# Interaction between marine turtles and artisanal fisheries in the eastern Mediterranean: a probable cause for concern?

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Abstract: A survey of the levels of marine turtle bycatch in the small-boat based fisheries in northern Cyprus and the Turkish Mediterranean (Alanya to Mersin) was undertaken by questioning a sample of fishermen (n = 54) in all harbours in the survey region. Fishermen in Turkey caught an estimated 2.5 turtles/boat/year *versus* an estimated 4.0 turtles/boat/year in Cyprus. This yielded a likely minimum bycatch estimate of over 2,000 marine turtles per year in the region. An estimated 10% of turtles were thought to be dead at the point of capture. Turtles were caught in both nets and on long-lines and were perceived as detrimental to the livelihood of fishermen either by damaging nets, spoiling catch or removing bait. Although few fishermen admitted to deliberately killing turtles, a larger proportion thought others did so. Given the likelihood that a proportion of sea turtles caught will be Green Turtles (*Chelonia mydas*), and due to the highly endangered status of this species in this region, interaction with these fisheries is thought to constitute a real threat to marine turtles in the eastern Mediterranean.

Kurzfassung: In allen Häfen im nördlichen Teil von Zypern und an der türkischen Mittelmeerküste zwischen Alanya und Mersin wurde eine Befragung von Fischern (n = 54) durchgeführt, um das Ausmaß der Beifänge von Meeresschildkröten abzuschätzen. In der Türkei werden 2,5 Meeresschildkröten pro Boot und Jahr gefangen, gegenüber 4,0 Meeresschildkröten pro Boot und Jahr auf Zypern. Daraus läßt sich für die Region ein jährlicher Beifang von mindestens 2000 Meeresschildkröten ermitteln. Schätzungsweise 10% der Tiere waren zum Zeitpunkt des Fangs bereits tot. Die Schildkröten werden offenbar sowohl in Netzen als auch mit Angeln gefangen und gelten bei den Fischern als schädlich, da sie die Netze beschädigen oder den Fang negativ beeinträchtigen bzw. entfernen. Obwohl nur wenige Fischer zugeben, daß sie absichtlich Schildkröten töten, glauben die meisten, daß dies andere Fischer tun. Geht man davon aus, daß es sich mit aller Wahrscheinlichkeit bei einem Teil der Tiere um Suppenschildkröten (*Chelonia mydas*) handelt, und zieht man den generellen Bedrohungsgrad der Art in Betracht, muß der Beifang als bedeutende Gefährdungsursache eingeschätzt werden.

Key words: *Chelonia mydas*, Green Turtle, *Caretta caretta*, Loggerhead Turtle, northern Cyprus, Turkey, incidental catch, mortality.

## Introduction

### Marine turtles in the Mediterranean

Of the seven or eight extant marine turtle species, only three are found regularly in the Mediterranean. These are the Loggerhead (*Caretta caretta*), Green (*Chelonia mydas*) and the Leatherback (*Dermochelys coriacea*) turtles. Within the region, Loggerhead and Green

Zoology in the Middle East 16, 1998: 49–64.
ISSN 0939-7140 © Max Kasparek Verlag, Heidelberg

Turtles both nest regularly. It is not known how current nesting numbers compare to past population levels, but from anecdotal accounts it would appear that they are now considerably lower and GROOMBRIDGE (1990) recommended that both species should be treated as critically endangered within the region. Due to the relative paucity of reliable demographic information regarding most life history stages, numbers of nesting females are used as an index of the relative abundance of the two species.

**Loggerhead Turtle.** This species is by far the more widely distributed within the Mediterranean. Significant nesting occurs on the coast of Greece (e.g. MARGARATOULIS 1982, 1989), Turkey (e.g. BARAN & KASPAREK 1989a, BARAN & TÜRKOZAN 1996, ERK'AKAN 1993, YERLI & DEMIRAYAK 1996) and Cyprus (e.g. BRODERICK & GODLEY 1996, DEMETROPOULOS & HADJICHRISTOPHOROU 1989). It is likely that a sizeable population nests on the coast of Libya (LAURENT et al. 1997) and low levels of nesting occur in Tunisia, Egypt, Syria, Israel and Italy. Juveniles are thought to be widely distributed within the region, however it has been hypothesised that small juvenile phases are not present in large numbers in the eastern basin (BARAN & KASPAREK 1989b. GODLEY et al. in press a). A recent molecular resolution of stocks of this species in the Mediterranean (LAURENT et al. in press) has demonstrated that although substantial numbers from Atlantic breeding populations share foraging grounds within the region, the Mediterranean breeding stock is functionally independent.

**Green Turtle.** Green turtles are now only found nesting in Turkey (e.g. BARAN & KASPAREK 1989a, COLEY & SMART 1992, GLEN et al. 1997, YERLI & CANBOLAT 1998), Cyprus (BRODERICK & GODLEY 1996, DEMETROPOULOS & HADJICHRISTOPHOROU 1989 and others) and occasionally in Israel (KULLER 1995). It is likely that juveniles of this species are more localised in distribution to the eastern basin, where they are often caught in fisheries and recorded stranded (BARAN & KASPAREK 1989b, GODLEY et al. in press a, LAURENT et al. 1996, MARGARATOULIS et al. 1986). Capture in the western basin is exceptional (pers. comm. L. LAURENT). The estimated annual female nesting population of green turtles could be as low as between 300–400 in the Mediterranean (GROOMBRIGE 1990). It is highly likely that this population should be considered functionally independent from that of the wider Atlantic (BOWEN et al. 1992).

## Incidental catch

Incidental catch in many fisheries has been suggested as a major cause of mortality of marine turtles, especially of adult and sub-adult individuals (HILLSTAD et al. 1995, LUTCAVAGE et al. 1997). In the waters off the USA, mortality due to the shrimp fishery has resulted in the mandatory use of *Turtle Excluding Devices* (TED) in shrimp trawlers in U.S. waters (HENWOOD & STUNTZ 1987, NATIONAL RESEARCH COUNCIL 1990).

Incidental catch of marine turtles in Mediterranean fisheries is a well established problem, and has been considered the major threat to marine turtles in the region in a recent review (LAURENT 1997. Tab. 1). Turtles interact with most types of fishing gear. Large numbers (mostly Loggerhead Turtles) are caught in pelagic longlines, during bottom trawling, and drift netting. Proximate mortality appears high in the Italian drift net fishery and the Spanish

Tab. 1. Review of estimates of incidental capture of marine turtles and mortality level (%) in different Mediterranean fisheries (after LAURENT et al. 1996, LAURENT 1997). N = number of individuals sampled to estimate mortality; ⊗: delayed mortality; *: onboard observations; NQ = not quantified.

| Fishing gear | Fishing zone | Estimated annual no. of captures | Direct mortality (%) | N | References |
|---|---|---|---|---|---|
| Trammel nets | | | | | |
| • Lobster | France | low | 100 | 8 | LAURENT 1991 |
| • Lobster | Corsica | low | 93.3 | 15 | DELAUGERRE 1987, LAURENT 1996 |
| • Fish | France | low | 28.5 | 9 | LAURENT 1996 |
| • Fish (Sole) | Corsica | low | 75.0 | 4 | LAURENT 1996 |
| | France | low | 53.1 | 128 | LAURENT 1991 |
| Gill nets | France | 10–100 | 50.0 | 6 | LAURENT 1991 |
| | Italy | NQ | 50.0 | NQ | ARGANO et al. 1992 |
| Drifting Longlines | Spain 1990 | 35,637 | 0.4 | 673* | AGUILAR et al. 1995 |
| | Spain 1991 | 22,000–23,637 | 0.4 | 425* | AGUILAR et al. 1995 |
| | | 100–1,000 | 24.4⊗ | 45 | |
| | Italy (Ionian Sea) | | NQ | | DE METRIO & MEGALOFONOU 1988, AGUILAR et al. 1995, MAS 1996 |
| | Malta | 1,500–2,500 | NQ | | GRAMENTZ 1989 |
| | Greece (Cephalonia) | 50 | NQ | | PANOU et al. 1992 |
| | Morocco | 3,000 | NQ | | LAURENT 1990 |
| | Algeria | 300 | NQ | | LAURENT 1990 |
| Drift-nets | Italy (Ionian Sea) | 16,000 | 29.0 | 31* | DE METRIO & MEGALOFONOU 1988 |
| | Italy (Ligurian & Tyrrhenian Seas) | low | 0.0 | 5* | DI NATALE 1995 |
| | Spain 1994 | 117-354 | 3.3 | 30* | AGUILAR 1995 |
| Bottom trawl | Greece (Peloponesus) | NQ | 2.6 | 38 | MARGARITOULIS et al. 1992 |
| | Italy | 1,000–1,500 | NQ | | ARGANO 1979 |
| | Croatia | 2,500 | NQ | | LAZAR & TVRTKOVIC 1995 |
| | Tunisia | 3,500–4,000 | 0.0 | 15* | LARENT & LESCURE 1994 |
| | Tunisia | 2,000–2,500 | 0.0 | 1* | BRADAI 1992 |
| | Turkey | high | 0.5 | 138 | ORUÇ et al. 1997 |
| | Turkey | high | 0.0 | 1* | LAURENT et al. 1996 |
| | Egypt | high | NQ | | LAURENT et al. 1996 |
| | France | low | 3.0 | 97 | LAURENT 1991, 1996 |
| | Corsica | low | 3.8 | 26 | DELAUGERRE 1987 |
| | Spain | low | NQ | | AGUILAR 1995 |

Tab. 2. The pattern of distribution of total marine harvest attributed to ports from the 4 divisions of the Turkish fishing fleet (for 1992) versus the overall proportion of each of the cumulative turtle catch in recent times (1968–1984). Data as recorded in the annual fishery statistics (TURKISH STATE INSTITUTE OF STATISTICS 1970–1994). Total annual catch of dolphins from the same publications for the period (1968–1982) are also shown.

| Region | Percentage of marine harvest (1992) | Turtle catch (1968–1984) | | Dolphin catch (1968–1982) | |
|---|---|---|---|---|---|
| Mediterranean | 11 % | 423 tons | 85.8% | 43 tons | 0.1% |
| Aegean | 15 % | 52 tons | 10.5% | 5 tons | 0.01% |
| Marmaris | 10 % | 13 tons | 2.6% | 7 tons | 0.02% |
| Black Sea | 64 % | 5 tons | 1.2% | 38 256 tons | 99.9% |
| Total | 100 % | 493 tons | 100.0% | 38 310 tons | 100.0% |

long-line fishery, however low levels of direct mortality (possibly approaching zero) are reported in trawling. In should be noted that no studies have yet quantified levels of any delayed mortality from Mediterranean trawling activity. Although generally lower numbers are caught in the less industrialised fisheries, mortality appears to be considerably higher.

Although there are no recent records of marine turtle bycatch from Cyprus, turtle harvest in Turkey in the recent past has been significant. Until the early 1980's relatively detailed records (by weight) of both turtles and dolphins caught by the Turkish marine fisheries were published (see Tab. 2). No turtle or dolphin catch was recorded after 1984 or 1982, respectively. Although neither of these data sets are thought to be exhaustive, they do give an indication of the importance of the catch of both these taxa in the past. It is apparent that the largest proportion of both the total marine harvest and of dolphins caught is attributed to the Black Sea ports. However, although generally low in productivity, the Mediterranean region is where most turtles were caught (433 tons of turtles were caught between 1968 and 1984, see Tab. 2).

In the eastern Mediterranean, fishing strategies can be simplified and are generally considered as being undertaken by two classes of boats (GÜCÜ & BINGEL 1994). Firstly, "small boats" – 4–10m in length and carry out beach-seining, long lining and fishing with trammel and gill nets – and secondly, "large boats" – over 10 m in length carry out purse – seining and trawling. This study was conducted to ascertain the levels of incidental catch of marine turtles in the small boat based, artisanal, fishery in northern Cyprus and on the Turkish Mediterranean coast.

## Methods

The study was undertaken in August 1995, during the closed season for trawling and purse-seining. Data were only collected from "small-boat" fishermen. Incidental catch in the regional trawl fishery has been the subject of recent international study (LAURENT et al. 1996. ORUÇ et al. 1997). The study area constituted two separate regions (Fig. 1): the complete coastline of northern Cyprus and the area of the Turkish Mediterranean coastline (Mersin to Alanya).

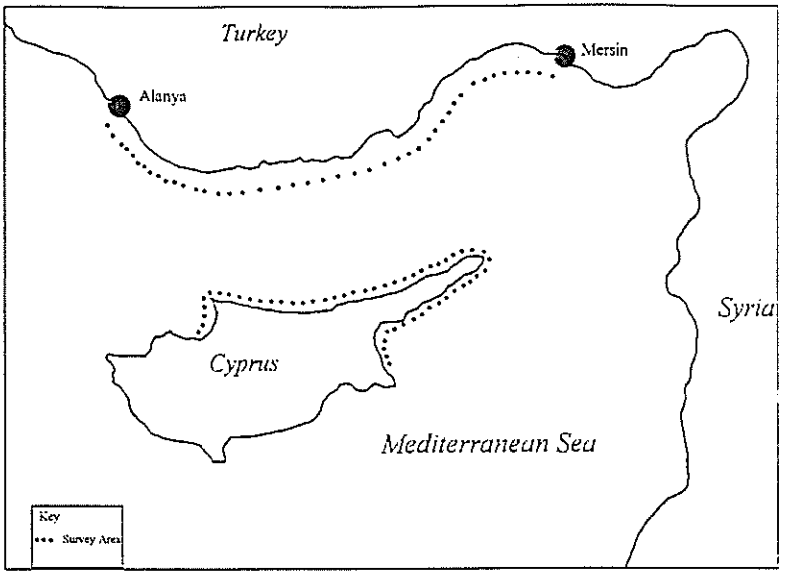


Fig. 1. Map of the eastern Mediterranean showing study sites.

Sample fishermen from every harbour in the study area were interviewed. Interviews were carried out in Turkish. All interviews in Turkey were carried out by BG and ACG. Those in Cyprus were carried out by BG and a member of staff from the local Department of Environmental Protection. Preceding each interview fishermen were urged to give full honest answers, as regardless of the outcome, no steps would be taken against them. Interviews were carried out in as standard a manner as possible, with questions asked in set order. Only data from one fisherman per vessel were included.

Port authorities in both regions were contacted to discover numbers of fishing vessels in each port. This was complicated by the fact that in Turkey, only numbers for each administrative region were available and these included vessels licensed to fish but inactive. In addition, vessels move freely between local harbours. In northern Cyprus, only numbers of licensees were available, and it was not possible to assign these to specific harbours. Because of these factors, the total number of small vessels in each size class was generated by asking the fishermen at each harbour how many vessels were based there. It was thought that this would give by far the most accurate estimate of the number of active fishing boats in each location.

Fishermen were asked how many turtles they caught in a season, the proportion which died as a result, in which months fishing was carried out, in which months turtles were sighted at sea and what size class they were (small <30cm, medium 30–50cm, large 50–90cm, very large >90cm), in which month turtles were caught and what sizes they were. Following this, a series of anecdotal questions regarding general attitudes and opinions were asked. It was not possible for fishermen to accurately assign the sea turtles to species, although they were all aware of the fact that sea turtles were distinct from the Nile Soft-shelled Turtle (*Trionyx triunguis*) which is also caught and called "Yahudi Kaplumbağa" (Jewish turtle) by fishermen based in the Mersin Harbour (and in theYumurtalık region, KASPAREK pers. comm.). In addition, fishermen in Cyprus also described rare but regular sightings of a "large black turtle", most likely to be leatherback turtles. This study focuses on Green and Loggerhead Sea Turtles.

Tab. 3. Summary statistics describing the fishing fleet in both regions.

| | Class | Cyprus | | Turkey | | Total | |
|---|---|---|---|---|---|---|---|
| Number of vessels (% fleet) | small | 171 | 96% | 409 | 77% | 580 | 82% |
| | large | 8 | 4% | 122 | 23% | 130 | 18% |
| | total | 179 | | 531 | | 710 | |
| Number sampled (%) | small | 32 | 19% | 22 | 5% | 54 | 9% |

Tab. 4. Data regarding the estimate of incidental catch of marine turtles.

| | Cyprus (n = 32) | Turkey (n = 22) | Total |
|---|---|---|---|
| Median no./boat | 4.0 | 2.5 | - |
| Interquartile range | 3.1–9.5 | 0.1–5.5 | - |
| Absolute range | 0–25 | 0–6 | - |
| Median estimate of catch | 684 | 1328 | 2012 |
| Interquartile catch estimate | 530–625 | 41–250 | 571–875 |

# Results and Discussion

## Estimation of current day incidental catch and mortality

Tab. 3 illustrates that the fishing fleet in the study area is considerable: there are 179 boats in northern Cyprus and 531 in Turkey between Mersin and Alanya. Although the fleet in northern Cyprus is more obviously dominated by small vessels (96% *versus* 77% in Turkey), the overall majority of vessels are of the small size class (82%). All vessels were found to utilise a combination of long-lines and gill/trammel nets. A summary of the statistics regarding the estimated number of turtles caught per year is given in Tab. 4. The estimated catch rate in northern Cyprus (median: 4.0 turtles/year/boat) was significantly higher than that in Turkey (2.5 turtles/year/boat: Mann-Whitney: W=1033, $p<0.01$). If these median estimates are taken as typical, the median estimate of incidental overall catch would be 2012 turtles (IQ range of estimates: 571–3875 turtles). Mortality levels estimated by fishermen are described in Tab. 5. There was an extremely high degree of variability in estimates among fishermen, ranging from 0–100% in both regions of the study range, however the interquartile ranges were much narrower. Median estimates of resultant mortality level were 10% in both Turkey and northern Cyprus (Mann-Whitney: W= 781, n.s.). Taking the median point estimate, the number of turtles killed by this fishery would be 202 annually (IQ range of estimates: 100–733). When excluding cases where fishermen recorded no turtle catch, there was no correlation between number of turtles caught by given fishermen and the mortality level (northern Cyprus: $R_S = 0.27$, $p = 0.27$, n.s.; Turkey: $R_S = 0.07$, $p = 0.712$, n.s.).

Tab. 5. Data regarding mortality levels of marine turtles caught in fisheries

| | Cyprus (n=32) | Turkey (n=22) | Total |
|---|---|---|---|
| Median mortality level | 10% | 10% | – |
| Interquartile range | 0–10% | 7.5–50% | – |
| Absolute range | 0–100% | 0–100% | – |
| Median kill estimate | 69 | 133 | 202 |
| Interquartile range of kill estimate | 0–69 | 100–664 | 100–733 |

The seasonality of fishing effort appears to be quite different between Turkey and northern Cyprus (Fig. 2). Although the effort in both fisheries is higher between May and September, there appears to be a far more marked decline in the proportion of fishermen who fish outwith summer months in Turkey. Although there is likely to be an effect of fishing effort on the number of sightings, it is possible that the temporal pattern of turtle sightings represents seasonality of either turtle visibility, abundance or activity levels. The seasonal pattern of when fishermen observe turtles at sea is very similar in both Turkey and Cyprus (Fig. 2), with turtles only being seen, between May and September, with peak numbers being seen between June and August. When the size classes are plotted (Fig. 3), it can be seen that although most fishermen see large juveniles and adults, very few see turtles less than 30cm in carapace length. This could be due to a combination of difficulty in seeing small turtles and the fact that very small individuals are largely to be found in a pelagic developmental environment (MUSICK & LIMPUS 1997).

The temporal distribution of the catch of marine turtles as described by the fishermen in Cyprus is in general similar to that of sightings, with most activity taking place between May and September and peak catch occurring June-August. There are however, a few small differences in the distribution as described by Turkish fishermen (Fig. 2). Although a few Turkish fishermen say they catch turtles in March and April, none are recorded as having caught any in September.

Upon inspection of the size class distribution of what fisherman recorded as being caught (Fig. 5) it can be seen that is biased more to the small and medium sizes (<50cm), markedly so in northern Cyprus. This suggests that the lack of small turtles in observations is due to difficulties in their detection. The size distribution in catch may mimic the natural makeup of the population or might represent an increased tendency for small turtles to be caught. There are two reasons why this might be the case: Firstly, large turtle of any species may be less likely to be caught during an interaction with fishing gear due to their size. Fishermen often report damage having been done to their nets and lines by entangled or hooked turtles which have escaped. This is more likely to occur in cases where larger, stronger individuals are caught. Secondly, a recent study utilising stable isotope analysis has suggested that Green Turtles in the region may not be obligate herbivores (GODLEY et al. in press b). Given the expected juvenile tendency to carnivory (BJORNDAL 1997), smaller turtles may be more likely to interact with long-line bait and captured fish in nets, increasing the bycatch of these size classes. If present, juvenile Loggerhead Turtles would also be expected to be caught in these fisheries as in other regions (Tab. 1). Evidence suggests that there is a paucity of these small individuals in the region, possibly due to some level of developmental emigration to the western basin (BARAN & KASPAREK 1989b, GODLEY et al. in press a). This hypothesis has been partially confirmed by recent molecular data (LAURENT et al. in press.).

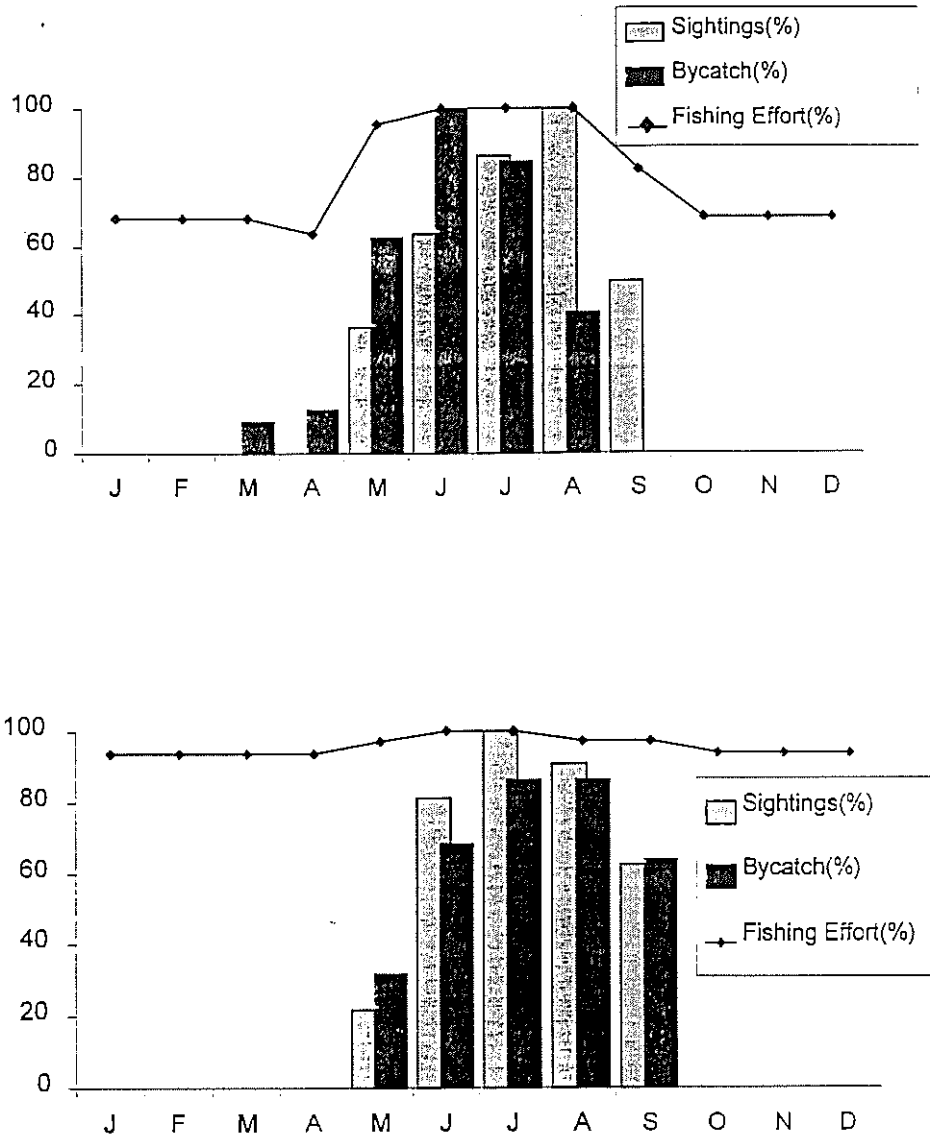


Fig. 2. Temporal distribution of sea turtle sightings, turtle bycatch and fishing effort as recorded by fishermen questioned in Turkey (% of those surveyed). Above: Turkey. Below: northern Cyprus.

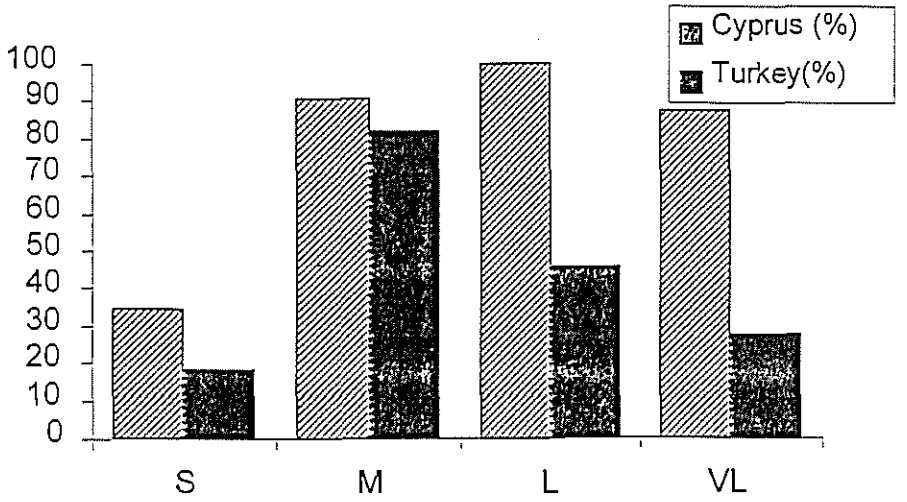


Fig. 3. Size distribution of size classes of sea turtles observed by fishermen (as % of fishermen surveyed) for both Turkey and northern Cyprus. S=small <30cm; M= medium 30-50cm; L= large 50-90cm, VL=very large >90cm.

## Wildlife-fishery interactions

It was the general opinion of fishermen in Turkey that both nets and longlines were involved in catching turtles: five (23%) thought nets more important, five (23%) thought longlines more important and 12 (55%) thought both methods equally important. However, in Cyprus, although 16 (50%) thought both methods were equally involved in turtle catch, a large proportion (15 = 47%) thought nets were important, with only one (3%) citing long-lines alone as significant. A large proportion (17 = 77% in Turkey; 31 = 97% = in northern Cyprus) of fishermen considered that turtles damaged their livelihood in some way, either by damaging nets, spoiling catch or removing bait from hooks. No individuals in Turkey saw turtles as the most problematic wildlife species, other taxa were cited (sharks: 3 = 14%; dolphins: 4 = 18%, monk seals: 1 = 5%), however this was not the case in Cyprus where 25 fishermen (78%) considered turtles to be a major problem with an additional three (9%) citing dolphins.

## The status of fish and turtle stocks

When asked about the status of fishery stocks 20 (91%) of the fishermen in Turkey thought they were declining. All of these fishermen though general over-fishing was to blame (20 = 100%), especially the trawl fishery (16 = 80%). In addition a number thought pollution was

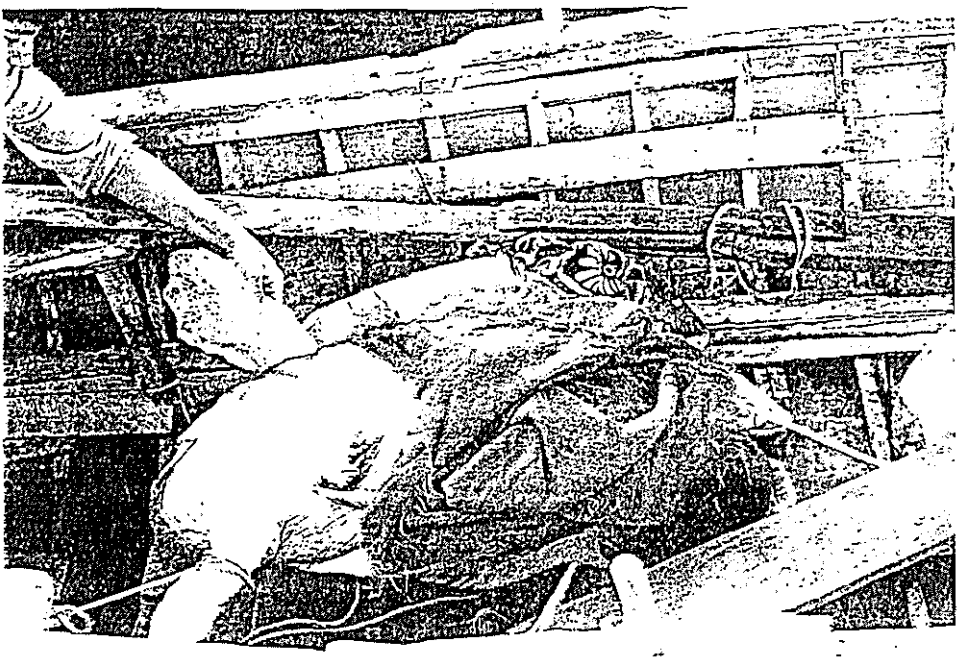

Fig. 4. No fisherman interviewed said that he ever killed a sea turtle. However, 33% of the fishermen interviewed thought that other fishermen did kill them.

also a reason (9 = 45%). In Cyprus all fishermen who had an opinion (25 = 78%) thought that fish stocks were, in general, declining due to trawler fisheries (22 = 88%), pollution (19 = 76%), general over-fishing (10 = 40%) and weather changes (5 = 20%). When asked the same question about turtles, of 16 respondents in Turkey, eight (50%) thought turtle populations to be decreasing, four (25%) thought them to be stable and four (25%) thought they were increasing. In Cyprus, opinion was relatively similar, with 12 fishermen (38%) stating they thought stocks to be decreasing, 13 (42%) thought them stable and only six (19%) thought them to be increasing.

## Attitudes of fishermen to turtles

When asked if they ever killed turtles, no fishermen in Turkey responded positively although seven (32%) thought that other local fishermen did kill them. In Cyprus nine fishermen (28%) admitted that they killed turtles and 20 (63%) thought that other fishermen did so. All fishermen in both regions were aware that turtles were protected and in Turkey, 21 (95%) thought that this should be the case, whereas only 21 (66%) in Cyprus agreed with protection. When asked what they did with the turtles they caught or killed, the fishermen in Turkey cited the non-commercial use of shells and meat; and blood and fat for medicinal purposes (including the treatment of asthma). In Cyprus, fishermen said that they occasionally used their meat and shell but mostly discarded the carcasses.

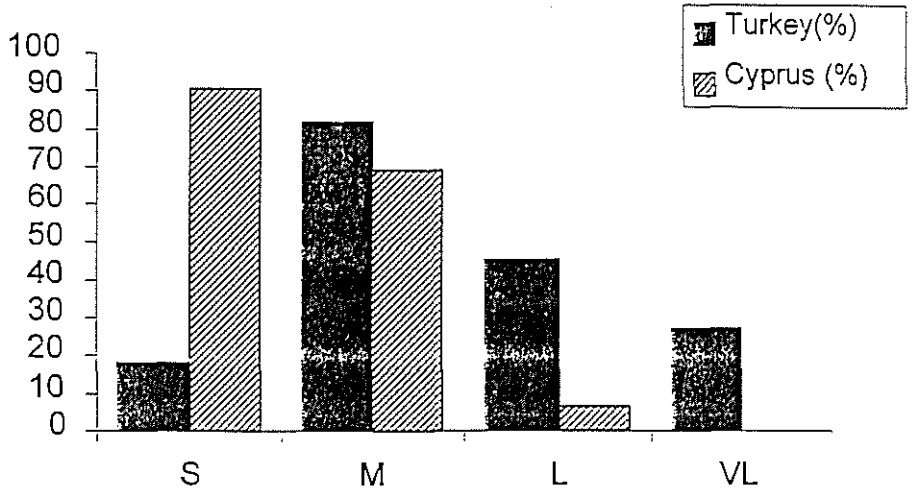


Fig. 5. Size distribution of size classes of sea turtles observed by fishermen (as % of fishermen surveyed) for both Turkey and northern Cyprus (Key: S=small <30cm; M= medium 30-50cm; L= large 50-90cm. VL=very large >90cm).

## General Discussion

Although a questionnaire-based survey of incidental catch is not as powerful as one which uses onboard observers to generate a catch per unit effort, in this situation, for fisheries with such diffuse effort, it is the only one which could realistically have been undertaken. Given that all fishermen knew of the protected status of turtles and the fact that the survey was conducted by a foreign researcher and a local authority figure, it is reasonable to expect the estimate of the numbers of turtles caught by fishermen to be a low one. It is likely that the incidental catch by artisanal fisheries in the eastern Mediterranean is substantial and certainly in excess of two thousand individuals in the combined study areas.

The estimate of 10% mortality at time of capture, would mean that at least two hundred turtles die immediately as a result of interaction with these fisheries. For the same reasons as described above, it is also likely that this figure is a low estimate. In addition, it is plausible that additional mortality resultant from physical injuries and hypoxic damage occurs. From data given regarding the size class of catch and comparison with available marine turtle stranding data in the region (BARAN & KASPAREK 1989b, GODLEY et al. in press a) it is likely that a large proportion of the turtles caught are juvenile Green Turtles. Given the highly endangered status of the Mediterranean population of this species, this interaction is a matter of concern.

Among the scientific community, there are grave concerns as to the future of Mediterranean fish stocks (BINGEL et al. 1993). This is mirrored in the popular opinion of its

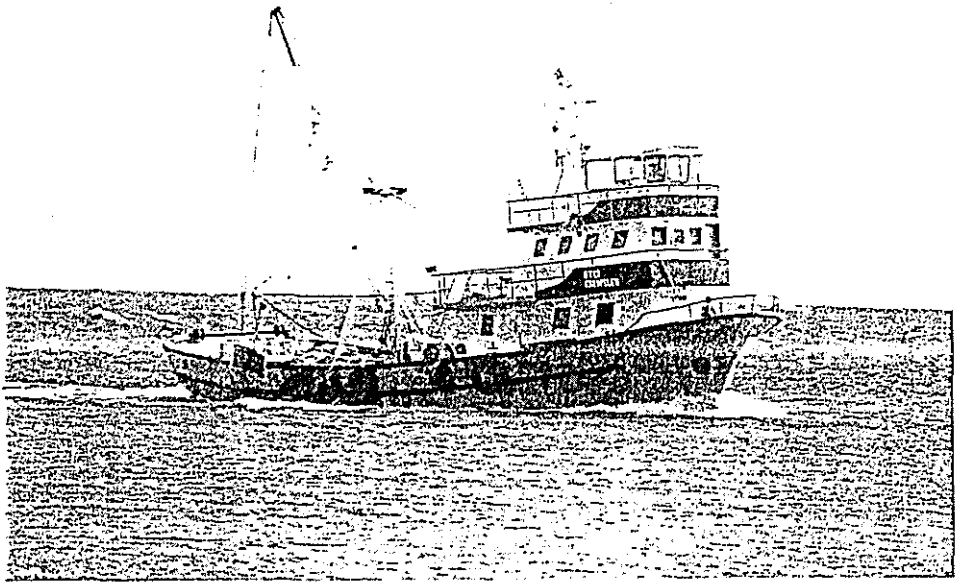

Fig. 6. Interaction with local fisheries is thought to constitute a real threat to marine turtles in the eastern Mediterranean.

artisanal fishers collated here. There would appear to be a need for greater control of fisheries in the region. On many occasions, the authors (BG and ACG) have observed trawlers flouting existing regulations and fishing within several hundred meters of the shore.

Turtles undoubtedly harm artisanal fisheries, whether by spoiling catch, eating bait or damaging equipment and often die as a result, whether by drowning, due to injuries sustained or being killed by fishermen. Finding sound and sustainable solutions is problematic. Compensation schemes would appear inherently flawed in that they may encourage fishermen to actively catch turtles. Undoubtedly, there is some goodwill in the fishing communities in both regions which should be built upon through education.

Within the eastern Mediterranean, there is urgent need for additional research into the interaction between marine turtles and fisheries. Key regions of interest are the Turkish artisanal fisheries both east and west of the present study. In addition, there are no published accounts of the effects of fisheries of in southern Cyprus, Syria, Lebanon and Israel. The work of LAURENT et al. (1996) suggests a significant bycatch of both turtle species by Egyptian fisheries. It is likely that fisheries in the countries constituting the eastern Mediterranean shores between Turkey and Egypt will also impact these populations, especially that of the Green Turtle which appears more localised in the region. There is an urgent need to discover foraging and developmental habitats for these species in this region so that pragmatic conservation steps can be taken towards an integrated management plans to preserve the Mediterranean populations of these species.

**Acknowledgements:** This work constitutes part of a PhD study funded by a University of Glasgow Post-Graduate Scholarship. Fieldwork was supported by the *Carnegie Trust for the Universities of Scotland*. Logistical assistance was given by ILKAY SALIHOĞLU of the *Institute of Marine Sciences, Middle Eastern Technical University* in Turkey and officers from the *Department of Environmental Protection* and the *Society for the Protection of Turtles in Northern Cyprus*. Additional assistance was given by A. KELLY, N. SAGDUYU, J. P. GRANADEIRO and M. KASPAREK. L. LAURENT gave valuable constructive criticism of early drafts and generously assisted with literature.

## References

AGUILAR, R. (1995): A survey of interactions between marine mammals and fisheries in the south-western waters of the ECC. – Report to the European Commission. University of Barcelona.

AGUILAR, R., J. MAS & X. PASTOR (1995): Impact of Spanish swordfish longline fisheries on the loggerhead sea turtle *Caretta caretta* population in the Western Mediterranean. p. 1–6. In: J. I. RICHARDSON & T. H. RICHARDSON (Eds.), Proceedings of the Twelfth Annual Workshop on Sea Turtle Biology and Conservation. NOAA Technical Memorandum, NMFS-SEFSC-361. – Miami, Florida.

ARGANO, R. (1979): Preliminary report on western Mediterranean sea turtles. – Annual Report of World Wide Fund for Nature. Project N° 1474.

ARGANO, R., R. BASSO, M. COCCO & G. GEROSA (1992): New data on Loggerhead (*Caretta caretta*) movements within Mediterranean. – Bolletin di Museum i Istituto di Biologia dell'Universita di Genova 56/57: 137–164, Genova.

BARAN, İ & O. TÜRKOZAN (1996): Nesting activity of the Loggerhead Turtle, *Caretta caretta*, on Fethiye Beach, Turkey, in 1994. – Chelonian Conservation and Biology 2(1): 93–96.

BARAN, İ. & M. KASPAREK (1989a): Marine turtles of Turkey: status survey 1988 and recommendations for conservation and management. – Heidelberg, 123 pp.

BARAN, İ. & M. KASPAREK (1989b): On the whereabouts of immature sea turtles (*Caretta caretta* and *Chelonia mydas*) in the eastern Mediterranean. – Zoology in the Middle East 3: 31–36, Heidelberg.

BINGEL, F., E. ÖZSOY & U. ÜNLÜATA (1993): A review of the state of the fisheries and the environment of the North-eastern Mediterranean (northern Levantine Basin). – Studies and Reviews, General Fisheries Council for the Mediterranean. N°65, FAO, Rome.

BJORNDAL, K. A. (1997): Foraging ecology and nutrition of sea turtles. p 199–231. In: P. L. LUTZ & J. A. MUSICK (Eds.), The Biology of Sea Turtles. – Boca Raton.

BOWEN, B., A. B. MEYLAN, J. P. ROSS, C. J. LIMPUS, G. H. BALAZS & J. C. AVISE (1992): Global population structure and natural history of the green turtle (*Chelonia mydas*) in terms of matriarchal phylogeny. – Evolution 46: 865–881.

BRADAI, M. N. (1992): Les captures accidentelles de *Caretta caretta* au chalut benthique dans le Golfe de Gabès. – Rapports et Procès Verbaux des réunions de la Commision Internationlae pour L'Exploration Scientifique de la Mer Mediterranée 33: 285.

BRODERICK, A. C. & B. J. GODLEY (1996): Population and nesting ecology of the Green Turtle, *Chelonia mydas*, and Loggerhead Turtle, *Caretta caretta*, in northern Cyprus. – Zoology in the Middle East 13: 27–46, Heidelberg.

COLEY, S. J. & A. C. SMART (1992): The nesting success of green turtles on beaches at Kazanli, Turkey. – Oryx 26(3): 165–171.

DE METRIO, G. & P. MEGALOFONOU (1988): Mortality of Marines Turtles *Caretta caretta* and *Dermochelys coriacea* consequent to accidental capture in the Gulf of Taranto. – Rapports et Procès Verbaux des réunions de la Commision Internationlae pour L'Exploration Scientifique de la Mer Mediterranée 31: 285.

DELAUGERRE, M. (1987): Statut des Tortues marines de la Corse et de la Méditerranée. – Vie Milieu 37: 243–264.

DEMETROPOULOS, A. & M. HADJICHRISTOPHOROU (1989): Sea Turtle conservation in Cyprus. – Marine Turtle Newsletter 44: 4–6.

DI NATALE, A. (1995): Driftnet impact on protected species: observer data from the Italian fleet and a proposal for a model to assess the number of cetaceans in the bycatch. – International Commission for the Conservation of Atlantic Tuna 44(1): 255–263.

ERK'AKAN, F. (1993): Nesting biology of loggerhead turtles *Caretta caretta* on Dalyan beach, Mugla-Turkey. – Biological Conservation 66: 1–4.

GLEN, F., B. J. GODLEY, A. KELLY & A. C. BRODERICK (1997): Marine turtle nesting on the Göksu Delta, Turkey, 1996. – Marine Turtle Newsletter 77: 17–19.

GODLEY, B. J., R. W. FURNESS & S. E. SOLOMON (in press a): Patterns of Mortality in Marine Turtles in The Eastern Mediterranean. – Proceedings of the 16th Annual Symposium on Sea Turtle Biology and Conservation.

GODLEY, B. J., D. R. THOMPSON, S. WALDRON & R. W. FURNESS (in press b): The trophic status of marine turtles as determined by stable isotope analysis. – Marine Ecology Progress Series.

GRAMENTZ, D. (1989): Marine turtles in the central Mediterranean Sea. – Centro 1(4): 41–56.

GROOMBRIDGE, B. (1990): Marine turtles in the Mediterranean: Distribution, population status, conservation. – Nature and Environment Series (Council of Europe) 48: 1–98, Strasbourg.

GÜCÜ, A. C. & F. BINGEL (1994): State of the fisheries along the Turkish Mediterranean Coast. – Turkish Journal of Zoology 18: 251–258, Ankara.

HENWOOD, T.A. & W. E. STUNTZ (1987): Analysis of sea turtle captures and mortalities during commercial shrimp trawling. – Fisheries Bulletin 85(4): 813–817.

HILLSTAD, H. O., J. I. RICHARDSON, C. MCVEA Jr. & J. M. WATSON, Jr. (1995): Worldwide incidental capture of sea turtles. p. 489–496. In: K. A. BJORNDAL (Ed.), Biology and Conservation of Sea Turtles: Revised Edition. – Washington D.C.

KULLER, Z. (1995): Nesting of marine turtles in the Mediterranean coast of Israel: summer 1994. – Israel Journal of Zoology 41(1): 96, Jerusalem.

LAURENT, L. (1990): Les tortues marines en Algérie et au Maroc (Méditerranée). – Bulletin de la Société Herpétologique de France 55: 1–23.

LAURENT, L. (1991): Les Tortues marines des côtes françaises méditerranéennes continentales. – Faune de Provence (C.E.E.P.) 12: 76–90.

LAURENT, L. (1996): Synthese historique de la presence de tortues marines sur la cotes de France (Cotes Mediterranean). – Observatoire du Patrimoine Naturel. Groupe Tortues Marines. Minister Francais de l'Environment. Unpublished.

LAURENT, L. (1997): Mediterranean project to reduce bycatch and mortality of marine turtles. – Report to the World Wild Fund for Nature, Mediterranean Programme. Rome.

LAURENT, L., E. M. ABD El-MAWLA, M. N. BRADAI, F. DEMIRAYAK, & A. ORUÇ (1996): Reducing Sea Turtle Mortality induced by Mediterranean Fisheries: Trawling activity in Egypt, Tunisia and Turkey. – Report to World Wide Fund for Nature (WWF-International), International Mediterranean Programme.

LAURENT, L., M. N. BRADAI, D. A. HADOUD, & H. M. El GOMATI (1997): Assessment of sea turtle nesting activity in Libya. – Marine Turtle Newsletter 76: 2–6.

LAURENT, L., P. CASALE, M. N. BRADAI, B. J. GODLEY, G. GEROSA, A. C. BRODERICK, W. SCHROTH, B. SHIERWATER, A. M. LEVY, D. FREGGI, N. E. M. ABD El-MAWLA, D. A. HADOUD, H. E. GOMATI, M. DOMINGO, M. HADJICHRISTOPHORO, U. L. KORNARAKY, F. DEMIRAYAK & Ch. GAUTIER (in press): Molecular resolution of marine turtle stock composition in fishery bycatch: a case study in the Mediterranean. – Molecular Ecology.

LAURENT, L. & J. LESCURE (1994): L'hivernage des tortues Caouannes *Caretta caretta* dans le sud Tunisien. – Revue d'Ecologie (Terre Vie) 49: 63–86.

LAZAR, B. & N. TVRTKOVIC (1995): Marine turtles in the eastern part of the Adriatic sea: preliminary research. – Natura Croatica 4(1): 59–74.

LUTCAVAGE, M. E., P. PLOTKIN, B. WITHERINGTON, & P. L. LUTZ (1997): Human Impacts on Sea Turtle Survival. p. 387-409. In: P. L. LUTZ & J. A. MUSICK (Eds.), The Biology of Sea Turtles. – Boca Raton.

MARGARITOULIS, D. (1982): Observations on loggerhead sea turtle *Caretta caretta* activity during three nesting seasons (1977-1979) in Zakynthos, Greece. – Biological Conservation 24: 193–204.

MARGARITOULIS, D. (1989): Loggerhead sea turtle nesting: Kiparissia Bay, Greece. – Marine Turtle Newsletter 49: 5–6.

MARGARITOULIS, D., N. KOUSIAS, G. NICOLOPOULOU & K. TENEKETZIS (1992): Incidental catch of sea turtles in Greece: the case of Lakonikos Bay. p 168–170. In: M. SALMON & J. WYNEKEN (Ed.), Proceedings of the 11th Annual Workshop on Sea Turtle Conservation and Biology (26.2.–2.3.1991, Jekyll Island, Georgia). – U.S. Department of Commerce. NOAA Technical-Memorandum, NMFS-SEFSC-302. Miami. Florida.

MARGARITOULIS, D., T. ARAPIS, E. KORNARAKI & C. MYTILINEOU (1986): Three specimens of the green sea turtle *Chelonia mydas* recorded in Greece. – Biologia Gallo-Hellenica 12: 237–243, Athens.

MAS, J. (1996): Estimas de mortilidad en captivido. – Internal Report. Instituto Español Oceanographia. Unpublished.

MUSICK, J. A & C. J. LIMPUS (1997): Habitat utilization and migration in juvenile sea turtles. p. 137–164. In: P. L. LUTZ & J. A. MUSICK (Eds.), The Biology of Sea Turtles. – Boca Raton.

NATURAL RESEARCH COUNCIL (1990): Decline of the Sea Turtles: Causes and Prevention. – Washington D.C.

ORUÇ, A., F. DEMIRAYAK & G. SAT (1997): Trawl Fisheries in the Eastern Mediterranean and its Impacts on Sea Turtles: The Conclusive Report. - World Wide Fund for Nature International and DHKD. Istanbul. 30 pp.

PANOU, A., G. ANTYPAS, Y. GIANNOPOULOS, S. MOSCHONAS, G. MOURELATOS, P. TOUMAZATOS, L. TSELENTIS, N. VOUTSINAS & V. VOUTSINAS (1992): Incidental catches of Loggerhead Turtles *Caretta caretta* in swordfish long lines in the Ionian Sea. – Testudo 3: 47–57

TURKISH STATE INSTITUTE OF STATISTICS (1970, 1971, 1974, 1979, 1981a, 1981b, 1982, 1984, 1985, 1986, 1994): Fishery Statistics 1968, 1969; 1970–71; 1972–75; 1976–79; 1980; 1981; 1982; 1983; 1984; 1992. – Publications No. 597, 626, 718, 874, 947, 666, 1987, 1066, 1129, 1166, 1666, Ankara.

YERLI, S. V. & A. F. CANBOLAT (1998): Results of a 1996 survey of *Chelonia* in Turkey. – Marine Turtle Newsletter 79: 9–11.

YERLI, S. V. & F. DEMIRAYAK (1996): Marine turtles in Turkey: A survey on nesting site status. – Doğal Hayatı Koruma Derneği (DHKD), Istanbul, 134 pp.

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