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Survival Rates of Black Sea Turbot (*Scophthalmus maeoticus* Pallas, 1811) Captured by Bottom Turbot Gillnets in Different Depths and Fishing Seasons Between 1999 and 2004

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Abstract

A study was performed between 1999 and 2004 in order to determine the survival rates of Black Sea Turbot (*Scophthalmus maeoticus* Pallas, 1811) captured by bottom turbot gillnets from different depths (D_1:≤30 m, D_2:31–50 m, and D_3:≥51 m) and seasons in Sinop Region (Black Sea, Turkey). The mean survival rates were found as to be 53.36±8.551%, 80.63±5.166%, 92.80±4.353 % on D_1:≤30 m, D_2: 31–50 m, and D_3:≥51 m, respectively and they were significantly ($P<0.05$) different from each other. A linear relationship was observed between fishing depth and survival rate, and described as follows $y = 0.9145x + 30.505$, where y=mean survival rates and x=fishing depths (r=0.79). The mean survival rates were found as to be 71.12±5.941%, 85.20±4.331%, 81.01±9.618 % and 85.05±10.735% in winter, spring, summer and autumn, respectively. And they were not significantly different from each other ($P>0.05$). The results suggest that the survival rates of turbot are not related to fishing soak time or season but strongly related to fishing depths. And the captured turbot breeders might have high survival captured by gillnet more than 51 m in turbot culture.

Key Words: Black Sea turbot (*Scophthalmus maeoticus* Pallas, 1811), Survival rate, Gill nets,

Introduction

Commercially, the turbot, *Scophthalmus maeoticus,* is one of the most valuable species in the Black Sea Basin, and currently is fished with gillnets and bottom trawls (Pradonov *et al.*, 1997; Mikhailov and Prodanov, 2003). Long-term former catch data of the countries sharing the stocks in the Black Sea show that majority of the turbot (72%) had been caught by Turkey and followed by the Commonwealth of Independent States (19%), Bulgaria (7%) and Romania (3%) (Pradanov *et al.*, 1997).

The Turkish fishery for the Black Sea turbot began in 19th century and the fish were caught in relatively shallow waters of 40 to 150 meters using gillnets specially made for turbot. When the turbot fishery became a more profitable venture, some gillnets were replaced by trawling in some areas during the late sixties, the latter being a more efficient and economical method of catching turbot (Acara, 1985).

Although some turbot culture has been conducted since 1998 at the Central Fisheries Research Institute in Trabzon (Turkey), mainly for stock enhancement purposes. At present, all of the marketed turbot come from the wild and are generally captured by gillnets (Hara *et al.*, 2002).

According to the State Institute of Statistics, the Turkish fishing fleet caught 2455 tons of turbot in 2001 (Anonymous, 2003). Of this production, 96% was reported to come from the Black Sea. Turbot is one of the most important target species in the Black Sea gillnet fisheries (Başaran and Samsun, 2004).

Although there are many studies on turbot such as distribution and migration (Karapetkova, 1980), stock estimation and bioecology (Acara, 1985; Zengin and Düzgüneş, 2003), physiology (Suzuki *et al.* 2001), reproduction (Hara 2001; Maslova 2002), adaptation to rearing conditions (Basaran *et al.* 1999), larval rearing (Khanaichenko *et al.*, 1994; Şahin and Üstündağ, 2003), brood stock rearing and spawning (Hara *et al.*, 2002), ammonia nitrogen excretion rate (Yiğit *et al.*, 2003), fisheries status (Zengin *et al.*, 1998; Samsun *et al.*, 2004), survival rates of brood stock (Başaran and Samsun, 2004), information on the survival rate of turbot is limited.

Turbot fishing in the Black Sea has mainly been carried out by 72% bottom gillnets, 26% trawls net and limited amount of 2% is the bycatch from purse seines (Zengin and Düzgüneş, 2003). Sinop region is one of the most productive fishing areas of the Turkish Black Sea Coast. Because the bottom trawl fishery has been forbidden for almost two decades in Sinop region, the turbot gillnet fishery has become popular. Currently, intensive fishing pressure has been observed on the turbot stock in the same region (Samsun, 2004).

Commercial fishing studies to assess the survival of fish after escape from fishing gears have attracted much of attention on fishery managements recently. Damage and stress in fish are recognized as serious problems in aquaculture, recreational catch and release fisheries and fish tagging research because they are known to effect growth, reproductive capacity and survival (Chopin and Arimoto, 1995).

The aim of the present study was to determine the survival rates of turbot caught by bottom turbot gillnets in different depths and seasons.

Material and Methods

The current study was carried out in Sinop (Central Black Sea Coast of the Turkey) from 1999 to 2004. The number of alive and died turbot was noted in the boat. In order to determine the fishing success and survival rate, the fish were classified into three different groups according to the depths at which they were captured (D_1:≤30 m, D_2:31–50 m, and D_3:≥51 m). A total of 66 turbot gillnets operation was observed while the fishing operation was performed 24, 15, 27 times for groups (D_1, D_2 and D_3), respectively from 1999 to 2004.

One-way ANOVA was used to test the differences between survival rates of groups. All statistical analyses were performed by using Statistical Package Minitab 13.0 and significance was accepted at P=0.05.

Results

A total of 726 turbot was caught during the study. Table 1 shows the number of fishing operation, mean soak time, minimum and maximum soak time, number of captured fish, number of live fish, survival rates after capture for each group according to the group D_1:≤30 m, D_2:31–50 m, and D_3:≥51 m and fishing seasons.

The mean survival rates of D_1, D_2 and D_3 values were found as to be 53.36±8.551%, 80.63±5.166%, 92.80±4.353% through the study, respectively. The survival rate of D_1 was significantly different from that of D_2 and D_3 ($P<0.05$). However, no significant difference was found between D_2 and D_3 on survival rates.

A linear relationship between fishing depths and survival rates was identified as $y = 0.9145x + 30.505$

Table 1. Number of fishing operation mean soak time, minimum and maximum soak time, number of captured fish, number of live fish, survival rates after capture for each group according to the group D_1:≤30 m, D_2:31–50 m, and D_3:≥51 m and fishing seasons

Fishing Seasons	Groups	D_1	D_2	D_3
	Depth (m)	≤ 30	31-50	≥ 51
1		7	3	3
2	Fishing	4	-	13
3	operation numbers	6	4	6
4		-	4	1
5		7	4	3
1		7	9	10
2		10	-	13
3	Soak time (day)	13	8	18
4		-	12	15
5		10	15	17
	Mean	10	11	15
1		7-8	7-13	9-12
2	Minimum-maximum soak	8-10	-	11-17
3	time (day)	10-15	7-10	14-24
4		-	9-15	15
5		7-15	11-20	10-25
1		27	18	30
2		23	-	194
3	Number of fish captured	68	25	133
4		-	19	33
5		32	18	106
1		21	16	30
2		12	-	188
3	Number of live fish	27	22	129
4		-	15	25
5		14	12	100
1		77.8	88.89	100
2	Survival rates after capture	52.17	-	96.91
3	(%)	39.71	88	96.99
4		-	78.95	75.76
5		43.75	66.67	94.34
	Mean survival rates	53.36±8.551	80.63±5.166	92.80±4.353

(1=1999-2000, 2=2000-2001, 3=2001-2002, 4=2002-2003 and 5=2003-2004 fishing seasons)

with high correlation coefficient (r=0.79), where y=mean survival rates and x=fishing depths (Fig. 1).

The duration days of turbot gillnets were different by each operation depth. The mean duration of days was estimated as 10, 11 and 15 for the groups, respectively. As shown in Figure 2, there is not a relationship between soak time and survival rates. Duration days of D_1 and D_3 were significantly different from each other ($P<0.05$).

The mean survival rates were found as to be 71.12±5.941%, 85.20±4.331%, 81.01±9.618 % and 85.05±10.735% in winter, spring, summer and autumn, respectively and they were not significantly different from each other ($P>0.05$). The highest mean survival rate and minimum confidence limits of turbot were found in spring. Also, the highest number of turbot was caught in this season. As shown in Table 2, turbot gillnet fisheries were mainly performed in winter and spring (spawning season) while it was seldom done in summer and autumn.

The fishing operation depths of turbot nets were different in every season. The minimum, maximum, and mean depth of operations was determined in winter, spring, summer and autumn as 8-36-22 m, 8-90-46 m, 18-120-46 m and 18-30-25 m, respectively (Figure 3 and Table 2). Fishing for D_3 was conducted mainly in spring and the most catch production was determined in this period.

Discussion

Although many studies on nutrition, trawl fisheries and marking of turbot are available, there is limited information on survival rate of turbot after caught by gillnet. Basaran and Samsun (2004) demonstrated that survival rate of turbot captured from the depth of ≤ 20 m, 20-45 m and ≥ 45 m is 24.9, 71.4 and 92%, respectively. They also confirmed that the highest survival rate of the fish after an adaptation period of one month on culture conditions is 48.3% in the group captured from the deepest fishing ground (≥ 45 m) by gillnet. In the present study, the highest survival rate of turbot was also observed on the fish captured at ≥ 51 m, which is

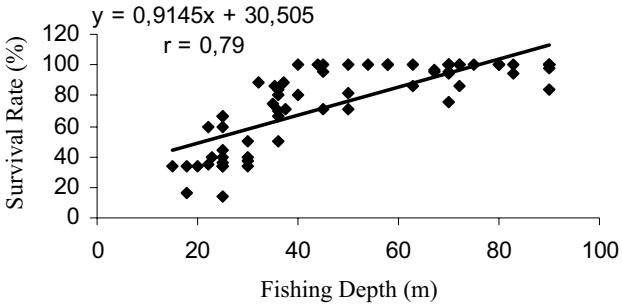

Figure 1. The relationship between fishing depth and survival rate.

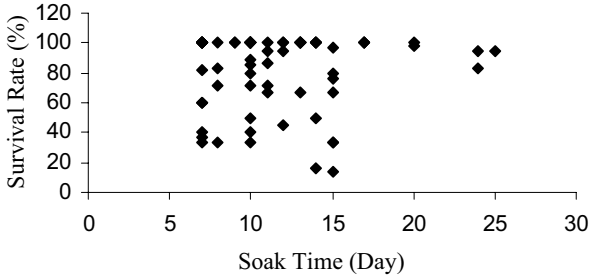

Figure 2. The relationship between soak time and survival rate.

Table 2. The mean survival rate, minimum - maximum values and 95% confidence interval of mean and mean fishing depth (in brackets minimum and maximum depths) of turbot according to seasons

Fishing seasons	Operation number	Number of caught fish	Mean survival rate (%)±SE	Min-max	95% confidence interval of mean	Fishing operation depth (m)
Winter	18	113	71.12 ± 5.941	33.33 - 100	58.58 - 83.65	22 (8-36)
Spring	33	480	85.20 ± 4.331	16.67 - 100	76.36 - 94.05	46 (8-90)
Summer	10	110	81.01 ± 9.618	14.29 - 100	59.25 - 102.76	46 (18-120)
Autumn	4	23	85.05 ± 10.735	33.33 - 100	57.45 - 112.65	25 (8-30)

in accurate agreement with Basaran and Samsun (2004).

The higher the depth in fishing operation was, the higher the survival rate was for the fish caught that was exposed to rough weather (nautical north winds or northeast winds). The nets in deeper waters remained in good condition while on the other hand they got dirty in shallow waters and took much time to clean and prepare for the next operation. For preparation, it took 1-2 days and 7-10 days for clear nets and dirty nets, respectively (Samsun, 2004).

In fishing of turbot in deep water above 51 meters, although the nets stay in the sea longer than the other groups, some factors are effective in keeping the turbots captured, alive. First, deep-water fishing is continually performed in spring and the weather conditions are good in these months. Therefore, fish in the net remains alive. Because fishing of the other groups is performed in winter and autumn, the nets in the sea are dirty due to storms. So, turbots caught in the net are not able to breathe normally. And because of the strong current, fish in the net are drifted and get injured due to being rubbed along the ground of the sea. That's why their rate of survival is less. It is known that the nets are lost under such weather conditions.

Basaran and Samsun (2004) explained that the survival rate of turbot captured from the deeper water (≥45 m) was higher since they had fewer hemorrhages on the external body surface than the fish captured from shallow waters.

The results of the study suggest that the survival rates of turbot were strongly related to fishing depths not soak time and season. The highest mean survival rate and minimum confidence limits of turbot were found in spring.

Weather conditions play a very significant role on fishing operation depth differences by seasons. In winter, the weather is cold and windy and the water is rough. The fishermen put their nets in shallow water. In addition, fish stay in shallow water in these months. It's highly estimated that the nets are mixed and lost in deep waters due to storms. When fish return back to warm waters for spawning in order to breed in spring and summer, large number of fish is caught with nets in deep waters. Therefore, fishing was conducted mainly in this period. In addition to this, fishermen's equipments play a significant role concerning this subject. The fishermen having a small boat and no hydraulic winch on board put their nets in shallow waters because pulling the nets in deep waters is very difficult to do by hand.

In recent years, alternative species such as turbot are getting more popular day by day due to the problems and over satisfaction on sea bass and sea bream cultured in Turkey. The breeders of wild turbot have been fishing with trawl and gillnets for culture. Also, further studies focused on fisheries by gillnet for wild breeders. Therefore, the survival of turbot caught by gillnets is more important.

The results suggest that the survival rates of turbot are not related to soak time or season but strongly related to fishing depths. According to all results, it can be suggested that wild turbot breeders might have high survival captured by gillnet more than 51 m in turbot culture**.**

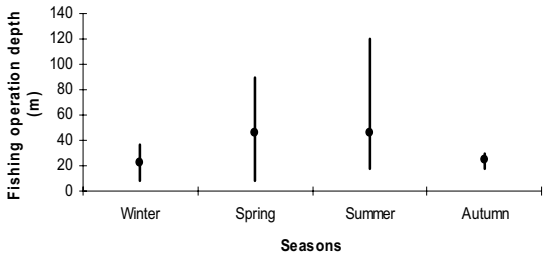

Figure 3. The depths of fishing operations by seasons.

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