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ARTICLE

Variation in the Effective Range of a Stereo-Video Lander in Relation to Near-Seafloor Water Clarity, Ambient Light and Fish Length

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Abstract
We studied how variation in seafloor water clarity, ambient light, and fish fork length influenced the maximum detection range of fish with a stereo-video lander on three temperate reefs of different depths (12–40, 44–91, and 144–149 m). Although the results are somewhat approximate and specific to the camera system, the methods we used can be applied to any stereo remote underwater visual survey system. In the 52 total lander deployments distributed between nearshore, mid-shelf and deep-shelf reefs in Oregon waters, seafloor light levels varied over 4 orders of magnitude, primarily as a function of depth. The seafloor scattering index was higher (low water clarity) and highly variable at the nearshore reef and lower (high water clarity) and less variable at the deeper reefs. In the 15 deployments with sufficient numbers of fish for detection range analysis, the mean maximum range of detection across species varied from 3.89 to 4.23 m at the deep-shelf reef, 3.32–5.55 m at the mid-shelf reef, and 1.57–3.42 m at the nearshore reef. Multiple regression analysis of the analyzed deployments showed a strong negative relationship between mean maximum detection range and the scattering index but no relationship with $\log_e$ of seafloor ambient light. The lack of a light effect showed that the artificial lights were adequately illuminating the field of view in which fish were identifiable, potentially an important system test for sampling across a range of seafloor light levels. Analysis of detection range versus fish fork length for Blue Rockfish *Sebastes mystinus* and Deacon Rockfish *S. diaconus* from a single deployment showed a reduction in detection range for 10–20-cm fish of about 1.15 m relative to the detection range of 25–45-cm fish, or about 41%.

Baited or unbaited remote underwater video stations (RUVs) are increasingly being used to sample reef fish populations (Murphy and Jenkins 2010; Mallet and Pelletier 2014; Campbell et al. 2015). Typically, RUVs are point-sampling systems that are deployed to the seafloor to record for a set period of time and then retrieved. Although originally developed primarily to study demersal fish populations (Ellis and DeMartini 1994; Gledhill et al. 1996), RUVs are now also being used for pelagic fish populations (Rees et al. 2015). As the use of RUVs has grown, progress has been made on better methods to standardize analysis of the video obtained (Bacheler and Shertzer 2013; Schobernd et al. 2014; Campbell et al. 2015). Research has also evaluated the relative strengths, weaknesses, and costs of RUVs in comparison with more traditional sampling methods, such as direct underwater visual census and capture-based survey gears (e.g., Brooks et al. 2011; Harvey et al. 2007; Mallet et al. 2014). Some of the comparative studies suggest combining RUV data with

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data from baited RUVs (BRUVS) or other sampling techniques to obtain a more comprehensive view of fish diversity and abundance (Bernard and Gotz 2012; Mallet and Pelletier 2014; Mallet et al. 2014). One difficulty in combining data from various visual survey tools is that the area surveyed with single-camera RUVs is frequently unknown (Murphy and Jenkins 2010). However, the development of stereo-video systems for RUVs creates the potential to quantify the area viewed, at least approximately, and produce fish density estimates (Harvey et al. 2004; Hannah and Blume 2014). This would primarily be the case of course, for RUVs used without bait or other attractants.

Although RUVs have been utilized across a very wide range of depths (Ellis and DeMartini 1994; Hannah and Blume 2012; Easton et al. 2015), for obvious reasons they have been utilized mostly in areas with consistently good water clarity, and often, in areas with high levels of ambient light on the seafloor. Recently, RUVS designed specifically for remote deployment into very rugged and deep rocky habitat have been developed and tested on temperate reefs in waters off of Oregon, where seafloor water clarity can be highly variable and ambient light levels on the seafloor can also vary greatly (Hannah and Blume 2012, 2014; Easton et al. 2015). The use of RUVs in highly variable seafloor conditions raises the question of how changes in water clarity and the availability of ambient light between different depths may be influencing the range of fish detection. We field-tested an approach to measuring the effective detection range of a stereo-video lander system and evaluated how this metric was influenced by seafloor water clarity and ambient light levels encountered at different depths, as well as by fish size. It should be noted that the detection ranges we estimated are specific to the RUV system we employed. The detection range of other systems will vary with the system components chosen, for example, due to differences in camera resolution and light sensitivity, focal length and other chosen settings, as well as the brightness and color of any artificial lights used. The brief analysis presented here is primarily a demonstration of one successful approach to investigating the effects of variation in seafloor conditions and fish length on detection range using a stereo-video system.

METHODS

Study area.—This study was conducted in marine waters off of Newport, Oregon. The reefs sampled (Figure 1) included a nearshore reef (Seal Rocks; depth, 12–40 m), a mid-shelf reef (Stonewall Banks; 44–91 m) and a deep-shelf reef (Enterprise Reef; 144–149 m).

Field methods.—To evaluate how the effective range of our stereo-video lander (Figure 2) varied as a function of changes in seafloor conditions often associated with reef depth, we deployed it at several reef locations between September 8, 2014, and January 3, 2015. All sampling was conducted during daylight hours on the 15-m F/V *Enterprise*, out of Newport, Oregon. Duration of the individual deployments varied from 6 to 15 min. At each site, we used the vessel's echo sounder to locate areas with large numbers of fish and then attempted to deploy the stereo-video lander directly into the chosen spot, which typically took several attempts before useful footage was obtained. The overall goal was to record stereo-video footage that encompassed a wide range in seafloor water clarity and ambient light levels and included large numbers of fish of different species and sizes at varied distances from the lander system.

During each lander deployment, we collected information on seafloor ambient light and water clarity. Seafloor ambient light (μmol photons·m^{-2}·s^{-1}) at each deployment site was measured with a cast of a weighted frame holding a Wildlife Computers TDR-MK9 tag incorporating a light meter. The light meter was oriented upwards, and each cast was conducted after drifting away from the lander deployment site to prevent influence on the meter reading from the video lander lights. Light and depth measurements were collected by the MK9 at 1-s intervals. Prior to field sampling, the TDR-MK9 was calibrated using an International Light IL1700 light meter and PAR sensor. The function used to convert the MK9 relative light units to irradiance units was

$$y = 3.8874 \times 10^{-7} x e^{0.096088x}, \tag{1}$$

where x is the relative light unit from the MK9 and y is the corresponding irradiance value in μmol photons·m^{-2}·s^{-1}.

To measure seafloor water clarity, we used a Wetlabs ECO-BBB scattering meter (Figure 2) that measured the backscatter, i.e., attenuation of 650 nm light (m^{-1}·sr^{-1}). Initially, we deployed the scattering meter via vertical casts on the same frame as the light meter. Part way through the study, we moved it to an attachment spot on the stereo-video lander frame, to better protect it (Figure 2). The scattering meter was also set to record data at 1-s intervals. For the cast data, we calculated a 3-s average value for light and scattering surrounding the time of maximum depth. For backscatter measurements with the meter attached to the video lander, we calculated a 3-min average of 1-s scattering values, beginning 2 min after the lander reached the seafloor. This 2-min delay was incorporated to allow any sediment that was disturbed by the lander hitting the seafloor time to settle. We refer to these two types of mean values for scattering hereafter as the scattering index.

Stereo-video lander system.—The stereo-video lander system (Figure 2) we used was almost identical to the system detailed in Hannah and Blume (2014). Briefly, the system utilized two high-definition Canon Vixia HFS21 video cameras in waterproof housings and equipped with wide-angle adapters and two Deep Sea Power and Light Sealite Spheres (3200 lm, 5650 Kelvin, 75° beam width) for illumination. The

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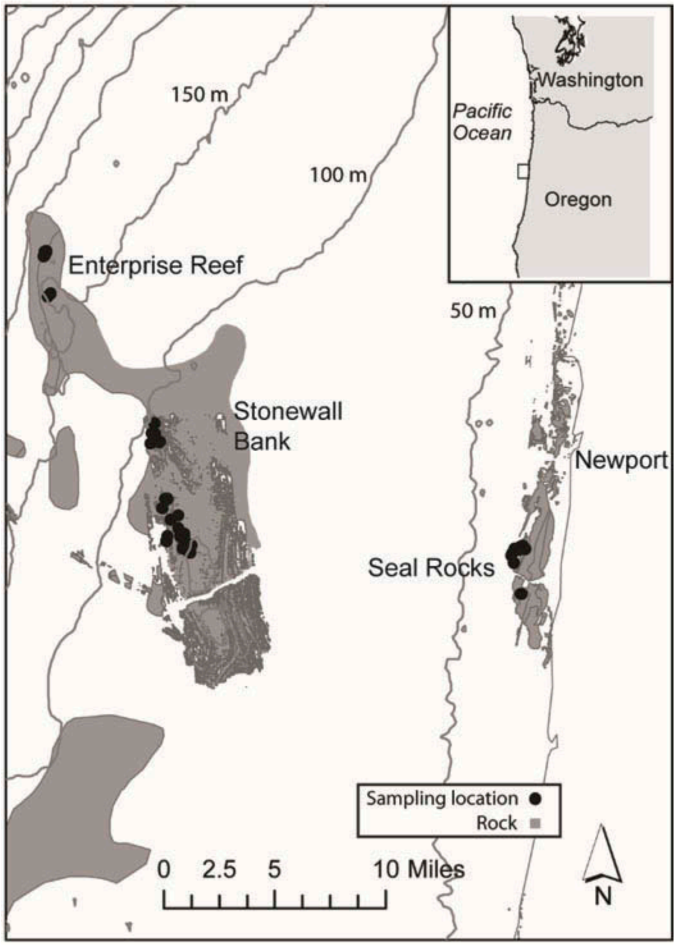

FIGURE 1. Coastal Oregon reefs that were sampled with the stereo-video lander. Shaded area is a composite of classified habitat including rock, boulder, and rock mix (Goldfinger et al. 2014). The 50-m to 150-m depth contours are depicted.

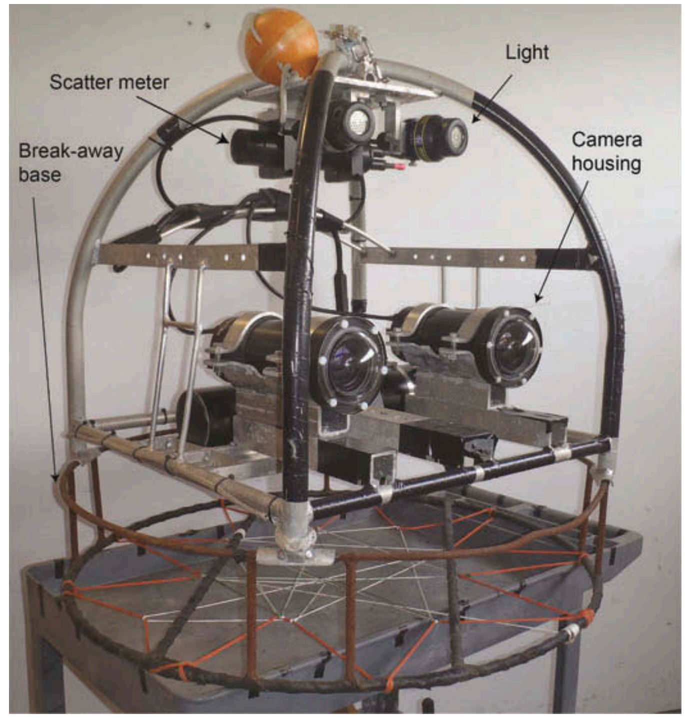

FIGURE 2. Photograph of the stereo-video lander used to determine effective range as related to identification of reef fish species in coastal Oregon, as well as the location of the scattering meter.

camera housings were fixed at a 40.3-cm baseline (center to center) and aimed inwards at a 4° angle. Each camera was set to "progressive scan," at 24 frames/s and a shutter speed of 1 cs. Prior to each deployment, we filmed a digital stopwatch with a readout in centiseconds with the stereo-video system so that the two video feeds could be later synchronized to the individual frame. In this study, we did not use bait or the bait support pole used by Hannah and Blume (2014). Calibration of the stereo-video system was completed using the Matlab (version R2011a) camera calibration toolbox (Bouget 2008) available online.

Video and statistical analysis.—The video footage and the data on scattering index and ambient light were reviewed to select deployments that included large numbers of fish targets and varied seafloor conditions. The video footage from each selected deployment was then imported into Adobe Premiere Pro CS5.5 so that it could be easily reviewed on a full-size computer screen. For each video deployment, paired, synchronized frames of identifiable fish targets were saved from the video feeds. The distance to each target was then estimated using the program *Sebastes* (Kresimir Williams, National Marine Fisheries Service, personal communication), a graphical user interface for measuring fish size and range via stereo-camera image pairs and the camera calibration parameters. Next the maximum range of detection was noted for each species observed in a deployment, and an average of these values was calculated across all species encountered during that deployment. This was considered an estimate of the mean maximum range of fish detection for that set of seafloor conditions. The relationship between mean maximum detection range and $\log_e$ seafloor ambient light and the scattering index was then analyzed graphically and using multiple linear regression.

We also evaluated how fish length, within a species group, influenced detection range. We conducted this analysis on a single lander deployment at the nearshore reef that captured video of a large mixed-size school of rockfish *Sebastes* spp. This school contained large numbers of the two cryptic species previously called Blue Rockfish *S. mystinus*, including the actual Blue Rockfish *S. mystinus*, as well as large numbers of the Deacon Rockfish *S. diaconus* (Frable et al. 2015). For this analysis, we graphed the maximum range estimate for each 3 cm fork length interval. To demonstrate something akin to a selectivity function for the stereo lander, we also

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fitted a linear regression to these data. Although our study was not designed to investigate differences in maximum detection range between fish species, we present some data for a few common shelf species that also demonstrate a species effect on detection range.

RESULTS

The stereo-video lander was deployed 52 times at the three chosen reef areas (Figure 1). This included 8 deployments at the deep-shelf reef, 31 deployments at the mid-shelf reef, and 13 deployments at the nearshore reef. The seafloor ambient light levels ($\log_e$ light) encountered in these 52 deployments ranged more than four orders of magnitude, decreasing from the nearshore reef to the deep-shelf reef (ANOVA: $P < 0.0001$; Figure 3, upper panel). The scattering index was higher and highly variable at the nearshore reef and generally lower and much less variable at both offshore (deeper) locations (Figure 3, lower panel; photo examples shown in Figure 4).

From these 52 deployments, 15 had large numbers of fish visible at a variety of ranges, allowing full analysis of the range of detection, including 3 at the deep reef, 6 at the mid-shelf reef and 6 at the nearshore reef (Table 1). The 15 analyzed deployments captured a range of conditions of ambient light similar to the larger group of 52 deployments (Table 1; Figure 3), but a somewhat narrower range of the scattering index because fish were not present in the lone deployment with a scattering index above 500. The general

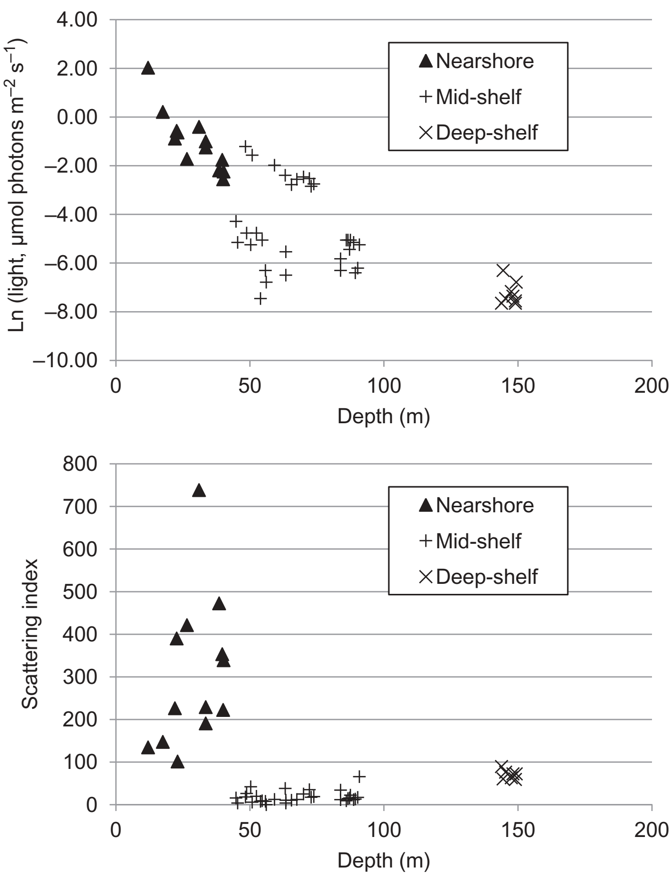

FIGURE 3. Measured values of seafloor ambient light (upper panel) and light scattering index (lower panel; attenuation of 650 nm light ($m^{-1}\cdot sr^{-1}$) versus depth for the three reef areas sampled with a stereo-video lander.

FIGURE 4. Images illustrating variation in water clarity and the light scattering index (see Figure 3) at two of the coastal Oregon reef sites sampled with a stereo-video lander. Upper panel shows excellent seafloor water clarity with very low ambient light at the deep-shelf reef, the middle panel shows poor water clarity with moderate light levels at the nearshore reef, and the bottom panel shows moderate water clarity with high ambient light at the nearshore reef.

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TABLE 1. Estimates of mean maximum detection range of a stereo-video lander for individual lander deployments at nearshore, mid-shelf and deep-shelf reefs off of Newport, Oregon, September 2014 through January 2015. The seafloor scattering index is attenuation of 650 nm light ($m^{-1}\cdot sr^{-1}$), and $\log_e$ of ambient seafloor light is $\log_e$(μmol photons$\cdot m^{-2}\cdot s^{-1}$).

Deployment	Number of species viewed	Depth (m)	Scattering index	Log_e ambient light	Maximum detection range (m)	
					Mean	SE
			Nearshore reefs			
1[a]	4	23.0	101.25	–0.635	3.42	0.48
2	2	12.0	138.39	2.026	2.52	0.26
3	3	22.0	231.47	–0.885	2.76	0.16
4	2	40.2	293.12	–2.240	2.04	0.11
5	1	39.7	299.22	–1.760	2.23	–
6	3	38.5	483.84	–2.192	1.57	0.21
Mean		29.2	257.88	–0.948	2.42	0.26
			Mid-shelf reefs			
1	5	48.3	14.06	–1.212	5.55	0.82
2	4	56.1	0.00	–6.785	3.79	0.18
3	3	55.8	7.90	–6.305	4.54	0.49
4	3	54.6	9.22	–5.055	3.32	0.52
5	3	72.2	86.56	–2.528	3.92	0.48
6	3	65.5	10.87	–2.778	4.83	0.39
Mean		58.8	21.43	–4.111	4.33	0.33
			Deep-shelf reefs			
1	3	143.9	89.53	–7.650	3.89	0.14
2	5	149.0	59.25	–7.554	4.23	0.35
3	3	149.4	72.42	–7.362	4.13	0.15
Mean		147.4	73.73	–7.522	4.08	0.10

[a]Deployment analyzed for Blue and Deacon rockfish range versus fork length (cm).

pattern of variation observed in seafloor ambient light and the scattering index as a function of depth in the 52 total deployments was also reflected in the 15 analyzed deployments (Table 1). At the nearshore reef, ranges were measured for numerous Black Rockfish *S. melanops*, both of the cryptic blue rockfishes treated as a species group, as well as Canary Rockfish *S. pinniger*, Lingcod *Ophiodon elongatus*, Kelp Greenling *Hexagrammos decagrammus*, and Pile Perch *Damalichthys vacca*. At the mid-shelf reef, ranges were measured for Deacon Rockfish, Canary Rockfish, Yellowtail Rockfish *S. flavidus*, Quillback Rockfish *S. maliger*, Vermilion Rockfish *S. miniatus*, Rosethorn Rockfish *S. helvomaculatus*, Yelloweye Rockfish *S. ruberrimus*, Lingcod, Kelp Greenling, and Spotted Ratfish *Hydrolagus colliei*. At the deep-shelf reef, fewer species were observed and ranges were measured for just Canary Rockfish, Yellowtail Rockfish, Widow Rockfish *S. entomelas*, Lingcod, and Spotted Ratfish.

Mean maximum range of detection at the deep-shelf reef averaged 4.08 m and varied from 3.89 to 4.23 m (Table 1; Figure 5). At the mid-shelf reef, where depth was also more variable, maximum detection range varied from 3.32 to 5.55 m and averaged 4.33 m (Table 1). At the nearshore reef, maximum detection range was lower and much more variable, ranging from 3.42 m down to just 1.57 m. A significant difference in detection range between reefs was noted (ANOVA: $P < 0.05$) and attributed to the lower detection range at the nearshore reef (Tukey–Kramer: $P < 0.05$). Multiple regression analysis showed that, across all analyzed deployments, mean maximum detection range had a strong negative relationship with the scattering index ($P < 0.001$) but no relationship with $\log_e$ of seafloor ambient light ($P > 0.05$, Table 2; Figure 5). Residuals from this model were normally distributed ($P > 0.05$).

The pattern of maximum detection range versus 3-cm fish length interval for Blue and Deacon rockfish (Figure 6, nearshore deployment 1) showed that the range of detection for smaller, juvenile fish was markedly lower than for adult-sized fish. Blue and Deacon rockfish between 10 and 20 cm FL were identifiable out to about 1.5–1.8 m, while under the same conditions, 25–45 cm fish were identifiable out to 2.6–3.0 m. This represents a reduction in detection range of about 1.15 m or about 41%. The one higher range estimate of 3.6 m shows that occasionally one or more fish are identifiable and measurable at ranges beyond the typical range of detection, in this case about 2.5–3.0 m (Figure 6).

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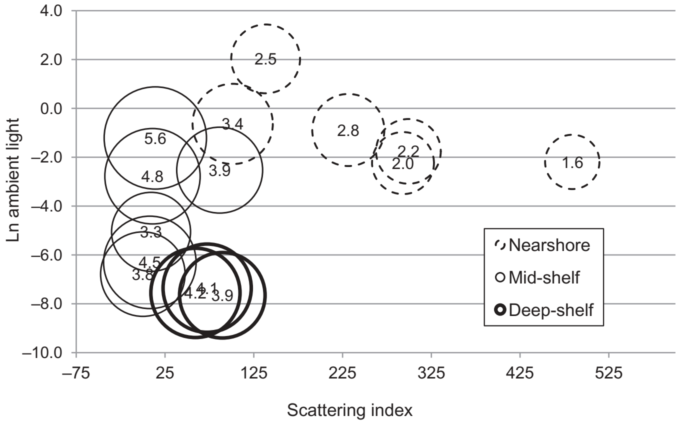

FIGURE 5. Bubble plot showing the joint effects of variation in seafloor ambient light (µmol photons·m^{-2}·s^{-1}) and the scattering index (attenuation of 650 nm light [m^{-1}·sr^{-1}]) on the estimated maximum range of fish detection in the 15 analyzed deployments (bubble area and value labels depict range in m) at the three coastal Oregon reef sites sampled with a stereo-video lander.

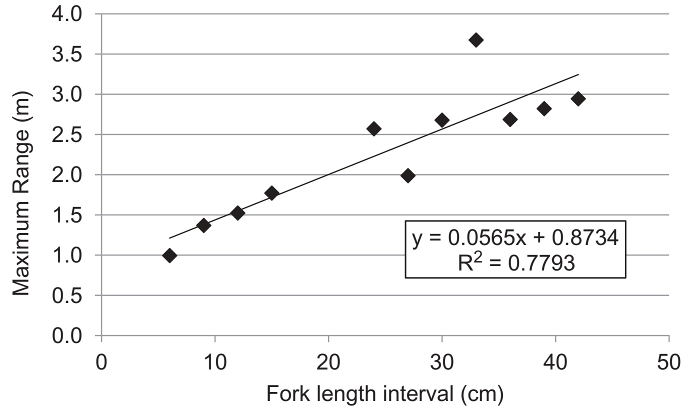

FIGURE 6. Relationship between 3-cm FL intervals (N = 84) and the maximum estimated range from the stereo-camera baseline for that interval for Blue Rockfish and Deacon Rockfish sampled with the stereo-video lander system shown (see Figure 2) in deployment 1 at the nearshore reef (see Table 1).

TABLE 2. Results of multiple regression analysis of mean maximum fish detection range (N = 15) on seafloor ambient light and scattering (see Table 1), as tested on coastal Oregon reefs.

Dependent variable	Parameter or variable	Coefficients	SE	R^2	$P > F$
Mean maximum fish detection range (m)	Intercept	4.2757	0.3559		0.0001
	Ambient light	–0.0208	0.0603		0.7360
	Scattering index	–0.0066	0.0013		0.0003
Full model				0.732	0.0004

A linear regression of maximum detection range on fork length interval was statistically significant ($P < 0.05$; Figure 6), demonstrating a length effect. It should be noted that it's unlikely that the effect of fork length on maximum detection range is inherently linear.

The lack of a strong influence of the scattering index or ambient light on mean detection range at the mid-shelf or deep-shelf reefs (Figure 5) suggests that within those two reef areas (Figure 1), variation in detection range can be compared between species. For the 4 species present in at least five deployments at these reef areas, maximum detection range did vary significantly between species (Table 3; ANOVA, $P < 0.05$), Yelloweye Rockfish being detected on average out to a range of 5.3 m, while Lingcod were detected out to an average range of just 3.9 m (Tukey–Kramer: $P < 0.05$).

DISCUSSION

Video landers have the potential to help with the problem of surveying groundfish species inhabiting untrawlable habitats but will not be as effective as other established sampling tools, like remotely operated vehicles, until methods can be found to better quantify the densities of fish observed. Our study demonstrates one method for obtaining quantitative estimates of fish density from a stereo-video lander, by measuring the maximum range of fish detection under a variety of seafloor conditions, which can be related to the area viewed using physical measurements of the view width from tank studies. Identifying the effect of fish length on lander range of detection (Figure 6) can be used in combination with fish counts and the relationship between area viewed and range to calculate different density estimates for fish of different sizes. This approach, with enough data, could also be implemented at a species level. The range estimates we developed are, however, by their nature, approximate. Some of our analyzed deployments may not have encountered enough fish at, and just beyond, the maximum range of detection to generate highly accurate estimates of maximum range. In some instances, single specimens of a species did not occupy a location out near the maximum detection range, reducing the mean detection range estimate for that deployment. Utilizing longer deployment times might help with this problem for low-abundance species. However, the problem is more basic

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TABLE 3. Comparison of the mean maximum detection range and standard error for four fish species detected in at least five of the nine mid-shelf and deep-shelf video-lander deployments tested on coastal Oregon reefs. Asterisk denotes significant differences in a Tukey–Kramer test following significant ANOVA ($P < 0.05$).

Species	Number of maximum range estimates	Mean maximum detection range	Standard error
Lingcod*	6	3.92	0.26
Yellowtail Rockfish	6	4.23	0.34
Canary Rockfish	6	4.32	0.30
Yelloweye Rockfish*	5	5.28	0.26

because fish have different markings, habits, shapes, and colorations, making some quite distinctive and easy to identify via video and others more difficult. In this study, Yelloweye Rockfish were detectable at a greater range than Lingcod in mid-shelf and deep-shelf deployments, most likely due to the drab, mottled coloration of Lingcod compared with the distinctive coloration and shape of Yelloweye Rockfish. Similarly, a distinctive fish such as a Tiger Rockfish *Sebastes nigrocinctus* might be identifiable with just its head in the field of view, at a distance of 6 m, while it may not be possible to distinguish a Vermilion Rockfish *S. miniatus* from a Canary Rockfish until it is within 3.5 m and is oriented in a way that the entire body profile can be clearly seen. This variability, however, is similar to the variable catchability that has been documented across species, fish size, and environmental conditions for other, capture-based sampling gears (e.g., Pennington and Godø 1995; Weinberg et al. 2002; Lauth et al. 2004).

Our study also shows that for reefs off of Oregon, especially nearshore reefs, water clarity may be an important source of variation in the range of fish detection. It also suggests that measuring seafloor light scattering in combination with lander video footage may allow for some ability to control for variation in water clarity when analyzing fish-count data. Our finding of no measurable effect of seafloor ambient light on the maximum range of fish detection across depth was unexpected. Our expectation of a light effect was based on the fact that even a cursory review of video lander footage with and without abundant ambient light shows that a larger area can be viewed with higher levels of ambient light (Figure 4). However, identifying fish from video footage requires more than just being able to see the fish; it must be visible in enough detail for identification, which is also influenced by the focal length setting of the camera (e.g., wide or telephoto). The lack of a light effect on range of detection in our study indicated that our lights and camera settings were well matched for working across a wide range in seafloor ambient light levels. It suggests that the field of view within which our cameras could provide sufficient detail for fish species identification was also adequately illuminated in the absence of ambient light. The approach we used to evaluate evidence for an ambient light effect on effective range may be an advisable visual system test, specifically for the purpose of determining if the artificial lights of an underwater video system are adequate for use across a wide range of seafloor ambient light levels.

The information and approach presented here should aid in the development of more quantitative use of stereo-video lander fish-count data on temperate reefs with variable water clarity. However, fully developing the potential of video landers as low-cost underwater visual sampling platforms will require additional study. An understanding of the size-selectivity of video landers across multiple target species is also needed and may be most important for demersal habitats that harbor both juvenile and adult fish of a given species. More information on the behavior of individual species with respect to the presence of a lander system, as has been developed for diver-based visual transect data (Bozec et al. 2011) would also be beneficial.

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REFERENCES

Bacheler, N. M., and K. W. Shertzer. 2013. Estimating relative abundance and species richness from video surveys of reef fishes. U.S. National Marine Fisheries Service Fishery Bulletin 113:15–26.

Bernard, A. T. F., and A. Gotz. 2012. Bait increases the precision in count data from remote underwater video for most subtidal reef fish in the warm-temperate Agulhas bioregion. Marine Ecology Progress Series 471:235–252.

Bouget, J. Y. 2008. Camera calibration toolbox for Matlab. Available: http://www.vision.caltech.edu/bouguetj/calib_doc/. (April 2011).

Bozec, Y., M. Kulbicki, F. Laloë, G. Mou-Tham, and D. Gascuel. 2011. Factors affecting the detection distances of reef fish: implications for visual counts. Marine Biology 158:969–981.

Brooks, E. J., K. A. Sloman, D. W. Sims, and A. J. Danylchuk. 2011. Validating the use of baited remote underwater video surveys for assessing

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the diversity, distribution and abundance of sharks in the Bahamas. Endangered Species Research 13:231–243.

Campbell, M. D., A. G. Pollack, C. T. Gledhill, T. S. Switzer, and D. A. DeVries. 2015. Comparison of relative abundance indices calculated from two methods of generating video count data. Fisheries Research 170:125–133.

Easton, R. R., S. S. Heppell, and R. W. Hannah. 2015. Quantification of habitat and community relationships among nearshore temperate fishes through analysis of drop camera video. Marine and Coastal Fisheries: Dynamics, Management and Ecosystem Science [online serial] 7:87–102.

Ellis, D. M., and E. E. DeMartini. 1994. Evaluation of a video camera technique for indexing abundances of juvenile Pink Snapper *Pristipomoides filamentosus*, and other Hawaiian insular shelf fishes. U. S. National Marine Fisheries Service Fishery Bulletin 93:67–77.

Frable, B. W., D. W. Wagman, A. Aguilar, and B. L. Sidlauskas. 2015. A new species of *Sebastes* (Scorpaeniformes: Sebastidae) from the northeastern Pacific, with a redescription of the Blue Rockfish, *S. mystinus* (Jordan and Gilbert, 1881). U.S. National Marine Fisheries Service Fishery Bulletin 113:355–377.

Gledhill, C. T., J. Lyczkowski-Shultz, K. Rademacher, E. Kargard, G. Crist, and M. A. Grace. 1996. Evaluation of video and acoustic index methods for assessing reef-fish populations. ICES Journal of Marine Science 53:483–485.

Goldfinger, C., S. K. Henkel, C. Romsos, and B. Havron. 2014. Benthic habitat characterization offshore the Pacific Northwest volume 1: evaluation of continental shelf geology. U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific Outer Continental Shelf Region, OCS Study BOEM 2014-662, Camarillo, California.

Hannah, R. W., and M. T. O. Blume. 2012. Tests of an experimental unbaited video lander as a marine fish survey tool for high-relief deepwater rocky reefs. Journal of Experimental Marine Biology and Ecology 430–431:1–9.

Hannah, R. W., and M. T. O. Blume. 2014. The influence of bait and stereo video on the performance of a video lander as a survey tool for marine demersal reef fishes in Oregon waters. Marine and Coastal Fisheries: Dynamics, Management and Ecosystem Science [online serial] 6:181–189.

Harvey, E., D. Fletcher, M. R. Shortis, and G. A. Kendrick. 2004. A comparison of underwater visual distance estimates made by scuba divers and a stereo-video system: implications for underwater visual census of reef fish abundance. Marine and Freshwater Research 55:573–580.

Harvey, E. S., M. Cappo, J. J. Butler, N. Hall, and G. A. Kendrick. 2007. Bait attraction affects the performance of remote underwater video stations in assessment of demersal fish community structure. Marine Ecology Progress Series 350:245–254.

Lauth, R. R., J. Ianelli, and W. W Wakefield. 2004. Estimating the size selectivity and catching efficiency of a survey bottom trawl for thornyheads, *Sebastolobus* spp. using a towed video camera sled. Fisheries Research 70:27–37.

Mallet, D., and D. Pelletier. 2014. Underwater video techniques for observing coastal marine biodiversity: a review of sixty years of publications (1952–2012). Fisheries Research 154:44–62.

Mallet, D., L. Wantiez, S. Lemouellic, L. Vigliola, and D. Pelletier. 2014. Complementarity of rotating video and underwater visual census for assessing species richness, frequency and density of reef fish on coral reef slopes. PLoS (Public Library of Science) ONE [online serial] 9(1):e84344.

Murphy, H. M., and G. P. Jenkins. 2010. Observational methods used in marine spatial monitoring of fishes and associated habitats: a review. Marine and Freshwater Research 61:236–252.

Pennington, M., and O. R. Godø. 1995. Measuring the effect of changes in catchability on the variance of marine survey abundance indices. Fisheries Research 23:301–310.

Rees, M. J., N. A. Knott, G. V. Fenech, and A. R. Davis. 2015. Rules of attraction: enticing pelagic fish to mid-water remote underwater video systems (RUVs). Marine Ecology Progress Series 529:213–218.

Schobernd, Z. H., N. M. Bacheler, and P. B. Conn. 2014. Examining the utility of alternative video monitoring metrics for indexing reef fish abundance. Canadian Journal of Fisheries and Aquatic Sciences 71:464–471.

Weinberg, K. W., D. A. Somerton, and P. T. Munro. 2002. The effect of trawl speed on the footrope capture efficiency of a survey trawl. Fisheries Research 58:303–313.

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