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The Effect of Pingers on Harbour Porpoise, *Phocoena phocoena* Bycatch and Fishing Effort in the Turbot Gill Net Fishery in the Turkish Black Sea Coast

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Abstract

This is the preliminary and the first study for understanding the effect of acoustic deterrent devices (pingers) on catch rates of fish (target turbot fish, *Schophthalmus maeoticus* and non target thornback ray, *Raja clavata*) and harbour porpoise (*Phocoena phocoena*) bycatch directly in the turbot gill net fishery in the Black Sea conditions. Sea trials carried out using Dukane NetMark™ 1000 pingers in an active (with pinger) and in a control (without pingers) turbot gill net between March 5 and April 2, 2006 off the Sinop Peninsula. The results showed that Dukane NetMark™1000 pingers have been significantly shown to be effective in reducing *P. phocoena* bycatch in turbot gill net fisheries without significantly affecting target and non-target fish size and catch. The "habituation" problem of the species should also be further investigated in the future.

Keywords: Fisheries, bycatch, pinger, turbot gill net, *Phocoena phocoena.*

Introduction

The Black Sea turbot, *Scopthalmus meaoticus* Pallas, 1811 is one of the most valuable commercial species in the Black Sea. The turbot fishery opens in September and ends the end of April and the fishery peaks from mid-March until by the end of April (Samsun, 2004). Turkey had major landings with a mean of 1990 tonnes (71.3%) from the mean total landing of 2793 tonnes during 1964–1992, followed by the former USSR with 532 tonnes (19.0%), and Bulgaria and Romania with 197 tonnes (7.0%) and 74 tonnes (2.7%), respectively (Prodanov *et al*., 1997). Catch was by bottom trawl gear and gill net and with mesh net sizes ranging from 160 and 360 mm. The boats used for turbot fishery are between 7 to 30 m in length. There are about 200 boats operating 25,000 bottom gill nets from twelve ports in the Western Black Sea (Tonay and Öztürk, 2003). Turbot has a high economic value and current production is too low to meet market demands.

Turbot gill net is the most dangerous fishing gear on the dolphins and porpoises in the Black Sea (Radu *et al*., 2003). Even though there is no reliable data on incidental catches in the Turkish Black Sea, every year several hundreds of dolphins are downed in gill nets and stranded on the shore between early April and June. Large number of dolphins also dies as the result of incidental catch during the sole, turbot and sturgeon fishing season. Supposedly, about 3000 *P. phocoena* and about 1500 *T. truncatus* die annually, because of bycatch in Turkey (TUDAV, 1999; Birkun, 2002).

In the Black Sea, three cetacean species, the harbour porpoise, *Phocoena phocoena* (Linnaeus, 1758), short beaked common dolphin, *Delphinus delphis* Linnaeus, 1758 and common bottlenose dolphin, *Tursiops truncatus* (Montagu, 1821) are known to occur (Öztürk *et al*., 2004; Birkun *et al*., 2006).

Cetaceans living in Turkish waters are categorized by the world conservation union (IUCN, 2008) in the red list as endangered (EN): *Balaenoptera physalus* (Linnaeus, 1758), vulnerable (VU): *Phocoena phocoena* (Linnaeus, 1758), *Physeter macrocephalus* Linnaeus, 1758, the least concern (LC): *Delphinus delphis* Linnaeus, 1758, *Stenella coeruleoalba* (Meyen, 1833), *Globicephala melas* (Traill, 1809), *Pseudorca crassidens* (Owen, 1846) and data deficient (DD): *Tursiops truncatus* (Montagu, 1821), *Grampus griseus* (G. Cuvier, 1812), *Ziphius cavirostris* G. Cuvier, 1823. In this red list, all three species in the Black Sea are categorized as EN (Reeves and Notarbartolo di Sciara, 2006; IUCN, 2008). In addition to this, commercial killing has been banned in the former Soviet Union, Romania and Bulgaria since 1966 and in Turkey since 1983 (TUDAV, 1999).

Many species and populations of cetacean have been exploited in the past. In most cases, threats posed by direct exploitation have been recognized and addressed effectively. Yet, cetaceans are also indirectly affected by several human activities, including commercial fisheries, coastal development, coastal and offshore drilling, dredging and dumping, military exercises, tourism development, scientific research, among others (Silva, 2007). Conflicts between fisheries and cetaceans generally take one or both of two forms. These are the accidental capture of cetaceans in fishing operations (bycatch) and the depredation of fishing gear by cetaceans, leading to loss of catch and damage to fishing gear (Brotons *et*

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al., 2008). In many cases, these two problems occur in the same fisheries, and resolving the latter problem may help resolve the former. Accidental catch and even some active fishing seem however, to remain the main and important cause of cetaceans' mortality (Buckel *et al*., 2006).

Bycatch of small cetaceans is a major problem in a number of gill net fisheries around the World. Accidental capture and entanglement in fishing gear is the biggest threat to cetacean population worldwide, killing more than 300.000 animals per year (Read *et al*., 2006).

Bycatch has been studied in the Black Sea (Öztürk *et al*., 1999; Birkun, 2002; Tonay and Öztürk, 2003), although more information is needed to elucidate this problem to design the conservation plan for the small cetaceans in the Black Sea. To straighten the interactions between small cetaceans and fishermen, the bycatch has to be reduced. The most suitable possibility to accomplish this can be achieved using acoustic deterrent devices "pingers" on fishing nets. Pingers are the devices that produce ultrasound. This ultrasound may be kept the dolphins and porpoises away from the fishing nets. However, there is no evidence that the Black Sea fishermen use pingers except for one study to determine the effects of pingers on dolphins' depredation in the monofilament bottom gill nets (Gönener and Bilgin, 2007) or any other special means to reduce undesirable interactions with dolphins.

This is the first time to reduce bycatch problem of the sub-species harbour porpoises, *Phocoena phocoena* (Rosel *et al*., 2003) using acoustic deterrent devices (pingers) and the affects of pingers on the catches of target turbot fish, *Schophthalmus maeoticus* and non target thornback ray, *Raja clavata* for the turbot gill net fishery in the Black Sea.

Materials and Methods

The pinger experiment was conducted between March 5 and April 2, 2006 around the Sinop Peninsula in the Black Sea (Figure 1). This period partly overlaps with the turbot gill net fishery peaks (Samsun, 2004).

We used Dukane NetMark™1000 pingers (Figure 2) as acoustic deterrent devices. These pingers emit a tonal signal of 300 m/sec duration every 4 sec with a fundamental frequency of 10–12 kHz and with significant harmonics up to 100 kHz. The manufacturer cites a source level of 132 dB (re 1 µPa at 1 m).

A total of 16 pieces of turbot gill nets added with each other was constituted control and active multifilament turbot gill nets with 160 mm mesh sizes and about 1,110 m length. The gill nets were rigged with a hanging ratio 0.50, and the number of mesh size in depth 8. The net twine was 210 d/ 6 no. Turbot gill nets which have the same characteristics were set together with the artisanal fishermen. A total of 20 turbot fishing trips with active and control nets was performed. Two turbot fishing trips with active and control nets were performed at the same date (Table 1).

The Dukane NetMark™1000 pingers were attached along the turbot gill nets float line with about 200 m distance between two pingers. Recommended distance was about 100 m for a Dukane NetMark™1000 pinger (Northridge *et al*., 2004). The sound pressure level and frequency of the Dukane pinger decrease with decay in (4 Alkaline AA cells) battery voltage (Trippel *et al*., 1999), so the pinger batteries were changed for every fishing operation between 168 – 288 hours. This is a sufficient period of time to cover one fishing operation. Recommended time is about 800 hours for the Dukane pingers (Northridge *et al*., 2004).

Fishing dates, coordinates, depths and soak time were recorded (Table 1). The coordinates of fishing operations were determined with GPS (Magellan 315 and Explorer 100). Depths were measured with (Apelco 460) fish finder. Total wet weight (W, 0.1 g) of turbot and thornback ray were weighed on fishing boat. We also measured fish and harbour porpoise

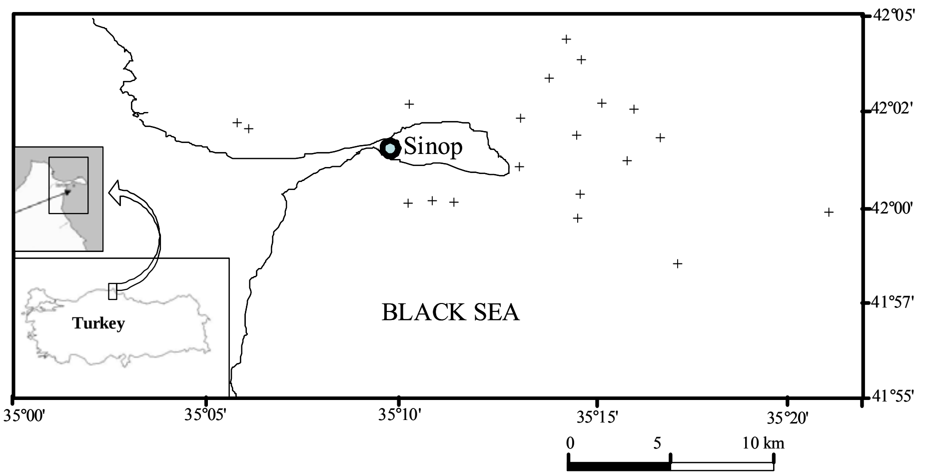

Figure 1. The locations of turbot gill net sets made off the Sinop Peninsula, Turkey.

Figure 2. Dukane NetMark 1000 pingers attached the turbot gill nets in the Black Sea (Photograph by Sedat Gonener).

Table 1. The fishing date, the number of fishing trips, coordinate, depths and soak time between 5 March 2006 and 2 May 2006 off the Sinop Peninsula, Turkey

Fishing date	No	Coordinates	Depth (m)	Soak time (h)	*P. phocoena* (n) Ctrl.	*P. phocoena* (n) Act.	*S. maeoticus* (n) Ctrl.	*S. maeoticus* (n) Act.	*R. clavata* (n) Ctrl.	*R. clavata* (n) Act.
5-15 March 2006	1	42°02'31"N 35°10'57"E	50.7	217	18	-	3	9	2	4
	2	42°04'27"N 35°13'64"E	90.7		-	-	11	9	1	7
15-26 March 2006	3	42°03'17"N 35°14'15"E	83.1	265	8	1	1	9	-	1
	4	42°02'27"N 35°15'22"E	79.0		4	-	6	10	3	-
22-31 March 2006	5	42°01'52"N 35°17'02"E	98.6	218	9	-	5	23	4	1
	6	42°00'19"N 35°11'54"E	57.9		11	-	1	4	-	3
26-5 April 2006	7	41°59'55"N 35°21'10"E	183.2	241	5	-	4	11	5	3
	8	42°03'77"N 35°13'96"E	146.5		-	-	12	14	-	-
1-13 April 2006	9	41°58'28"N 35°17'21"E	99.0	288	6	-	3	11	4	1
	10	42°02'31"N 35°16'29"E	87.0		3	-	4	21	-	-
7-18 April 2006	11	42°02'14"N 35°13'10"E	59.9	264	1	-	6	9	3	1
	12	42°00'40"N 35°10'28"E	34.0		4	-	-	8	6	-
12-21 April 2006	13	42°00'16"N 35°11'09"E	47.9	216	3	-	2	11	6	2
	14	41°56'42"N 35°14'32"E	68.5		2	-	9	13	3	-
13-20 April 2006	15	41°59'07"N 35°14'11"E	65.9	168	1	-	13	9	1	4
	16	42°01'36"N 35°12'49"E	43.8		1	1	1	6	4	-
13-24 April 2006	17	42°02'02"N 35°06'01"E	18.5	264	1	-	13	9	-	-
	18	42°01'58"N 35°06'28"E	17.2		5	-	-	2	-	5
24 April 2 May 2006	19	42°00'43"N 35°14'47"E	52.9	192	4	-	6	11	-	-
	20	42°01'44"N 35°16'64"E	97.5		6	-	1	13	4	-
Total					92	2	101	212	46	32

* Ctrl:control (without pingers), Act: active (with pingers)

length. Catch per unit effort (CPUE) was calculated for control and active nets as CPUE = Catch (individual) / soak time (hours).

We used two sample t-tests to compare CPUE, length and weight by species during active and control sets. A Chi-square test was used to detect differences in number of *P. phocoena*, *S. maeoticus*, and *R. clavata* caught with control and active nets.

Results

During the research, a total of 20 active and 20 control sea trials were conducted from 17.2 to 183.2 m water depths. The maximum and the minimum soak time were 168 and 288 hours, respectively. Total 92 *P. phocoena*, 101 *S. maeoticus* and 46 *R. clavata* were caught with control net, and 2 *P. phocoena*, 212 *S. maeoticus* and 32 *R. clavata* were caught with active net (Table 1). Thornback ray was the only bycaught fish species. No other fish species were caught. Harbour porpoise was the only species and accounted for all of the cetacean entanglements (Figure 3). No other two dolphin bycatch was recorded. All bycaught *P. phocoena* were dead. Harbour porpoise damage to the turbot gill nets (active and control nets) was not observed during the study period.

Effect of Pingers on Harbour Porpoise CPUE

Figure 4 compared the CPUE retained in active and control sets. Total CPUE of *P. phocoena* captured

Figure 3. Harbour porpoise, *Phocoena phocoena*, entangled in turbot gill nets off the Sinop Peninsula in the Black Sea (Photograph by Sedat Gonener).

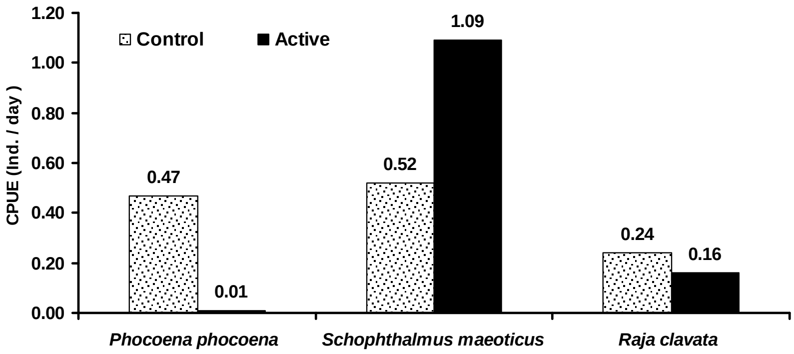

Figure 4. Fish and dolphin CPUE by pinger status (control and active).

during control sets (0.47) was greater then that captured during active sets (0.01) ($P<0.05$).

Effect of Pingers on Turbot CPUE

The mean turbot CPUE during active sets was 1.09 and during control sets was 0.52. The mean *S. maeoticus* CPUE captured during active sets was greater than that captured during control sets ($P<0.05$).

Effect of Pingers on Non-target Fish Species

During active sets, the mean total nontarget fish (*R. clavata*) count was 0.16 and during control sets was 0.24. There was a difference ($P<0.05$) in discard counts between active and control sets. *P. phocoena* bycatch in the control nets was 46 times higher than active nets. Using χ^2 test bycatch rates with pingers was significantly less for *P. phocoena* ($\chi^2 = 86.170$, $P<0.001$), reverse this, *S. maeoticus* were captured more with control nets ($\chi^2 = 39.364$, $P<0.001$). Dukane NetMark™1000 pingers did not reduce the catch per unit effort of target fish, *S. maeoticus* and non target fish, *R. clavata* ($P<0.05$)

Effect of pingers on size of catch

Table 2 compares the summary of length and weight of catch retained in active and control sets. There was no significant difference in the length for the target fish, *S. maeoticus* and nontarget fish, *R. clavata*. Also length frequency distributions of turbot and thornback ray were compared between active and control nets ($P>0.05$, Figure 5)

Discussion

In the present study, it was achieved that acoustic deterrent devices (Dukane NetMark™1000 pingers) have been significantly shown to be effective in reducing *P. phocoena* bycatch in turbot gill net fisheries without significantly affecting target fish turbot, *S. maeoticus* and non-target fish thornback ray, *R. clavata*, catch. Similarly, International Whaling Commission (IWC, 2000) reported that the most reasonable hypothesis is that pingers reduce bycatch rates by producing a sound that dolphins and porpoises find aversive. Scientific experiments with pingers also demonstrated that these can be effective in reducing the bycatch of small cetaceans in several

Table 2. Summary of length and weight of catch by pinger status (active and control)

Species	Active	Control		Active	Control	
	Length (cm)			Weight (kg)		
	Mean ± s.e. (min-max)	Mean± s.e. (min-max)	P	Mean± s.e. (min-max)	Mean±s.e. (min-max)	P
Turbot	47.7±0.6 (30.9-78.6) n = 212	46.3±0.8 (31.4-76.2) n = 101	> 0.05	2.0±0.2 (0.5-9.0) n = 212	2.4±0.1 (0.5-9.4) n = 101	< 0.05
Thornback Ray	50.9±0.9 (39.5-59.1) n = 46	49.9±1.2 (38.2-57.2) n = 32	> 0.05	1.5±0.1 (0.5-3.4) n = 46	1.6±0.1 (0.5-2.5) n = 32	> 0.05
Harbour Porpoise	110.8±17.3 (98.6-123.0) n = 2	132.1±1.9 (95.5-167.5) n = 92	-	-	-	-

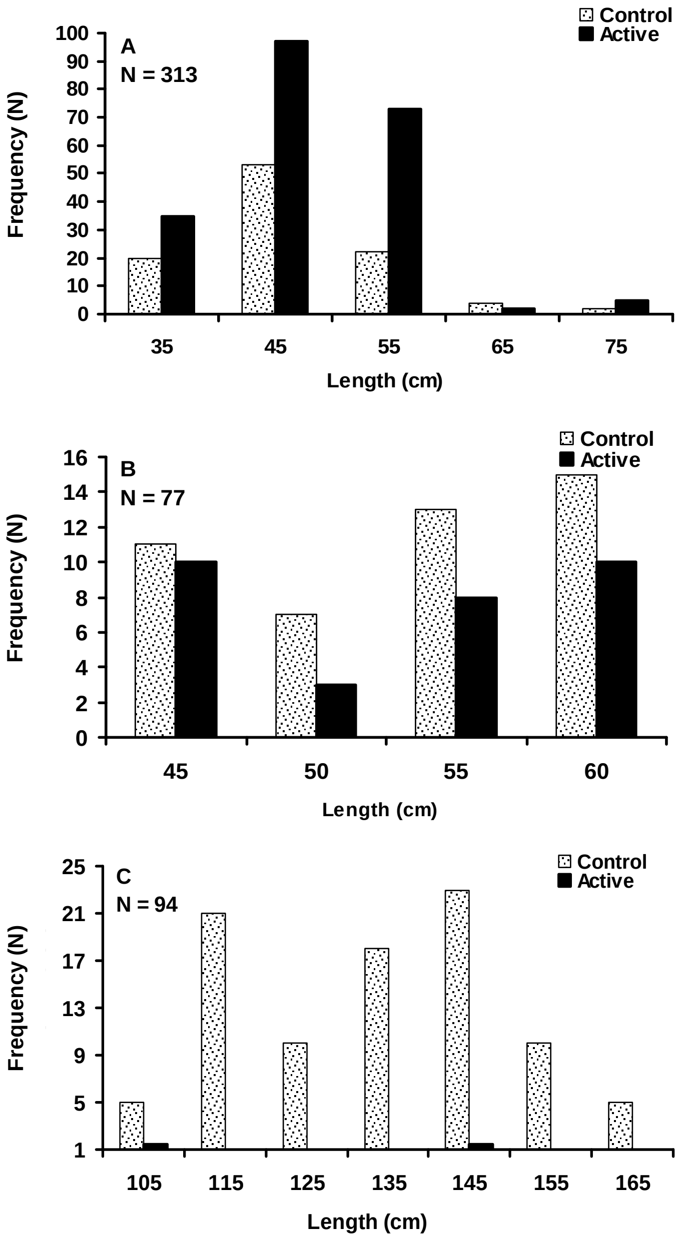

Figure 5. Length frequency distribution A: turbot, B: thornback ray, C: harbour porpoise caught between 5 March 2006 and 2 May 2006 off the Sinop Peninsula.

areas at least in the short term (Kraus *et al*., 1997; Trippel *et al*., 1999; Gearin *et al*., 2000; Carlström *et al.,* 2002; Barlow and Cameron, 2003; Burke, 2004). For example in a control experiment, both Gearin *et al.* (2000) in the Eastern North Pacific, and Kraus *et al.* (1997) in the Western North Atlantic demonstrated that the pingers caused a significant reduction in bycatch of *P. phocoena*, in a gill net fishery. We found out that *P. phocoena* bycatch rate was 46 times higher than in the active nets. Similarly, it was reported that bycatch rate was 12 fold for common dolphin, *Delphinus delphis* (Barlow and Cameron, 2003) and 10 fold for *P. phocoena* (Kraus *et al*., 1997).

Many studies investigated the bycatch, the depredation, and the deterrent effects of pingers on dolphins and porpoises. On the other hand, negative effects of pingers such as reduction of fishing effort, habituation, habitat exclusion, hearing damage, and dinner bell effect have also been reported (Franse, 2005). It was suggested that pingers deter clupeid fish species such as herring, *Clupea harengus* (Kraus *et al*., 1997).

Our results also suggest that Dukane NetMark™1000 pingers had no significant negative effect on target, *S. maeoticus* and nontarget fish, *R. clavata*, size and catch in the Black Sea turbot gill nets fishery. These are consistent with findings in other field experiments using the Dukane NetMark 1000 pingers (Trippel *et al*., 1999; Gearin *et al*., 2000; Carlström *et al*., 2002; Culik *et al*., 2001), using the Save Wave® pingers (Burke, 2004), and using AQUAmark 200 pingers (Gönener and Bilgin, 2007). However, pingers had no effect on catches of most fish, including Spanish mackerel (*Scomberomorus maculatus*), Atlantic cod (*Gadus morhua*), pollock (*Pollachius virens*), silver hake (*Merluccius bilinearis*), broadbill swordfish (*Xiphias gladius*), thresher shark (*Alopius vulpinas*), and shortfin mako shark (*Isurus oxyrinchus*) (Kraus *et al*., 1997; Carlström *et al*., 2002; Barlow and Cameron, 2003; Burke, 2004; Aitken *et al*., 2000).

Catch per unit effort of turbot with active nets was greater than control nets. This may be the result of fright reaction of turbot to bycaught *P. phocoena* in the control nets or the alarm response to pingers. We also did not observe harbour porpoise damage to the turbot gill nets during the study period. But, these situations should be studied in more details for turbot gill net fisheries in the Black Sea.

Based on our observations, we suggest that Dukane NetMark™ 1000 pingers may be an effective mitigation strategy for the interactions between *P. phocoena* and turbot gill net fishery in the Black Sea. On the other hand, although the debate on the habituation of pingers by dolphins and porpoises is ongoing, the European Union Common Fisheries Policy mandates the use of pingers in some area (see: European Union Council Regulation No 812/2004 of 26.04.2004).

This is the preliminary and the first study for understanding the effect of acoustic deterrent devices on catch rates of fish and porpoise bycatch directly in the turbot gill net fishery in the Black Sea conditions. Future studies need to be conducted to determine the negative effects of pingers concerning such as habituation, habitat exclusion, hearing damage, and dinner bell effect during long term periods in Turkish fisheries in the process of accession to the European Union.

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