COLUMN
PERSPECTIVE

Out with the New And In With the Old: Reviving a Traditional Makah Halibut Hook for Modern Fisheries Management Challenges

Ian J. Stewart | International Pacific Halibut Commission, Seattle, WA 98199

Jonathan J. (Čibuqsus) Scordino | Makah Fisheries Management, P.O. Box 115, Neah Bay, WA 98357. E-mail: Jonathan.scordino@makah.com

Joseph R. Petersen | Makah Fisheries Management, Neah Bay, WA | Northwest Indian Fisheries Commission, Forks, WA

Alex W. Wise | Makah Fisheries Management, Neah Bay, WA | Neah Bay High School, Neah Bay, WA

Cole I. Svec | Makah Fisheries Management, Neah Bay, WA | Neah Bay High School, Neah Bay, WA

Reginald H. Buttram | Makah Fisheries Management, Neah Bay, WA

Joshua L. Monette | Makah Fisheries Management, Neah Bay, WA | Neah Bay High School, Neah Bay, WA

Maria R. Gonzales | Makah Fisheries Management, Neah Bay, WA

Russell Svec | Makah Fisheries Management, Neah Bay, WA

Joe Scordino | Scordino Consulting, Edmonds, WA

Kaeden Butterfield | Makah Fisheries Management, Neah Bay, WA | Neah Bay High School, Neah Bay, WA

William Parker | Neah Bay, WA

Laurence A. Buzzell | Makah Fisheries Management, Neah Bay, WA | Neah Bay High School, Neah Bay, WA

Although fisheries challenges evolve rapidly, historical approaches may provide "new" tools for managers. In the state of Washington, the Makah Tribe have used čibu·d, their traditional fishhook, to target Pacific Halibut *Hippoglossus stenolepis* long before the advent of modern fisheries. We describe our experience in rediscovering this historical harvesting method, testing the species selectivity, refining the approach, and producing a tool ready for application in modern fisheries management. Over nearly a decade, we were able to uncover substantial traditional knowledge in the community. Turning this knowledge into a reproducible and consistent product for testing proved difficult. Initial attempts to deploy the gear using commercial longlines encountered a range of challenges, but suggested refinements for further research. Subsequent experiments in recreational fisheries were successful due to the lessons learned during initial work. Our experience may be of value to others hoping to investigate historical methods with potential for addressing modern problems.

INTRODUCTION

This project began in 2011, when a youth of the Makah Tribe (Laurence Buzzell), interning at Makah Fisheries Management, wrote a proposal to determine whether the traditional ecological knowledge locked in the design of the Makah Tribe's traditional halibut hook, the čibu·d (pronounced chi-bood), reduces bycatch during Pacific Halibut *Hippoglossus stenolepis* (hereafter halibut) fishing. Modern halibut fisheries are well managed for the sustainability of the halibut population and fisheries (Clark 2003), but some of the species caught incidentally during both recreational and commercial fisheries have depleted populations and reducing their fishing mortality would benefit their recovery. If čibu·d do reduce bycatch, particularly of depleted non-target species, then the use of čibu·d in modern fisheries could provide important conservation benefits. Through the course of 9 years, the authors of this study worked closely with Makah elders and present day Makah fishermen. We examined traditional hooks at the Makah Cultural and Research Center and from private collections, and delved into the anthropological and ethnographical literature to learn how to build replicas of the čibu·d and to effectively fish them in modern fisheries. We tested the knowledge we gathered over four separate experiments, each phase building upon the results of the previous efforts. The result of this series of studies was the finding that the čibu·d, when constructed well, had statistically similar performance for catching halibut during recreational fisheries, while dramatically reducing bycatch as compared to the commonly employed hooks in the current fisheries.

History

Unlike many Indian Tribes of the Pacific Northwest, the village sites for the Makah Tribe were largely not located near salmon rivers, but were instead located near productive marine waters for hook and line fishing, seal hunting, and whaling (Swan 1855). Fishing with hooks became a highly developed art, and so hooks of various shapes were used for the different kinds and sizes of fish (Waterman, n.d.). Halibut were

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fished with a special hand-made hook known to the Tribe as the čibu·d (Scordino et al. 2017). Makah elders and the ethnographic record report that the čibu·d was selective for catching halibut, and for the intermediate size range of halibut captured (Swan 1870; Waterman, n.d.). The čibu·d was the primary tool employed by the pre-industrial fishery of the Makah Tribe that already exceeded 1.5 million pounds in the late 1800s (Collins 1996; Figure 1). Historically, čibu·d were fished from a canoe using a hand line that was attached to a spreader bar with two čibu·d suspended just above the bottom (Stewart 1977).

Originally, the čibu·d was made by steam bending wood, primarily western hemlock *Tsuga heterophylla* and true firs *Abies* spp. (Friedman 1975), into the appropriate shape and attaching a bone barb (Figure 1). Starting around the beginning of the 20th century, most čibu·d were made of brass, bronze, or steel with a steel barb. The čibu·d were fished by Makah tribal members until about the 1970s, when the hooks went out of favor, likely due to the time and workmanship they take to construct, and the accessibility of cheap, modern hooks.

PROJECT BEGINNINGS

Many management changes have been made to the commercial halibut longline fishery off the state of Washington to reduce bycatch (Trumble 1996; Melvin et al. 2001), particularly that of rockfish *Sebastes* spp. Rockfishes are a particularly sensitive species group of bycatch in the halibut fishery due to their life history characteristics and physiology (Parker et al. 2000). Most rockfish have long life spans, late sexual maturation, and a closed swim bladder that causes them to experience barotrauma and low survival rates when brought up from depth (Parker et al. 2000). Area closures, bag limits, and selective harvest of predators have been explored as tools for rockfish management in both the United States and Canada (Yamanaka and Logan 2010; Oken and Essington 2016). Considerable catches of rockfish still occur despite these spatial closures in Pacific Halibut longline fisheries.

It was identified that a better solution to bycatch mortality might be to develop a gear modification to prevent rockfish from being captured by the longline hooks (Erickson and Berkeley 2008). However, efforts to modify hooks to be more selective for halibut had not yet proven successful (Kaimmer and Stoner 2008; Kaimmer and Wischniowski 2013). On the basis of the ethnographic records (Waterman, n.d.; Swan 1870; Arima 1975) and knowledge of the Makah elders, we hypothesized that fishing with čibu·d could be used to reduce bycatch during halibut fisheries.

In 2011, Laurence Buzzell and Jonathan Scordino learned of efforts by William (Billy) Parker to construct čibu·d (Figure 2) from wood following traditional methods. They became excited about the potential of using čibu·d to address bycatch concerns and developed a proposal to build and deploy čibu·d using longline gear in commercial fishing areas off the coast of Washington. A collaboration with NOAA Fisheries scientists led to the proposal and funding of two federal research grants: Preserve America (available: https://preserveamerica.noaa.gov/) and Cooperative Research (available: http://bit.ly/2Qdu3s1). These grants provided modest funding for exploring several methods of čibu·d construction, building a sufficient supply for longline testing, chartering a tribal fishing vessel for conducting field tests, and analyzing the results. Importantly, the formal project was initiated with a community meeting held in 2012 at the Makah Cultural and Research Center (MCRC), in order to better appreciate and benefit from the considerable traditional knowledge and experience that existed, particularly among the tribal elders (Figure 3).

Community Involvement and Traditional Knowledge

Between the archived holdings of the MCRC and items brought in by community members, a number of very old to more recent čibu·d were available for comparison. We also visited with Makah elders and reviewed video and audio archives at the MCRC to learn how to shape metal čibu·d. Based on our research, we observed that čibu·d were commonly made with brass rod for the frame, and, based on a video at the MCRC with tribal elders Hugh and Frank Smith, that a straightened steel fish hook was used for the barb of the čibu·d. We photocopied two čibu·d to use as reference prototypes for replicating the shape of čibu·d (Figure 4), the two čibu·d had very similar shapes. One of the čibu·d was from the MCRC collection and the other čibu·d was made by Frank Smith, who was a Makah tribal member noted for his skill in making čibu·d.

The first step of the longline study was to replicate historically fished Makah metal čibu·d. We used 0.635-cm diameter round 360 half-hard tempered brass rod cut into 30.5-cm increments for constructing the frame of each čibu·d in this study. Each rod was ground to a tapered point to mimic the taper of the photocopied čibu·d and was then free-form hand bent (Figure 5). The barb of the čibu·d was made by straightening an 8/0 Mustad stainless steel salmon hook. The čibu·d frame had a groove cut into the surface where the barb was attached. The barb was placed in the groove, wrapped with copper or steel wire, and then soldered in place. The barb tip was positioned so that it was two finger's to one thumb's width

Figure 1. Makah fishing using traditional methods in the late 1800s, when catches already exceeded 1.5 million pounds (Collins 1996). Photo credit: International Pacific Halibut Commission archives.

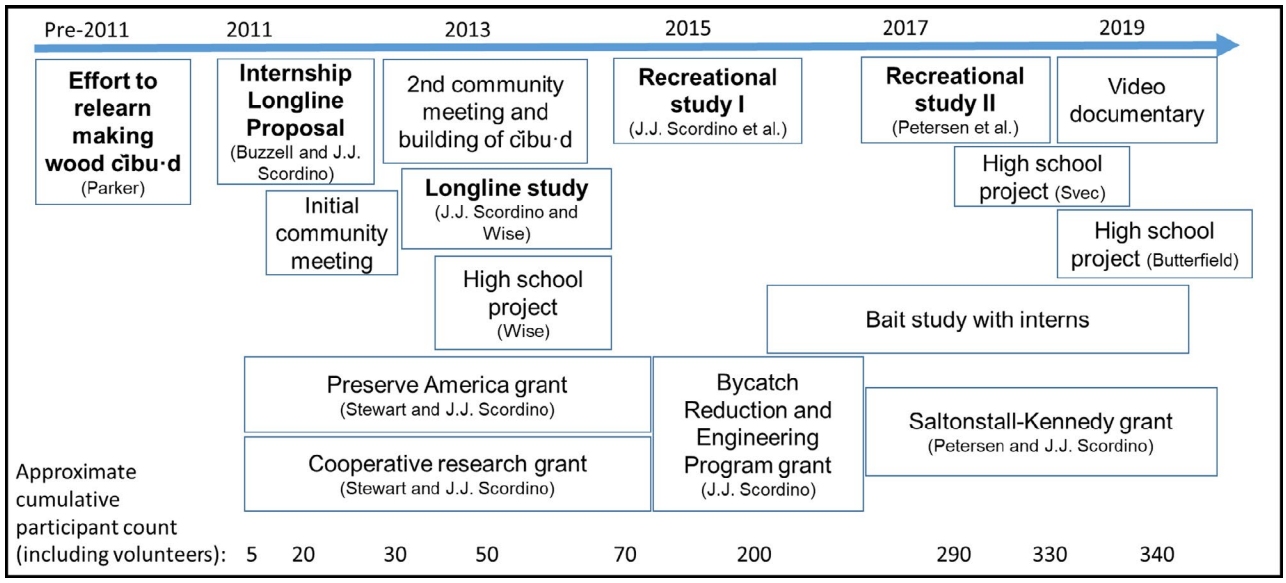

Figure 2. Timeline of čibu·d study phases, milestones, funding, and participation.

Figure 3. Jesse Ides (Hushta), a Makah elder with personal experience making and fishing čibu·d, inspects a hook constructed for the longline study in 2013. Photo credit: D. Preston, Northwest Indian Fisheries Commission.

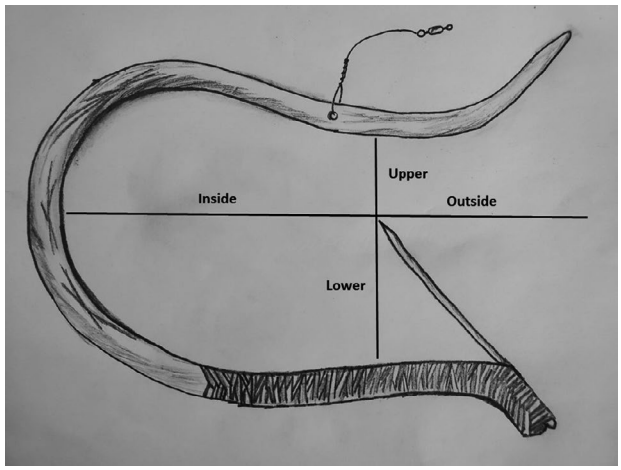

Figure 4. Sketch of reference čibu·d, noting the four dimensions recorded relative to the tip of the barb. Drawing credit: J. Petersen.

from the top of the čibu·d frame, based on how it was positioned in the past for metal čibu·d (J. Ides, personal communication). The last step of making the čibu·d was to wrap the frame of the čibu·d with cotton twine. The cotton twine was placed to help keep the bait from sliding along the frame of the čibu·d when it was tied in place (S. McCarthy, personal communication).

A second community meeting was held to update interested tribal members on the status of the project and to recruit volunteers to make the 200 čibu·d required for experimental testing with longline fishing gear. More than 40 people volunteered their time to construct the čibu·d, including six authors of this paper. The involvement of the many volunteers helped increase support in the community for the project overall. Even though every čibu·d was carefully shaped with the intent of mimicking the reference, there was considerable variability in the shape of the čibu·d made by volunteers. This represented the first of many challenges in adapting a historical method to scientific design—controlling the variability among individual čibu·d. Measurements of the 200 brass čibu·d constructed for longline fishing showed that although they were on average very similar to the reference, the individual dimensions varied substantially (Table 1). This would prove quite important in further evaluation and project design.

There were records of metal čibu·d fished with a small hole drilled in the upper portion of the hook, and piano wire used to suspend the čibu·d from the spreader bar. We had concern that piano wire would not be durable enough for longlining. In Stewart (1977) there is a drawing of a Makah čibu·d with a swivel attached to it. Although we did not see any čibu·d with

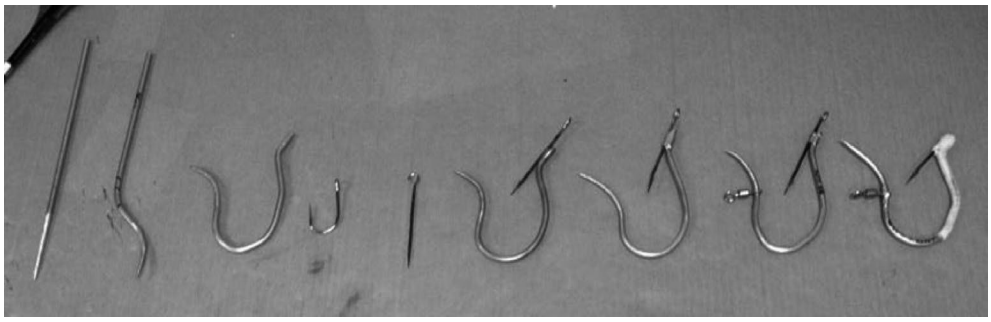

Figure 5. Steps in the construction of a handmade brass čibu·d. Photo credit: R. Carlson.

Table 1. Dimensions (mm; see Figure 4) of the primary reference čibu·d vs. those constructed for the initial longline study (N = 200).

	Reference čibu·d	Study čibu·d		
Measurement	**Value**	**Minimum**	**Average (SD)**	**Maximum**
Upper	23	9	23 (5.6)	40
Lower	36	19	37 (5.3)	49
Outside	61	48	72 (9.1)	94
Inside	62	34	62 (9.8)	87

an attached swivel in the MCRC or in personal collections of tribal members, we decided to attach an 8/0 barrel swivel to the top of the čibu·d frame by passing the rod of the frame through one open loop of the swivel and then wrapping the čibu·d frame on each side of the swivel with wire and soldering the wire so that the swivel could not slide off the čibu·d frame. The čibu·d were attached to longline "snap" gear (where hooks are removed from the groundline on retrieval, versus "stuck" or "fixed" gear, where they are permanently attached) mimicking how circle hooks are commonly fished in the modern commercial fishery. A hog ring was used to attach the 8/0 swivel on the čibu·d to rubber hosing. The other side of the hose was attached with a hog ring to a standard longline snap. For a standardized comparison, snap gear using 13/0 circle hooks (the most common size used in the local fishery) was used.

We then worked with tribal fishermen to identify locations where both halibut and bycatch species would be present to allow for comparison of the catch rates of each between čibu·d and circle hooks. Due to a modest amount of funding, this resulted in a single crew (including authors J.J. Scordino and A. Wise) conducting 10 deployments of the experimental longline from September 26–28, 2013 on board the Makah fishing vessel *Rennell Sound* with the same crew (including authors J. Scordino and A. Wise). All fishing was conducted off the west coast of the Olympic Peninsula, on the edge of the Juan de Fuca Canyon in the Pacific Ocean, at depths ranging from 200 to 320 m. During each deployment, circle hooks and čibu·d were alternated on the gear until an approximate target of 300 hooks (150 čibu·d and 150 circle hooks) had been deployed. All hooks were baited with Pacific Herring *Clupea pallasii* cut into pieces of roughly 7 cm in length.

Catches from this approximately 3,000-hook paired experiment were modest, at 813 total fish captured, of which 424 were halibut (Table 2). However, only 47 fish (42 halibut) were captured on čibu·d. Only two rockfish were captured (both on circle hooks), with Pacific Spiny Dogfish *Squalus suckleyi* accounting for the vast majority of the bycatch. Circle hooks caught significantly more halibut (Paired t-test, df =9, t stat = −3.6, $P = 0.006$) and more bycatch (Paired T-test, df = 9, t stat = −5.3, $P < 0.001$) per 100 hooks than did čibu·d. The čibu·d had a bycatch rate (non-target catch/total catch) of only 12%, compared to 49% for circle hooks (Paired t-test, df = 9, t stat = 4.3, $P = 0.002$). Although clearly indicating a much reduced rate of bycatch on čibu·d, the catch rate for halibut was very low, indicating little commercial viability, at least for the brass hooks as constructed and fished in the study.

LESSONS LEARNED

Materials Mattered

Traditional čibu·d were made of wood that may have floated or at least been neutrally buoyant (Stewart 1977), thus maintaining the hooks off the bottom. Even the later metal čibu·d used in more recent Makah fisheries were jigged with a handline attached to a spreader bar with the čibu·d suspended above the bottom (J. Ides and P. Greene, personal communication). The relatively easy to bend but heavy brass čibu·d, when fished on a longline probably did not float, which may have contributed to the low observed catch rate. Potentially better performing wooden čibu·d were too difficult to mass produce and were unlikely to handle the rigors of commercial longline fishing. We concluded that better hook materials and gear configurations were necessary for improved catch rates.

Standardization Was a Challenge

Constructing the replica čibu·d used for the study by hand was one of the most enjoyable and engaging aspects of the project for both the scientists and community member volunteers. However, this approach produced a wide range of sizes and shapes. Although all čibu·d were measured individually, only size categories of čibu·d were recorded during longline trials, and there were a number of instances when individual hooks were not attributed to their respective catch, such that it was not possible to determine whether specific hook dimensions had a significant effect on catch rates. It appeared

Table 2. Catch and catch-rates for species encountered during the longline study.

		Total catch		Catch per 100 hooks	
Common name	**Scientific name**	**Circle hook**	**čibu·d**	**Circle hook**	**čibu·d**
Arrowtooth Flounder	*Atheresthes stomias*	21	1	1.40	0.06
Big Skate	*Raja binoculata*	2	0	0.12	0.00
Sablefish	*Anoplopoma fimbria*	9	2	0.52	0.13
Pacific Spiny Dogfish	*Squalus suckleyi*	346	2	22.78	0.20
Lingcod	*Ophiodon elongatus*	1	0	0.06	0.00
Pacific Cod	*Gadus macrocephalus*	2	0	0.11	0.00
Petrale Sole	*Eopsetta jordani*	1	0	0.07	0.00
Yelloweye Rockfish	*Sebastes ruberrimus*	2	0	0.12	0.00
All non-target species		384	5	25.18	0.39
Pacific Halibut	*Hippoglossus stenolepis*	382	42	26.20	2.86
Aggregate bycatch rate (non-target/total)				49%	12%

to those involved that some hooks had fished very well and others were largely ineffective.

More Was Not Better

As identified in the historical record, čibu·d were traditionally fished as singles or pairs. Converting this approach to longline fishing resulted in many challenges. These included tangles during setting or retrieval of the gear and difficulty re-baiting čibu·d for multiple deployments (it took 60–120 seconds to bait a čibu·d as compared to 5–10 seconds for a circle hook). In addition, when faced with a large number of hooks retrieved rapidly, čibu·d were often bent or broken during handling of the gear and/or catch. We concluded that the čibu·d worked as a selective fishing tool for catching halibut, but were not easily amenable to deployment on a large scale and in a commercial setting where efficiency was a primary necessity.

Statistical Significance Was Elusive

With modest funding and the above-mentioned challenges, we were unable to achieve sample sizes that could provide statistical significance for measuring the relative catch rates of halibut and rockfish. Yet the initial results did show that the čibu·d did indeed select for halibut at a much higher rate than modern circle hooks. Plans to test the size selectivity of halibut were also thwarted by both a limited sample size and size range of fish captured. Informal power analysis suggested that we would be unable to perform a large enough experiment without much greater funding and much higher catch rates to compare the performance of circle hooks and čibu·d under commercial longline fishery conditions. We concluded that a different application for čibu·d should be considered.

SUBSEQUENT PHASES

Recreational Fishing of Free-Form, Hand-Bent Brass čibu·d

Based on the results and experience gained from the longline study, we considered alternative applications for čibu·d as a modern tool. Recreational fisheries have similar bycatch challenges and potential impacts on ecosystems to that observed in the commercial fisheries (McPhee et al. 2002; Coleman et al. 2004). The recreational fishery also provided a more controlled setting for deploying čibu·d, where a single hook could be used and could be easily fished off the bottom as described by Stewart (1977). In 2015, a grant from the Bycatch Reduction and Engineering Program (available: http://bit.ly/30LvtMj) was secured and a second field study initiated. This study, previously published (Scordino et al. 2017), is summarized briefly below.

Scordino et al. (2017) evaluated the čibu·d against paired circle hooks (size 8/0) commonly used for recreational fishing using a contracted charter boat and a large number of volunteer anglers (N = 125) over 17 days of fishing effort. The study utilized the same čibu·d used in the earlier longline study. To allow evaluation of the effect of the variability in shape of the handmade čibu·d on fishing performance, each čibu·d was individually numbered and measured prior to fishing. Although a smaller overall number of fish were captured, almost twice as many were taken on čibu·d than in the longline study (78 vs. 42, respectively). Catch rates of non-target species were again significantly less for the čibu·d (non-target catch/total catch = 11%) than for circle hooks (49%). Although catch rates for halibut on čibu·d remained much lower than for circle hooks, the ratio of 1 halibut on the čibu·d per 2.9 on circle hooks represented a substantial improvement over the longline study ratio of 1 on čibu·d per 9.6 on circle hooks. The recreational fishery study also surveyed anglers and documented a strong positive response of anglers to using čibu·d, indicating that čibu·d represented a promising alternative for reducing catch of non-target species during recreational halibut fisheries.

An interesting observation during the recreational fishing study was that when anglers tangled their lines, and had fish on, that the lines with circle hooks were more likely to retain the hooked fish than were the lines with čibu·d. We also observed that anglers who kept steady pressure on their line while reeling up their fish were more likely to land fish hooked on čibu·d than were anglers that took breaks while reeling up. Together these observations may help explain the larger disparity in catch performance of čibu·d and circle hooks during the longline study in which hooks are fished passively than during recreational fishing study where anglers actively respond to fish bites and immediately reel in fish.

Efforts to Improve the Recreational Fishing Performance of čibu·d

The longline study and the recreational fishing study (Scordino et al. 2017) both indicated that the ethnographic record was correct; čibu·d are very selective for catching halibut. As such, it appeared to be a potential tool for fisheries management of recreational halibut fisheries. However, we were concerned that anglers may not be satisfied fishing čibu·d due to the low catch rate of halibut when compared to circle hooks. Upon reviewing the results of our first two studies, we identified four remaining factors that were potentially causing reduced catch rates of halibut on the čibu·d. The first was that using Pacific Herring for bait may have decreased the fishing performance of the čibu·d. The ethnographic record consistently reported that "devil-fish" (octopus) was the primary bait used in historical halibut fishing (Waterman, n.d.; Swan 1870; Arima 1975) and that sometimes other baits were used such as fillets of rockfish (Arima 1975); notably the ethnographic record does not include any records of Pacific Herring as a bait choice for halibut fishing. Second, the shape of the čibu·d; specifically, the distance of the barb tip from the base of the čibu·d frame affected fishing performance. Moving forward, we wanted to use only optimally and consistently shaped čibu·d. Third, we hypothesized that our construction process may have led to poor retention of hooked fish. The straightened fish hook used for the barb frequently bent or broke, allowing a hooked fish to escape before it was netted. The material used for the frame of the čibu·d could also have affected fishing performance; use of more buoyant wood or plastic might be better than brass. Finally, reviewers of the Scordino et al. (2017) paper suggested that our use of paired 8/0 circle hooks did not provide a good comparison to the catch performance of a single čibu·d, because the paired hooks may have had higher performance simply due to having two hooks. To address these factors, and build upon the experience of the previous studies, we undertook two new čibu·d studies.

To evaluate the impact of bait choice on fishing performance of the čibu·d, we undertook a low-budget study conducted entirely with youth of the Makah Tribe who interned with Makah Fisheries Management (Figure 6). The study design was simple; four čibu·d were fished simultaneously, each baited with either Pacific Herring, squid, octopus, or rockfish fillet (Figure 7). When a fish was hooked, all four hooks were reeled to the surface—sometimes more than one fish was hooked before all gear could be retrieved. We then recorded the sum of catch by bait type. Only sets that caught fish were included in our statistical analysis. Based on 30 sets, we found no statistical difference in the catch rates by bait type (Chi Squared Test of Independence, $df = 3$, $p = 0.29$) suggesting that our use of Pacific Herring as the bait for our studies may not have negatively affected the fishing performance of the čibu·d. Interestingly, although not statistically significant, the best performing bait (10 of 32 total fish caught) was the fillet of rockfish.

To address the remaining three factors, we undertook a second recreational project with funding support from the Saltonstall–Kennedy Grant Program (available: http://bit.ly/2OBAtk6). That previously published study (Petersen et al. 2020) first compared the fishing performance of highly standardized čibu·d made from four different materials: brass, stainless steel, plastic, and wood. The metal čibu·d were made to a standardized shape, using a compact metal bender, rather than free-form bending by hand, and the plastic čibu·d were all made from the same mold to ensure the consistency of hook shape. We used 0.3175-cm diameter stainless steel rod for the barb instead of straightened fish hooks and positioned the barb on all the metal and plastic čibu·d, so that the barb tip was 36 mm above the bottom of the čibu·d frame to improve the performance of the čibu·d, based on the findings of Scordino et al. (2017). Each of the wooden čibu·d were shaped using molds, and we used elk femur bone for the barb. The wood used for the wooden čibu·d had impurities, such as knots, and had inconsistent grain density that affected how well the wood conformed to our mold and how well it held shape when it cooled and dried after steaming, and were therefore more variable in shape than čibu·d of the other three materials. The fishing performance was not statistically different among brass, stainless steel, or plastic. However, the čibu·d made from wood had significantly lower catch of halibut. That study then used the brass čibu·d to compare čibu·d fishing performance with a single 16/0 circle hook and paired 8/0 circle hooks for continuity with the previous study. The brass čibu·d again had a significantly lower bycatch rate (non-target catch/total catch = 14%) than both the paired 8/0 (non-target catch/total catch = 53%) or single 16/0 circle hook (non-target catch/total catch = 38%). No significant differences were found in catch rates of halibut for the čibu·d compared to both the 16/0 and paired 8/0 circle hooks, although observed catch rates on paired 8/0 and single 16/0 circle hooks were slightly higher than on the čibu·d (1 halibut on čibu·d to every 1.2 on the single 16/0 circle hook and 1.4 halibut on paired 8/0 circle hooks). Finally, the čibu·d produced after these extensive design modifications and refinements were of comparable efficiency to modern gear, but with lower bycatch, that could be readily deployed in the recreational fishery. Interaction with volunteer anglers during this and earlier work also suggested a further benefit—many enjoyed the opportunity to fish with čibu·d for the experiential value of

Figure 6. Makah Fisheries Management intern, Ian Olson, assisting in the collection of data for comparing recreational čibu·d catch rates using different bait types in 2019. Photo credit: E. Allyn.

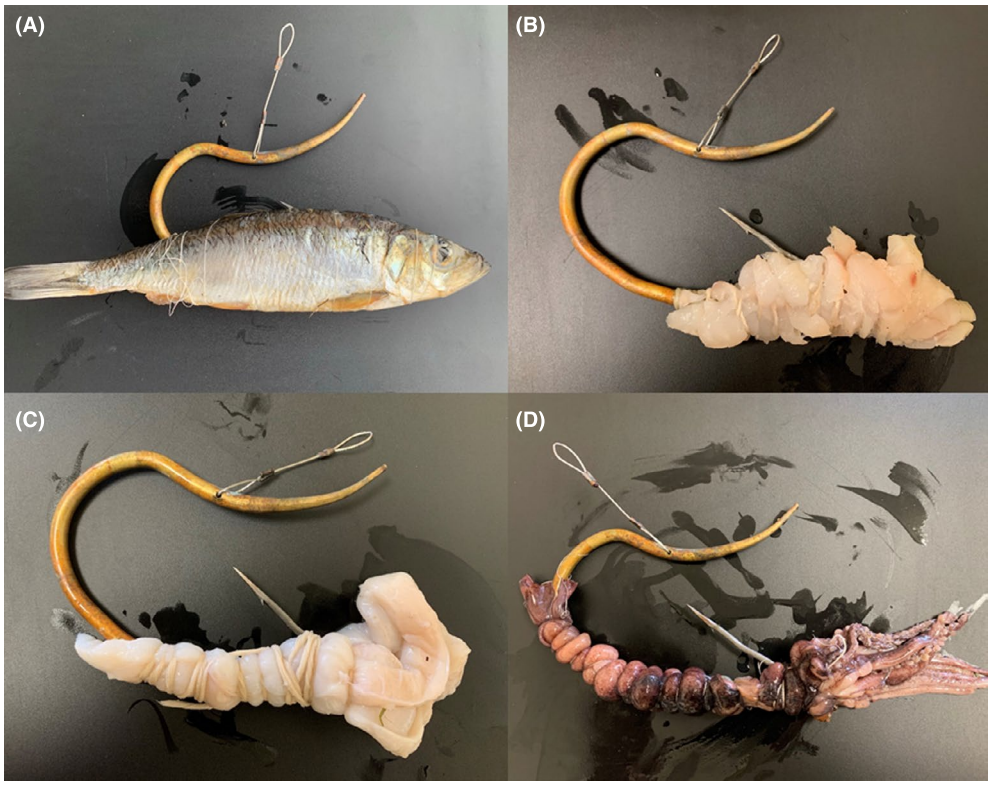

Figure 7. Examples of čibu·d baited with (A) Pacific Herring, (B) rockfish, (C) octopus, and (D) squid. Photo credit: K. Butterfield.

employing a time-honored method developed and refined by the Makah. However, our observations during the recreational studies of losing fish hooked on čibu·d when anglers did not maintain tension, and the vast increase in time it takes to bait a čibu·d as compared to a circle hook make it clear that the use of čibu·d is not viable for commercial longline fisheries.

Potential Benefits of Further Evaluation of Hook Design

Stewart (1977) described traditional halibut hooks of the Pacific Northwest as having different designs based on region. Generally stated, the southern design was made from wood, steam bent into a U shape, whereas the northern design was made from the crotch of a branch or by lashing two pieces of wood together in a V shape. Within each regional design, each Tribe or First Nation that used the hook had slight differences in the specific hook design (Waterman, n.d.; Stewart 1977). This study focused solely on the traditional and historic halibut hook of the Makah Tribe. For logistical reasons, most of the effort of the study utilized only a small number of very similarly shaped reference čibu·d, even though čibu·d shared with Jonathan Scordino by community members showed that each Makah family have slight differences in design, including in shape and size. Thus, the reference čibu·d we used may not have been the optimal shape for fishing performance. Future studies could compare the performance of traditional halibut hooks of the northern and southern designs, or between general designs used by different Tribes or First Nations, or compare family-specific variations within a Tribe or First Nation to determine if differences in fishing performance within and among specific fishing areas. In this study, we focused on evaluating čibu·d used during the modern fishing practices of longlining and recreational rod-and-reel fishing. Additional studies could evaluate traditional deployment techniques, such as using a hand-line connected to a spreader bar with two čibu·d (Stewart 1977) or the use of cultural rituals as described by Smythe (2018) and other authors. These techniques may improve the fishing performance of the čibu·d or other traditional halibut hooks of the Pacific Northwest; they might even result in a fishing method that outperforms present day recreational fishing methods for catching halibut.

Public Outreach and Education

The most recent extension of the project has been the completion of a video documentary. Although not yet publicly released as of this writing, that effort parallels this paper in describing the major aspects of the research from start to finish in the words of one of the participants in the study (and an author here). It may eventually be included in an exhibit at the MCRC, and provides a readily accessible resource for tribal members and the general public to learn about the project.

THE BIGGER PICTURE

This study provides an example of the challenges, as well as the inherent value in exploring and formalizing traditional knowledge for use in modern fisheries applications. The work produced a new level of documentation for the Makah's čibu·d and a renewed interest among community members and local scientists (e.g., Salmen-Hartley 2018). It provided an opportunity for 260 volunteer anglers to try fishing the čibu·d for the first time and reflects the growing popular interest in such methods observed in other parts of the coast (e.g., http://bit.ly/3eLj3MK; Malindine 2017; Smythe 2018).

This study provided the opportunity for 5 different high school students to make their first formal entry into

experimental fisheries science. These students gained a new level of engagement with academics and a personal connection to experimental design and analysis. One student won a local award for Marine Sciences Student of the Year for his work on the longline project. Another student presented a research poster with his analysis of the bait study as part of his internship. Over the course of the 9 years, over 340 people contributed to at least one phase of the work (Figure 2). Partnerships involving NOAA Fisheries, the International Pacific Halibut Commission, and the Makah Fisheries Management have continued through professional and personal contacts.

On a broader level, this study can serve as a reminder to fisheries scientists that sometimes a historical method can be re-engineered for a modern problem. The list of new fisheries challenges continues to grow rapidly to include bycatch of non-target species, capture and removal of invasive species, and conservation of sensitive habitats—all these could potentially benefit from rethinking some current approaches. There are many existing fisheries techniques that are based on historical methods, evolved over time for specific needs. These include examples such as the use of circle hooks based on traditional Mäori hook designs (Paulin 2007), the re-emergence of fish wheels (Meehan 1961), and reef nets (Claxton 2015) for selective harvest in mixed-species salmon fisheries and for non-lethal scientific sampling, as well as potentially many other historical harvesting methods of which the authors are unaware. What other tools may be hiding in our archives that could provide old solutions to new management challenges if we are willing to explore them in the right context?

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