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Effect of Towing Duration on the Catch per Unit of Swept Area (CPUE) for Lizardfish, *Saurida undosquamis* (Richardson, 1848), from the Bottom Trawl Surveys in the İskenderun Bay

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Abstract

For many marine surveys, a standard trawl is towed at each selected station over a period of time ranging from 30 minutes to as long as 120 minutes. A trawl towing duration experiment was conducted to determine whether different towing durations (60, 90, 120 and 150 minutes) had the same effect on the catch per unit of swept area (CPUE) of *Saurida undosquamis*, taking into consideration the variations in the CPUE among other members the Mullidae family (*Mullus barbatus*, *Mullus surmelatus*, and *Upeneus moloccensis*), *Metapenaeus stebbingi*, and non-target (by-catch) species. A simple random sampling technique was used for the survey sampling. The mean CPUE did not vary significantly with towing duration ($P > 0.05$) for the *Saurida undosquamis* catch. However, when towing was allowed to continue for 150 minutes, CPUE decreased dramatically while the CPUE values of the non-target species suddenly increased. The systematic decrease in the CPUE values along with the increase in the towing for Mullidae family turned out to result from predation by *Saurida undosquamis* on the Mullidae family as prey and also escape from the mesh due to gear saturation in the case of *M. stebbingi.* Gear saturation by non-target species and predator-prey relationship were among the possibilities considered as candidates for the main factors affecting the decrease in the CPUE values of the various species with increased towing duration. Thus, it was found through scientific surveys that after 120 minutes of towing, sampling on the economic catch was biased in the multi-species fishery of İskenderun Bay. The scientific surveys also demonstrated that short tows were at least as efficient as long tows for CPUE.

Key Words: Towing duration, *Saurida undosquamis*, catch per unit of swept area (CPUE), bottom trawl survey.

Introduction

Estimates of the abundance and length distribution of commercial fish stocks based on trawl surveys have become a management necessity in many areas (Godø *et al.*, 1990). A major assumption made in these surveys is that catch rates are constant no matter how long the towing duration is. Any deviations from a linear relationship between catch and the amount of effort put into fishing may have significant implications for catch composition and abundance estimates and may introduce biases into the results of trawl surveys (Wassenberg *et al.*, 1998).

The towing duration of commercial trawls may be as long as 200 min (Godø *et al.*, 1990), but it is reported that monetary constraints, coupled with the need for large numbers of replications in observational studies conducted on towing duration in order to maintain statistical validity, restrict the scientific survey durations (Wassenberg *et al.*, 1998). Thus, the standard towing duration for many trawl surveys usually varies from 30 minutes to 120 minutes at each selected station. However, as large fish may swim in the mouth of the trawl for long periods of time without entering the cod-end, different towing durations may result in varying catch rates and size compositions. Thus, some fish may not be caught in a short towing period (Godø *et al.*, 1990; Wassenberg *et al.*, 1998; Somerton *et al.*, 2002).

Lizardfish is a diurnal species of fish that is one of the top predators in the Northeast Mediterranean benthic ecosystem (Yousif, 2003). Lizardfish penetrated into the Mediterranean Sea from the Indo-West Pacific through the Suez Canal (İşmen, 2002). This species occurs in large populations and it is of considerable commercial importance in the region. Fish belonging to the same taxonomic family have provided approximately 50% of the total economic catch in İskenderun Bay (Can and Demirci, 2003). The diet of this species consists of 95% fish (mainly from the Mullidae family) and 5% crustaceans (penaid shrimp) (JICA, 1993). In İskenderun Bay, *M. stebbingi* provided 76.9% of the total shrimp catch (Can *et al.*, 2005). Also, it was reported that greater than 50% of the trawl catch in İskenderun Bay consisted of non-target species (Demirci, 2003).

In this study, we have investigated how the CPUE of *S. undosquamis* is affected by changes in towing duration, taking variations in the CPUE of the Mullidae family (*Mullus barbatus*, *Mullus surmelatus*, and *Upeneus moloccensis*), *M. stebbingi*, and non-target species into account. Prior to this study, evaluations of this kind had not been reported for multi-species fishery in İskenderun Bay.

Materials and Methods

This study was conducted between March 2002 and February 2003 in İskenderun Bay (Figure 1). In total, 40 trawl hauls were conducted using R/V 'Mustafa Kemal-1'. The head-rope length and cod-end mesh size of the trawl net used were 28 m and 18 mm, respectively. Towing speed was 2 knots. Towing durations were 60, 90, 120, and 150 minutes. In this study, 60, 70, and 75-minute tows were all grouped as being considered to have lasted for 60 minutes in duration; 90, 95 and 100-minute tows, for 90 minutes; and 120 and 135-minute tows, for 120 minutes; and 150, 160 and 170-minute tows, for 150 minutes. All hauls were carried out in daytime.

The simple random sampling technique was applied for the survey sampling. Deck sampling and catch record procedures were selected as per Spare and Venema (1992). Catch per unit effort (CPUE) is most often based on either commercial or survey data. Survey data are preferred because they are usually collected with a standardized procedure that is kept constant to the extent possible (Maunder, 2001). CPUE (kg/km^2) was calculated as the catch weight (Cw), divided by the area (*a*) swept out for each species in each haul.

$$\text{CPUE} = \text{Cw}/a.$$

The swept area (*a,* km^2) or the 'effective path swept' for each haul is estimated thus:

$$a = D.h.X$$

where h is the length of the head-rope, D is the distance covered, and X is the fraction of the head-rope length which is equal to the width of the path swept by the trawl, or 'wing spread', h*X. The value of X ranges from 0.40 to 0.66. It has been suggested that X should equal to 0.50 to provide the best compromise value for Mediterranean Sea (Spare and Venema, 1992), but Bingel (2002) reports that it varies from 0.30 to 0.40 for Turkish deep trawl nets. Hence, the value of X could be taken to be 0.40 for this study. The distance covered (D_i) was estimated for each haul in units of nautical miles (Spare and Venema, 1992), then converted into the kilometres multiplying by 1.852 (one nautical mile = 1.852 km):

$$D_i = 60x\sqrt{(Lat_1 - Lat_2)^2 + (Lon_1 + Lon_2)^2 \cos 0.5^2 (Lat_1 + Lat_2)}$$

Where, Lat1: Latitude at the beginning of the haul (degrees), Lat2: Latitude at the end of the haul (degrees),

Lon1: Longitude at the start of the haul (degrees), Lon2: Longitude at the end of the haul (degrees).

The coefficient of variation (CV) was used to assess the variability:

$$CV = \frac{100.\sqrt{V}}{CPUE},$$

Where, V is the variance. Since the presence of zero catch for some hauls artificially increases the CV, such hauls were excluded from the data analysis (Somerton *et al.*, 2002).

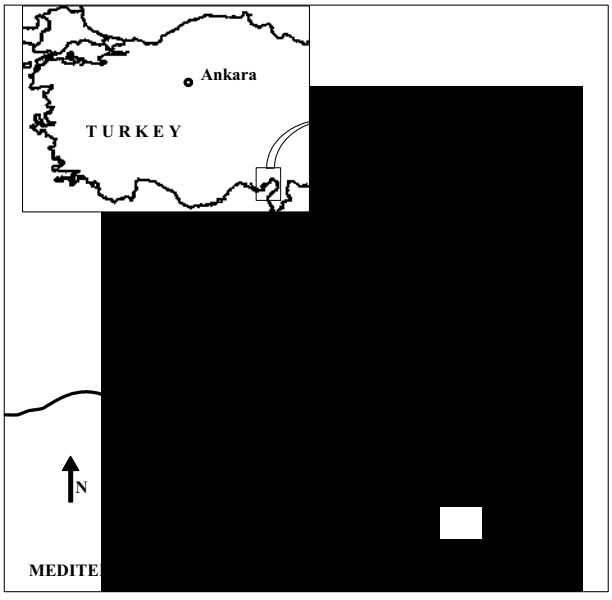

Figure1. Sampling area and trawled stations.

Results

Number of hauls, towing depths, and area swept out with different towing durations were given in Table 1. A high positive correlation between towing duration and area of swept (r = 0.97) was noted.

During the investigation, a total of 1,239.3 kg economic catch was recorded. *Saurida undosquamis*, the Mullidae family (*Mullus barbatus*, *Mullus surmelatus,* and *Upenus molocensis*), and *Metapenaus stebbingi* each accounted for approximately 36%, 17% and 5% of the total economic catch, respectively. These three groups were taken together provided about 58% of the total economic catch. Non-target (by-catch) species constituted about 59 % of the total catch.

For the *S. undosquamis*, CPUE values increased for durations ranging between 60–120 minutes but then suddenly decreased at 150 minutes and longer, but there was no significant difference in mean CPUE values between the towing durations ($p>0.05$). The mean CPUE decreased gradually for Mullidae and *M. stebbingi* as towing duration increased. However, as in the case for the total catch and for *S. undosquamis*, no significant differences occurred between different towing durations ($p>0.05$). The mean CPUE values for *M. stebbingi* decreased while towing duration increased. The mean CPUE values for non-target species tended to increase as towing duration increased and only the 150-minute towing showed a statistically significant amount of difference from the others ($p<0.05$) (Table 2).

Discussion

The general theory behind trawl catching suggests that the fish fall back into the trawl out of exhaustion from swimming at trawl speed in the mouth of the net. Because of this, the method is referred to as 'catching by exhaustion' (Godø *et al.,* 1990). This theory implies that if swimming capacity increases with fish size, long tows should capture larger fish with a higher catch rate, i.e., catch per unit of effort, than that of the shorter ones. In contrast to this, Godo *et al.* (1990), Wassensberg *et al.* (1998), and Somerton *et al.* (2002) found that the mean size of a variety of fish and crab species remained nearly constant, but that CPUE increased as tow duration decreased. They tried to explain this paradox as having arisen from a potential underestimation of the effective swept area, catch-by-surprise or escape from under the footrope (Godø *et al.,* 1990; Wassenberg *et al.,* 1998; Somerton *et al.,* 2002). Yet none of these enabled clear identification of the causal mechanism at work.

Our results for CPUE for the *S. undosquamis* were not consistent with the findings of previous studies. For total catch and *S. undosquamis*, CPUE increased with towing duration up to 120 minutes, but then it decreased dramatically after 150 minutes of towing. For towing durations of up to 120 minutes, our findings for CPUE seem to agree with the general theory of trawl catching to a certain extent. Our CPUE results for the Mullidae family and *M.*

Table 1. Number of hauls (N), area of swept (a±SD) and towing depths (d±SD) by towing durations

Towing Duration	N	a ± SD (km^2)	d ± SD (meters)
60	3	0.054±0.028	36.7±16.9 (17-50)
90	9	0.065±0.019	32.9±16.8 (14-57)
120	21	0.088±0.018	29.7±19.5 (11-73)
150	7	0.093±0.015	37.4±13.9 (23-64)

Table 2. The mean catch per unit swept area ($\overline{CPUE} \pm SD$) with Coefficient of Variations (CV) and number of observed haul (N) by species for different towing durations

Towing Duration (minutes)	*Saurida undosquamis*			Mullidae			*Metapenaeus stebbingi*			Non-target species		
	$\overline{CPUE} \pm SD$ (kg/km^2)	CV (%)	N	$\overline{CPUE} \pm SD$ (kg/km^2)	CV (%)	N	$\overline{CPUE} \pm SD$ (kg/km^2)	CV (%)	N	$\overline{CPUE} \pm SD$ (kg/km^2)	CV (%)	N
60	47.4±18.8	39.7	3	133.8±165.5	123.7	2	---	---	---	520±198.7	38.2	3
90	115.4±119.4	103.4	9	96.68±113.1	116.9	9	122.9±168.6	134.5	2	424.2±342.2	80.7	3
120	169.4±94.1	55.5	21	68.6±71.9	104.8	17	63.5±85.4	134.5	10	617.3±684	110.8	21
150	55.3±47.2	85.2	7	60.3±69.9	115.9	6	4.9	---	1	1609.6±1239.2	76.9	7

stebbingi were consistent with those of previous studies (Godø *et al.,* 1990; Wassenberg *et al.,* 1998; Somerton *et al.,* 2002) in that CPUE values decreased with increased towing durations. The CPUE of the non-target species remained stable up until 120 minutes, and then suddenly increased when towing duration passed the 150-minute mark.

It was not clear why the unexpected changes in CPUE with increased towing duration occurred. One possible explanation is that an error may have been made in measuring the effective towing path. However, although we did not use a special tool such as Scanmar to determine the effective towing path, we found that there was a high positive correlation between the towing duration and the effective path swept out. Hence, the probability of the inaccuracy having occurred in the towing path measurements is low.

An alternative explanation for the unexpected changes is variation in trawl catching capacity over time. On longer tows, the net may fill up or close up during turns and sweep out a narrower path, resulting in mobile organisms avoiding capture. It is obvious that the net and footrope tended to bounce and skip over the ground as the footrope became snagged behind obstacles (Wassenberg *et al.,* 1998). Thus, it is plausible to assume that on longer tows, there was a higher probability of encountering such obstacles than on shorter ones. Godo *et al.* (1990) suggest that on the rough bottom floor of a body of water, sudden changes in trawl geometry could disturb the fish schooling in front of the net. However, these explanations were not in accord with our results for CPUE, especially for the total catch and the *S. undosquamis* catch, because we did not detect any systematic change in CPUE with increasing towing duration. Another possible explanation is that, as the net filled up, the cod-end became more rounded so that small fish could escape through the mesh. This mechanism may have been one of the factors leading to the decrease in the CPUE of the Mullidae family and *M. stebbingi* with increasing towing duration. Crustaceans tend to jump over the trawl net while fishing is taking place, and if trawl geometry changed with increased towing duration (the mouth of the trawl net might get narrower), then the probability of such act occurring would have been higher in longer tows. Another possible explanation for the decrease in the CPUE of the Mullidae family with increasing towing duration is the predator-prey relationship. The Mullidae family makes up most of the diet of *S. undosquamis*. We observed whole fish in the mouth of *S. undosquamis* just after the hauls, as well as specimens of whole, undigested fish that belonged to Mullidae family and the small-size *S. undosquamis* in the stomachs of larger-size *S. undosquamis*. This was strong evidence that the species predated on the Mullidae family even after having been captured in the trawl net, resulting in a decrease in the CPUE of the Mullidae family with increasing towing durations.

Yet another process that may have been at work is gear saturation. At high densities, fish would start to accumulate in front of the trawl, with individuals arriving later overflowing and escaping with a resulting decrease in catch efficiency. If accumulation of fish in the trawl mouth increased with increasing tow length, catch per minute would decrease (Godø *et al.,* 1990). During the study, 35 non-target species belonging to different families were observed. Among them, Cheloniidae and Dasyatidae had the highest catch rates. Furthermore, the specimens belonging to these two families were larger in size. Thus, non-target species might have contributed significantly to gear saturation. The dramatic decrease in the CPUE of all groups of fish (except non-target species, which had the highest the CPUE in the 150-minute towing) supports this hypothesis.

Consequently, among the aforementioned explanations, gear saturation by non-target species and predation were considered to have been the main factors leading to the observed decrease in the CPUE of the species with increasing towing duration. Thus, it turned out that after the 120 towing minutes, sampling on the economic catch is biased in the multi-species fishery of İskenderun Bay in scientific surveys. It was also shown that short tows were at least as efficient as long tows for CPUE estimates in scientific surveys. Nevertheless, there is a need for more experimental research to cast light on the effects of towing duration on the mean size of catch and CPUE with smaller towing intervals, such as increments of 15 and 30 minutes, and with towing when it is carried out at night as well as during the day.

References

Bingel, F. 2002. Balık Populasyonlarının İncelenmesi. Baki Kitapevi, Adana, 404 pp.

Can, M.F. and Demirci, A. 2003. Spatial variability of total biomass for some demersal fishes inhabiting İskenderun Bay (Turkey), International Symposium of Fisheries and Zoology, İstanbul, 81-88 pp.

Can, M.F., Mazlum, Y., Demirci, A. and Aktaş, M. 2005. The Catch Composition and Catch Per Unit of Swept Area (CPUE) of Penaeid Shrimps in the Bottom Trawls from İskenderun Bay, Turkey Turkish Journal of Fisheries and Aquatic Sciences, 4: 85-89.

Demirci, A. 2003. İskenderun Körfezinde Demersal Stoklarda Hedef Olmayan Türler ve Biyokütlelerinin Tahmini. MSc Thesis, Hatay: Mustafa Kemal University.

Godø, O.R., Pennington, M. and Vølstad, J.H. 1990. Effect of tow duration on length composition of trawl catches. Fish. Res., 9: 165-179.

İşmen, A. 2002. Age, growth, sex ratio and spawning season of Lizardfish (*Saurida* Undosquamis, Richardson, 1848), in the İskenderun Bay, Eastern Mediterranean, Workshop on Lessepsian Migration, Gökçeada, 108-115.

JICA. 1993. Survey Report of Demersal Fishery Resources in Marmara, Aegean and Mediterranean. TKB Tarımsal Üretim ve Geliştirme Müdürlüğü, Ankara.

Maunder, M.N. 2001. A general framework for integrating the standardization of catch per unit of effort into stock assessment models. Can. J. Fish. Aquat. Sci., 58: 765-803.

Somerton, D.A., Otto, R.S. and Syrjala, S.E. 2002. Can changes in tow duration on bottom trawl surveys lead to changes in CPUE and mean size?. Fish. Res., 55: 63-70.

Spare, P. and Venema, S.C. 1992. Introduction to Tropical Fish Stock Assesment (Part1). FAO Fish. Tech. Pap., Rome.

Wassenberg, T.J., Burridge, C.Y., Connell, M. and Gribble, N. 1998. A validation of short-duration scientific tows as a representation of long commercial –length tows: comparing the catch rates, size composition and species composition of prawn trawler bycatch in the far northern Great Barrier Reef, Australia. Fish. Res., 36: 35-46.

Yousif, A. 2003. Diel variability of size and catch rate of three fish species and three penaid prawns in the NW Red Sea trawl fishery. Fish. Res., 63: 265-274.