

RESTRICTED MOVEMENTS OF THE AMERICAN EEL, *ANGUILLA ROSTRATA*
(LeSueur), IN FRESHWATER STREAMS, WITH COMMENTS
ON GROWTH RATE¹

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INTRODUCTION

The European eel, *Anguilla vulgaris* Turton, has been studied extensively. Bertin (1956) summarized the pertinent literature on this species. The American eel in comparison, has received little attention. Carlander (1950) compiled existing data on the latter.

The results discussed here were derived as a side-line of more extensive studies on the home range of sunfishes (Centrarchidae) and suckers (Catostomidae); a report on the first phase of this work will appear in the near future (Gunning and Shoop, *In Press*). Home range is defined as the area over which an animal normally travels. Gerking (1959) listed 33 species of fishes which exhibit restricted movement or occupy home ranges. The American eel has not been investigated in this regard.

METHODS

Home range studies in stream environments are generally conducted by arbitrarily dividing a continuous stream section into several segments, marking the fish in each segment distinctively, and subsequently sampling the segments, as well as adjacent areas upstream and downstream, to determine how restricted fish movements are (Gerking, 1953; Gunning, 1959; Gunning and Shoop, *In Press*). In the present study, the streams were sampled with an electrical shocker; the details of the sampling procedure will be given elsewhere (Gunning and Shoop, *In Press*). The eels were marked distinctively either by removing one of the pectoral fins or attaching a monel-metal strap tag (fingerling size). Tags were attached dorsally a short distance in front of the posterior end of the vertebral column, in such manner that the hold-fasts of the tags

penetrated the musculature. This tagging method is considered to be unsatisfactory, since many tags were lost from the fish judging by the number of recaptured eels possessing scars and notches in the tagging location. Fin-clipping is the better of the two methods we used. However, with only two pectoral fins one can have only two clipping combinations per segment of stream studied. Vladikov (1957) found monel-metal strap tags to be unsatisfactory for eel tagging. He designed ring-shaped strap tags and another type designated "split ring and plate tag." The latter were attached to the lower jaw of eels; they were considered to be satisfactory.

Two study areas (Figs. 1-3) at Talisheek Creek, St. Tammany Parish, Louisiana, and one study area (Figs. 3-4) at Big Creek, Grant Parish, Louisiana, were utilized. Talisheek Creek is 10-20 feet wide at the study areas used, with a few expansions of greater width. Big Creek is 25-35 feet wide at the point of our investigation. In Talisheek Creek, eels are generally collected in pools over a mud bottom, or at obstructions in riffle areas. In Big Creek, where the largest specimens were taken, eels are generally collected under overhanging banks, which afford cover, or at obstructions such as log jams. All study areas were located in the headwaters of the streams where water depth was not prohibitive to successful collection of fishes.

RESULTS

Talisheek Creek

The movements of 15 eels in Talisheek Creek are shown in Table 1. Numerical designations are given to facilitate discussion. Multiple recaptures (eels 1, 11, and 12) resulted in a total of 19 recorded move-

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ments for the 15 eels. The first stream segment in which a given eel was first captured is taken as an assumed home area. All subsequent statements concerning extent of movement are thus based on this assumed home area. Hence, an eel marked and subsequently recaptured in the expanded pool region at the upper end of

section A, Study Area I, Talisheek Creek (Fig. 1) would be recorded in our field notes as having moved 0-50 feet. Extent of movement of the 19 recaptures may be summarized as follows (Table 1): 1) four eels moved 0-50 feet, 2) seven eels moved 51-100 feet, 3) six eels moved 101-150 feet, and 4) two eels moved 151-200 feet.

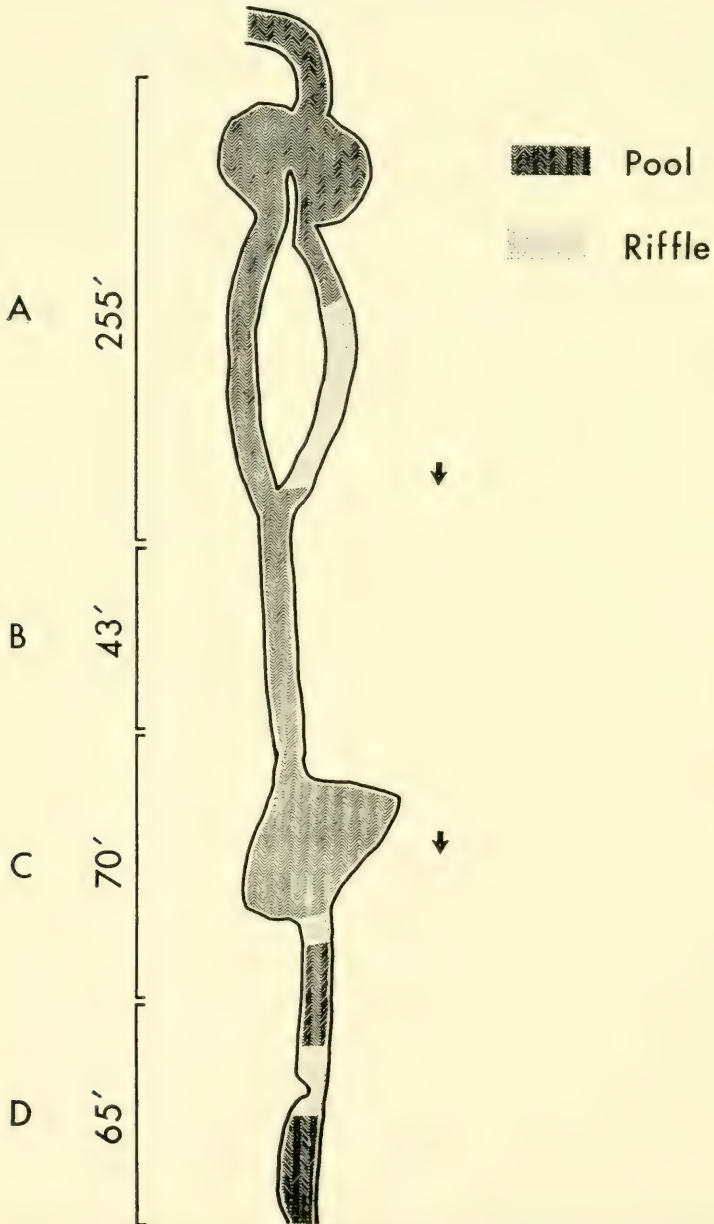


Figure 1. Diagram of Study Area I, Talisheek Creek. Section A is not drawn to scale. Direction of stream flow is indicated by arrows.

All eels were individually recognizable except numbers 9, 10, 14, and 15. All four of these were marked on July 21, 1960, by removing the left pectoral fin. Limited duplication of recaptures was thus possible with regard to these four eels.

The size range of eels 9, 10, 14, and 15 when marked was 305-360 mm, total length. For purposes of determining approximate in-

creases in length from July 21, 1960, to July 26, 1961, for eels 14 and 15, the larger length (360 mm) was used. Eel 14 thus grew at least 138 mm/year. Eel 15 grew at least 325 mm/year, which means that it almost doubled in total length during one year of growth. The writers are not aware of any growth rate data for the American eel derived from the mark-recapture method.

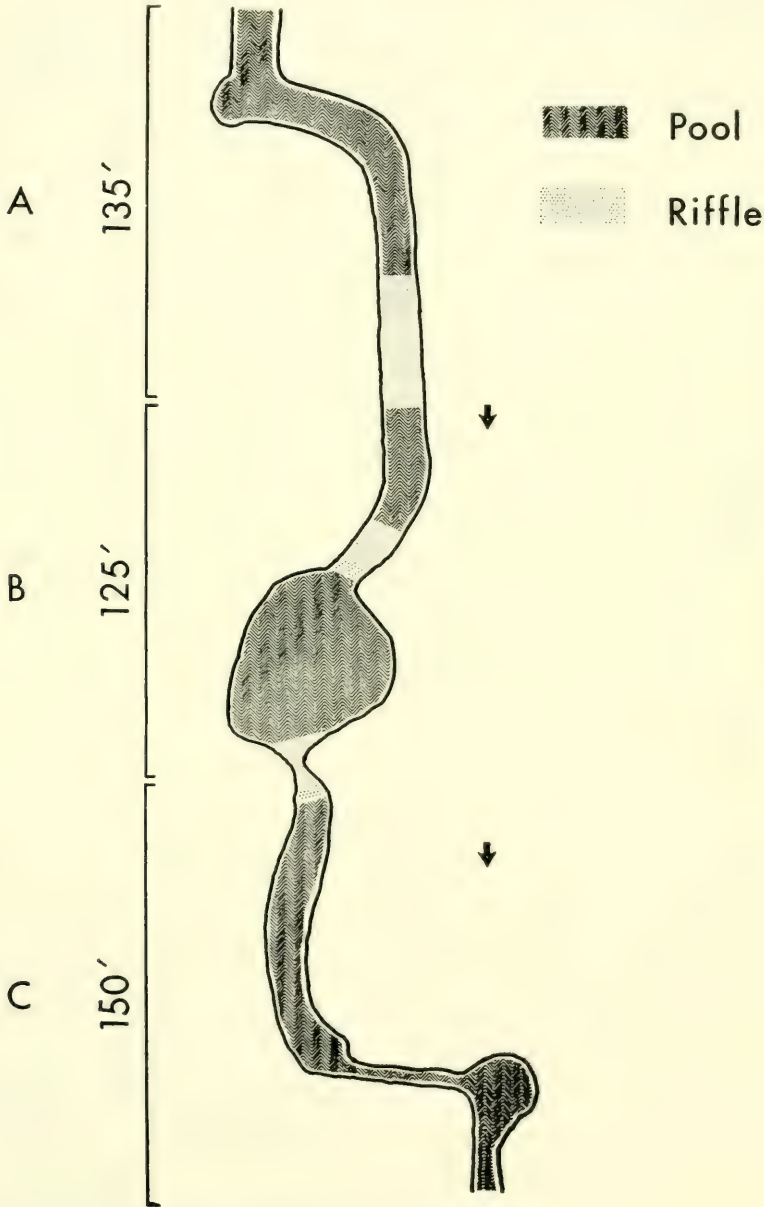


Figure 2. Diagram of Study Area II, Talisheek Creek.

For this reason we record the present observations. The growth rates for our American eels (14 and 15) are considerably higher than growth rates reported for American eels studied in Canada (Smith and Saunders, 1955). The latter authors determined the number of annuli on the scales of a large sample of eels; data on eels believed to be in their fourth to twelfth year of freshwater life were included. Maximum growth derived from scale analysis appears to be 77 mm/year, compared with at least 138 mm/year and 325 mm/year for our two specimens. Although our growth data are extremely limited, the mark-recapture method is far superior to scale analysis in the determination of growth rate. Bertin (1956) states that eel scales should not be used as a measure of the passage of time, and presents data to support his contention. Otoliths

are considered to be more reliable as age indicators. One would expect slower growth in Canada than in Louisiana due to latitudinal differences. To reconcile a discrepancy of this degree however, otolith readings or mark recapture data for Canadian specimens are needed. Smith and Saunders (1955) realized the limitations of the scale method of age and growth analysis.

Bertin (1956) reported that the growth of the European eel is extremely irregular. He reached this conclusion after reviewing data on several thousand eels. Bertin (1956: 42-43) emphasized that the dimensions and weight of one individual may be five times as great as those of another individual of the same age. He reported that an eel of 45 cm could belong to any one of age groups VI-X.



Figure 3. Geographic location of the study areas on Talisheek Creek and Big Creek.

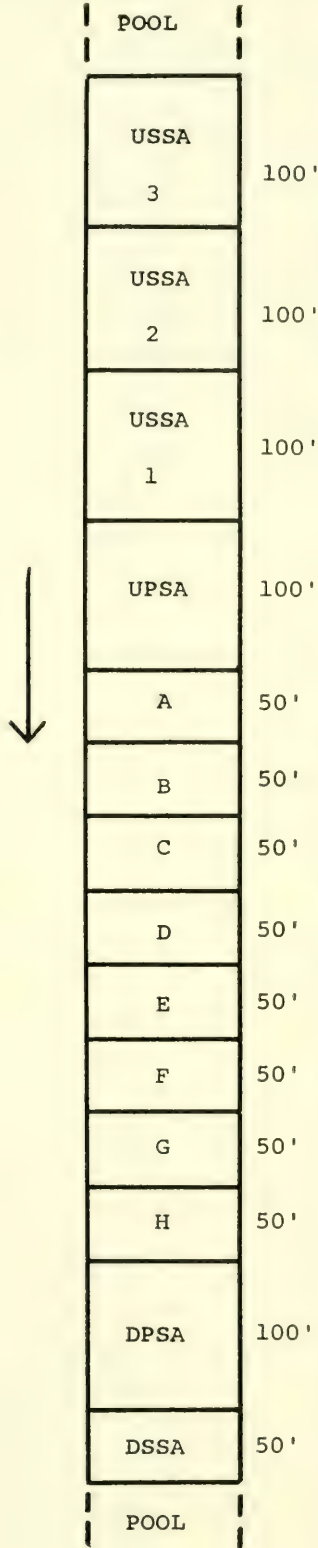


Figure 4. Schematic representation of the study area on Big Creek. The stream segment is actually S-shaped. USSA, Upstream Secondary Stray Area; UPSA, Upstream Primary Stray Area; DPSA, Downstream Primary Stray Area; DSSA, Downstream Secondary Stray Area.

TABLE 1.
Movements of American eels in Talisheek Creek, Louisiana

Eel Number	Date Marked*	Date Recaptured	Total Length in mm.	Distance Travelled (In Feet)
1	9/7/60	-----	390	-----
		9/30/60	-----	0-50
		10/28/60	-----	0-50
		11/18/60	-----	0-50
2	11/18/60	-----	310	-----
		12/9/60	310	0-50
3	9/7/60	-----	255	-----
		9/30/60	-----	51-100
4	9/7/60	-----	355	-----
		9/30/60	-----	51-100
5	10/28/60	-----	280	-----
		12/9/60	285	151-200
6	9/7/60	-----	560	-----
		10/28/60	-----	51-100
7	9/7/60	-----	305	-----
		10/28/60	-----	51-100
8	9/30/60	-----	390	-----
		10/28/60	-----	101-150
9	7/21/60	-----	305	-----
		7/28/60	-----	51-100
10	7/21/60	-----	360	-----
		7/28/60	-----	51-100
11	8/9/60	-----	-----	-----
		9/7/60	321	101-150
		11/4/60	-----	101-150
12	10/7/60	-----	567	-----
		11/4/60	-----	51-100
		12/2/60	-----	101-150
13	8/10/60	-----	360	-----
		10/7/60	-----	151-200
14	7/21/60	-----	360	-----
		7/26/61	498	101-150
15	7/21/60	-----	360	-----
		7/26/61	685	101-150

* All eels were identified by metal tags except numbers 9, 10, 14, and 15; these were fin-clipped.

Big Creek

Four eels were marked in the study area at Big Creek (Figs. 3-4). No other unmarked eels were taken in the 950 foot segment of stream during the period it was studied; a single eel was captured in a basket trap in a large pool below the study area (Fig. 4), however. One of the four eels (610 mm total length) was tagged with a monel-metal strap tag on November 25, 1960; it was never taken again. A second eel (Table 2, eel 3) was tagged in

the same manner on September 1, 1960. It was subsequently recaptured in the same stream segment on November 25, 1960, but was not taken again. The remaining two eels (Table 2, eels 1-2) were fin-clipped; these were taken repeatedly.

Eel number 1 was recaptured six times between July 7, 1960, and May 6, 1961. During this 10-month period, the eel probably remained within a home range consisting of 450 linear feet of stream (Table 2; Fig. 4).

TABLE 2.
Recapture data for three American eels marked in Big Creek, Louisiana

Eel Number	Date Marked*	Stream Segment Marked In	Date Recaptured	Stream Segment Recaptured In	Total Length in mm.
1	7/7/60	Section A	-----	-----	-----
			7/8/60	USSA #2	-----
			10/21/60	USSA #3	660
			11/25/60	USSA #3	-----
			3/25/61	UPSA	678
			4/22/61	USSA #1	685
2	4/14/60	Section D	5/6/61	UPSA	-----
			-----	-----	760
			6/7/60	D	-----
			6/8/60	A	-----
			7/7/60	F	-----
			8/2/60	D	-----
3	9/1/60	USSA #3	5/30/61	C	-----
			-----	-----	915
			11/25/60	USSA #3	-----

* Eel number 3 was marked using a monel-metal strap tag; the other two were fin-clipped.

Eel number 2 was recaptured five times between April 14, 1960, and May 30, 1961. During this 13-month period the eel presumably remained within a home range consisting of 300 linear feet of stream (Table 2; Fig. 4).

Eel number 1 grew 25 mm between October 21, 1960, and April 22, 1961. Since a full year's growth was not recorded, no comparison is made with other data.

DISCUSSION

On the basis of the recapture data presented here, we conclude that eels occupying the headwater regions of streams exhibit restricted movements. The eel recaptures from Talisheek Creek indicate, mostly on the basis of short-term observations (one week to three months, except numbers 14-15; Table 1), that the home range of the eel is probably 200 linear feet of stream or less. The Big Creek recaptures, covering longer time periods of 10-13 months, indicate that these eels were restricted to home ranges of 300-450 linear feet of stream. The home range of smaller fishes, sunfishes for example, generally ranges from 100-200 feet (Gerking, 1953; Gunning, 1959; Gunning and Shoop, *In Press*). Sufficient recapture data were not available to compare home ranges of young versus older eels.

One factor detracts from the home range hypothesis. Twenty-seven eels tagged in Study Areas I and II, Talisheek Creek, were not recaptured. Tag loss is known to be

significant, hence this factor should be considered. Although our field notes are not complete in this regard, nine instances were recorded wherein eels lost tags. Scars and notches were clearly visible at the tagging location. Nevertheless, critics of the home range hypothesis would point out that a considerable percentage of the 27 eels that were marked but not subsequently recaptured may have left the study areas.

Fortunately, a limited check on the relative amounts of straying from study areas on Talisheek Creek was feasible. The two study areas utilized were 0.4 mile apart. We have collected marked longear sunfish (*Lepomis megalotis*), bluegill (*Lepomis macrochirus*), and spotted bass (*Micropterus punctulatus*) that have traversed the distance between the two study areas in whole or in part. We have not, however, taken eels that have strayed from the study areas, although equal opportunity was afforded to do so.

Vladykov (1957) recorded eel movements of 200 miles extent in the St. Lawrence River and other waters of Quebec. The maximum time recorded between tagging of an eel and its recovery was five years and eleven months. Movements of 200 miles are not spectacular, considering that eels are presumed to travel from a spawning area in the Sargasso Sea to inland streams of North America. Smith and Saunders (1955) described runs of the American eel from various lakes in New

Brunswick, Canada, which represented the beginning of their return trip to the ocean. The movements of eels must be considered with respect to the specific environment they occupy and the phase of their life history being completed.

Eels entering the mouth of the Pearl River, of which Talisheek Creek is a tributary (Fig. 3), could travel a minimum of 30 miles to reach the study areas on Talisheek Creek. The present configuration of Talisheek Creek differs somewhat from that shown in Figure 3 due to the construction of a canal. Those eels entering the mouth of the Mississippi River would normally travel 250-350 miles if their destination should happen to be the study area on Big Creek. One must keep in mind the fact that many alternate routes would be possible, since eels can travel overland to a limited degree if the ground is moist (Eddy and Surber, 1947; Bertin, 1956).

Eels are catadromous; thus the primary recruitment of freshwater eel populations is by elvers from the ocean. One might anticipate that the distance of a habitat from salt water would affect the number of young eels that reach it (Smith and Saunders, 1955). The effect of distance alone is often obscured, however, since it is modified by man-made obstructions, mortality during extended journeys, and so forth. Smith and Saunders (1955) showed that the smaller standing crops of eels per unit area in New Brunswick lakes were associated with greater distances from the sea and with obstructions to eel movements.

The composition of the eel population of Talisheek Creek differed greatly from that of Big Creek, which is much farther from the Gulf of Mexico (Fig. 3). The smallest eel taken in Big Creek measured 610 mm total length. On the other hand, 13 of the 15 eels taken in Talisheek Creek measured less than 400 mm total length when first captured (Table 1). The general impression gained from studying both streams was that Talisheek Creek has a dense eel population. One of us (G.E.G.) has sampled some 30 streams in midwestern United States, mostly in Illinois, without seeing an eel population as dense as the one in Talisheek Creek. Further studies are needed in order to determine if other streams tributary to

the Gulf of Mexico have such dense eel populations.

It has been assumed for some time that only female eels travel very far inland. The males, which are smaller in size, are believed to remain near the various river mouths in brackish water.

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ABSTRACT

Movement of the American eel was studied in two headwater streams in Louisiana. Eels were marked using metal tags or by fin-clipping. Short-term experiments in Talisheek Creek yielded home range estimates of 200 linear feet of stream. Long-term observations, though limited, indicated home ranges up to 450 linear feet of stream for larger specimens. Limited growth data based on observation of marked eels showed that growth is quite irregular, a fact well-established for the European eel.