

## Investigations on Drift-Net Fishery for Swordfish (*Xiphias gladius* L.) in the Aegean Sea

Okan AKYOL

Ege University, Faculty of Fisheries 35100, Bornova-Izmir - TURKEY

Mustafa ERDEM

Muğla University, Faculty of Fisheries 48000, Muğla - TURKEY

Vahdet ÜNAL, Tevfik CEYHAN

Ege University, Faculty of Fisheries 35100, Bornova-Izmir - TURKEY

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**Abstract:** This study reports an investigation carried out on swordfish drift-net fishery at 2 main swordfish fishing ports, Sivrice (northern) and Fethiye (southern), in the Aegean Sea in 2001-2002. Forty-five boats are used for swordfish fishing in the Turkish Aegean Sea. In these major areas, the highest number of boats 6-10 m in length and 11.5-80 hp in engine power was in the Sivrice area, while the highest number 10-14 m in length and 85-135 hp in engine power was in the Fethiye area. Almost all of the boats were made of wood. Swordfish drift-netting occurs in practice between Sivrice and the island of Lesvos and in both national and international waters between Fethiye and Rhodes. The drift nets are made of multifilament polyamide (PA) netting yarn, 210d/54-60 no, are about 3 to 7 km long, have a 500 mm mesh opening and are 20 meshes deep at Sivrice. They are about 14 km long, made up of various nets mixed together with 4 km for leerfish (*Lichia amia*) and 6 km for bullet tuna (*Auxis rochei*), have a 440 mm mesh opening, and are 30 meshes deep in the part for swordfish in Fethiye. Illuminated buoys are attached to each side of the net. Fishing effort and catch per unit effort (CPUE) in the swordfish biomass were rather low at Sivrice. The low CPUE in the biomass was probably the result of worsening meteorological conditions in the region. In each area, bluefin tuna (*Thunnus thynnus*), little tunnies (*Euthynnus alletteratus*), Mediterranean spearfish (*Tetrapturus belone*), albacores (*Thunnus alalunga*), bullet tuna (*Auxis rochei*), dolphinfish (*Coryphaena hippurus*), dolphins (*Delphinus delphis*), manta rays (*Mobula mobular*), sunfish (*Mola mola*) and sharks (*Mustelus vulgaris*) were recorded as non-target catches.

**Key Words:** Swordfish, *Xiphias gladius*, drift-nets, Aegean Sea.

### Ege Denizi'nde (Türkiye) Kılıç Balıkları (*Xiphias gladius* L.) İçin Kullanılan Sürüklenen Solungaç Ağları Balıkçılığı Üzerine Araştırmalar

**Özet:** Bu çalışma, Ege Denizi'nde iki ana balıkçılık limanı olan Sivrice ve Fethiye'de kılıç avcılığı için kullanılan sürüklenen solungaç ağları üzerine 2001 ve 2002 yılında yürütülen araştırma sonuçlarını içermektedir. Toplam 45 tekne Ege Denizi'nde kılıç balığı avcılığı yapmaktadır. Fethiye alanında 10-14 m boyunda ve 85-135 BG'ndeki tekneler en yüksek sayıdayken, Sivrice alanında 6-10 m boyunda ve 11,5-80 BG'ndeki tekneler çoğunluktadır. Hemen hemen teknelerin tamamı ahşap malzemeden yapılmıştır. Sürüklenen solungaç ağları ile kılıç balığı avcılığı pratikte Sivrice ve Midilli arasında ve Fethiye kıyıları açıkları ile Rodos adası arasında ulusal ve uluslararası sularda yapılmaktadır. Sivrice'de sürüklenen ağlar, multifilament polyamid (PA) ip, 210d/54-60 numara ip kalınlığında, yaklaşık 3-7 km uzunluğunda, 500 mm tam göz boyu ve 20 göz derinliğinde; Fethiye'de 4 km'si akya (*Lichia amia*), 6 km'si tombik (*Auxis rochei*) olmak üzere toplam 14 km uzunluğunda karışık ağlardan oluşmuş, kılıç ağı bölümü 440 mm tam göz boyunda ve 30 göz derinliğindedir. Işıklı şamandıralar ağın her iki ucuna tutturulmuştur. Sivrice'de balıkçılık gücü ve ağırlıkça birim çabaya düşen av miktarı oldukça düşük değerlerde kaydedilmiştir. Ağırlıkça düşük değerlerdeki birim çabaya düşen av, muhtemelen bölgede kötü giden meteorolojik şartların sonucudur. Her iki alanda yunus (*Delphinus delphis*), manta (*Mobula mobular*), pervane balığı (*Mola mola*), köpekbalıkları (*Mustelus vulgaris*), mavi yüzgeçli orkinos (*Thunnus thynnus*), yazılı orkinos (*Euthynnus alletteratus*), Akdeniz kılıcı (*Tetrapturus belone*), albakor (*Thunnus alalunga*), tombik (*Auxis rochei*), ve lambukalar (*Coryphaena hippurus*), hedef dışı av olarak kaydedilmiştir.

**Anahtar Sözcükler:** Kılıç balığı, *Xiphias gladius*, Sürüklenen solungaç ağları, Ege Denizi.

### Introduction

Among the large pelagics exploited in Turkey, the swordfish (*Xiphias gladius* L.) is least important based on low annual landings. For example, in 1999, the amount

was only 230 t (1). The exact time when swordfish fishery starts in Turkey is unknown. Onat (2) reported that, in the late 1960s, swordfish fishery by harpoon started in April, May and June, and also swordfish were

caught using drift-nets in the Bosphorus on moonless nights between September and November.

Northridge (3) stated that drift gillnets (or drift-nets), in common with other types of gillnet, are among the simplest and oldest methods of fishing. Such nets operate by gilling or entangling fish in the meshes of a sheet of netting. The netting is held more or less vertically in the water column by means of a buoyant floatline at the top of the net. Nets rigged in this way may be used singly or, by joining them together serially, as a fleet of nets. Drift-nets are usually fished at night, as the meshes of the net are less visible to the fish, and multiflament twines are also used in many drift-net fisheries, and have an advantage that they are less rigid than monofilament ones, which means that once a fish is gilled, it is less likely to be able to escape (3).

Currently, 2 methods are commonly used in swordfish fishery in Turkish waters: drift-netting and long-lining. According to recent activities, swordfish fishery is limited to 2 main fishing ports, Sivrice and Fethiye.

Only fragmentary information on swordfish fishery in Turkey exists, such as the studies by Onat (2), Artüz (4), Tokaç et al. (5), Gököğlü and Oray (6), Aliçlı (7), and Erdem and Akyol (8).

The aim of this investigation was to give a satisfactory picture of the drift-net fishery for swordfish and to produce the first set of basic data for drift-net fishery in the Aegean Sea.

### Materials and Methods

Data on the number of fishing vessels, the corresponding catch, non-target catches, the fishing gear's characteristics, and the location of the fishing grounds were obtained through direct investigations at Sivrice fishing port during 2001 and Fethiye fishing port during 2002. Estimates of the total catch were obtained

through direct investigations and interviews with fishermen.

Fishing effort (f) and catch per unit effort (CPUE) were calculated using the following formula, modified from De Metrio and Megalafonou (9):  $f = (a'/100) \times g$  where  $(a'/100)$  represents the average length of nets placed daily in the sea divided by the 100 net unit (200 m length of stretched net is called 1 unit and the length of the drift-net is 66 m after being mounted on the upper and lower ropes). Therefore, 100 net unit is equal to  $100 \times 66 = 6600$  m for the drift-nets used for swordfish. "g" is the number of fishing days. The CPUE was computed in the biomass with the formula  $CPUE = kg/f$ .

Fork length (from the tip of the lower jaw to the fork of the caudal fin = LJFL) and total weight of 115 swordfish were measured during 9 surveys on board off the Fethiye coast.

The allometric growth formula  $W = aL^b$  was used to determine the length-weight relationship, where W is total weight, L is fork length, and a and b are constants.

### Results

#### Fishing Ports

The investigation showed that 45 boats from the 2 main ports, in 2 major areas, fished for swordfish in Turkey during 2001-2002. The number of boats, grouped by size and engine power (hp), are shown in Table 1.

Table 1 shows that Sivrice has a higher number of boats than Fethiye. In these major areas, the highest number of boats 6-10 m in length and 11.5-80 hp in engine power was in the Sivrice area, while the highest number 10-14 m in length and 85-135 hp in engine power was in the Fethiye area. Almost all of the boats were made of wood with only one (17 m long; 280 hp) being made of steel, in the Sivrice area. Two or three

Table 1. Division of vessels according to size and engine power.

Major Region or Fishing Port	Number of Boats	Length (m)			Engine Power (hp)			
		6-10	10-14	14-18	Min.	Max.	Mean	Sum
Sivrice	25	19	5	1	11.5	280	68 ± 11	1700
Fethiye	20	6	10	4	11	335	101.6 ± 16.2	2032
Total	45	25	15	5	11	335	83 ± 9.7	3732

persons work on each boat. Concerning the engine power of the fishing boats, the Fethiye fleet has higher engine power than the Sivrice fleet. This is obviously due to boats from the Fethiye area conducting their activities much further from port.

### Fishing Grounds

Swordfish drift-netting occurs in practice between Sivrice and the island of Lesvos, named the Müsellim Strait, and in both national and international waters between Fethiye and Rhodes (Figure 1). Fishery takes place at a depth range of 150 to 350 m in the Müsellim Strait, and 1000 to 3000 m in the Fethiye region.

### Fishing Period

According to a Turkish fishery circular, there are 2 seasonal closures for swordfish fishing. These are from

June 1 to July 31 and from October 1 to January 31 (totally 6 months) in all Turkish territorial waters (10).

During the rest of the year, fishing is carried out only 70-80 days a year due to the meteorological conditions and phase of the moon. Fishing takes place only on moonless nights. However, the Fethiye fleet carries out its fishing activity using drift-nets or drifting long-lines in international waters of the Mediterranean until 15 July.

### Drift-net Characteristics

The drift-nets are made of 210d/54-60 no, multiflament polyamide (PA) 500 mm mesh size netting, rigged as 3 to 7 km long, and 20 meshes deep at Sivrice (Figure 2). While in the Fethiye region the nets are about 14 km long, made up of 4 km for leerfish (*Lichia amia*) (210d/24 no, 480 mm mesh size), 6 km for bullet tuna (*Auxis rochei*) (210d/18-24 no, 340 mm mesh size) and

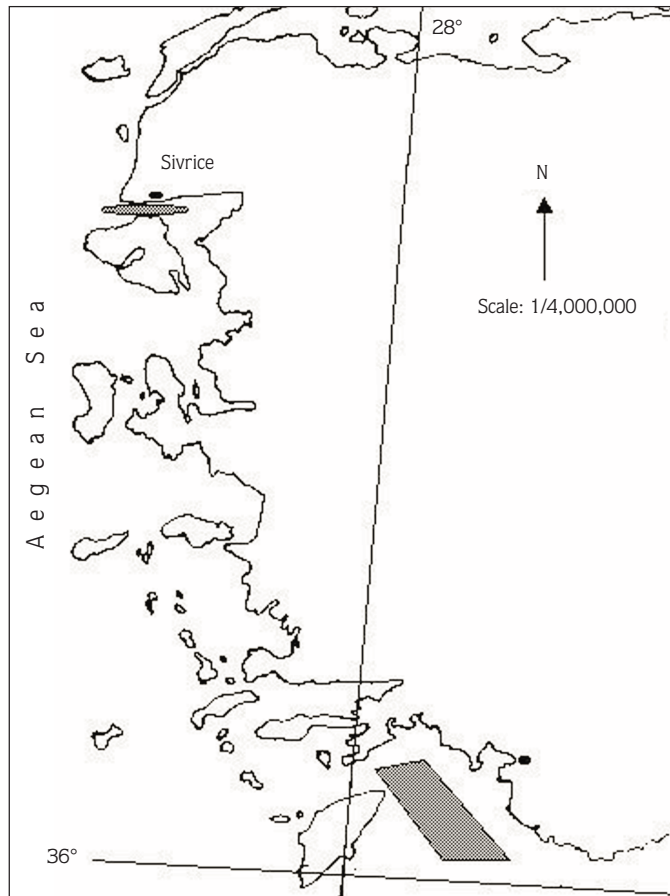


Figure 1. Distribution of drift-net activities for swordfish in the Aegean Sea.

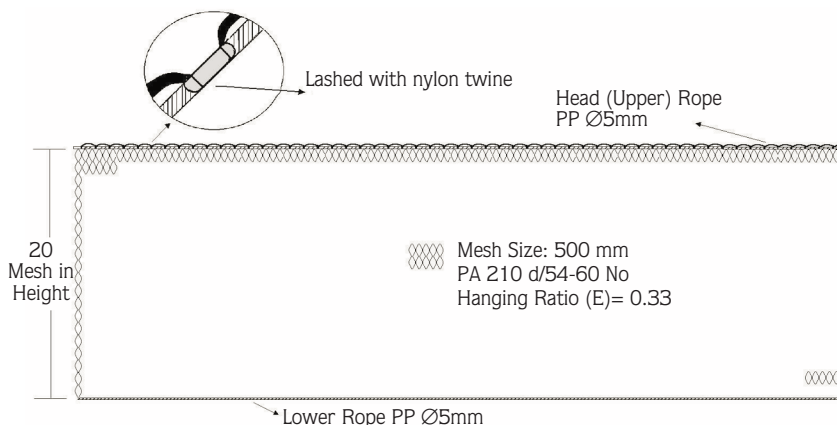


Figure 2. Drift-net scheme, used in the Sivrice region.

4 km for swordfish (210d/42 no, 440 mm mesh size, 30 meshes deep). Illuminated buoys are attached to each side, for ease of visibility at night. The setting of drift-nets begins at about sunset, with hauling at about midnight for checking, and then once or twice more before sunrise.

### Non-target Catches

In the Sivrice region, bluefin tuna (*Thunnus thynnus*), little tunnies (*Euthynnus alletteratus*), Mediterranean spearfish (*Tetrapturus belone*), bullet tuna (*Auxis rochei*), dolphinfish (*Coryphaena hippurus*), manta rays (*Mobula mobular*), sunfish (*Mola mola*) and sharks (*Mustelus vulgaris*) were recorded as non-target catches. A total of 2141 kg landings caught by 23 boats, on 17 fishing days in 2001 were separated as 1260 kg (59%) of swordfish and 881 kg (41%) of bluefin tuna and a small fraction of Mediterranean spearfish as non-target catches at Sivrice.

In the Fethiye region, bluefin tuna (*T. thynnus*), little tunnies (*E. alletteratus*), albacores (*Thunnus alalunga*), Mediterranean spearfish (*T. belone*), bullet tuna (*A. rochei*), dolphinfish (*C. hippurus*), sharks (*M. vulgaris*) and dolphins (*Delphinus delphis*) were recorded as non-target catches.

### Fishing Effort and CPUE

In the 2 major areas, Sivrice was selected as the pilot port for precise effort and corresponding catch in the fishing season. The fishing effort and CPUE according to boats at Sivrice are shown in Table 2.

### Size Distribution

Fork lengths of 115 swordfish caught in the sea off Fethiye were measured in 2002. Most of the catch ranged from 130 to 160 cm. The proportion of individuals longer than 130 cm, which is the minimum landing size in Turkey (10), was 90% (Figure 3).

### Length-weight Relationship

The length-weight relationship for 115 specimens for the sexes combined was

$$W = 7 \times 10^{-8} \times L^{3.532}, r = 0.949$$

where W is expressed in kilograms and L in centimetres. Figure 4 demonstrates the length-weight relationship of swordfish.

Alıçlı (7) reported that the length-weight relationship for 794 specimens for the sexes combined of swordfish in the south-eastern Mediterranean was  $6.10^{-7} L^{3.617}$ ,  $r = 0.983$ . These findings were found to be quite similar.

### Discussion

There is a gap in the literature on Turkish drift-net fishing. Northridge (3) reported the existence of only sardine drift-nets, 365 m in length with a 32 mm mesh. The number of vessels operating this gear was not given (3). Although Tokaç et al. (5) gave a little information about the technical characteristics of a drift-net in the Sivrice region, the present study provides the first comprehensive information on swordfish drift-net fishery.

Table 2. Fishing effort and CPUE according to boats at Sivrice.

Boats	Number of Fishing Days	Landings (kg/year)	Length of Nets (m)	f	CPUE
1	72	1000	5940	65	15.4
2	75	700	6600	75	9.3
3	60	400	5280	48	8.3
4	140	1000	6600	140	7.1
5	80	1000	3960	48	20.8
6	75	500	3960	45	11.1
7	80	200	7920	96	2.1
8	60	400	6600	60	6.7
9	60	200	5280	48	4.2
10	60	200	3300	30	6.7
11	50	145	7260	55	2.6
12	50	110	4620	35	3.1
13	65	206	6600	65	3.2
14	30	27	3960	18	1.5
15	40	60	3300	20	3
16	30	250	3960	18	13.9
17	2	0	1320	0	0
18	40	200	4620	28	7.1
19	50	200	6600	50	4
20	50	400	5940	45	8.9
21	40	200	5940	36	5.6
22	40	50	4620	28	1.8
23	20	350	3960	12	29.2
24	15	70	3960	9	7.8
25	45	250	3960	27	9.3
Means	53.2 ± 5.4	325 ± 60	5042 ± 307	44 ± 6	7.7 ± 1.3

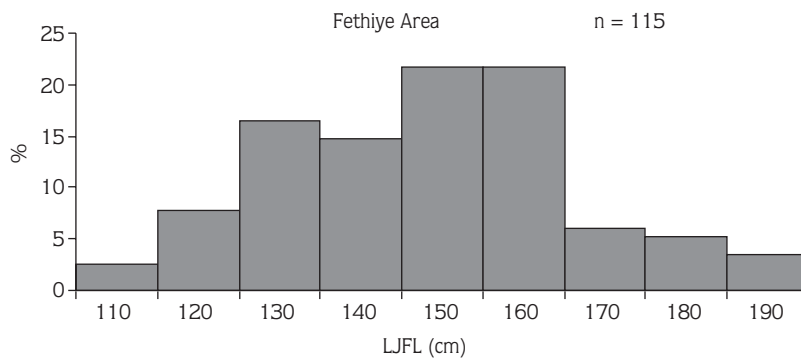


Figure 3. Length frequency distribution of swordfish in the Fethiye region in 2002.

Fishing effort and CPUE in the swordfish biomass were rather low (mean CPUE,  $7.7 \pm 1.3$  kg) in Sivrice. The CPUE was lower than that registered in the Gulf of Taranto (9) or at the islands of Kalymnos, Chania and Kythnos in Greek waters (11). The low CPUE in the biomass was probably the result of unstable

meteorological conditions in the region. However, most fishermen in the region fish for swordfish part-time. The reasons are not only related to low CPUE but also highly related to economic factors such as the low income level of fishermen, and the high cost of fishing operations. Indeed, that is why swordfish fishery is undertaken part-

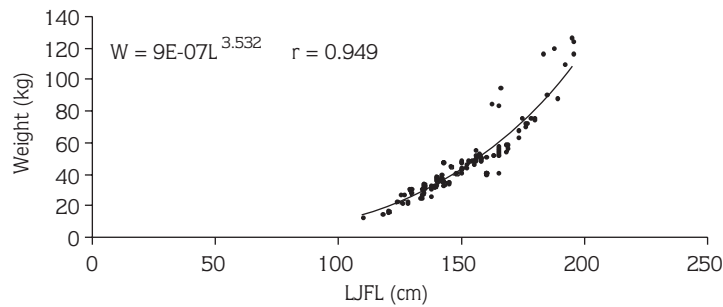


Figure 4. Length-weight relationship of swordfish in the Fethiye region.

time in the region and most fishermen have a second livelihood like olive farming and animal husbandry.

Ten species, *T. thynnus*, *E. alletteratus*, *T. belone*, *A. rochei*, *T. alalunga*, *M. mobular*, *C. hippurus*, *M. mola*, *M. vulgaris* and *D. delphis* were recorded as non-target catches from drift-net fishery in the Aegean Sea. Fishermen in the Fethiye region reported that 23 dolphins were caught (of which 18 died) by drift-nets in 2002, while no dolphin by-catch was reported in the Sivrice region. According to Northridge's (3) review, at least 44 non-target fish species have been recorded in Mediterranean drift-net fisheries, but catch rates are unknown. In addition, both turtles and marine mammals are also caught. Non-target species in the Aegean Sea were at lower levels than in the Mediterranean.

Fishing for swordfish normally takes place over 6 months in Turkey. However, the main activity is concentrated in May, August, and September on moonless nights, because of closed seasons and bad

meteorological conditions. When not fishing for swordfish most fishermen in Turkey are engaged in other coastal fisheries or farming.

In Greek waters, swordfish fishery is only closed from October 1 to January 31. This closure aims to protect zero group (newly born) individuals and fishing is carried out only with drifting long-lines because drift-nets are strictly banned in Greece (Dr. G. Tserpes, pers. comm.).

In Turkey, swordfishing in all Turkish territorial waters is banned during 2 periods, June 1 - July 31, and October 1 - January 31. This is done to protect the young fish and reproductive activity. Moreover, all types of drift-netting are banned throughout the year. However, most Turkish fishermen claim that drift-netting is more size selective than long-lining. According to them, young swordfish can pass through the mesh easily. Indeed, few undersized fish were caught by the drift-nets during our observation period. The authors of this study suggest further investigation of this matter.

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