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CRUISE REPORT: 1993 TRACKING STUDY OF DOLPHINS AND TUNA

During 1992, the IATTC, in cooperation with the NMFS and the University of Hawaii, studied the relationship between spotted dolphins and yellowfin tuna by radio-tagging dolphins and sonic-tagging yellowfin tuna from the same aggregation. By tracking both species simultaneously it was believed that the resulting information would be valuable in two ways. On the scientific side, the study of tuna and dolphin movements and interactions, in conjunction with food-habits studies conducted by the IATTC and NMFS, would help to establish the longevity and dynamics of the tuna-dolphin bond and whether and to what degree it is food-based. On the tactical side, we could determine whether the bond loosens or breaks at particular times or under certain conditions, and, if so, whether the tuna would be vulnerable to fishing at such times.

During the 1992 cruise, we attempted to capture spotted dolphins and yellowfin tuna from the same aggregation, attach transmitters to as many individuals of each species as practical, release them, and monitor their movements. The dolphins and tuna were captured by a U.S. tuna purse-seiner, the *Nicole K.*, and tracked from the NOAA ship, R/V *McArthur*, and two launches. Six dolphins were tagged and tracked; three time-depth recorders (TDRs) were deployed on the dolphins and two of them were recovered when the dolphins were recaptured. Five tuna were tagged but none could be tracked.

A second cruise was conducted in 1993 to continue the research. Thirty days of shiptime were available aboard the R/V *McArthur* between 6 November - 5 December 1993. We targeted an area off the coast of central Mexico where the seas were likely to be the calmest during November (Figure 1, Table 1). The Mexican purse seiner, *Convemar*, was chartered by the IATTC and the Programa Nacional para el Aprovechamiento del Atún y Protección de los Delfines (PNAAPD) during this period to capture tuna and dolphins. The PNAADP conducted acoustic and bubble-curtain experiments aboard the seiner. Scientists from the IATTC, NMFS, University of Hawaii, Universidad Nacional de Costa Rica, and PNAAPD participated in the tracking study (Table 2).

Once the tuna were captured by the purse seiner, some were tagged by lancing them in the dorsal musculature with sonic transmitters attached to flat dart heads. We attempted to apply the transmitters to the fish by capturing them using handlines inside

the net from a 5-m boat and by lancing the free-swimming fish using scuba divers. There were no appropriate sets with sufficient tuna, however, to make either of these methods successful. Swimmers, however, were able to successfully lance free-swimming fish during backdown. Three types of transmitters were used: one type gives only horizontal movement information (V3: range 0.5-0.75 nm), while the other two transmit the ambient pressure to monitor the animals' swimming depth in addition to location (V7P: range 0.75-1.0 nm; V3P: range 0.5-0.75 nm). The transmitters had a nominal longevity of 8-13 days.

The dolphins were caught by swimmers inside the net prior to backdown and placed in a raft. The dolphins were outfitted with radio transmitters mounted on plastic saddles that were attached to the dorsal fin with two 1/4-in. delrin pins. The delrin pins were secured by magnesium nuts that corrode in sea water, releasing the package in a few weeks. The length and sex of the dolphins were recorded and the dolphins were released inside the net so that the entire aggregation could be released from the net together. We also attached TDRs to most of the dolphin transmitter packages. This device recorded the depth of the package every 5 seconds, which could then be compared with the vertical movements of tuna tagged with depth-sensitive transmitters. In order to recover the data, however, we had to recapture the dolphin and remove the package.

The entire tuna-dolphin aggregation was to be released from the net together, either by releasing the bow end of the net or by using the backdown method. Two tracking launches deployed by the *McArthur* were positioned prior to the release along the anticipated escape route of the aggregation. Both launches were rigged with sonic- and radio-tracking gear so that they could be used to track both dolphins and tuna. When sonic-tracking from the launches, the pulse repetition rate of the sonic transmitter was decoded, and the position of the launch, time, and depth of the tuna were recorded approximately every 5 seconds. When radio-tracking from any of the vessels, the position, time, heading of the vessel, bearing to the dolphin, and signal strength were recorded every 15 minutes.

A SEACAT mini-CTD (for measuring depth, temperature, and conductivity converted to salinity) or an XBT was deployed from the *McArthur* approximately every 4 h to a depth of at least 200 m. Of particular interest was the correlation of the swimming depths of the dolphins and tuna with the depth of the thermocline.

Results

Eighteen sets were made on dolphins (Table 1). Spotted dolphins were tagged during 5 sets, and tuna were tagged during 3 sets. Five dolphins were tracked during the study from 1 to over 4 days (Table 1). Three tuna carrying depth-sensitive transmitters were tracked for 1 h, 8 h, and 31 h. These tracks allow us to compare the

horizontal and vertical movements of the two species. The capability for making repetitive sets on the same dolphins and observing them from the helicopter also provided data on the recruitment of tuna to the dolphins. It also allowed us to monitor changes in herd size and composition of the dolphins.

Tracking the dolphins also provided an opportunity to recover the TDRs. We recovered 3 of the 4 TDRs deployed after the dolphins had been at liberty for 18.5 h, 2 days, and over 4 days. The TDRs measured and stored the depth of the dolphins every 5 sec. Thus, a history of the dolphin's diving behavior was preserved when the TDR was recovered. The diving data can be interpreted to determine the times and depths that the dolphins feed and their preferred swimming depths, particularly in relation to the thermocline. The data could also potentially be useful for calibrating herd size and abundance estimates by calculating the percentage of time that, on average, a dolphin would be visible at or near the surface.

Analysis of the TDR data from the 1992 and 1993 cruises (5 dolphins) indicated that spotted dolphins make deep dives at night, apparently to feed on organisms in the deep scattering layer as they migrate toward the surface at night (Figures 2-3). These deep dives were particularly apparent just prior to dawn and just after sunset. The deepest dive recorded was to 203 m during one of the dawn diving bouts of dolphin D9. During the daytime, the dolphins typically dove to < 20 m (Figure 4).

The tuna showed a different pattern. During the day, the tuna swam in the mixed layer to depths of about 35-40 m, just below the typical dive depths of the dolphins. After dusk, however, the tuna narrowed their vertical movements to shallower depths up to about 25 m at the same time that the dolphins were diving deeper. Figures 5 and 6 show the change from the nighttime diving pattern to the daytime one around dawn. The deepest swimming depth of the tuna (T1) was 110 m.

The simultaneous tracking of dolphins and tuna suggests that the association is neither permanent nor obligatory. During the 31-hour track of Tuna T1, the fish followed the dolphins for about 1 hour after they were released from the net, but then separated at 1215 h. The tuna were not observed with dolphins throughout the rest of the track even though several dolphin sightings were made in the close vicinity of the tuna. Tuna T5 was not released simultaneously with the dolphins (the dolphins were released at backdown, but the tuna had to be released afterwards by opening the bow end of the net), but was with a dolphin herd later that night (1900 h) as evidenced by the echolocation sounds heard through the tracking hydrophone and the visual observations of dolphins around one of the tracking boats.

The success of such a project is due in large part to the cooperation, experience, and skill of the captains and crews of the *Convemar* and the *McArthur*. The skipper of the

Convemar, Benjamin Cervantes, and his crew accepted with good grace the fishermen's heresy of letting fish go. It was due to their skill, hard work, and persistence that resulted in the recapture of the three dolphins tagged with TDRs. The *Convemar* was also used to track dolphins. CDR Dave Peterson of the *McArthur* provided support, advice, and encouragement to safely conduct our operations. His officers and crew integrated themselves into every facet of the research: tagging and tracking dolphins and tuna, logistical support, and collecting environmental data. The scientific teams aboard the vessels are listed in Table 2.

Table 1. Summary of studies conducted aboard the R/V McArthur and purse seiner Convemar during 6 November - 5 December 1993. Tagging studies conducted by the IATTC, NMFS, and University of Hawaii; acoustic recording and bubble-curtain experiments conducted by Programa Nacional para el Aprovechamiento del Atun y Protección de los Delfines (PN).

SET NO.	DATE (TIME)	LATITUDE	LONGITUDE	DOLPHINS CAPTURED	TUNA CAPTURED (tons)	TUNA LOADED (tons)	EXPERIMENTAL WORK
1	9 Nov (1203)	22° 11'N	109° 56'W	0	0	0	None.
2	10 Nov (1538)	19° 27'N	106° 24'W	200 S. attenuata	5	5	None.
3	15 Nov (1103)	13° 32'N	101° 11'W	160 S. attenuata 38 S. longirostris 2 T. truncatus	5	5	We aborted tagging operation due to steering failure on tracking launch. PN- acoustic recordings.
4	19 Nov (1350)	17° 48'N	103° 30'W	20 S. attenuata	< 1/2	0	Tagged Dolphin D7 (191-cm male) 148.300 MHz (TDR). Tracked 18.5 h. PN- acoustic recording.
5	20 Nov (0848)	17° 21'N	103° 54'W	27 S. attenuata 4 S. longirostris	0	0	Recovered TDR from D7. PN- acoustic recording
6	20 Nov (1545)	18° 5'N	103° 55'W	225 S. attenuata	4-5	4-5	Too late for tagging study. PN- bubble experiment.
7	21 Nov (0841)	18° 34'N	103° 57'W	60 S. attenuata	4-5	1	Tagged Dolphin D8 (198-cm female) 148.370 MHz (TDR), Tuna T1 (ca. 60 lbs.) 50 KHz, and Tuna T2 (ca. 60 lbs.) 60 KHz. Tracked D8 49h and T1 31h. PN- bubble experiment.
8	23 Nov (0845)	18° 37'N	104° 2'W	200 S. attenuata 1 D. delphis	15	15	Recovered TDR from D8. Aborted tagging operation due to broken purse cable.
9	25 Nov (0750)	18° 52'N	105° 33'W	20 S. attenuata	1	1	Aborted tagging operation due to high proportion of calves. PN- bubble experiment.
10	25 Nov (1530)	18° 21'N	105° 4'W	90 S. attenuata 30 S. longirostris	< 1/2	< 1/2	Too late for tagging study. PN- bubble experiment.

11	26 Nov (0804)	18° 28'N	104° 14'W	120 S. attenuata	6	6	Tagged Dolphin D9 (196-cm female) 148.370 MHz (TDR); Tuna T3 (ca. 60-80 lbs.) 50 KHz, and Tuna T4 (ca. 60 lbs.) 60 KHz. Tracked D9 4.25 days and T3 1h.
12	27 Nov (1311)	18° 32'N	103° 57'W	300 S. attenuata	1	1	Aborted tagging operation because no fish were seen until backdown.
13	28 Nov (0755)	18° 33'N	104° 5'W	300 S. attenuata	5	5	Attempt to recapture D9 failed. PN- bubble experiment.
14	28 Nov (1206)	18° 29'N	104° 19'W	0	0	0	Attempt to recapture D9 failed.
15	29 Nov (0917)	18° 26'N	104° 17'W	8 S. attenuata	< 1/2	< 1/2	Attempt to recapture D9 failed.
16	29 Nov (1456)	18° 23'N	104° 4'W	14 S. attenuata 1 D. delphis	0	0	Attempt to recapture D9 failed. Tagged Dolphin D10 (200-cm male) 148.300 MHz (TDR). Tracked 32h.
17	30 Nov (1130)	18° 21'N	104° 12'W	30 S. attenuata 21 S. longirostris	5-8	< 1/2	Tagged Dolphin D11 (175-cm male) 148.319 MHz; Tuna T5 (ca. 20 lbs.) 60 KHz, and Tuna T6 (ca. 20 lbs.) 71 KHz. Tracked D11 11h and T5 8h. PN- bubble experiment.
18	30 Nov (1621)	18° 17'N	104° 16'W	2 S. attenuata	0	0	Recovered TDR from D9.

Table 2. List of scientific personnel aboard the NOAA research vessel R/V *McArthur* and the Mexican purse seiner *Convemar*.

McArthur

Michael Scott (Chief Scientist, IATTC)
Robert Olson (IATTC)
Susan Chivers (NMFS)
Kim Holland (Univ. of Hawaii)
Marco García (IATTC)
Howard Rhinehart (IATTC)
Wes Armstrong (NMFS)
Jenny Asch (Universidad Nacional de Costa Rica)
Gabriel Aldana (PNAADP)

Convemar

Dave Bratten (IATTC)
Tomás Arizpe (Universidad Nacional Autonoma de Mexico)
Humberto Robles (PNAAPD)

FIGURE 1

TUNA-DOLPHIN TRACKING STUDY: 1993

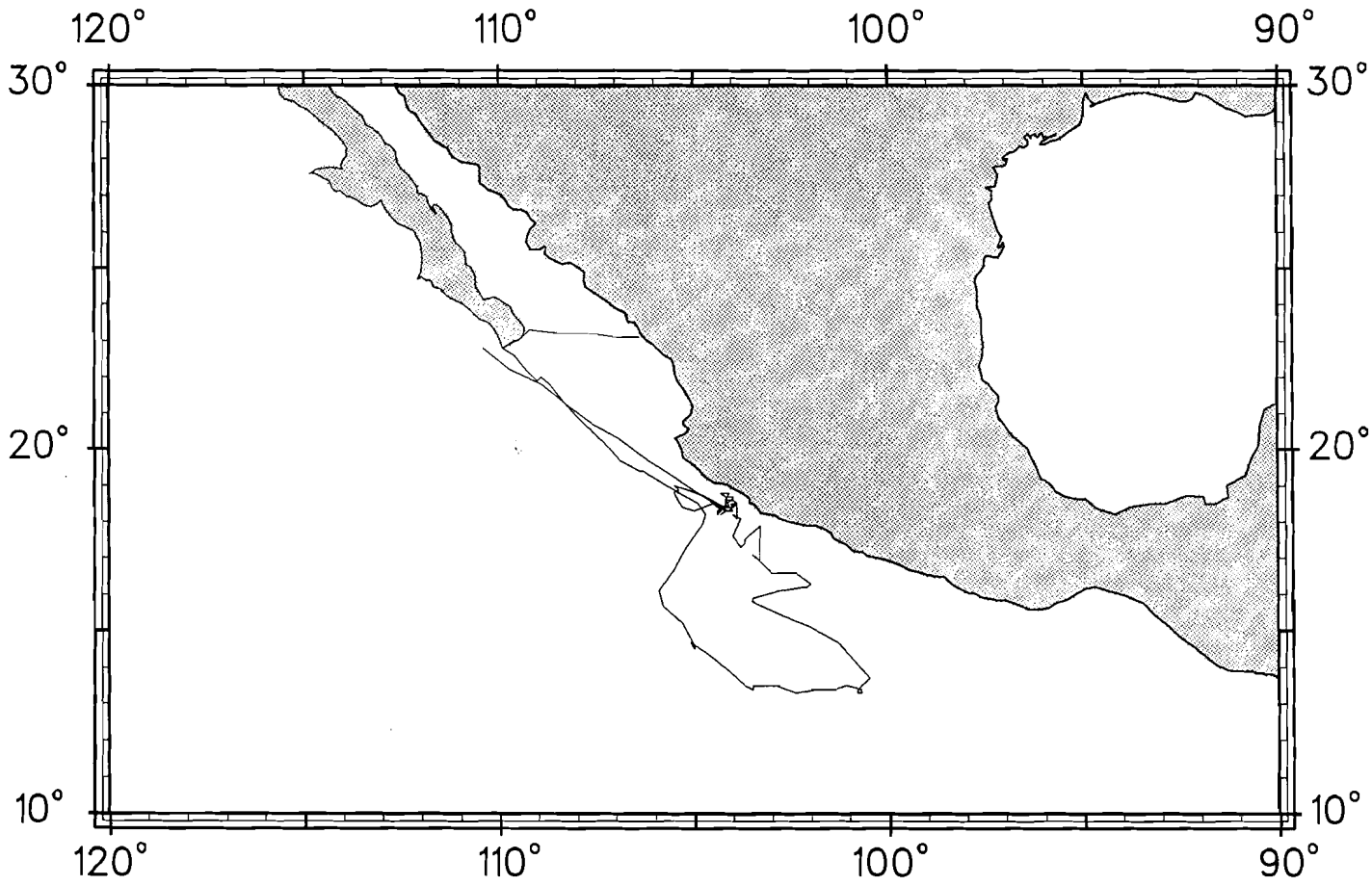
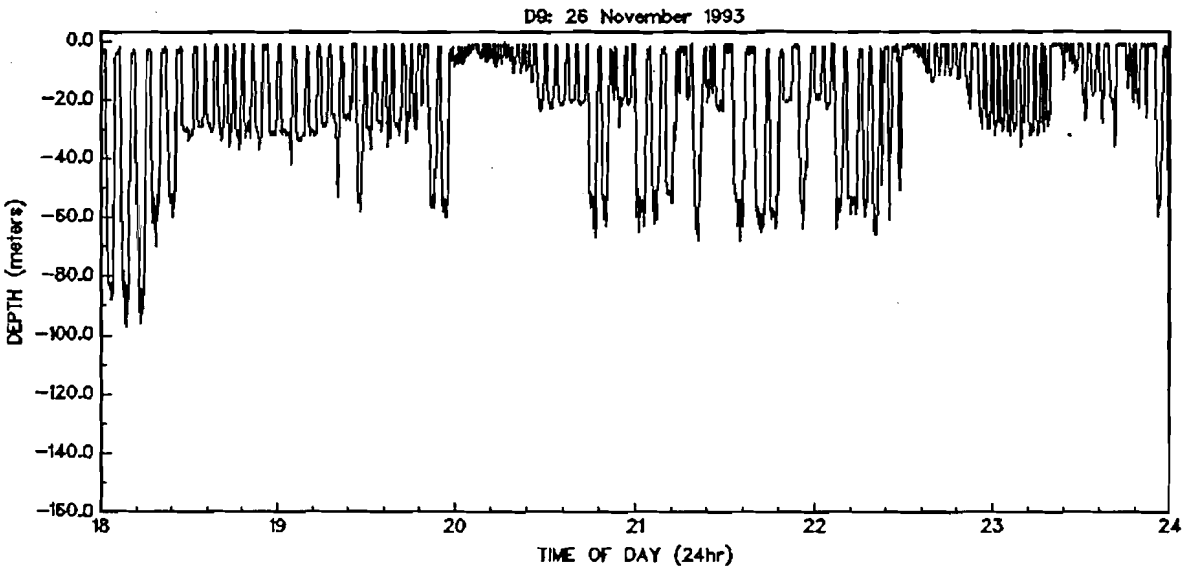


FIGURE 2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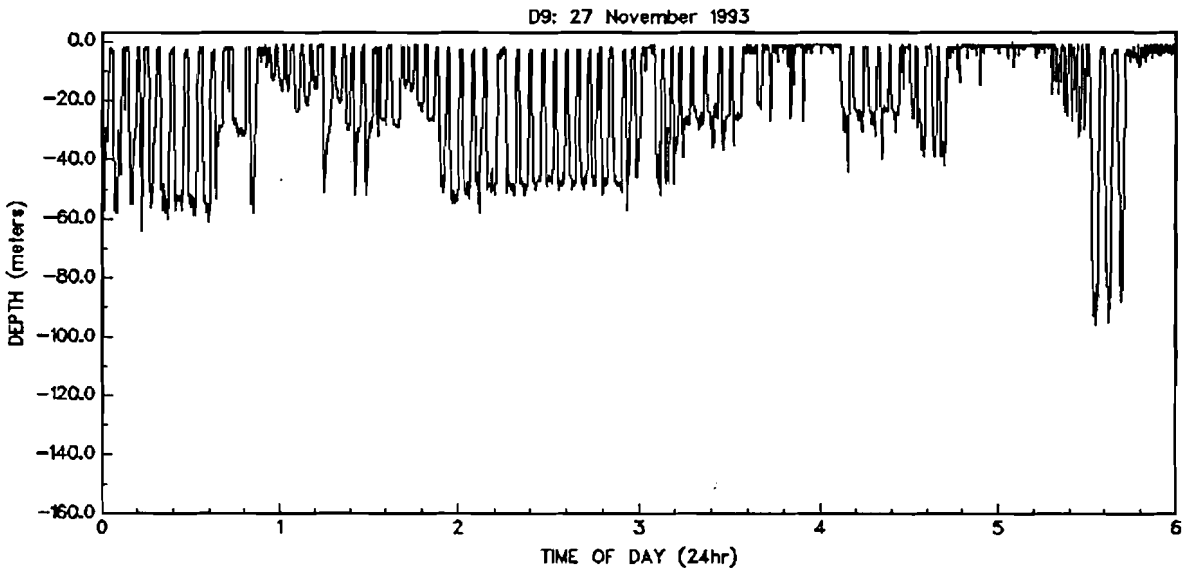
DEPTH (meters)
18
19
20
21
22
23
24
TIME OF DAY (24hr)

FIGURE 3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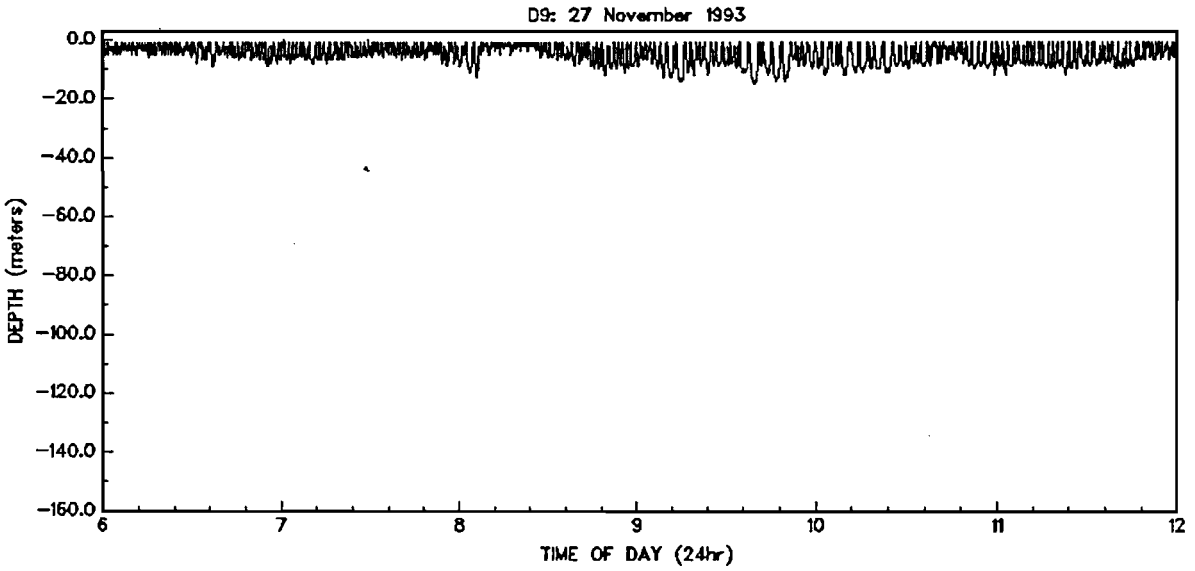
DEPTH (meters)
0
1
2
3
4
5
6
TIME OF DAY (24hr)

FIGURE 4


D9: 27 November 1993
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-100.0
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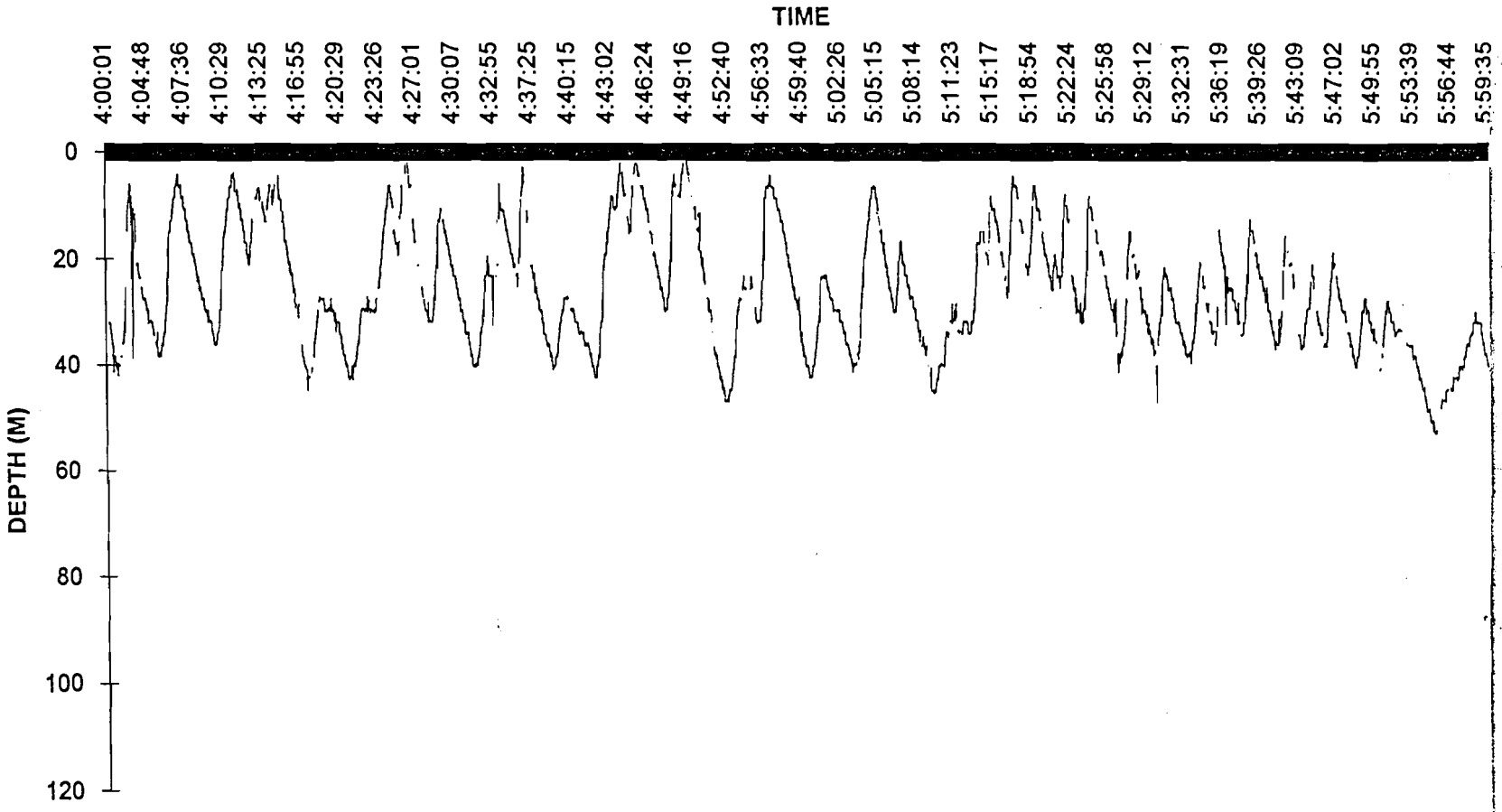
DEPTH (meters)
6
7
8
9
10
11
12
TIME OF DAY (24hr)

FIGURE 5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5:47:02
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DEPTH (M)
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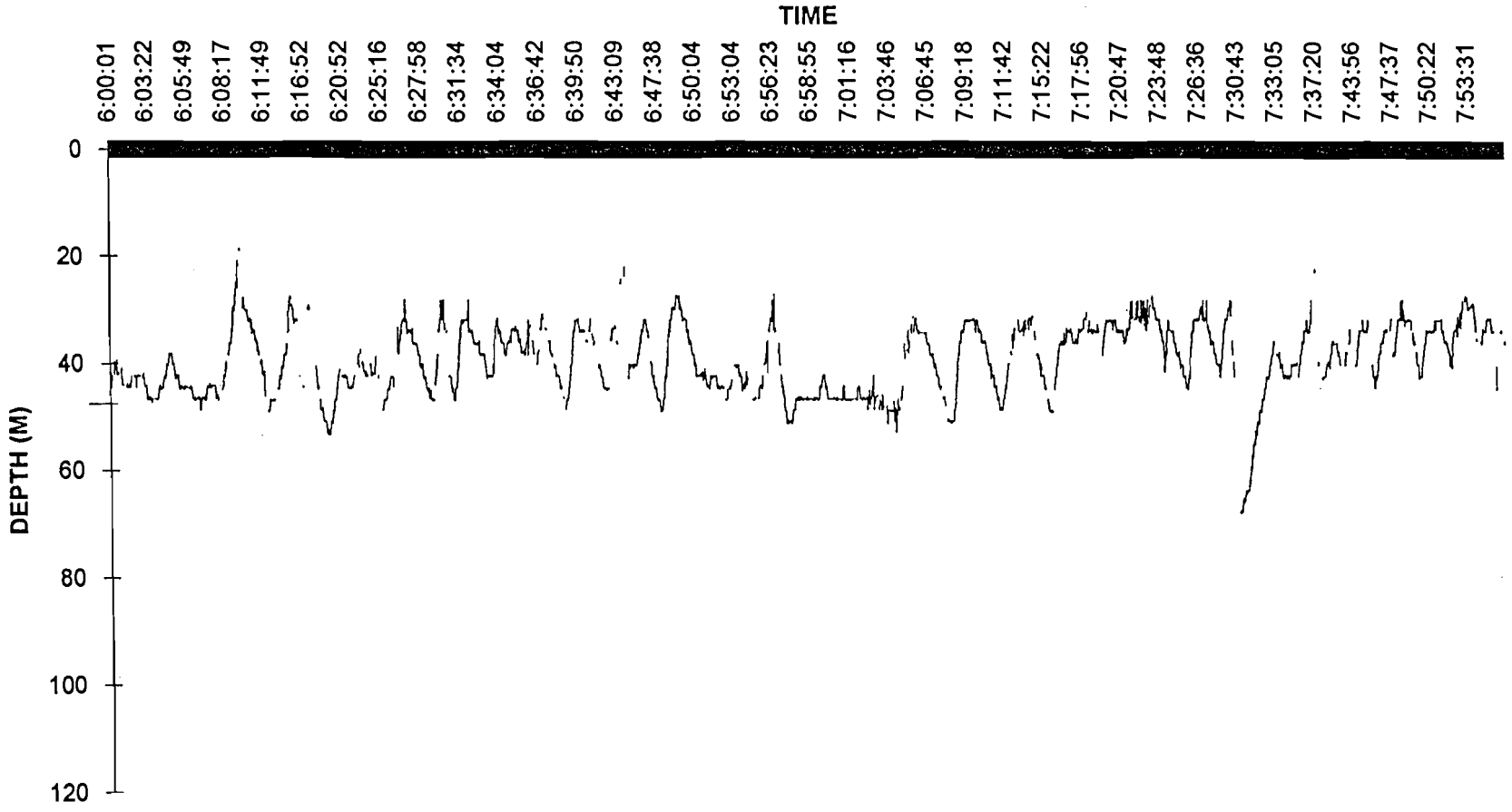
20
40
60
80
100
120

FIGURE 6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DEPTH (M)
0
20
40
60
80
100
120