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# CRUISE REPORT: TRACKING STUDY OF DOLPHINS AND TUNA

## INTRODUCTION

The nature of the tuna-dolphin bond is still unclear despite the many years of research devoted to both tunas and dolphins in the eastern tropical Pacific Ocean (ETP). Yellowfin tuna (*Thunnus albacares*) are associated most frequently with spotted dolphins (*Stenella attenuata*), but are found with spinner dolphins (*S. longirostris*) and common dolphins (*Delphinus delphis*) as well. The overlap in the feeding habits of spotted dolphins and yellowfin tuna found by Perrin et al. (1973) suggests that the relationship may be food-based; however, the similarity in feeding habits could be a result, rather than the cause, of this association. Studies by the IATTC suggest that the relationship may be a diurnal one (Scott, 1991), although the dynamics of these multi-species aggregations are not very well known.

A better understanding of the biology of the dolphins and tunas has been gained from tagging and tracking studies (Bayliff, 1979; Perrin et al., 1979; Carey and Olson, 1982; Holland et al., 1990), but these studies did not address the nature of the tuna-dolphin bond in the ETP. To study the relationship between these species, we proposed to radio-track spotted dolphins and sonic-track yellowfin tuna from the same aggregation simultaneously. This information would be valuable in two ways. On the scientific side, the study of tuna and dolphin movements and interaction, in conjunction with food-habits studies conducted by the IATTC and NMFS, will help to establish the longevity and dynamics of the tuna-dolphin bond and the degree that 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 this preliminary study, we attempted to capture spotted dolphins and tunas 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 tuna purse-seiner, the *Nicole K.*, and tracked from the NOAA ship, R/V *McArthur*, and its launches.

## METHODS

Thirty days of shiptime were available aboard the R/V *MacArthur* between 6 November - 5 December 1992. We targeted two areas where the seas were likely would to be the calmest during November: the area within 250 miles of the coast of Costa Rica and Panama (from about the Golfo de Nicoya to Punta Mariato), and the area between

90-100° W and 10-12° N (east of Clipperton), (Forrest Miller, IATTC, pers. comm.). The *Nicole K.* was chartered for the same 30-day period to capture tuna and dolphins.

We installed radio- and sonic-tracking equipment on the two hydrographic launches and radio-tracking gear aboard the *McArthur* and the purse seiner. Four-antenna arrays (Yagi-Uda antennas oriented at 90°-intervals) were mounted on the masts of the *McArthur* and the *Nicole K.*, and on 10-ft masts aboard the launches. A mount for the hydrophone was welded to the side of each launch.

We attempted first to capture the tuna prior to the backdown procedure by angling from a 5-m boat inside the net using handlines. Large fish were to be drawn near the boat, measured, and lanced in the dorsal musculature with a sonic transmitter attached to a flat dart head (Bayliff and Holland, 1986). Smaller tuna were to be brought on board and tagged by suturing (Carey and Olson, 1982; Holland et al., 1985). After tagging and measuring, the leader from the handline would be cut and the fish allowed to swim free inside the net until the entire tuna-dolphin aggregation was released as simultaneously as possible. When the capturing the tuna by handlining proved difficult, skindivers applied the transmitters with a lance to free-swimming fish just prior to and during backdown.

We used ultrasonic transmitters (VEMCO in Halifax, Nova Scotia) that have a nominal longevity of 3 days with an operating range of 0.5-0.75 mile. Two types of transmitters were used: one type ("pingers") gives location information, while the other transmits the ambient pressure to monitor the animal's swimming depth in addition to location.

The dolphins were caught by swimmers prior to backdown and placed in a raft. The dolphins were outfitted with radio transmitters (Telonics in Mesa, Arizona) 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 days or a few weeks. The tissue plugs removed to attach the package were saved for genetic analysis. 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 together. When feasible, other dolphins in the herd were rototagged for later identification. We also attached time-depth recorders (TDRs) to some of the dolphin transmitter packages. This device recorded the depth of the package every 10 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, preferably by releasing the bow ortza to open the net. When that method did not appear to be practical, we used the backdown method to release all the animals. The launches were positioned prior to the release along the anticipated escape route of the aggregation.

One launch was primarily dedicated to tracking dolphins, the other to tracking the tuna. Both launches were rigged with sonic- and radio-tracking gear so that we could triangulate positions (sonic receivers: VEMCO in Halifax, Nova Scotia; radio: receivers, scanners, and data processors from Telonics in Mesa, Arizona, direction finder from ATS in Isanti, Minnesota). The strategy was not to attempt to track all animals simultaneously, but to focus on single animals, collecting data on other animals on an opportunistic basis or as a backup if the signals from the focal animals were lost. While the tracking was being conducted, an observer aboard the seiner's helicopter estimated the numbers of dolphins and tonnage of tuna present.

A SEACAT mini-CTD (for measuring depth, temperature, and salinity) or an XBT was deployed from the *McArthur* approximately every 4 h. Observations of bird flocking behavior were also made from the *McArthur* to study the association of seabirds with dolphins and tunas, and to study daily variation in flock size.

## RESULTS

### Tagging effort

Eleven sets were made on spotted dolphins (Table 1, Figure 1). Dolphins were tagged during 5 sets, and tuna were tagged during 2 sets. Of the 30 days of shiptime available, 7 days were lost due to deadhead time, and 9 days due to weather or seas that did not allow the *McArthur's* tracking boats to be launched. An additional 5 days were spent searching in areas where the density of spotted dolphins was low because we had to leave areas of higher density due to poor weather. Only 9 days were spent in higher-density areas with good weather.

### Tests of Tagging and Release Methods

During Set No. 1, the *Nicole K.* attempted to release dolphins and tunas simultaneously by dropping the bow ortza. The corkline dropped for 30-40 m from the seiner's bow; most of the tuna escaped through the opening, but the dolphins did not and required release by hand. Three dolphins died during this set. Because of the risk to the dolphins, we used the backdown procedure during the remaining sets to release the dolphins and tuna together. The dolphin mortality for the remaining sets was zero.

We attempted to capture tuna for tagging by fishing inside the net with hook-and-line gear during 8 sets, but none were caught. Only on one set did a fish strike at the baited hook, although some fish ate or at least investigated the dead chum. We also tested the use of swimmers to tag free-swimming tuna in the net with a lance during 3 sets. Four tuna were tagged in this manner just prior to or during the backdown procedure. We discovered that the speed of backdown was important for successfully tagging and releasing the tuna. A slow backdown allowed the dolphins and tuna to concentrate at the apex and improved the chances of tagging a tuna, but decreased the chances that the tuna would escape because the corks would not drop very deep after the dolphins had left the net.

The ability to tag and release the tuna also depended greatly on the behavior and numbers of the tuna. The tuna generally swam slowly in the net prior to backdown, often swimming under the dolphins and sometimes under a drifting raft. The tuna usually swam deeper than 10 m and often could not be seen early in the set. As the net channel formed during the backdown, the tuna swam faster and shallower as the area to swim in decreased. We believe that at least 10-15 tons of tuna should be in the net to successfully tag tuna in this manner. Larger schools came closer to the surface, particularly as the net constricted, making it easier for swimmers to tag the tuna. Larger schools were also easier to back out of the net.

Capturing, tagging, and releasing the dolphins proved to be easier. Teams of swimmers were able to grab individual dolphins when the net was constricted just prior to backdown and place them in a partially flooded raft for tagging. The tagging process became more efficient with experience, lasting only 7 min in later sets. The dolphins were released back inside the net so that they could be backed out with the rest of the herd. The design of the transmitter package appeared to provide good support for the antenna and yielded strong transmissions. Observations of the tagged dolphins showed that the package did not appear to hinder their swimming.

Three tagged dolphins and three tuna were successfully released from the net on Set No. 8. One tuna that tangled in mesh while the seiner rolled net was tagged with a depth-sensitive transmitter (60 kHz) and released back into the net. It appeared moribund, however, and was not expected to survive (it sank passively after tagging). Therefore, when two other tuna were tagged by lancing during backdown, one was tagged with another depth-sensitive transmitter at the same frequency while the other was tagged with a pinger (69 kHz). During backdown, all of the estimated 275 dolphins and about 13 of the estimated 15 tons of tuna were released, including the previously moribund tagged tuna which was observed to be swimming with the school and in apparently good condition. Unfortunately, this led to confusion in tracking the tuna out of the net when two fish bearing transmitters at the same frequency swam in different directions. The signals were lost before a heading could be determined. The backdown was conducted before we had planned (due to the dolphins crowding at the apex and spilling over the corkline), and before the tracking vessel was in position. During the subsequent 3 days, no signals were heard from the tagged tuna even though all of the tagged dolphins were resighted or recaptured.

**Dolphin tracking results**

Six dolphins were tracked during the study; 5 were tracked for 1-2 days; a sixth track was abandoned after 2.5 h to attempt another set (Table 1). The tracking system worked very well, with ranges up to 13 miles from the *McArthur* and the *Nicole K.* and greater than 5 miles from the launches. The direction finders could not give bearings at these maximum ranges, but proved to give reasonably accurate and reliable bearings at closer ranges. The system is a great improvement over manual direction-finding systems for tracking dolphins. The dolphins did not appear to react to close approach

by the tracking launches, nor did they avoid the *McArthur* when tracking from less than 2 miles. The dolphins did appear to scatter when the *McArthur* approached slowly within one-half mile of the group to listen for acoustic signals from the tuna.

Tracking the dolphins, even without the simultaneous tracking of the tuna, proved to be worthwhile for several reasons. It provided data on the movements and diving times of six spotted dolphins. Their movement speeds and surfacing patterns can be compared under different circumstances: e.g., feeding vs. travelling, "normal" behavior vs. behavior during chase or after release from the net. Tracking the dolphins overnight also reduced the searching time to find a dolphin-tuna aggregation to set on the next morning. This capability for making repetitive sets on the same dolphins and observing them from the helicopter 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.

**Time Depth Recorders**

Tracking the dolphins also provided an opportunity to recover TDRs. It was initially thought that it was a long shot to monitor a particular individual while setting on a running and scattering dolphin herd, then capture the portion of the herd containing that individual, grab that individual out of the herd while in the net, and recover the tag. Nonetheless, we recovered 2 of the 3 TDRs deployed after the dolphins had been at liberty for 25-44.5 h.

The TDRs measured and stored the depth of the dolphins every 10 sec and the ambient temperature every minute. Thus, a history of the dolphin's diving behavior was preserved when the TDR was recovered. This is the first dive-depth data ever collected for spotted dolphins. 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. The data would likely change assumptions about dolphin movements for energetics studies.

Preliminary analysis of the TDR data indicate that spotted dolphins make deep dives at night, apparently to feed on organisms in the deep scattering layer during their daily vertical migration (Figures 2-3). These deep dives are particularly apparent at dawn and dusk. The daytime diving pattern is also quite interesting; the dolphins consistently dive to the top of the thermocline and swim at that depth before returning to the surface (Figure 4). We will be examining these patterns in more detail.

The primary reason for placing the TDRs on the dolphins was to compare the diving behavior of the dolphins with that of tuna tagged with depth-sensitive transmitters. Although we cannot yet compare the diving patterns during simultaneous tracks, we can now compare the data collected from this study with data on swimming depths from previous tracking studies of yellowfin tuna.

## FUTURE RESEARCH

During this study we have resolved several of the uncertainties that were inherent in such an ambitious project. We discovered that we could capture, tag, and track dolphins effectively. The tracking launches could closely approach the dolphins without disrupting their behavior. The fact that we could recapture individual dolphins to recover TDRs was particulary heartening. We found that the tuna could be tagged by swimmers in the backdown channel. We found that if sufficient numbers of tuna were present, they could be backed out of the net with the dolphins.

There are two problems for future simultaneous tracking experiments that need to be solved. One is to find the best method to tag the tuna and release them from the net nearly simultaneously with the dolphins. The other is how to reduce the amount of field time lost to weather and deadhead time.

Catching tuna with hook-and-line was not successful during this study, although we did observe interest by some fish in the chummed bait, and anecdotal reports indicate that tuna have have been caught hook-and-line in the net. Advantages of tagging with this method are that the fish can be measured and that the fish could be tagged prior to backdown, allowing the dolphins and tuna to be backed out rapidly without the congestion at the apex that could be caused by swimmers attempting to tag the fish as they swim by. One possible alternative for future work would be to use live bait for chumming, although this would require installing live-bait tanks aboard the one of the vessels.

A modification to the use of swimmers tagging the tuna in the backdown area would be to use scuba divers. This would make tagging easier because of the greater mobility of the divers and the potential for tagging the fish prior to backdown when they are swimming more slowly in the net. By tagging the tuna earlier in the set, the dolphins and tuna could then be released using a fast backdown (creating deep sinkage of the corkline) and alleviate any congestion that may be caused by swimmers at the apex. For all the alternatives, it is likely that the chances for tagging and rapid release improve markedly when 15 tons of tuna or more are present in the net. Rapid release of both dolphins and tuna may be facilitated by modifying the net in the backdown channel to allow the net to drop lower and for a longer time so that the tuna go out rather than turning back from the net and heading back toward the boat.

The problem of lost field days due to weather may be alleviated by choosing a different area or month to conduct the study. The areas chosen for this study characteristically have relatively low average wind speeds in November. However, the launches often could not be deployed, not due to local wind-driven seas, but due to swells coming from multiple directions. The multiple swells appeared to be due to our proximity to the Inter-tropical Convergence Zone and lying downwind of the Gulf of Tehuantepec. An alternative area off Acapulco has a high density of spotted dolphins and relatively good weather. A backup technique would be to use a towed hydrophone

array to track tunas from the *McArthur* when the weather is too poor to deploy the launches. The ship would still have to get within one-half mile of the tagged tuna and thus may affect the behavior of the dolphins. We will investigate these ideas further.

It became evident early in the cruise that the success of such a project depended greatly on the cooperation, experience, and skill of the captains and crews of the *Nicole K.* and the *McArthur*. The skipper of the *Nicole K.*, Bill Madruga, showed good humor and much patience, his experience allowed us to conduct the study as safely and effectively as possible. It was his skill and persistence that resulted in the recapture of the two dolphins tagged with TDRs. His crew spent every set in the water rescuing dolphins, tagging tuna, or bringing dolphins to be tagged. CDR Dave Peterson of the *McArthur* provided support, advice, and encouragement to safely conduct our operations. His crew members integrated themselves into every facet of the research: tagging and tracking dolphins, logistical support, and collecting environmental data. Future studies should consider the importance of the cooperation and skill shown by the crews of both vessels, and the experience they have gained during the current study would be a valuable asset in future studies.

## LITERATURE CITED

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Table 1. Summary of sets and tagging and tracking operations.

| DATE | SET NUMBER | NUMBER DOLPHINS CAUGHT | TONS TUNA CAUGHT | TONS TUNA BOARDED | DOLPHINS TAGGED | TUNA TAGGED | FREQUENCY | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| 9 NOV | 1 | 24 | 10 | <1 | | | | Set to test feasibility of releasing dolphins and tuna by releasing the ortza. |
| 11 NOV | 2 | 45 | 11 | 11 | | | | Launch used for handlining tuna capsizes in net. Experiment aborted. |
| 14 NOV | 3 | 200 | 10 | 10 | | | | No fish caught on handline. One dolphin captured, but released when the ship began backdown prematurely. |
| 19 NOV | 4 | 12 | 7 | 3 | D1 (TDR) 181-cm female | | 148.260 MHz | No fish caught on handline. One dolphin tagged and tracked to see if more tuna will be recruited to the dolphins by tomorrow. Tracked D1 for 25h (1240 19 Nov - 1330 20 Nov) |
| 20 NOV | 5 | 0 | 0 | 0 | | | | Skunk set. Attempt to recapture D1. |
| 20 NOV | 6 | 12 | 0 | 0 | | | | No fish to tag. Recovered TDR from D1. |
| 22 NOV | 7 | 150 | 10 | 0 | D2 177-cm male | | 148.138 MHz | No fish caught on handline. Tagged and tracked dolphin to attempt recapture same dolphins and tuna again tomorrow and try again. All fish backed out. Tracked D2 for 30.5h (1240 22 Nov -1815 23 Nov). |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 23 NOV | 8 | 275 | 15 | 2 | D3 (TDR)<br>187-cm female<br>D4<br>195-cm female | | 148.090 MHz<br><br>148.111 MHz | Set on D2's group. No fish caught on handline. One fish gilled in net was tagged and released. Two others were tagged by lancing during backdown. Could not maintain contact with tagged tuna after backdown (see text). Two dolphins were also tagged and tracked along with D2.<br>Tracked D3 for 29h (1055-1815 23 Nov, 0818-2324 25 Nov, 1345-1900 26 Nov).<br>Tracked D4 for 38h (1055 23 Nov - 0110 25 Nov). |
| | | | | | | T1<br>T2<br>T3 | 60 kHz<br>69 kHz<br>60 kHz | |
| 24 NOV | 9 | 175 | 15 | 2 | D5 (TDR)<br>167-cm female | | 148.300 MHz | Set on D4's group. No fish caught on handline. Two fish lanced in backdown channel, but did not back out of net.<br>Tracked D5 for 44.5h (1220 24 Nov - 0900 26 Nov). |
| | | | | | | T4<br>T5 | 60 kHz<br>65.54 kHz | |
| 26 NOV | 10 | 35 | 1 | 1 | D6<br>195-cm female | | 148.190 MHz | Set on D5's group. No fish caught on handline. Recovered TDR from D5. No fish were lanced soon after the dolphins were backed out so the attempt was aborted.<br>Tracked D6 for 2.5h (1033-1354 26 Nov). |
| 26 NOV | 11 | 7 | 2 | 2 | | | | Attempt to recapture D2 failed and no attempt to tag was made because so few fish and dolphins were in the net. |

Fig 1

# DOLPHIN-TUNA TRACKING STUDY

## 1992

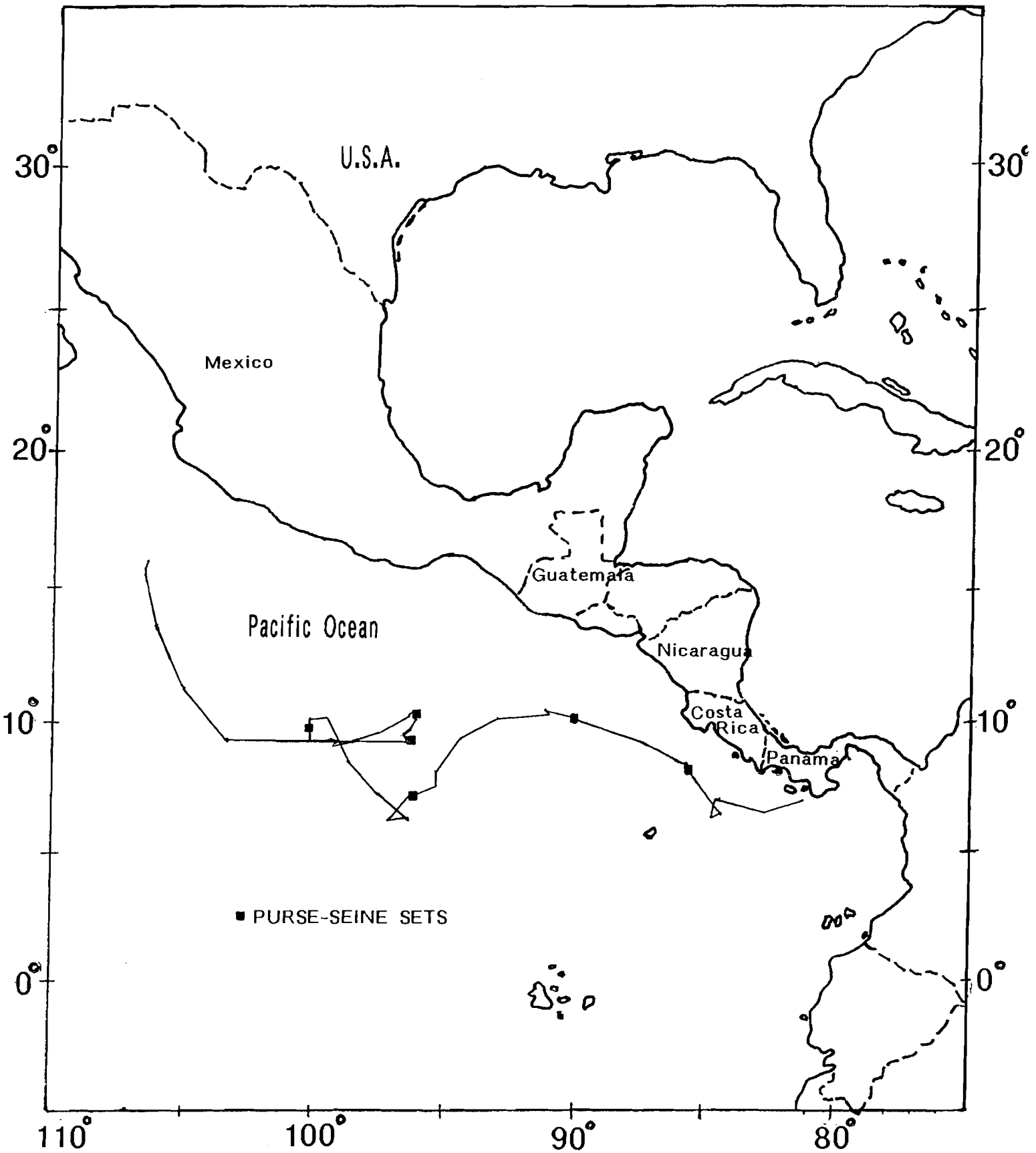


Fig 2

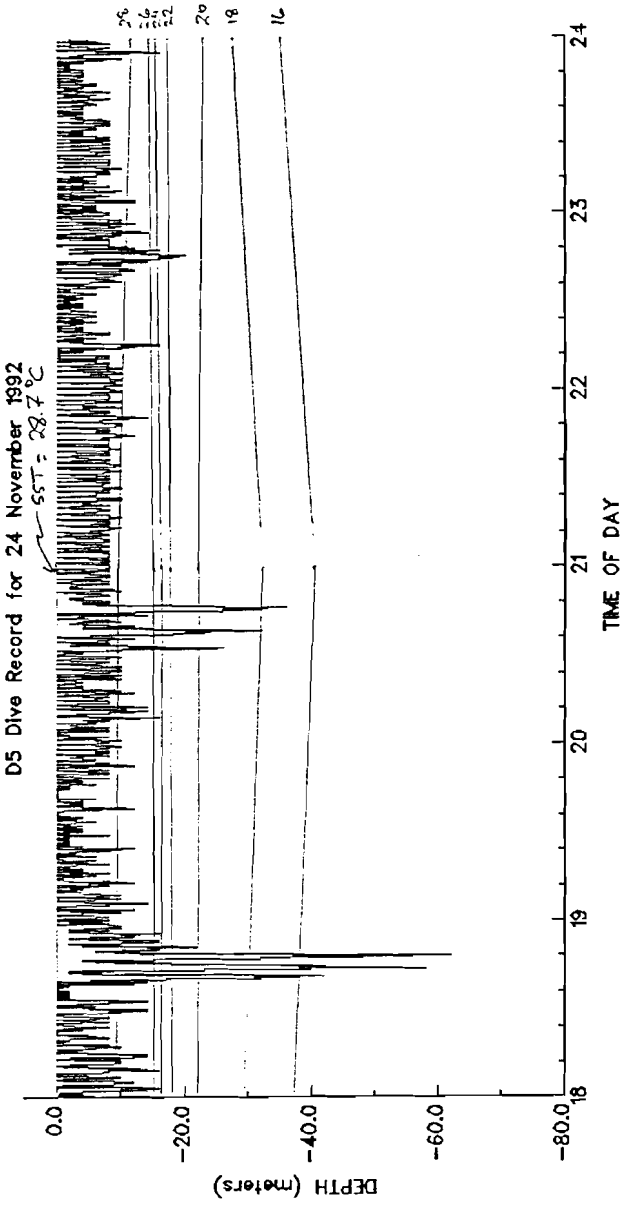

D5 Dive Record for 24 November 1992
SST = 28.7°C
26
24
22
20
18
16
0.0
-20.0
-40.0
-60.0
-80.0
DEPTH (meters)
18
19
20
21
22
23
24
TIME OF DAY

Fig 3

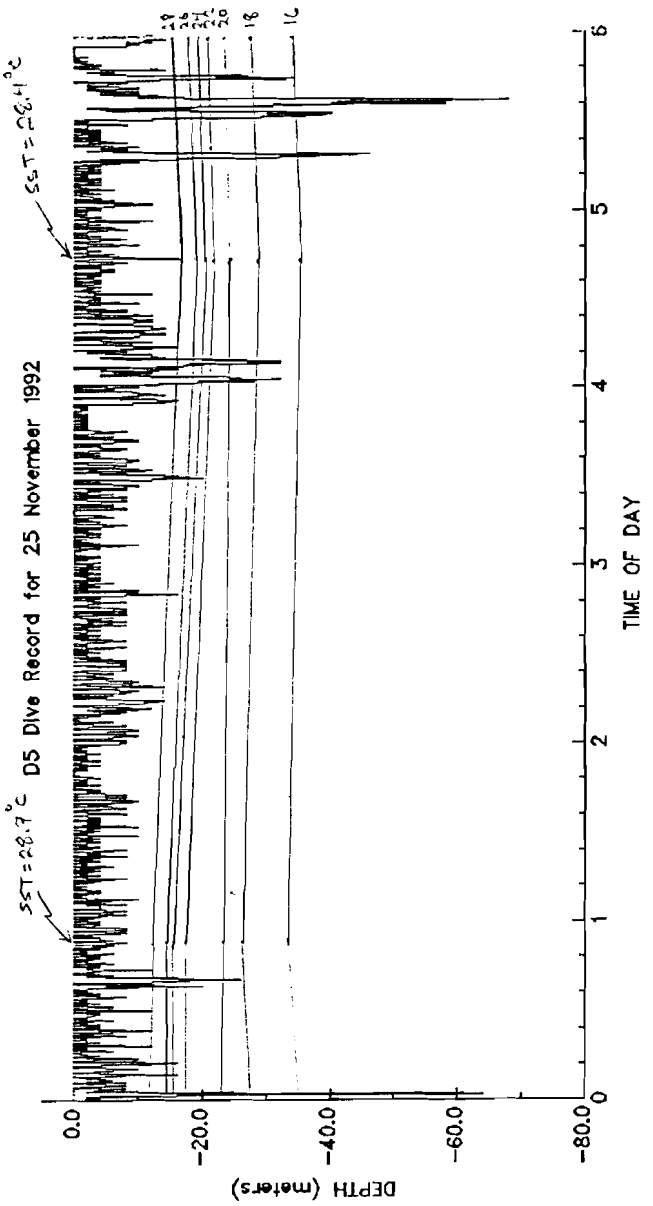
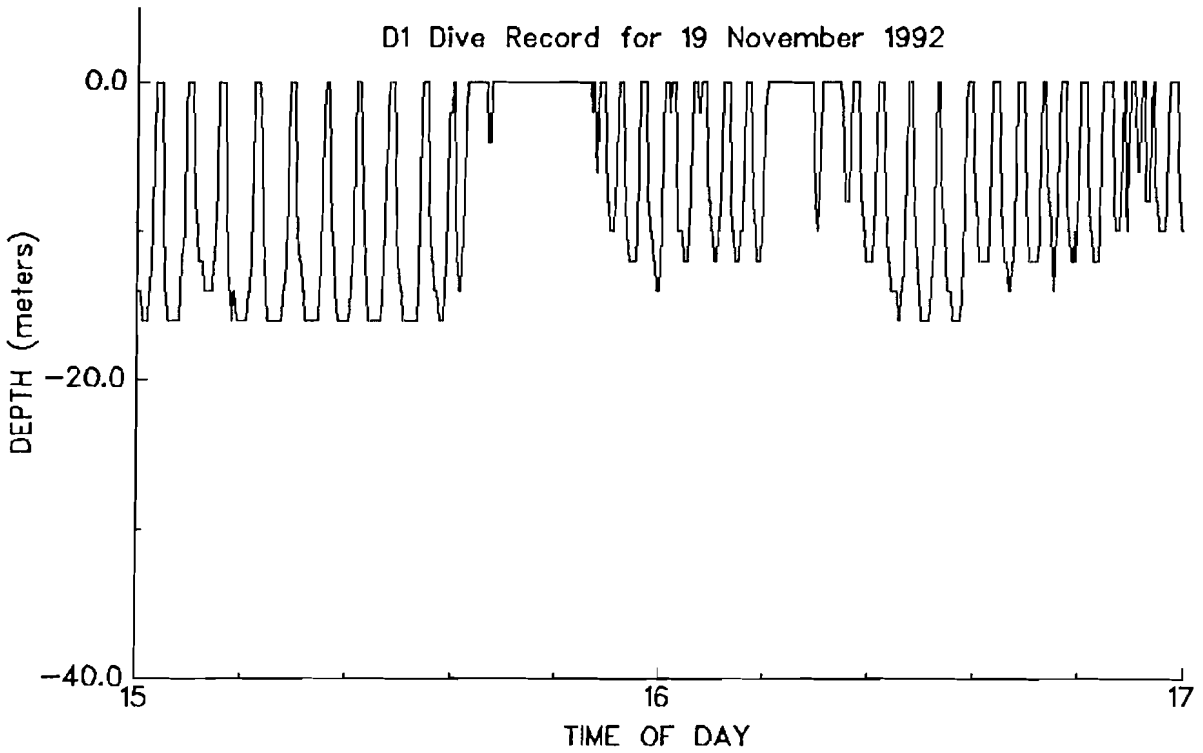

D5 Dive Record for 25 November 1992
SST = 28.7°C
SST = 28.4°C
DEPTH (meters)
0.0
-20.0
-40.0
-60.0
-80.0
TIME OF DAY
0
1
2
3
4
5
6
18
16

Fig 4


D1 Dive Record for 19 November 1992
0.0
-20.0
-40.0
DEPTH (meters)
15
16
17
TIME OF DAY