Reducing Longline Fishing Bycatch Through the Use of the čibu·d

Total cost: $27,562.62

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Executive Summary

The rockfish species of the Pacific coast, due to attributes of their reproductive cycle and depletion from overfishing in years prior, are currently on or being considered for placement on the endangered species list. As such, there is a limit placed every season on the maximum allowed bycatch of these endangered rockfish species in a given area. If bycatch limits are exceeded all fisheries in the area are shut down for the season. There have been modifications to trawl gear to reduce the bycatch of rockfish. Longlining gear is also a contributor the rockfish bycatch, and as of late has received no modifications to reduce it. I propose to test if using traditional chiboods of the Pacific coast will reduce the bycatch of rockfish as compared to contemporary circle hooks. I also propose to test if the chibood hook design is selective in what it catches. The experiment will be conducted using an 1800-foot longline with 300 hooks on it, with 150 hooks of both types on the line, in alternating order on the line. A paired t-test will be used to detect if there is a difference in mean proportion of hooks per set which catch rockfish and halibut. An f-test will be used to detect a difference in means of the length of rockfish and halibut. Finally a two-sample t-test will be used to detect if there is a difference in mean length of rockfish and halibut. The project will go on from July 18th to August 31st; the budget will be $27,562.62. I anticipate that the chibood will prove to have a lower bycatch of rockfish than the circle hook and be more selective in terms of the size of the catch, by catching the medium sized halibut. This outcome would mean that both rockfish bycatch will be reduced, avoiding the shutting down of other fisheries, and it would help keep halibut stocks healthy by reducing catch of large halibut to allow them to breed and by allowing small halibut to grow to legal size without potential of hooking mortality. The results of this project will be posted on www.makah.com.

Introduction

Rockfish have been commercially harvested since the mid-1800s in California, and the 1940s along the rest of the Pacific coast (Parker *et al.* 2000). The rockfish's long lifespan coupled with low reproduction rate and a low survival rate when being pulled up from the water, where they experience something similar to the bends, has made them particularly vulnerable to overfishing (Parker *et al.* 2000). Many of the rockfish species of the Pacific coast are depleted and some have been listed as endangered in recent years (Parker *et al.* 2000).

Due to their vulnerability to overfishing, rockfish stocks are monitored by the National Marine Fisheries Service (NMFS). NMFS sets limits on catch and bycatch of rockfish species to prevent over-fishing. If a fishery were to exceed this limit then the NMFS would shut down the fishery and all other fisheries within the region. This type of closure is illustrated when in 2002 a large portion of the continental shelf was closed down to limit the bycatch of several overfished rockfish species (PFMC 2002). This is also apparent with the yellow-eye and canary rockfish off Washington which are kept on watch by the NMFS and overfishing these species will also shutdown fisheries.

Lately there have been modifications to fishing methods to reduce the bycatch of rockfish species. For example, there is a new design for bottom trawl nets in which a low-

rise trawl incorporates a “cutback” headrope, to enable the rockfish to swim over the net while still catching the flatfish. It was found that this new design had a 25-59% higher catch rate of flatfish, while rockfish and roundfish 25cm and larger had a catch reduced from 34% to 97% (King *et al.* 2004). Another modification to the trawl net that has affected bycatch has been the reduction of the size of the wheels used to drag the net across the ocean floor, restricting the nets to more sandy/muddy bottoms, avoiding the main rockfish habitat (Bellman *et al.* 2005).

A longline is a line that generally has between 1000 to 3000 hooks attached to it and can range in length from 1800 feet to miles in length. The hooks used on the longlines are usually circle hooks, which are a modern design praised for its efficiency and ease of which it allows you to remove the fish from the hook. The design of the hook is made so that the hook is supposed to press against the point of resistance, which in the case of a fish is the cheek. This design allows fish to be removed more easily, the ease removal and how it does not hook the gut means there is a higher survival rate of the fish caught (Sea Grant Florida 2008). However, even with these new hooks rockfish are rarely released alive. Rockfish experience barotraumas when they are pulled up from depth which causes them to die due to them experiencing something similar to the bends.

Figure 1: This is a chibood made from iron and provided to the Burke Museum by the Makah Tribe.

In order to prevent or halt the bycatch of rockfish there will need to be modifications to the current longlining gear, starting with the halibut fishery. The Makah Tribe and other tribes from southern Washington all the way up to Alaska have their own special kind of hooks for halibut, called a chibood. The hooks vary slightly by the region in which they were constructed in, with a somewhat more bulky northern version and thinner southern version, but both were for the same purpose. Archeologists believe chiboods were built to only target halibut, avoiding the catch of rockfish and other roundfish (Stewart 1977). Also their design reportedly allowed them to target the middle aged, medium sized halibut, avoiding the small younger ones and old larger ones, letting them easily fish in one area year after year without adversely affecting the population

(Stewart 1977). Replacing current circle hooks used in longlining with chiboods may reduce or even eliminate the bycatch of rockfish during halibut longline fisheries.

If the Makah chiboods work as advertised then these hooks could also have a positive impact on sport fishing as well as longlining. The sports fishermen aiming for halibut could replace their normal hooks with chiboods. This change would further help to reduce the bycatch of the rockfish species and prevent the NMFS from closing down fisheries within the region.

I propose a project to test the belief of archeologists that chiboods do not catch rockfish and that they are selective for the size of halibut they catch. I will test if there is a difference in catch of rockfish and halibut with current longline circle-hooks and the traditional Northern Pacific coast chiboods in a study design pairing both hook designs on longline sets. The size of the halibut and rockfish will also be tested to determine if the chibood is selective for the size of the catch.

Methods

Sites

The longlines will be set off the northwest coast of Washington in the Makah Usual and Accustomed fishing grounds. They will be set where there are large amounts of halibut and rockfish. These sites will be determined by our contractor who will be a local fisherman with knowledge of the area.

Description of Sampling Gear

The lines shall be 1800 feet long with an alternating hook pattern with 300 hooks of which 150 are circle hooks and 150 are chiboods (Figure 1). Using alternating hooks on a longline ensures both hook designs are sampling the same environment and have equal availability to rockfish and halibut. This is an important consideration due to the clustered distribution of rockfish and halibut. The circle hooks will be size 14, while the size and design of the chiboods will be based off of chiboods from the Makah Cultural and Research Center. The hooks will be attached to the line via snap gear, with the goal being to attach hooks at 5-6 foot intervals. Each hook will need a snap to attach it to the line and a section of garden hose, about 6 inches, to keep the hook from tangling with the line. The chiboods will also need a more complicated design to fish like it originally was used by the Makah. To simulate how they were used by the Makah, they will need a float and a 28 inch line up to a spreader to keep the hook 60 centimeters off the bottom (Figure 2).

The size of the float needed can be determined by testing them in a tank of water.

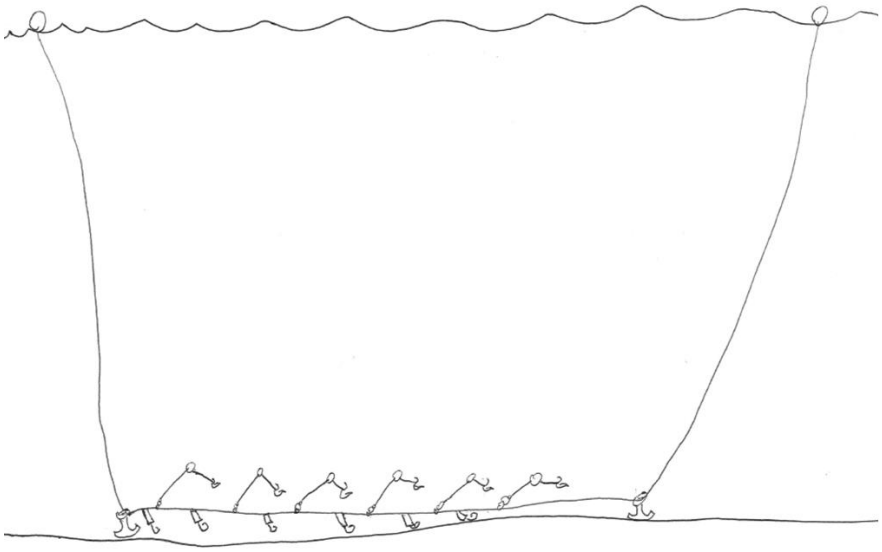

Figure 2: Schematic of how I anticipate the experimental fishing gear to be fished.

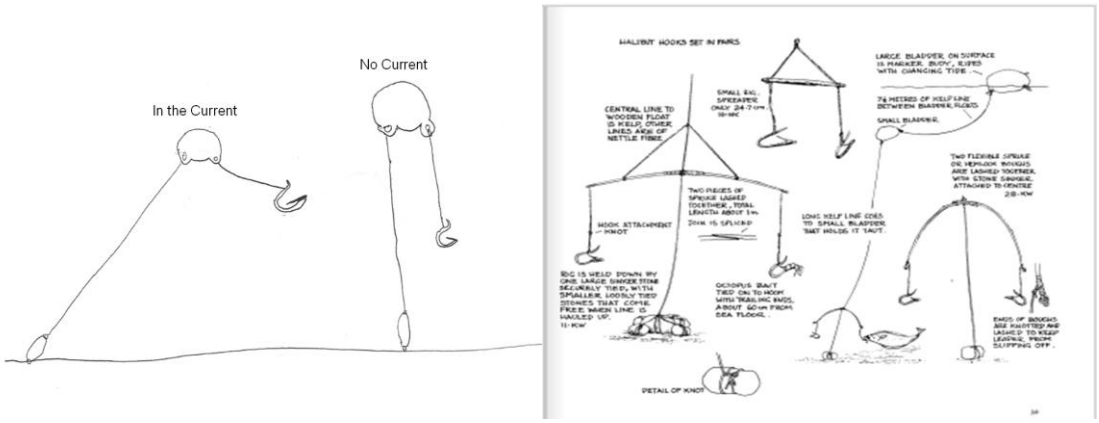

Figure 3: Side-by-side comparison of how I anticipate the traditional gear to be used and how the gear was used by the tribes.

Data Collection

For the data collection the fish will be collected via the longline. Each longline set will soak for about 2 hours. Catch will be divided by species and counted. The length of each fish will be measured in centimeters with a measuring tape from the tip of the nose to the fork of the tail. Each longline set will be recorded separately.

Data Analysis

The goal of this project is to test if longline fishing with chiboods will reduce rockfish bycatch while maintaining halibut catch and to test if chiboods are selective for the size of fish they catch. I will be using a Student's paired t-test to compare the proportion of halibut and rockfish catch per hook of each design. I will use a two-sample t-test to compare the average length of halibut and rockfish caught by hook type. I suspect halibut will have similar average length by hook design but very different variances. I will use an F-test to test for differences in variance.

The design of this study allows the power to detect a difference in proportion of rockfish and halibut catch per hook type. To determine sampling power I have assumed I will catch six rockfish using circle hooks and four rockfish using chiboods per 150 hooks of each hook type per set, a standard deviation of 0.02, and an alpha of 0.05. If 20 sets are done then there will be a power of 0.8073 to detect differences in proportion of hooks with rockfish catch (figure 4). I may detect a smaller difference in observed catch of rockfish if the observed difference in proportion is greater than 0.02 (figure 5). The analysis is sensitive to the standard deviation of number of rockfish caught per set. I expect to have enough power to detect differences in the mean proportion of hooks catching rockfish if the standard deviation is less than 0.02 (figure 6). I expect to have similar power to detect differences in proportions of hooks catching halibut by hook design.

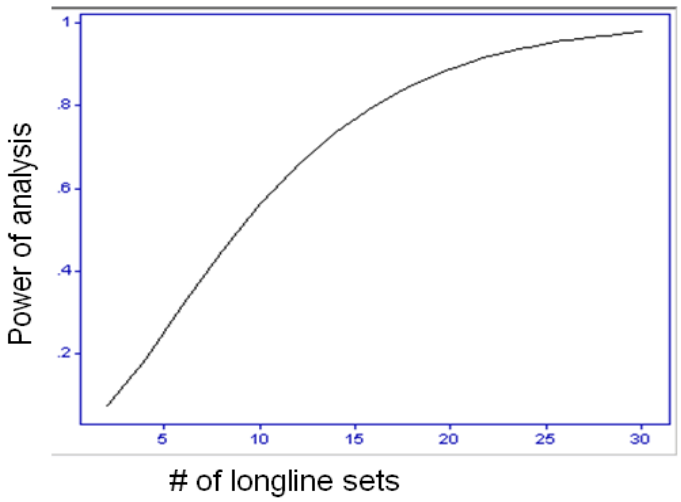

Figure 4: A graphical representation of how to determine the number of longline sets required to have the power to detect a difference.

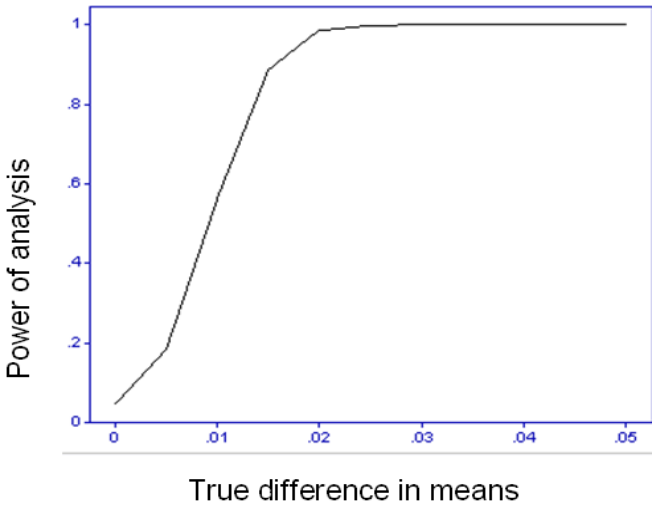

Figure 5: A graphical representation of the power to detect a true difference in means between 0.05% of hooks that have rockfish on them.

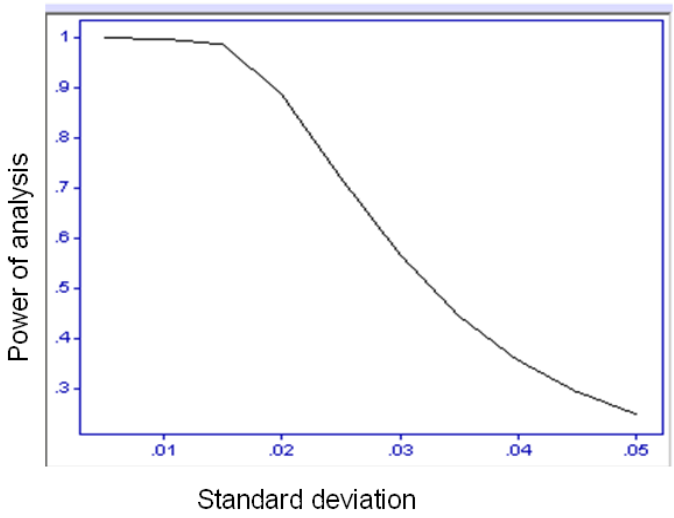

Figure 6: A graphical representation of how the standard deviation affects the power of the analysis to detect a difference in the mean proportion of rockfish caught per hook design.

To examine our power to determine differences in length of halibut caught I assumed ten halibut were caught per hook design per set. I also assumed the average length of halibut caught was 94 cm based on reported catch by the IPHC (Forsberg 2010) and I estimated that standard deviation is 8 cm for circle hooks and 5 cm for chiboods. Figure 7 shows the power of an analysis based on observed differences in size of catch by hook design. Based on this analysis we have high confidence we will detect a difference in length of halibut by hook design if the true difference in length is greater than 2 cm (power=0.85). I will also explore differences in variances because chiboods reportedly target only medium sized halibut. With the same assumptions as used for the two-sample t-test I have a power of 0.91 to detect a difference in variances using an F-test.

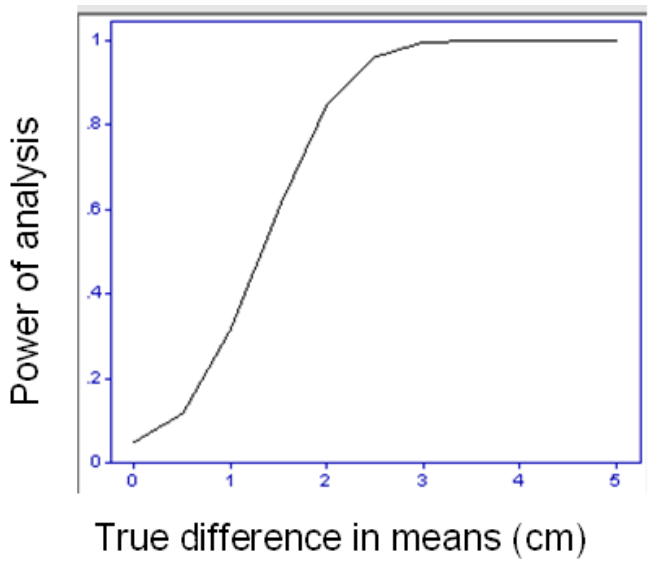

Figure 7: Power of analysis to find a difference in means of halibut length given a true difference of means on the x-axis. Assumptions for this graph are that the sample size is 200 halibut per hook design; sigma is 8 for circle hooks and 5 for chiboods, and alpha equal to 0.05.

To examine our power to determine differences in length of rockfish caught I assumed that six rockfish were caught with the circle hook design and four were caught with the chibood hook design per set. This should result in a total of 120 rockfish for circle hooks and 80 for chiboods. I also assumed that the average length of rockfish caught would be about 30 cm and that the standard deviation is 3 for chiboods and 6 for circle hooks. Figure 8 shows the power of an analysis based on observed differences in size of catch by hook design. Based on this analysis we have confidence that we will detect a difference in length of rockfish by hook design if the true difference in length is greater than 2 cm (power=0.87). I will be exploring the differences in variances because chiboods reportedly target only medium sized halibut then if it proves to catch rockfish as well then they might only get the medium sized rockfish as well, meaning the old breeding adults can continue on. With the same assumptions as used for the two-sample t-test I have a power of 0.92 to detect a difference in variances using an F-test.

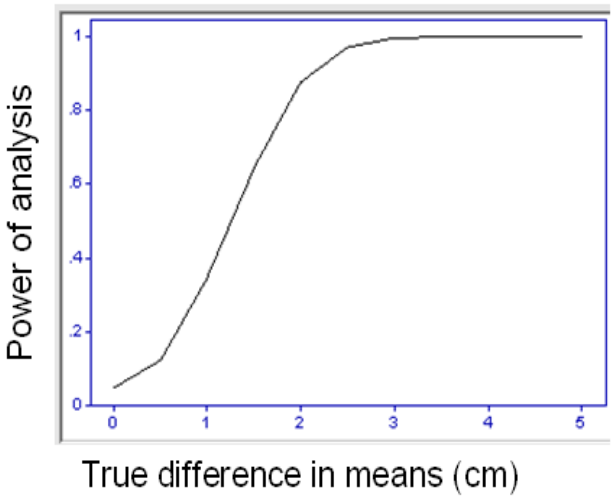

Figure 8: Power of analysis to find a difference in means of rockfish length given a true difference of means on the x-axis. Assumptions for this graph are that the sample size is 120 rockfish for circle hooks and 80 rockfish for chiboods; sigma is 6 for circle hooks and 3 for chiboods, and alpha equals 0.05.

Anticipated Results

I anticipate that that the chibood will prove to be more selective in terms of catch size of halibut and rockfish and will have less bycatch of rockfish than the circle hook. If chiboods prove to have less bycatch of rockfish and still maintain halibut catch levels, then they should replace circle hooks in longline and sport fisheries targeting halibut. The reduced bycatch of rockfish would be useful to reduce the bycatch of vulnerable rockfish species. If the size selectivity of halibut catch by chiboods is as reported, then use of chiboods in sport and longline fisheries will increase the sustainability of halibut fisheries.

Literature Cited

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Time Table

June 18th - Start building chiboods
July 2nd - Finish with the chiboods, starting construction of the snap gear
July 3rd - Tank test for chibood snap gear
July 11th - Finish snap gear construction
July 13th - Start fishing (data collection)
July 20th - End fishing (end data collection)
July 23rd - Data entry
July 24th - Starting data analysis
August 3rd - End data analysis
August 6th - Writing results in manuscript form
August 31st- Publish results on Makah.com & deliver to funder

Budget

	Grant Funding	Match	Total Funding
Supplies	$ 4,110.00		$ 4,110.00
Minor Contract	$ 1,000.00		$ 1,000.00
Major Contract	$ 7,000.00		$ 7,000.00
Salary	$ 5,873.28	$1,545.60	$ 7,418.88
Fringe	$ 1,585.79	$ 571.87	$ 2,157.66
Indirect	$ 5,028.88	$ 847.20	$ 5,876.08
Total	**$ 24,597.95**	**$2,964.67**	**$ 27,562.62**

Supplies

Refer to the itemized supply budget for info on the supplies. Fuel, food and bait are all provided by the contractor during the field tests.

SUPPLIES

Item	Unit cost	Units	Total
Metal	$8 per hook	200	$ 1,600
Garden Hose (6 in. per circle, 12 in. per chibood)	75 ft at $42	4	$ 168
Snaps	$1 EACH	340	$ 340
Ganion line (8in. Per circle hook)			$ 60
Circle hooks	111.77 per box of 500	1	$ 112
Chibood Float	$3 per float	175	$ 525
Tools			$ 200
Longline	$300 per. 1800 ft.	2	$ 600
Longline Buoys	$30	4	$ 120
Anchors	$100 per anchor	2	$ 200
Bait	contract	contract	contract
Rain Gear	$80	1	$ 80
Boots	$80	1	$ 80
Field Books	$5	1	$ 5
Measuring Boards	$10	2	$ 20
Total			$ 4,110

Itemized supply budget:

Minor Contract

The minor contract is for an expert to help in the construction of chiboods.

Major Contract

The major contract is for a local fisherman to act as our guide and to take us out on his boat to collect data. The contractor will provide the expertise in operating the gear, food, bait, and fuel.

Salary

The salary is for employing a tech 2 temporary emergency hire for this project. The hire will earn $12.88/hour, working for 456 hours over the course of this project.

Fringe/Indirect

The fringe rate is 27%.

Indirect

The Makah Tribe’s accepted indirect rate is 40.01%.