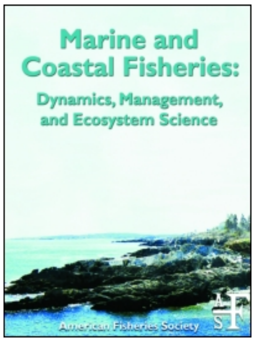

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ARTICLE

Tailoring Ecological Monitoring to Individual Marine Reserves: Comparing Longline to Hook-and-Line Gear to Monitor Fish Species

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Abstract
Fishery-independent hook-and-line surveys are currently being used to assess marine reserve performance in California and Oregon using a regionally standardized approach. Catch compositions generated from these hook-and-line surveys (pole-and-line gear) at Oregon's southernmost marine reserve were compared with local commercial landing data. Several species present in the commercial catch were undersampled in the marine reserve hook-and-line dataset, including China Rockfish *Sebastes nebulosus*, Vermilion Rockfish *S. miniatus*, Quillback Rockfish *S. maliger*, Copper Rockfish *S. caurinus*, and Cabezon *Scorpaenichthys marmoratus*. We conducted a gear selectivity study to explore whether modified commercial long-lining gear could supplement current hook-and-line efforts. Both gear types were fished simultaneously from a single vessel inside and outside of the reserve. Species composition, catch rate, size distribution, and fish condition between the two gear types were compared. Catch composition differed significantly between longline and hook-and-line gear. Catch rates of nearshore rocky reef fish species were higher for longline than hook-and-line gear for all but two species. Importantly, higher catch rates were significant for three of the species of interest (Cabezon, Vermilion Rockfish, and Copper Rockfish). For four different species, larger individuals were caught on the longline compared with the hook-and-line gear. Incidence of predation and mortality were higher with long-lining but limited to three species groups: Black Rockfish *S. melanops*, Blue Rockfish *S. mystinus* and Deacon Rockfish *S. diaconus* complex, and Canary Rockfish *S. pinniger*. Symptoms of barotrauma were higher with hook-and-line gear. We demonstrated that longline gear can be used to catch and release species targeted by the local fishery and used simultaneously with hook-and-line gear from a single vessel to broaden both the species and the size ranges sampled. These results underscore the need to consider regionally standardized long-term monitoring approaches in conjunction with locally tailored efforts to generate data for detecting marine reserve effects at both local and regional scales.

Fishery-independent data—collected independently from fisheries landings and logbooks—are recognized as important for improving fishery stock assessments (Harms et al. 2010), monitoring for temporal changes in trophic structure (Shackell et al. 2010), and evaluating the performance of spatial fishing closures (Yoklavich et al. 2007). Different sampling methods have been used to generate fishery-independent data, including nonextractive visual surveys (Watson et al. 2005) and extractive surveys using a variety of fishing gear. Extractive surveys are particularly useful in the nearshore waters of the

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northeastern Pacific Ocean, where limited water visibility can severely restrict the available sampling days for conducting visual surveys. In this region, extractive trawl and hook-and-line surveys are commonly used to sample the fish community (Bechtol 2000; Yamanaka 2001; Yamanaka and Logan 2010; Bradburn et al. 2011), though their use is often dictated by the type of habitat to be surveyed. For example, hook-and-line gear is used to sample rocky reefs that are home to many commercially and recreationally important species, as trawl gear would snag in these complex, hard-bottom habitats. Fishery-independent hook-and-line surveys (hereafter "hook and line" refers to pole-and-line gear specifically) have expanded in recent years in the nearshore waters of the northeastern Pacific Ocean both to assess reef fish abundance (Wendt and Starr 2009; Harms et al. 2010) and to monitor marine reserve performance (Haggarty and King 2006; Yochum et al. 2011; Huntington et al. 2014; Starr et al. 2015). The numbers of marine reserves are growing in both California, where 124 marine managed areas were implemented between 2007 and 2013 (Kirlin et al. 2013), and Oregon, where 13 marine managed areas were implemented between 2012 and 2016. These management areas include mandates to establish robust and appropriate long-term surveys to evaluate changes in the marine community within these managed areas over time. At this early stage of reserve implementation, it is timely to validate whether survey methods are appropriately tailored to the marine communities most likely to show responses to this management strategy—namely, species targeted by local fisheries (Molloy et al. 2009; Huntington et al. 2010; Claudet et al. 2010).

Interstate collaborations for monitoring marine reserves have helped to standardize the hook-and-line surveys in Oregon and California based on the design developed by the California Collaborative Fisheries Research Program (CCFRP). Following the CCFRP protocols, sportfishing boats are manned with volunteer anglers using standardized pole-and-line gear to generate catch data (CCFRP; Wendt and Starr 2009). Surveys are conducted within marine reserves (where extractive fishing is prohibited), as well as comparison areas (where fishing activity is permitted). The standardized monitoring approach has several benefits, including the ability to analyze reserve performance at larger spatial scales and across state boundaries using consistently collected data. Yet, all sampling gears are selective, disproportionately sampling certain species or sizes more than others (Bacheler et al. 2017). While large-scale population assessments can correct for gear selectivity and catchability, this approach is not yet a common practice for small-scale, low-replication abundance surveys that comprise most assessments of reserve performance (Fraschetti et al. 2002; Claudet and Guidetti 2010). The CCFRP design may not provide an adequate sample of fish populations targeted by local fisheries, making it challenging to assess the true abundance of fish inside and outside a marine reserve unless gear comparisons are undertaken. Generally, the fish species most likely to respond (in increased size or abundance) to reserve protection are those targeted by the fishing activities in the surrounding area (Côté et al. 2001; Clements et al. 2012). As such, best practices for marine reserve evaluation should ensure that gear comparison studies are undertaken to ensure adequate fishery-independent sampling of species valued in the local fishery. This may entail supplementing the regional surveys with methods tailored to species targeted by local fisheries to ensure that these species are adequately sampled.

Redfish Rocks Marine Reserve, Oregon's southernmost marine reserve, offers an opportunity to evaluate the feasibility of supplementing a regional fishery-independent approach with surveys tailored to a local fishery. The Redfish Rocks Marine Reserve was closed to all extractive fishing activities on January 1, 2012. Oregon Department of Fish and Wildlife (ODFW), the agency tasked with long-term ecological monitoring of Oregon's reserves, follows the regional CCFRP approach to conduct hook-and-line surveys within the reserve and comparison areas. The small fishing town of Port Orford (the closest port to the Redfish Rocks Marine Reserve) hosts a unique fishery within the state. No sportfishing operations exist in Port Orford, and recreational angling is limited due to a hydraulic hoist entry requiring vessels to meet specific weight and dimensional requirements to be lowered into the water (Wedell et al. 2005). The majority of nearshore fishing activity is conducted by a small commercial fleet that uses pot, hook-and-line, and longline gears (Gilden 1999). An active live-fish fishery (fish captured and sold alive at a premium price) accounts for approximately a third of landings in Port Orford (T. Calavan, ODFW, unpublished data). Port Orford fishermen use both hook-and-line and longline gears. Local fisherman target colorful, demersal fish species (not necessarily the most abundant nearshore species) that fetch higher prices within the live-fish fishery. To establish appropriate long-term monitoring methodologies for the Redfish Rocks Marine Reserve, it is important to test whether the CCFRP sampling method adequately samples the species targeted by local fisheries.

This study was designed to evaluate whether current hook-and-line monitoring of the fish communities in the Redfish Rocks Marine Reserve adequately samples the species most commonly landed in the commercial catch and, if not, explore whether alternative sampling gear could better target the commercially valued species using a catch-and-release approach. We began by reviewing the landing data at Port Orford to identify which species, and in what proportions, comprise the commercial catch in comparison to ODFW's hook-and-line surveys conducted in and around the Redfish Rocks Marine Reserve. We then explored whether commercial longline gear, modified for catch-and-release sampling, could be used successfully as a fishery-independent approach that would sample a species composition more closely resembling the commercial catch.

METHODS

Fishery-dependent and -independent comparison.—Fishery-independent hook-and-line surveys (using the regional CCFRP approach) were initiated in 2011 and have continued annually at the Redfish Rocks Marine Reserve and its associated comparison areas by the ODFW Marine Reserve Program. Commercial landing data for the nearshore groundfish fishery were collected at Port Orford by the ODFW with gear type denoted. This fishery-dependent data from 2011 to 2015 was compared with the Marine Reserve Program's hook-and-line surveys from 2011 to 2015 to compare catch composition as a proportion of total catch among gear types. For the purposes of this study, analysis was restricted to the two dominant commercial gear types in the region: hook and line (pole and line) and longline. Only species comprising > 1% of the total commercial catch were included in the comparison. It should be noted that Canary Rockfish *Sebastes pinniger* and Yelloweye Rockfish *S. ruberrimus* were listed as overfished during this time and could not be retained commercially. Hence, these two species are not included in the comparison of the commercial catch to the fishery-independent marine reserve data.

Gear comparisons.—All gear comparison surveys were conducted at the Redfish Rocks Marine Reserve and a nearby Humbug comparison area in spring of 2015 and 2016 (Figure 1). Through partnership with local fishing captains, the surveys were conducted in rocky reef habitats, where the commercial nearshore groundfish fishing effort was focused (in the case of the marine reserve, prior to reserve closure). All fishing occurred within the existing sampling cells currently used for the hook-and-line surveys conducted by ODFW's Marine Reserves Program. These cells (500 m × 500 m) were placed in rocky reef habitats (identified from high-resolution multibeam and backscatter mapping efforts) between depths of 15–35 m and overlapped with known fishing spots shared by local captains. This stratification process resulted in 11 sampling cells created within Redfish Rocks Marine Reserve and 9 sampling cells created within the comparison area. All fishing activity occurred within these existing cells, with the exception of two longline sets that occurred adjacent but outside of the cells in order to survey rocky reef habitat features of interest (Figure 1).

Longline and hook-and-line sampling was conducted during 6 d/year (2015 and 2016) aboard the same commercial fishing vessel (n = 12 fishing days). All sampling days were 8 h long with fishing commencing 1 h after sunrise. Sampling cells were randomly selected; typically, five cells were fished each day (depending on weather and field logistics) to match CCFRP methods. The vessel captain was instructed to set the location of both gear types within the sampling cell to ensure gear was deployed over rocky reef habitats and (in the case of hook-and-line sampling) the vessel drift would be confined within the selected cell. As such, the placement of the longline sets and the hook-and-line fishing drifts were not randomly selected within the cells. This approach is identical to the regional CCFRP hook-and-line surveys (Wendt and Starr 2009).

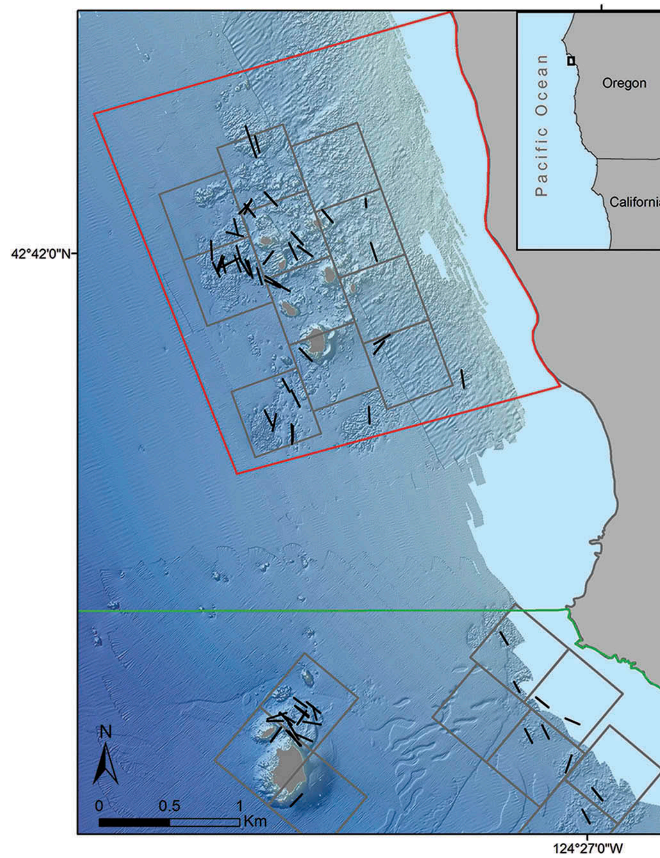

FIGURE 1. The study site showing the Redfish Rocks Marine Reserve boundary in red and the Humbug comparison area in green. Grid cells (dark gray) overlay rock habitat, where fishing was conducted in 2015 and 2016 using both hook-and-line and longline gear. Longline sets are shown as black bars. The bathymetry layer depicting rocky habitat is incomplete in the shallow regions (light blue).

The commercial fishing vessel carried three ODFW scientists, a deckhand, and the captain who had 30+ years of local fishing knowledge. The vessel carried three longlines that were each deployed twice during the course of the fishing day. The longline skate consisted of a 138-m weighted ground line with 100 12/0 hooks on 0.30-m-long leaders spaced 1.37 m apart. Each ground line was anchored at the beginning and end of the line and with short lengths of chain at 20-hook intervals. Hooks were baited with squid *Loligo opalescens*. Longlines were deployed by the captain and deckhand, and the spatial position, depth, and soak time were recorded for each longline set. Soak times (duration from the last hook in to the first hook out) were intentionally short, averaging approximately 2 h, to aid in maintaining favorable fish condition for catch and release. Longline deployment depths ranged from 13 to 43 m, with a mean depth of 30 m. Once the targeted soak time was reached, the lines were retrieved by the captain and deckhand. Fish were processed by the biological staff by identifying fish to species, measuring length (fork length in cm), evaluating physical condition and symptoms of barotrauma, and releasing the fish as quickly as possible. Physical condition was evaluated as the presence or absence of hook damage, bodily injury (i.e., damage visible to the external surface of the fish possibly from predation attempts or scale abrasion during longline capture), and fish dead upon landing. Barotrauma was evaluated as the presence or absence of eye crystallization and esophageal eversion. Fish were either released at the surface or at depth using a SeaQualizer if barotrauma symptoms were present. Six longline sets were completed in a typical sampling day (weather permitting). Three sets were deployed in the morning; three sets were deployed in the afternoon. A total of 70 sets were completed for this survey over 2 years.

During longline soak times and midday rebaiting, hook-and-line sampling was conducted by the three ODFW staff within the same cells as the longline sets. As with the longlines, the captain selected where to drift within the cells to target the species of interest. Drift locations were a minimum of 150 m from the soaking longlines to reduce any influence of longline bait on the hook-and-line catch. Drift depths ranged from 10 to 44 m, with a mean depth of 29 m. Anglers were instructed to avoid fishing in the water column and focus on jigging close to the bottom to target demersal species. Terminal gear (i.e., fishing tackle including lure, jig, and/or hook type) consisted of a 170 g diamond jig with a 2/0 triple hook configuration. Landed fish were removed from the hook and processed identically to the longline methods. As with the CCFRP regional method, three 15-min drifts were targeted within each cell. On average, five cells are completed during an 8-h day of conducting hook-and-line surveys. This allowed for six longline soaks and five hook-and-line cells to be executed in an 8-h day. Even though both surveys were conducted on the same vessel during an 8-h survey day, these sampling efforts equate to the same efforts had these surveys been conducted separately.

Data analyses.—Traditional CPUE estimates of catch rate do not readily facilitate comparisons across differing measures of “effort” (i.e., a longline set soak time does not equal the effort of single angler hook-and-line fishing). Hence, we conducted analyses at the day-scale in which effort was an 8-h fishing day for both gear types. Multivariate catch composition between hook-and-line and longline gear was conservatively compared using count data standardized at the unit of replication (individual sets for longline; unique sample cells fished in a given day for hook and line) to remove the influence of catch rate on the analysis. Standardized composition data were then averaged per fishing day (n = 12). A Bray–Curtis similarity coefficient was calculated on this standardized species composition matrix and analyzed using a two-way crossed analysis of similarity (factors: gear, year) followed by cluster analyses to determine percent similarity of fish community composition between factor levels. Multivariate analyses of community composition were conducted in PRIMER 7.0 (Clarke and Gorley 2006).

Species-specific daily catch rates (as count per gear per day) were compared between the longline and hook-and-line sampling, pooling across the two sampling years (n = 12). Only species comprising > 1% of the total catch were analyzed using a t-test on $\log_{10} + 1$ transformed data or the nonparametric equivalent for species that failed the Shapiro–Wilk test for normality. Size structure of the species comprising > 1% of the total catch were compared between hook-and-line and longline sampling. Kolmogorov–Smirnov tests compared size-frequency distributions, and Wilcoxon rank-sum tests compared mean size for each species. When significant Kolmogorov–Smirnov test results were found, the size-frequency distributions for these species were graphed by fitting a kernel density to the distribution for both hook and line and longline.

To compare the condition of fish caught by hook-and-line and longline gear, prevalence (as percent of individuals) exhibiting hook damage, bodily injury, barotrauma (rockfishes *Sebastes* spp. only), and death were calculated per gear type. All statistical analyses were conducted using the R statistical package (R Core Team 2012) and the ggplot2 package (Wickham 2009) for plotting the size-frequency distributions.

RESULTS

Comparing Fishery-Dependent and -Independent Data

Commercial nearshore groundfish landing data from Port Orford from 2011 to 2015 was composed of 10 species that comprised > 1% of the catch (Figure 2). One third of the commercial catch in this region was caught using longline gear. Unsurprisingly, catch composition differed between longline and hook-and-line gears. Specifically, the longline catch was comprised of a greater proportion of Blue Rockfish *S. mystinus* and Deacon Rockfish *S. diaconus* (these two species were grouped as they are morphologically difficult to distinguish consistently), Cabezon *Scorpaenichthys marmoratus*, China Rockfish *S. nebulosus*, Copper Rockfish *S. caurinus*, Lingcod *Ophiodon elongatus*, Vermilion Rockfish *S. miniatus*, Tiger Rockfish *S. nigrocinctus*, and Quillback Rockfish *S. maliger* compared with the hook-and-line catch. The catch composition from the commercial hook-and-line landings closely resembled the catch composition of ODFW hook-and-line surveys (Figure 2); both were dominated by Black Rockfish *S. melanops* and contained only small proportions of some species highly valued in the live-fish fishery, such as Cabezon and China Rockfish.

Longline versus Hook-and-Line Gear

Over 12 d of sampling, a total of 638 fish were caught on longline, while 655 fish were caught on hook and line (Table 1). Twelve species comprised > 1% of the catch. Daily catch rates

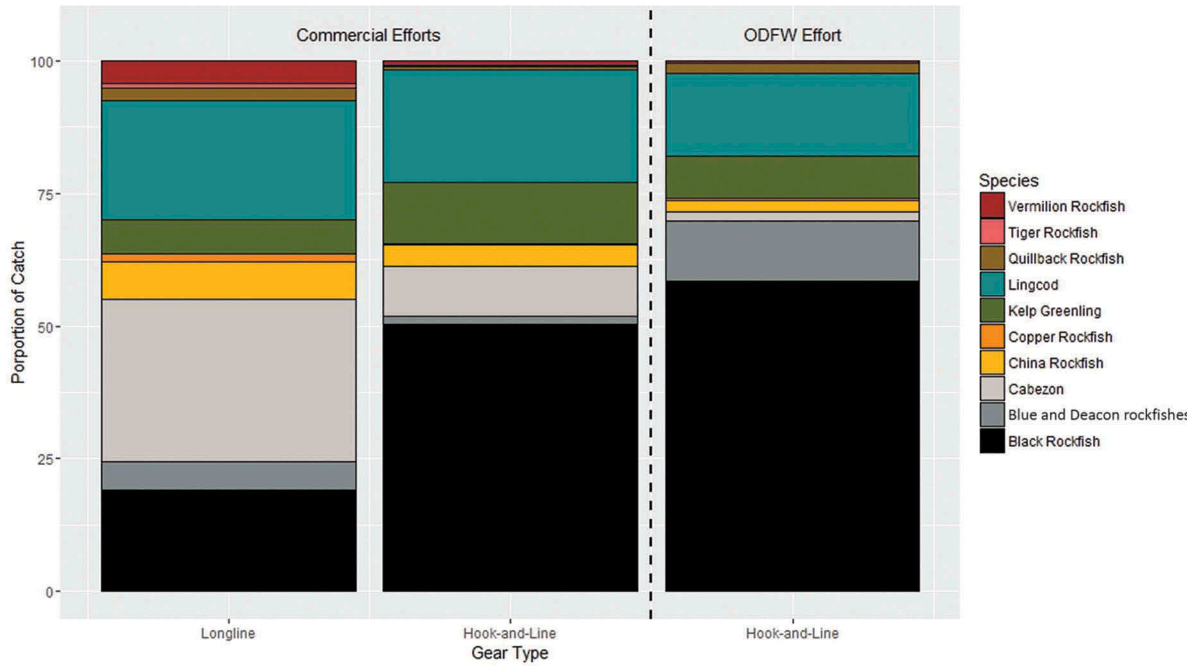

FIGURE 2. Catch composition of species comprising > 1% of the catch at Port Orford for commercial landings using longline and hook-and-line gear (left of dashed line) and ODFW Marine Reserve Program's landings using hook-and-line gear (right of dashed line) from 2011 to 2015. Yelloweye Rockfish and Canary Rockfish were listed as overfished during this period and could not be retained commercially; hence, they are absent from the commercial catch composition.

between the two gear types were comparable (longline mean ± SE = 54.17 ± 3.92 individuals/day; hook-and-line mean ± SE = 55.08 ± 8.23 individuals/day) and did not differ statistically (two sample *t*-test: *t*-ratio = –1.58, $P = 0.14$).

While the total number of fish landed was similar between the gear types, the species composition of those landed fish differed significantly among the gear types (analysis of similarity: global $R = 0.80$, $P < 0.01$). Sampling year only contributed to modest differences in catch composition (global $R = 0.24$, $P < 0.01$). Based on group-averaged clustering, the longline community composition and hook-and-line community composition exhibited 52% similarity within the gear types (Figure 3).

Species-specific catch rates per sampling day differed among the two gear types (Figure 4). Black Rockfish, the

TABLE 1. Size structure (fork length [FL] in cm) of the 12 species comprising > 1% of the catch from hook-and-line (HnL) and longline (LL) sampling. The *P*-values from Kolmogorov–Smirnov (K–S) tests comparing size-frequency distributions are shown, as are *P*-values from Wilcoxon tests comparing mean size for each species. Species highlighted in bold italics showed a significant difference in mean size and/or size-frequency distribution.

	Hook-and-line FL				Longline FL				K–S test	Wilcoxon rank-sum test	
Species	*N*	Range	Mean	SE	*N*	Range	Mean	SE	*P*-value	*P*-value	Comparison
Black Rockfish	331	19–56	41.01	0.23	130	32–51	41.47	0.31	0.385	0.504	
Blue and Deacon rockfishes	37	16–38	31.89	0.88	38	26–41	35.29	0.53	***0.017***	***0.001***	***HnL < LL***
Cabezon	9	36–63	52.44	3.57	78	36–78	55.12	0.85	0.262	0.676	
Canary Rockfish	53	20–42	30.77	0.81	106	26–60	40.00	0.73	***<0.001***	***<0.001***	***HnL < LL***
China Rockfish	19	31–41	35.68	0.61	39	29–46	36.79	0.53	0.410	0.154	
Copper Rockfish	5	39–55	48.60	3.14	38	32–53	44.87	0.81	0.354	0.217	
Kelp Greenling	66	24–48	36.88	0.39	18	32–47	38.33	0.87	0.377	0.234	
Lingcod	93	33–98	64.20	1.19	105	49–114	73.10	1.30	***<0.001***	***<0.001***	***HnL < LL***
Quillback Rockfish	15	17–46	30.87	2.12	39	23–50	38.92	1.00	***0.016***	***0.001***	***HnL < LL***
Tiger Rockfish	1	40–40	40.00		4	40–52	44.25	2.66			
Vermilion Rockfish	2	49–51	50.00	1.00	15	38–59	50.53	1.53	0.697	0.654	
Yelloweye Rockfish	16	19–64	37.06	2.28	28	29–62	40.93	1.62	***0.035***	0.167	

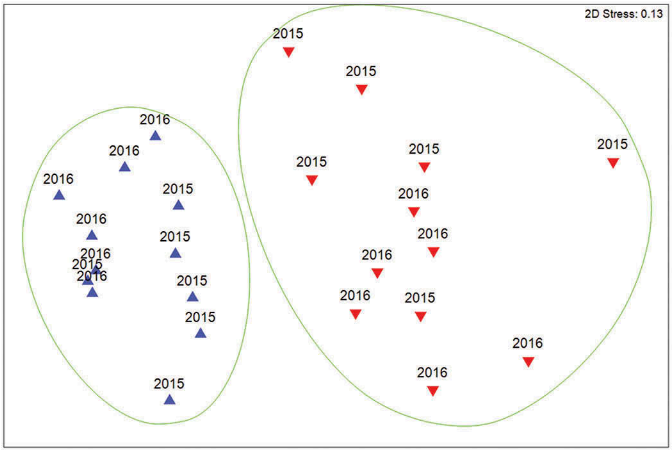

FIGURE 3. Nonmetric multidimensional scaling plot showing catch composition as standardized count data from hook-and-line (blue) and longline (red) fishing gear. Data were averaged for each sampling day (n = 12). Cluster overlays indicating 52% similarity in catch composition are shown in green.

dominant species observed, were more than twice as abundant in the hook-and-line catch as in the longline catch. Hook-and-line gear also caught significantly more Kelp Greenling *Hexagrammos decagrammus*. For the remaining 10 species, longline daily catch rates equaled or exceeded the hook-and-line catch rates. For several of the target species, including Cabezon, Copper Rockfish, and Vermilion Rockfish, this difference was significant (t-test or nonparametric Wilcoxon rank-sum test; $P < 0.05$).

The sizes of fish caught by the two gear types differed. In general, larger individuals were caught on the longline. For four different groups of species (Blue and Deacon rockfishes, Canary Rockfish, Quillback Rockfish, and Lingcod), this difference in mean size was significant (Table 1). Likewise, the size-frequency distributions of five fish species differed significantly between longline and hook and line (Table 1), though these differences were not consistent among the five species (Figure 5). For example, the size-frequency distribution for the Blue and Deacon rockfishes was negatively skewed for both gear types, with a greater proportion of large individuals sampled by the longline gear. For Canary Rockfish and Lingcod the size-frequency distributions were positively skewed for both gear types, with a greater proportion of large individuals sampled again by the longline gear. Quillback Rockfish were negatively skewed for longline only, sampling a higher proportion of larger individuals than hook and line. Yelloweye Rockfish longline size-frequency

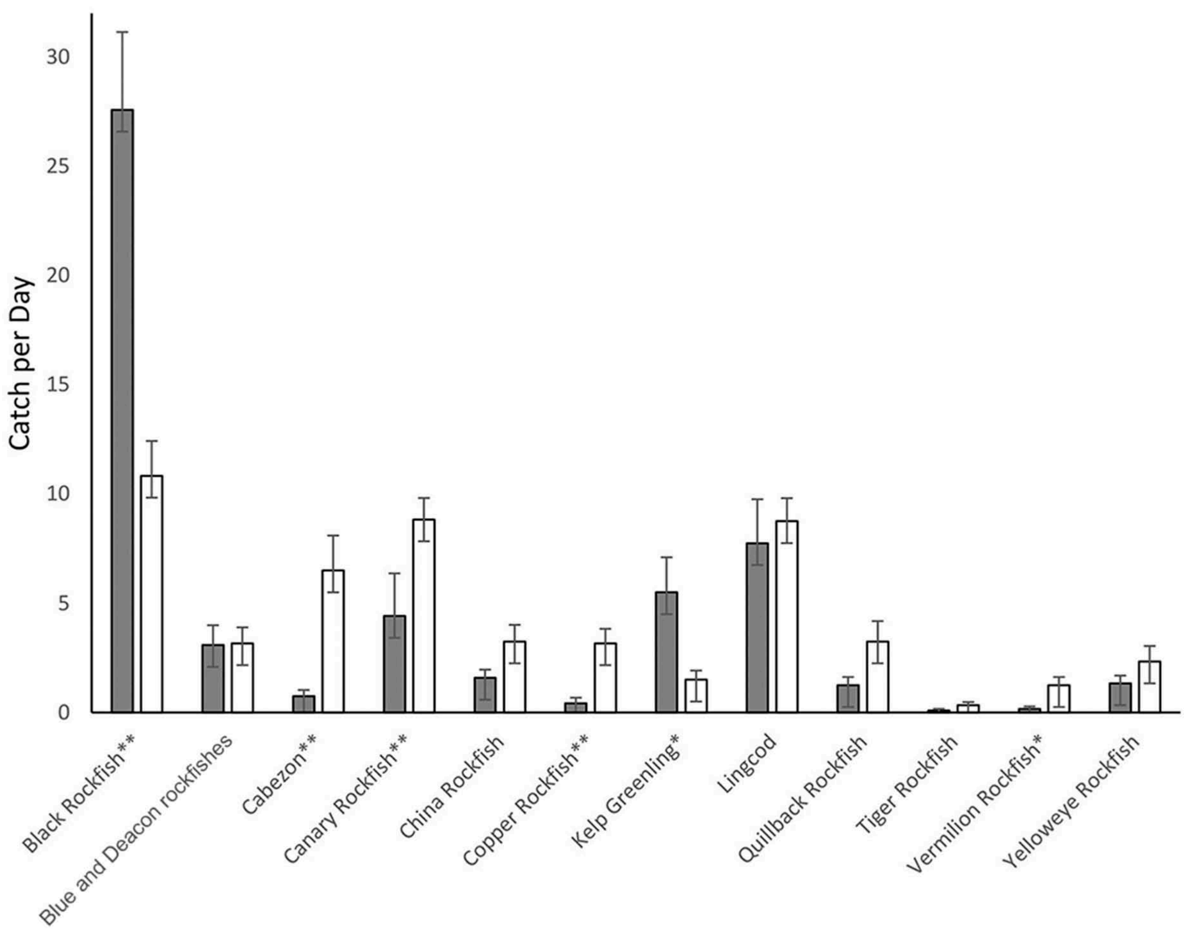

FIGURE 4. Mean catch per day (error bars show SE) between hook-and-line (gray bars) and longline (white bars) gear, calculated per sampling day (n = 12). One asterisk indicates $P < 0.05$ and two asterisks indicate $P < 0.01$ from a t-test or the nonparametric equivalent. Untransformed data are presented in the figure.

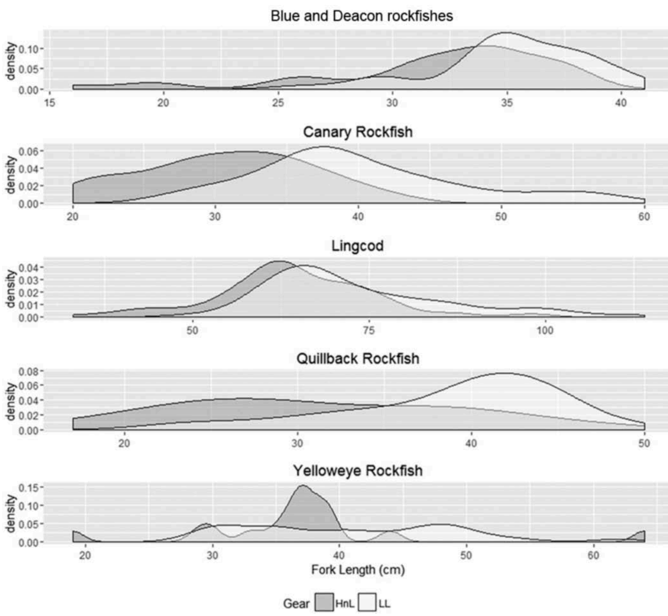

FIGURE 5. Smoothed density plots (kernal density estimates based on proportion of total) of size-frequency distributions for the species in bold from Table 1, showing significant differences between hook-and-line (HnL) and longline (LL) gear.

distributions sampled a broader size range more evenly than hook and line.

Fish Condition and Cost

Long-lining resulted in a higher incidence of hook damage (7%), bodily injury (3%), and death (3%) in the fish retrieved than hook-and-line gear (5%, 1%, and 0%, respectively). The mortality observed during long-lining was restricted to three species groups: Black Rockfish, Blue and Deacon rockfishes, and Canary Rockfish and was highest for the Blue and Deacon Rockfish complex (33% of individuals caught died, largely from predation events from Lingcod). Incidences of observed barotrauma symptoms among the rockfishes were lower for long-lining than for hook and line. Visible eye crystallization was observed in 3% of the longline catch compared with 5% from the hook-and-line catch. Esophageal eversion through the mouth was observed in 19% of the longline catch compared with 41% of the hook-and-line catch.

DISCUSSION

With the overarching goal of improving ODFW's ability to resolve ecological changes within the state's newly established system of marine reserves, this study illustrates how supplementing the existing hook-and-line monitoring surveys with longlines can expand the dataset for currently undersampled species that are targeted in the local fishery around Redfish Rocks Marine Reserve. We first identified differences in catch composition between the commercial landings in Port Orford (featuring higher proportions of China, Vermilion, Quillback, and Copper rockfishes as well as Cabezon) compared with the regional hook-and-line survey design (i.e., CCFRP methods) conducted in the same waters. These locally valued species include data-poor stocks (e.g., Quillback, Copper, and China rockfishes) that stand to benefit from additional fishery-independent data to improve species management. In addition, these species possess attributes, such as large maximum body size and nonobligate schooling behavior, that have been demonstrated to respond favorably to reserve protection (Claudet et al. 2010). Hence, there is a need to ensure that the marine reserve monitoring efforts for Redfish Rocks Marine Reserve sample these species of interest. We then showed that longline gear can be successfully used in a catch-and-release approach to increase sampling of these target species.

Daily catch rates of nearshore rocky reef fish species were higher for longline than for hook-and-line gear for all but two species (Black Rockfish and Kelp Greenling). Greater effort could be employed to increase the number of longline sets per day, or increase the drift duration or number of anglers fishing during hook-and-line sampling, to alter these catch rates. However, we used a five-person sampling team for an 8-h day for both methods, working efficiently to ensure that the sample sizes completed in each day (six longline sets and five hook-and-line cells) were the equivalent of using each method alone during a sampling day with the same size crew in 8 h. It is worth noting that despite the small sample size of this study ($n = 12$), we were able to detect several significant differences in catch composition and the size of individuals landed between the gear types. This reflects the large differences between (and/or small variance within) the gear types, which resulted in high statistical power (e.g., avoidance of type II errors in which significant differences are not detected when they are truly present). Larger sample sizes may reveal further significant differences for some species such as Quillback Rockfish and China Rockfish that show trends of greater catch rates from longline but for which significance was not attained. The greater catch rates of demersal and solitary species may have been influenced by the position of the longline gear along the bottom, as many of these species are found on the bottom or hovering slightly above the bottom. Also, the longline gear was both baited and had a longer soak time than hook and line, which can allow fish to aggregate near the longline and result in overestimates of population size because of attraction to bait (Grimes et al. 1982). Species such as Cabezon, China Rockfish, and Quillback Rockfish primarily prey on benthic organisms and would have a greater chance of encountering the bait than species that prey on midwater species. Accordingly, the lower catch of Black Rockfish, a schooling species that frequently occupies the water column, was expected as longline gear is optimized for sampling benthic species. In contrast, hook-and-line gear is deployed repeatedly through the water column over the course of the drift to reset the gear, increasing the encounter rates with midwater species. Correcting for the influence of baited fishing and soak duration on fish catchability will be necessary to generate improved estimates of population size from demersal longline CPUE.

Longline gear selected for larger individuals for some species, but this was not consistent among functional groups or families. It is worth considering the value of longlines to sample the larger, presumably older, individuals from the population given the disproportionate role of so-called BOFFFs (big old fat fecund females; Hixon et al. 2014) to fish population structures, both in the context of marine reserve performance and for informing fisheries management. Differences in size structure between the two gear types may be driven by hook size selectivity, as the longline surveys used larger hooks than hook and line. For example, longlines likely limited catches of Kelp Greenling due to the small mouth size of this species and therefore represented a truncated size structure of this species. Yet, for most species, the size ranges from longline often exceeded the range generated from hook-and-line sampling offering a broader glimpse of the population size structure.

This study demonstrates that longlines, though not commonly used in catch-and-release research efforts due to concerns of fish injury or mortality (but see Starr et al. 2000) can supplement current catch-and-release fishery-independent efforts when monitoring nearshore species. To our knowledge, this study is the first to use modified commercial longline gear as a catch-and-release method for marine reserve monitoring. Admittedly, injury and mortality rates were somewhat higher with the longline sampling, though this was limited to only a few species. However, incidence of barotrauma among rockfish species was much lower in the longline catch compared with hook-and-line sampling. This may be in part due to differing rates of acclimation among species (Hannah and Matteson 2007) and the slower retrieval rates of the longline (compared with the rapid reeling up of fish caught on hook-and-line gear), which may allow for a longer acclimation period. As barotrauma reduces the survival rates of released fish, longlines may have an advantage over hook-and-line sampling in postrelease survival rates. Future efforts could experiment with shorter soak times (60–90 min) in an attempt to improve fish condition or with sample timing to sample during the time when large female Lingcod migrate offshore since nearly all observed mortality was attributed to Lingcod predation. Lastly, long-lining may not be suitable in all areas, such as shallow waters or around kelp forests, and would require a knowledgeable longline captain and crew to safely execute.

While numerous studies exist to guide marine reserve placement and implementation, comparatively few studies have been conducted to inform best practices for how to evaluate the performance of these reserves (but see Underwood 1994; Lincoln-Smith et al. 2006; Claudet and Guidetti 2010; Huntington et al. 2010). Marine reserves within the northeastern Pacific Ocean vary greatly in their physical and ecological characteristics as well as their socioeconomic contexts, making it unlikely that a single study design or survey tool will be applicable to all of these areas (Fraschetti et al. 2002). This investigation underscores the need to consider regionally standardized, long-term monitoring approaches in conjunction with locally tailored efforts to generate robust data for detecting marine reserve effects at both local and regional spatial scales. Indeed, Gunderson et al. (2008) argues that the management of productive temperate reefs must be organized on very small spatial scales in order to be effective. We suggest that marine reserve monitoring in temperate reef habitats should parallel management, considering the local scale within a larger regional framework. Here, we demonstrate the value of understanding the local fishery and then using local commercial catch data to assess whether existing marine reserve monitoring data are capturing the species of value in this fishery. From our findings from this assessment and the gear comparison, we suggest that fishery-independent surveys for Oregon's southernmost marine reserves would benefit from a hybrid approach incorporating longline and hook-and-line survey methods. Both methods can be simultaneously and cost-effectively collected from a single commercial fishing vessel. Furthermore, longline surveys, which have greater selectivity for solitary, demersal nearshore species, can serve as an important source of both size and abundance data to help manage these data-poor species. Lastly, we reiterate the need to critically evaluate long-term monitoring protocols early in the marine reserve implementation process. As the marine reserve program in Oregon is still in its infancy, now is the time to improve and revise ecological monitoring best practices for this long-term management strategy.

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