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**Evaluation of the čibu-d, traditional halibut hook of the Makah Tribe, for reducing catch  
of non-target species in recreational Pacific halibut fisheries**

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24 **Evaluation of the čibu·d, traditional halibut hook of the Makah Tribe, for reducing catch**  
25 **of non-target species in recreational Pacific halibut fisheries**

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29 ABSTRACT

30 On the US west coast, the incidental mortality of non-target fish species in the  
31 recreational fishery for Pacific halibut (*Hippoglossus stenolepis*; hereafter halibut) is a  
32 management concern. One potential approach to reducing non-target fish mortality is to  
33 use fishing hooks that more effectively target halibut. In this study, we evaluated the  
34 feasibility and effectiveness of using the čibu·d, a halibut hook traditionally used by the  
35 Makah Tribe, for recreational halibut fishing. The Makah Tribe ethnographic record  
36 indicates that the čibu·d was selective for moderately sized halibut with little or no catch  
37 of other species. We tested the fishing performance of the čibu·d as compared to paired  
38 circle hooks (size 8/0) commonly used for recreational fishing using a charter-boat and  
39 volunteer anglers. Catch rates of halibut and non-target species, relative (target to non-  
40 target) catch ratios, and size selectivity of halibut caught by the two types of hooks were  
41 evaluated. Interviews with anglers were also conducted to assess angler opinions on use  
42 of the čibu·d. Catch rates of both halibut and non-target species were significantly less  
43 for the čibu·d than for circle hooks. Although catch rates were lower for čibu·d, they  
44 were 7.4 times more likely to catch a halibut than a non-target species compared to circle

45 hooks. The catch ratio result, along with the positive response of anglers to using the  
46 čibu·d, indicate the čibu·d is a feasible hook type alternative for reducing catch of non-  
47 target fish species during recreational halibut fisheries particularly in areas where catch of  
48 non-target species is a conservation concern.

49

50 KEYWORDS: PACIFIC HALIBUT; *HIPPOGLOSSUS STENOLEPIS*; BYCATCH;  
51 RECREATIONAL FISHING; FISHING HOOKS

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## 54 1. INTRODUCTION

55 Impacts of recreational fisheries have often been overlooked due to the disparity in the  
56 impacts between commercial fishermen and recreational anglers and logistical difficulties of  
57 monitoring and evaluating impacts of recreational fisheries (Cooke and Cowx, 2004, 2006;  
58 Lewin et al., 2006). Recent studies have found that recreational fisheries can have a variety of  
59 direct and indirect impacts (Schroeder and Love, 2002; Cooke and Cowx, 2006; Lewin et al.,  
60 2006). It has also been shown that catch-and-release and release of unwanted or prohibited fish  
61 contributes to the problem because hooked fish experience increased mortality and reduced  
62 fitness (Wilson et al., 2014). Recent research and education programs have resulted in reduced  
63 mortality of released fish during recreational fisheries (Cooke and Suski, 2004; Bartholomew  
64 and Bohnsack, 2005), however the best measure to prevent mortality of unwanted fish is to not  
65 hook them. This study focused on gear modifications to reduce bycatch in recreational Pacific  
66 halibut (*Hippoglossus stenolepis*; hereafter halibut) fisheries in the International Pacific Halibut  
67 Commission (IPHC) regulatory area 2A (Washington, Oregon and California). In 2014, the

68 recreational fishery was allocated 44% of the total allowed quota within regulatory area 2A  
69 (Gilroy et al., 2015). The popularity of recreational halibut fishing in this area has increased  
70 rapidly since the 1970s to the point that extremely short fishing seasons (i.e. the season was three  
71 days in Area 4 of Washington in 2015) and quotas are now necessary to prevent overfishing  
72 (Dykstra, 2015). In spite of their short duration, there are still management concerns due to  
73 bycatch of non-target fish species. Some areas are closed to all bottom fishing, including halibut  
74 fishing, to prevent catch of rockfish (CDFG, 2015; ODFW, 2015; WDFW, 2015). In some  
75 regulatory areas, some or all species other than halibut must be discarded during halibut fishing  
76 (ODFW, 2015; WDFW, 2015).

77         The non-target species of greatest concern for management in area 2A are yelloweye  
78 rockfish (*Sebastes ruberrimus*) and canary rockfish (*Sebastes pinniger*) (NOAA, 2012).  
79 Rockfish (*Sebastes sp.*) are generally long-lived, reproduce late in life, and when reeled up from  
80 depth experience barotrauma which leads to high rates of post-release mortality (Parker et al.,  
81 2000). Thus, management measures to prohibit retention do not ameliorate fishing impacts to  
82 rockfish (Hannah et al., 2008). Recent research has led to the development of devices to descend  
83 rockfish to depth for release which have been shown to substantially increase survival relative to  
84 releasing rockfish at the surface (Hochhalter and Reed, 2011), although benefits of deepwater  
85 release have not been equal for all rockfish (Hannah et al., 2014). Rockfish are not the only non-  
86 target species caught during recreational halibut fishing that are sensitive to over-fishing. Spiny  
87 dogfish also are long-lived, have delayed maturation (Saunders and McFarlane, 1993), have had  
88 populations collapse due to fishing pressure (Musick et al., 2000), and are commonly caught  
89 during recreational halibut fisheries.

90           The primary hook type used to catch halibut changed from ‘J’ hooks to circle hooks in  
91 the early 1980s primarily because the circle hook increased the retention of halibut (Leaman et  
92 al., 2012). The use of circle hooks also improved the ability of anglers to release halibut and  
93 other species with reduced mortality or trauma because the circle hook most commonly hooks  
94 the lip of a fish whereas the “J” hook often hooks deeper in the mouth (Cooke and Suski, 2004;  
95 Batholomew and Bohnsack, 2005). Even with the use of circle hooks and the implementation of  
96 closed areas, the catch rate of non-target species like rockfish is still a concern (Kaimmer and  
97 Wischniowski, 2012). Kaimmer and Wischniowski (2012) tested the use of a circle hook with a  
98 thin wire across the gape of the hook to prevent rockfish catch while fishing for halibut, but they  
99 did not find a significant reduction in the catch of large rockfish. The authors concluded that the  
100 similarity of hooking behavior of large rockfish and halibut negates the likelihood that a hook  
101 could be modified to be selective for halibut but not for large rockfish (Kaimmer and  
102 Wischniowski, 2012). However, a hook that targets halibut and prevents the catch of rockfish  
103 and other non-target species may have been developed thousands of years ago.

104           Tribes of the Pacific Northwest have fished for halibut since time immemorial giving  
105 them ample opportunity to develop hook designs to specifically target halibut while not catching  
106 non-target species. Fishermen of the Makah Tribe were said to be singular in their purpose of  
107 catching specific species of fish (Waterman, undated), so much so that the Makah language does  
108 not have a generic word for fishing but rather has fishing terms that include the target species  
109 name (Swan, 1870). A special hook, called the čibu·d by the Makah Tribe, was made to target  
110 halibut (Figure 1; Swan, 1870; Waterman, undated; Stewart, 1977). The čibu·d is a ‘U’ shaped  
111 hook that was used by tribes from northern Washington through southern Alaska. North of  
112 Vancouver Island, the čibu·d frame was made from the elbow of a branch or by lashing two

113 pieces of wood together; from Vancouver Island southward the čibu·d frame was made from  
114 steam bending a single piece of hemlock, true fir, or yew (Freidman, 1975; Stewart, 1977). The  
115 barb of the čibu·d was historically made from bone, antler, or wood (Waterman, undated;  
116 Stewart, 1977). As metal became available to tribes (~1800s) it was used for making both the  
117 frame and the barb of the čibu·d (Stewart, 1977). The southern čibu·d was fished with a hand-  
118 line that was attached to a spreader bar which suspended two čibu·d one meter apart roughly 60  
119 cm above the bottom (Stewart, 1977). Northern čibu·d were also fished with a hand-line that  
120 was attached with a slip knot to a sinker, with the čibu·d floating above the sinker off the bottom  
121 (Stewart, 1977)

122         The čibu·d was reported to only, or at least very selectively, catch halibut (Swan, 1870;  
123 Waterman, undated; Stewart, 1977). In addition, the hook was reported to selectively catch  
124 halibut around 11.3-13.6 kg (Waterman undated; Huelsbeck pers. comm.) at a time when the  
125 average halibut was reported to be 27.2 kg (Anonymous, 1858). The size selectivity of the  
126 čibu·d was made possible by the length of the barb preventing small halibut from biting the hook  
127 while the distance of the gap between the barb tip and the frame of the čibu·d prevented the lip  
128 of a large halibut from passing over (Waterman, undated). If čibu·d are as selective for species  
129 and size of halibut caught as the ethnographic and archeological record suggest, then the hook  
130 could be a very useful tool for fisheries management for minimizing impacts to non-target  
131 species (Hall et al., 2000; Werner et al., 2006). The benefit of the size selectivity of the čibu·d  
132 would be that large halibut, which are predominately female (Loher and Seitz, 2008), would stay  
133 in the population to reproduce (Birkeland and Dayton, 2005).

134         In this study, we tested the relative performance of čibu·d in a recreational halibut fishery  
135 in Washington. Our primary hypotheses were that 1) the čibu·d would have similar halibut catch

136 to the commonly used circle hooks, 2) the čibu·d would have significantly lower catch of non-  
137 target (bycatch) species, and 3) the čibu·d would catch a more selective size range of halibut than  
138 circle hooks. Noting that gear modifications are only effective if anglers are willing to use them  
139 (Campbell and Cornwell, 2008), we also interviewed the volunteer anglers who participated in  
140 this study to determine if anglers would desire to use the čibu·d in future halibut recreational  
141 fishing.

142

## 143 **2. MATERIALS AND METHODS**

144

### 145 *2.1 Construction of čibu·d*

146 The first step in making the čibu·d was to grind one end of a 0.625 cm (0.25 inch)  
147 diameter brass rod from roughly 6.5 cm (2.5 inches) gradually out to a narrowing tip. The rod  
148 was then cut at 30.5 cm (12 inch) of length. The brass rod was then hand-bent into the frame of  
149 the čibu·d mimicking photocopies of historically fished metal čibu·d found in the collection of  
150 the Makah Culture and Research Center and in personal collections of Makah tribal members. A  
151 straightened 8/0 stainless steel salmon hook was wrapped in place with steel or brass wire and  
152 then soldered to serve as the barb. An 8/0 barrel swivel was added using wire wrapped on each  
153 side of the frame and soldered to complete the hook. Each čibu·d varied slightly in shape  
154 because the čibu·d were handmade by volunteers. To determine whether čibu·d shape, or  
155 position of the barb inside the frame of the čibu·d, affected fishing performance, every čibu·d  
156 was uniquely numbered and then photo-copied so that measurements could be taken of the  
157 position of the barb and the shape of the čibu·d. The five measurements were: A) barb tip to top

158 of frame, B) barb tip to opening of čibu·d, C) barb tip to bottom of frame, D) barb tip to inside of  
159 frame, and E) length of barb (Figure 2).

160

## 161 *2.2 Gear configuration*

162 Prior to test fishing, pilot efforts were conducted to determine how best to configure the  
163 čibu·d on recreational fishing gear. We tried using a one-meter long spreader bar to suspend two  
164 čibu·d as they were fished in the past, but found the large spreader bar to be too sensitive to  
165 ocean currents. Instead, a 50.8 x 20.3 cm 'L' shaped spreader bar, commonly used in  
166 recreational halibut fishing, was used with a 0.91 kg weight attached to the short side using a 5-  
167 10 cm leader of 36.3-kg test fishing line. The swivel on the čibu·d was connected directly to the  
168 swivel snap on the long side of the spreader bar. We did not use a leader for the čibu·d because  
169 trials showed that doing so caused the čibu·d to tangle with the spreader bar. We chose to  
170 compare a single čibu·d to a pair of 8/0 circle hooks tied on a single leader because fishing a pair  
171 of circle hooks is the standard practice for fishing with bait for halibut for most anglers in  
172 Washington. For the circle hooks, the spreader was configured identical to the čibu·d except that  
173 two 8/0 circle hooks were solid-tied 6-10 cm apart at the end of a 30 – 45 cm leader of 22.7-kg  
174 test fishing line (Figure 3).

175 The resulting configuration placed the suspended čibu·d roughly 20 - 25 cm above the  
176 bottom assuming that the weight was on the bottom and the fishing line had tension straight to  
177 the surface. We directed anglers to descend their line until hitting the bottom and then to reel up  
178 off the bottom so that they could drop their pole tip down and feel bottom but were fishing above  
179 the bottom most of the time. When fished as directed, the čibu·d and circle hooks would have  
180 been fished about 60 cm above the bottom as they were historically (Stewart, 1977).



181           We used the same bait on both the circle hooks and čibu·d for each set – either herring or  
182 octopus. Octopus was selected because it was the primary bait used for halibut fishing by the  
183 Makah Tribe historically (Swan 1870, Waterman undated; Stewart 1977) and herring was  
184 selected because it is the most common bait used by anglers in area 2A currently. Octopus was  
185 fished during the first two sample days, however catch rates were much lower than with herring  
186 so the rest of the experiment was conducted using herring. We used the same size grade of  
187 herring for every hook within a set, and herring were fished whole. On circle hooks, herring  
188 were positioned with a hook through the head of the herring and one just posterior of the  
189 midsection. On the čibu·d, herring were tied to the frame of the čibu·d below the barb by  
190 wrapping either cotton twine or Kwikfish™ stretchy thread around the bait and tying in place.  
191 We fished similar size pieces of cut octopus for both the čibu·d and the circle hooks tied  
192 similarly to the herring, but with a portion of the octopus cut into thin strips and trailing to flutter  
193 in the current. We ensured that all bait used on each set was the same size to prevent the bait  
194 size from affecting the length of halibut caught (Kaimmer, 2004).

195

### 196 *2.3 Study area*

197           All fishing trials were conducted in the Pacific Ocean, from the port of Neah Bay (Figure  
198 4). We targeted recreational fishing areas that are known to have both high halibut catch rates  
199 and high catch rates of non-target species such as rockfish. We also included some sites with  
200 high halibut catch rates (regardless of bycatch rates), to generate an adequate sample size for  
201 comparing size selectivity.

202

### 203 *2.4 Field tests*

204           The experimental design for the study called for 4 to 14 anglers to fish for a 30-minute  
205 set and to catch as many fish as they could. To accomplish this, we contracted a charter vessel  
206 with capacity to fish 14 anglers at a time. Half the anglers on each set fished 8/0 circle hooks  
207 and half fished a čibu·d. After each set the anglers moved to a different position on the boat and  
208 fished a different hook type than they had fished on the previous set. Anglers rotated between  
209 hook types to prevent individual angler fishing ability (e.g. ability to feel a bite and to set a hook  
210 or ability to maintain bait close to the bottom) from biasing results. The charter boat made one  
211 trip per day on a predetermined weekday/weekend schedule on days that were otherwise closed  
212 to recreational halibut fishing. Our IPHC permit required us to release all live halibut, and any  
213 halibut that died during hooking and retrieval were saved for donation to Makah Tribe seniors  
214 (anglers did not retain any halibut).

215           Data was collected during and after each set. For each set we recorded time, date,  
216 position, bottom type, depth, weather variables such as Beaufort sea state, and what type of bait  
217 was used. When fish were caught they were netted so that fish could be released alive – this  
218 deviates from the normal charter-boat fishing operation where halibut are gaffed. During the set  
219 we recorded species, length (snout to fork of tail), type of hook used, angler who caught the fish,  
220 and, if a čibu·d, what the identification number was for the hook for each fish caught.  
221 Photographs were often taken of fish caught on čibu·d to document the position of the čibu·d in  
222 the mouth of the fish. After the set we interviewed each of the anglers to determine if they  
223 hooked and lost any fish, how many fish they caught (to cross validate the catch we recorded),  
224 and to get their estimate of time off the bottom during the set (e.g. time not spent fishing due to  
225 tangled gear, catch retrieval, etc.).

226 We used volunteer anglers in the study to minimize costs and to include a variety of  
227 angler skills. Volunteer anglers were recruited through fishing groups/clubs, colleagues at other  
228 research or management organizations, co-workers, friends, and through word of mouth. Some  
229 volunteers fished for multiple days, but most only fished one day.

230

### 231 *2.5 Angler surveys*

232 At the conclusion of each fishing trip we interviewed the anglers using eleven questions  
233 to assess their interest in marine conservation, knowledge of overfished or sensitive species, and  
234 what they felt about their experience fishing with a čibu·d including whether they would like to  
235 fish with it again (supplementary materials). We interviewed anglers during the return trip;  
236 however in some cases there was insufficient time to interview all anglers, or some were either  
237 asleep or seasick.

238

### 239 *2.6 Data Analysis*

240 During some sets there were an odd number of anglers, and therefore an unequal number  
241 of circle hooks and čibu·d, so catch per set was standardized by dividing the total catch on each  
242 hook type by the number of anglers. After standardizing, catch per set was compared by species  
243 and by species groups (e.g. rockfish, non-halibut flatfish, non-target species) for each hook type  
244 using two-tailed paired t-tests with each 30 minute set as the sampling unit. We compared the  
245 raw (unstandardized) ratio of halibut to non-target species using a Fisher's exact test with all sets  
246 pooled. A paired t-test showed that we deployed similar number of circle hooks and čibu·d per  
247 set (Two-tailed t-test,  $df = 103$ ,  $p = 0.17$ ) allowing us to assume equal effort by hook type per set  
248 for the analysis. We compared the odds-ratio for each non-target species and species group to

249 halibut by hook type using Fisher exact tests in the program R. Fisher's exact test were used  
250 instead of chi square tests due to the small expected cell counts for many of the comparisons.  
251 The lengths of halibut caught were compared between hook types using an F test to detect  
252 differences in variance of lengths and using a two-sample t-test to detect differences in average  
253 length.

254 Catch efficiency was defined as the probability of landing a halibut once hooked and was  
255 compared by hook type with a Fisher's exact test with all hook deployments pooled together.  
256 We calculated the number of times a fish was hooked but lost from our post-set interviews with  
257 anglers and calculated the fish landed from the recorded catch data. In this analysis, we assumed  
258 that anglers could distinguish between an event where a fish is hooked and fighting against the  
259 hook, but is subsequently lost while reeling in, from other events such as the hook snagging the  
260 bottom or a fish strike in which a fish is not hooked.

261 We evaluated the effect of the five measurements recorded for each čibu·d using four  
262 criteria for fishing performance. The four criteria were: whether a čibu·d caught a halibut,  
263 caught a non-target fish, lost a fish, or caught halibut at a rate above or below the average rate for  
264 catching halibut on a čibu·d. To avoid misinterpreting site effects as hook performance we  
265 limited this analysis to čibu·d that had been fished during at least four sets. Box plots were  
266 created for each hook measurement to evaluate if additional statistical analysis was warranted.  
267 When box plots revealed potential effects, an ANOVA was run to test if differences were  
268 significant.

269 Post-fishing angler surveys were analyzed using standard descriptive statistics such as  
270 mean, mode, and variance. We used angler experience (number of years of halibut fishing) for

271 classifying anglers into groups when comparing their interest in fishing a čibu·d in the future via  
272 a chi-square test of homogeneity.

273

### 274 **3. RESULTS**

275

#### 276 *3.1 Set data*

277 Fishing was conducted on the M/V Windsong during the months of April, May, and June  
278 of 2015 for a total of 17 days of fishing and 103 thirty-minute sets. The depth at the start of each  
279 set ranged from 40 to 200 m. with a mean depth of 131.7 m. Sets were conducted in areas of  
280 sandy, gravel, rocky and mixed substrate bottom habitats. Octopus was used as bait for six sets  
281 and herring was used for the rest of the sets. Anglers fished circle hooks 489 times and čibu·d  
282 479 times during the 103 sets. A total of 89 fish (eight species) were caught on čibu·d with  
283 87.6% of catch being halibut and 438 fish (18 species) were caught on circle hooks with 51.1%  
284 being halibut (Table 1).

285

#### 286 *3.2 Comparison of catch by hook type*

287 On average, čibu·d caught significantly fewer fish than circle hooks per standardized set  
288 (Two-tailed paired t-test,  $df = 102$ ,  $p < 0.001$ ). Likewise, we also observed significant reduction  
289 in catch rates of both halibut ( $p < 0.001$ ) and non-target fish species ( $p < 0.001$ ) on čibu·d  
290 compared to circle hooks. Significant reductions in catch using čibu·d compared to circle hooks  
291 were also observed in many species commonly caught during recreational halibut fishing in  
292 Washington; species that were caught less frequently were not observed to have statistically  
293 significant differences in catch rates by hook type (Table 1).

294 We found strong evidence that the ratio of halibut to non-target catch was greater for  
295 čibu·d than circle hooks (Fisher's exact test,  $p < 0.001$ ); čibu·d were 7.4 (95% CI 3.7 to 16.5)  
296 times more likely than circle hooks to catch a halibut than a non-target fish species. We found  
297 larger differences in odds ratios for catch of halibut compared to round bodied fish, like lingcod  
298 (*Ophiodon elongates*) and rockfish, than we did for flatfish, particularly for arrowtooth flounder  
299 (*Artheresthes stomias*) (Table 2). For the two non-target fish species of particular interest in this  
300 study, we found significant differences in catch by hook type for canary rockfish (Fisher's exact  
301 test,  $p=0.001$ ) but not for yelloweye rockfish (Fisher's exact test,  $p=0.26$ ; Table 2).

302

### 303 *3.3 Size selectivity by hook type*

304 Although we observed a more defined mode of halibut, caught between 81-85 cm on the čibu·d  
305 versus between 71 cm and 90 cm on the circle hooks (Figure 5), the size distributions were not  
306 significantly different (F-test,  $df = 69, 220, p = 0.069$ ). The čibu·d caught significantly larger  
307 halibut on average (84.8 cm;  $sd = 7.9$  cm) than did the circle hook (82.2 cm;  $sd = 9.2$  cm)  
308 (Student's two-tailed t-test,  $df = 289, p = 0.033$ ).

309

### 310 *3.4 Fish loss by hook type*

311 Anglers reported that čibu·d were 4.4 times more likely to lose a hooked fish than circle  
312 hooks (Fisher's exact test,  $p < 0.001$ , 95% CI 3.0-6.4; Table 3). However, it is important to note  
313 that for all anglers in the study it was their first time fishing a čibu·d which could have made it  
314 harder for anglers to accurately document if a fish was hooked and lost on the čibu·d as it was  
315 for them with circle hooks. Furthermore, many of the anglers in the study had very little halibut  
316 fishing experience (33% fishing halibut for first time). Anglers rotated hook types between sets,

317 so the impact of an angler's halibut fishing experience should have equally affected the results  
318 for both hooks.

319 Landing efficiency could also have been effected by hook failure in the čibu·d. On  
320 thirteen occasions, the barb on the čibu·d was noted to have broken either in retrieving the fish or  
321 once the fish was on deck or in the net. In other instances, barbs were observed to be loose and  
322 able to pivot from side to side. When barbs were found to be loose, they were removed from the  
323 study, but some sets may have been made before this was noted. We also noted in a few  
324 occasions that when the angler lost tension on their line that they lost their catch. This was  
325 particularly noticeable when anglers on the charter boat tangled their fishing lines with other  
326 anglers.

327

### 328 *3.5 Assessment of čibu·d shape and position of barb*

329 A total of 107 čibu·d were fished during the study; of these we evaluated the shape of  
330 only 47 that had been fished during at least four sets. Boxplots revealed that only the distance of  
331 the barb tip from the bottom of the frame of the čibu·d affected fishing performance (Figure 6).  
332 The distance from the tip of the barb to the bottom of the čibu·d frame significantly affected  
333 whether a čibu·d caught halibut (ANOVA,  $F = 4.90$ ,  $p = 0.032$ ) and whether a čibu·d had more  
334 or less catch of halibut than the average catch of all čibu·d (ANOVA,  $F = 5.40$ ,  $p = 0.025$ ). A  
335 larger gap on average was observed between the barb tip and the bottom of the čibu·d frame for  
336 čibu·d with good fishing performance compared to those with poorer performance (Figure 6).  
337 None of the measurements were shown to affect fishing performance for catch of non-target  
338 species or lost catch.

339

340 *3.6 Angler survey results*

341 Post-fishing surveys were conducted with 84 of the 125 anglers. Interviewed anglers  
342 ranged in age from 13 to mid-70s. Angler fishing experience ranged from fishing halibut for the  
343 first time to 45 years of recreational halibut fishing experience with mean experience of 10.4  
344 years (sd = 12.0); 30% of anglers interviewed had not fished for halibut previously.

345 The majority of anglers expressed a strong interest in marine conservation with an  
346 average score of 8.84 (sd = 1.5) on a 10-point scale (where 1 is not interested and 10 is very  
347 interested), with 94% of respondents scoring the question with either moderate or greater interest  
348 in marine conservation. The majority of respondents (64%) noted that their interest in marine  
349 conservation was driven by their desire to fish again in the future and for future generations to  
350 have the opportunity to fish. A quarter of the respondents noted their career or livelihood was  
351 linked to marine conservation.

352 The majority of the anglers expressed concern with bycatch during recreational fishing  
353 and the status of depleted or vulnerable species caught during halibut fishing specifically (80%  
354 and 64% respectively). Anglers who were not concerned about bycatch indicated that they don't  
355 have bycatch when recreationally fishing or that the halibut fishing season is so short that they  
356 had no concerns with bycatch impacts. The majority of anglers surveyed stated that they  
357 normally take measures to prevent bycatch while recreational fishing, with 52.7% of anglers  
358 noting use of lures, hook sizes, or baits that target the species and size grade of fish they hope to  
359 catch to prevent bycatch. However, 21.6% of anglers stated that they take no measures to  
360 prevent bycatch.

361 Anglers were generally knowledgeable about which species of fish were depleted in the  
362 areas they most commonly fish, although few were able to give a complete list of species names.



363 It was more common for anglers to note generally that salmon or rockfish are a concern. Anglers  
364 were decidedly less knowledgeable about whether the fish they buy at markets or restaurants are  
365 depleted or vulnerable to depletion. Only 8% of those interviewed expressed that they make  
366 educated choices based on knowledge of the fisheries or use public education such as the  
367 Seafood Watch Program of the Monterey Bay Aquarium. Interestingly, 25% expressed that they  
368 do not check if the fish they buy are sustainably managed, but would if they knew how.

369 The majority of anglers expressed a positive experience in fishing a čibu·d with an  
370 average score of 7 (sd = 2.91) on a 10-point scale (where 1 is Poor and 10 is Great). Those that  
371 did not like the čibu·d generally noted that they did not catch a fish on the čibu·d or that they lost  
372 fish. Experienced anglers often noted that they could not feel a bite on the čibu·d as well as they  
373 could on circle or 'J' hooks. Those that had a positive experience fishing the čibu·d observed  
374 that it was easier to feel a fish, that they caught halibut, that they did not catch bycatch or were  
375 confident that a hooked fish would be a halibut, and that it did not snag. Some anglers also  
376 noted factors other than the actual fishing performance of the čibu·d such as enjoyment in fishing  
377 a traditional hook, learning about northwest culture, that fishing the čibu·d was a unique and new  
378 challenge, and that they enjoyed the weather and comradery with other anglers.

379 We observed a strong dichotomy in angler response to whether or not they would want to  
380 use a čibu·d or circle hook when fishing for halibut in the future with anglers expressing a strong  
381 preference for circle hooks, a strong preference for čibu·d, or showing no preference at all  
382 (Figure 7). The polarity of those interviewed was also reflected in the average score which was  
383 5.06 (sd = 3.3) on a 10-point scale (where 1 is a preference for čibu·d and 10 is a preference for  
384 circle hooks).

385 Anglers with five or more years of experience fishing for halibut had significantly  
386 different preferences for whether or not they would want to fish with a čibu·d in the future  
387 compared to inexperienced anglers. Experienced anglers were more likely to prefer circle hooks  
388 (40.9%) or have no preference (43.2%), as compared to less experienced anglers who were more  
389 likely to prefer čibu·d (50%) with equal response for no preference or preferring circle hooks  
390 (Chi-square test of homogeneity,  $df = 2$ ,  $p = 0.0037$ ). The reasons for preferences were primarily  
391 that for those that preferred circle hooks, the circle hooks catch more fish including lingcod;  
392 those that preferred the čibu·d generally noted that they liked the elimination of bycatch.  
393 However, many of those that preferred fishing the čibu·d expressed factors other than fishing  
394 performance of the hook such as enjoying fishing the čibu·d because it was traditional gear either  
395 from their heritage or just of interest to them. Others stating an interest in čibu·d cited the  
396 introductory talk given to them on how the ethnographic record suggests the hooks were more  
397 selective for species and size of halibut caught.

398

#### 399 **4. DISCUSSION**

400 Results of this study confirm the ethnographic record that čibu·d selectively catch halibut  
401 and have low rates of catch of other species. However čibu·d were not as effective as paired 8/0  
402 circle hooks at catching halibut. Over all sets, 2.87 halibut were landed on paired circle hooks  
403 for every halibut landed on a čibu·d. In 1880, fishermen of the Makah Tribe landed 719.5 metric  
404 tons of halibut while hand-lining čibu·d (Collins, 1996) showing that the čibu·d can be used very  
405 effectively for halibut. It is quite likely that our gear deployment and inexperience fishing čibu·d  
406 reduced halibut catch rates on the čibu·d. We chose to fish only one čibu·d to avoid challenges  
407 of how ocean currents affect larger two-čibu·d spreader bars even though fishing two čibu·d is

408 legal for recreational fishing. If we had fished two čibu·d on a spreader bar, like we did for  
409 circle hooks, we would likely have had some unquantifiable increase in halibut catch on čibu·d.  
410 Furthermore, every angler participating in this study was either fishing the čibu·d for the first  
411 time or had very little experience and it is likely if they had equal experience fishing with the  
412 čibu·d as they had with circle hooks that catch rates on the čibu·d would have been greater.

413 Another factor affecting the catch rate of halibut was how the čibu·d were constructed.  
414 We learned during this study that čibu·d with a larger gap between the base of the frame and the  
415 barb tip outperformed čibu·d that had a smaller gap. We also found that our technique of making  
416 the barb of the čibu·d (straightening a stainless steel 8/0 hook) resulted in points of weakness that  
417 led to barbs bending or outright breaking leading to the loss of hooked halibut. In the future we  
418 plan to make all čibu·d with straight stainless steel rod to improve the integrity of the barb and to  
419 standardize the shape of the čibu·d to have a larger gap between the čibu·d frame and the barb tip  
420 to improve catch rates. It is likely that with more experience in how to deploy, fish, and  
421 construct the čibu·d that catch rates of halibut would improve.

422 Angler survey results show that if the čibu·d becomes commercially available, at least  
423 some anglers would be interested in fishing it. Anglers stated that they like that the čibu·d had  
424 low catch of non-target species, that fish stayed hooked, and that it was easy to free the čibu·d  
425 from snags. Inexperienced anglers on average had a stronger preference for fishing the čibu·d on  
426 future halibut fishing trips than anglers with more than five years of halibut fishing experience.  
427 We attribute this result in part to two factors. First, more experienced anglers are more set in  
428 their ways and comfortable with the gear they fish. Second, experienced anglers are more  
429 familiar with the regulations and understand that fishing a čibu·d could eliminate their  
430 opportunity to catch desirable bottomfish, such as lingcod, deeper than 36.6 meters (120 feet)

431 since bottomfish retention in Washington is allowed only during the recreational halibut fishery  
432 for waters deeper than 36.6 meters. However, despite these two factors, half of the experienced  
433 anglers and three-quarters of the inexperienced anglers expressed that when they go halibut  
434 fishing again they would prefer to fish with ĉibu·d or would have no preference for fishing either  
435 the ĉibu·d or circle hooks.

436 The majority of anglers stated that they take measures to prevent bycatch during  
437 recreational fishing. The primary measure anglers use is the selection of species specific lures or  
438 hooks to prevent catch of non-desirable species. Based on this, and the strong interest that  
439 anglers stated they have in marine conservation, we think that with education and outreach many  
440 anglers will voluntarily switch to using ĉibu·d if they were widely available. However, to keep  
441 angler interest in using the ĉibu·d, catch rates of halibut may need to be improved (Arlinghaus,  
442 2006; Campbell and Cornwell, 2008).

443 In the right situation the ĉibu·d can be an effective tool for reducing mortality of non-  
444 target species. It would be best if the ĉibu·d were fished in areas that prohibits the retention of  
445 other species or in areas where there is high concern regarding catch of non-target species. For  
446 instance, the ĉibu·d would be very effective for use in Oregon where regulations prevent anglers  
447 from retaining other species when they are fishing for halibut (ODFW, 2015). However, the use  
448 of a ĉibu·d could increase hooking mortality for released halibut. Circle hooks were consistently  
449 observed to hook the lip of halibut which allowed us to easily de-hook the fish whereas with the  
450 ĉibu·d fish sometimes hooked deeper in the mouth resulting in more frequent injury than was  
451 observed for circle hooks. Based on this observation, it does not appear that ĉibu·d would be a  
452 good choice for fisheries that have size limits or otherwise encourage the release of halibut.

453 Noting the low bycatch rate on čibu·d, managers could potentially operate special  
454 fisheries in areas only allowing fishing with the čibu·d to prevent catch of fish species of  
455 concern. For instance, currently in area 2A there are numerous recreational fishing areas closed  
456 to recreational halibut fishing due to concerns of rockfish bycatch. These areas could be fished  
457 with minimal bycatch if anglers used čibu·d. Managers could also require the use of the čibu·d  
458 in other areas that are not currently protected but are known to have moderate or high levels of  
459 catch of species of concern. Anglers will likely respond more positively to new regulations that  
460 allow them to continue to fish their accustomed areas with new gear than to regulations that  
461 exclude them from fishing grounds. If managers do set up special management areas for the  
462 čibu·d, it would encourage anglers to invest in the gear and learn to fish with it. Once anglers  
463 have čibu·d and become proficient fishing them, they would be more likely to voluntarily choose  
464 to use the čibu·d instead of less selective gear types while halibut fishing.

465

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481

## 482 **References**

483 Anonymous, 1858. "The fisheries of Puget Sound and vicinity." *New York Tribune* 27 Dec.

484 1858: 6.

485 Arlinghaus, R., 2006. On the apparently striking disconnect between motivation and satisfaction

486 in recreational fishing: the case of catch orientation of German anglers. *North Am. J. Fish.*

487 *Manag.* 26, 592–605. doi:10.1577/M04-220.1

488 Bartholomew, A., Bohnsack, J.A., 2005. A review of catch-and-release angling mortality with

489 implications for no-take reserves. *Rev. Fish Biol. Fish.* [Rev. Fish Biol. Fish.] 15, 129–154.

490 doi:10.1007/s11160-005-2175-1

491 Birkeland, C., Dayton, P.K., 2005. The importance in fishery management of leaving the big

492 ones. *TRENDS Ecol. Evol.* 20, 356–358. doi:10.1016/j.tree.2005.03.015

493 California Department of Fish and Game. 2015. California ocean sport fishing regulations,

494 2015-2016. Accessed 29 February 2016.

495 <https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=93478&inline=true>

496 Campbell, L.M., Cornwell, M.L., 2008. Human dimensions of bycatch reduction technology:

497 current assumptions and directions for future research. *Endanger. Species Res.* 5, 325–334.

498 doi:10.3354/esr00172

499 Collins, C.C., 1996. Subsistence and survival: the Makah Indian Reservation, 1855-1933. *Pac.*  
500 *Northwest Quart.* 180-193.

501 Cooke, S.J., Cowx, I.G., 2004. The role of recreational fishing in global fish crises. *Bioscience*  
502 54, 857–859. doi:10.1641/0006-3568(2004)054[0857:TRORFI]2.0.CO;2

503 Cooke, S.J., Cowx, I.G., 2006. Contrasting recreational and commercial fishing: searching for  
504 common issues to promote unified conservation of fisheries resources and aquatic  
505 environments. *Biol. Conserv.* 128, 93–108. doi:10.1016/j.biocon.2005.09.019

506 Cooke, S.J., Suski, C.D., 2004. Are circle hooks an effective tool for conserving marine and  
507 freshwater recreational catch-and-release fisheries? *Aquat. Conserv. Mar. Freshw. Ecosyst.*  
508 14, 299–326. doi:10.1002/aqc.614

509 Dykstra, C., 2015. 2015 halibut sport fishery review. International Pacific Halibut Commission  
510 Report of Assessment and Research Activities 2015. p. 36-46.

511 Friedman, J.P. 1975. Prehistoric use of wood at Ozette archaeological site. PhD dissertation,  
512 Department of Anthropology, Washington State University, Pullman, Washington.

513 Gilroy, H.L., Erikson, L.M., Kong, T.M., Mactavish, K.A., 2015. 2015 commercial fishery and  
514 regulation changes. International Pacific Halibut Commission Report of Assessment and  
515 Research Activities 2015. p. 23–35.

516 Hall, M.A., Alverson, D.L., Metuzals, K.I., 2000. By-catch: problems and solutions. *Mar. Pollut.*  
517 *Bull.* doi:10.1016/S0025-326X(00)00111-9

518 Hannah, R.W., Parker, S.J., Matteson, K.M., 2008. Escaping the surface: the effect of capture  
519 depth on submergence success of surface-released Pacific rockfish. *North Am. J. Fish.*  
520 *Manag.* 28, 694–700. doi:10.1577/M06-291.1

521 Hannah, R.W., Rankin, P.S., Blume, M.T.O., 2014. The divergent effect of capture depth and  
522 associated barotrauma on post-recompression survival of canary (*Sebastes pinniger*) and  
523 yelloweye rockfish (*S. ruberrimus*). *Fish. Res.* 157, 106–112.  
524 doi:10.1016/j.fishres.2014.04.007

525 Hochhalter, S.J., Reed, D.J., 2011. The effectiveness of deepwater release at improving the  
526 survival of discarded yelloweye rockfish. *North Am. J. Fish. Manag.* 31, 852-860.

527 Kaimmer, S., 2004. 1998 Gear and bait experiments. Technical Report No. 48, International  
528 Pacific Halibut Commission. Seattle, Washington. 27 p.

529 Kaimmer, S.M., Wischniowski, S. 2013. Hook modification study to reduce rockfish bycatch on  
530 circle hooks. International Pacific Halibut Commission Report of Assessment and Research  
531 Activities 2012. p. 487-491.

532 Leaman, B.M., Kaimmer, S.M., Webster, R.A., 2012. Circle hook size and spacing effects on the  
533 catch of pacific halibut. *Bull. Mar. Sci.* 88, 547–557. doi:10.5343/bms.2011.1059

534 Lewin, W.-C., Arlinghaus, R., Mehner, T., 2006. Documented and potential biological impacts  
535 of recreational fishing: insights for management and conservation. *Rev. Fish. Sci.* 14, 305–  
536 367. doi:10.1080/10641260600886455

537 Loher, T., Seitz, A.C., 2008. Characterization of active spawning season and depth for eastern  
538 Pacific halibut (*Hippoglossus stenolepis*), and evidence of probable skipped spawning. *J.*  
539 *Northwest Atl. Fish. Sci.* 41, 23–36. doi:10.2960/J.v41.m617

540 Musick, J.A., Burgess, G., Cailliet, G., Camhi, M., Fordham, S. 2000. Management of sharks and  
541 their relatives (Elasmobranchii). *Fisheries* 25, 9-13.

542 NOAA. 2012. Status of stocks 2012: Annual report to congress on the status of U.S. fisheries.  
543 NOAA Fisheries. Accessed 10 February 2016.



544 <[http://www.nmfs.noaa.gov/sfa/fisheries\\_eco/status\\_of\\_fisheries/archive/2012/2012\\_sos\\_rtc](http://www.nmfs.noaa.gov/sfa/fisheries_eco/status_of_fisheries/archive/2012/2012_sos_rtc)  
545 [.pdf](#)>

546 Oregon Department of Fish and Wildlife, 2015. 2015 Oregon sport fishing regulations.  
547 Accessed 11 February 2016.  
548 <http://www.dfw.state.or.us/fish/docs/2015/2015%20Oregon%20Sport%20Fishing%20Regs>  
549 [\\_r12-11-14.pdf](#)

550 Parker, S.J., Berkeley, S.A., Golden, J.T., Gunderson, D.R., Heifetz, J., Hixon, M.A., Larson, R.,  
551 Leaman, B.M., Love, M.S., Musick, J.A. and O'Connell, V.M., 2000. Management of Pacific  
552 rockfish. *Fisheries* 25, 22-30.

553 Saunders, M.W., McFarlane, G.A. 1993. Age and length at maturity of the female spiny dogfish,  
554 *Squalus acanthias*, in the Strait of Georgia, British Columbia, Canada, in: The reproduction  
555 and development of sharks, skates, rays and ratfishes. Springer, Netherlands, pp. 49-57.

556 Schroeder, D.M., Love, M.S., 2002. Recreational fishing and marine fish populations in  
557 California. *Calif. Coop. Ocean. Fish. Investig.* 43, 182–190.

558 Stewart, H., 1977. Indian fishing: early methods on the Northwest Coast. Seattle, WA.  
559 University of Washington Press.

560 Swan, J.G., 1870. The Indians of Cape Flattery, at the entrance to the Strait of Fuca, Washington  
561 Territory. *Smithson. Contrib. to Knowl.* 16, ix+108pp.

562 Washington Department of Fish and Wildlife, 2015. Washington sport fishing rules: effective  
563 July 1, 2015 to June 30, 2016. Accessed 11 February 2016.  
564 <http://wdfw.wa.gov/publications/01726/wdfw01726.pdf>

565 Waterman, T.T., (undated). The fishing-equipment of the Makah Indians. Museum of the  
566 American Indian/Heye Foundation Records, Box 282 and Folder 10; National Museum of the  
567 American Indian Archive Center, Smithsonian Institution. 54 p.

568 Werner, T., Kraus, S., Read, A., Zollett, E., 2006. Fishing techniques to reduce the bycatch of  
569 threatened marine animals. *Mar. Technol. Soc. J.* 40, 50–68.

570 Wilson, S.M., Raby, G.D., Burnett, N.J., Hinch, S.G., Cooke, S.J., 2014. Looking beyond the  
571 mortality of bycatch: sublethal effects of incidental capture on marine animals. *Biol.*  
572 *Conserv.* 171, 61–72. doi:10.1016/j.biocon.2014.01.020

573

574

575 Figure captions

576 Figure 1: The traditional čibu·d of the Makah Tribe made of hemlock or true fir as depicted in  
577 Waterman (undated) with a line wrapped around the čibu·d used for tying the bait in place.

578

579 Figure 2. A čibu·d constructed for this study showing the five measurements collected : A) barb  
580 tip to top of frame, B) barb tip to opening, C) barb tip to bottom of frame, D) barb tip to inside of  
581 frame, and E) length of barb.

582

583 Figure 3. Circle hooks and čibu·d were fished using recreational spreader bars: panel A shows  
584 the configuration of the spreader bar and paired circle hooks used in the study, panel B shows  
585 how the čibu·d was attached to the spreader, panel C shows how herring was baited on the paired  
586 circle hooks, and panel D shows how the čibu·d were baited by tying a herring to the frame of  
587 the čibu·d.

588

589 Figure 4. Study area of the 2015 čibu·d recreational halibut fishing experiment.

590

591 Figure 5. Histogram of the length of halibut caught on circle hooks (black) and čibu·d (gray)  
592 during the study.

593

594 Figure 6. Observed differences in the measured distance between the barb tip and the bottom of  
595 the čibu·d frame for whether a čibu·d caught halibut (left panel) and whether a cibud caught a  
596 halibut at a rate above or below the average for all čibu·d (right panel).

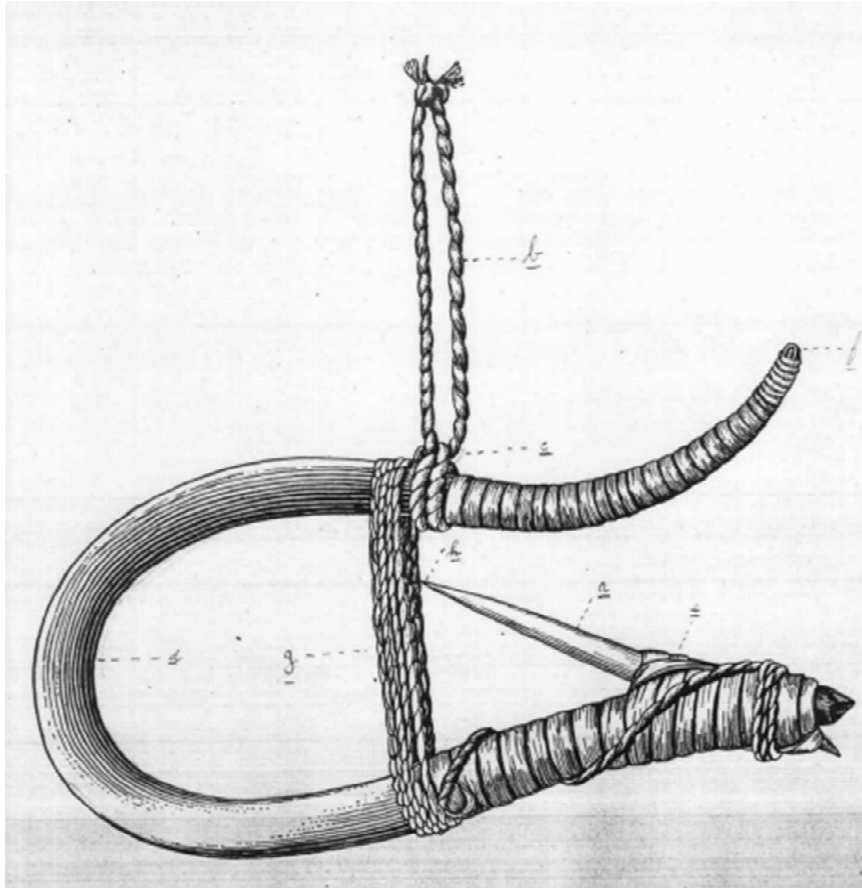
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598 Figure 7. Histogram of angler responses to a question regarding which hook they would prefer  
599 to fish when fishing for halibut in the future with a score of 1 a strong preference for circle  
600 hooks, a score of 10 a strong preference for čibu-d, and a 5 for no preference for either hook  
601 type.

602

603 Figures

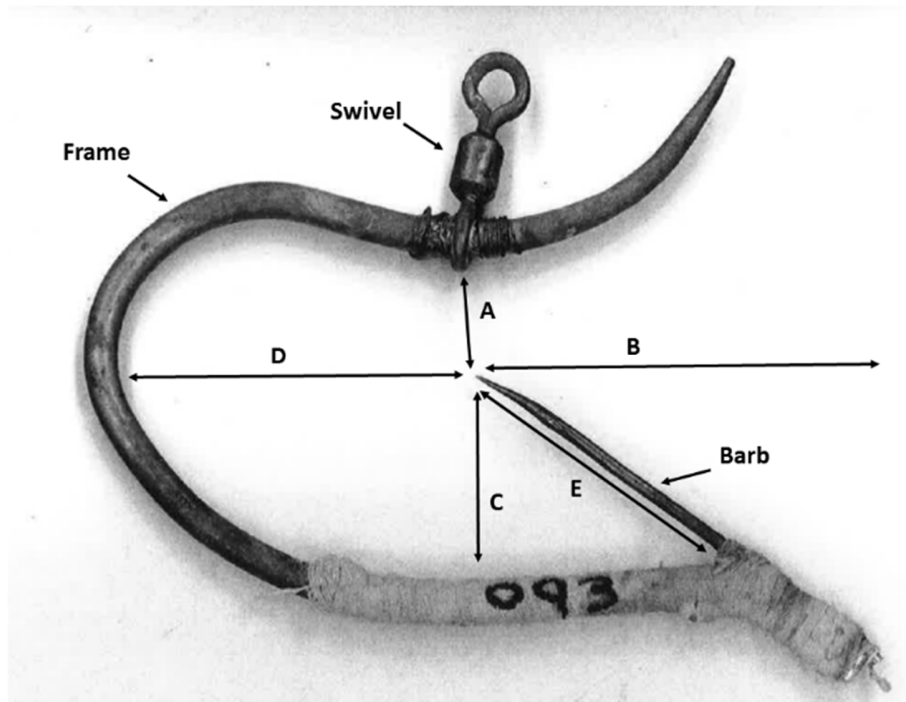
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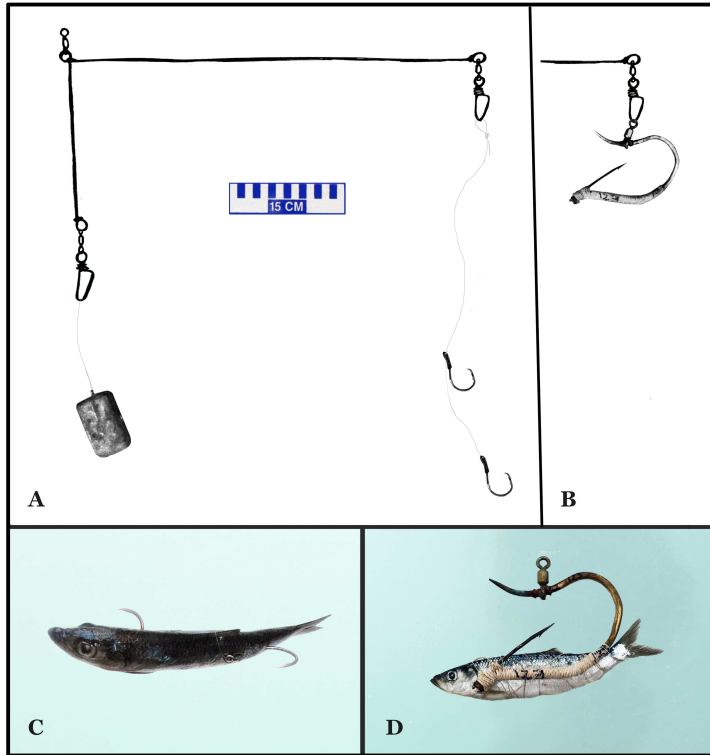
606 Figure 1

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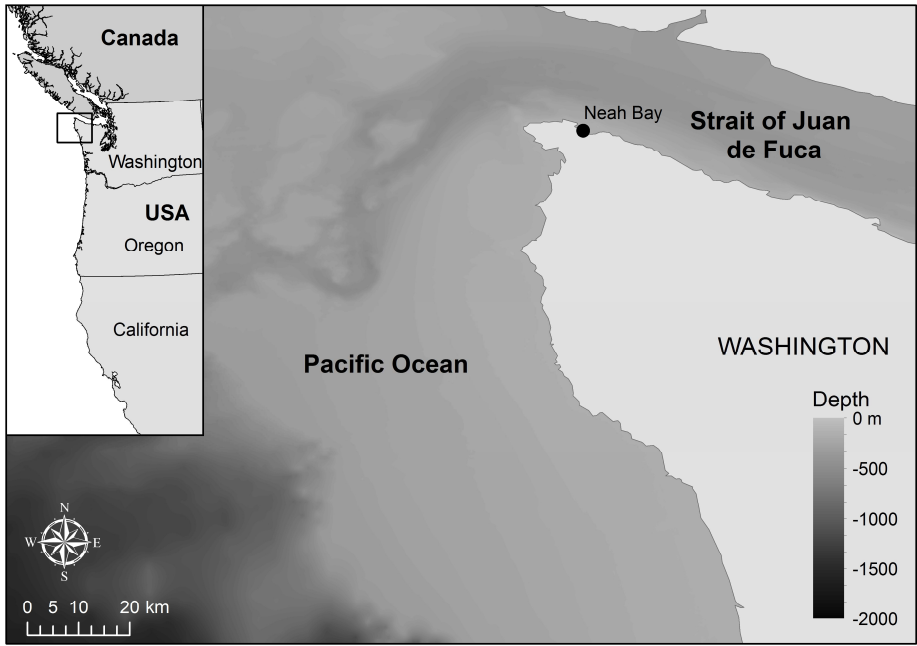
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609 Figure 2



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611 Figure 3

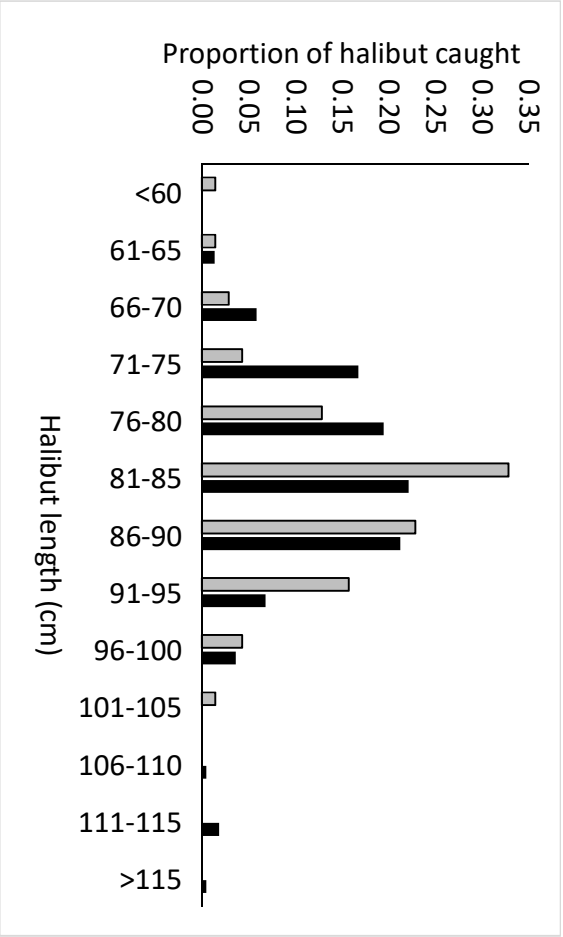


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614 Figure 4

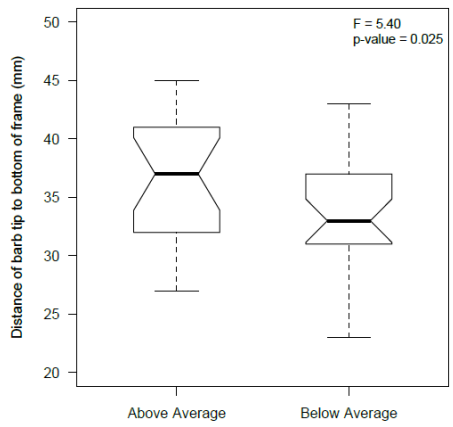
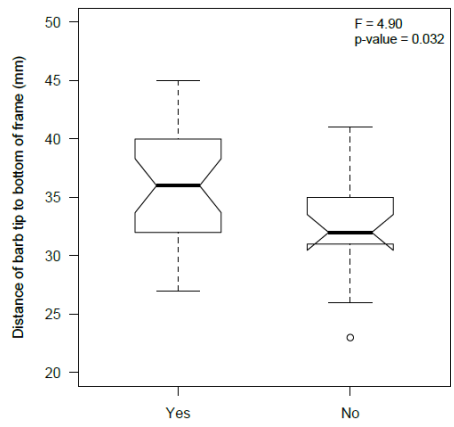




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617 Figure 5



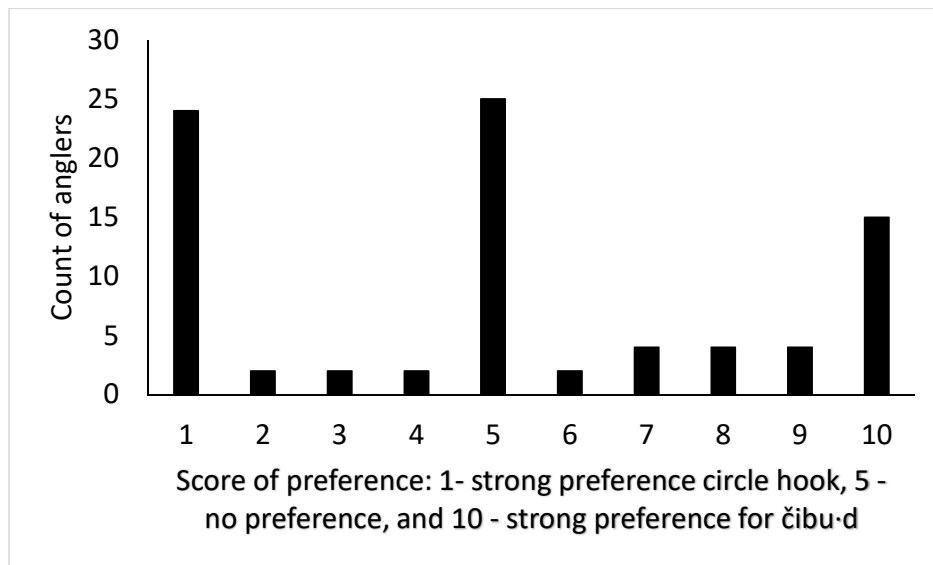
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621 Figure 6

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623

624

625

626 Figure 7

627 Table Captions

628

629 Table 1: Average standardized catch per set with standard error in ( ), p value from a paired t-  
630 test with 102 degrees of freedom, and total catch by species for the two hook types.

631

632 Table 2: Odds ratios and p values from Fisher's exact tests comparing the catch of halibut to  
633 non-target species and species groups for čibu·d compared to circle hooks.

634

635 Table 3: Comparison of the number of fish hooked and lost to the number of fish landed by hook  
636 type.

637

638

Common name	Species name	Standardized catch			Total catch	
		Circle	čibu·d	p value	Circle	čibu·d
Arrowtooth Flounder	<i>Artheresthes stomias</i>	0.021 (0.008)	0.004 (0.003)	0.030	9	2
Baccacio Rockfish	<i>Sebastes paucispinis</i>	0.002 (0.002)	0.000 (0.000)	0.032	1	0
Black rockfish	<i>Sebastes melanops</i>	0.003 (0.003)	0.000 (0.000)	0.320	1	0
Canary Rockfish	<i>Sebastes pinniger</i>	0.072 (0.020)	0.002 (0.002)	<0.001	34	1
Chilipepper Rockfish	<i>Sebastes goodei</i>	0.002 (0.002)	0.000 (0.000)	0.320	1	0
Spiny Dogfish	<i>Squalus suckleyi</i>	0.052 (0.015)	0.002 (0.002)	0.001	25	1
Dover Sole	<i>Microstomus pacificus</i>	0.037 (0.013)	0.000 (0.000)	0.004	15	0
Greenstriped Rockfish	<i>Sebastes elongatus</i>	0.002 (0.002)	0.000 (0.000)	0.320	1	0
Pacific Halibut	<i>Hippoglossus stenolis</i>	0.500 (0.062)	0.180 (0.027)	<0.001	224	78
Lingcod	<i>Ophiodon elongatus</i>	0.153 (0.032)	0.002 (0.002)	<0.001	76	1
Pacific Cod	<i>Gadus macrocephalus</i>	0.017 (0.007)	0.002 (0.002)	0.018	8	1
Petrale Sole	<i>Eopsetta jordani</i>	0.003 (0.003)	0.000 (0.000)	0.320	1	0
Quillback Rockfish	<i>Sebastes maliger</i>	0.028 (0.012)	0.000 (0.000)	0.021	11	0

Rosethorn Rockfish	<i>Sebastes helvomaculatus</i>	0.008 (0.005)	0.000 (0.000)	0.097	4	0
Big Skate	<i>Raja binoculata</i>	0.000 (0.000)	0.004 (0.003)	0.160	0	2
Longnose Skate	<i>Raja rhina</i>	0.002 (0.003)	0.000 (0.000)	0.320	1	0
Vermillion Rockfish	<i>Sebastes miniatus</i>	0.002 (0.002)	0.000 (0.000)	0.320	1	0
Yelloweye Rockfish	<i>Sebastes ruberrimus</i>	0.030 (0.012)	0.004 (0.003)	0.011	15	2
Yellowtail Rockfish	<i>Sebastes flavidus</i>	0.021 (0.008)	0.000 (0.000)	0.008	10	0
Total		0.953 (0.067)	0.202 (0.027)	<0.001	438	89
Total Bycatch		0.453 (0.055)	0.022 (0.007)	<0.001	214	10

640

641

642 Table 1

643

644

645

---

<b>Species</b>	<b>p value</b>	<b>Odds ratio</b>	<b>95% Confidence interval</b>	
			<b>Lower bound</b>	<b>Upper bound</b>
Arrowtooth Flounder	0.740	1.6	0.3	15.2
Non-halibut flatfish	0.034	4.3	1.0	38.7
Lingcod	<0.001	26.4	4.4	1067.1
Pacific Cod	0.460	2.7	0.4	125.1
Spiny Dogfish	0.008	8.7	1.4	361.4
Canary Rockfish	0.001	11.8	1.9	486.3
Yelloweye Rockfish	0.260	2.6	0.6	24.0
All Rockfish	<0.001	9.1	2.9	46.5
All Roundfish	0.030	10.9	4.6	31.2
Total Bycatch	<0.001	7.4	3.7	16.5

---

646

647 Table 2

648

<b>Hook type</b>	<b>Hooked and lost</b>	<b>Fish landed</b>	<b>Landing efficiency</b>
Circle hooks	103	437	80.9%
čibu·d	91	88	49.2%

649

650 Table 3



651 **Supplementary Materials**

652 Interviewer:

653 Angler:

654 Date:

655 How would you rate your interest in marine conservation?

656

657 1 2 3 4 5 6 7 8 9 10

658 Not interested Moderate interest Highly interested

659

660 Why?

661

662 2. Are you concerned with bycatch of depleted or vulnerable species during recreational fishing?

663

664 1 2 3 4 5 6 7 8 9 10

665 No, it is not problem Not aware of any concern Yes, I am very concerned

666

667 Why?

668

669 3. Are you concerned about the status of fish species bycaught during recreational halibut  
670 fishing?

671

672 1 2 3 4 5 6 7 8 9 10

673 No concern Some concern I am very concerned

674

675 Why?

676

677 4. Where do you most often fish? Do you know which species of fish are depleted due to  
678 overfishing or are vulnerable to overfishing where you most often fish?

679

680 5. What measures do you take to prevent bycatch when recreationally fishing?

681

682 6. Do you check if fish species you are buying at markets or restaurants are known to be  
683 depleted or poorly managed?

684

685 1 2 3 4 5 6 7 8 9 10

686 No You would if you knew You always check if species is depleted

687

688 7. How long have you fished for halibut? How often do you fish halibut? Can you describe the  
689 changes in halibut, rockfish or other species you have caught in the years you have been fishing?  
690 What catch areas do you recreationally fish for halibut in?

691

692 8. How would you rate your experience fishing a čibu·d? Please write and explain why you  
693 have chosen the score your chose.

694

695 1 2 3 4 5 6 7 8 9 10

696 Poor Fair Good Great

697

698

699 9. If you were to go halibut fishing again would you prefer to fish circle hooks or čibu·d based  
700 on your experience? Please write and explain why you have chosen the score you chose.

701

702 1 2 3 4 5 6 7 8 9 10

703 I prefer circle hooks Comparable I prefer čibu·d

704

705 10. Do you think today's experiment was a fair trial of the two hook types? Describe why you  
706 think it was or was not.

707

708 11. Do you think sport halibut fishing should be restricted due to bycatch and if so how?