Fisheries Session

Home Range of Largemouth Bass in the Tidal Upper Chesapeake Bay

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Abstract: Radio telemetry was used to determine home ranges of 38 largemouth bass *(Micropterus salmoides)* from the tidal upper Chesapeake Bay in Maryland. Bass from opposite shores (Susquehanna = west, Northeast = east) were tagged from 1991–1993 and tracked for 4–15 months (1991–1995) depending on battery life. Mean home range of Susquehanna bass (246 ha, N = 16) was larger than non-migratory Northeast bass (119 ha, N = 18) but the difference was not significant. Mean home range (2140 ha) of 4 migratory Northeast bass that made an annual spawning migration across the Bay was significantly different than the mean home ranges for the Northeast, Susquehanna, and pooled groups (178 ha). Mean home range for all groups (119–2140 ha) was much higher than home range sizes reported in the literature for freshwater lakes and impoundments (0.01–21 ha). Our results suggest that observed differences in home range sizes between freshwater and tidal systems are related to tidal influence and/or some correlate in the habitat. As opposed to freshwater systems that generally provide a relatively stable and predictable environment, largemouth bass in tidal systems are influenced by daily, lunar, and seasonal tidal fluctuations, seasonal and weather related brackish water influx, and seasonal and storm event related freshwater inflow.

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Animals usually occupy a limited area that contains resources necessary for sustaining life and reproduction. When the environment does not provide these basic needs animal condition and the animal population itself may be compromised. The area that an animal occupies has been described in different ways. Burt (1943) described home range as the area over which an animal normally travels, excluding the occasional excursion that may be exploratory in nature. Fish and Savitz (1983) defined the home range of fish as the area occupied for 5 consecutive days or more; Warden and Lorio (1975) used 2 or more consecutive days as a criterion for home areas that comprise a home range. Home ranges may be affected by habitat, season, and social interactions (Tester and Sniff 1973). Knowledge of home range and movement patterns of an animal may help to determine environmental requirements and constraints for that animal (Winter 1977), which can be used to define a framework for habitat assessment on impacts of anthropogenic activities (Minns 1995) that may affect the animal's ability to survive. This knowledge is also valuable to resource managers for developing appropriate management strategies.

The most common method used to calculate home range for largemouth bass has been a variation of the minimum convex polygon method (Winter 1977). The minimum convex polygon method (Mohr 1947, Hayne 1949) forms a convex polygon by connecting the outermost locations and then calculating the enclosed area. When calculating the home range of a fish if a side of the polygon crossed land, the shoreline was used as the boundary (Winter 1977, Michener 1979, Bowen 1982, Fish and Savitz 1983, Savitz et al. 1983, Bekoff and Mech 1984, Betsill et al. 1986, Mesing and Wicker 1986, Colle et al. 1989, Siebold 1991). A disadvantage of the minimum convex polygon method is the lack of description of the area used most frequently by the animal within the home range. To address this shortcoming the percent convex polygon method was developed as a variation of the minimum convex polygon method (Michener 1979, Bowen 1982, Bekoff and Mech 1984), calculating home range from a polygon formed from a percentage of the innermost observations (e.g. 50%, 75%, or 95%).

Most studies of home range size of largemouth bass have been done in freshwater lakes, rivers, and impoundments with estimates ranging from 0.01 to 7.83 ha (Lewis and Flickenger 1967, Peterson 1975, Lantz and Carver 1976, Winter 1977, Doerzbacher 1980, Fish and Savitz 1983, Bestill et al. 1986, Mesing and Wicker 1986, Woodward and Noble 1997). The largest reported home range in a freshwater lake was by Colle et al. (1993) who estimated a mean home range of 21 ha for largemouth bass from a Florida lake but this was from a disturbed system following removal of all submersed vegetation from the lake by grass carp *(Ctenopharyngodon idella).* A review of the published home range literature described in Seibold (1991) and Richardson (1996) does not indicate a relationship between home range and the size of the system. Variation has also been reported in the literature as to whether largemouth bass even have home ranges or roam freely (Ball 1947), or whether groups of bass within a population behave differently — some more mobile while others are more sedentary (Elser 1960, Moody 1960, Richardson-Heft et al. 2000, Hartman et al. 2001). Much less work on largemouth bass in tidal systems has been done, and we found only 1 study where home range size had been estimated. Siebold (1991) reported a median home range of 199.3 ha for 22 adult tidal Potomac river largemouth bass based on data from a radio-tracking study.

The objective of our study was to determine the home range of adult largemouth bass in the upper Chesapeake Bay, a large (12,200-ha), tidally-influenced system of freshwater rivers and open bay habitat. We describe home range as the area that an individual bass was located in the upper Chesapeake bay during the radio telemetry tracking period.

Methods

The study area was the tidal fresh and oligohaline waters of the upper Chesapeake Bay system (12,200 ha) north of Spesutie Island on the western shore and north of Turkey Point on the eastern shore upstream to all tributary tidal/non-tidal dividing lines (Fig. 1). The upper Bay area is a complex, open water tidal system with several main channels and depths ranging from <1 m to 20 m, a mean daily tidal amplitude of 0.6 m, and salinity ranging from <1.0 to 2.5 ppt (Stroup and Lynn 1963). Approximately 8,000 ha of this system, known as the "Susquehanna Flats," has a mean depth of <1 m at mean low tide.

Two areas on opposite shores of the Bay were used as capture and release sites

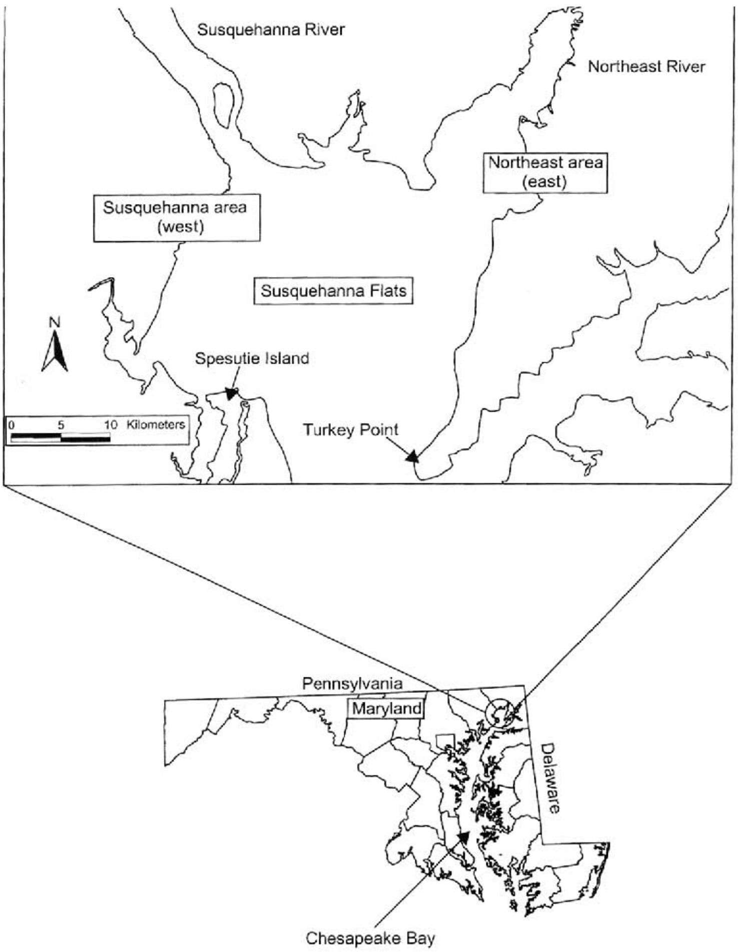

Figure 1. Map of the tidal upper Chesapeake Bay study area (12,200 ha).

for largemouth bass: the northern portion of the Northeast river (Northeast), near the tidal and non-tidal dividing line; and the western shore between the mouth of the Susquehanna river and Swan creek (Susquehanna). Habitat between the 2 areas was distinctly different. The Susquehanna area was characterized by high flow rate (615 m^3/second, 1984 U.S. Geol. Serv. water resources flow data), abundant submerged aquatic vegetation (SAV) stands comprised primarily of Eurasian watermilfoil *(Myriophyllum spicatum),* hydrilla *(Hydrilla verticillata),* and wild celery *(Vallisneria americana),* and some wooden pilings. The Northeast area had low flow (1 m^3/second, 1984 U.S. Geol. Serv., water resources flow data), little to no SAV, and abundant wooden pilings, submerged fallen timber, and boat docks (Fewlass 1992, 1995).

Home range size was calculated from radio telemetry data collected from 38 non-displaced bass. Radio transmitters were inserted into largemouth bass collected by electrofishing in the upper Chesapeake Bay between September 1991 and December 1993 (16 from the Susquehanna area, 22 from the Northeast area). Total lengths of these bass ranged from 370–555 mm; their weights ranged from 736–2494 g. Transmitter size (11–22 g) was selected to insure that transmitter weight was $< 2\%$ of the fish wet body weight. Minimum transmitter life expectancy was 4 months for fish tagged in 1991, and 6–13 months for fish tagged in 1992 and 1993. Surgical procedures used to implant radio transmitters were the same as described by Richardson et al. (1995). Tag insertion time ranged from 3–5 minutes, bass were then placed in a 378-liter aerated recovery tank in water containing 0.26 ml/liter Stress Coat for 1–3 hours. After recovery the bass were released at their capture site.

Radio tracking episodes covered an approximate area of 9,100 ha by boat. Unique transmitter frequencies in the 48–49 MHz range allowed each bass to be individually identified. During tracking episodes a boat-mounted Yagi antennae was used to locate a signal, and upon closer approach a hand-held directional loop antennae was used to pinpoint the bass location. For 1991–1993 bass were tracked 3 times a week for the first 2 months after release, twice a week for the next 2 months, and once weekly thereafter until transmitter expiration. During 1994–1995 bass were tracked 3 times a week for the first month, and once a week thereafter.

The position of a located bass was marked on a map of the study area and the geodetic coordinates (latitude/longitude) were collected using a Portable Loran-C. Geodetic coordinates were converted to Universal Transverse Mercator (UTM) system coordinates to calculate home ranges using a computer program developed by Ackerman et al. (1990).

We used the percent convex polygon method (Michener 1979, Bowen 1982, Bekoff and Mech 1984) at the 95% level to calculate home range size with software developed by Ackerman et al. (1990). We selected this method to allow exclusion of outlier locations yet still allow for comparison with previous bass home range estimates. When the polygon included land the area of land was manually deleted from the computer calculated home range, thus making the shoreline the home range boundary line (Winter 1977). The Mann-Whitney test (Sokal and Rohlf 1987) was used to analyze (alpha = 0.05) whether bass home range size was similar between the 2 sample areas (Susquehanna, Northeast).

Table 1. Home range information, mean, median, and range, (ha) from radio telemetry data for 38 upper Chesapeake Bay largemouth bass, 1991–1995.

	Home range			
Group[a]	*N*	Median	Range	Mean
Susquehanna (A)	16	158	13–389	246
Northeast, all (A)	22	118	10–2440	486
Northeast, non-migratory (A)	18	64	10–405	119
Northeast, migratory (B)	4	2329	1464–2440	2140
Pooled Susquehanna/Northeast (A)	38	121	10–2440	384

a. Null hypothesis of similar home range size not rejected for groups followed by the same letter (alpha = 0.05).

Results

The mean number of times bass were located during the study was 27 (range 10–44), and home range size calculated for the 38 largemouth bass varied from 10 to 2440 ha (mean 384 ha). Mean home range for the 16 Susquehanna bass was 246 ha (range 13–389 ha) whereas the mean home range for the 22 Northeast bass was 486 ha (range 10–2440 ha). The null hypothesis that bass from both areas had similar home range sizes was not disproved (Table 1). Because the null hypothesis was not disproved the home range size data for Susquehanna and Northeast bass were pooled and analyzed. The combined Susquehanna and Northeast mean home range was 178 ha (range 10–2440 ha) (Table 1). Fish length ($N = 38$) was not correlated with home range size ($r = –0.33$).

Four Northeast bass had home ranges from 1464 to 2440 ha (mean 2140 ha), and when tested against the home ranges for the Susquehanna group (mean 246 ha), the remainder of the Northeast group ($N = 18$, mean 119 ha), and the combined Susquehanna and Northeast groups (mean 384 ha), the null hypothesis of similar home range size was rejected (alpha = 0.05) for each comparison (Table 1). These 4 Northeast bass crossed the bay from the eastern shore to the western shore each spring in 2 consecutive years in what is suspected to be a spawning migration, returning to the Northeast river area 2–3 months later each year.

Discussion

Largemouth bass inhabiting upper Chesapeake tidal waters have larger home ranges than what has been reported for bass inhabiting freshwater lakes and impoundments. Our results were similar to the median home range size (199.3) reported by Siebold (1991) for largemouth bass in the tidal Potomac river, which in size and habitat is much different than our upper Chesapeake bay study area but is strongly tidally influenced. Movements of largemouth bass in response to varying salinity levels have been reported in tidal marshes in Alabama (Swingle and Bland 1974) and Louisiana (Meador and Kelso 1989), and migration to overwintering and spawning sites were observed for largemouth bass in the tidal Hudson River (Green et al. 1993, Nack et al. 1993). This suggests that any observed differences in home range sizes between freshwater and tidal systems may be related to the tidal influence and correlates in the habitat. As opposed to freshwater systems that generally provide a relatively stable, predictable environment, home range size of largemouth bass in tidal systems may be influenced by daily, lunar, and seasonal tidal fluctuations, seasonal and weather related brackish water influx, and seasonal and storm event related freshwater inflow.

Work in freshwater has reported that lack of food increases territory size in fish (McFadden 1969, Slaney and Northcote 1974, Hixon 1980). We suggest, however, that the large home ranges observed in the tidal upper Chesapeake bay are more a function of a multi-faceted environment influenced by tidal changes as opposed to a widespread lack of resources, particularly food. Largemouth bass growth and condition in the upper Chesapeake bay and the Potomac river was excellent (Fewlass 1996), and creel surveys indicated high angler catch rates (Heft 1996). Bass residing in tidal rivers are confronted with daily changes in water level, which not only affects their needs (e.g., shelter, cover, feeding areas) but also that of their prey. To cope with these changes we suggest that tidal bass occupy a larger, more diverse area that meets not only their seasonal needs but their daily needs due to tidal influence. This is also supported by the larger mean home range we found for Susquehanna bass as opposed to Northeast bass. Habitat in the Susquehanna is less diverse and much more scattered and dependent on SAV, while in the Northeast the habitat is relatively more concentrated and diverse with the majority being more seasonally permanent: wooden pilings, rock reefs, fallen timber (Fewlass 1992,1995). Susquehanna bass may have to travel within a larger area to find suitable habitat daily and seasonally.

The extremely large home ranges (1464–2440 ha) of 4 Northeast bass were very likely due to seasonal spring spawning migrations. During the spawning period all 4 bass traveled across the upper Bay to the same tributary on the western shore, an historical bass spawning area (L. Fewlass, unpubl. data), then returned 2–3 months later and remained in the Northeast area until the next year's spawning period when the migration was repeated. This occurred even though ample spawning habitat was available in the Northeast river and successful bass reproduction has been documented (L. Fewlass, unpubl. data). Seasonal migrations of bass in fresh and tidal waters have been reported by other researchers (Fetterolf 1952, Funk 1957, Elser 1960, Moody 1960, Miller 1975, Mesing and Wicker 1986, and Nack et al. 1993) and our results suggest that at least a portion of the upper Chesapeake bay population may exhibit this behavior.

In conclusion an animal's home range includes all the annual seasonal habitat aspects that are required by the animal based on its life history, information that is vital to any resource management strategy. Our findings illustrate the importance of this concept through the variation in bass home range sizes we found depending on location and reproductive strategy (migratory vs. non-migratory). Management efforts need to be tailored to meet the needs of "groups" of bass within a fishery with specific home range areas. Knowledge of home range size provides resource managers with an understanding of the various habitat components required by the fish, a politically and socially valuable management tool that provides support for habitat protection and mitigation efforts, and another tool for fisheries managers charged with managing finite resources in the face of increasing angler use and human development.

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