

## IMPACT OF SWORDFISH FISHERIES ON SEA TURTLES IN THE AZORES

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The surface longline fishery around the Azores targets swordfish (*Xiphias gladius*). Bycatch from this fishery includes loggerhead sea turtles (*Caretta caretta*) and occasionally leatherback sea turtles (*Dermochelys coriacea*) that are either hooked or entangled in the lines. Hooks are generally set at depths of 15-50 m and baited with squid, mackerel, or sometimes with shark meat. The size classes of loggerhead sea turtles caught ranged from 41.3 to 65.4 cm curved carapace length and constitutes the largest size class of loggerheads occurring in the Azores. The impact on this size class affects the survival of the southeastern United States (SEUS) population of loggerheads because the loggerheads from the Azores are primarily from SEUS rookeries. For one commercial longline boat, we observed that the mean capture of turtles per 1000 hooks by month ranged between a minimum of 0.04 in May and a maximum of 0.79 in July with a weighted mean catch of 0.27. October and November also registered high catch rates. Of 60 turtles recorded, 54 were hooked in the mouth, 3 in the esophagus, 1 in the eye, 1 in the flipper, and one was undetermined. The turtles that were caught were physically strong, except one that was weak and another dead. Total capture of loggerhead sea turtles is estimated to be 4190 for the entire fleet fishing in the Exclusive Economic Zone of the Azores during the swordfish season (May to December) of 1998. We strongly recommend that observer programs be continued because capture rates may vary among years and among fishing boats.

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### INTRODUCTION

The surface longline fishery around the Azores targets swordfish (*Xiphias gladius*). In 1998, the fleet can be divided into three main components: open-deck wooden boats (ODWB, n = 17), small-size cabin-deck boats (CDB<sub>1</sub>, n = 26) and large size cabin-deck boats (CDB<sub>2</sub>, n = 24). The ODWB consist of small size fishing boats that deploy an average of 800 hooks daily. This artisanal fleet, as well as the CDB<sub>1</sub>, fishes for swordfish during the summer season and shifts to demersal stock fishery in the winter months. CDB<sub>1</sub> lack freezing capacity, stay at sea for about one week, and deploy an average of 1500 hooks per set. The large size CDB<sub>2</sub> conduct fishing campaigns that can last about a month, due to

their freezer capacity, and deploy an average of 2500 hooks per set. During the winter months, the CDB<sub>2</sub> extend their fishing areas outside the Exclusive Economic Zone (EEZ) of the Azores (Simões 1995; Silva & Pereira 1998; Silva in press). The swordfish season is from May/June to December (SILVA & PEREIRA, 1998; M. Serpa, pers. comm; J. Simões, pers. comm.).

Bycatch from this fishery is mainly sharks (primarily *Prionace glauca*), but also includes loggerhead sea turtles (*Caretta caretta*) and occasionally leatherback turtles (*Dermochelys coriacea*), that are either hooked or entangled in the lines. Hooks are generally set at depths of 15-50 m and baited with squid, mackerel, or sometimes with shark meat. Light sticks are not commonly used in this area.

BOLTEN et al. (1994) and MARTINS et al. (2001) reported the size frequency of turtles captured on longlines in the Azores, as well as their physical condition and position of the hooks. Similar studies are being conducted in the Pacific, Mediterranean, and Atlantic (see WITZELL & CRAMER 1995). The results are a cause for concern. Mortality rates reported for longline fisheries are somewhere between 10 - 30% of the turtles caught (MAYOL 1990; AGUILAR et al. 1995).

The objectives of this paper are to report observations on the incidental capture of sea turtles in the waters around the Azores, as well as to estimate the number of loggerhead sea turtles captured by the longline fishery during the 1998 swordfish season.

## MATERIAL AND METHODS

The data were recorded during an 8 month period, from May to December 1998. One of us (RLF) was an observer on board the longline vessel (CDB<sub>2</sub>) F/V ALTAIR during 30 days in May and 20 days in August. Data on the fishing operation (effort and type of gear) and environmental parameters (surface temperature and wind) were recorded. When possible, the GPS position, the curved carapace length, physical condition, type of bait used, and position of the hook were recorded for turtles captured. The behavior of the turtle on release and other relevant observations were also recorded.

During the months when RLF was not on board, capture data were collected by the chief engineer. The data on the number of sets were obtained from the Captain's logbook and the number of hooks per set was estimated by the Captain.

The gear used was the U.S. type, that consisted of a monofilament mainline on which branchlines are attached successively with hooks at a fixed distance. At six-hook intervals, a buoy is attached for the suspension of the gear. The hook used was "Ancora" 17/0, and the bait was mackerel, squid, and shark meat. Between the hook and the branchline, a 30-cm steel leader was used to retain the shark bycatch. The gear

(approximately 35 nautical miles) was deployed at dusk and retrieved beginning at dawn.

For calculation of the total captures by the entire swordfish fleet we have assumed that the catch per unit effort (number of turtles / 1000 hooks) was the same for the 3 main components of the fleet operating in the area. A weighted mean catch per 1000 hooks was calculated using the formula:  $\Sigma(\text{mean catch per month per 1000 hooks} \times \text{number of sets per month}) / \text{total number of sets}$ .

## RESULTS

Sixty loggerhead turtles were captured and brought onboard the ship, however, only carapace lengths for 45 turtles were recorded. In addition, three leatherback turtles (two on adjacent hooks) and an undetermined, but small, number of loggerheads were too large to be brought onboard and were released by cutting the line. Because we do not have information on the turtles that were not brought onboard, they have been excluded from the analyses presented in this paper. The curved carapace lengths of the 45 loggerheads ranged from 41.3 to 65.4 cm (mean, 52.2 cm; SD, 5.5) (Fig. 1). The sizes of the loggerheads captured in the longline fishery are significantly larger than those of the general population in the waters around the Azores (see BOLTEN et al. 1993; Kolmogorov-Smirnov Test,  $k_s = 0.7805$ ,  $p < 0.001$ ; Fig. 2). BOLTEN et al. (1994) and MARTINS et al. (2001) reported similar results for the loggerhead size classes caught in the longline fishery.

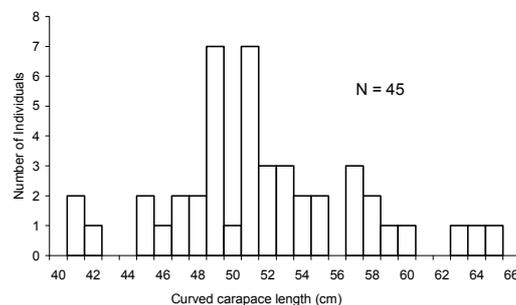


Fig. 1. Size distribution (curved carapace length, cm) of loggerheads captured by the longline fisheries in the Azores in 1998.

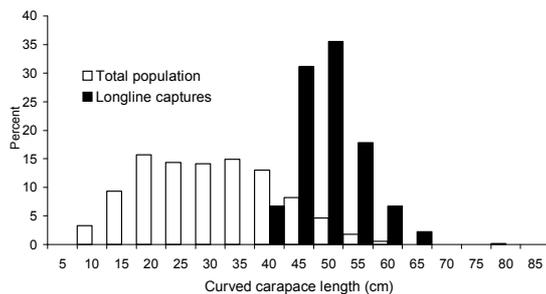


Fig. 2. Comparison of the size distribution of all loggerheads in the waters around the Azores (n=731; BOLTON et al., 1993) and those captured by the longline fishery in the Azores in 1998 (n=45). Loggerheads captured in the longline fishery are significantly larger (Kolmogorov-Smirnov Test,  $k_s = 0.7805$ ,  $p < 0.001$ ).

The capture rate of turtles varied between 0 and 7 per set with a mean capture for 1000 hooks per month ranging from 0.04 in May to 0.79 in July. These values are presented in Fig. 3. The maximum capture rate occurred in July followed by October and November.

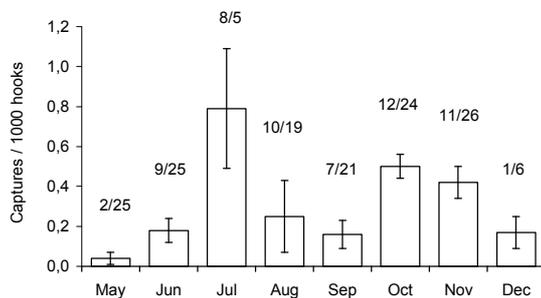


Fig. 3. Mean capture per 1000 hooks each month for loggerhead sea turtles captured in the Azores in 1998; fractions above the error bars represent the number of turtles/number of sets for each month; bars represent Standard Error.

Of the 60 loggerheads recorded, 54 (90%) were hooked in the mouth, 3 (5%) were hooked deep in the gut, one (1.67%) was hooked in the eye, one was hooked in the front flipper, and the position of the hook in one loggerhead was not determined. Although we do not have information on the frequency of bait used, 13 of the 60 turtles captured were caught on hooks baited with mackerel and 10 with squid; the bait was not

determined for the other 37 turtles. During our period of study, only four turtles that were brought onboard were released with the hooks still in place. All other turtles had the hooks removed before release. All of the turtles were physically strong except one that was dead as a result of the line having wrapped around its head and another that was weak when caught but recovered before being released.

Based on our data, a mean catch rate of 0.27 turtles per 1000 hooks was determined. The fishing effort for the entire fleet was estimated to be  $1552 \times 10^4$  hooks for the swordfish season of 1998 in the Azorean EEZ (Table 1). Therefore, the number of turtles caught from May to December for the entire fleet in the Azorean EEZ was estimated to be 4190.

Table 1.  
Estimate of the fishing effort for the Azorean EEZ, May to December 1998.

Boat Type	No. Boats	Sets / Month *	Hooks / Set **	Hooks May-Dec***
CDB <sub>2</sub>	24	20	2500	$9600 \times 10^3$
CBD <sub>1</sub>	26	12	1500	$3744 \times 10^3$
ODWB	17	20	800	$2176 \times 10^3$
Total				$1552 \times 10^4$

\*CDB<sub>2</sub> and CBD<sub>1</sub> in SIMÕES (1995) and ODWB in Serpa (pers.com.).

\*\*Number of hooks per set in SILVA (1998) and SIMÕES (1995).

\*\*\*Eight months.

## DISCUSSION

The size classes of loggerheads caught by the longline fishery constitute the largest size classes of the turtles occurring in the Azores (Fig. 2; BOLTON et al. 1993; 1994; MARTINS et al. 2001). Based on a stage-based population model for loggerhead turtles from the southeastern United States, CROUSE et al. (1987) concluded that these large size classes are important for the survival of the U.S. populations of loggerhead sea turtles in the Atlantic. BOLTON et al. (1998) using mtDNA sequence analyses, demonstrated that the juvenile loggerheads encountered in Azorean waters are primarily derived from the nesting populations of the southeast U.S. and represent the size classes missing in that region (CARR 1986).

LAURENT et al. (1992) showed that the main factor affecting population growth rate for the Mediterranean loggerhead population is adult survival and considered fecundity to be less important. Thus, the reduction of natural or anthropogenic mortality of eggs is not sufficient as a conservation measure to assure the survival of the species. It is of high priority to concentrate efforts on the protection of large sub-adults and adults (PANOU et al. 1995). LIMPUS & REIMER (1994) summarized the ecology and biology of loggerhead turtles in the southern Pacific and emphasized, referring to CROUSE et al. (1987), that in a declining population, adult and large immature turtles make the greatest contribution to the survival of the population.

No previous data on catch per unit of effort of turtles have been published from the Azores. Our loggerhead captures data show a maximum capture rate in July followed by another peak in October and November. These data are, in part, in accordance with the results of CAMIÑAS (1996) for the years 1986 to 1995 obtained by the Spanish fleet fishing in the Mediterranean. That is, the autumn captures are higher than the spring captures, and the maximum catch per 1000 hooks varied among June, July and August. The main difference between our data from the Azores and those of CAMIÑAS (1996) is the higher catch values for the autumn months in our data. In the Ionian Sea, Greece, PANOU et al. (1992) reported that the highest capture rates occurred from May to August, with a maximum in May and June.

The number of turtles hooked in the esophagus and/or gut (5%) is much less than that reported in a previous study in the Azores (BOLTEN et al. 1994) where the authors reported that 29.6% of the 27 live loggerheads caught were hooked in the esophagus and the rest in the mouth. More recently, MARTINS et al. (in press), for the same area reported that in 81 loggerheads, 17.3% were hooked in esophagus and/or gut and 2.5% were hooked externally. However, WITZELL & CRAMER (1995) reported for Western North Atlantic that 25 of 27 turtles were hooked in the mouth and 2 were hooked externally and no turtles were hooked in the esophagus.

Turtles were rarely sacrificed by the fishermen. However, the fishermen do not generally have the time to remove the hook prior to releasing the

turtles. Frequently they cut the line and release the larger turtles without bringing them onboard. Generally, only the smaller turtles are brought onboard where the line is cut and the turtles are then released. Hauling the turtles onboard by the line may cause increased injury as a result of increased internal tissue trauma from the hook. Death may occur when a turtle is caught near a big fish and is not able to swim to the surface to breathe.

AGUILAR et al. (1995), based on observations in captivity of turtles with internal hooks, estimated that 20 to 30% of sea turtles might die after being captured by the Spanish longline fishery. These mortality rates are difficult to extrapolate to turtles released back into the sea by the longline fishery. Data on the survival of sea turtles after being caught by a hook and released are needed for the estimate of the impact of the swordfish longline fishery. If AGUILAR's et al. (1995) estimate of 20-30% mortality is used, 838 to 1257 of the approximately 4190 loggerheads were killed by the swordfish fishery of the Azores during the 1998 fishing season.

It is necessary to assess the extent of the problem of bycatch in the swordfish longline fishery in the Azores so that the capture and/or the mortality of sea turtles can be reduced. An experiment is underway during the 2000 fishing season in the Azores that will test hook type in relation to bycatch of sea turtles. We strongly recommend that observer programs be continued to monitor sea turtle bycatch rates because capture rates may vary among years and among fishing boats.

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