WCPFC–SC1 **FT IP–4**

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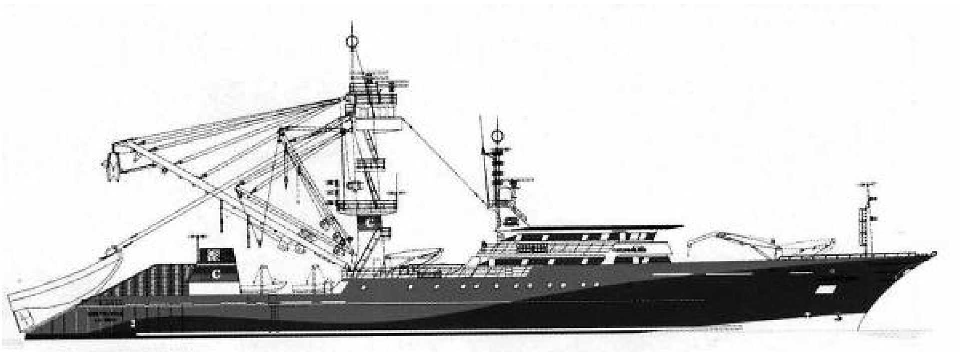
Notes on a longline trip in the New Caledonia EEZ using TDRs in combination with remote sensing data (SSH and SST)



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Notes on a longline trip in the New Caledonia EEZ using TDRs in combination with remote sensing data (SSH and SST)

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In May 2005 a longline trip was made on a New Caledonian longliner, F/V *Yellowfin* (Beverly 2002), on one of its regular tuna longline fishing trips. SPC's Fisheries Development Officer, Steve Beverly, accompanied the crew on the trip at the request of the vessels owners, Albacore SARL, who wanted feedback on the boat's fishing strategy.

The objective of the brief study was to assist Albacore SARL with their longline vessel in resolving problems the captain was having in locating fish using sea surface temperature (SST) and remote sensing data; and to offer advice on why F/V *Yellowfin* (Figure 1) wasn't doing as well as Albacore's other boat, F/V *Baby Blue* (Figure 2), even when they were fishing in the same vicinity.

Figure 1. F/V *Yellowfin*.

Figure 2. F/V *Baby Blue*.

Catch and Effort

Five sets were made, all in roughly the same area just to the east of Maré in the Loyalty Group of Islands east of the main island of New Caledonia (La Grande Terre) between 18 and 22 May. The fishing was roughly concentrated in an area around 21º30’S and 168º45’E. Setting was done going from southeast to northwest. During the same five day period F/V *Baby Blue* was fishing about 8 nm to the east of F/V *Yellowfin*, setting on parallel lines.

F/V *Yellowfin* typically started setting the line at about 06:30, setting 1750 hooks in 35 hook baskets. The bait was a mix of South African pilchards and California sardines. Line setter speed was 10 kn and boat speed was 5 kn, giving a sagging ratio (SR) of 0.5. Branchlines were 10 m long and floatlines were 10 m. The interval between branchlines was 36 m which corresponded to 7 seconds on the setting timer. The only known setting parameter for F/V *Baby Blue* was basket size which was 30 hooks.

Sea surface temperatures were recorded before and during the sets (and during the hauls). Temperature depth recorders (TDRs) were attached to certain baskets to monitor depth and temperature at depth. Hauling typically began at about 15:00 and continued until all of the line was recovered at about 00:00 or 01:00. All target fish were recorded and hook positions noted, but fork lengths were not measured. TDR data were retrieved right after the hauls were completed. The day after each set, catch information from the previous day was passed from F/V *Baby Blue* to F/V *Yellowfin*.

Catch and position information for both boats was then communicated to Albacore's office in Noumea via a satellite e-mail connection.

Total catch of marketable fish for F/V *Yellowfin* for the five sets was 121 albacore (*Thunnus alalunga*), 34 bigeye (*T. obesus*), 19, yellowfin (*T. albacares*), 1 blue marlin (*Makaira mazara*), 2 swordfish (*Xiphias gladius*), 13 opah (*Lampris guttatus*), 2 mako sharks (*Isurus oxyrhinchus*), and 3 wahoo (*Acanthocybium solandri*). Total number of marketable fish was 195. Total number of hooks for the five sets was 8400. Nominal CPUE for marketable fish was therefore 2.3 fish per 100 hooks. Just estimating on the weight (albacore = 15 kg, bigeye = 30 kg, yellowfin = 20 kg, mako = 40 kg, blue marlin = 100 kg, swordfish = 75 kg, wahoo = 10 kg, opah = 20 kg) gives a total weight for the five sets of 4025 kg (weights had to be estimates as most fish were quarter-loined and blast frozen on board). Based on these estimates, nominal CPUE by weight would be 48 kg/100 hooks. CPUE for albacore was 1.4 fish/100 hooks and 22 kg/100 hooks. CPUE for bigeye was 0.4 fish/100 hooks and 12 kg/100 hooks.

F/V *Baby Blue* caught a total of 387 marketable fish weighing 6330 kg (estimate) on 9000 hooks during the same five-day period fishing in the same vicinity (five days was not the length of either boat's fishing trip, just the amount of time that the study covered). This gives a nominal CPUE of 4.3 fish per 100 hooks and 70 kg per 100 hooks. CPUE for albacore was 3.5 fish/100 hooks and 53 kg/100 hooks. CPUE for bigeye was 0.05 fish per 100 hooks and 1.6kg/100 hooks. Table 1 below summarises the catch of both boats.

Table 1: Summary of catch and effort results of the two boats for the same five day period

Boat	Total hooks set	Catch		Catch/100 hooks		Albacore/100 hooks		Bigeye/100 hooks	
		Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)
F/V *Yellowfin*	8400	195	4025	2.3	48	1.4	21	0.4	12
F/V *Baby Blue*	9000	387	6330	4.3	70	3.5	53	0.05	1.6

All tuna except large bigeye were loined, wrapped, and blast frozen for export to Europe. Bigeye tuna were chilled in RSW holds for export to Japan. Byproduct fish were chilled for local sales. It can be seen from the table that the two boats had very different results. F/V *Yellowfin's* catch rate was about 53 per cent of that of *F/V Baby Blue's* catch rate by numbers of fish and 68 per cent by weight of fish. F/V *Yellowfin's* catch rate for albacore was only 40 per cent of F/V *Baby Blue's* by number of fish and 40 per cent by weight. F/V *Yellowfin's* catch rate for bigeye tuna, however, was 800 per cent that of F/V *Baby Blue's* by number and 750 per cent by weight.

In terms of albacore, F/V *Baby Blue* outfished F/V *Yellowfin* by a factor of over two-to-one. However, in terms of bigeye tuna, F/V *Yellowfin* outfished F/V *Baby Blue* by a factor of eight-to-one. The answer to the question of why they were getting such different results lies almost solely in setting strategy, particularly since they were setting in the same area on the same temperature break using the same bait, and set and haul times were similar. In addition, the captains of the two vessels have similar histories and experiences in the fishery. They are arguably the two best longline captains in New Caledonia. F/V *Yellowfin* was targeting deeper by setting 35 hook baskets, while F/V *Baby Blue* was targeting higher up in the water column by setting 30 hook baskets. The only other notable difference was the longline systems on each boat. F/V *Yellowfin* has an Australian made system (Costa) while F/V *Baby Blue* has an American made system (Lindgreen-Pitman). No TDR results were obtained from F/V *Baby Blue* but just by looking at the catch results – fewer bigeye and more albacore and yellowfin tunas – it can be assumed that F/V *Baby Blue's* deepest hooks were getting down to no more than about 300 m while F/V *Yellowfin's* deepest hooks were getting down to 425 m. F/V *Yellowfin's* sets were landing fewer hooks within the depth ranges of albacore and yellowfin tunas while F/V *Baby Blue* was landing almost no hooks in the bigeye zone (see TDR results below).

TDR results

In all 26 TDR deployments were made using Star-Oddi TDRs (http://www.star-oddi.com/). The average results for five TDRs that were placed on the shallowest hook position were 51.4 m and 25.5ºC. The ranges for the shallowest hook position were 40 to 65 m and 24.5 to 25.8ºC. The average results for 14 TDRs placed on the deepest hook position were 393 m and 14ºC. The ranges for the deepest hook positions were from 350 to 425 m and from 13 to 15.5ºC (Figure 3). As fish came up during the haul the hook number was noted by counting remaining branchlines until a float appeared. That way depth of capture could be reasonably extrapolated.

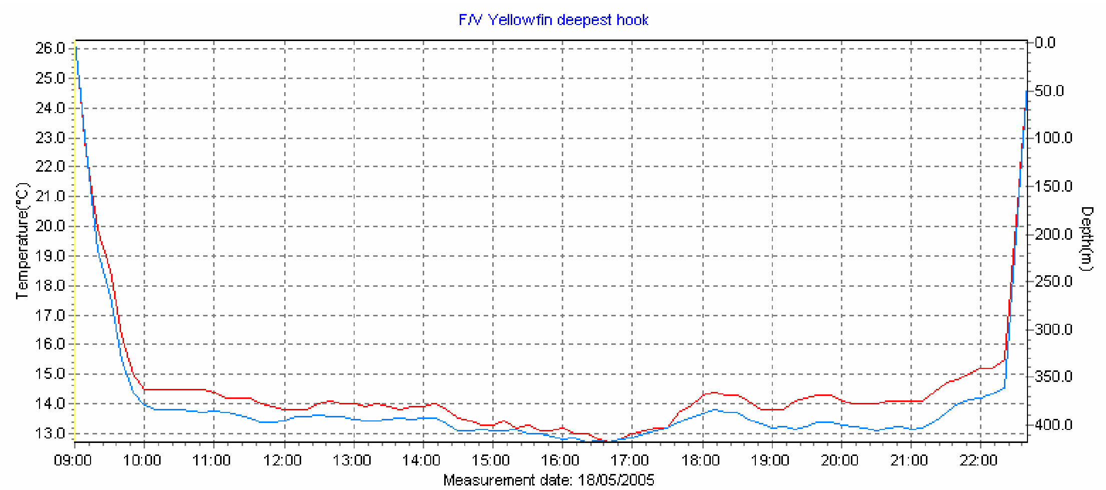

Figure 3. Temperature depth graph for deepest hook on a 35 hook basket

TDR results were very interesting for one basket that was set at 09:30 on 21 May and hauled at 18:00. A total of eight TDRs were placed at five hook intervals along the entire 35 hook basket on hook positions numbered #1, #5, #10, #15, #20, #25, #30, and #35. Results were as follows (25C1583, etc, refer to data file, depth is in metres and temperature in degrees centigrade):

- #1 - 25C1583 – 55 m 25.0ºC
- #5 - 28C1586 – 170 m 21ºC
- #10 - 25C1588 – 320 m 17ºC
- #15 - 18C1589 – 425 m 13ºC

- #20 - 12C1590 – 425 m 13ºC
- #25 - 9C1591 – 340 m 16ºC
- #30 - 7C1593 – 180 m 20.5ºC
- #35 - 9C1605 – 42 M 25.8ºC

One opah was on hook number #25, so depth of capture was 340 m and temperature was 16ºC. Bite time was not evident on the TDR graph. Three bigeye tuna of around 30 to 35 kg each were caught on hooks #17, 18, and 19 corresponding to 425 m and 13ºC. Bite time for at least one of the bigeye was 15:00. Figure 4 shows what that basket looked like in the water and where the fish were caught (the positions for yellowfin and albacore were extrapolated from hook numbers on other baskets).

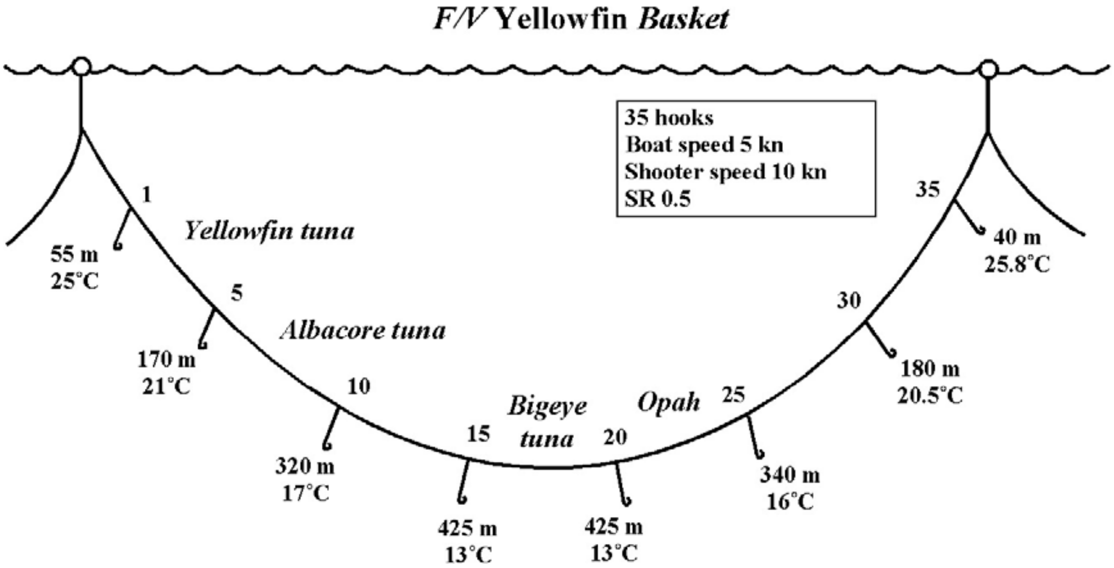

Figure 4. A basket of gear showing fish capture relative to temperatures and depths at 8 hook positions.

Figure 4 actually gives a generalised view of the line: fish captures, temperatures, and depths overall were probably close, if not the same, to the positions as noted in the diagram. These generalised results – catching yellowfin at 40 to 170 m, albacore between 170 and 320 m, and bigeye and opah at 340 to 425 m are somewhat dissimilar to results obtained during a recent one year study conducted in New Caledonia (Chavance 2005), especially for albacore tuna. The study was based on several trips with a cumulative effort of 8100 hooks (compared to 8400 hooks for one trip on F/V *Yellowfin*). Chavance found that 80 per cent of the albacore captures were between 10 and 410 m and 12 to 22ºC water while 80 per cent of bigeye captures were in 250 to 380 m and 17 to 19ºC water. Albacore and bigeye samples were relatively low compared to what commercial boats in the fishery normally encounter. In addition, all sets were made in close proximity to the reef and not in an area normally considered as high seas. These two factors – low sample size and the fact that they may have been fishing on resident stocks, may account for the differences in the depths of capture of albacore and bigeye compared to the results obtained from F/V *Yellowfin*.

By looking at the results one might think that management at Albacore SARL would be very pleased with F/V *Yellowfin's* catch and not so pleased with F/V *Baby Blue's*. Bigeye tuna is the prize, albacore is byproduct. Quite the opposite was true. The management team at Albacore SARL actually preferred more albacore (and yellowfin) and fewer bigeye for marketing reasons. To accomplish this for future fishing trips, it was recommended that F/V *Yellowfin* switch to shallower sets to target greater numbers of albacore and yellowfin tuna. Besides decreasing the number of hooks in a basket they could speed the boat up or slow the line setter down during setting to change the SR. An SR of 0.75 (ie, boat speed of 7.5 kn and shooter speed of 10 kn) would probably do the trick for starters. Some experimentation would get it right, although double-checking with TDRs would be best.

In fact, the recommendation of using fewer hooks per basket and slowing down the line setter speed was subsequently implemented and results were very promising in the months following this brief study. Management at Albacore SARL reported that on 17 July, for example, F/V *Yellowfin* set 1750 hooks in 30 hook baskets at 22º45'S and 164º00'E and had a good catch of 91 albacore, 1 bigeye, 1 mahi mahi, and 3 yellowfin. They reported that overall F/V *Yellowfin* and F/V *Baby Blue* were getting similar catches since F/V *Yellowfin* began changing their setting strategy. For a future study it would be useful to monitor the measurable parameters of F/V *Baby Blue's* sets, such as shooter speed, boat speed, SR, and actual depth using TDRs in order to make a better comparison.

Using remote sensing charts – SSH and SST

Besides changing fishing strategies, there are other things that Albacore SARL can do to improve catch results on both boats: the better use of remote sensing data and more diligence in using on-board SST monitors. For the May trip on F/V *Yellowfin* the latest NLOM 32 Degree Page sea surface height (SSH) and sea surface temperature (SST) charts available on the Internet (Anon 2005) were taken along by the Fisheries Development Officer, but they were for 14 May (Figure 5) while the first day of fishing was 18 May. Still, the SST chart was useful in locating the general vicinity of a temperature break, which was later confirmed by on-board monitoring (the arrow on the chart shows the approximate fishing area).

The NLOM 32 Degree Page is the US Navy website for Naval Research Laboratory (NRL) Global Analysis and Modeling. NLOM stands for NRL Layered Ocean Model. In 2001 the NRL participated in a meeting of the International Global Ocean Data Assimilation Experiment (GODAE) Steering Team that was held in Noumea. That's how they came to define a New Caledonia sub-region on their webpage (pers. com. from Harley Hulburt) . Most Pacific Island areas are not depicted with the same resolution. This is a lucky break for New Caledonia fishermen. NLOM has recently added current/speed layer charts to their website and they may include more sub-regions in the future, including Pacific Island areas.

One good strategy for a small fishing company such as Albacore SARL would be for management to supply the latest copies of NLOM charts to the captains just before departure. That way the boats could at least have a primary target fishing ground to begin their search. If they had charts for three or four consecutive days they could also have an idea of how the water was moving. The ideal situation, however, would be for the boats to receive the charts on a daily basis. In order to receive remote sensing data daily they would need to have PCs with appropriate software – and Iridium satellite telephones. Another option would be for someone on land to try to interpret the charts and direct the boats to good fishing grounds on a daily basis. This was tried once at Albacore SARL with disastrous results so is maybe a good idea only if there is a fish master on shore. In fact, Albacore SARL is now in the habit of supplying charts to their captains before departure.

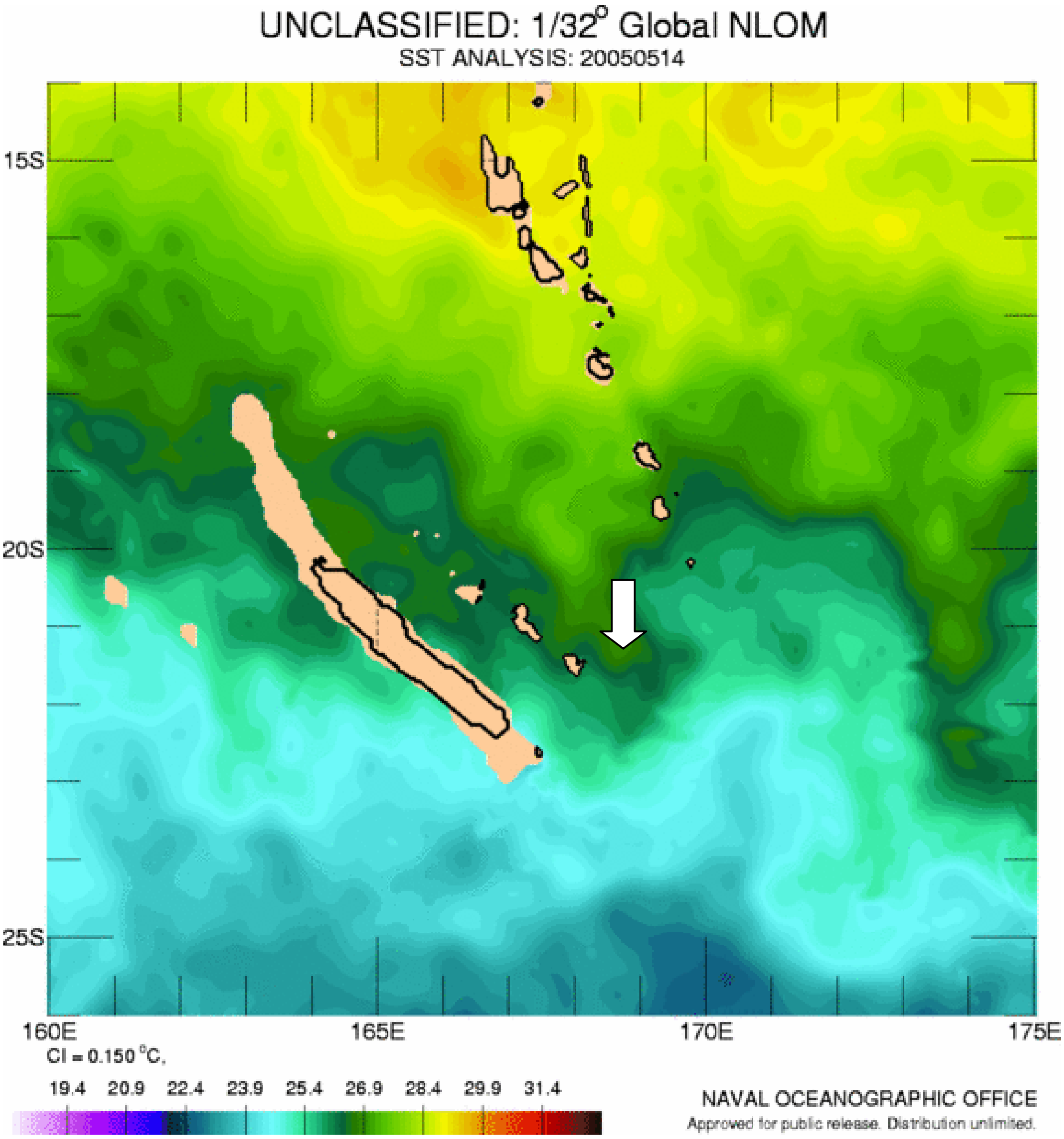

Figure 5. NLOM SST chart for 14 May 2005 for New Caledonia's EEZ. White arrow shows approximate fishing area.

Monitoring SST on-board

The current situation is that F/V *Yellowfin* has SST monitoring capability with readout in degrees centigrade but it is incorporated into the echo sounder. The captain doesn't like to leave the echo sounder operating as he believes that the signal may attract whales. In any event, he is on deck 100 per cent of the time during the haul so he doesn't get feedback on temperature and catch. Interestingly, the same indifference to SST was identified with the same captain years ago (Beverly1997). For this brief trip all temperature monitoring was done by the investigator. F/V *Baby Blue* has an independent SST monitor but the readout is in degrees Fahrenheit. This makes it difficult for the two boats to compare information except to identify breaks. Notwithstanding all this, the temperature break identified on the NLOM chart was confirmed. During the first set on 18 May it was found that fishing dropped off significantly when SST dropped below 25.3ºC (south side of break) and increased significantly at temperatures of around 25.5 to 25.7ºC (north side of break). The position of this change corresponded to the line identified on the NLOM chart. In order to be aware of this, however, someone had to diligently monitor SST in the wheelhouse during the haul. After this discovery, F/V *Yellowfin* shifted to the north for subsequent sets and fishing improved.

The ideal situation would be for both boats to have the same brand of SST monitor. After installation they should be calibrated so they give the same readings. They can do this when the boats are side-by-side either at the wharf or at sea. Temperature monitors with shear alarms are best. They give an audible signal when SST rises or drops significantly. If they had the same SST monitors they would be better able to share SST info. This would help them to identify temperature breaks and the orientation of temperature breaks (the direction they are running). When the boat is underway including during setting, SST should be noted in the logbook along with position every 30 minutes, and at least once during each watch while searching for fish. While hauling, SST should be noted, along with position, every time a significant catch is made (ie, three or four target fish in a row). This can be done in the log book or as an event mark on the plotter.

Hindcasting using NLOM charts

Another thing that can be done is to hindcast catch data with charts corresponding to the same date for past efforts. Best catches and worst catches over a one year period, for example, could be plotted onto SSH and SST charts to try to determine what chart features, if any, point out good or not so good fishing spots. This will give the captain better insight into what to look for on the charts.

With this in mind, hindcasting was done by examining catch data from F/V *Yellowfin* and the NLOM charts for two different days of fishing: 24 June 2005 and 17 July 2005. These days were chosen because the catch for the main target species, albacore tuna, was mediocre on 24 June and very good on 17 July. F/V *Yellowfin* had a relatively poor catch for 24 June 2005, fishing at 22º39'S and 165º14'E 9 (25 albacore on 1750 hooks, or 1.4 fish/100 hooks). By contrast, on 17 July 2005, fishing at 22º35'S and 164º00'E, they had a very good catch of the main target species (91 albacore on 1750 hooks, or 5.2 fish /100 hooks). NLOM SSH and SST charts were looked at for both days; the position of the boat at the start of setting was roughly plotted on the charts (white arrows) and the two sets of charts were compared.

The NLOM SSH chart for 24 June (Figure 6) does not show any pronounced features in the vicinity where F/V *Yellowfin* was fishing. There is no eddy and little contrast. The SST chart (Figure 7) does not exhibit a temperature break in this area. The isotherms are far apart and there is little contrast. Just by looking at the charts it is hard to tell what brought them to fish in this area (if they were using the charts).

The NLOM SSH chart for 17 July (Figure 8), on the other hand, shows a pronounced eddy just to the south of F/V *Yellowfin's* position (white arrow). In fact they were setting on the edge of the eddy in what was probably a temperature break or front. This is confirmed when the position (white arrow) is plotted onto the SST chart for the same day (Figure 9). There is a definite thermal front running roughly east/west through the EEZ.

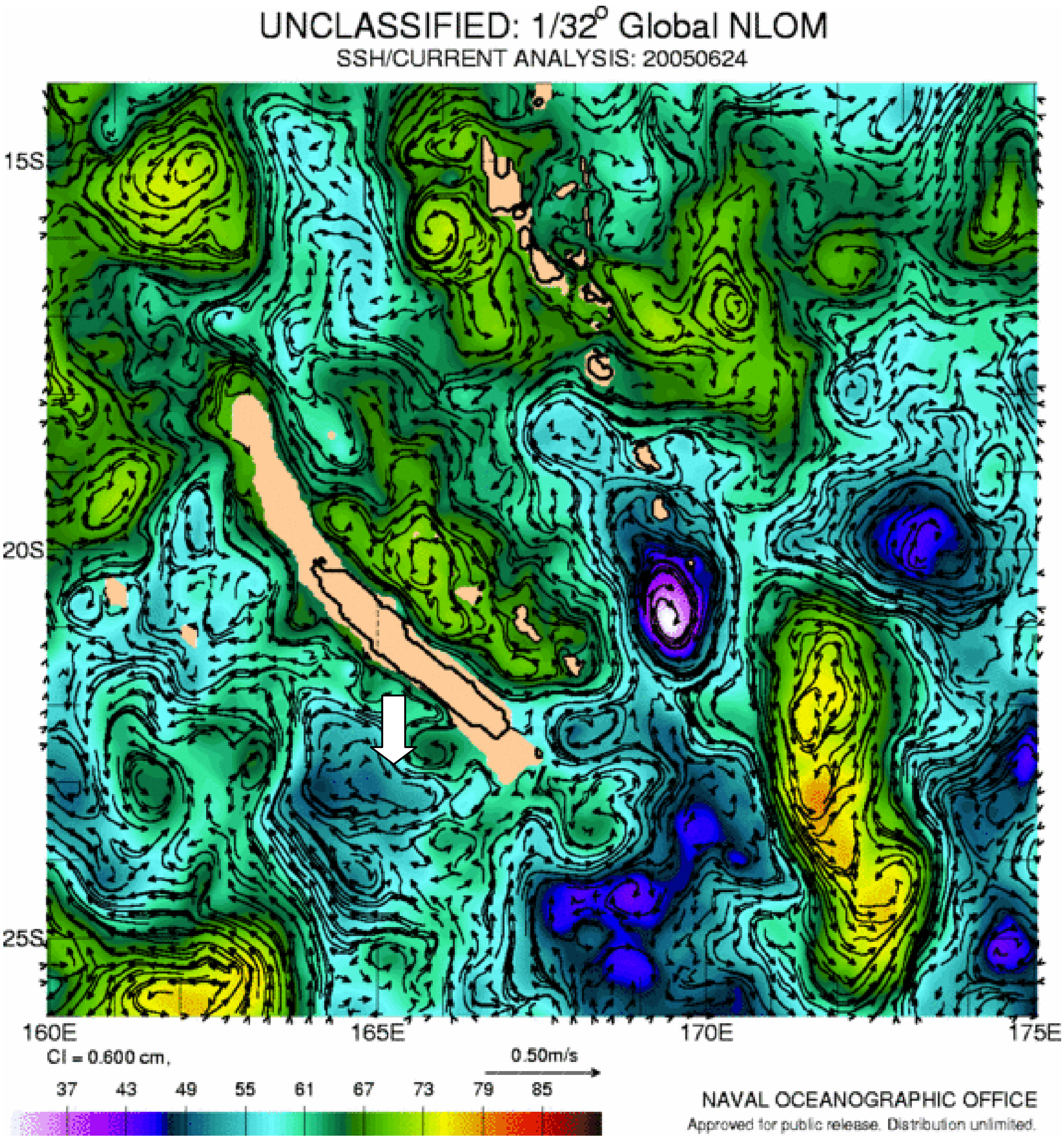

Figure 6. NLOM SSH for 24 June 2005 for New Caledonia's EEZ. Poor fishing.

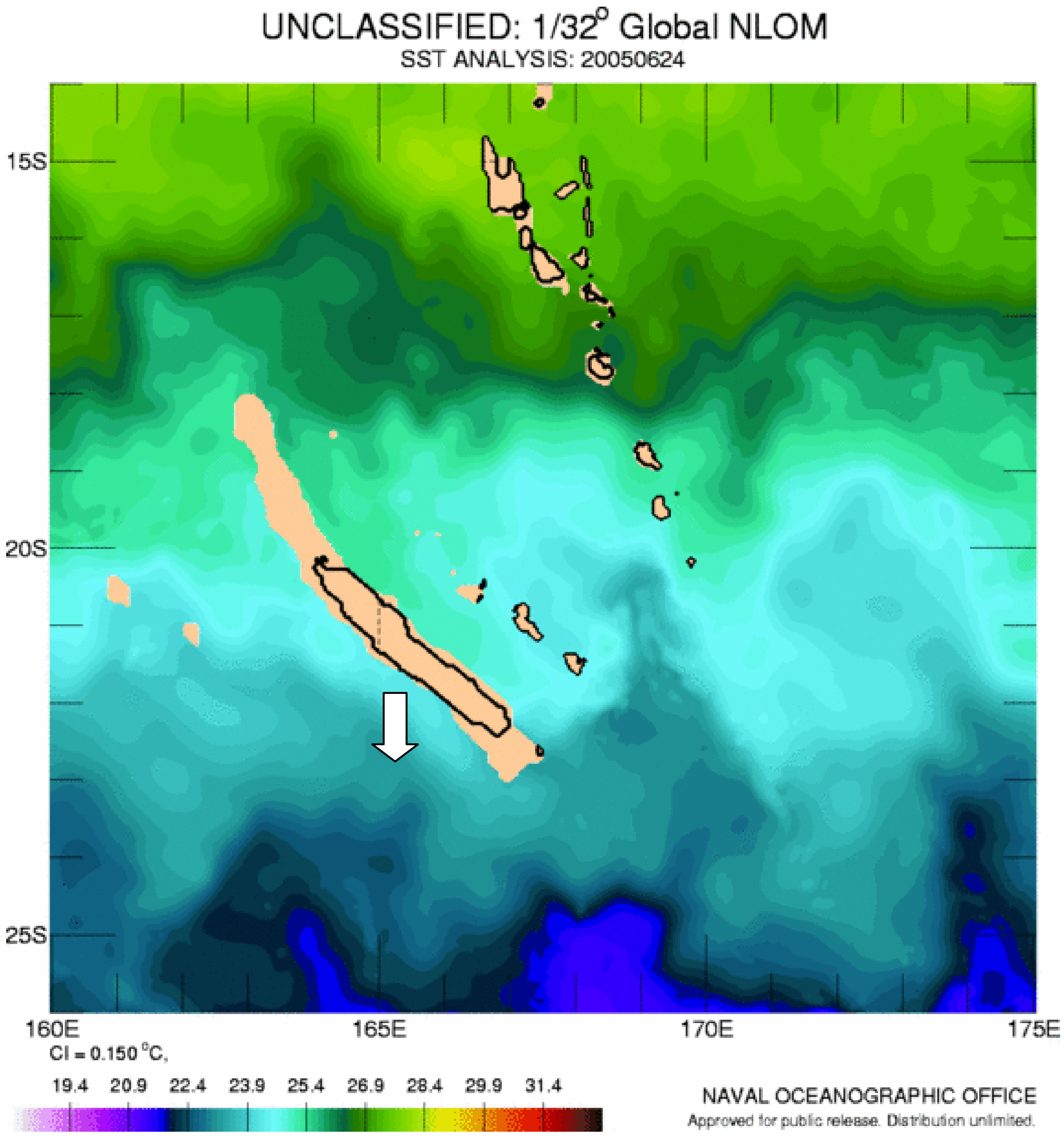

Figure 7. NLOM SST for 24 June 2005 for New Caledonia's EEZ. Poor fishing.

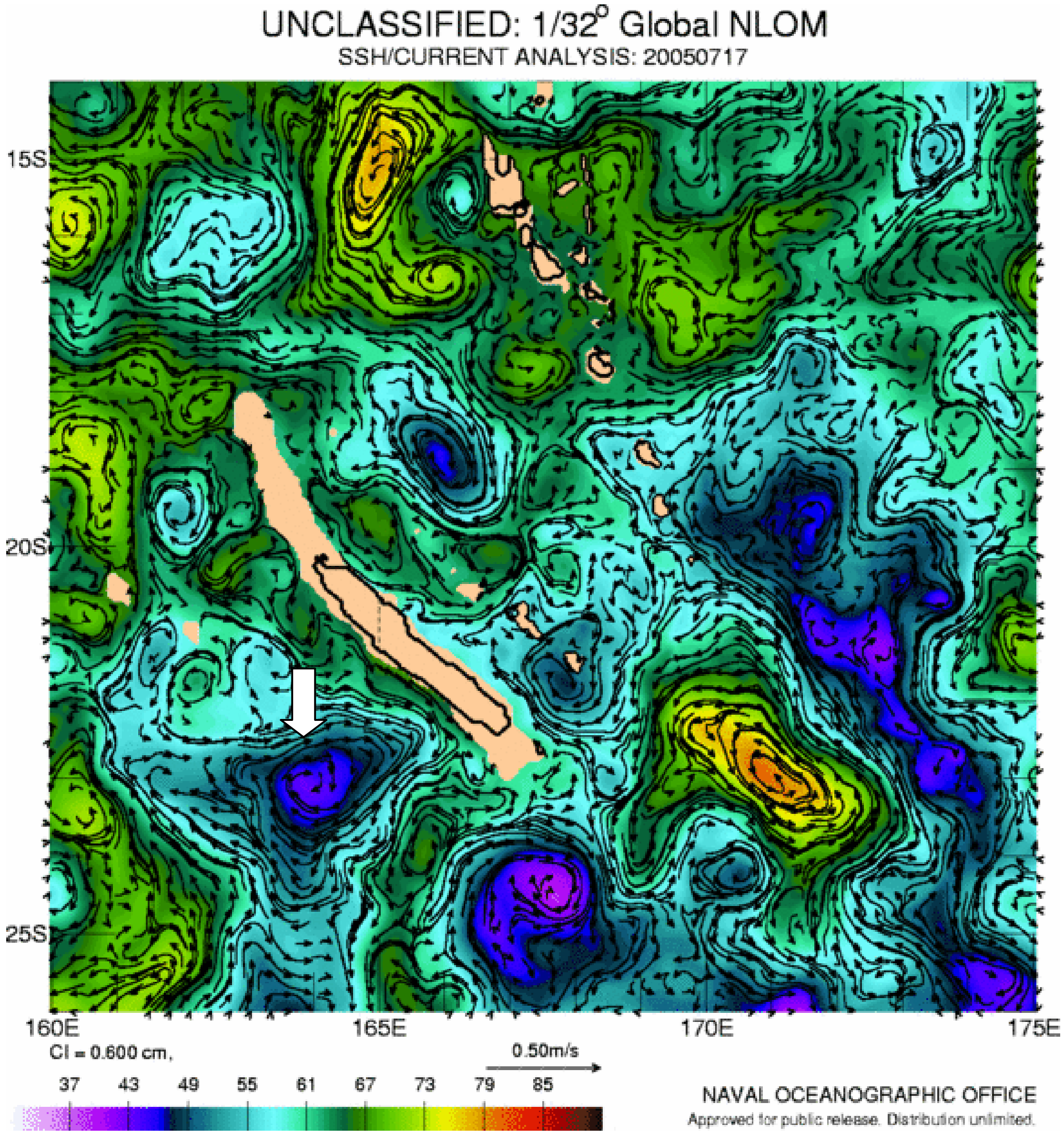

Figure 8. NLOM SSH for 17 July 2005 for New Caledonia's EEZ. Good fishing.

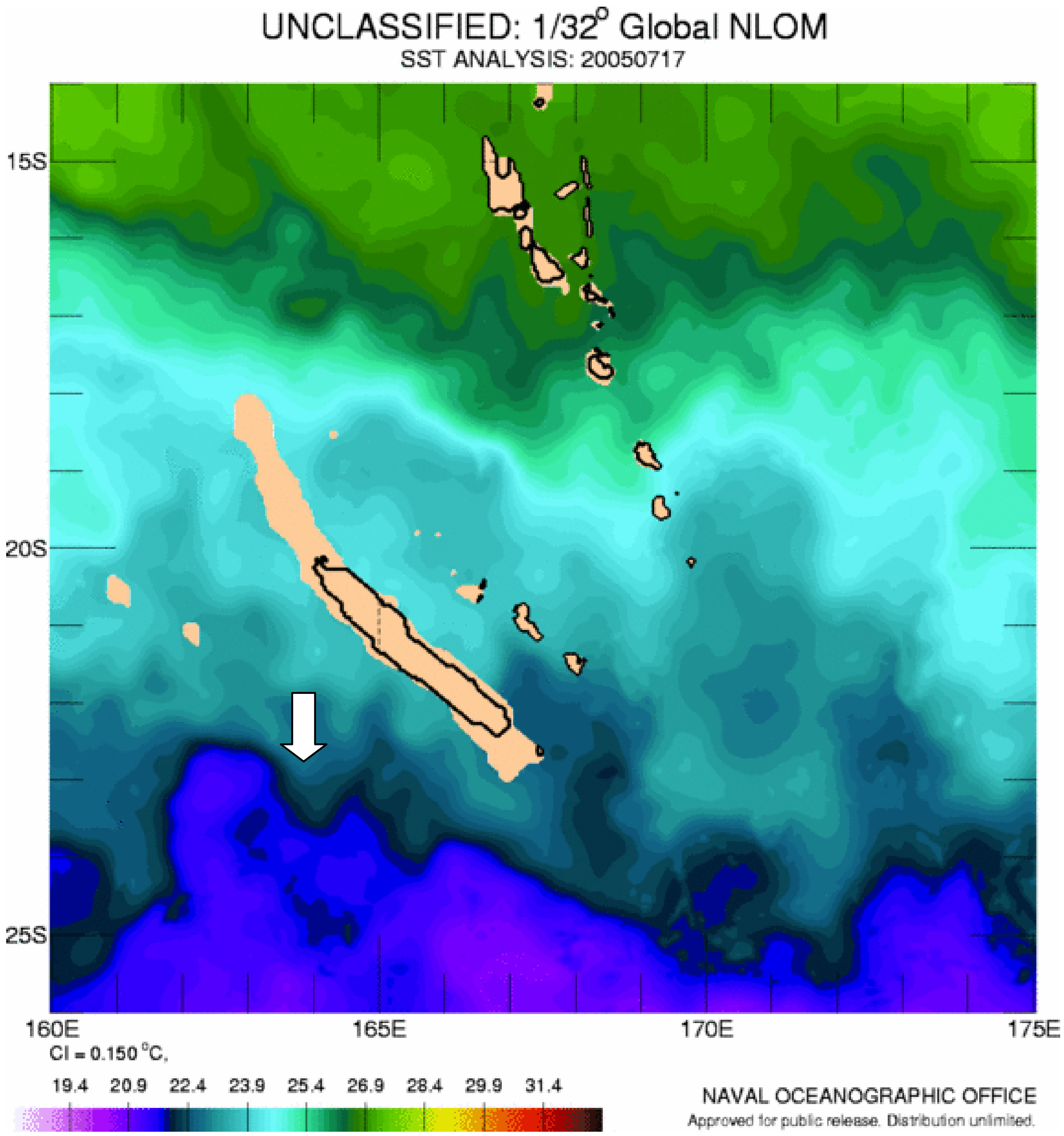

Figure 9. NLOM SST for 17 July 2005 for New Caledonia's EEZ. Good fishing.

As an ongoing project, it is proposed to collect logbook data from Albacore Sarl for just one boat, F/V *Yellowfin*, and to hindcast this onto the NLOM charts over a period of time. Findings will be reported to management and to the captains. Management has agreed to supply the catch information but would prefer that any long term effort and results remain confidential.

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