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Options for a Total Allowable Catch for Seamount Monchong and Bigeye Tuna on the Cross Seamount

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DRAFT

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Introduction

At its 145th Meeting, the Western Pacific Regional Fishery Management Council directed staff to develop an options paper for the October 2009 Council Meeting that provides available data for the consideration of a total allowable catch (TAC) on the Cross Seamount for both tuna and monchong.

The principal reasons for considering a TAC include concerns expressed at Council meetings by fishermen and the general public that Hawaii's non-longline pelagic fisheries (NLPF) tend to land juvenile bigeye tuna, especially from the Cross Seamount and that this may be detrimentally depleting fish that would recruit to the Hawaii-based longline and nearshore small boat pelagic fleets. Although one study by Adam et al. (2003) suggested that the rate of exchange of bigeye between Cross Seamount and Hawaii's inshore fisheries is relatively low and need not be of great management concern for either species, suspicions about effects on other fisheries persist.

Further, the Cross Seamount is a unique structure as the shallowest seamount within US exclusive economic zone (EEZ) waters around Hawaii, rising to within 300 m of the surface. It is the only relatively shallow seamount that is accessible to NLPF vessels which use a variety of hook and line gear to catch tuna and other pelagic fish. Most recently, the use of shortlines (longlines < 1 nm in length) and conventional longlines have been used to target the seamount monchong (*Eumegistis illustris*). Seamount monchong has increased in the catch from this fishery since 2000 to 25,000 lbs per year in 2008. The seamount monchong may exhibit a greater degree of site fidelity than the tunas which aggregate on and around the Cross Seamount but move elsewhere. Seamount monchong is present at other seamounts in the Hawaii Archipelago and elsewhere, however, its stock structure is unknown.

Purpose and need

The purpose of the proposed action is to analyze establishment of a TAC for seamount monchong and bigeye tuna being caught at the Cross Seamount. The intention would be to maintain sustainable production of seamount monchong and bigeye tuna from the Cross Seamount at optimum levels, without over-depleting the localized stocks of both species on the seamount.

Non-Longline Pelagic Fishing in Hawaii

The following description of non-longline pelagic fishing in Hawaii has been freely adapted from Glazier et al. (2009). Troll fishing and deep-sea offshore handline fishing has long been a critically important aspect of life in the Hawaiian Islands. Indeed, use of handlines to capture various tuna species is the most enduring form of fishing in the Central and Western Pacific. It has, however, undergone a series of changes over the course of its history.

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Ika-Shibi Fishing

Ika-shibi is a nighttime small-boat tuna fishery that was developed in the nearshore waters of Hawaii Island during the second decade of the twentieth century. Captain and crew (typically one or two) deploy a parachute-type sea anchor to keep the vessel in a relatively stable and slow drift, typically above or near favored drop-offs such as the 600 and 1,000 fathom curves, and around *ko`a*, fish aggregating devices (FADs), or other features. *Ika* is the Japanese word for squid and *shibi* is the Japanese word for tuna.

The summer months have been particularly productive for the ika-shibi fishery in years past, though some years involve a winter bite as well. Production and use of chum lines by cooperative captains is common. Lunar phase is considered important by many fishermen. Underwater 25-50 watt lamps and sometimes 25 watt above-water lamps running from a 12 volt power source attract biomass, baitfish, and squid to the vessels. Squid are preferred bait, but ʻōpelu (mackerel scad) or frozen squid are used on occasion and may initiate a night's fishing until squid are caught (Rodgers 1987). *Palu* (chum; in this fishery often anchovy or sardine) is intermittently dispersed as an attractant in the water column during the course of the operation.

Three or four long braided polypropylene or nylon lines are equipped with leaders of between 300 and 400 pound test, baited 14/0-16/0 or size 32 to 56 circle hooks, and lead-filled tubular weights, and cleated at staggered depths for fishing between around 10 to 15 fathoms and sometimes deeper, depending on the target bathymetric, thermocline, or other feature. A breakaway line, often made of cotton cord, enables the fish to run with the bait before snapping and setting the hook. Some vessels have hollow railings so the breaking cord will alert the fishermen to a hookup.

Once the hook is set, the fish is played quickly and is hauled to the boat by hand on the main line. Both skill and strength are needed to detect the strength of the fish and allow them to run if necessary to avoid breaking the line or leader. Strikes often occur in clusters, making for periods of high levels of activity on board. Fish are stunned with bat, and terminated by bullet or by stiff wire run through spine/brain cavity. Large fish are bled, gilled, and gutted and some operators head the fish. Consistent use of ice and icy brine has reduced burn problems characteristic of historic ika-shibi operations. Much effort is exerted to chill the fish adequately in order to meet wholesaler requirements.

Palu Ahi Fishing

Palu ahi is a daytime small-boat tuna fishery developed in the Pacific Islands over the millennia. In Hawaiian, "*palu*" refers to chopped and/or mashed bait. Historically, the material was wrapped around a smooth stone or sometimes placed in a bag and lowered to depth over a specific target, usually reef formations called ko`a, where ahi (ahi ko`a) or other species were known to congregate. Some informants assert that pelagic and other species would be "trained" to come to and feed at such features, and that at the appropriate time a number would be captured by handlining methods. The type of palu and the manner of its preparation were critical in the traditional context. In more recent

years, the daytime palu ahi has been conducted most typically on the leeward Kona Coast of Hawai'i Island, often around FADs or ko`a. Some modern captains use parachutes for slower drift; others do not. The palu ahi method may also be called "bust bag" or "drop stone" in local vernacular.

In the case of the "drop stone" technique, a hook baited with `ōpelu, whole or part, is wrapped with leader and chopped `ōpelu or other palu around a flat-sided beach cobble or similar stone. When the bait is lowered in a cloth or canvas bag to the proper depth, the mainline is jerked, thereby releasing a double-curl slipknot securing the bag. The contents are spilled, ideally incurring a feeding reaction by the tuna. The stone falls off onto the bottom while the chum and leader spread out. While this gear is fished in as little as 10 fathoms at nearshore ko`a and as deep as 80 fathoms at offshore buoys, range of depth can vary extensively, depending on the nature of the targeted feature. Appropriate depth of set may be determined by experimenting or by identifying the depth large fish on a depth recorder.

Make dog is similar in nature, and probably a natural evolution of drop stone in that it allows the fisher to retain the weight. The technique may also have origins in Japan or in Japanese immigrants in Hawai'i, as the phrase "make doggu" is also sometimes used, meaning "wrapped device." The method involves use of a flat, ovoid lead weight - one side of which is convex and amenable to placement of the coiled leader, baited hook, and palu. The gear is wrapped in a cloth and lowered in a similar fashion. It is rigged such that the lead weight remains tethered to the mainline and can be retrieved. Leaders may range from 150 to 300 pounds and 13/0 to 16/0 or 28-43 size circle hooks are used in both techniques, and thus constant and movement-sensitive pressure on the mainline is essential during retrieval.

Overall skill and strength, and speed in preparing the stone or bag, are essential for success. Much skill and dexterity is needed to haul large fish on light leaders; this must be done in a smooth and gentle manner. Some fishermen may distribute palu around the vessel to encourage a surface rush, to which they react with a short line and/or a pole and line kept at the ready for this eventuality.

Cross Seamount Fishery

A distinct handline fishery was developed in the early 1970's when enterprising fishermen took advantage of aggregated populations of fish at Cross Seamount and weather buoys in the far offshore zone (Figure 1). Pelagic resources at the Cross Seamount were first pursued by a couple of operators in the mid- 1970s. Crowding in historically used areas and perception of diminishing resources originally led to exploration in the far offshore zone. Activity at the seamount slowly increased as word of success gradually spread through a network of prospective participants. While only four to six operators fished the area through the 1980s, as many as 14-20 captains and crew were making the voyage when the fishery ultimately reached a peak level of participation the early 1990s. The peak in production from this fishery occurred between 1995 and

2000 when almost 1.5 million lbs was landed each year but has since declined sharply to less than 400,000 lbs, and few handline operators now frequent these areas

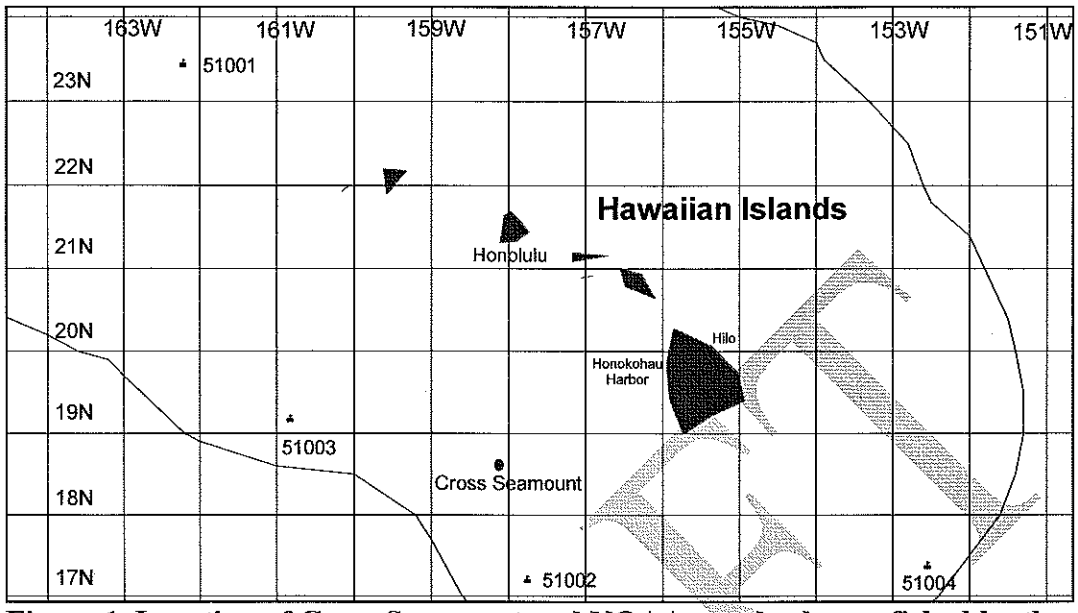

Figure 1. Location of Cross Seamount and NOAA weatherbouys fished by the offshore non-longline pelagic fishery.

Given that Cross Seamount is located at 180 40' N, 1580 10' W, or about 160 nautical miles south of Honolulu, some of the vessels involved in the handline fishery at the feature have been longer than what might typically called small boats in Hawai'i. While many have been in the range of 45 feet and occasionally up to 60 feet in length, some have been as small as 32 feet. A few boats were specifically designed and built for this fishery, with narrow hulls, relatively low sides, compartmented fish boxes, and extendable mounts for danglers. Cross Seamount is part of the Navigator Seamount chain. The mountain rises from a seafloor depth of about 4,000 meters to about 330 meters from the ocean surface, and tends to influence current flow in the area. Both yellowfin and bigeye tuna aggregate here and have been the primary subjects of pursuit by the handline fleet, which tends to land small and medium size class tuna at relatively shallow depths (Itano and Holland 2000).

The full range of handline methods are used at the seamount, including the drop stone and make dog palu ahi techniques during the day, and night-time methods similar to those used in the ika-shibi fishery. Strategic timing and speed of drift in the localized current pattern is typical. Locally caught squid or frozen scad are used for bait, and frozen anchovy or other fish are typically used for palu. Most captains also troll while steaming to the grounds. Hydraulic line haulers are sometimes used to haul fish aboard. More recently, a few of the long-term operators in this fishery have pioneered the use of 'short-lines' or longline-type gear < 1 nm in length, which is not regulated as a longline under current federal regulations.

Operators have used shortline gear as configured in Figure 2 to target bigeye tuna but have also adapted this gear to target seamount monchong (Figure 3). This innovation has also contributed to concerns about the offshore handline/mixed gear fishery because bigeye tuna continue to be subjected to overfishing across the Pacific, and seamount monchong are likely to be a more limited resource, with stronger site fidelity than the more cosmopolitan tunas.

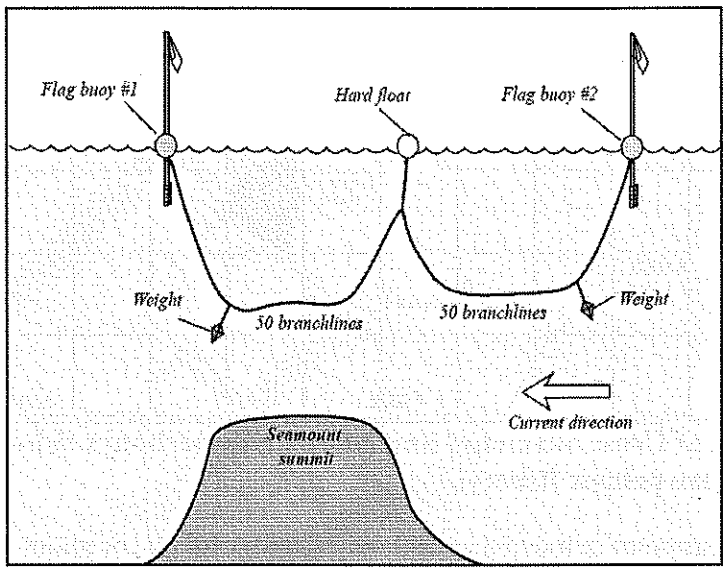

Figure 2. Deployment of short line gear on the Cross Seamount to target seamount monchong. Source: Itano (2004)

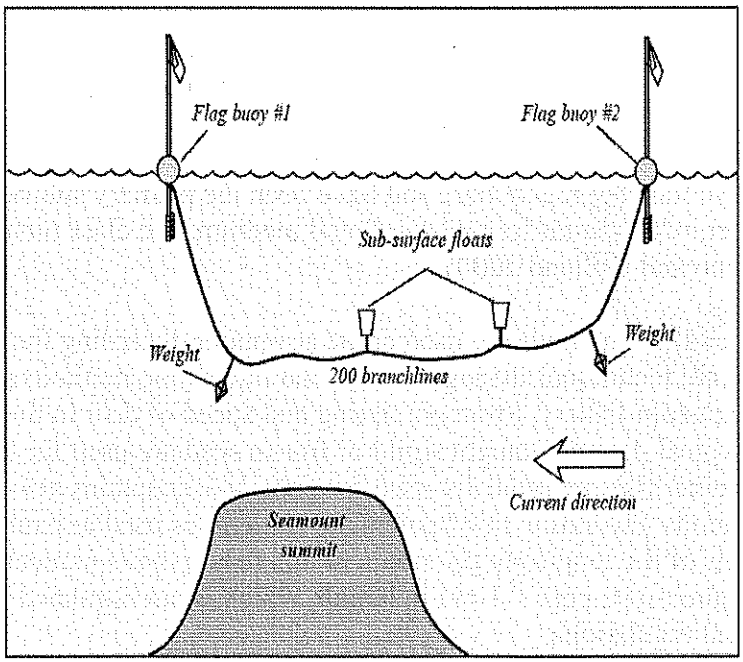

Figure 3. Deployment of short line gear on the Cross Seamount to target bigeye tuna. Source: Itano (2004)

Informal discussions with fishermen operating on the Cross Seamount indicate that over time the configurations of the shortline to catch seamount monchong and bigeye tuna have evolved beyond those shown in Figures 2 and 3.

Definitions of shortline gear

The Code of Federal Regulation defines longline gear as follows but does not explicitly define shortline gear.

"Longline gear means a type of fishing gear consisting of a main line that exceeds 1 nm in length, is suspended horizontally in the water column either anchored, floating, or attached to a vessel, and from which branch or dropper lines with hooks are attached; except that, within the protected species zone, longline gear means a type of fishing gear consisting of a main line of any length that is suspended horizontally in the water column either anchored, floating, or attached to a vessel, and from which branch or dropper lines with hooks are attached."

The State's definition also uses the 1 mile threshold. "Shortline fishing is defined as "Fishing using a horizontal mainline, less than one nautical mile in length and suspended from the ocean surface with floats, from which leaders with baited hooks are suspended. The State also defines vertical line fishing as "Fishing using a vertical line mainline, suspended from the surface with float, from which leaders with baited hooks are attached and ending with a terminal weight."

The one mile threshold is intended to allow for the continued use of 'kaka-lines' (i.e. shortlines) by small boat pelagic fishermen in Hawaii's EEZ waters, without subjecting them to the requirements of an existing longline limited entry program.

Catch and fishing effort data

Catch and fishing effort reports are submitted by fishermen as a requirement of the State of Hawaii's Commercial Marine License (CML) program. Fishermen operating on the Cross Seamount utilize a variety of hook and line gear, including tuna handlining, ika-shibi gear, palu-ahi gear, vertical longlines, trolling, and shortline gear. Some of these gears are reported separately in the State of Hawaii's CML database, along with another category, 'hybrid' which is a mix of different gears and which contributes a significant volume of the Cross Seamount catch.

For this options paper, the fishery data from the Cross Seamount from 1999-2008, were analyzed to establish catch limits for bigeye tuna and seamount monchong. The catch data were disaggregated to daily catches by individual fishermen, fishing gears employed and species landed. Catch and effort were summarized annually for shortline gear, the hybrid combination, and handline gear.

Results

Catch, fishing effort and catch composition

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The total volume of fish caught from the Cross Seamount between 1999 and 2008 was 4,460,000 lbs, which represents about 9.3% of the total combined NLPF catch from the Main Hawaiian Islands (MHI) over this ten year period (Figure 4). In the latter half of the time series, i.e. from 2004 to 2008 (Figure 4) the contribution from the Cross Seamount to the total commercial NLPF catch has ranged between 6-14 percent.

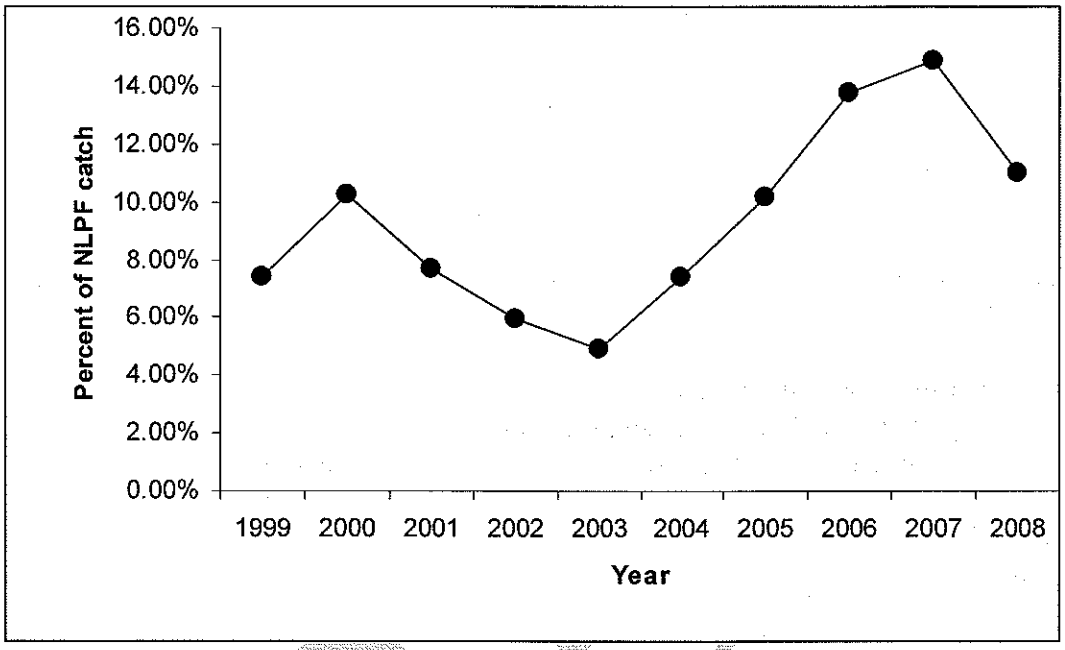

Figure 4. Percent of MHI NLPF catches from Cross Seamount (MHI NLPF catch total excludes catches from aku pole and line vessels). Source NOAA Fisheries

The composition of the Cross Seamount catch between 1999-2008 is given in Table 1. The catch is dominated by bigeye tuna which forms almost two thirds of the catch, with another quarter of the catch from yellowfin landings. Over the ten year time series seamount monchong forms about 2.7% of the total catch; however the catch of seamount monchong has been steadily increasing in the Cross Seamount catch (Figure 5) and over the last four years has risen to almost four percent of the total catch

Table 1. Species composition of Cross Seamount between 1999-2009

Species	Catch (1999-2008)	Percent of catch
Bigeye Tuna	2,940,483	65.9258%
Yellowfin Tuna	1,201,121	26.9292%
Monchong	123,367	2.7659%
Mahimahi	79,086	1.7731%
Aku	25,794	0.5783%
Blue Marlin	21,546	0.4831%
Walu	19,857	0.4452%
Ono	15,432	0.3460%
Tuna (Misc.)	14,089	0.3159%
Thresher Shark	3,788	0.0849%

Species	Catch (1999-2008)	Percent of catch
Swordfish	3,003	0.0673%
Shortbill Spearfish	2,917	0.0654%
Striped Marlin	2,248	0.0504%
Billfish (Misc.)	2,146	0.0481%
Mako	1,316	0.0295%
Kaku	1,032	0.0231%
Shark (Misc.)	762	0.0171%
Others	1,379	0.0003%

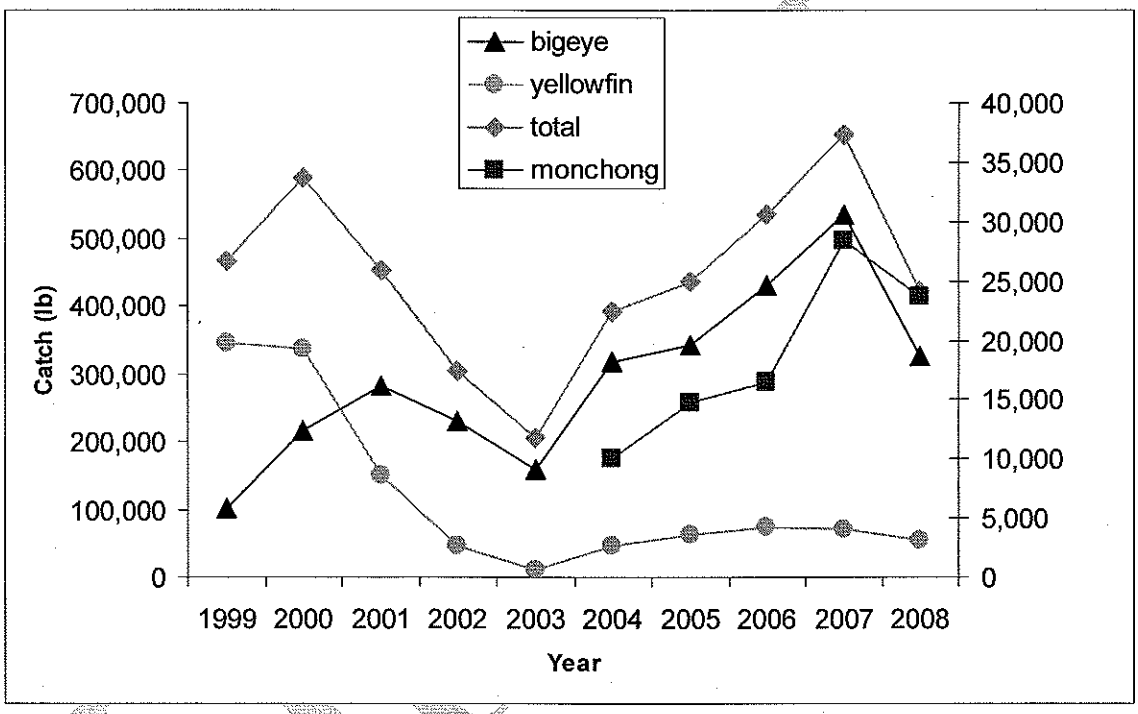

Figure 5. Time series of total catch, bigeye, yellowfin and seamount monchong from Cross Seamount

Figure 5 shows the ten year time series of total catch and principal species from the Cross Seamount. The total catch trajectory declined from around 600,000 lbs in 2000 to about 200,000 in 2003, over which time yellowfin catches also declined. The increasing catch trend after 2003 has been strongly driven by the increasing volume of bigeye tuna from the Cross Seamount and to a lesser extent from the increased volume of monchong.

The fishery dynamics of the Cross Seamount have varied over the ten year time period. The number of fishermen reporting landings from the Cross has ranged from seven to fifteen, with a mean of nine. Overall, fisherman participation has shown a declining trend (Figure 6).

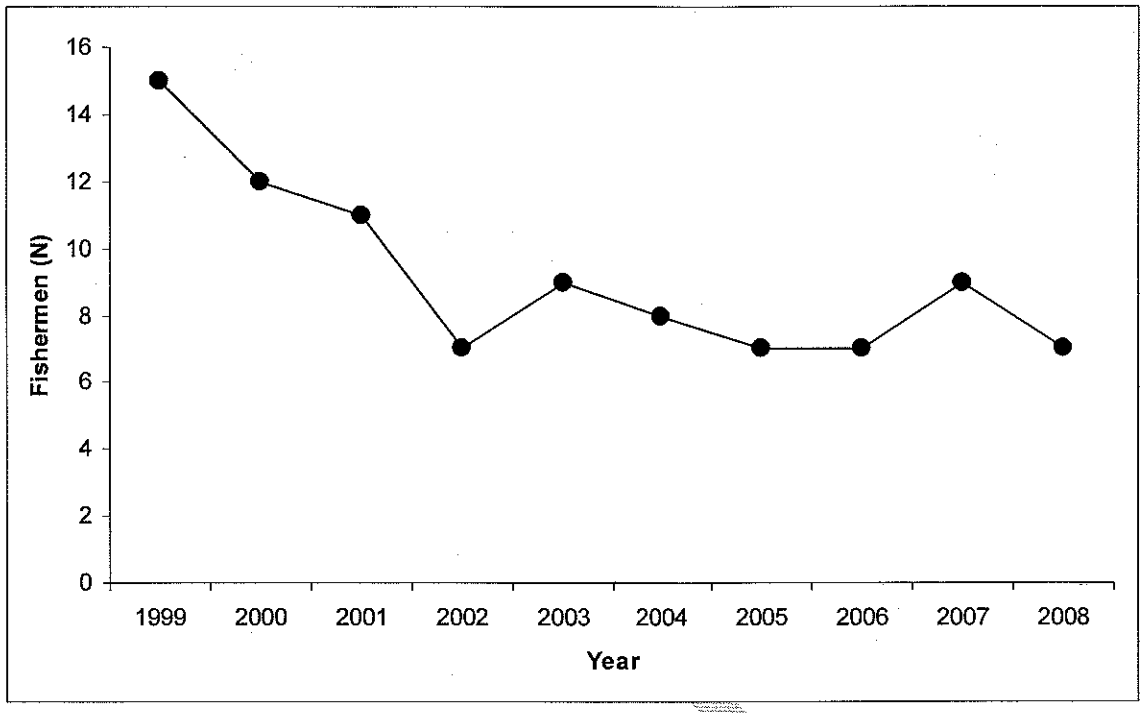

Figure 6. Number of fishermen reporting landings from the cross seamount, 1999-2008, Source NOAA Fisheries.

About 38% of the total catch from the Cross Seamount comes from a mix of gears lumped under the 'hybrid' category (Table 2). The gears used in the hybrid category comprise various handlines, pole and line, shortlines and vertical lines. Tuna handline gear used in isolation from other gears was most common between 1999 and 2004, although over the entire time series this gear type contributed to over 33% of the catch. However, handline gear is still commonly deployed as part of the hybrid category of fishing gear. Shortline gear began to be deployed earlier this decade and now accounts for about 17% of the reported catch, although the percentage is likely higher due to the use of shortlines in the 'hybrid' category. Together, hybrid, handline and shortlines form about 90% of the catch from the Cross Seamount over the entire time series (Table 2), and hybrid and shortline contributed to 62% and 30% of the total catch between 2004 and 2008.

Table 2. Fishing gears used on the Cross Seamount (1999-2008). Source NOAA Fisheries

Gear	Catch (lb)	Percent of total catch
Hybrid mix of gears	1,696,629	38.04%
Tuna handline	1,490,474	33.42%
Short line	758,115	17.00%
Ika-shibi	233,109	5.23%
Troll	44,437	1.00%
Palu-ahi	31,003	0.70%
Miscellaneous	206,522	4.62%

Estimating allowable catches

TAC from average catch

One approach to estimation of allowable catch for the Cross Seamount can be based on average catches over the ten year time series (1999-2008) or only the most recent years (2004-2008) (Table 3).

Table 3. Average catches of seamount monchong and bigeye tuna from 2004-2008 and 1999-2008 from the Cross Seamount.

Species	Average 2004-2008 (lbs)	Average 1999-2008 (lbs)
Monchong	18,642	13,707
Bigeye	390,403	294,048

TAC from equilibrium surplus production models

Another approach is to examine the relationship between catch and fishing effort and estimate a maximum sustainable yield (MSY) from these data and use the MSY or a fraction thereof as the allowable catch.

Estimation of the MSY for seamount monchong is confounded by the two principal sources of fishing effort, namely the mix of different gear and the reporting of how many shortline segments were used in a shortline set. However, the data from the Cross Seamount shortline catch reports were sufficient to generate nominal annual numbers of sets of the shortlines which are typically set in gangs or fleets. A simple equilibrium production model for the years 2003-2008 is shown in Figure 7, although the data points can not be displayed for confidentiality reasons. The fitted curve produced a MSY of 16,700 lbs. However, a significant volume of seamount monchong was also caught by 'hybrid' gear sets. If the hybrid gear catch data are combined with the shortline data, simply by adding in the annual number of hybrid sets to the shortline sets and adding the catch totals for the years 2002-2008 (Figure 8), the estimated MSY is 21,000 lbs.

Similar exercises were conducted with the bigeye tuna data using the handline catch and effort (Figure 9: 1999-2008), shortline catch and effort (Figure 10: 2003-2008) and hybrid catch and effort (Figure 11: 2002-2008). The MSY for all tuna handlining (includes tuna handline, ika-shibi and palu-ahi) (Figure 9) was 285,000 lb. Catch and effort for shortline and hybrid gear catches combined (Figure 10) for bigeye tuna from the Cross Seamount generated an MSY of 500,000 lbs, while the combined handline, hybrid gear and shortlines combined MSY of about 487,000 lbs (Figure 11).

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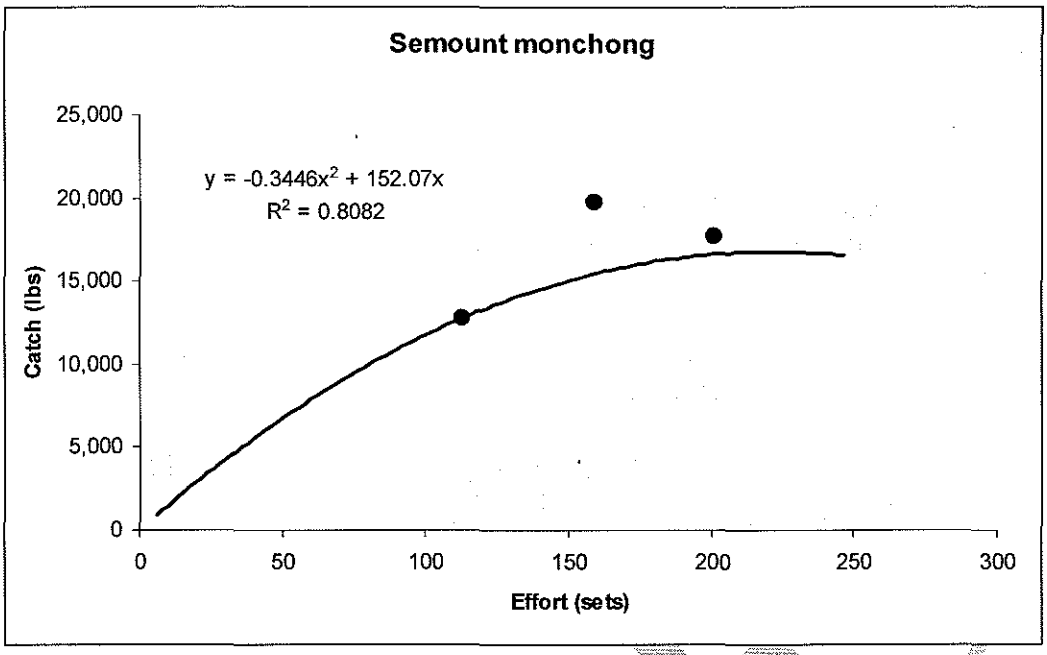

Figure 7. Catch versus fishing effort from 2003-2008 for shortline catches of monchong from Cross Seamount fitted with an equilibrium production model. Points for years 2003-2005 can not be shown for confidentiality reasons.

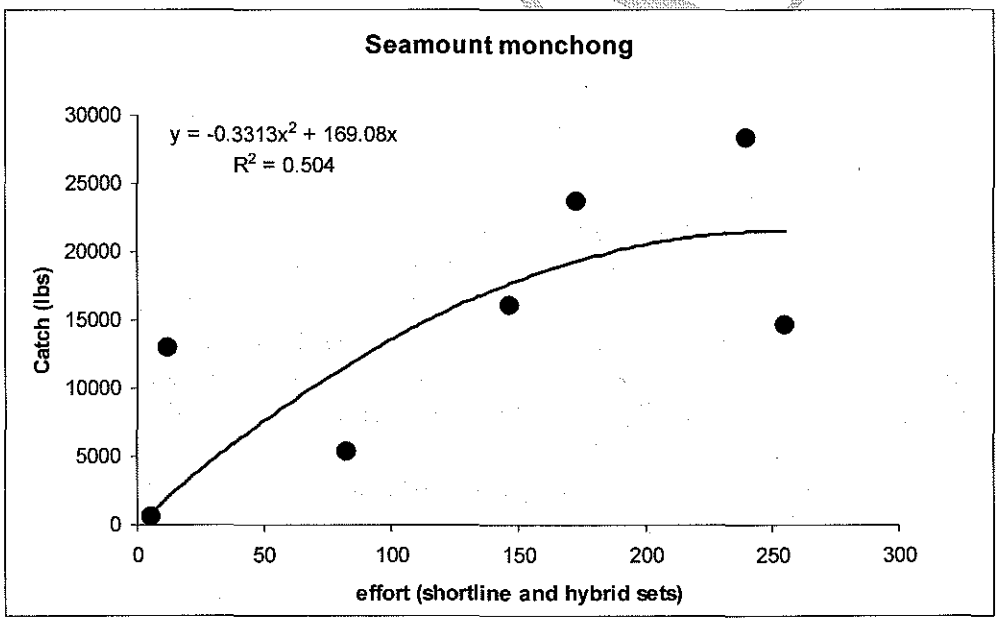

Figure 8. Catch versus fishing effort from 2003-2008 for shortline and hybrid gear catches of monchong from Cross Seamount fitted with an equilibrium production model.

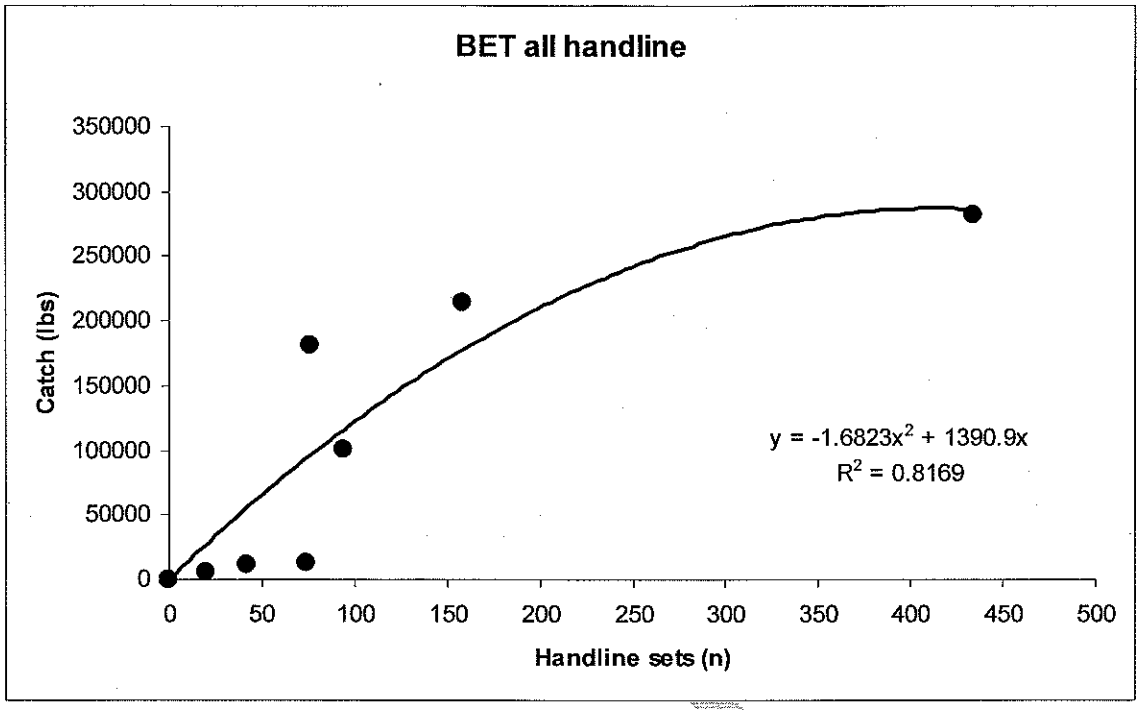

Figure 9. Catch versus fishing effort from 1999-2008 for all handline catches of bigeye tuna from Cross Seamount fitted with an equilibrium production model. Data for 2003 not shown for confidentiality reasons.

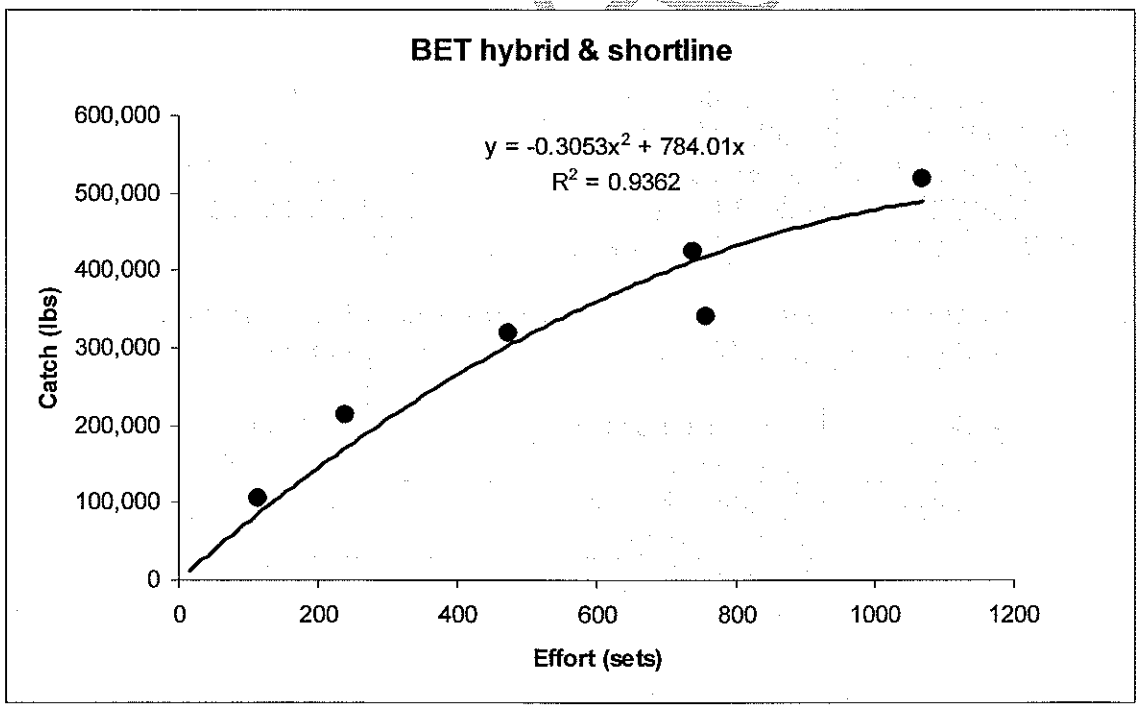

Figure 10. Catch versus fishing effort from 2002-2008 for combined shortline and hybrid catches of bigeye tuna from Cross Seamount fitted with an equilibrium production model. Data for 2002 not shown for confidentiality reasons.

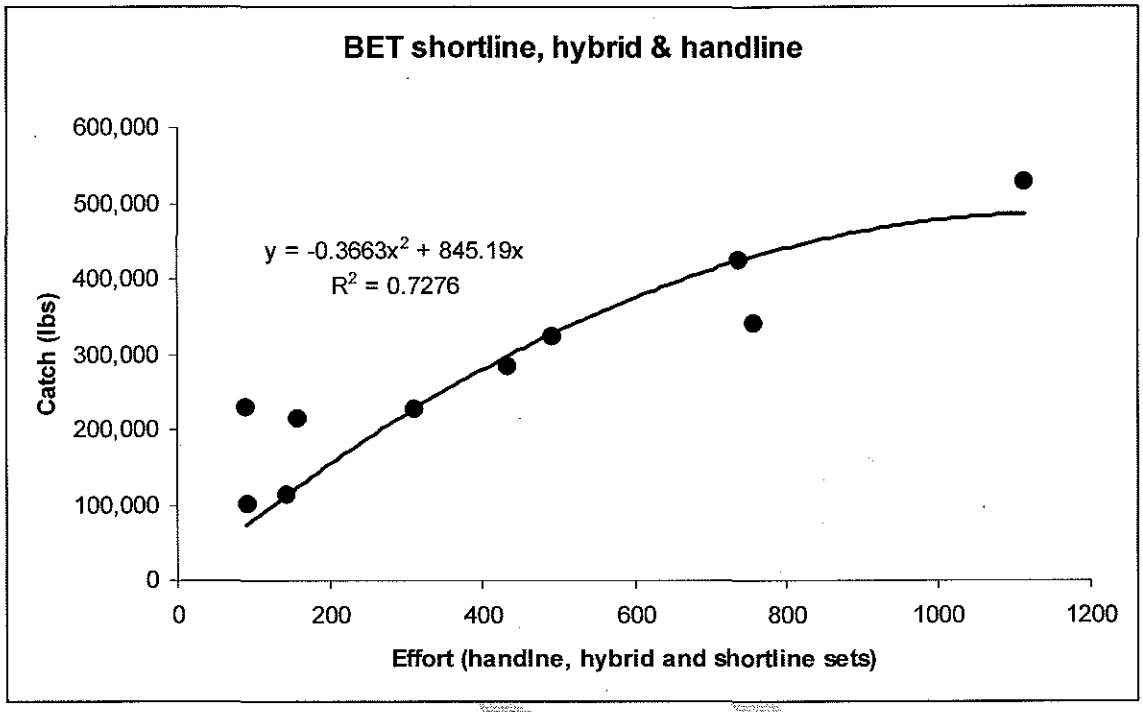

Figure 11. Catch versus fishing effort from 1999-2008 for catches of bigeye tuna by combined handline, hybrid gear and shortline combined from Cross Seamount fitted with an equilibrium production model.

A summary of the MSY estimates from the equilibrium production models is given in Table 4. **However despite the apparent good fit to the data of a simple surplus production model to the data sets, there is, in most instances, no statistically significant declining relationship of catch rate with fishing effort. This lack of a relationship between catch rates and fishing effort confounds interpretation of the apparent MSY values from the curve fits in Figures 7-11.**

Table 4. Summary of nominal MSY estimates from equilibrium production models for seamount monchong and bigeye tuna on the Cross Seamount

Species	Gear type or combination	Years	Nominal MSY(lbs)
Seamount Monchong	Shortline only	2003-2008	16,700
Seamount Monchong	Shortline & Hybrid	2002-2009	21,000
Bigeye	Handline only	1999-2008	285,000
Bigeye	Shortline & Hybrid	2002-2008	500,000
Bigeye	Shortline & Hybrid & Handline	1999-2008	487,000

TAC from dynamic production models

Assistance was sought from the NMFS Pacific Islands Fisheries Science Center (PIFSC) to make some preliminary investigations of the data to see if they were amenable to more complex analyses than simple equilibrium production models. However, for most of the

data sets catch rates do not decline in proportion to effort and hence confound attempts at dynamic production models.

Options for Total Allowable Catches

Option 1. NO ACTION

Under the no-action option, a total allowable catch not would be set for catches of seamount monchong and bigeye tuna on the Cross Seamount.

Pros: The advantages of taking no action include no increase in the administrative burden and monitoring requirements for the Cross seamount fishery. Also, fishermen catches of bigeye tuna and seamount monchong would not be limited.

Cons: Unconstrained fishing on seamount monchong may lead to localized depletion of this stock on the Cross Seamount. Figures 6 and 7 suggest that in the current fishery increasing fishing effort does not result in major increases of monchong catch. However, fishing on this stock for the better part of a decade has not resulted in any downwards shift in the average size of seamount monchong (Figure 12). Although bigeye tuna are part of a greater Pacific population, tagging data shows that they recruit to the Cross and have a residence time of about 30 days at the Cross Seamount (Adam et al 2002). This means that unconstrained fishing may deplete the bigeye stock, which would have an effect on the transfer and availability of fish from the Cross to Hawaii's inshore and longline fisheries. The average size of bigeye from the Cross Seamount (Figure 13) shows that the majority of the catch is juveniles and there is no overall size trend in the data.

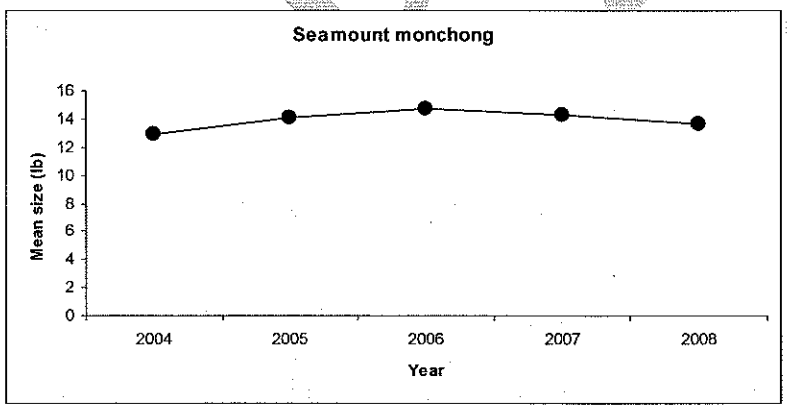

Figure 12. Average size of monchong caught on the Cross Seamount, 2004-2008, by a combination of fishing gears. Years prior to 2004 can not be shown for confidentiality purposes.

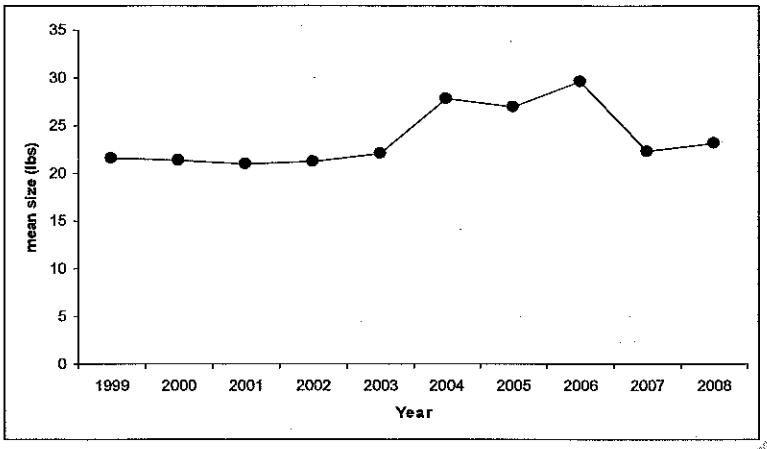

Figure 13. Average size of bigeye tuna caught on the Cross Seamount, 1999-2008, by a combination of fishing gears.

Option 2. TAC based on average catch

Under option 2, the Council would establish a TAC for seamount monchong and bigeye tuna based on catch history from the Cross seamount.

Pros: Estimation of a TAC is relatively straightforward based on using either a short term (5 year) or long term (10 year) catch average.

Cons: The value of setting a TAC is influenced by the selection of the catch data used to generate the mean catch. Using the previous five years (2004-2008) results in a higher TAC than using a longer time (10 year) period. The longer term mean is nearly 25% lower than the more recent 5-year average for monchong, and 20% for bigeye tuna. Implementation of a TAC also will result in a greater administration, enforcement and monitoring burden.

Option 3. TAC based on equilibrium surplus production models

Under option 3, a TAC for seamount monchong and bigeye tuna would be set based on surplus production models.

Pros: The establishment of a TAC is based on the response of the stock to changes in fishing effort, and in the absence of any life-history data for seamount monchong, may be the only way to establish a TAC other than from mean catch. Similarly, although bigeye tuna on the Cross Seamount are part of a larger pan-Pacific stock, their residence time on the Cross Seamount means that they may be depleted by sustained fishing and that there is likely to be an optimum level of catch.

Cons: The data used to generate MSYs show a significant increasing catch trend for seamount monchong and bigeye tuna arguing against equilibrium conditions for this fishery. Moreover, although the fits to the data appear to be statistically significant, in most instances the CPUEs do not decline appreciable with effort. Further, its is

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questionable whether it is appropriate to combine catches by shortlines with hybrid gear sets as in the case of monchong or combine hybrid, shortline and handline sets in the case of bigeye tuna.

Option 4. TAC based on dynamic surplus production models

Under option 4, a TAC for seamount monchong and bigeye tuna would be set based on dynamic surplus production models.

Pros: The establishment of a TAC is based on the response of the stock to changes in fishing effort, and in the absence of any life-history data for seamount monchong, may be the only way to establish a TAC other than from mean catch. However, the data used to generate MSYs shows a significant increasing catch trend for seamount monchong and bigeye tuna arguing against equilibrium conditions for this fishery. Similarly, although bigeye tuna on the Cross Seamount are part of a larger pan-Pacific stock, their residence time on the Cross Seamount means that they may be depleted by sustained fishing and that there is likely to be an optimum level of catch.

Cons: The relatively short time period of the data sets is insufficient to establish an equilibrium yield. Moreover, in most instances the CPUEs do not decline appreciably with fishing effort. Further it may be inappropriate to combine catches by shortlines with hybrid gear sets as in the case of monchong or combine hybrid, shortline and handline sets in the case of bigeye tuna.

Council Action

The Council may wish to select a method by which a TAC will be established for the Cross Seamount, either from the options described here or by some other process, or they may recommend a TAC not be set at this time (no action), or they may recommend other options be analyzed for management of the NLPF at Cross Seamount.

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