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Pelagic Longline Fishery for Albacore (*Thunnus alalunga*) in the Mediterranean Sea off Egypt

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Abstract

This study highlighted the occurrence of a pelagic longline fishery targeting albacore in the Eastern Mediterranean Sea off Egypt. Species selectivity of the fishing method was assessed. Catch per unit effort "CPUE", size frequency and length-weight relationship were estimated for the target species. This fishing method was found to be highly selective for albacore, where its catch represented about 93.5% of the total landed catch. The major by-catch species were swordfish *Xiphias gladius* (2.5%) and the little tunny *Euthynnus alletteratus* (2.4%). Skipjack *Katsuwonus pelamis*, dolphinfish *Coryphaena hippurus*, Bigeye thresher *Alopias superciliosus*, and oilfish *Ruvettus pretiosus* represented collectively, 1.5% of the total landed catch. The fork length of albacore ranged from 54 to 138 cm, with an average of 79.1±7.2 cm. Total weight ranged from 4 t 40 kg with an average of 8.8±7.2 kg. The length-weight relationship was determined to be $W = 5.26 \times 10^{-5} L^{2.75}$ (W in kg, L in cm). The CPUE for albacore ranged from 7 to 22 fish / 1000 hooks for the different fishing trips, with an average CPUE of 12 fish/1000 hooks (SE±4.4).

Keywords: Eastern Mediterranean, longline, albacore, *Thunnus alalunga*, by-catch, selectivity, CPUE.

Introduction

Albacore, *Thunnus alalunga*, is one of the principal market tunas (Majkowski, 2007). It is an epi-and mesopelagic highly migratory species, inhabiting both subtropical and temperate waters of all Oceans, including the Mediterranean Sea. In the Atlantic Ocean and Mediterranean Sea, there are three stocks for albacore: northern and southern Atlantic stocks (separated at 5^{o} N), and the Mediterranean stock. This population subdivision was established based on fisheries distribution, identification of separate spawning areas, different growth rates, morphological differences, and some tagging information (ICCAT 2011). The average reported catch of albacore from the Mediterranean Sea during the last decade (2000-2009) was 5,185 ton/year. The majority of this catch came from Italy (71%) and Greece (16%), while Cyprus, Spain and Turkey produced 4.6%, 4.3%, and 3.5%, respectively. Pelagic longline fishing is the main catching method for albacore in the Mediterranean Sea, where 59% of the average catch are caught by this fishing gear. About 30% of the catch is caught by other surface gears, excluding driftnet fishing which is prohibited in the Mediterranean according to the binding resolutions of the International Commission for the Conservation of Atlantic Tuna (ICCAT) and European Union (Akyol and Ceyhan, 2012), and 10% is caught by purse seines. Only one percent is caught by baitboat and trolling methods (ICCAT 2011).

Unlike the northern and southern Atlantic stocks of albacore, there are no ICCAT regulations directly aimed at managing the Mediterranean Albacore stock. In 2010, a Mediterranean albacore data preparatory meeting was held, and the recommendation of having an assessment session devoted to the Mediterranean albacore stock was contemplated for 2011. This is due to the lack of information concerning reported catches by many nations, inadequate coverage of artisanal gears, and the very limited information on size composition of Mediterranean albacore and its fishery biology (ICCAT 2006-2009). However, because of the global decline in the spawning stock biomass (SSB) of this species (37% decline) over the last two decades, and the risk that population declines would be much greater if the implemented catch quota were overestimated, this species is listed as Near Threatened (Collette *et al.*, 2011)

The current study aimed at describing a developing pelagic longline fishery targeting albacore tuna in the Egyptian waters of the Mediterranean Sea.

The species selectivity, catch per unit effort (CPUE), length frequency and length-weight relationship of albacore (the target species) were investigated.

Materials and Methods

Longline fishery survey was conducted during albacore fishing season between June and July 2010. The fishing gear and method that used to catch albacore by Egyptian fishermen were described. The fishing ground is shown in Figure 1. Based on 18 fishing trip surveying operations (74 fishing days) during the fishing season, catch and effort data were collected. Species composition, total number of hooks, total number and weight of fish caught per trip were recorded. The fishing effort (f) and CPUE for albacore could be calculated using the following formula, modified from De Metrio and Megalofonou (1988):

$$f = (a'/1000) \times d$$

where a' is the average number of hooks in longline per day (divided by the 1000 hooks longline effort unit), d is the number of fishing days per trip,

CPUE = N /f (N is the number of fish caught)

CPUE = B /f (B is the biomass of fish caught)

A caliper-like measuring board was used to measure the fork length of albacore at the landing site (Dameitta) and onboard the fishing boat during the fishing operations. The fork length (cm) of 1,577 albacore specimens were measured and used to form the length frequency (at 2 cm length intervals).

Length–weight relationship of albacore was fitted to 274 specimens using fork length (to the nearest 0.5 cm) and fish weight (to the nearest g). The parameters (a, b) of the power equation describing the length-weight relationship;

$$W = a L^{b}$$

were estimated by transforming this equation into the linear form;

$$Ln\ W = Ln\ a + b\ Ln\ L$$

and running the regression analysis (the ordinary least squares method) between the natural logarithm of fork length in cm "Ln L" as independent variable and the natural logarithm of the fish weight in kg "Ln W" as a dependent variable.

Results

Fishing Gear and Method

The fishing boats «longliners» are of the wooden type ranging from 14 to 17 m in length. The engine power ranges from 70 to 130 hp. The crew number ranges from 7 to 10 persons.

The fishing gear that used by Egyptian fishermen to catch albacore tuna is a pelagic longline that is set horizontally. The mainline is made of nylon monofilament (1.2 mm diameter) to which thousands of branchlines (snoods) are attached through swivels, each branchline is made of nylon monofilament (1.0 mm diameter) with a single baited hook (size 7

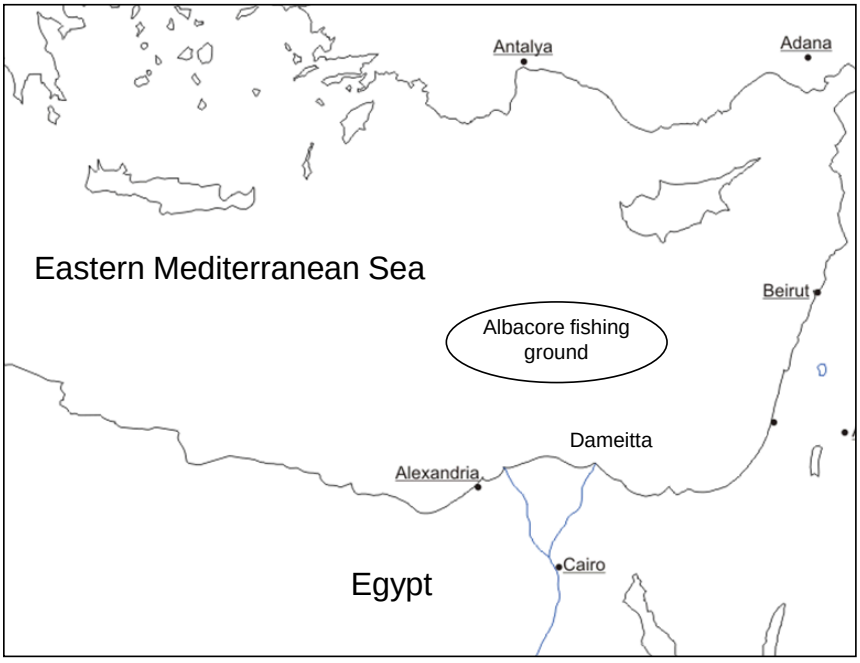

Figure 1. Albacore fishing ground in the eastern Mediterranean Sea off Egypt.

straight shank hook). Frozen sardine is usually used as the bait.

Each fishing boat often uses from 4,000 to 4,500 hooks, contained in 8 or 9 boxes. Each box contains a part of the mainline to which about 500 branchlines are attached. Figure 2 shows a schematic drawings of mainline and branchlines with floats between two flag buoys, in addition to details of branchline (snood) structure.

Longlines are usually set and hauled manually (by hand) and just once a day. Setting the longline usually starts just before the sundown (at 5.^{00} pm) taking about 5 hours (up to 10.^{00} pm). Hauling the longline starts at early morning (at 7.^{00} am) through the day time (till 5.^{00} pm), and setting it starts again for the next day.

Species Composition

Species composition was estimated as occurrence percentage (in number) for each species. Albacore, *Thunnus alalunga*, represented the highest percentage of all species caught (93.5%). Swordfish, *Xiphias gladius*, and little tunny, *Euthynnus alletteratus* are represented 4.9% of the total catch, while all other bycatch species (*Katsuwonus pelamis*, *Coryphaena hippurus*, *Ruvettus pretiosus* and *Alopias superciliosus*) contributed 1.6% (Table 1).

As discards, only one loggerhead *Carretta carretta* was recorded during all fishing operations, and from 5 to 10 stingray *Dasyatis violacea* were discarded each fishing day per boat.

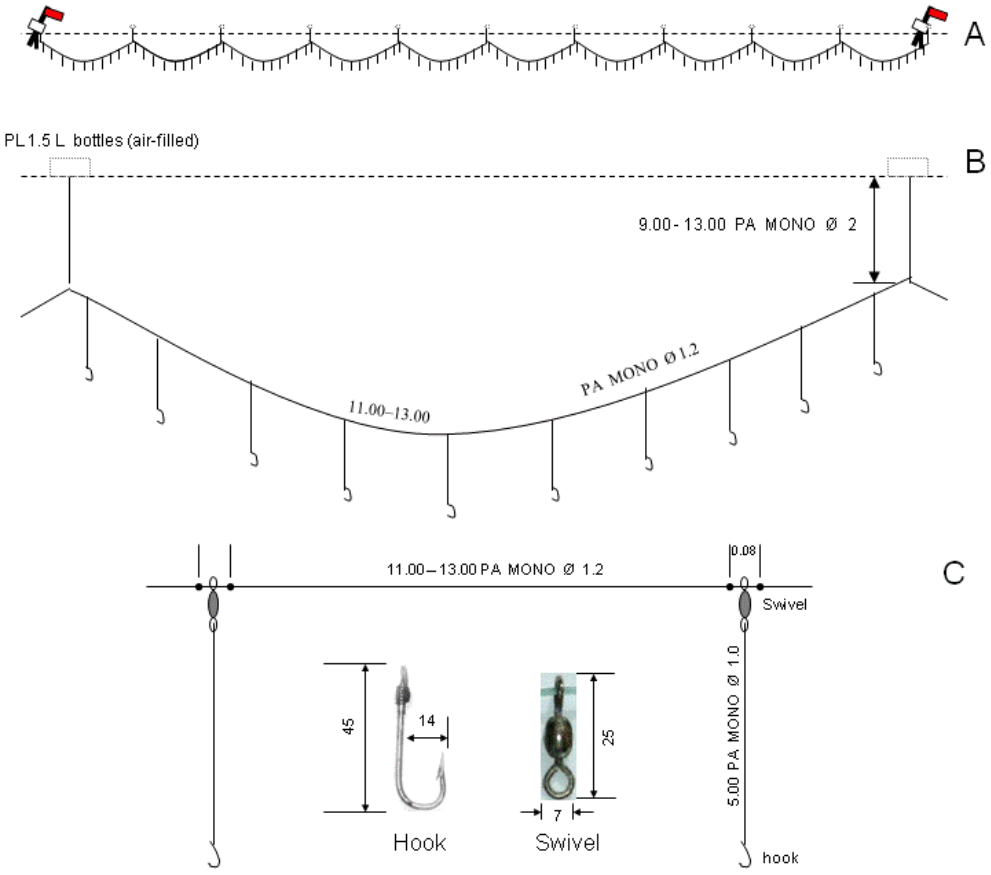

Figure 2. Schematic drawings showing floats between two flag buyoy (A), branchlines (snoods) between two floats (B), and structure of branchline and distance between two snoods (C) in albacore pelagic longline used by Egyptian fishermen.

Table 1. Species composition of albacore pelagic longline used by Egyptian fishermen in the eastern Mediterranean Sea

Species	English name	No of fish caught	% of occurence
Thunnus alalunga	Albacore	3,487	93.5
Xiphias gladius	Swordfish	92	2.5
Euthynnus alletteratus	Little tunny	91	2.4
Katsuwonus pelamis	Skipjack	5	0.1
Coryphaena hippurus	Dolphinfish	23	0.6
Ruvettus pretiosus	Oilfish	7	0.2
Alopias superciliosus	Bigeye thresher	24	0.6

Effort, Catch and CPUE

Table 2 shows the effort, catch and catch per unit effort (CPUE) of albacore based on 18 fishing trips surveying operations (74 fishing days) during the fishing season. The fishing effort ranged between 4,000 to 4,500 hooks/day (4–4.5 effort unit/day) with an average effort of 4,184±248 hook/day (4.2±0.2 effort unit/day). The catch of albacore ranged between 28 to 100 fish /day with an average of 51±21 fish/day and between 258 to 950 kg /day with an average of 467.9±193.1 kg/day. CPUE ranged between 7 to 22 fish/1000 hooks with and average of 12±4.4 fish/1000 hooks and between 64.4 to 211.1 kg/1000 hooks with an average of 110.9±41.7 kg/1000 hooks.

Size Frequency and Length – Weight Relationship

As shown in Figure 3, the fork length of albacore ranged from 54-106 cm. Only one large fish was recorded with 138 cm fork length and 40 kg total weight. The average fork length was estimated to be 79.1±7.2 (SE) cm. The retention length (L50) was determined from the cumulated frequency percentage and found to be belonging to the length group 80 cm.

Total weight of individual albacore ranged from 4–40 kg, with an average of 8.8±2.78 kg. About 82% of individuals represented in weight classes from 6 to 10 kg, about half of them (42.7%) belonged to weight classes from 8-9 kg (Figure 4).

Figure 5 shows the relationship between fork length (cm) and total weight (kg) of albacore caught by Egyptian fishermen. This relationship could be described by the following power equation:

$W = 5.26 \times 10^{-5} L^{2.75}$, with a strong correlation coefficient ($R^2 = 0.98$).

Discussion

Longline fishing for albacore in the Egyptian offshore waters in the eastern Mediterranean Sea is a developing fishery by Egyptian fishermen. Although some longliners started to fish there for 6 or 7 years, targetting albacore, catch statistics for albacore and its fishing fleet are not available or even recorded. The present study is the first attempt to investigate this developing pelagic longline fishery for albacore in the Egyptian waters. Data collection and sampling were limited to some fishing boats, which started this fishery, during their fishing trips and at the landing site (Damietta).

As a target species, albacore represented the bulk of the landed catch, forming 93.5%, compared to other by-catch species which represented collectively 6.5% of the landed catch «expressed in numbers». This result indicates that the pelagic longline used by Egyptian fishermen to catch albacore is highly selective for this species. The low selectivity of other

Table 2. Effort, catch and CPUE of albacore, based on 18 fishing trips surveying operations (74 fishing days) in the eastern Mediterranean Sea off Egypt

	Hooks Number/day	Fishing effort (f)/day	Albacore Number/day	Albacore Biomass/day	CPUE Number/effort	CPUE Biomass/effort
Minimum	4000	4	28	258	7	64.4
Maximum	4500	4.5	100	950	22	211,1
Average ±SE	4184 ± 248	4.2 ± 0.2	51 ± 21	467.9 ± 193.1	12 ± 4.4	110.9 ± 41.7

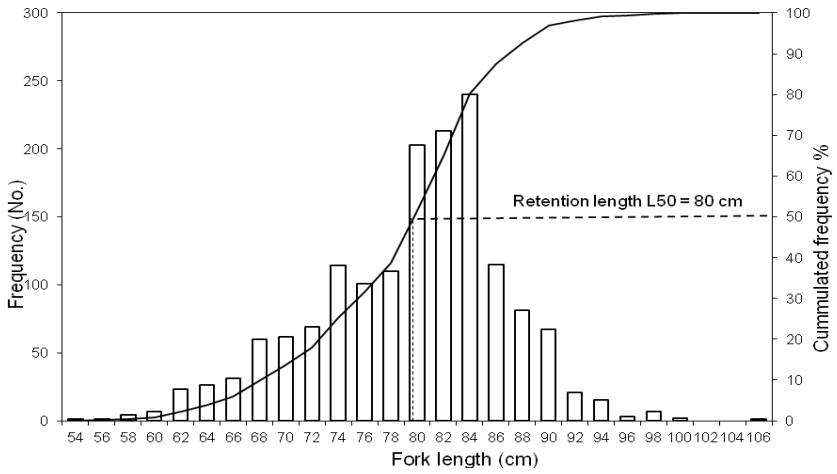

Figure 3. Length frequency distribution (bars) and accumulated frequency % (line) of albacore in the eastern Mediterranean Sea off Egypt.

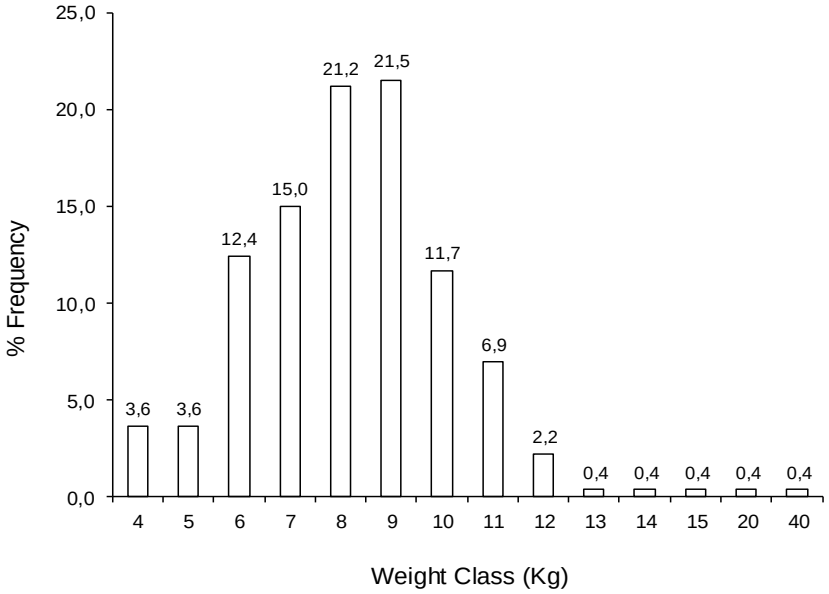

Figure 4. Percentage composition of the different weight classes of albacore in the eastern Mediterranean Sea off Egypt.

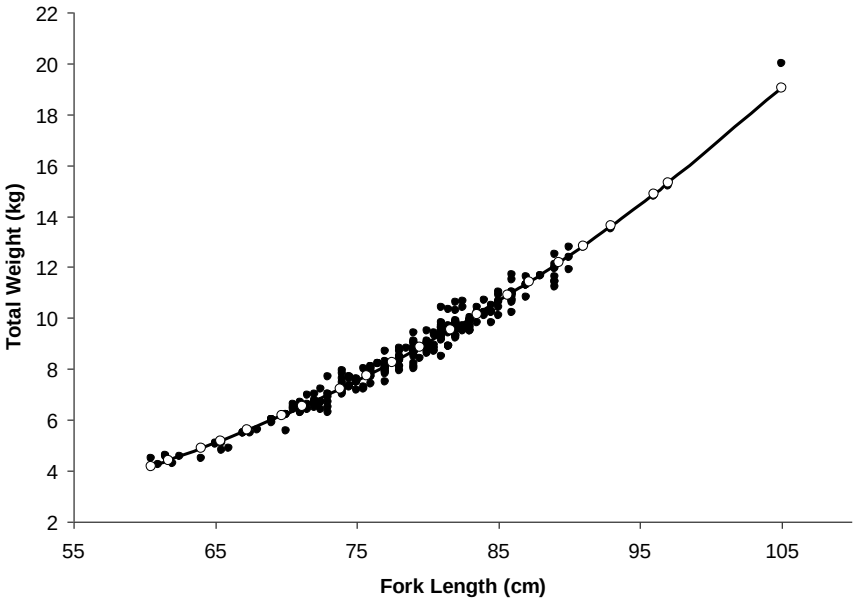

Figure 5. Length – weight relationship of albacore in the eastern Mediterranean Sea off Egypt.

by-catch species in this study may be attributed to season, gear design and operation, geographic location and oceanographic factors (Megalofonou *et al*., 2005; Tserpes *et al*., 2008; Coll *et al*., 2010; Macías *et al*., 2012).

Based on the data reported by Hsieh *et al*. (2010), and Chang and Yeh (2010), it is clear that the results of catch per unit effort in the present study are comparable to those reported for the North Atlantic albacore (Hsieh *et al*., 2010) and for the South Atlantic albacore (Chang and Yeh, 2010) during the period from 1990–2008. The average CPUE for the albacore in the North Atlantic was 8 fish/1000 hooks and ranged between 4-15 fish/1000 hooks, while that for albacore in the South Atlantic was 13 fish/1000 hooks and ranged between 8–20 fish/1000 hooks.

However, care should be taken into account since the CPUE obtained for albacore in the present study may not reflect the actual albacore abundance in the fishing area. Based on observations on acoustic telemetry, Laurs *et al*. (1980) and Laurs and Lynn (1991) indicated that individuals of albacore in the Northeast Pacific of age ranging from 3-5 years spent 80% of the time at a depth of 100 m. In addition, Bard, (2001), mentioned that large albacore (average weight is 21 kg) in the North Atlantic is freely

swimming at depths from 100-450 m with a maximum abundance at depths from 250-300 m. Thus, probably a major part of albacore may remains far from attraction of the baits set at the fishing depth in the present study (20–30 m).

Length data for 1577 albacore showed that the fork length ranged from 54 to 106 cm. However, fish belonging to length classes from 74 to 86 cm represented the bulk of the catch (75%), the estimated average length and graphically determined retention length (L_{50}) were found to be within the length class 80 cm (as shown in Figure 3). This average length is larger than that of albacore caught by driftnet fishing in the eastern Mediterranean (Karakulak *et al*., 2007; Karakulak *et al*., 2011).

Based on the findings of Arena *et al*. (1980) (cited in Alonso *et al*., 2005), that the fork length at first sexual maturity of albacore in the Mediterranean sea is 62 cm, the pelagic longline used by Egyptian fishermen catch mainly adult albacore. This is in agreement with previous papers that reported similar fork length ranges of albacore caught by pelagic longliners (Alonso *et al*., 2005; Di Natale *et al*., 2005).

The length-weight relationship of albacore showed an allometric growth reflected in the regression coefficient b (the exponent of the power equation, b = 2.75). This negative allometric growth « b<3 » is characteristic to the Mediterranean albacore stock, whereas the Atlantic ocean albacore stocks are characterised by a positive allometric growth « b>3 » (Penney, 1994). Compared to the results from other previous studies (Table 3), the power equation describing the length-weight relationship of albacore caught by Egyptian fishermen in the eastern Mediterranean shows a great similarity to the results of Megalofonou (1990 and 2000) on Mediterranean albacore.

It is noteworthy that, in the present study, the length and weight measurements were collected during June and July only (Summer season), this should be considered because differences in the value of b may be attributed to many factors including seasonal, regional, water temperature, sex, food availability, and the fork length range included in the regression analysis (Tesch, 1971; Pitcher and Hart, 1982; Karakulak *et al.*, 2011).

The presence of only one large fish of 138 cm FL and the missing of (not represented in the catch) all albacore belonging to the length range between 106-138 cm. This may indicate a case of growth overfishing, or confirm a size-based vertical distribution (Bard, 2001) so that larger size groups live at higher depths out of reach for the fishing depth in the present study.

Future research should be carried out to study the spatial distribution, biology and exploitation of albacore in the eastern Mediterranean Sea through a regional research program in order to have sufficient data required to design a sustainable fisheries management plan.

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Table 3. Length – weight relationship of albacore in the Atlantic Ocean and Mediterranean Sea by different authors

Albacore Stock	F.L- Range	Number of specimens	Equation	Reference
Mediterranean	55 - 89	1742	$W = 3.119 \times 10^{-5} \times FL^{2.880}$	Megalofonou, 1990
North Atlantic	42 - 117	714	$W = 1.339 \times 10^{-5} \times FL^{3.107}$	Santiago, 1993
South Atlantic	46 - 118	1008	$W = 1.372 \times 10^{-5} \times FL^{3.079}$	Penney, 1994
Mediterranean	57 - 92	998	$W = 5.312 \times 10^{-5} \times FL^{2.740}$	Megalofonou, 2000
Eastern Mediterranean	64 - 94	171	$W = 0.132 \times FL^{2.52}$	Karakulak *et al*., 2007
Eastern Mediterranean	64 - 94	336	$W = 0.000160 * FL^{2.467}$	Karakulak *et al*., 2011
Eastern Mediterranean	60 - 105	274	$W = 5.26 * 10^{-5} * FL^{2.750}$	Present Study

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