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Update on the use of underwater video to characterize the species, size composition and vertical distribution of tunas around floating objects

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Update on the use of underwater video to characterize the species, size composition and vertical distribution of tunas around floating objects

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Abstract

The rapid characterization of a pelagic fish community found in association with floating objects is seen as a critical tool useful for reducing bycatch levels and landings of undersize tuna in purse seine fisheries. It is believed that purse seine fishermen can become highly proficient at school evaluation using many different approaches (acoustic, visual, behavioural, etc.) as they are able to refine estimates through daily comparisons of realized catch. However, their ability to do so is difficult to test and poorly documented. Hard-wired underwater video equipment can be used to evaluate the accuracy of pre-set estimates and also developed as a tool to refine acoustic (echo sounder and sonar) estimates and selectivity.
A self-contained underwater video system was further evaluated following initial trials during 2008. Despite poor resolution of recorded images, pectoral fin characteristics appear to be a useful character to identify juvenile bigeye tuna at sizes greater than around 50 cm FL. Pectoral fin lengths of yellowfin and bigeye less than 40 cm FL may be to be too similar to be used to differentiate the species using this approach but further evaluation is required. However, the lengths noted in the report are estimates based on examinations of sampled catch and morphological characters can be quite variable within a population. Further tests using laser equipment to verify fish length in situ during video recording are recommended. Due to the lack of species diversity encountered during the 2009 cruise it is recommended that further trials should be conducted during 2009/10 targeting yellowfin/bigeye comparisons, small tuna-like species and finfish bycatch. Work in collaboration with a commercial tuna purse seine vessel would be ideal and means to effect such an arrangement should be explored.

Background

It is well known that floating objects in the pelagic environment attract a wide variety of sea life that become highly vulnerable to exploitation. Purse seine gear is particularly effective in harvesting whatever collects around floating objects; whether natural, man-made, moored to the seafloor or free drifting. Management concerns have developed with increased vulnerability and fishing mortality associated with floating objects in several categories that include:

a) juvenile bigeye and yellowfin tuna;
b) small tuna-like species such as *Euthynnus* and *Auxis* species;
c) commercially undersized tuna of any species that are too small for processing or become easily damaged in storage;
d) finfish bycatch species such as oceanic triggerfish and rainbow runner that are normally discarded;
e) finfish bycatch that are highly esteemed by other fisheries but discarded by purse seine fleets such as wahoo, dolphinfish and marlin species;
f) bycatch species of special ecological significance, i.e. marine turtles, marine mammals and oceanic sharks.

Thus the issue encompasses a wide variety of concerns over the sustainability of target tuna stocks, the discarding and wastage of target and non-target species, bycatch of finfish deemed highly desirable by other fisheries or for recreational/subsistence purposes and the take of

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endangered species or species of special ecological significance. Categories a, b and c have been collectively termed Small Tuna on Floating Objects (STF0), whose reduction in fishing mortality has become a priority of all RFMOs.

A rapid and cost effective means to discriminate species and size of STFO and bycatch species would be a critical tool to mitigate bycatch levels. Acoustic surveys and high definition echo sounders have attempted to discriminate tuna by size and species based on target strength measurements (Bertrand and Josse 2000; Josse and Bertrand 2000; Miguel et al. 2006). However, acoustic data is often difficult to interpret due to confounding factors such as hull noise, vessel speed, shifting fish orientation and the relative size or presence of a swim bladder. Another approach being proposed and tested is to use acoustic surveys coupled with learned experience of fishers and other means to estimate the characteristics of floating object aggregations to assess the accuracy of these estimates that may be useful for avoidance of STFO (IATTC 2008; Morón 2008).

The use of hard-wired underwater video equipment to visually verify species and individual size of fish in floating object aggregations was suggested in a paper by Schaefer and Fuller (2007). This idea was further proposed and supported by the WCPFC during 2008 with an initial report presented to SC4 (Itano 2008). This report has been provided to SC5 for reference purposes as SC5/FT IP-02.

The viewing of underwater video images in real time could be a useful way to improve selectivity and reduce bigeye and small (undersize) tuna and bycatch in as follows:

- Used as a way to visually check aggregations and avoid setting on STFO when observed.

- Used to verify sounder and sonar images to refine acoustic estimates of size and species.

- Used to test the ability of fishermen to interpret acoustic images (useful to assess efficacy of vessel or fleet specific quotas on STFO).

This report provides a brief update on the use of underwater video gear for species and size discrimination on floating object associations.

Materials and methods (2008)

The camera system used was the Deep Blue Professional Grade color video system from Splashcam Marine Video[5] as described in Itano (2009) and depicted in **Figure 1**. This system is rated to a depth of 600 m with a metal camera head measuring 7.6 x 8.9 cm. Further details are provided in Itano (2009).

During 2008 the system was tested during a 30 day tuna tagging cruise that was conducted on the Hawaii-based vessel Double D to instrumented data buoys of the Tropical Atmosphere/Ocean (TAO/Triton) array south of Hawaii to the Line Islands of Kiribati and high seas areas east of Palmyra Atoll and Christmas Island (**SC4 GN-IP-1)**. The system was slowly lowered on tuna schools found in aggregation to the TAO buoys at 02°N and 05°N latitude, 155°W longitude during May 2008. The camera system was suitably weighted and manually lowered from the stern of the vessel to a depth of approximately 35 – 55 m with

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[5] http://www.splashcam.com/Deep_Blue/db.htm

simultaneous acoustic observation of the school on the vessel's Furuno 5FCB 585 echo sounder. Digital images of the echo sounder image were taken when video recording took place.

Unfortunately, the camera was found to be defective during the 2008 cruise that resulted in a gross overexposure of the majority of the field of view during recording sessions. The unit was returned and replaced by the manufacturer at no additional cost and used during 2009.

Figure 1. SPLASHCAM video system with viewing/recording gear (left) and camera head (right) rigged prior to deployment

Materials and methods (2009)

The replacement video camera was used during a second tagging cruise during May 2009 using the same vessel and in the same areas visited during the 2008 tagging cruise. Aside from the replacement camera head, all other components of the video and recording system and deployment procedures were identical to those used during 2008.

Results

The video clips and acoustic images described here were recorded on 28 May 2009 between 1030 – 1230 hrs. The aggregation was originally located and fished in association with the NOAA National Data Buoy Center (NDBC) instrumented mooring 51028 (00°00', 153°53'W) on 26 May 2009. At the time of the recording the school had been successfully disaggregated from NOAA 51028 and had re-associated with the tagging vessel Double D that was drifting on sea anchor at approximate position 00°03'S, 153°49'W.

The tuna aggregation was reported as relatively large; conservatively estimated at >100 short tons of skipjack and >50 tons of bigeye tuna. The video camera head was lowered into the aggregation to a depth of approximately 36 – 55 m when video recordings were made while digital still images were recorded of the images displayed by the ship echo sounder.

The replacement of the video camera head resulted in a slight improvement in the overexposure problem encountered during the 2008 cruise. Unfortunately the images captured were still grainy and of low resolution, which may be characteristic of this particular system under these conditions. However, despite the low image quality it was possible to distinguish tuna species in most cases.

a) Video images

i. Bigeye tuna

The bulk of the aggregation captured on video clips appeared to consist of bigeye tuna of approximately 50 – 70 cm FL as distinguished by an elongated pectoral fin when viewed from the side (**Figure 2**). The pectoral fin is finely tapered, ending in a sharp point compared to the shorter, thicker pectoral fin of similarly sized yellowfin tuna. With experience the robust body form and larger head length/FL compared to yellowfin can also assist in identification.

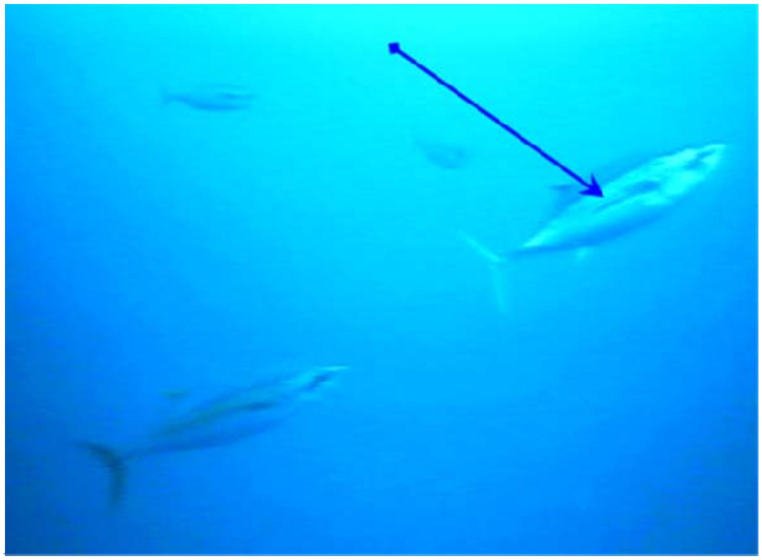

Figure 2. Bigeye tuna approximately 65 cm showing elongated, tapered pectoral fin

In viewing the video there are times when the pectoral fin becomes obscured by a mid-lateral golden/yellowish band that can become distinct on live yellowfin and bigeye tuna. Another common problem had to do with the orientation of the pectoral fin as it can be difficult to see if viewed side-on in thin cross section rather than flat against the body.

The tuna pictured in the left portion of **Figure 2** could not be identified in this frame as the pectoral fin characteristics are not sufficiently clear to discriminate yellowfin from bigeye tuna. However, the fin orientation of swimming tuna changes rapidly and bigeye identification could generally be resolved by following an individual fish through the video using pectoral fin characteristics. Bigeye tuna of this size often erect their pectoral fins away from their body when swimming or maneuvering as do yellowfin. However, the greater length and shape of the erected fin of bigeye can be used to distinguish the species. **Figure 3** shows the same tuna pictured in **Figure 2** seconds later as it turned away from the camera revealing long, crescent shaped and finely tipped pectoral fins characteristic of a bigeye tuna (blue arrow).

Figure 3. Bigeye tuna identified by long, crescent shaped, finely tipped pectoral fins.

Figure 4 shows images of tuna believed to be medium-sized bigeye tuna ~65 – 95 cm FL. The tuna closest to the camera has the long, curving and finely pointed pectoral fin and deeply rounded body form characteristic of a bigeye tuna of this size.

Figure 4. Images of tuna identified as bigeye based on pectoral fin characteristics and body morphology.

Figure 5 provides a comparison of bigeye and yellowfin pectoral fin characteristics for fish greater than ~60 cm (see Itano and Fukofuka 2007 for details). The pectoral fin of yellowfin tuna of this size are relatively thick and stiff with a blunt tip compared to bigeye pectoral fins that are thinner, finely tipped and form a smooth, crescent shaped arc when viewed from above or below. Body morphology can also be used to distinguish bigeye (deep bodied, body outline a smooth arc) from yellowfin (elongate, straight line from second dorsal to caudal fin). The head length relative to fork length of bigeye is larger compared to yellowfin but these characters are more useful for medium to large specimens. **Figure 6** provides a comparison between similar sized yellowfin and bigeye tuna. Note differences in pectoral fin characteristics, body morphology, head length/depth. At this size the second dorsal fins of yellowfin begin to elongate.

Figure 5. Pectoral fin characteristics. a) bigeye tuna in front of yellowfin tuna; b) pectoral fin of Bigeye tuna 88 cm FL; c) Bigeye tuna 96 cm FL; d) Yellowfin tuna 96 cm FL.

Figure 6. Yellowfin tuna (96 cm FL); bigeye tuna (93 cm FL)

ii. Yellowfin tuna

Yellowfin tuna were much more difficult to identify in this video. Difficulty in distinguishing yellowfin by pectoral fin length was related to the difference between observing a long pectoral fin compared to “not” seeing a long fin but not knowing if this was a true observation or if it was due to viewing angle, lighting or blending in with body coloration.

However the difficulty in observing yellowfin may be largely due to the fact that relatively few juvenile yellowfin were observed in the aggregation that was reported as consisting of a nearly mono-specific aggregation of juvenile bigeye tuna. The same problem occurred during the May 2008 cruise where bigeye tuna predominated.

iii. Bycatch species

The only bycatch species noted in the video are rainbow runner (*Elegatis bipinnulata*) that were readily identifiable by body morphology, swimming characteristics and striped coloration (**Figure 7**).

Figure 7. Rainbow runner readily identified by coloration pattern and body shape

iv. Observations of tagged fish

Although low in resolution, the video was able to record several tuna carrying plastic dart tags that are easily observed trailing from below the second dorsal fin insertion point (**Figure 8**). The light/external temperature sensor stalks of archival tags are also recognizable in the video protruding from the central abdominal region where the tags had been recently implanted. The tags observed during this portion of the cruise were Wildlife Computers; model MK9 with 9 cm stalks.

Figure 8. Conventional 13 cm plastic dart tag in tuna (tentatively identified as yellowfin)

b) Echo sounder image

Figure 9 shows video images of a dense concentration of tuna captured by the video system. Following the video further, the fish could be identified as juvenile bigeye tuna. This school type is referred to as a “shiner” by tuna fishermen as the school will reflect in a silvery glow when sunlight catches the tightly packed school as shown in the right side of the figure.

Figure 9. Densely packed school of bigeye tuna at approximately 38 m depth

Figure 10 is a composite of digital images taken of the Furuno echo sounder display during the 2008 (left) and 2009 (right panel) cruises. Note that the scales read in fathoms and are slightly different from each other. The left panel is described in ***Figure 12*** from the report of the 2008 cruise (see WCPFC-SC5-FT SWG/IP-2) that identified that target as a dense aggregation of bigeye tuna that were also simultaneously identified visually by video recording.

The right panel shows a tuna school at approximately 10 – 35 fathoms (18 – 64 m) simultaneous to when the school was being recorded on video and verified visually as consisting of bigeye tuna. Both echo sounder screens shows the dark red, densely packed display characteristic of the high density echo return of bigeye tuna due to their relatively large swim bladder (Schaefer and Fuller 2007).

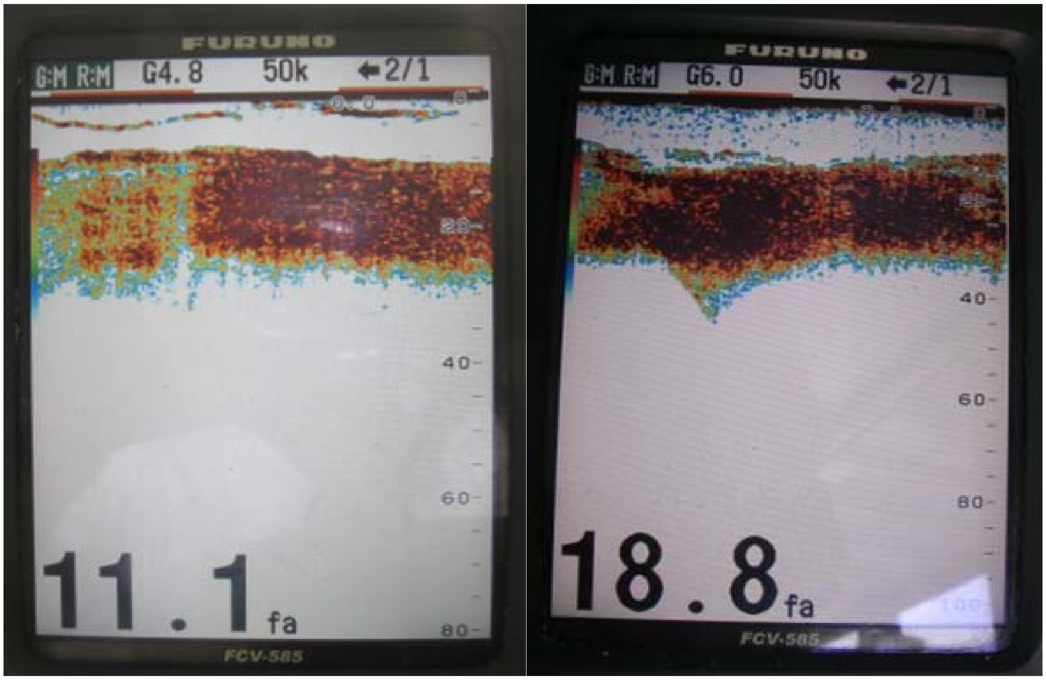

Figure 10. Schools of bigeye tuna from the same Furuno echo sounder from 2008 (left panel) and 2009 (right panel) cruises as verified by simultaneous video observations

Discussion

The image quality of the video captured during the 2009 cruise was disappointing despite the complete replacement of the video recording head by the manufacturer. However, image quality was sufficient to identify bigeye tuna encountered during the survey using pectoral fin characteristics and body morphology.

It should be noted that the visual identification of bigeye tuna using these characters is not difficult for fish larger than approximately 60 – 65 cm FL and become very easy at sizes greater than 80 cm. However, pectoral fin length and body shape become quite similar for yellowfin and bigeye less than 45 cm and are nearly identical for very small specimens less than 35 cm FL (**Figure 11**).

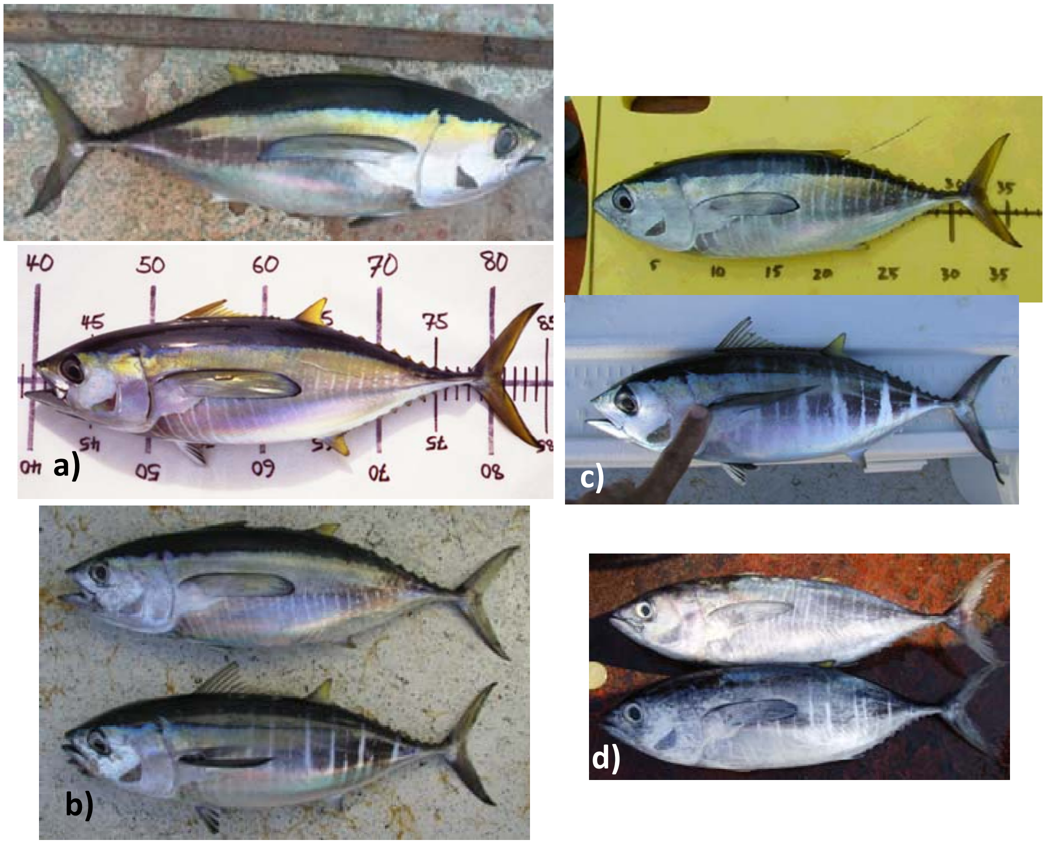

Figure 11. Yellowfin and bigeye characteristics for small fish listed top to bottom within each panel: a) BE 44 cm, YF 41 cm; b) YF and BE 36 cm; c) YF and BE 33 cm; d) YF and BE 31 cm

On the basis of trials to date it seems doubtful if video discrimination will be a useful tool for differentiating yellowfin from bigeye at sizes less than around 40 cm FL. However, it may not be as critical to discriminate each species at these smaller size classes. Reductions in fishing mortality for both yellowfin and bigeye less than ~40 cm have been recommended for management purposes and the avoidance of both during fishing operations would be beneficial.

The full testing of the system still suffers from the need to be evaluated under different oceanic conditions on a variety of scenarios that include: yellowfin and bigeye less than 50 cm, a full size range of skipjack tuna, small tuna-like species (i.e. *Auxis* and *Euthynnus*), mackerel scad (*Decapterus* spp.) and other common bycatch species. Additional field trials will continue in 2009/2010 to attempt to evaluate these species scenarios. Work in collaboration with a commercial tuna purse seine vessel would be ideal and means to effect such an arrangement will be explored.

Determining fish size is another potential benefit of using a hard wired video approach. Reliable and stable morphological characters need to be identified in conjunction with measuring systems that use laser devices to confirm accurate fish length. Further work comparing external characters of target species by size class similar to the example in **Figure 11** is recommended.

Acknowledgments

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