SEASONAL DISPERSAL AND HABITAT SELECTION OF CUNNER, *TAUTOGOLABRUS ADSPERSUS*, AND YOUNG TAUTOG, *TAUTOGA ONITIS*, IN FIRE ISLAND INLET, LONG ISLAND, NEW YORK[1]

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ABSTRACT

Results of field observations examining seasonal movements in the cunner, *Tautogolabrus adspersus*, and young tautog, *Tautoga onitis*, showed a small portion of a resident population located off Fire Island, N.Y., to disperse seasonally. Dispersal was from habitats which provide cover for both species throughout the year to seasonal habitats occupied primarily during summer. While both species exhibit a high degree of association with cover, results of experimental transfers of young tautog, monitored either ultrasonically or directly by divers with self contained underwater breathing apparatus, showed that fish will leave a suboptimal habitat even though cover is present. Dispersal and habitat selection are discussed in relation to seasonal changes in the environment and ecological requirements of the fish.

Association with and dependence on cover by marine fishes have been observed for a wide variety of species, exemplified by those which reside on coral reefs (e.g., see: Hobson 1968, 1972, 1973; Sale 1969a, 1971, 1972, 1977; Smith and Tyler 1972, 1973). Although the number of species is much less, similar associations with cover also occur in temperate waters (e.g., see: Hobson 1971; Bray and Ebeling 1975; Hobson and Chess 1976; Olla et al. 1974, 1975).

In both tropical (Hobson 1968, 1972) and temperate regions a major behavioral trait of the family Labridae is that members show a strong association with cover. Field studies on two temperate-water labrids of the northwest Atlantic, cunner, *Tautogolabrus adspersus* (Olla et al. 1975), and young tautog, *Tautoga onitis* (Olla et al. 1974), have demonstrated their close association with cover. Under laboratory conditions similar associations have been observed for both species (cunner, Olla and Bejda unpubl. obs.; young tautog, Olla and Studholme 1975).

Over several years, incidental sightings of cunner and young tautog always found them in association with cover. However, it was apparent that a substantial number of fish were in areas in which cover was present only seasonally, e.g., macroalgae and mussel beds. This suggested to us that there must be movement to these areas sometime after emergence from winter torpor (Olla et al. 1974, 1975) in March or April and movement away from these areas in the fall as the cover provided at these areas diminished. The possibility of seasonal dispersal and habitat selection appeared likely. At least for adult tautog changes in habitat requirements with season have been established, as evidenced by the fact the fish migrate offshore to overwinter (Cooper 1966; Olla et al. 1974).

In this study we have examined seasonal movements in cunner and young tautog, basing our observations on trapping and tagging, as well as surveying shelter sites seasonally by direct observation with scuba or mask and snorkel. We also performed a series of transfer experiments to examine certain aspects of habitat selection.

MATERIALS AND METHODS

Based on previous scuba observations, six study sites (A, B, C, D, E, and F; Figure 1) within Fire Island Inlet, Long Island, N.Y., were selected at which to monitor the seasonal movements of cunner and young tautog. One site (A) was inhabited throughout the year and will be referred to as a perennial site. The five other sites (B, C, D, E, and F) were utilized only during late April through

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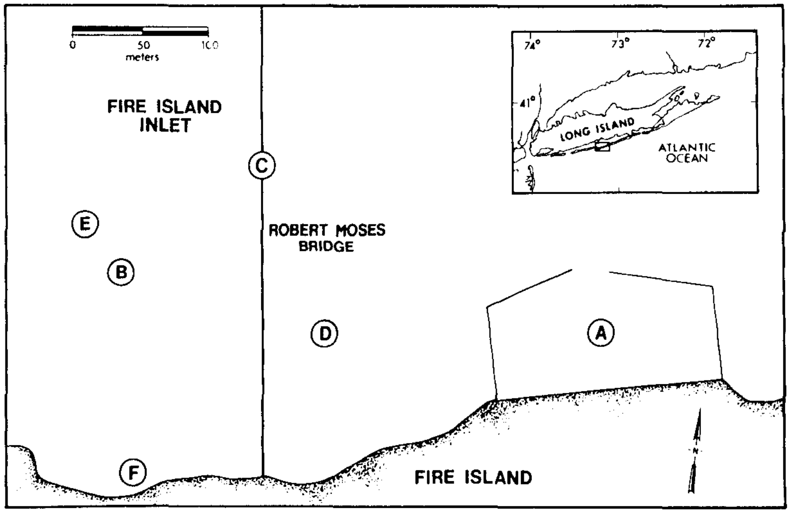

FIGURE 1.—Location of study sites for cunner and young tautog within Fire Island Inlet, Long Island, N.Y. (see text for site descriptions).

October and will be referred to as seasonal sites. A description of each site follows.

Site A was the boat basin at the Fire Island Coast Guard Station, an open pentagon (110 × 52 × 47 m), constructed of tongue-and-groove planks, steel sheeting, and piles (Olla et al. 1975). Along the outer perimeter was a zone of riprap (0.2 – 0.4 m in diameter), 3 m wide and 2 m high. The mean water depth ranged from 2.4 to 8.8 m. Beds of the mussel, *Mytilus edulis*, were located along the walls, piles, and bottom.

Site B was a 20.3-cm diameter drain pipe originating at the Fire Island water treatment plant. Located at a mean depth of 7.5 m, a 1.5-m section of the pipe was exposed and paralleled the bottom at a distance of 1 m. Beds of mussels surrounded the pipe in about a 6-m radius.

Site C was one of the support piers for the Robert Moses Bridge, consisting of quarried stone and reinforced concrete. The mean water depth was 7.5 m. The pier was incrusted with mussels to a depth of 2 m below the high water mark.

Sites D and E each consisted of an exposed vertical mud bank about 6 m long and 1 m high. Irregularly spaced along the face of each bank were approximately 35 to 50 holes, apparently a result of erosion, varying in size from 12 to 20 cm wide and 5 to 15 cm deep. Small clumps of mussels were distributed along the top of each bank. Site D was at a mean depth of 6.0 m and Site E at 7.6 m.

Site F was a grass bed which bordered a rocky shore line for 75 m and extended out from the shore 13-20 m. During the late spring and summer, the area typically consisted of dense growths of eelgrass, *Zostera marina*, and algae (*Codium* spp., *Enteromorpha* spp., *Polysiphonia* spp., and *Ulva* spp.). Beds of mussels were interspersed between the vegetation. Water depth throughout the area varied from 0.3 to 1.5 m.

A seventh area, a small cove at the mouth of Fire Island Inlet, not designated in Figure 1, was the site of two transfer experiments involving experimental cover. This site had a barren sand bottom, primarily dredge spoil, at a mean depth of 3.7 m.

Three methods, trapping, direct visual counts, and tagging, were used to monitor, for both cunner and tautog, the periods and limits of movements as well as the types of habitats utilized. Fish traps were placed at Sites A, B, C, D, and E with two traps at Site A from March through November, one trap at Site B from May through November, and one trap each at Sites C, D, and E from June through November. Traps at each site were pulled at regular weekly intervals throughout the study and the number of cunner and tautog recorded. To compare the catch of the traps at the perennial site with the catch at the seasonal sites, we calculated the mean number of fish caught per trap per week for each habitat type. Traps captured cunner ranging in size from 3.9 to 25.0 cm ($\bar{x}$ = 14.5 cm) and tautog from 7.3 to 35.0 cm ($\bar{x}$ = 16.9 cm). Traps also provided the fish for the tagging portion of the study, as well as one means of recapture.

Visual counts of cunner and tautog were made at Site F from the end of February through October. A series of six transects the length of the site and 3 m wide were swum by divers, counting all tautog and cunner observed within each transect with the sum of the six transects being the total count.

Cunner and tautog (≥14.0 cm) trapped at Sites A, B, C, D, and E were tagged throughout the study with Floy-67C[3] anchor tags. Tags were consecutively numbered allowing identification of individual fish and their release site. Each tag was printed with a request for fishermen catching tagged fish to return the tag, accompanied by information as to the location and date the fish was caught. Fish were recaptured either in our traps or by recreational fishermen.

Ultrasonic tracking was employed for short-term monitoring of movement and cover association of young tautog residing at both a perennial (Site A) and seasonal (Sites B and F) habitats. Four fish (two at Site A, one at Site B, and one at Site F) were individually tracked using the same procedures previously described by Olla et al. (1974, 1975) for capturing, handling, and tracking.

A series of transfer experiments was conducted to examine habitat selection in young tautog. All fish were captured at Site A and released at either existing, seasonal habitats (Sites B and C) or at experimental habitats which we established (see below). Fish were transferred by boat in 100-l barrels of aerated seawater with the time to travel from capture to release sites ranging from 5 to 15 min. Four fish (three at Site B and one at Site C) were separately released at the seasonal habitats and tracked ultrasonically. Five transfers were made to the experimental habitats. One transfer was a single fish, released and monitored ultrasonically. The other transfers consisted of four group releases with 10 fish/group. The response of the fish in these releases was monitored directly using scuba. While lying motionless, 5 m from the release site, the observer recorded at 1-min intervals the number of fish present. Cover at the experimental habitats consisted of masonry structures constructed from standard cement blocks (20 × 20 × 40 cm) positioned in a manner which laterally exposed the central cavities (7 × 13 × 20 cm) of each block. Cement blocks had been shown to be readily acceptable as cover by young tautog in the laboratory (Olla and Bejda unpubl. obs.). The structure for the single fish release was a four-block cube (40 × 40 × 40 cm). Two structures were used in the group releases. They were identical 12-block rectangular prisms (120 × 40 × 40 cm).

[3]Reference to trade names does not imply endorsement of commercial products by the National Marine Fisheries Service, NOAA.

RESULTS

Catch and Direct Sightings at Seasonal and Perennial Habitats

It was apparent from catch data and direct underwater sightings that a majority of the habitat sites were utilized only seasonally by both cunner and young tautog. Throughout the summer, substantial numbers of fish were captured at Sites A-E (Table 1) or sighted directly at Site F (Table 2). In September, there was a gradual decline in the catch of cunner and in October a sharp decline in both cunner and tautog at Sites B-E (Table 1). At Site F, direct visual counts indicated the same general trend (Table 2). However at Site A, while there was little change in catch during September, the catch of both species increased in October (Table 1). In November, Sites B-F were observed directly with scuba and no fish were sighted. At Site

TABLE 1.—Mean monthly catch of cunner and young tautog at perennial (A) and seasonal (B-E) sites.

	Mean catch/unit effort[1]			
	Cunner		Tautog	
Month	Perennial site	Seasonal sites	Perennial site	Seasonal sites
March	11.0	ND[2]	6.5	ND
April	36.0	ND	2.7	ND
May	6.8	9.5	2.5	9.2
June	19.7	8.5	1.3	10.6
July	13.8	5.3	0.6	11.9
August	21.8	6.1	6.2	9.8
September	21.9	2.8	8.6	8.0
October	34.0	3.0	14.9	1.0
November	9.7	0	3.8	0

[1]Unit effort = one trap fished 1 wk.
[2]ND = no data.

TABLE 2.—Visual counts using scuba or mask and snorkel of cunner and young tautog at seasonal Site F.

	Total number			Total number	
Date	Cunner	Tautog	Date	Cunner	Tautog
Feb. 28	0	0	July 2[1]	53	7
Mar. 4	0	0	8[2]	165	60
12	0	0	9[2]	93	27
20	0	0	10[2]	89	16
25	0	0	15	107	29
Apr. 2	0	0	16[2]	42	13
29	17	3	29	44	24
May 20	29	11	Aug. 12	63	20
22	74	20	13	169	71
29	60	15	Sept. 3	42	7
June 5	65	14	24	34	6
11	79	19	Oct. 2	0	0
18	10	0	20	0	0
26	69	12	29	0	0

[1]Mean of two counts.
[2]Mean of three counts.

A, although large numbers of fish were sighted, the catch was declining (Table 1). The decline in catch at Site A may be related to lowered activity associated with decreasing temperature with the fish overwintering in torpor at this site (Olla et al. 1974, 1975). Although traps were not in place in Sites B-E earlier than May, no fish were sighted directly in these areas or at Site F (Table 2) prior to mid- or late April. The presence of fish at Site A throughout the year led us to term this a perennial habitat, while Sites B-F, where fish were only seen seasonally, we defined as seasonal habitats.

Recaptures

Tagged fish showed limited movements, with 91.3% of the cunner and 73.2% of the tautog recaptures occurring at the same site at which they were released (Table 3). For the remainder of the fish, i.e., those recaptured at other sites, there were seasonal differences in where they were captured. From May through August, recaptures were at seasonal as well as perennial sites (Table 3). But then from September through November, all recaptures were from sites which would be considered perennial, including ones outside the study area (Table 3).

Movements and Association with Cover of Young Tautog at Seasonal, Perennial, and Experimental Habitats

In an earlier study, we had established that young tautog remained within several meters of cover (Olla et al. 1974). Specifically, the cover referred to in that study was Site A, identified in this study as a perennial habitat. To reconfirm the observation of the previous study, two fish (no. 1, 2; Table 4) were ultrasonically tracked for 48 h at Site A. Agreeing with the earlier results, both fish remained within several meters of the site.

The question we next addressed was whether young tautog showed a similar association with cover at seasonal habitats. To answer this question, we captured and released two fish affixed with ultrasonic tags at Sites B (no. 4; Table 4) and F (no. 3; Table 4). The results of tracking showed the two fish to have a similar affinity to these sites as the fish had to the perennial one, remaining within 3 to 6 m of cover.

The area over which the fish ranged varied with the size of the site. For example, when fish no. 3 was released at Site F, which consisted of beds of algae and eelgrass measuring about 15 × 75 m, it moved freely throughout the habitat, but never more than several meters beyond its perimeter. On the other hand, fish no. 4 released at Site B where cover was highly limited (0.2 × 1.5 m) exhibited less movement, while again remaining within several meters of cover. It appeared that the close association to cover was the same at both seasonal and perennial habitats.

Thus far, all of the fish that were tracked had been released at the same site at which they were captured. Our next question was whether fish that were displaced from where they were captured

TABLE 4.—Size, capture and release sites (Figure 1), and period monitored for nine young tautog ultrasonically tracked.

Number	TL (cm)	Capture site	Release site	Tracking duration (h)
1	22.5	A	A	48
2	24.0	A	A	48
3	20.2	F	F	24
4	24.5	B	B	48
5	21.5	A	B	48
6	22.8	A	B	72
7	23.0	A	B	48
8	24.0	A	C	48
9	22.5	A	(1)	24

1Experimental cover.

TABLE 3.—Number and location of recaptures of cunner and young tautog tagged and released at perennial and seasonal sites.

					No. recaptured at other sites			
					May-August		September-November	
Species	Release site	No. released	Total no. recaptured	No. recaptured at release site	Perennial sites	Seasonal sites	Perennial sites	Seasonal sites
Cunner	A	875	176	166	5	1	4	0
	B	83	13	7	0	3	3	0
	C	15	0	0	0	0	0	0
	D	54	6	5	0	0	1	0
	E	10	0	0	0	0	0	0
	Total	1,037	195	178	5	4	8	0
Tautog	A	245	25	20	0	1	4	0
	B	283	29	18	0	5	6	0
	C	72	12	11	0	0	1	0
	D	123	3	2	0	0	1	0
	E	41	2	1	0	1	0	0
	Total	764	71	52	0	7	12	0

would accept and remain at a different site. Four fish captured at Site A, the perennial habitat, were affixed with ultrasonic tags and released at either of two seasonal sites. Three fish were released separately at Site B (no. 5-7; Table 4) and a fourth at Site C (no. 8; Table 4) and individually tracked for 48 to 72 h. The fish appeared to accept the transfer to a different habitat with all four fish remaining within several meters of the release site.

The close association with cover exhibited by fish ultrasonically monitored at both perennial and seasonal habitats indicated the possibility that the apparent dependence on cover might be such that a fish would remain at any object that afforded cover. To examine whether the presence of cover was the sole determinant of habitat acceptance, we transferred a fish from Site A to a structure constructed of cement blocks, measuring 40 × 40 × 40 cm, and located on a sand bottom 50 m from a habitat with which fish were associated (Site F). The fish (no. 9; Table 4), during the first 5 min after release, circled the structure and moved farther away with each circuit, showing little, if any, attraction. When about 10 m from the structure, it swam shoreward and reached Site F about 5 min later. The fish remained at this site during the next 24 h, showing the same degree of movement exhibited by fish no. 3 (Table 4) which had been previously captured and released at this site.

It was possible that the fish moved from the structure because of its proximity to a natural habitat, therefore affording it a choice. It was also possible that social factors related to the release of a single fish rather than a group may have played a role in the rejection of the structure as a habitat. To control for these factors, we next released fish in a group of 10, 4.5 km from their home range and 100 m from the nearest natural habitat at which conspecifics were present. To broaden the scope of our queries we included the possible influence of factors such as food and naturally occurring cover on habitat selection. Two cement block structures (120 × 40 × 40 cm) were placed 10 m apart. Both were identical except that while one consisted simply of bare cement blocks, the other contained clumps of mussels and algae (*Ulva* sp.), naturally occurring food and shelter material. Two groups of 10 fish each (15-23 cm) captured at Site A, were released together at each habitat while being observed with scuba. Within 5 min of being released, the fish left both structures, swimming away in various directions.

The habitats were then modified by the addition to each of a fish trap. To the habitat which contained mussels and algae the trap added was overgrown with various fouling organisms and had been in continuous use over a period of 4 to 5 mo, capturing both tautog and cunner. The fact that this trap captured fish consistently led us to conclude that it provided an attractive stimulus or set of stimuli. The trap added to the bare structure was new. A group of 10 fish (10-25 cm), captured at Site A, was released at each habitat. As previously, the fish left the bare habitat within 5 min. Dispersal from the other habitat was more gradual with the last fish leaving about 60 min after release. In all instances, the fish departed, indicating that factors in addition to those provided were necessary for mediating habitat selection.

DISCUSSION

It was clear from the results of trapping, tagging, and direct underwater observation that some portion of the cunner and young tautog populations dispersed in late spring. The dispersal was from the boat basin (Site A, which we termed a perennial habitat) to habitats that were utilized only seasonally. Once adopting a seasonal habitat, the fish appeared to remain there until fall. Then there was a general movement back to a perennial habitat, but as was evident from the capture of tagged fish at perennial sites outside of the study area, not necessarily the one from which they dispersed in the spring. Once arriving at a perennial habitat, the fish remained to overwinter in torpor, not emerging until sometime in early spring when the temperature reached 5° to 6°C (Olla et al. 1974, 1975).

Supporting our findings for seasonal movement, Briggs (1977) found a marked increase in the number of young tautog captured during the fall at the Kismet artificial reef, 6 km from our study area. This increase, we surmise, also reflects the movement of fish from seasonal habitats to one which appears to be perennial.

In attempting to define habitat requirements for both species, it is apparent that cover is a critical factor. During the day when these fish are active, they remain within several meters of cover, and at night when quiescent and unresponsive, they are either in, against, or under cover (Olla et al. 1974, 1975). Once becoming torpid in winter, they remain under cover until spring. It seems reasonable to assume that dependence on cover is related to protection from predation. Large adult tautog, not as vulnerable to predation because of their size, move away sometimes considerable distances from cover each day to feed (Olla et al. 1974).

With such a strong tendency to remain in proximity to cover, the question arises as to what causes a portion of the population to disperse. It is clear that environmental factors are changing with season as are the requirements of the fish. Both species in the spring have emerged from 3 to 4 mo of torpor, which has required them to live on stored energy reserves. The need for food arising from winter deprivation, coupled with the increased metabolic requirements resulting from the increase of temperature in late spring, might stimulate feeding and the competition for food. At least until June, the major dietary component for both species is *Mytilus edulis* (Olla et al. 1975), and thus competition for food would be both intra- and interspecific.

The spawning season for cunner also peaks during June (Dew 1976). Thus we can expect that competition for participation in either group spawning (Wicklund 1970) or pair spawning (Pottle and Green[4]) would increase. This increase would relate either to participation in gamete release or male territoriality as related to pair spawning. Although the majority of tautog studied were immature and would generally not be involved in the reproductive competition, it is possible that the arrival from offshore of adults that are in spawning condition (Olla et al. 1974) and which we know to be highly aggressive (Olla and Samet 1977; Olla et al. 1977) may also play a role in the dispersal of the smaller fish.

Competition in both species is manifested through aggression (for tautog, Olla and Studholme 1975; Olla et al. 1977, 1978; for cunner, Olla and Bejda unpubl. field and laboratory obs.). The increase in aggression that may occur at the perennial habitat as a result of competition could cause this site to become suboptimal, at least for some portion of the population. Seasonal changes in levels of aggression within a population might result in corresponding seasonal changes in the carrying capacity of the habitat.

Support for the idea that fish will leave a suboptimal habitat is reflected in the results of the transfer experiments where young tautog left the cement block structures provided for them. Similar results were obtained with juvenile cunner (Olla unpubl. obs.). In attempting to examine the mechanism for habitat selection in the manini, *Acanthurus triostegus sandvicensis*, Sale (1969b) performed a series of laboratory experiments and concluded from these that there was a higher intensity of exploratory behavior exhibited when animals were subjected to an inadequate environment. Similarly, it could be concluded that young tautog were showing greater exploratory behavior when they left the experimental cover provided for them. A portion of the fish that disperse will be lost, with the probability of survival decreasing as the amount of time taken to find a suitable habitat increases. Nevertheless, through this mechanism, fish are able to utilize seasonally available resources.

The return to perennial habitats from seasonal ones in the fall may also be related to these becoming suboptimal for the fish, but for different reasons than those which caused dispersal in the spring. At habitats which exist only seasonally, as in the case with macroalgae and eelgrass beds, the actual cover that these beds provide begins to wane as they start to die back in the fall. Although some sites were structurally more permanent, such as Site B (the submerged pipe), the animals did not use them as perennial habitats, and the changes which were occurring to render them suboptimal were not obvious. Besides changes in the environment, of prime importance for consideration is the change in the animals' requirements for cover. What served adequately in summer is not adequate for winter.

In observing cunner and young tautog in the field during winter torpor, both species were found in deep recesses and often buried under several millimeters of sand, farther under cover than observed during nighttime quiescence in summer. This afforded them greater protection during the winter. The seasonal sites studied did not provide cover equivalent to that at perennial ones, which have numerous deep crevices and holes.

Laboratory studies on adult tautog confirm the change in cover requirements during winter torpor (Olla et al. 1977; Olla and Studholme 1978). As temperature declined, the fish began to show an affinity for those structures which would serve as cover during the winter at least 1 to 2 wk before

[4]Pottle, R. A., and J. M. Green. 1978. Field observations on the reproductive behaviour of the cunner, *Tautogolabrus adspersus* (Walbaum), in Newfoundland. Unpubl. manuscr., 27 p. Department of Biology and Marine Sciences Research Laboratory, Memorial University of Newfoundland, St. John's, Newfoundland A13 3X9.

torpor was observed at which time the fish actually burrowed under them being almost completely covered by sand. These structures differed from the ones the fish used throughout the rest of the year at night. In the field, the offshore movement of the adults begins 4 to 8 wk before they would encounter temperatures that would induce torpor (Olla et al. 1974), indicating a change in habitat requirements with season. About the same time that adult tautog are moving offshore, cunner and young tautog are moving to perennial sites.

Association with cover is no doubt a strongly motivated behavior for young tautog and cunner, but one for which there is a considerable range of adaptation. Under seasonally changing conditions or when habitats are simply suboptimal as in the transfer experiments, the animals will disperse, leaving cover at the risk of predation until alternate sites are found (as discussed earlier). On the other hand, a closer association results from transient environmental causes, such as the presence of predators resulting in young tautog fleeing to cover (Olla et al. 1974). Similarly, elevated temperature stress causes young tautog to associate more closely with cover, at least under laboratory conditions (Olla and Studholme 1975).

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