHI Deep 7 bottomfish. However, non-Deep 7 bottomfish are also harvested by a greater range of gear methods, which results in levels, and rates of exploitation that have not been assessed quantitatively or qualitatively in any previous stock assessment.

While a separate stock assessment for MHI non-Deep 7 bottomfish is the preferred approach, until one is produced, estimating a proxy for OFL and probabilities of overfishing for this stock complex based on projection results of the Catch 2/CPUE 1 scenario combination for MHI Deep 7 bottomfish is an appropriate approach given the fact that only catch data is available for the non-Deep 7 stock complex. Additionally, this catch data indicates that reported commercial catches of MHI Deep 7 bottomfish in proportion to the total reported commercial catches of all MHI bottomfish (Deep 7 + non-Deep 7) are relatively stable over time as reported in Tables 5 (Estimates of total Deep 7 catches) and Table 6 (Estimates of total bottomfish catches) contained in Brodziak et al. (2011). Therefore, reported commercial catches of MHI non-Deep 7 bottomfish in proportion to total reported commercial catches of all MHI bottomfish are also stable over time.

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[1] MHI non-Deep 7 bottomfish include uku *(Aprion virescens)*, white ulua *(Caranx ignoblis)*, black ulua *(Caranx lugubris)*, taape *(Lutjanus kasmira)*, yellowtail kalekale *(Pristipomoides auricilla)*, butaguchi (*Pseudocaranx dentex)* and kahala (*Seriola dumerili). Taape catches had been accounted for in the Hawaii CREMUS under the Family Lutjanidae since this is primarily a shallow water coral reef fish and is an invasive species in Hawaii.*

Table 1 summarizes the average proportion of the reported commercial catches (C) of MHI Deep 7 bottomfish relative to the total reported commercial catches of all MHI bottomfish for three time periods: (1) 1949-2010; (2) 2000-2009; and 2008-2010 as presented in Tables 5 and 6 in Brodziak et al. (2011). The proportion of MHI Deep 7 catch (P_{DEEP7}) to the total MHI bottomfish catch is also provided and is calculated using the following equation:

$$P_{DEEP7(t)} = C_{DEEP7(t)} / C_{Total\ BMUS(t)}$$

These three time periods were chosen because they reflect the nature of the Hawaii bottomfish fishery over (1) the entire available catch history; (2) the recent decade; and (3) the last three years when the fishery operated under a catch limit system. The results summarized in Table 2clearly demonstrates that the proportion of Deep 7 to the total reported commercial catches of all MHI bottomfish (Deep 7 + non-Deep 7) has been relatively stable over time with ranges from 0.666 percent to 0.72 percent of the total bottomfish catch.

Table 1. Proportion of reported commercial catches of MHI Deep 7 and total reported commercial MHI bottomfish catch over time under Catch 2/CPUE 1 scenario

	t = 1949-2010	**t =2000-2009**	**t =2008-2010**
Catch of Deep 7 bottomfish[1]	281.3	234.3	221.5
Catch of Total BMUS[2]	422.1	325.3	330.7
Proportion of Deep 7 (P_{DEEP7})	0.666	0.720	0.700

[1] Source: Table 5 in Brodziak et al., (in press)
[2] Source: Table 6 in Brodziak et al., (in press)

Because two Hawaii BMUS, taape *(Lutjanus kasmira)* and kahala (*Seriola dumerili),* are specifically excluded from the NMFS Hawaii bottomfish stock assessment parameters, their catch information is not included in the total bottomfish estimates used in Table 6 of Brodziak et al. (2011). These species were lumped with their congenerics under their respective coral reef fish families.

To estimate an OFL proxy for the MHI non-Deep 7 bottomfish stock complex and a range of commercial non-Deep 7 bottomfish catches that would produce probabilities of overfishing ranging from zero percent to 100 percent, the commercial catch values for MHI Deep 7 bottomfish associated with Catch 2/ CPUE Scenario 1 as presented in Table 17.1 of Brodziak et al., (2011) and shown in Appendix 1 can be divided by the P_{DEEP7} values in Table 1 above. The results of this calculation will derive the total commercial catch equivalent of all MHI bottomfish (Deep 7 + non-Deep 7) and the corresponding probabilities of overfishing all MHI bottomfish. To derive the level of catch that would produce the corresponding probability of overfishing for MHI non-Deep 7 bottomfish (excluding taape and kahala), the level of catch for MHI Deep 7 bottomfish is simply subtracted from the level of catch for all MHI bottomfish.

Table 2 summarizes the results of this calculation for the time period 1949-2010. This time period is identical to the time period used to produce projection results for the Deep 7 stock complex and is the baseline to which impact analyses will be compared.

Table 2. Commercial catch (1000 pounds) of MHI Deep 7 BMUS, MHI non-Deep 7 BMUS and all MHI BMUS combined that would produce probabilities of overfishing in 2012 from 0 through 99% based on 1949-2010 catch data (P_{DEEP7} = 0.666)

Probability of Overfishing[1]	Catch of MHI Deep 7 BMUS[1]	Catch of All MHI BMUS *(Deep 7 + non-Deep 7)*[2]	Catch of MHI non-Deep 7 BMUS[2]
0	11	17	6
5	147	221	74
10	197	296	99
15	229	344	115
20	255	386	131
25	277	415	138
30	299	449	150
35	319	479	160
40	341	512	171
45	361	542	181
50	383	575	192
55	407	611	204
60	429	644	215
65	455	683	228
70	481	722	241
75	513	779	266
80	549	824	275
85	597	896	299
90	665	998	333
95	783	1176	393
99	1001	1503	502

[1] Source: Table 17.1 in Brodziak et al., (2011)
[2] Excludes Hawaii BMUS taape *(Lutjanus kasmira)* and kahala (*Seriola dumerili)*

Based on Table 2 above, the catch limit associated with a 50 percent probability of overfishing the MHI Deep 7 bottomfish complex in fishing year 2011-12 and again in fishing year 2012-13 is 383,000 lb. The catch limit associated with a 50 percent probability of overfishing the MHI non-Deep 7 bottomfish complex in fishing year 2012 and again in 2013 is 192,000 lb and is the OFL proxy. This OFL proxy can be apply to 2014 and beyond until a new stock assessment is conducted.

SSC's Calculation of ABC for 2012

At its 108th meeting held October 17-19, 2011, the SSC considered the use of the 2010 MHI Deep 7 bottomfish stock assessment to establish by analogy, a range of commercial non-Deep 7 bottomfish catches that would produce probabilities of overfishing fishing year 2012 for the three time periods (1949-2010; 2000-2009; and 2008-2010).

However, because this approach is based on analogy, and MSY-based reference points for non-Deep 7 bottomfish have not been derived from statistically-based stock assessment models, the

SSC also considered setting ABC in accordance with the Tier 5 ABC control rule as described in the Hawaii FEP. The Tier 5 ABC control rule directs the SSC to multiply the average catch from a time period where there is no quantitative or qualitative evidence of declining abundance ("Recent Catch") by a factor based on a qualitative estimate of relative stock size or biomass (B) in the year of management. When it is not possible to analytically determine B relative to the biomass necessary to produce the maximum sustainable yield (MSY) from the fishery (B_{MSY}), the process allows for an approach based on informed judgment, including expert opinion and consensus-building methods. Table 3 provides a summary of the Council's default ABC control rule for data poor stocks.

Table 3. Tier 5 ABC Control Rule (Data poor, Ad hoc Approach to Setting ABCs)

If estimate of B is above B_{MSY}	ABC = 1.00 x Recent Catch
If estimate of B is above minimum stock size threshold (MSST), but below B_{MSY}	ABC = 0.67 x Recent Catch
If estimate of B is below MSST (i.e. overfished)	ABC = 0.33 x Recent Catch

In defining "Recent Catch" to apply in the ABC control rule, the SSC considered two approaches: (1) average catch over the five year period (2006-2010) as shown in Table 4; and (2) catch corresponding with the 75th percentile of the time period (1966-2010) shown in Table 5.

Upon reviewing the various approaches presented at the 108th meeting, the SSC stated that it had no basis for choosing one approach over another. Hence, the SSC recommended taking an average of the following three ABC estimates: 1) ABC associated with the 50% probability of overfishing (OFL proxy) of entire catch time series (1949-2010) using the analogy method; 2) ABC from 1*mean of recent catch (2006-2010); and (3) ABC from the 1*75th percentile of the catch (1966-2010).

The SSC noted the ABCs could be derived using three different approaches and gave equal weight to each of the three methods. The SSC also determined it applicable to "model average" the estimates to derive an overall estimate that explicitly takes into account the uncertainty associated with the three estimates. This approach is known as multi-model inference (Burnham and Anderson 2002). Applying the multi-model inference approach, the SSC recommended the non-Deep 7 bottomfish ABC be set at 135,000 (Table 6)

Table 6. Results of SSC multi-model inference approach for MHI non-Deep 7 Bottomfish

Method	**Previous Associated Catch (lbs)**
1. 50% probability of overfishing (1949-2010)	192,000
2. Average Catch (2007-2010)	104,984
3. 75th percentile of catch (1966-2010)	107,610
Average	**134,866 ≈ 135,000 ± 49,497**

2013 Catch Data Update

The following section recalculates the catches associated with the various methods considered by the SSC at its 108th meeting using 2011 catch data.

Approach 1: Average Recent Catch

Table 4 provides a time series of reported commercial catch of each species of the non-Deep 7 species from the MHI between the years 1966-2013. Prior to 1982, the commercial data collection program did not distinguish various species of Carangids (jacks) such as butaguchi, (*Pseudocaranx dentex)*, black ulua *(Caranx lugubris)*, and white ulua *(Caranx ignoblis)*; therefore catches for these species prior to 1982 are zero. Catches of yellowtail kalekale *(Pristipomoides auricilla)* are insignificant relative to other species. Based on this approach, the total average catch of all MHI non-Deep 7 combined for the last five years (2009-2013) was 117,420 lb (±20,308)

Table 4. Reported commercial catch of MHI non-Deep 7 (1966-2013)

Fishing Year	Uku	Butaguchi	Black ulua	White ulua	Yellowtail kalekale	Total (lb)
1966	57,833	0	0	0	0	57,833
1967	58,540	0	0	0	0	58,540
1968	49,664	0	0	0	0	49,664
1969	57,526	0	0	0	0	57,526
1970	47,405	0	0	0	0	47,405
1971	48,697	0	0	0	0	48,697
1972	48,064	0	0	0	0	48,064
1973	66,857	0	0	0	0	66,857
1974	77,918	0	0	0	0	77,918
1975	61,722	0	0	0	0	61,722
1976	62,115	0	0	0	0	62,115
1977	67,951	0	0	0	0	67,951
1978	83,702	0	0	0	0	83,702
1979	87,031	0	0	0	0	87,031
1980	74,651	0	0	0	0	74,651
1981	84,859	0	0	481	0	85,340
1982	100,860	2,175	0	5,694	0	108,730
1983	131,631	1,255	0	13,673	0	146,559
1984	138,276	2,921	117	20,553	0	161,867
1985	49,251	4,034	902	9,868	0	64,055
1986	104,019	19,414	363	14,774	0	138,570
1987	56,725	1,698	61	7,458	0	65,942
1988	343,177	6,026	354	22,643	0	372,201
1989	207,734	10,454	503	19,744	0	238,434

Fishing Year	Uku	Butaguchi	Black ulua	White ulua	Yellowtail kalekale	Total (lb)
1990	97,235	6,840	62	13,375	0	117,512
1991	90,266	7,895	24	6,806	0	104,991
1992	88,389	2,229	93	7,075	0	97,786
1993	69,948	3,760	68	2,891	0	76,667
1994	71,802	4,678	169	2,691	0	79,340
1995	62,456	6,264	186	3,214	0	72,121
1996	53,237	3,260	52	6,210	0	62,759
1997	67,957	5,923	192	2,203	0	76,276
1998	61,088	1,943	315	3,715	0	67,061
1999	90,968	1,946	12	2,976	0	95,901
2000	83,318	2,947	73	4,044	0	90,382
2001	58,436	1,814	122	4,199	5	64,576
2002	57,155	1,659	421	4,183	1	63,420
2003	45,704	1,635	1,180	12,873	0	61,391
2004	76,815	1,394	1,034	14,112	43	93,399
2005	63,505	1,493	453	11,213	25	76,688
2006	59,569	298	267	9,076	32	69,241
2007	68,953	880	773	26,722	0	97,328
2008	92,872	1,193	405	15,856	6	110,331
2009	87,175	1,083	549	13,794	35	102,636
2010	123,250	772	3,348	17,986	27	145,383
2011	109,497	1,385	1,554	18,904	51	131,391
2012	101,758	742	827	12,368		90,013
2013	138,822	1,028	1155	17,240		158,169

Ave. 2006-2010	**86,364**	**845**	**1069**	**16,687**	**25**	**104,984**
Ave. 2007-2011	**96,349**	**1,063**	**1,326**	**18,652**	**30**	**117,420**
Ave. 2009-2013	**112,100**	**1,002**	**1,487**	**16,058**	**38**	**125,518**
StDev09-13	**19,833**	**262**	**1,106**	**2,826**	**12**	**28,633**

Source: NMFS WPacFIN unpublished data

Figures 1-4 illustrate the reported commercial catches of uku (*Aprion virescens*) and all non-Deep 7 bottomfish, butaguchi, (*Pseudocaranx dentex)*, black ulua *(Caranx lugubris)*, and white ulua *(Caranx ignoblis)* over the available time series. Figure 1 clearly illustrates uku is the primary stock harvested in the fishery.

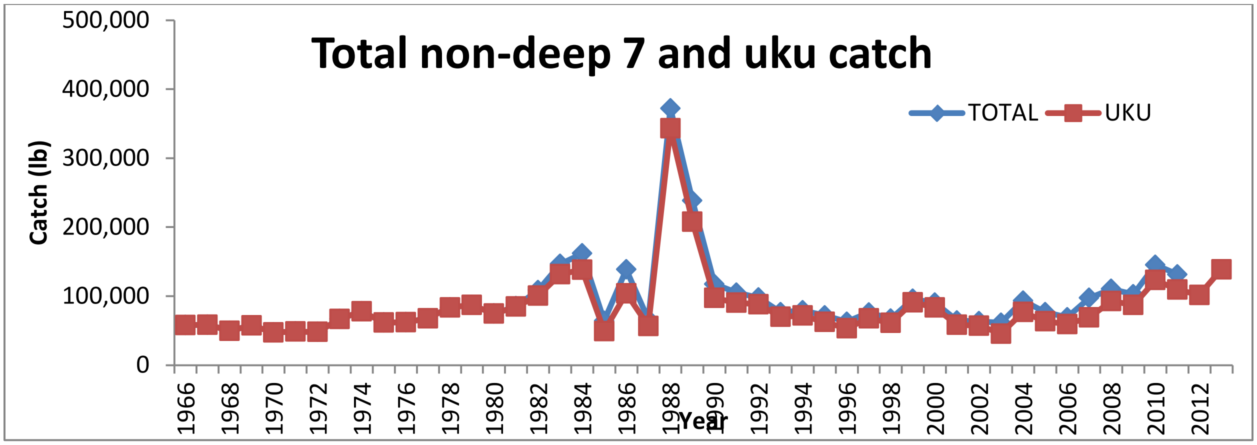

Figure 1. Reported catches of all MHI non-Deep7 bottomfish and uku (1966-2013)

(Source: WPFMC 2014)

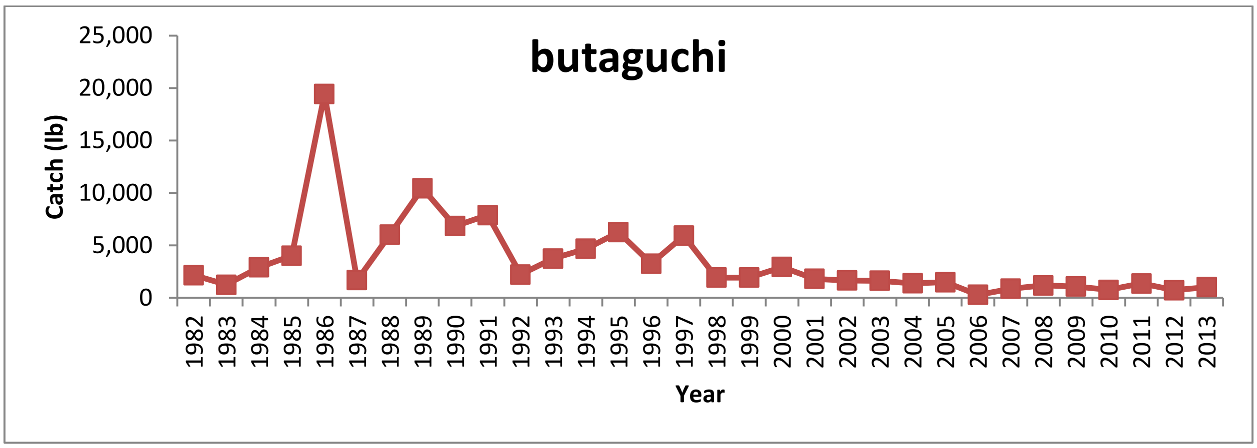

Figure 2. Reported catches of butaguchi in the MHI between 1982-2013

(Source: WPFMC 2014)

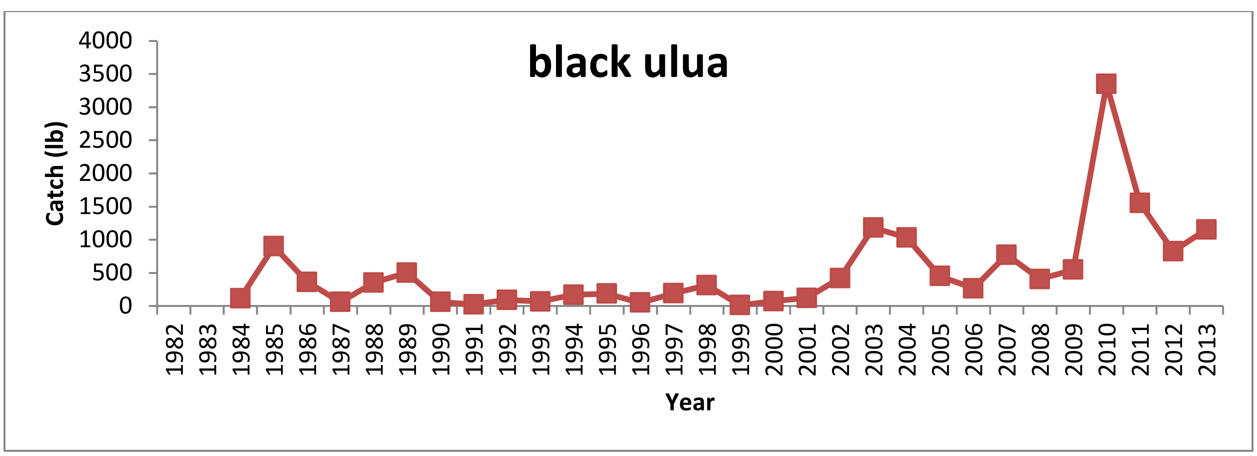

Figure 3. Reported catches of black ulua (1982-2013)

(Source: WPFMC 2014)

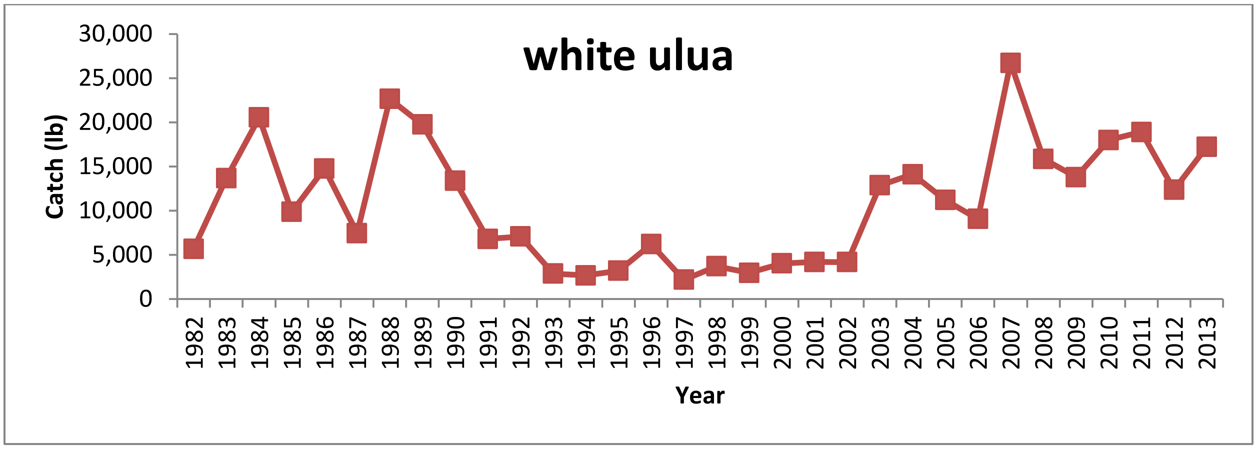

Figure 4. **Main Hawaiian Islands catches of white ulua (1982-2013)**

(Source: WPFMC 2014)

Approach 2: 75th Percentile Approach

Table 5 provides the 75th percentile of the catch for each species individually and for the MHI non-Deep 7 stock complex as a whole based on data from 1966-2010, 1966-2011 and from 1966-2013. The 75th percentile is the value of an array (in this case the level of catch in terms of pounds) below which 75% of the observations may be found. The SSC noted that the 75th percentile is a non-parametric approach, that is, a distribution free method and does not rely on assumptions that the data are drawn from a given probability distribution. The SSC also noted that non-parametric measures are a better way to summarize data with considerable inter-annual variability as opposed to averaging (Chambers et al., 1983; Cleveland 1993).

As noted previously, prior to 1982, the commercial data collection program did not distinguish various species of Carangids (jacks) such as butaguchi, black ulua, and white ulua; therefore catches for these species from which the 75th percentile was derived included data beginning in 1982.

Table 5. 75th Percentiles for the non-Deep7 bottomfish catch from 1966 to 2010, 1966 to 2011, 1966 to 2013

Species	75th %ile 1966-2010 (lb)	75th %ile 1966-2011 (lb)	75th %ile 1966-2013 (lb)
Uku	88,389	89,797	91,444
Butaguchi	4,677	4,517	4,195
Black ulua	477	514	717
White ulua	14,032	14,443	14,774
Yellowtail Kali[1]	30	35	35
Total non-Deep 7 catch	107,608	109,306	103,225

[1] The 75th percentile for yellowtail kalekale was estimated for the catch from 2001

The results of the multi-model inference approach for MHI non-Deep 7 Bottomfish using the data through 2013 is presented in Table 7.

Table 6. Results of SSC multi-model inference approach for MHI non-Deep 7 Bottomfish

Method	Current Associated Catch (lbs)
1. 50% probability of overfishing (1949-2010)	192,000
2. Average Catch (2006-2013)	125,518
3. 75th percentile of catch (1966-2013)	103,225
Average	**140,248 ≈ 140,000 ± 46,184**

For the purpose of ACL specifications for Hawaii non-Deep 7 bottomfish, taape *(Lutjanus kasmira)* and kahala (*Seriola dumerili)* are not included as they were specifically excluded from the NMFS Hawaii bottomfish stock assessment parameters. Instead, ACLs for these species are being considered under the ACL specification for Coral Reef Ecosystem (CRE) MUS currently in development. Specifically, catches of taape would be included in the CRE ACL specification for the family Lutjanidae (coral reef-associated snappers) while catches of kahala would be included in the CRE ACL specification for the family Carangidae (coral reef-associated jacks).

Approach 3: Biomass-augmented catch-MSY model

MSY was estimated for the Hawaii non-deep 7 bottomfish using the catch-MSY approach originally developed by Martell and Froese (2012) where it implemented a Monte-Carlo simulation to generate a biomass project using a range value of rate of population increase, *r*, and carrying capacity, *k*, minus the catch at any step in the time series. This approach was augmented by adding biomass information as one of the priors (Sabater and Kleiber 2014a). The augmented approach is useful if there is a biomass estimate. In the absence of the biomass estimate, the model defaults to running the original routine as described by Martell and Froese (2014). An MSY value of 265,000 lbs was generated for the non-deep 7 bottomfish stock complex (Sabater and Kleiber 2014b).

There were previous recommendations to remove uku from the non-deep 7 complex because of recent changes in the fishery whereby uku is no longer a substitute fish when the MHI deep 7 bottomfish fishery closes. The uku fishery had evolved on its own and is now a regular targeted fishery. If a separate ACL were to be specified for uku, an FEP amendment is required to establish uku as a different management unit. The working group members agreed to keep uku under the non-deep 7 but to also to treat uku as an indicator species to be monitored as a separate species and as a complex.

Using the biomass-augmented catch-MSY approach, the method-B MSY estimate for the non-deep 7 bottomfish is 265,000 lbs (Sabater and Kleiber 2014b). Applying the same stock status determination methodology in the P* analysis, the stock status dimension score is 2.5. The P-S dimension yields a score of 7.5 (see table below for details). Combining all the dimension scores yield a score of **18** and a corresponding P* value of **32**. The risk table is shown below.

Hawaii Coral Reef Ecosystem (Mullidae-Goatfish) (non-FSSI)

Species Name	Scientific Name	Prod.	Susc.	Sum	Ave	Justification
UKU	Aprion virescens	7.5	7.5	15	7.5	Long lived (26 years); slow growing; highly targeted; takes 5 years to reach maturity; average length 50 cm from an Lmax of 81 cm

Risk table for the non-deep 7 bottomfish

risk table – k-revise b									
5%	10%	15%	20%	25%	30%	35%	40%	45%	50%
112.2	129.9	144.5	158.1	172.3	187.1	203.7	221.2	239.9	259.2

The corresponding catch level associated with this risk is **187,100 lbs**.

SSC Action

The SSC must specify an ABC for 2013. The SSC should consider the following methods:

1.1.1 Option 1: No Action (Status Quo)

Under this alternative, SSC would use the model average approach using data through 2011 which would retain the Hawaii Non Deep 7 Bottomfish ACL at 140,000 lbs. This new number corresponds to 25 to 30 % risk of overfishing.

1.1.2 Option 2: Use model average approach incorporating 2011 data

Under this alternative, the ABC for the Hawaii Non-Deep 7 Bottomfish will be 140,000 lbs similar to option 1. This number corresponds to 25 to 30% risk of overfishing.

1.1.3 Option 3: Use the Biomass-Augmented Catch-MSY approach

Under this alternative, the ABC for the Hawaii Non-Deep 7 Bottomfish will be 187,100 lbs. This corresponds to 30% risk of overfishing using the risk table generated by the Biomass Augmented Catch-MSY approach.