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Effectiveness of Bait and Unbait in Trapping of Astacid Crayfish

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Abstract

The effectiveness of baited and non-baited traps was evaluated from June and December 2003 in Eğirdir Lake. A total of 400 fyke-nets was set randomly along the shoreline at intervals of approximately 3 m, and hauled over 7 months. The mean catch per unit effort (CPUE) was found vary for sampling periods and treatments. In both treatments, average of CPUE were increased with increasing sampling periods. In addition, mean CPUE was found significantly different in both treatments ($P<0.05$). The overall average CPUE in non-baited traps were 2 times greater than baited traps. More crayfish occupant non-baited traps (n= 1947 traps, 69.5%) than baited traps (n= 945 traps, 33.7%). The larger and older crayfish were caught non-baited traps while baited traps had smaller size crayfish. Although there were significant differences in the capture of crayfish between non-baited and baited traps, but no differences were found males and females in both treatments for 7 months study. There was an obvious increased number of traps caught crayfish in both non-baited and baited traps from July to December. The catching of crayfish had been prohibited by law until 1999 in Lake Eğirdir. When catching of crayfish was allowed again, fishing potential increased gradually each season. Crayfish behaviour appears to have the most effect on catch per unit trapping effort, but without bait can improve the overall catch. Improvement in harvesting efficiency can be achieved by developing trap designs that maximize catch while minimizing escape of crayfish.

Keywords: *Astacus leptodactylus*, catch composition, CPUE, fishing potential, Eğirdir Lake, Turkey.

Astacid Kerevitlerin Avcılığında Yemli ve Yemsiz Tuzakların Etkinliği

Özet

Eğirdir Gölü'nde 2003 yılının Haziran ayından Aralık ayına kadar yemli ve yemsiz kullanılan pinterlerin av etkinliği incelenmiştir. Toplam 400 adet pinter tesadüfi olarak seçilen kıyı hattı boyunca 3 m aralıklarla atılmış ve 7 ay boyunca kontrol edilmiştir. Araştırma periyodu boyunca yemli ve yemsiz pinterler ile yakalanan kerevit miktarlarında belirgin bir artışın olduğu gözlenmiştir. Ortalama birim çabadaki av miktarı (CPUE) örnekleme periyotları ve her iki deneme grubu için farklı bulunmuştur. Yemli ve yemsiz pinterlerde ortalama CPUE'nun araştırma periyodu boyunca arttığı ve iki gruba ait ortalama CPUE değerleri arasındaki farkın önemli ($P<0,05$) olduğu belirlenmiştir. Yemsiz pinterlerin ortalama CPUE değeri yemli pinterlerin iki katı olarak hesaplanmıştır. Araştırma periyodu boyunca yemsiz pinterlere (n=1947 kerevit, %69,5), yemli pinterlere (n=945 kerevit, %33,7) göre daha çok kerevitin girdiği tespit edilmiştir. Yemli pinterler ile boyca küçük kerevitler, yemsiz pinterlerle ise boyca büyük ve yaşlı bireyler avlanmıştır. 7 ay boyunca yemli ve yemsiz pinterlerin av miktarları arasındaki fark önemli ($P<0,05$) bulunurken, eşeyler arasındaki fark önemsiz ($P>0,05$) bulunmuştur. Kerevit avcılığı 1999 yılına kadar yasaklanmıştır. Avcılık tekrar serbest bırakıldığında ise balıkçılık çabasında sürekli artış olmuştur. Kerevitlerin davranışları birim av çabası üzerine son derece etkili görünüyor ve yemsiz pinterlerin tüm av üzerinde daha etkili olduğu anlaşılmaktadır. Toplam ürün verimliliğinin arttırılması, pinterlerden kerevitlerin kaçışını en aza indirecek ve av miktarını arttıracak pinterlerin ve uygun yemin geliştirilmesi ile sağlanabilir.

Anahtar Kelimeler: *Astacus leptodactylus*, av kompozisyonu, CPUE, balıkçılık çabası, Eğirdir Gölü, Türkiye.

Introduction

Astacus leptodactylus (Eschscholtz, 1823) is the only native crayfish species in Turkey. It is considered a valuable fishery resource, as there are no other commercially important species of Crustacea found in freshwaters in Turkey. Eğirdir Lake support very good population of *Astacus leptodactylus*. The surface area of Eğirdir Lake is 479 km^2 and the average depth is 8.5 m (Altınkale, 2001). This lake is

inhabited by 13 species of fish, including carp, *Cyprinus carpio* (Linnaeus, 1758), and pike perch *Stizostedion lucioperca* (Linnaeus, 1758), which are economically important (Bolat, 2001). In addition, *Potamogeton*, *Myrophyllum*, *Ranunculus*, *Sagittaria*, *Phragmites* and *Chara* sp. are the most common aquatic macrophytes (Kesici, 1997) that are important food and shelter for crayfish in this lake.

The Eğirdir Lake is the main crayfish source, and also support Turkey's natural crayfish production. Approximately 2000 tonnes of *A. leptodactylus* were harvested from Eğirdir Lake between 1976 and 1984. Until 1984, freshwater crayfish played an important role as a high quality live export product, but after 1986, crayfish production declined dramatically in most lakes and dam reservoirs from 5000 tonnes to 200 tonnes. Hence, *A. leptodactylus* harvesting was forbidden between 1987 and 1999 in the lake because of the crayfish plaque *Aphanomyces astaci*, (Schikora, 1903), pollution, overfishing, and agricultural irrigation (Baran *et al*., 1987; Oray, 1990; Bolat, 2001; Harlıoğlu *et al*. 2004). Although the plague is still observed in some lakes in Turkey, there has been an increase in the amount of *A. leptodactylus* harvested from the wild (Diler and Bolat, 2001). The legal catching period is regulated by the government. Fishing is permitted from 15 June onward, and ends on 1 November in the lake. Crayfish has been heavily exploited for nine years in Eğirdir Lake. The harvest (tonnes) was 128 in 1999, 358 in 2000, 797 in 2001, 274 in 2002, 581 in 2003, 397 in 2004, 114 in 2005, 34 in 2006, and 14 in 2007.

The reproductive cycle of *A. leptodactylus* can be described as follows: the breeding season begins with the decline in water temperature in the fall. Mating occurs during October and November when water temperature is 7-12°C and egg-laying takes place 4-6 weeks later, when the water temperature is 6-11°C. Therefore, crayfish catching is forbidden during the reproductive season.

The most frequently employed method and perhaps most criticized methods of capturing crayfish has been traps. Comparisons of different types of traps indicate a high variability in trap efficiency (Bean and Huner, 1978), due in part to escape of captured animals. Different kind of materials such as fish, chicken, pet food, liver, and artificial baits are used for catching crayfish. Traditionally, natural baits were exclusively used and included fresh or fresh-frozen fishes (Huner and Barr, 1991). Use of fish as bait has several disadvantages. Fish must be stored, usually frozen, and then thawed and cut. Fishes are also seasonal in supply and produce foul odors. Additionally, old bait must be removed from the traps daily and discarded.

Several factors bias trap catches, such as trap type and mesh size (Stuecheli, 1991; Qvenild and Skurdal, 1989), bottom substrate (Flint and Goldman, 1977), temperature, lunar cycles (Somers and Stechey, 1986) and the presence of various predator fishes and other crayfish species (Somers and Green, 1993), bait type (Somers and Stechey, 1986; Kutka *et al*., 1992) and stage, i.e. fresh, frozen. In addition, different bait types have been shown to select for size, sex and crayfish species (Somers and Stechey, 1986; Kutka *et al*., 1992).

Fishing crayfish was done in Turkey with a fyke-net, which is a cylindrical trap with two funnel entrances, i.e., double funnels at each end, until the beginning of the 1980s. When the crayfish enter the hoop net and pass a funnel, they cannot go back. It is necessary to use bait to catch crayfish with this trap type, if bait is not put in these traps, crayfish do not enter into them. Later, one-entrance traps were used in increasing numbers (Furst, 1988). This type of traps are generally called as fyke-nets. Fyke-nets are widely used for catching crayfish in inland water resources across the world. Fyke-nets have been used by fishermen with different baits such as bread, potato, apple, prussian carp *Carassius auratus gibelio* (Bloch, 1782), sugar beet, water melon, tomato etc. (Balık *et al*., 2003) The yield of crayfish in Eğirdir Lake had represented approximately 30% of total annual harvest in Turkey. Crayfish catching was allowed again in 1999 due to an observed improvement in population structure. Therefore, the crayfish population should be observed and managed responsibly, to characterize a sustainable fishery of the species and to determine the maximum sustainable yield. CPUE data is a suitable method for observing of crayfish population. Although strictly forbidden to use bait in traps, the traps will become attractive to use of bait or appropriate bait in order to obtain maximum harvest from catchable yield.

The objective of this study was to determine trap efficiency especially for fyke-nets by using with and without bait throughout the legal season for seven months.

Materials and Methods

The test fishing was conducted between June and December 2003 in Eğirdir Lake. A total of 400 fyke-nets was set randomly along the shoreline at intervals of approximately 3 m, and at 4 to 7 m depths, for each sampling session. The nets were set in the late afternoon in each study area, and were visited the next day, because *A. leptodactylus* is active at night and often hides in a shelter in the day (Bolat, 2001) or after 7 days, depending on weather conditions. Crayfish were sampled monthly using fyke-nets of 34 mm mesh size. The nets baited with prussian carp, *Carassius auratus gibelio* (Bloch, 1782) and without bait. The fish were, as a common procedure, frozen and thawed before being used as bait. The fyke-nets were commercial and traditional traps for this region. After collecting all nets, the nets were returned to the same place. The nets have never been used on other lakes, because of risk of crayfish plague transmission.

Water quality was monitored at least once a month, with the exception of temperature (°C), dissolved oxygen (mg/L), and pH, which were measured two times a day with a model 55 YSI oxygen meter (Yellow Springs Instruments Company, Ohio). Calcium content (Ca^{+2} mg/L), and hardness ($CaCO_3$ mg/L) were checked monthly for this lake. Calcium content was analyzed by EDTA titration method.

The crayfish was weighed (WWT) to the nearest 0.01g. After each collection, total length (TL mm) of crayfish (from tip of rostrum to tip of telson) was measured to nearest millimeter. Measurements were made with Vernier callipers.

Catch per unit effort (CPUE) by dividing the number of crayfish to trap number and catch efficiency by dividing number of traps to be occupied by crayfish to total trap number was calculated as follows for each harvest:

$$CPUE = \Sigma N_c / \Sigma N_{fn}$$

where ΣC_n is the sum of number of crayfish in harvest and ΣNf_n is the sum of fyke-net set during the study.

The difference between the rates of catchability was tested with chi-square and student-t test was used to compare with bait and non-bait groups at the $P<0.05$ level (Ott, 1993).

Results

A total of 3348 crayfish were trapped, 1120 (33.4%) crayfish were trapped with baited trap and 2228 (66.6%) were trapped with non-baited traps. The mean catch per unit effort (CPUE) was found to be vary between sampling periods and treatments (Table 1). CPUE ranged from 0.30 to 0.60 for baited trap while CPUE ranged from 0.42 to 1.05 for non-baited trap between June and December. Differences in mean CPUE among two treatments were highly significant ($P<0.05$) (Table 1). In the both treatments, the mean CPUE increased gradually during sampling periods (Figure 1). The overall average CPUE in non-baited traps were 2 times (0.40 for baited traps and 0.80 for non-baited traps) greater than baited traps (Table 1).

A total of 5600 traps were set and hauled

Table 1. The crayfish ratio in catch per unit by using baited and non-baited traps

Months	Catch Composition					
	Baited Traps			Non-baited Traps		
	N	Catch Crayfish	CPUE	N	Catch Crayfish	CPUE
June	400	118	0.30	400	167	0.42
July	400	126	0.32	400	271	0.68
August	400	121	0.30	400	256	0.64
September	400	139	0.35	400	342	0.86
October	400	157	0.39	400	369	0.92
November	400	218	0.55	400	402	1.01
December	400	241	0.60	400	421	1.05
Total	2800	1120	0.40*	2800	2228	0.80*

* Differences in mean CPUE among two treatments were significant ($P<0.05$)

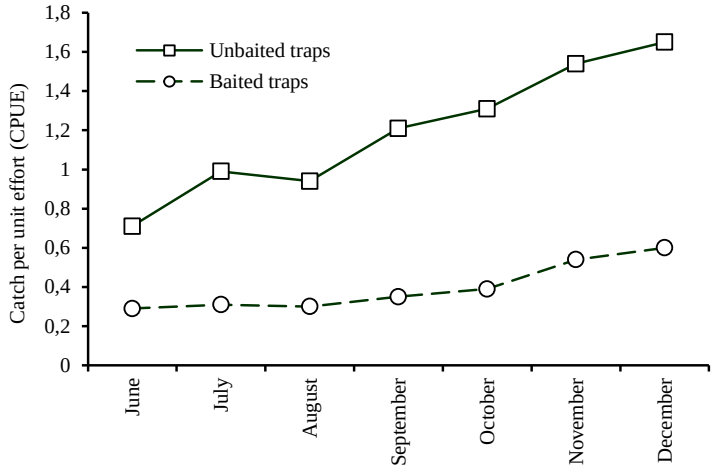

Figure 1. Comparison of catch per unit effort (CPUE) between baited and non-baited traps.

throughout this study. Based on the data from the seven months, crayfish were the occupants in 33.7% of the baited traps while non-baited traps contained 69.5% crayfish. The difference between the rates of catchability was found significant (x^2=157.05, d.f. 12). There was a clear increased number of traps caught crayfish in both non-baited and baited traps from June to December (Table 2). The size of crayfish varied from 53 to 146 mm TL, and most of them were around 118 mm TL. The larger and older crayfish were obtained from non-baited traps while baited traps had smaller size crayfish. For example, the crayfish occupying non-baited traps have 110±0.6 mm TL while baited traps have 98±0.3 mm TL. No statistical difference was observed in mean TL of males (106±0.5 TL mm) and females (102±0.3 TL mm) crayfish occupied in both traps.

Water quality parameters in this lake was within acceptable limits for growth and development of *A. leptodactylus* (Köksal, 1988). The water temperature ranged from 8°C to 22°C (mean 18°C) during the sampling period. Dissolved oxygen was 8.7 mg/L, pH was 7.0-7.6, and calcium concentration of water was 52 mg/L. The fishermen who had fishing license and renewed their license regularly indicated that the catching effort increased rapidly 7 times between 1999 and 2003 (Table 3). 483 fishing boats and 1024 fishermen had license and total trapping effort daily was approximately 1,200,000 traps in 2001.

Discussions

The density of macrophyte has affected trapability, catchability and catch efficiency of crayfish (Abrahamsson, 1983). Mean depth has fallen from 0.5 to 1.2 m in summer in Eğirdir lake. When water level decreased, aquatic macrophyte (as a biomass) has increased significantly (Kesici, 1997). Because the temperature decrease to freezing, decomposition of plant matter begins. During the decomposition, the plant materials serve as a substrate for bacteria and attached algae that are consumed by organism that, in turn, are food for crayfish. In addition, crayfish is an important catalyst in turnover of organic matter and may reduce the effects of eutrophication (Hessen and Skurdal, 1989; Hessen *et al*., 1993). Trap catch is affected by numerous factors including water temperature, water quality, forage and feeding regime, population density and size structure, weather patterns and moon phase, trap design, trap density, number of trapping days, trapping strategy, and bait type and bait quantity (Romaire, 1995). The physiological stress associated with depressed levels of dissolved oxygen, over a period of several days decreases feeding activity and subsequent catch (Araujo and Romaire, 1989). For this reason, non-baited traps had the occupant of (69.5%) crayfish while baited traps contained (33.7%) in fishing during 7 months. The mean CPUE's in baited traps was half of non-baited traps and statistically important. Because November is the month of mating for crayfish in this lake, CPUE's has increased gradually in both baited and non-baited traps. It is understand from the present study that the use of bait in the fyke-nets was not more economical than empty ones, at the same time it can affect the water quality of the lake

Table 2. Effectiveness of baited and non-baited traps on catchability of crayfish

	Baited Traps			Non-baited Traps		
Months	N	n	n%	N	n	n%
June	400	92	23	400	144	36
July	400	95	23.7	400	230	57.5
August	400	101	25.2	400	221	55.2
September	400	122	30.5	400	300	75
October	400	138	34.5	400	336	84
November	400	194	48.5	400	345	86.2
December	400	203	50.7	400	371	92.7
Total	2800	945	33.7	2800	1947	69.5

N: number of traps set each sampling date.
n: number of traps to be occupied by crayfish

Table 3. The progress in fishing potential after crayfish catching was released in 1999

Years	Fishermen	Fishing Boats	Total Traps	Yield (Ton)
1999	115	105	260.000	128
2000	290	274	725.000	358
2001	1024	483	1.200.000	786
2002	1024	483	1.600.000	274
2003	1024	483	1.800.000	581

negatively. According to Balık *et al*. (2002), 45.6 t bread, 38.6 t potato, 48.2 t apple and 145 t prussian carp were used as bait in 2001. Most of these baits had been decomposed in water, and the water quality had been negatively affected by them. The water quality of this lake is more important than fishery for the people who live in that region. But, there is a common view among the fishermen and other authors (Romaire, 1995; Balık *et al*., 2003) that the crayfish are not caught with fyke-nets without bait. This study results contrary of previous study results.

The traps were set randomly along the shoreline at intervals of approximately 3 m, and at 7 to 10 m depths, for each sampling session. Fish and crayfish receive a strong chemical food signal. Avoidance behaviour has been demonstrated by crayfish in the presence of a predatory fish (Stein, 1977; Appelberg and Odelstrom, 1988). Visual (Bruski and Dunham, 1987) as well as chemical (Hazlett, 1985) stimuli are involved. Blake and Hart (1993) indicated that the scent of the predator elicited avoidance behaviour in signal crayfish, *Pacifastacus leniusculus*. Crayfish respond to fish carrion odour, reflecting the importance of olfaction in crayfish foraging strategy (Willmann *et al*., 1994). It is indicated that crayfish were eager to feed on the flesh of a predatory fish only if frozen or after a few decay, probably because the freshly killed fish presented alarm stimuli. In this study, we found fish and crayfish co-occurring in baited traps. It could be explain to catch differences between baited and non-baited traps. At that time crayfish used non-baited traps as a shelter by increased refuge to avoid to fish. As a result, traps without baits catch more crayfish.

Another explanation for the great differences in catch may be mesh size selection for harvested crayfish is the most important factor that effect fishing. In Eğirdir Lake, 34 mm mesh size nets were used dominantly. The smaller mesh traps retain a smaller crayfish, thus reducing the average fishing size. The larger and older crayfish were obtained from non-baited traps while baited traps had smaller size crayfish. But, our results indicate that no statistical difference was observed in mean TL of males (106±0.5 TL mm) and females (102±0.3 TL mm) crayfish, which they occupied in both traps. This situation may be due to population or fishing season. Abrahamsson (1983) indicated that males and females had different trapability and also varies to season. In addition, the size of crayfish catch is correlated with the time traps remain in the water. The shorter the trap set, the higher the number of small crayfish caught. Intense trapping efforts usually increase overall yields, but can decrease the average size by temporarily decreasing the density of larger crayfish and removing crayfish before they have sufficient time to grow to larger sizes (Pfister and Romaire, 1983). In our study, we observed that bait has been consumed or the attractants in the bait have been leached, crayfish begin to leave traps and escaping is easier for long time period.

Some other factors have been affecting crayfish fishing due to water conditions, cannibalism, predation, food availability and food quality, population density, genetic influences, or diseases (Kutka *et al*., 1992; Rach and Bills, 1987). Generally, harvest is conducted by using traps, but seining has also been used in some region. Each trap is baited with one piece or different bait types (Kutka *et al*., 1992). The highest yield of crayfish has been obtained in October and November in Lake Eğirdir (Bolat and Aksoylar, 1997). Crayfish are relatively inactive in summer time (June and August) because of molting (Figure 1). *A. leptodactylus* is active and feeds during the night (Mackevicience *et al*., 1999). While the crayfish are fed during the night, predator fish are fed in the day time in this lake. But, shoreline of Eğirdir Lake has macrophytes, which are provided an ever better protecting against predators than without plant cover. In addition, water visibility in summer was very poor in this lake, which was another protecting against predators.

Crayfish in Turkey have a highly market price and fishermen obtained with a considerable additional source of income. Although maximum harvest and effort restrictions have not been implemented, overfishing has been continued. Moreover, crayfish population has nearly been collapsed and researchers as well as societies have concerned about the future of crayfish in this lake. It has been thought that ecological and economical activities will become more and more devastating in Lake Eğirdir.

To conclude, it is not favourable to use bait in traps for crayfish catching scientifically, but it can be favourable to select the most effective bait to get more harvest in the next. The number of crayfish declines significantly if the trap is not emptied in 24 h, due to escapes. That is why the size of crayfish caught is correlated with the time during which traps remained in water. The shorter the trap set, the higher the number of small crayfish caught.

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