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Research Article

Interactions Between Sea Turtles and Fishing Along the Aegean Coast of Turkey

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ABSTRACT

In this study, the interactions (encountering and bycatching) of the sea turtles with fisheries in the Aegean Sea were investigated.

Data were collected by face-to-face survey with a total of 404 fishermen in 98 fisheries cooperatives for 5 provinces (Çanakkale, Balıkesir, İzmir, Aydın and Muğla) between August 2016 and October 2017.

The interactions are more intense in places where fishing activities coincide with the living areas of these living beings. Although there is maximum (100%) interaction (visual contact) on the coast of Aydın (100%), the average annual encounter within these five provinces is quite high with 88%. While there is a significant difference in the rate of encounters with turtles had been found between the provinces ($p<0.05$), there is no significant difference in the rate of bycatching with fishing gears ($p>0.05$). Even though one of every four fishermen who participated in the survey had bycaught sea turtles at least once, the most of bycatching occurred in the fishing gears in the group of trammel/gill nets with 76%.

In areas where sea turtles are concentrated on the Aegean coast, applications should be carried out to prevent or reduce incidental catch of the fishing gears. Because the results show that these living beings are heading towards the Aegean north due to global warming.

Keywords: Aegean Sea, sea turtles, fishing gears

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INTRODUCTION

Although the Aegean Sea has an intended coastline with many bays, gulfs and islands, fishing grounds are limited due to steep, broken topography and a narrow continental shelf, and national waters of Turkey. Saroz, Çandarlı, Izmir, Sığacık, Kuşadası, Güllük and Gökova Bays as well as adjacent water of Gökçeada and Bozcaada are important fishery areas in the Aegean Sea and are rich in biodiversity similarly to the Mediterranean (Kınacıgil and İlkyaz, 1997). According to 2017 records, 30% (4027 fishing vessels) of Turkey's fishing fleet is located in the Aegean region (TUIK, 2018). 33% of the boats using the trammel/gill nets, as well 30% of the boats using both of longlines and handline are registered at the Aegean ports. In addition to the small-scale vessels, 6% of the trawlers and 17% of the purse seines are in the Aegean. This situation has lead to diversification of fishing gears for effective fishing. While fishing for large vessels is only carried out during the fishing season in non-banned areas, there is no such limitation for small boats. Small-scale fishermen usually make their living by fishing mostly on coastal areas.

The Bern Agreement which concerned the European Conservation of Natural Life and Natural Environment was signed by the European Economic Community and other member

countries in 1982. The agreement was approved by the Council of Ministers dated 9 January 1984 and numbered 84/7601 and was published in the Federal Register dated 20 February 1984 and entered into force in Turkey. At the same time in the vernacular of the day according to Article 16 entitled "Fishing Forbidden Species" of the notification on the Arrangement of Commercial Fishing Regulations No. 4/1 of the notification No 2016/35 (Anonymous, 2016) which was enacted by published in the Federal Register dated August 13, 2016 and numbered 29800 and which was valid as of 01/09/2016, that is forbidden to catch, collect, keep on board, disembark, transport and sell species of *Caretta caretta* (Linnaeus, 1758), *Chelonia mydas* (Linnaeus, 1758) and *Dermochelys coricea* (Vandelli, 1761) in all our waters. Aegean fishermen use the name *C. caretta* for all sea turtles which they have seen. Only the fishermen in Muğla can distinguish the Nile turtle (*Trionyx triunguis*) from other turtle species because their morphological characteristics are obviously different.

The sea turtle population in the Eastern Mediterranean was seriously exploited as a target species in the first half of the 20th century. Nowadays, the most important threats to these turtle populations are anthropogenic effects in nest sites and interaction with fishing (Casale, 2008). Even though the dominant small-scale coastal fishing, traditional subsistence fishing and recreational fishing in coastal Turkey, there is no extensive study on bycatch of turtle. Despite of the dominant small-scale fishing, artisanal fishing and recreational fishing in coastal areas of Turkey, there is no extensive study on the bycatching of turtles.

In this study, the interactions (encountering, bycatching and saving) of sea turtles with the fisheries in the Aegean Sea were investigated. Within this framework, we have tried to reveal the situation of the bycatch of sea turtles with different fishing gears according to time and space and mentioned applications to reduce them.

MATERIAL AND METHODS

The study was carried out along the coasts of the Aegean Sea in Çanakkale, Balıkesir, İzmir, Aydın, and Muğla within 34 districts bound to these provinces and in 98 cooperatives areas between August 2016 and October 2017. The data were collected through a face-to-face survey of 404 fishermen in these cooperative areas. In this context, questions about general information about with used fishing gears, boat characteristics, fishing area, the average amount of catch and problems encountered, the conditions of interaction with sea turtles (encountering, bycatching and saving) and the reduction of the bycatching of sea turtles (propensity to use deterrents and the points of view of fishermen such as TED's, longline hooks, shark silhouettes, acoustic signals) were used. Legal research ethics committee approval permissions for the survey were obtained from the Aegean University Scientific Research and Publication Board and related Ministry. Every fisher interviewed was informed about the purpose of the work, the confidentiality of the collected data and their names would be preserved. The interviews were carried out after the fishers agreed to participate in the survey. Face-to-face interviews and survey were organized at ports, on fishermen's boats or in cooperative buildings. The survey was designed for the purpose of investigating the views of fishermen and their interactions with sea turtles, none of the questions have been made from multiple-choice or limited and they were open-ended to set fishermen free.

The total number of registered fishermen in the Ministry of Agriculture and Forestry has been accepted as the mainland along the coast of Aegean Sea (the shoreline from the Çanakkale border to the Antalya province border). In this case, the number of fishermen on the mainland is 5076.

The number of the survey to be made according to the sampling size account is calculated by the following formula *(Newbold, 1995)*.

$$n = \frac{Nxt^2xpxq}{d^2(N-1) + t^2 * p * q}$$

N = Number of individuals in the population

n = Number of individuals to be sampled

p = frequency of observation of the event to be investigated (probability)

q = probability of not observation of the event to be investigated (1-p)

t = value in the t table at a certain degree of freedom and at the determined level of error

d = ± error

95% confidence level and 5% error margin were accepted in the calculation of the total sample size, and the probability of observation and non-observation of the event was taken as 50-50% due to heterogeneous construction. Accordingly, the number of fishermen to be sampled was calculated as 357, and random stratified sampling method was applied with the aim of providing a homogeneous distribution.

However, the survey data obtained during the field studies revealed that the current number of fishermen was 4569 on the Aegean Sea coast. In this case, it was calculated that the number of interviews required to be done by recalculating the sampling size account was 354 and the layer interval was 0.078. During the field studies, face-to-face interviews were made with 404 fishermen instead of 354 fishermen as a result of fishermen's approach to the subject and their willingness to participate in the survey.

Information on the target and catch composition was obtained from co-operative presidents and fishermen, and information on bycatch of sea turtles was taken only from fishermen. The obtained data were analyzed in MS-Excel and SPSS 22 programs. The chi-square test was used to compare the number of turtles according to the boat, season, area and fishing gears.

RESULTS AND DISCUSSION

It has been determined that current the number of registered fishermen is 4569 on the Aegean Sea coasts during fieldwork. In this case, it is calculated that the number of the survey to be made by recalculation of the sample volume is 354 and the interval of stratum is 0.078. A survey was conducted with 404 fishermen during the field studies. The number of the survey to be carried out according to the respectively were 60 for Çanakkale, 18 for Balikesir, 149 for İzmir, 26 for Aydın and 68 for Muğla, and the number of the survey was carried out the respectively 83 in Çanakkale, 26 in Balıkesir, 177 in İzmir, 32 in Aydın and 86 in Muğla.

All of **t**he fishers who carried out the survey were male individuals. The age distribution of 57% of fishermen were between 40 and 59 years. A large proportion (81%) is composed of elementary / secondary school graduates. In Behramkale, which is especially connected to the Ayvacık district of Çanakkale, the vast majority of the male individuals were directed to fisheries instead of continuing education-training, while the ladies were involved in education and training activities. 94% of fishermen are fishing with boats either by their own boat or obtained the right to use it by renting. The rest of the fishermen are boat workers. The number of fishermen who are members of the cooperatives in where is 85%. 80% of fishermen are fishing with less than 9 m of boats and 73% of them catch less than 10 kg per day. The distribution of fishing gear used by 400 of the 404 fishermen who participated in the survey is as in table 1.

Table 1. Fishing gears which used by fishermen and distributions

Fishing Gears	Number of Fishermen	Percentage of Fishermen (%)	Percentage of Fishing Gear Used (%)
Trammel/ Gill net	343	68.9	85.8
Longline	92	18.5	23.0
Trawl	6	1.2	1.5
Purse seine	9	1.8	2.3
Fishing line	33	6.6	8.3
Others	15	3.0	3.8
Total	498	100	125

The 252 fishermen use only a trammel/gill net, and 91 fishermen use a second fishing gear with a trammel/gill net. 13 fishermen use longline as the only fishing gear and 76 fishermen use thetrammel/gill net as a second fishing gear together with longline. For this reason, the number of fishing gear used can be increased to 498 and the rate to 125%.

89% of the fishermen who participated in the survey observed visual contact with sea turtles at least once during the catching operation and 274 fishermen had encountered sea turtles at least four times during the season. While all of the fishermen encounter sea turtles in Aydın, the least encounter with 82% is in Izmir (Figure 1). For this reason, there was a significant difference in the rates of encounters with turtles had been found between the provinces (P = 0.004). 77.3% of in the rates of encounters with turtles had been at most during the fishing operation in the summer. Followed by spring with 11,1%, autumn with 7,1% and winter with 4,5%. An encountering is observed absolutely within these five provinces in every seasons, at least of in the rates of encounter were in the winter and at most in the summer.

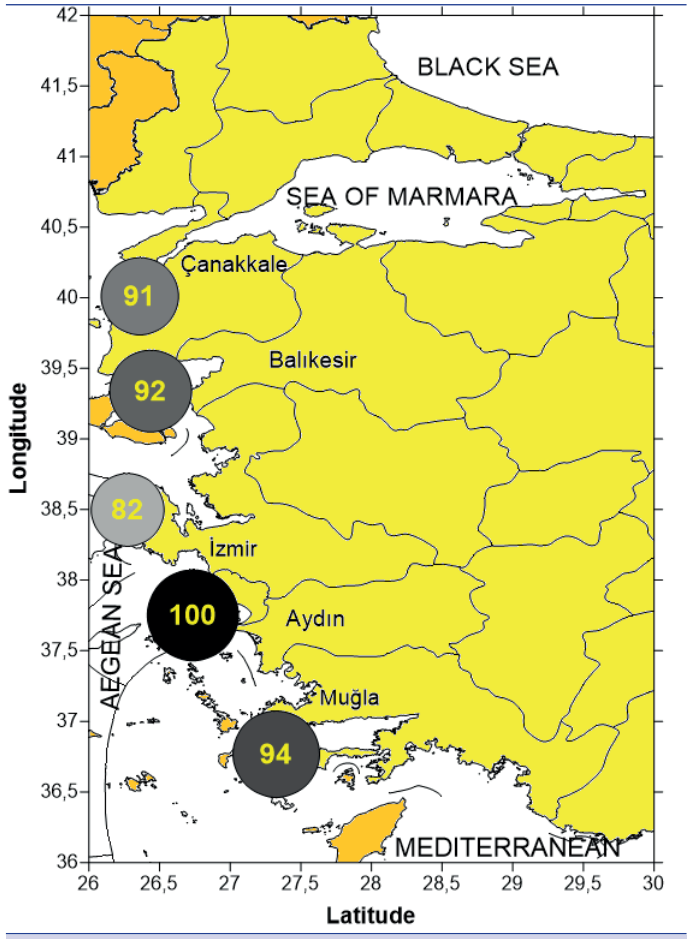

Figure 1. According to the provinces the rates of encounter with sea turtles.

While 299 (75%) of 399 fishermen who participated in the survey never bycaught sea turtle but 100 (25%) of them bycaught at least once. 46 of the 100 fishermen who said they caught sea turtles with fishing gear during fishing operations bycaught at least once, 40 of fishermen bycaught 2-4 times and 14 of fishermen bycaught more than 5 (Table 2). 18 of 79 fishermen in Çanakkale, 9 of 25 fishermen in Balıkesir, 35 of 177 fishermen in İzmir, 13 of 32 fishermen in Aydın and 25 of 86 fishermen in Muğla have bycaught sea turtle with their own fishing gears. Nevertheless, as incidental catching of turtles in the fishing gears there was no significant difference between the provinces (P = 0.054).

According to the number of vessels and fishing gear, the distribution of 25% of fishermen who bycaught sea turtle during the fishing operations is detailed in the table 2. According to this, trammel/gill net is the fishing gear that catches the most turtles, followed by longline, fishing line, purse seine, trawl and others. İzmir where most bycaught sea turtles come at the beginnig of the other provinces, the rate of catches is high in Balıkesir and Çanakkale.

The methods of save (release) of sea turtles is varied according to fishing gears (Table 3). Cutting the mesh in the trammel/gill nets and cutting the branchline of the longline are the most commonly used release methods. Six fishermen who make their living by trawl and 9 fishermen who make their living by purse seine stated that they had carried out the rescue process respectively by emptying the trawl bag or while collecting the nets, taking back from the edge of the net.

60 of the 100 fishermen who participated in the survey, saved a sea turtle in the marine environment without putting it in the boat, 40 of them rescued them on the boat. According to 99 of 100 fishermen who bycaught sea turtles even if not bycaught none of the turtles are injured, only a turtle saved from the trammel/gill net was injured in İzmir. None of the fishermen had any knowledge of how to intervene in the first phase. 98 of the 100 fishermen who bycaught the sea turtle said that the bycaught turtle's breathing was regular and quickly swam away after being rescued from the trammel/gill net, 2 fishermen did not notice the conditions of the turtles, for they did not pay attention to their breathing. A possible bycatching result 401 (99%). Fishermen had no knowledge of how to assist a sea turtle with irregular breathing, only a total of 3 fishermen said that they had enough knowledge about how they should intervene in a probable breathing problem in Küçükkuyu and Babakale and in the center of Çanakkale province.

322 (80%) of the fishermen were be unwilling to use Turtle Excluding Devices (TED), circle types of hooks for longline, dogfish silhouettes for trammel/gill net, remover devices that emit sound waves at certain frequencies according to non-target fishing composition, and in addition to this the newly developed fishing gears, equipments and methods for reducing the non-target fishing in the fishing gear of sea turtles. Only 81 (20%) fishermen willing to use these devices and methods since they are open to all technological developments for the sustainability of the ecosystem and the continuation of fishing.

Even though small-scale fisheries are dominant in the Aegean Sea, the non-target catching of sea turtles is not included in the evaluations. Although small-scale fishing (trammel/gill net, longline, fishing line, etc.) is not as effective as large-scale fishing (trawl, purse seine) in terms of production, it is in greater interaction because they use fishing areas together with sea turtles. The vast majority of the boats used in the Aegean Sea fishery are the

Table 2. Distribution of bycaught sea turtles according to provinces and fishing gears.

Number of bycatches	Provinces	Fishing Gears						
		Trammel/ Gill net	Longline	Fishing Line	Purse Seine	Trawl	Others	Total
at least once	Çanakkale	7	-	2	-	-	-	8
	Balıkesir	7	1	1	-	-	-	8
	İzmir	15	6	3	-	-	-	17
	Aydın	2	-	-	2	-	-	4
	Muğla	8	4	-	-	1	-	9
two to four	Çanakkale	5	-	2	-	-	-	5
	Balıkesir	1	-	-	-	-	-	1
	İzmir	12	2	-	2	-	-	15
	Aydın	5	1	-	1	-	-	6
	Muğla	6	7	2	1	2	1	13
more than five	Çanakkale	2	1	2	1	-	-	5
	Balıkesir	-	-	-	-	-	-	-
	İzmir	3	-	-	-	-	-	3
	Aydın	2	1	-	1	-	-	3
	Muğla	1	-	-	1	1	-	3

Table 3. The method and rate of rescue of sea turtles from fishing gears by fishermen.

Rescue Style	Number of Fishermen	Number of Fishermen (%)	Save (%)
Cutting the nets	354	71.5	88.1
Cutting the branch line of the longline	92	18.6	22.9
Cutting the fishing line	34	6.9	8.5
Emptying the trawl bag	6	1.2	1.5
Taking back from the edge of the net	9	1.8	2.2
Total	495*	100	123.1

**The total number seems to be high due to the fact that some fishermen also use two types of fishing gears.*

small-sized boats under 12 m. Because of the fact that the number of boats in small-scale fisheries is high and the lack of time closure increases the probability of interaction with sea turtles. However, most studies on the reduction of incidental catching of sea turtles and their fishing as well as the records kept are usually related to large-scale fisheries. In small-scale fishing (including traditional and subsistence fishing) and hand-line fishing, non-target catch is not generally taken in consideration (Peckham *et al.,* 2007). However, in some studies, small-scale fishing is also seen as an important risk factor for by-catching of sea turtles (Peckham *et al.,* 2007; Shigueto *et al.,* 2008).

Sea turtles have interacted intensely in areas where small-scale fishermen used the trammel/gill net, longline and fishing tackle sets in the Aegean waters, Since the trammel/gillnets used vary according to the target species, there are too many different types of trammel/gill net. The capture of sea turtles with the trammel/gill nets are varied according to the type of nets, the place where it is used and the fishing effort. While only one *C. caretta* was caught in the 131 operations with pelagic sword trammel/gill nets at the moonless night (Akyol *et al.,* 2012), drifting nets, which are a different type of trammel/gill nets, by-caught 5 *C. caretta* in 125 operations of albacore (*Thunnus alalunga*) fishing in the Aegean waters (Akyol and Ceyhan, 2012). Although there are many applications to reduce of incidental catching of sea turtles with trammel/gill nets, many tools and methods are still being tested to reduce of incidental catching. In Mexico where the tortoises are heavily distributed, in the Punta Abreojos region, emitting ultraviolet light LEDs (peak wavelength 396 nm) have been tested at 40 cm bottom of trammel/gill nets in order to prevent bycatching of *C.mydas,* and as a result, 209 *C. mydas* in the control net and 123 *C. mydas* in the experimental net were caught (Wang *et al.,* 2013). Another means of reducing the interaction of sea turtles with trammel/gill nets is the use of acoustic signal transmitter (pingers) (Kraus *et al.,* 1997). Experiments have shown that acoustic signal transmitters are initially effective for decreasing interactions of both dolphins and turtles with fishing gears.

Longline sets are the second fishing gear used widely in Aegean waters. Most of the fishermen using the trammel/gill nets use longline concurrently. Longlines can be set up in different depths and shapes depending on the target species. It throws depth varies from 10 m to 350 m in the Aegean Sea. Longline and sea turtles are in high interaction in areas of this depth. 28071 sea turtles were caught with longline in the Mediterranean Sea between 1990 and 2008 (Wallace *et al.,* 2010). Deaths of sea turtles which were caught with bottom longline are inevitable as they could not surface of the sea to breathe. The hook which is developed for catching of target species, and changed forages have been succeeded for decreasing of by-catching sea turtles. Yet J-type hooks have common usage, circle hooks have dropped the by-catch of sea turtle (FAO, 2010). Even the narrowest point of the circle hook is wider than the J-type hook. A decrease in mortality rates of *C. caretta* which are released from the circle hook have been observed (Foster *et al.,* 2012). Another factor affecting the interaction of turtles with the fishing gears are the feed used in longling fishing. The most preferred baits in fishing tunny and swordfish with pelagic longline are squid and mackerel. Sea turtles tend to eat the bait with small bites until it ends on the hook. Turtles swallow the hook together with the squid meat. Because it is more elastic than fish meat, and they cannot eat by biting squid meat in pieces (FAO, 2010). However, recently it has been established that the blue-painted squid meat drops bycatch of the sea turtles (Swimmer *et al.*, 2004). Flash light bars, dogfish silhouettes, radio frequency waves, chemicals, deterrent sounds also fall into the other ways of reducing the interaction of sea turtles with pelagic longline (Wiedenfeld *et al.,* 2015). However despite all this, it is not possible with today's technology to reduce the non-target catching to zero.

In the study, it was determined that sea turtles were caught in 67% of the trawl fishing boats. In trawls, success was achieved not only in the selectivity of size of the target species but also in the selectivity of the non-target species. The sea turtles caught in the trawl drowns, since they can not get out of the net to breath. When the data of trawling in the Mediterranean Sea between 1990 and 2008 was compiled, it was reported that 16041 sea turtles had been caught (Wallace *et al.*, 2010). The number of turtles caught by 11 trawlers during the 1999-2000 the open season between Mersin and Samandağ had been reported as 698 (Taşkavak *et al.*, 2006). In the same study, two of them were without TED and one of them was fishing by hanging a TED on the trawl net, while a total of 12 sea turtles were caught in TED-free net, 3 individuals of them were escaped through TED. Especially, since

there is alot of sea turtle interaction in the shrimp trawls which take place in the bottom trawler, the strategies to reduce the interaction with some modifications (using TED) in these trawls started by the National Marine Fisheries Service (NMFS) 25 years ago in the Atlantic Ocean and in the Gulf of Mexico. It can be said that the TEDs are the most successful technological development in reducing the by-catching of turtles in trawls. It is possible to say that the TEDs are the most successful technological development in reducing the by-catching of turtles in trawls.

In the study, all purse-seine fishermen said that they caught sea turtles during the fishing operation. During the operation, turtles can coil in the network, and their pallets and crusts can be injured by pulling the net potently (NMFS, 2017). The turtle that is attached to a network, while being pulled by the net collecting roller both it can be damaged by falling from the top and it can be crushed while passing through a net reel (FAO, 2010). All of the purse-seine fisheries who participated in the survey, release turtle on the edge of the net without taking to the boat with aid of a assistant boat which is called skiff and ladle in the marine environment.

It is estimated that the annual number of by-catching of sea turtles in the world is 85000 (Wallace *et al.*, 2010) and in the Mediterranean is 44000 (Casale, 2011). Humber *et al*. (2014) estimated that the total number of sea turtles caught legally was 42000 per year, and that this number was 31268 only in Papua New Guinea, Nicaragua and Australia. In a survey conducted in Italian waters in 2014, it was estimated that bycaught turtles numbered 52340 individuals (Lucchetti *et al*., 2017). According to the results obtained in this study, only 25% of the Aegean fishermen caught sea turtles at least once during the fishing operation between August 2016 and October 2017.

It is possible to state that while the sea turtles are thought to stop by the Aegean Sea for feeding purposes only, their living areas have headed for the north according to this study. The lack of any significant difference between the cities of bycatching supports the idea that sea turtles, who generally use the Mediterranean coasts for spawning and the Aegean Sea for feeding purposes, have headed north. This case can be explained by the way sea turtles head towards the Aegean coasts based on the warming of northern waters due to global warming.

For some fishermen, sea turtles are the living beings that come to the ensnared fish on the net, cause damage to nets and yield, and bring about time loss when they are caught. Sea turtles tear away the fish caught on the net by shivering the net, and leave a three-hole trace on the net by unripping with their flippers. However, fishermen claimed that the damage caused by sea turtles to their nets is less important than the damage by dolphins and seal attacks. These living beings are either released by splitting the fishing gear with powerful movements depending on the types and material of the fishing gear, or are saved from the fishing gear and put back in the marine environment depending on the attitude of the fishermen. The death of the sea turtle interacting with the fishing gear is inevitable when it cannot breathe from the surface, as it cannot pull through the gear or it goes unnoticed by the fisherman.

When fishermen encounter a wounded sea turtle, they reach out for the person or people, who will deal with the situation, barely. The intervention not only causes time loss, but can also make the fishermen feel guilty. For this reason, the fishermen leave these living beings in their environment without any intervention. The flow of data about turtles encountered or by-caught is missing due to the fact that there is no obligation to keep a logbook for boats under twelve meters. An appropriate registration method should be established to ensure reliable data flow associated with these protected species. Furthermore, incentives should be given to fishermen for the use of tools and methods that reduce by-catching instead of banning fishing activities in areas where turtles are abundant.

Considering the data obtained from the study areas, it can be said that sea turtles are commonly found along the Aegean coast. The reliability of the collected data is high, as it relies on that the fishermen have been fishing in this area for many years. While the first aim of the studies is the protection of sea turtles who live in the areas the study carried out, the protection of dolphins and seals, which fishermen encounter during fishing, is the second one. For a sustainable ecosystem, training packages containing information on the protection of these living beings can be prepared and active participation of fishermen can be ensured. In addition, more detailed studies are needed in the region because local fishermen have not encountered juvenile or hatchling individuals.

Ethics Committee Approval: Legal research ethics committee approval permissions for the survey were obtained from the Aegean University Scientific Research and Publication Board.

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