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Research Article

Is natural bait type a stochastic process for size and condition of fishes in the recreational fishery of İzmir Bay?

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Abstract

Determining bait type might be one of the most important factors that influence the amount and size of the fish catch in marine recreational fishery. To this end, the relationships between two types of natural bait and catch per unit effort (CPUE), yield per unit effort (YPUE), fish size and condition ($K=W/TL^3 *100$) were evaluated in the recreational fishery of İzmir Bay (Middle Eastern Aegean Sea, Turkey). The most abundant angling species on Turkish coasts: annular sea bream (*Diplodus annularis*), blotched picarel (*Spicara flexuosa*), two-banded sea bream (*Diplodus vulgaris*) and bogue (*Boops boops*) were collected by anglers between September 2006 – February 2007 using as baits onyx (*Solen vagina*) and sardine (*Sardina pilchardus*). The average CPUE and YPUE of hooks baited with onyx were significantly higher than hooks that were baited with sardine. Eventhough the averages of specimens caught with sardine bait were larger than those with onyx, except for bogue, total length-frequency distributions revealed some differences only for annular sea bream and blotched picarel between the two baits. High conditioned individuals of bogue were caught with sardine bait and the rest of the other species with onyx.

Keywords: Anglers; Natural bait; Condition; Recreational angling; Aegean Sea.

Introduction

Angling is a small scale fishing activity which is performed intensively in the Aegean Sea. Various species are captured in different months by different methods, whether the activity is recreational or commercial. The material of the fishing lines and the duration of the operations importantly affect the catch composition; the most important factors affecting the catch yield are hook and bait (KAYKAÇ *et al.,* 2003). Fish are captured through their mouth, palate or other body parts. The most important parts of the hook during capture are the end and the neck. The neck part of the hook is named as crosswise or straight according to the angle between the main body and the neck (ERZINI *et al.,* 1998). Crosswise hooks are more likely to scratch than straight ones;

consequently they are accepted as more effective. Also size selection of fishes induced by hook size and number of captures was reduced when using large hooks, but bigger specimens and more valued species were caught (CERDÀ *et al.,* 2010). It was reported that morning hours are more preferred for longline and fishing line operations (ERZINI *et al.,* 1999). Also LÖK *et al.* (2008) determined the maximum species and individual numbers in morning observations at the Dalyanköy artificial reefs by using the visual census method.

In addition, bait may have important effects on angling. Selectivity of species and sizes are the most familiar ones, however survival of caught and released fishes could also be related to bait. The effects of natural bait choices were investigated in the Balearic Islands (Western Mediterranean) according to hooking locations for mixed-species marine recreational fishery, and it was reported that survival rates were affected by bait choices of caught fishes (ALÓS *et al.,* 2009). For any bait or combination of baits to be successful in catching fish, it is reasonable to assume that it must stimulate both olfactory and gustatory responses. In addition, the bait must have a certain physical strength, to ensure that it is not lost during setting, and that the bait is not torn off the hook by fish that bite at the bait without ingesting it (JACOBSEN & JOENSEN, 2004). Smell, taste, texture and toughness of baits are several factors which influence the catch rate and thus efficiency. However, all of these factors are connected with the foraging behaviors of the species targeted (LØKKEBORG, 1989). The decision-making process of the fish, which ultimately determines whether it is hooked or not, has been quite simply described by WOOTON (1991) as the following sequence:

Detect ⇨ Ignore
⇩
Approach ⇨ Avoid
⇩
Select ⇨ Reject
⇩
Manipulate ⇨ Eject
⇩
Ingest

CPUE (catch per unit effort) and YPUE (yield per unit effort) are also other important issues which are related to bait type in recreational fishery. As in other parts of the world, on Turkish coasts many recreational fishermen engage in angling for relaxation. Satisfaction of the anglers is related to how many or how big are the fishes they catch. In this case, bait becomes an important part of the activity. Influence of bait type on CPUE and species composition of catch has been reported from hook-and-line commercial fisheries (LØKKEBORG & BJORDAl, 1992; WOLL *et al.,* 2001).

389 fish species are known on the Turkish coast of the Aegean Sea, and 225 of them are distributed in İzmir Bay (BILECENOĞLU *et al.,* 2002). Especially species belonging to sparidae and centracanthidae families are caught intensively in angling fishery. Two of the most popular natural baits, onyx (*Solen vagina*) and sardine (*Sardina pilchardus*) are generally used in marine recreational angling fishery on the Aegean coasts of Turkey and the effects of them on size and species selection are always important questions. The goal of this study is threefold. Four of the most abundant angling species on Turkish coasts; annular sea

bream (*Diplodus annularis*), blotched picarel (*Spicara flexuosa*), two-banded sea bream (*Diplodus vulgaris*) and bogue (*Boops boops*) are selected to firstly investigate the effect of onyx and sardine baits in the CPUE and YPUE. Second, is there any size selection that can be attributed to bait types? Finally is there any significant difference in the condition of fish related to natural bait types. It is the first study aimed at determining the impacts of bait preference on angling efficiency on the eastern coast of the Aegean Sea.

Materials and Methods

A total of 30 fishing trials, five times per month were carried out by the same 3 anglers from September 2006 to February 2007. The sampling area was located in Izmir Bay, in the eastern region of the Aegean Sea (Fig 1).

Fishing operations took place from the boat the "NEREIS" which is 6,5m in length and has a 9 hp engine. Depth of the fishing areas varied between 14 and 17m. Samplings were performed with the same technical featured fishing lines by three anglers, and baits were onyx and sardine. Duration of all samplings were fixed and limited to 2 hours. Trials were carried out during morning hours between 09:00 and 11:00 am. The technical detailed plan of the angle, used in experiments is shown in Figure 2. Two of the four side leaders were baited with

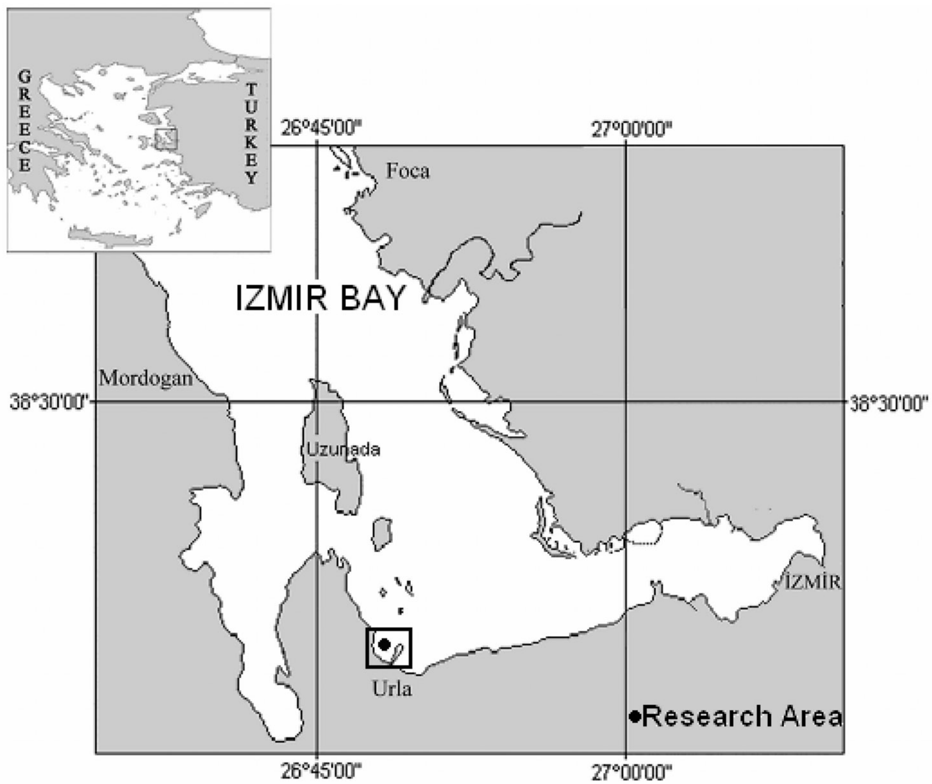

Fig. 1: Research area.

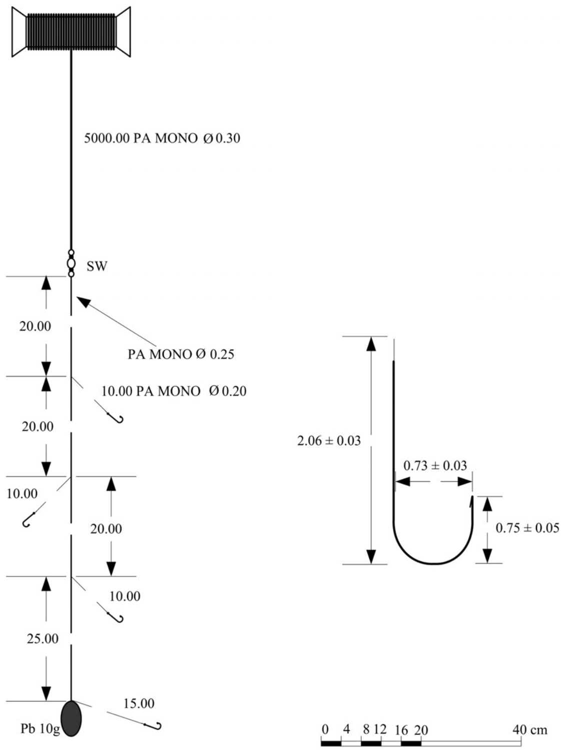

Fig. 2: Technical plan of fishing lines used in experiments.

approximately equal sized pieces of onyx, (mean weight= 2.4 gr; S.D= 0,4; n=50) and the rest of them with sardine (mean weight= 1,8 gr; S.D=0,6; n=50) randomly and equally in every setting. The bait losses of anglers were noted in every trial separately and the significance of their ratio was tested by a chi-squared test.

Total length, TL, of all sampled individuals was measured to the nearest 0.1cm using a 30cm ruler, weight, W, was taken using a digital balance with a precision of 0.01g. A Kolmogorov-Smirnov (K-S) test was used to compare the differences between length frequency distributions of individuals which were caught with different baits (SIEGEL & CASTELLAN, 1988). CPUE (a) and YPUE (b) values were calculated with the formula as recommended by GODØY *et al.* (2003), which was customized for this study;

$$CPUE = \frac{\sum n}{\sum number\ of\ hooks * \sum (\ fishing\ trials * anglingtime\ )} \quad \text{(a)}$$

$$YPUE = \frac{\sum weight}{\sum number\ of\ hooks * \sum (\ fishing\ trials * anglingtime\ )} \quad \text{(b)}$$

Fulton's condition factor (FULTON, 1911):

$$K = \frac{W}{L^3} * 100$$

where W, the weight and L, total length of the fish, was also used to calculate K (condition) of each fish. Univariate analyses were used to test the effects of bait differences in CPUE, YPUE and K of fishes. According to this mixed-effects model, bait type (sardine vs. onyx) was considered a fixed categorical factor, days and anglers were considered random factors in the nested ANOVA design for each species and pooled data. Statistica 7 software was used for statistical tests.

Results and Discussion

During the study, 1251 individuals in total were caught from 4 species in 30 angling sessions. Descriptive statistic values of each are presented separately in Table 1.

Using sardine as bait, anglers caught 378 individuals or 30.2% of the total catch. For onyx, a total of 873 fish were caught comprising 69.8% individuals. The CPUE (all species pooled) ranged from 0 to 9 fish per angler per hour. The mean CPUE ± S.D. was 6.95 ± 3.70 individual fish per angler per hour. According to baits this result was changed as 0 to 5, and 2 to 9 per angler per hour, and the mean CPUE ± S.D. were 1.05 ± 0.03, and 2.43 ± 0.07 respectively for sardine and onyx. Average CPUE of investigated species, annular sea bream, bogue, two-banded sea bream and blotched picarel are given in Table 2. The nested ANOVA design showed that significantly more fish per unit effort were caught using onyx than using sardine (Table 3).

In total, 47520 g of fish were weighed in trials. Using sardine, anglers caught 14127 g or 29.7%. For onyx, a total of 33393 g of fish were caught comprising 70.3% of total biomass. The total YPUE ranged from 0 to 978 g and was on average ± S.D. 229 ± 42.3 g biomass per angler per hour (Table 2). For baits YPUE was changed as 0 to 440 g and 275 to 978 g per angler per hour, and the mean YPUE ± S.D. were 39.24 ± 0.62, and 92.75 ± 1.12 respectively for sardine and onyx. The average YPUE ± S.D. of the investigated species were given in Table 2. According to the nested ANOVA design, both species and pooled data were significantly higher in YPUE for onyx bait than sardine bait (Table 3).

As seen from the figures and tables, onyx was the most efficient bait both for CPUE and YPUE. Species caught by onyx and sardine showed 38.3% difference according to number of individuals. In general, fish sizes have some differences according to bait types. Contrary to CPUE and YPUE results, average TL results of sardine bait were higher than onyx bait except for bogue (Table 2). However, TL size predominance of sardine bait was significant only for annular sea bream and blotched picarel ($p<0.001$). While little differences were seen in TL means for two-banded sea bream and bogue, these were not significant statistically ($p>0.05$) (Table 4). Total length-frequency distributions for species were given by histograms in Figure 3 and Figure 4.

The condition value (K) of the species ranged from 0.85 to 2.08 and was on average ± S.D. 1.38 ± 0.11. It could be said that hooks baited with onyx were more attractive for higher conditioned specimens of annular sea bream, two-banded sea bream and blotched picarel ($p<0.01$). Their average ± S.D. were 1.72 ± 0.14, 1.54 ± 0.13, 1.31 ± 0.13 respectively (Table 2). Conversely, sardine bait was more efficient for specimens of bogue which have a higher condition. All

Table 1
Species, total catches (n), mean, minimum (min), maximum (max) total length (TL) and weight (W) values, and their standard deviations (±SD) by bait type (onyx vs. sardine) during the experimental angling sessions.

Bait type:	**onyx**			**sardine**		
Species	**n**	**TL(cm)**	**W(gr)**	**n**	**TL(cm)**	**W(gr)**
Annular sea bream	211			130		
mean		12,6	36,9		13	36,7
min		9,4	13,1		11,2	22,1
max		17,2	86,1		16,1	63,2
±SD		0,18	1,48		0,18	1,43
Bogue	140			49		
mean		17,3	56,2		15,6	46,3
min		12,1	21,2		12,1	22,1
max		20,5	85,1		19,6	72,3
±SD		1,4	3,66		2,59	2,49
Two banded sea bream	226			87		
mean		12,5	32,2		13,4	38,4
min		10,1	14,1		10,4	14,2
max		17,6	92,3		16,1	65,2
±SD		1,97	1,68		1,82	1,77
Blotched picarel	296			112		
mean		13,8	35,1		14	33,3
min		12,1	24,1		12,4	25,2
max		16,6	65,2		15,8	47,3
±SD		1,1	3,72		1	1,24

Table 2
Summary of average ±S.D. CPUE, YPUE, fish size (TL) and K (fish condition) between bait types observed when all species were pooled, and in the rest of each.

Bait type		**Species pooled**	**Annular sea bream**	**Bogue**	**Two banded sea bream**	**Blotched picarel**
Sardine	CPUE (fish angler 1 hour)	1,05±0,03	0,36±0,02	0,14±0,01	0,24±0,01	0,31±0,02
	YPUE (g angler 1-hour)	39,24±0,62	13,25±1,41	6,31±2,51	9,29±1,21	10,39±1,24
	Fish size (mm)	13,82±1,84	13,0±0,18	15,6±2,59	13,4±1,82	14±1
	K	1,35±0,10	1,53±0,07	1,18±0,13	1,47±0,10	1,20±0,12
Onyx	CPUE (fish angler 1-hour)	2,43±0,07	0,59±0,01	0,39±0,04	0,63±0,03	0,82±0,01
	YPUE (g angler 1-hour)	92,75±1,12	21,66±1,50	21,87±3,66	20,23±2,16	28,98±3,77
	Fish size (mm)	17,18±1,82	12,6±0,18	17,3±1,40	12,5±1,97	13,8±1,10
	K	1,41±0,12	1,72±0,14	1,07±0,09	1,54±0,13	1,31±0,1

Table 3
Univariate results of the bait effects for CPUE, YPUE and K (fish condition) in the nested ANOVA design according to categorial predictors for each species and pooled data.

	Factors	Species	df	MS	F	p
			35			
		Annular sea bream		6,34	10,01	***
CPUE	baits (days * anglers)	Bogue		1,86	4,07	***
		Two banded sea bream		5,26	9,60	***
		Blotched picarel		9,44	17,25	***
		pooled		59,94	24,19	***
		Annular sea bream		892,62	3,86	***
YPUE	baits (days * anglers)	Bogue		956,23	4,73	***
		Two banded sea bream		742,56	6,63	***
		Blotched picarel		689,56	11,68	***
		pooled		1284,29	21,33	***
		Annular sea bream		0,08	8,60	**
K	baits (days * anglers)	Bogue		0,05	7,93	**
		Two banded sea bream		0,04	4,33	**
		Blotched picarel		0,06	6,79	**

Factors, categorial predictors; MS, mean square; F, F-ratio; df, degrees of freedom; **, very significant: $p<0.01$***,very highly significant: $p<0.001$.

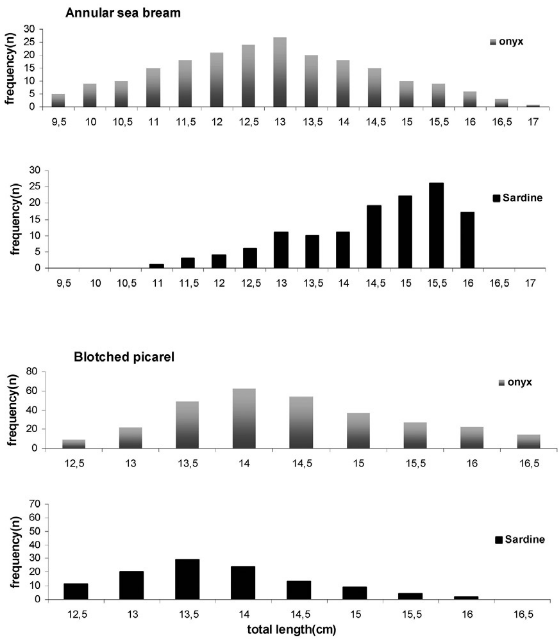

Fig. 3: Total length-frequency distribution of annular sea bream and blotched picarel caught with both baits.

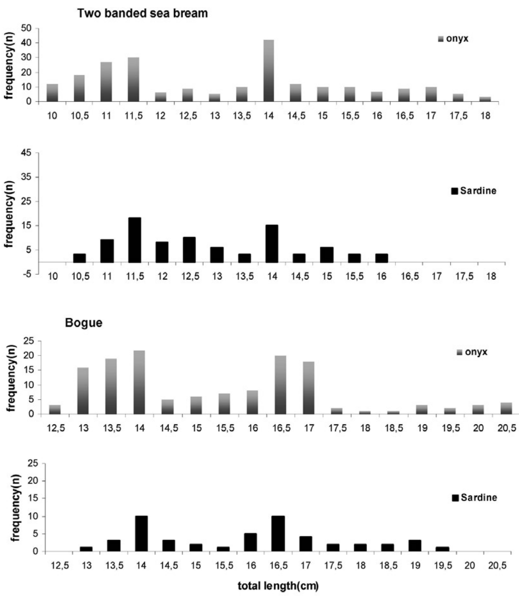

Fig. 4: Total length-frequency distribution of two-banded sea bream and bogue, caught with both baits.

Table 4
Results of the K-S test for length frequency differences of each species between bait types.

Species	D	Do	p
Annular sea bream	0,438	0,158	***
Bogue	0,272	0,151	***
Two banded sea bream	0,173	0,179	ns
Blotched picarel	0,19	0,226	ns

D, observed value; Do, expected value; *** (D>Do; p<0.001); ns (D<Do; p>0.05).

of the investigated species in our study were categorized as omnivores according to their feeding habits (KARPOUZI & STERGIOU, 2003).While bigger individuals of annular sea bream were captured with sardine bait (Fig. 3, Table 4), more conditioned annular sea bream individuals were caught with onyx bait. Even though fishes are not found in the diet of annular sea bream specimens between 7-25 cm TL range (STERGIOU & KARPOUZI, 2002), individuals between 11-16 cm TL were also caught by a fish (sardine bait) in our study. Sardine bait was more efficient on the smaller individuals of blotched picarel (Fig. 3, Table 4), but onyx bait was more attractive to higher conditioned specimens. That is to say, bait choice could differ between individuals of the same species. STERGIOU & KARPOUZI (2002) determined that fish, copepods, appendicularians and cladocerans are the feeding prey of blotched picarel, however in our study 72% of them were caught with a bivalve (onyx bait). The magnitude of the effect of bait type on species composition is probably related to angling skill and different angling techniques (ALÓS *et al.,* 2009). It follows that smaller individuals of blotched picarel may be captured according to the hand sensitivity of fishermen during biting attacks of the specimen on the soft bodied sardine bait. While algae and copepods are included in the diet of bogue (STERGIOU & KARPOUZI, 2002), specimens of them were caught with bivalve and fishes. All of these differences in this study between food choices and feeding habits could be because of the form of the baits. Neither onyx, nor sardines were thoroughly attached to hooks with their whole body. They were cut into small pieces for hooks. That is why attacks by the fishes on these baits could be related to smell or appearance. The reason for the impact of bait on species composition is probably related to species-specific preferences for food (STONER, 2004). Also, sex and reproduction periods of the species could affect these kinds of choices. The difference in condition values of fishes related to length-weight relationship may be attributed to one or more factors: the season and effects of different areas, changes in water temperature and salinity, sex, food availability, differences in the number of specimens examined as well as in the observed length ranges of the species caught (TESCH, 1971; MOUTOPOULOS & STERGIOU, 2002). Therefore in further studies, related factors must be investigated in order to have better explanations for the behaviour of species to fishing gears.

LØKKEBORG *et al.* (1989) reported that if two kinds of baits are used on the long-line, then it could have a synergistic effect. In this study, utilization of two different baits could have similar effects on catch composition. It is suggested that bait size is probably the most important factor affecting the size of captured fishes. Increasing abundance of scavengers that are mostly small individuals of aggregated species, may cause bait loss and reduce fishing power, confirming observations from other authors that firm fleshed bait are less likely to be torn from hooks by scavengers or break apart and fall off hooks than soft-bodied species (SHOMURA, 1955). It was determined in our experiments that soft bodied sardine bait is more likely to drop off hooks easily than onyx by mechanical effects of surface waves, water currents or biting attacks of species. Loss of onyx and sardine from hooks was found to be 51% and 68% respectively. This difference could be because of the softer body structure of the sardine compared to the onyx, but it was not significant statistically ($p<0.05$). This could be one of the most important reasons for low catch efficiency of sardine bait. Loss rates between fresh, frozen, and salted soft bodied baits did not show a statistical significance (WARD and MYERS, 2007). However, salting the bait is a very common method for Turkish anglers to increase strength structure of bait. On the other hand, the attractiveness of salted bait in affecting the behavior of species in comparison with fresh bait has to be investigated in further studies.

Recreational angling fishery is getting more popular day by day on Turkish coasts. Selection of the baits could change both amount and sizes of the captured fishes. Daily catch amount of some species are categorized by their weight and some by number of individuals in Turkish Amateur Fishery Regulations (ANONYMUS, 2010). Daily total catch limit for weighed species is 5 kg per person per day. In addition there is only a minimum landing size (MLS) limitation for two-banded sea bream which is 21 cm TL and which is related to our study. However, the first reproduction length (FRL) is not clear for two- banded sea bream in İzmir Bay and should be investigated; there is no size limitation for other sampled species and average TL values in our study were higher than those given (FRL) by other authors. KINACIGİL *et al.* (2008) found 10-10.5 cm and 17.3-15.6 cm FRL for females and males of annular sea bream and bogue respectively. FRL for blotched picarel was found 11.5-13.1 for females and males respectively (SOYKAN *et al.,* 2010). Not only biological, but also more detailed behavioral investigation is needed to verify effects of natural baits on species that are captured in recreational angling fishery.

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