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Abstract

(April 1995) - Nocturnal Reproductive Behavior in Semotilus atromaculatus (Pisces, Cyprinidae). By E.G. Maurakis, et al., 3 pp.

Techniques of Videotaping Fishes From Above the Surface of the Water. By E.G. Maurakis and W.S. Woolcott, 3 pp.

The Effect of Preservation on Urogenital Papilla Length in the Least Brook Lamprey Lampetra aepyptera. By P.A. Cochran and M.E. Sneen, 3 pp.

Museum Notes by H.L. Bart and M.S. Taylor; Regional Reports.

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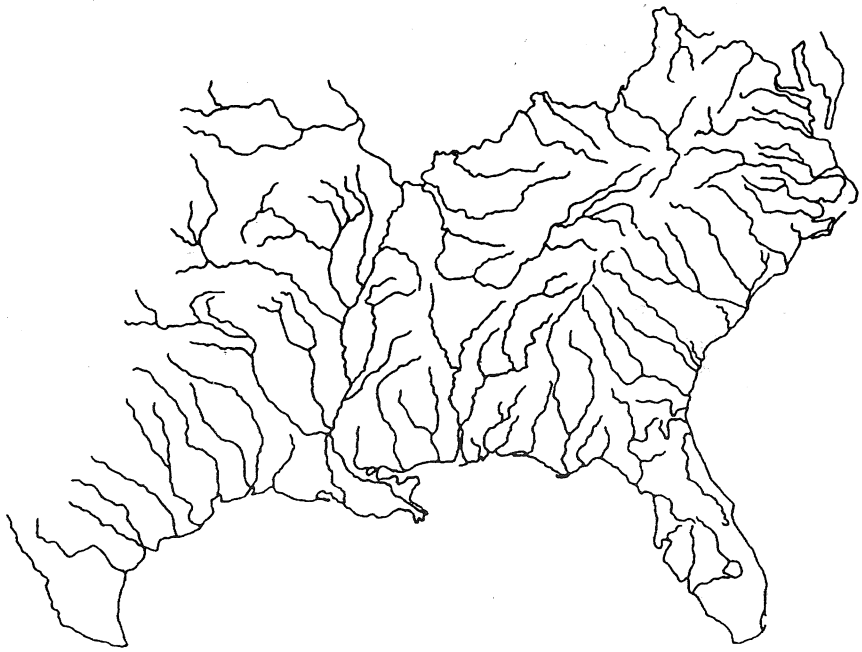

Contents

Technical Reports

Notes

ATTENTION

SFC Business Meeting

Thursday, 20 April 1965
5:00 - 6:00 P.M.
LeConte
Holiday Inn - World's Fair Convention Center
Knoxville, Tennessee

NOCTURNAL REPRODUCTIVE BEHAVIOR IN *SEMOTILUS ATROMACULATUS* (PISCES, CYPRINIDAE)

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ABSTRACT

Nocturnal reproductive behavior in *Semotilus atromaculatus* observed and recorded on videotapes is described and compared to that recorded in daylight. The percent of time spent for each of four reproductive activities (breeding male in pit position, nest-building, agonistic displays/combat, and spawning) was comparable to its corresponding diurnal activity. Activities of fishes at night over a nest continued as light intensities were increased gradually with rheostats. As the primary male *S. atromaculatus* was in high color, and color cannot be detected by fishes at low nighttime lumen levels, senses (e.g. olfactory, lateral line, and tactile), other than vision, are instrumental in communication among nocturnal breeding males and females and diurnal breeding ones as well.

INTRODUCTION

Washburn (1945), the only reference found to nocturnal spawning in *Semotilus atromaculatus* (creek chub), stated daylight reproductive activities in the species continued into the night, ceasing when water temperature dropped below 51 F (10.6 C). Recently (1991 and 1993) we observed and videotaped *S. atromaculatus* spawning at night. In this paper nocturnal reproductive activities in this species are described and compared with those that occur diurnally.

MATERIALS AND METHODS

Nocturnal reproductive behavior in *S. atromaculatus* was studied in East Branch Genito Creek (James River drainage), Virginia, Goochland Co., Co. Rt. 641, during 2000-2310 hours EST, 28 March 1991, and during 1945-2345 EDT, 20 April 1993 (water temperature, 15.3 C and 15.9 C, respecively; stream width, 2 m; stream depth, 0.15 m). Videotapes of diurnal reproductive behavior were made from two sites: in the same creek from 1100-1400 hours EDT, 17 April 1989 (water temperature, 17.8 C; stream width, 4 m; stream depth, 0.15 m); and in an unnamed tributary of Falling Creek (York River drainage), Hanover Co., Rt. 667 about 3.2 km N of Ashland, Virginia from 1450-1620 hours EDT, 23 May 1987 (water temperature, 15.0 C; stream width, 1 m; stream depth, 0.25 m).

Behavior was videotaped from above the surface of the water with a Sony television camera (operated at a light gain of 18 decibels at night) and recorded on 3/4 inch videotape. A hydrophone, placed in the nest to monitor sound, was attached to the video recorder.

Splashing of the water by the breeding fish revealed the location of nests. Two light systems were employed. On 28 March 1991, two 7.5 V incandescent spotlights (100,000 candle power each) provided illumination. One spotlight was focused on the streambed halfway between the nest and an undercut bank; the second illuminated the spawning pit of the nest. On 20 April 1993, two 12-V battery-powered halogen spotlights (each 1-million candle power), equipped with rheostats, were focused as described above.

Videotaped nocturnal activities and supplemental data from field notes were compared with field notes and video recordings of diurnal behavior in *S. atromaculatus*. Four reproductive activities were analyzed: breeding male in pit position (i.e., posturing in spawning pit before and after stone excavation and deposition, and spawning attempts), nest-building, agonistic displays/combat, and spawning. The duration of each behavior was timed with a stop watch, and recorded as percent of time of all behaviors during total observation periods. The number of successful spawns and unsuccessful spawns (clasp did not occur) were counted and expressed as percent of total spawning attempts. Average percentages of nocturnal reproductive activities in *S. atromaculatus* were compared to those seen in day (Table 1).

RESULTS

Average percentages of time that a tuberculate male *S. atromaculatus* (in high breeding color) spent in the pit position (33.6) and in nest-building (44.5) at night were comparable to

Table 1. Mean (± one standard deviation) and range (in parenthesis) of percent time of selected reproductive behaviors in *Semotilus atromaculatus* (video observation time, night = 39.5 min; day = 34.13 min).

Behavior	% time/behavior	
	Night	Day
	15.6 C ± 0.4 (15.3 - 15.9)	16.4 C ± 2.0 (15.0 - 17.8)
♂ in pit position	33.6 ± 1.8 (32.3 - 34.8)	31.0 ± 7.5 (23 - 37.9)
Nest building	44.5 ± 0.6 (44.1 - 44.9)	43.1 ± 8.8 (33.4 - 50.4)
Spawning clasp	7.7 ± 0.7 (7.2 - 8.2)	17.3 ± 6.3 (10.2 - 22.1)
Agonistic encounters	14.0 ± 0.4 (13.8-14.3)	8.7 ± 6.2 (1.5-12.5)

those (31.0 and 43.1, respectively) recorded during the day (Table 1). Average percent (7.7) of spawning time at night was about one-half that which that occurred during the day (17.3); however, average percent time engaged in spawning was similar (day, 10.2; night, 7.7) at comparable water temperatures (day 15.0 C and night 15.6 C). Average percent of number of successful spawns (34.0) was greater at night than the average (23.8) recorded for the day (Table 2).

The percent of time the nest attendant male spent in combat with intruder males was related to the number of intruders in the vicinity of the nest (Table 1). Combat at night occupied 14.0% of the attendant male's time (seven intruders), whereas in the daylight at one nest the average percent of combat time was 12.0 (two intruders) and at another 12.5 (four intruders). At a third nest during daylight, where only three contacts were made with a single intruder, combat time was 1.5%.

Clinostomus funduloides (rosyside dace) and *Phoxinus oreas* (mountain redbelly dace), both in high breeding colors and feeding on eggs, were nest associates of *S. atromaculatus* at night as in the day. Like in daylight, agonistic behavior (i.e., parallel swim, head butting and chasing) within each species occurred frequently as males jockeyed for optimum feeding positions over the nest.

Neither of the 7.5 V spotlights without rheostats attracted fishes for over 5 min. As one spotlight was moved upstream toward the nest, the fishes, apparently startled by the illumination, retreated 2 m upstream to an undercut bank. After the majority of the *C. funduloides*, *P. oreas* and female *S. atromaculatus* had returned to the illuminated nest after 5

Table 2. Mean (± one standard deviation) and range (in parenthesis) of percent of number of unsuccessful and successful spawning clasps in *Semotilus atromaculatus* (video observation time, night = 39.5 min; day = 34.13 min).

Clasps	% number	
	Night	Day
	15.6 C ± 0.4 (15.3 - 15.9)	16.4 C ± 2.0 (15.0 - 17.8)
Unsuccessful	66.0 ± 2.8 (64 - 68)	76.2 ± 9 (67.8 - 85.7)
Successful	34.0 ± 2.8 (32 - 36)	23.8 ± 9 (14.3 - 32.1)

min, the breeding male *S. atromaculatus* returned and resumed reproductive activities.

With the halogen lamps using rheostats, all fishes continued their activities as illumination was increased to maximum output (i.e., the nest-building male *S. atromaculatus* continued to construct a pit/ridge nest and spawn with females, and *C. funduloides* and *P. oreas* continued to jockey for positions over the pit). Similarly, the fishes continued their activities when light intensities were decreased to zero, and when they were increased again to maximum intensity within 3 min.

The hydrophone did not pickup sound emanations from the fishes.

DISCUSSION

Species-specific behaviors are used as effective management tools in preserving habitats of species (McNeely et al., 1990). Videotaping fishes during the day or night permits analysis of species-specific behaviors that directly relate to their habitat requirements. We propose that non-intrusive light systems (e.g. infrared and image intensifiers, reviewed by Collins et al., 1991) are not required for making observations of certain species at night. Through our observations and reviews of videotapes, we did not perceive an alteration of the activities of fishes over a nest when light intensities were increased gradually with rheostats. The movement of a nest-building male *S. atromaculatus* from the rear of the pit to the upstream slope of the pit where he deposited stones progressed uninterrupted as illumination increased. Similarly, the sinuous swimming of individual *C. funduloides* continued without disruption when the first glow of light reflected from their bodies. *Phoxinus oreas* was not present on the nest at this time.

Instantaneous exposure of fishes to full illumination resulted in a startle response where fishes swam away from the nest. The response was like that produced by sudden

physical movements on the bank during the day. Fishes returned to nests as they accommodated to lights and continued their breeding activities.

Development of color and breeding tubercles are secondary sexual characteristics in male *S. atromaculatus* and other species in *Semotilus* during the spawning season (Lachner and Jenkins, 1971; Ross and Reed, 1978; Woolcott and Maurakis, 1988). It has been assumed that color display is related to visual recognition of males by females (Shute and Shute, 1991). While this may be true, the male *S. atromaculatus* we observed over nests at night, when color cannot be detected (Guthrie, 1986), were as brightly colored as males observed in daylight. Like Ross and Reed (1978), who reported male *Semotilus corporalis* intensified in color during combat, we have observed color intensification in male *S. atromaculatus* during agonistic encounters. Because color intensification in male *S. atromaculatus* has been related to combat behavior, and does not elicit a change in behavior of females in the species (Maurakis and Woolcott, 1992), we propose that color is not involved in attracting females of this species at night, although they may be attracted initially to the male during daylight.

According to Guthrie (1986) the visual system cannot serve as a color receptor in diurnal spawning species that spawn at night, as light lumens are below threshold levels for color detection. As nocturnal spawning behavior in *S. atromaculatus* was similar to that in day, sensory systems (e.g. olfactory, lateral line, and tactile), other than vision, probably are involved in communication among both diurnal and nocturnal breeding males and females.

ACKNOWLEDGEMENTS

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TECHNIQUES OF VIDEOTAPING FISHES FROM ABOVE THE SURFACE OF THE WATER

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BACKGROUND

Reighard (1910) described methods of making direct observations with the aid of underwater viewers and still cameras for studying the habits of fishes in the field. Other researchers (e.g. Hankinson, 1932; Lachner, 1946; Raney, 1940), using similar devices, plus their keen observations, made significant contributions in documenting the behaviors of freshwater fishes. However, direct field observation (with note taking) and still photography fail to allow researchers to review and analyze the subtle actions that occur in behaviors. Motion picture photography (cinematography and videography), on the other hand, allows one to review and analyze behaviors repeatedly, although the method has some of the same technical and logistical problems that faced Reighard. Raney (1940) clearly states some of the problems in using filming techniques to study the behaviors of fishes:

> Some methods of observation used in studying the habits of other vertebrates have been used 'in fishes' but with the variations and modifications demanded by the aquatic habitat. Thus the camera may be utilized but only rarely from the confines of a shelter or so-called 'blind'. Adverse conditions as too great depth, excessive turbidity, and surface reflection make it impossible to observe successfully much of the time when fishes are spawning. Some early work 'with the camera' on breeding habits is practically worthless because of the uncertainty about the identity of the species of fish seen.

More recently, some researchers (e.g. George, 1980; Collins et al., 1991) have utilized underwater video cameras (using either visible spectrum or infrared lights) with varying degrees of success to document activities of fishes in the field. Few biologists, however, have successfully taped the activities of fishes in streams from above the surface of the water. Prior to our use of frame-by-frame analysis of videotapes beginning in 1986, not a single author had reported 20 conspicuous reproductive behaviors that we now have identified and categorized into sequences of behavior for over 35 species of cyprinids and catostomids in 375 hours of recordings.

This paper describes the cameras, recorders, lighting sources, camera techniques, recording methods, and analytical techniques that we have used to videotape reproductive behaviors of fishes from above the surface of the water.

EQUIPMENT AND TECHNIQUES

Cameras, Recorders, and Power Supplies

Two types of color video cameras are used. One, a 3-chip camera (Charge Coupled Device, CCD, resolution = 520 lines), is equipped with a 12x zoom lens (focal length = 10-120 mm). This manually focused CCD camera has three internal filters (3200 , 5600 +1/8 Neutral Density, and 5600), an automatic/manual iris diaphragm, and three light gain boost settings (0, 9, and 18 decibels, db). The second is a Nuvicon tri-tube camera (resolution = 350 lines) equipped with a 12x zoom lens (focal length = 10.5-126 mm) and an automatic/manual iris diaphragm. Each camera is operated on a tripod equipped with a fluid head for making vertical and horizontal maneuvers smoothly from one target area to another.

CCD camera images are recorded on professional quality 20-min 3/4-inch videotapes using a portable, NTSC color 3/4-inch video signal system cassette recorder (recording speed = 9.53 cm/sec). During night, the Sony CCD camera may be operated at a light gain of 18 db. Fourteen rechargeable 12-V batteries (charge life = 1 hr each during continuous use in daylight) are required to supply power to the CCD camera and recorder for 14 hr. At night, battery life is decreased to 0.5 hr per battery as the db setting is increased to photomultiply the visual signal. Images generated from the second camera are recorded on 2-hr industrial 1/2-inch tapes using a portable, NTSC color 1/2-inch video signal system cassette recorder (recording speed = 3.34 cm/sec).

Camera Techniques

We incorporate the five cinematographic techniques (camera angle, continuity, cutting, close-ups, and composition), discussed by Mascelli (1965) to videotape activities of fishes.

Camera angle: Camera angle is the position of the camera that is required to view objects, their movements and setting (Mascelli, 1965). Of the three camera angles (objective, subjective, and point of view) we use the objective one to present the activities of fishes from a sideline viewpoint, as **in**

the eyes of an unseen observer.

Continuity: Continuity is the continuous logical flow of visual images in time and space, supplemented by sound, which depicts events in a coherent realistic manner (Mascelli, 1965). We employ an organized shooting plan (i.e., outlines, story boards, or detailed shooting scripts) to avoid shots of unrelated subjects, although at times, we must adapt to the conditions required by the action and circumstances in the field.

Two filming techniques (master scene and triple take) are employed to achieve continuity. The master scene technique (continuous recording of events in chronological order) is used to film sequential behaviors. It is preferred over the triple take technique until a camera operator learns the possible sequences of behaviors that may occur. The triple take technique gives shot-to-shot continuity, from a long shot to a medium shot, and finally ending in a close-up. It collapses continuous activities into small parts to illustrate detail and relativity to the whole. A camera operator must think back to the last shot before filming the present shot, and also ahead to the next shot.

Directional continuity (e.g. map direction, entrances and exits of fishes) is the direction in which subjects are moving relative to a given point of reference. For example, a wide shot of fishes swimming upstream over a nest (facing left in the camera) followed by a sequence where close-ups of fishes are facing right, breaks directional continuity, and confuses the viewer as to the actual direction of the stream. In an editing studio, we also use various electronic transitional devices (fades, dissolves, wipes, sounds) to bridge time and space, while still maintaining clarity of continuity.

Cutting: Cutting, synonymous with editing, is the physical or electronic removal of extraneous film or tape not pertinent to the main topic (Mascelli, 1965). Although cutting is performed in the studio, we did not depend on a studio editor's skill to correct avoidable mistakes made while in the field once we understood editing from a visual, rather than a technical standpoint. Our first cuts are made in the field, where we decide what and when to edit (turning the camera off and on) during taping of scenes. Under special circumtances, we cross cut scenes (="back at the ranch", Mascelli, 1965), to parallel edit two or more events in an alternating pattern to compare and contrast behaviors among species.

Close-up: Close-up, a device unique to motion pictures, allows large-scale portrayal of a portion of the action (Mascelli, 1965). It transports a viewer into the scene, eliminates all non-essentials momentarily to isolate the significant activity, and adds visual clarity and dramatic impact. As there are no substitutes for experience in videotaping, nor for familiarity of behaviors of fishes, we have learned to anticipate sequence in behaviors, and document them by matching the camera angle and size of a close-up of one behavior with that of another.

Composition: Composition is the arrangement of pictorial elements to form a unified harmonious whole (Mascelli, 1965). Compositional principles and elements (e.g. balance, centering, movement, position) are the most pliable of all cinematographic rules and techniques. Our primary compositional priorities are centering and position. For example, fishes at the center of a screen dominate a scene and keep the viewer focused. The position and movement of a fish are shown relative to the setting during a particular activity (e.g. upstream movement of a fish from one location to another within a behavioral sequence).

Recording Methods

The clearest pictures are obtained in calm, shallow (0.1-0.5 m deep), tannin- and turbidity-free streams. Videotaping is performed where illumination (sun or artificial lights) is at right angles or in back of cameras. Cameras are placed in the stream or along its bank, generally within 15 m of fishes. Cameras, without polarizing filters, usually are positioned on a stream bank at an angle of 45° to minimize light reflection from the surface of the water. Camera position alone can be used to effectively reduce reflected light by 100 percent. Polarizing filters are fixed to camera lenses to eliminate residual reflected light as the sun moves overhead, and as fishes change positions.

Filming from an elevated bank (>3 m) yields a vantage point where all activities that occur within 50 m from the camera can be recorded. With a 12x zoom lens, filming within 3 m of the target yields a detailed account of activities yet limits the field of vision to within 10 m of the target. At lower camera elevations, glare increases as the angle of incident light increases.

Lighting

The most lucid pictures are obtained in full sunlight. Partial shadows of tree branches, or those that move back and forth over fishes, not only cause uneven lighting that impede detection of detail, but are distracting as they break continuity. Uneven surface flows created by riffles or partially submerged objects that increase glare can be reduced effectively to laminar flows by placing a seine, brails or logs upstream of the target to optimize picture clarity. The vantage point of the camera is modified to accommodate changes that occur in available sunlight, incidence of reflected light, and positions of fishes.

Adverse weather conditions can preclude videotaping. For example, fog and light rains reduce visual clarity, distort images, as well as can damage electronic components of video equipment. We have, however, used 3 mil plastic to cover all camera parts except the lens during a sprinkle. Whether in open or tree-lined streams, wind can cause ripples in the water that distort images, and diffract and reflect light beyond the planar capabilities of polarizing filters.

Non-intrusive light systems (e.g. infrared and image intensifiers reviewed by Collins, et al., 1991) are not required for making observations and videotaping fishes at night. Two 12 V battery powered halogen spotlights (each 1-million candle power), equipped with rheostats, provide sufficient illumination for us to observe and videotape activities in the dark. Activities of fishes continue uninterrupted as light intensities are increased to maximum output with rheostats

(Maurakis et al., 1995). The brightness of the lamps limits the need for the photomultiplier on the CCD camera. Previously, we had used two 7.5 V incandescent spotlights (each 100,000 candle power) without rheostats for illumination at night; however, the lower intensity of these lights required that the camera be operated constantly at 18 db, which reduced battery life.

Review of Videotapes

In the laboratory, field videotapes are copied, and catalogued according to species, collection number, locality data (country, state, drainage, locality, and date), and tape number. Copies of tapes are played repeatedly in normal speed, slow motion, frame pause, and single frame advance. Tapes are viewed on a 25-inch screen color television monitor to identify behaviors. Tapes are analyzed according to Sabaj's (1992) four part review. Activities associated with a particular nest are reviewed in their entirety at normal tape speed to identify subjects and behaviors (individual fishes are readily identifiable). A tape is replayed with pauses for note taking. Activities of fishes are described and divided into a chronological sequence of episodes. A single episode consists of a particular behavior (e.g. nest-reworking) expressed by a single fish (e.g. dominant male). Episodes directly related to activities of short duration (e.g. spawning, 1-2 sec) are replayed at normal speed, in slow motion, and frame by frame. Orientation of fishes to each other is determined at this time. The entire tape is reviewed again at normal speed to confirm previous observations. These are compared with field notes and video recordings of the diurnal and/or nocturnal behaviors of the species from other localities.

CONCLUSION

If environmental conditions permit, videotaping from above the surface of the water with proper equipment enhances the power of observation by focusing on a particular event. Tape recordings provide an opportunity to identify and review specific behavioral episodes (Maurakis et al., 1991). Videotapes serve as permanent records, and allow frame-by-frame analysis of behaviors of individuals, and interactions within or among species. Species-specific behaviors can be used as effective management tools in preserving habitats of species (McNeely et al., 1990), as they directly relate to the habitat requirements of species.

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THE EFFECT OF PRESERVATION ON UROGENITAL PAPILLA LENGTH IN THE LEAST BROOK LAMPREY, *LAMPETRA AEPYPTERA*

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INTRODUCTION

In male lampreys, the urogenital papilla becomes elongate as the spawning season approaches. Kott et al. (1988) reported that the length of the urogenital papilla, expressed as a proportion of branchial length, is taxonomically useful in distinguishing among male lampreys of nonparasitic species. Subsequently, Sneen and Cochran (1990) reported a significant difference in relative papilla length of *Ichthyomyzon gagei* from the southeastern U.S. and *I.* cf. *gagei* from Wisconsin.

Fixing and preservation may significantly alter morphological measurements of lampreys (e.g., Beamish, 1982; Cochran, 1987; Cochran and Pettinelli, 1988; Morkert and Bergstedt, 1990; Docker and Beamish, 1991). Typically, these processes result in shrinkage, which may be relatively more severe in lampreys than in most other fishes because of their reduced skeletal investment. The purpose of our study was to examine the effect of fixing and preservation on the ratio of urogenital papilla length to branchial length in the least brook lamprey, *Lampetra aepyptera*. Such an effect, if unaccounted for, might confound the use of this measure for taxonomic purposes. We expected that urogenital papilla length would be reduced in preserved specimens, but we were unsure if the ratio of papilla length to branchial length would be similarly affected.

METHODS

We collected *Lampetra aepyptera* on 12 March 1991, at several sites in Marshall and Itawamba counties, Mississippi (Table 1). Eight adult male lampreys, hereafter referred to as Group A, were held alive and returned to the laboratory for measurement. After the lampreys were anesthetized with tricaine methanesulfonate (MS 222), total length of each specimen was measured to the nearest millimeter, and branchial and urogenital papilla lengths, as defined by Kott et al. (1988), were measured to the nearest 0.01 mm with a digital micrometer. The lampreys were fixed for two days in 10% formalin, soaked in water for two days, and preserved in 70% ethanol. During this process, they were held in individual vials so that their identities could be maintained. After 33 days in ethanol, each lamprey was remeasured for total length, branchial length, and urogenital papilla length. Paired t-tests were used to assess statistically the changes in these measures.

Table 1. Sites in Mississippi at which *Lampetra aepyptera* were collected on 12 March 1991. The sample size indicated is the number of adult males included in later analyses. Those in Group A were measured both prior and subsequent to preservation, whereas those in Group B were measured only after preservation.

County	Stream	Sample Size A	Sample Size B
Marshall (T4S,R1W,S6)	Tributary to Chewalla Creek	1	0
Marshall (T4S,R1W,S5)	Tributary to Chewalla Creek	7	21
Itawamba (T11S,R9E,S14)	Tributary to Bull Mountain Creek	0	6

In addition to lampreys in Group A, a set of 27 adult male *L. aepyptera* (Table 1) were fixed in the field in 10% formalin after anesthesia with MS 222. After transfer to 70% ethanol in the laboratory, they were held until July 8, 1991, before being measured. Hereafter, these lampreys will be referred to as Group B.

RESULTS AND DISCUSSION

Branchial length and total length were significantly correlated in both living and preserved samples, but urogenital papilla length was not correlated with either variable (Table 2). Kott et al. (1988) found mean branchial length and mean total length to be highly correlated among lamprey species. They also found mean total length and mean urogenital papilla length to be weakly correlated among species, but only when parasitic lampreys were included in the analysis. When parasitic species were excluded, the two variables were uncorrelated.

Fixing and preservation effected significant reductions in total length, urogenital papilla length, and the ratio of urogenital papilla length to branchial length (Table 3). Although branchial length was reduced in the preserved specimens, the decline was not significant, and the mean

Table 2. Correlation among total length (TL), branchial length (BL), and urogenital papilla length (PL) in samples of adult male *Lampetra aepyptera*. Sample sizes (n) for each group are indicated.

Sample	n	TL vs BL	BL vs PL	TL vs PL
Group A				
live	8	0.893**	-0.128	-0.098
preserved	8	0.962**	-0.265	-0.256
Group B				
preserved	27	0.893**	0.040	0.016

**p < 0.01

percentage reduction (2.2% of the mean for living specimens) was not as great as for total length (4.8%) or urogenital papilla length (13.5%). The stability of branchial length apparently reflects the relatively greater investment of skeletal tissue in the branchial region. The mean percentage decline in the ratio of urogenital papilla length to branchial length (11.4%) obviously resulted primarily from the change in urogenital papilla length.

The mean ratios of urogenital papilla length to branchial length we observed in this study (Table 3) are well below the mean of 0.408 reported for *L. aepyptera* by Kott et al. (1988), although we did record individual values as high as 0.519 among the preserved specimens in Group B. We probably observed lower ratios because we collected our specimens in advance of the spawning season. Kott et al. (1988) reported a change in the mean ratio at one collection site from 0.226 on 6 February to 0.388 on 18 March.

The percentage reduction in total length of preserved adult *L. aepyptera* in this study was comparable to that observed in other studies. Cochran and Pettinelli (1988) reported a mean reduction of 7.6% in total length of adult *Ichthyomyzon* cf. *gagei* fixed in 10% formalin and preserved in 70% ethanol. *Ichthyomyzon unicuspis* treated in a similar fashion shrank by an average of 6.6% (Cochran and Marks, in press). Beamish (1982) and Docker and Beamish (1991) presented regressions for converting between live and preserved total lengths of adult *I. gagei* and large larval *L. aepyptera* fixed and preserved in 5% formalin. For individuals 113.4 mm in length, the mean total length of living lampreys in Group A (Table 3), their equations predict shrinkage by 2.9% and 3.1%, respectively. Average shrinkage of 100-mm larval sea lampreys (*Petromyzon marinus*) was 3.8% when fixed and preserved in 5% formalin and 4.3% in 10% formalin (Morkert and Bergstedt, 1990).

We do not know how long it takes for morphological measurements of lampreys preserved in 70% ethanol to stabilize. Docker and Beamish (1991) stated that large ammocoetes of *L. aepyptera* preserved in 5% formalin achieved constant length and weight in 7 days. Morkert and Bergstedt (1990) reported that most shrinkage of larval sea lampreys fixed and preserved in 5 or 10% formalin occurred within the first 2 hours. In the present study, the measurements for lampreys in Group B, which were stored for nearly 4 months in ethanol, were not substantially different from those for Group A, which were preserved for only one month (Table 3). However, to adequately assess the effect of duration in preservative on morphological measurements would require paired comparisons of measurements for individual lampreys.

Table 3. Mean total length (TL), branchial length (BL), urogenital papilla length (PL), and ratio of urogenital papilla length to branchial length (PL/BL) for samples of adult male *Lampetra aepyptera*. Standard errors are in parentheses, and sample sizes (n) for each group are indicated. For group A, the results of paired comparisons between measurements for live and preserved specimens are indicated in the appropriate columns.

Sample	n	TL (mm)	BL (mm)	PL (mm)	PL/BL
Group A	8				
live		113.4 (4.3)	11.87 (0.72)	3.52 (0.24)	0.306 (0.031)
preserved		108.0 (4.2)	11.50 (0.53)	3.09 (0.31)	0.275 (0.033)
paired t value		(22.97***)	(0.24)	(3.74**)	(3.01*)
Group B	27				
preserved		107.9 (2.0)	11.37 (0.18)	3.37 (0.27)	0.298 (0.024)

*p < 0.05
**p < 0.01
***p < 0.001

We have identified an effect of fixing and preservation on the ratio of urogenital papilla length to branchial length. If this ratio is to be used effectively in comparisons among lamprey taxa or among populations from different geographic locations, then not only should all lampreys be at a comparable reproductive state (Kott et al., 1988), but all should be treated identically with respect to fixing and preservation. Differences among individuals or groups with respect to types or concentrations of preservatives, or with respect to schedules of fixing and preservation, might contribute to variability that obscures taxonomic differences, or worse, to biases that are confounded with taxonomic effects.

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MUSEUM NOTES

The Auburn University Museum Fish Collection

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HISTORY

The Auburn University Museum fish collection (standard symbolic code - AUM, Leviton et al., 1985; Leviton and Gibbs, 1988: 281 [address correction]) was established in 1930 by entomologist, Frank E. Guyton. Guyton collected fishes while sampling streams of east-central Alabama with students from the Alabama Polytechnic Institute (A.P.I.), the forerunner of Auburn University. Specimens from these early collections formed the basis of descriptions and systematic treatments of taxa such as the redeye bass *Micropterus coosae* (holotype and paratypes; Hubbs and Bailey, 1940), Alabama spotted bass *M. punctulatus henshalli* (paratypes; Hubbs and Bailey, 1940), bronze darter *Percina palmaris* (paratypes; Bailey, 1940), and eastern redfin darter *Etheostoma whipplii artesia* (specimens used in color description; Hubbs and Black, 1941). In fact, A.P.I. specimens and Guyton's contributions are acknowledged, in all of the above works. In most instances, A.P.I. specimens were donated to Michigan and are now cataloged in the Museum of Zoology. However, in a few cases (notably *Micropterus coosae* and *M. p. henshalli*) paratypes were retained at A.P.I., and are now part of the AUM fishes type collection.

The AUM fish collection built up gradually through the efforts of Guyton, and fisheries biologists such as H.S. Swingle, John D. Black, and Jack S. Dendy. William Smith-Vaniz, a student of Dendy's, contributed numerous collections and used the Auburn Fish Collection as the basis for a Master of Science thesis, which culminated with the publication of

Freshwater Fishes of Alabama, in 1968.

Growth and use of the Auburn fish collection was greatest during the period 1967-1983, when the collection was under the care of John S. Ramsey. Ramsey brought to Auburn University the experience in collection building and quality care he had gained as a student of Royal D. Suttkus at Tulane University. Under Ramsey's tenure as curator, regional holdings were substantially increased, and material from a number of foreign countries was added. Many of the foreign collections were obtained by students and faculty in Auburn's internationally renowned Fisheries and Allied Aquacultures Program. A backlog of international collections lacking proper collection data accumulated, and this, together with specimens Ramsey obtained through the local aquarium trade, formed the basis of a diverse teaching collection, which Ramsey used in courses such as general and systematic ichthyology. Ramsey and his students used the main research collection in studies of taxonomy, life history, conservation, and hybridization (e.g., Mathur, 1973; Mathur and Ramsey, 1974; Wallace and Ramsey, 1981; Timmons et al., 1983; Wieland, 1984; Johnson and Ramsey, 1990). In addition to curating the fish collection, and teaching and research responsibilities in both the Fisheries and Zoology departments, Ramsey's served as Leader of the Auburn University Cooperative Fish and Wildlife Research Unit.

Ramsey left Auburn University in 1983. The collection was idle for five years before the senior author was hired Curator in 1988. At the time of the senior author's hiring, the ichthyology position was converted to 100% Zoology with responsibilities divided equally among curating and basic science teaching and research.

The decision was made to move the collection from the Fisheries Building (Swingle Hall) to newly renovated Zoology Department space (the "Physiology Building") on the north end of the Auburn campus. The move was performed by professional movers under the constant supervision of the authors at a cost of $14,000. In moving the collection, specimens had to be cleared from shelves, and the shelving dismantled and reassembled in the new space before the specimens could be reshelved. The collection, which had been arranged alphabetically by family in Swingle Hall, was rearranged in phylogenetic family order (following Nelson, 1984) during the move. During the senior author's term as Curator, the emphasis was on curating and improving the collection facility. However, collections from across the southeastern United States (roughly 1,200 lots in all), made in connection with a study of regional influences of stream fish diversity, were added during this time.

The senior author left Auburn in December 1991. The junior author remained at Auburn and cared for the collection until April of 1992. Students of the senior author completing graduate studies at Auburn University provided intermittent care and access to outside researchers until December 1994.

HOLDINGS

The following account on holdings in the AUM fish collection is based primarily on computerized records which represent roughly 80% of all collection records. There are presently 27,695 cataloged lots in the collection as of the last electronically cataloged entry. The 21,677 computerized lots represent 241,043 specimens of 1,199 nominal species, in 510 genera, and 140 families. The Collection is roughly three-fourths freshwater and one-fourth marine. Cyprinids make up roughly 34% of the computerized records; centrarchids 19%; percids 14%; catostomids 6%; ictalurids 5%. Thirty-seven of the 48 contiguous United States plus Alaska, and the territories of Puerto Rico, Guam, and the U.S. Virgin Islands are represented in the collection (21,110 lots in all). The strongest representation is from the southeastern United States (88% of computerized lots), primarily the states of Alabama (10,269 lots), Georgia (4,700 lots), Tennessee (1,874 lots), Mississippi (917 lots), Florida (803) and South Carolina (257 lots). River systems most prominently represented are the Alabama River inclusive of the Tallapoosa, Coosa and Cahaba rivers (6,779 lots or 31%), and the Apalachicola River inclusive of the Chattahoochee, Flint and Chipola rivers (4,190 lots or 19%).

International representation in the collection is also very good. The following foreign countries are represented: Mexico, Guatemala, Belize, Honduras, Nicaragua, Colombia, Ecuador including the Galapagos Islands, Peru, Brazil, Bolivia, Argentina, Uruguay, Dominican Republic, Haiti, Jamaica, Norway, Liberia, Mali, Niger, Cameroon, Central African Republic, Indonesia, the Philippines, and Taiwan. In all, there are 1,248 cataloged lots of international fishes with at least this many more lots in unsorted and uncataloged backlog. Roughly 70% of the international material is from the fresh waters of South America, principally the Amazon Basin.

The total backlog of unsorted and uncataloged material is estimated at between 9,000 and 11,000 lots. Included in this material are collections from a number of regional faunal surveys such as the West Point Reservoir (Chattahochee River) pre-impoundment survey. At the time of the fish collection's move to its present location, the backlog material was boxed and stored in the basement of the Forestry Building (Smith Hall) directly adjacent to the Fisheries Building. The material was inventoried in 1991 to assess curatorial needs and to establish accessioning priorities. None of the backlog was accessioned during the authors' tenure at Auburn. However, all international collections and the West Point Reservoir pre-impoundment survey collections were transferred to the main fish collection facility. The remainder of the backlog material is still in the basement of Smith Hall with no climate control. Most recently, the Forestry Department has been pressuring the Zoology Department to transfer the remaining backlog material to Zoology Department space.

The following nominal species/subspecies are represented by types (secondary only): *Scaphirhynchus suttkusi* Williams and Clemmer, *Campostoma pauciradii* Burr and Cashner, *Notropis cahabae* Mayden and Kuhajda, *Fundulus julisia* Williams and Etnier, *Micropterus coosae* Hubbs and Bailey, *Micropterus punctulatus henshalli* Hubbs and Bailey, *Etheostoma brevirostrum* Suttkus and Etnier, *Etheostoma etnieri* Bouchard, *Etheostoma flavum* Etnier and Bailey, *Etheostoma lachneri* Suttkus and Bailey, *Etheostoma pyrrhogaster* Bailey and Etnier, *Etheostoma ramseyi* Suttkus and Bailey, *Etheostoma raneyi* Suttkus and Bart, *Etheostoma tallapoosae* Suttkus and Etnier, *Etheostoma zonistium* Bailey and Etnier, *Percina brevicauda* Suttkus and Bart, and *Percina palmaris* Bailey. Types and osteological specimens (cleared and stained and dry skeletons) are stored in a wall-mounted cabinet in a secured room housing lower fishes (see below).

CURATION

The fish collection is presently housed in two adjoining rooms in the Physiology Building on the north side of the Auburn University campus. The collection is arranged phylogenetically in Nelson (1984) family order. Agnathans through scorpaeniformes and all type specimens are housed in one of the rooms; perciformes through tetraodontiformes are housed in the other. The room housing higher fishes has a low ceiling that can only accommodate 7 ft-high shelves. The room has entryways on both ends connected by a corridor. Physiologists use the corridor to access labs in the rear (west) wing of the building, and as an emergency evacuation route. The front (north) entryway is a keyless, self-closing door with signs warning against unauthorized entry. The rear entry is an open archway connecting the collection room to a small work area for visitors. A double steel door at the rear of the visitor area has a panic bar for rapid escape from inside the building, and a coded key-pad lock to restrict access to the building from outside. The room housing lower fishes has a ceiling high enough to accommodate 10 ft-high shelves. It has a single, keyed entry and, thus, is more secure than the "low-ceiling room".

The vast majority of lots in the collection are fluid preserved; "cleared and stained" and dry skeleton lots number fewer than 200. The fluid collection is preserved in both ethanol (70%) and isopropanol (45-50%). The earliest collections, including all of the A.P.I. material, are preserved in ethanol. Until recently, all of the rest of the collection was preserved in isopropanol.

The early collections and some of the more valuable recent material are stored in high quality, bail-top jars. Jar labels in use throughout the collection are a heavy parchment type. Jars with baked resin lids were used extensively in the collection in the 1970's and early 1980's. Temperature control was a problem in the Fisheries Building (Swingle Hall). The temperature changes caused the resin lids to loosen and alcohol levels to back off. To control this, Ramsey started a practice of sealing the jars with vinyl tape.

In 1989, an ambitious realcoholing effort was started to convert all of the collection to ethanol. By the end of 1991, half of the collection had been transferred to ethanol. During realcoholing, baked resin lids were replaced with soft-molded polyethylene lids with foam liners. Tank storage in the collection was also upgraded from styrofoam coolers and plastic tubs to museum-quality 36-in stainless-steel tanks.

In the early 1980's, in order to control a growing overflow problem, Ramsey established a policy of discarding or exchanging lots of common species that were already well represented in the collection. In verifying identifications, Ramsey noted which species or which portions of large lots were to be retained. Records for all verified species were entered into the electronic catalog, but only species or individuals that were retained were assigned catalog numbers.

Three different cataloging systems have been in use at different times during the history of the fish collection. Guyton established the first hand-written catalog in 1930 with sequential entries based on date and location of collection, and a listing of species collected. Dendy and Smith-Vaniz established a new cataloging system in 1964 based on accession date. To use an example included in volume one of the hand-written ledger, the number "483-2" would signify the year of accession (1948), the sequence of accession (3rd collection accessioned from that year), and the species entry from the list of captured species (2nd species cataloged from the list of collected species).

Ramsey established a sequential numbering system and recataloged early collections under this system. The sequentially numbered catalog fills seven cloth-bound ledgers. The hand-written catalog was discontinued in October 1983 in favor of an electronic cataloging system. The original electronic system, also established under Ramsey, was in Appleworks format and consisted of locality and species databases linked by a sequential accession number. Accession numbers assigned to collections in the electronic cataloging system are written in pencil to the left of the catalog number for the first lot of each collection. All entries after AUM 23970 are cataloged in the electronic cataloging system. Early collections were accessioned in the order in which they were electronically cataloged, but later collections were apparently accessioned according to Ramsey's research interests. For example, all Coosa River system and Chattahoochee collections were accessioned in sequence. The only interruptions to this sequence were new collections, which were accessioned as they were recataloged. About one-fifth of the collection was computerized during Ramsey's time at Auburn.

The authors modified Ramsey's electronic cataloging system and developed an electronic labeling system. Data from the previous electronic cataloging system were imported into the new system and an additional three-fifths of the collection data were computerized, bringing the total percentage of the collection computerized to the present 80 percent. The new system is based on a dBase IV platform. It consists of separate accession, species, locality and drainage databases linked by a sequential accession number. The accession database includes fields for accession number,

latitude/longitude, field number, date, method and time of collection, collectors, number of species and specimens taken, range of catalog numbers for species lots, and processor, verification and cataloger information (name and date). The species database includes fields for accession number, family number, family, catalog number, genus, subgenus, species, subspecies, authority and type status, and number of specimens seen and kept. The locality database comprises country, state/province, county/district, and locality description fields. The drainage database includes fields for drainage, subdrainage and the specific body of water sampled. A loan database was planned but not completed.

A unique system was developed for generating high-quality jar labels directly form the electronic cataloging system. The system employs a plotter with a rapidograph nib. A program, written in SASgraph, formats a page of 20, 3 x 2 in labels with standard label fields, accepts information from the electronic database, and fills in species, locality, collector, date, etc., in fonts of different types and sizes. The plotter accepts 11x14 sheets of heavy parchment paper, which is an ideal stock for wet labels. A temporary database accumulates "pages" of labels and gives the user the option of saving incomplete pages or printing labels with blank fields. The database in maintained on a 386 IBM compatible PC with two 80 megabyte hard drives.

All collection records and computing equipment are housed in a large room adjoining the "low-ceiling room". The seven-volume hand-written catalog, printouts of all computerized records in accession sheet format, and an assortment of identification manuals and other reference books, are stored on wall-mounted shelves. Loan records and correspondence are stored in a filing cabinet. The filing cabinet also contains a nearly complete file of original descriptions and subsequent systematic treatments of species represented in the collection, a file of reprints of studies that utilized material in the collection, and a listing of all international holdings. Archived with the records are Guyton's original A.P.I. series catalog, copies of Smith-Vaniz's field notes and the original artwork used in *Freshwater Fishes of Alabama*, and field notes for other donated collections.

PRESENT STATUS AND FUTURE PROSPECTS

Craig Guyer, a herpetologist and Curator of Amphibians and Reptiles at Auburn University, has been overseeing use of the collection since 1992. The authors are often consulted when special needs arise. In addition, Mary C. Freeman, who has been affiliated with the National Ecology Research Center's, Stream Ecology Field Station at Auburn University since 1992, is actively working in the collection and helping to facilitate use by outside researchers. Thus, although the collection has been without a curator for over three years, it continues to be used in research, and it is under the watchful eyes of qualified individuals. The most pressing need at the moment is finding new storage space for the backlog material in the basement of the Forestry Building.

The recent completion of a new Life Sciences building has opened space in the building that presently houses most of the Zoology Department, (Funchess Hall). There are plans to relocate physiologists currently in the Physiology Building to Funchess Hall, and move the amphibian, reptile and vertebrate paleontology collections (and their curators) to the vacated Physiology Building space. Presumably, the move would create sufficient space to accommodate the remaining backlog fish material as well. The Physiology Building presently houses the bird and mammal collections in addition to fishes. Thus, all vertebrate collections should soon be consolidated into a single building.

What is uncertain is when a permanent curator for the fish collection will be hired. Faculty in the Department of Zoology and Wildlife Science (particularly the curators of other AUM collections) understand the importance of the fish collection, and view the hiring of a new curator of fishes as an important priority. Unfortunately, an ichthyologist is not the *top* priority for hire in the Zoology Department. However, expertise in basic ichthyology is also important to the program in Fisheries and Allied Aquacultures. It is conceivable that the two departments could once again share an ichthyology position, especially if the position did not have the added burden of administrative responsibility in the Cooperative Fish and Wildlife Research Unit, as was the case with Ramsey's position. It is hoped that Auburn University will pursue such a position in the very near future, in order to maintain its fish collection and its long tradition in basic ichthyology.

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REGIONAL SFC REPORTS

REGION I - Northeast

Bob Jenkins at Roanoke College is still redhorsing around. He's trying to track down a complete specimen of the robust redhorse from the Pee Dee River; all he has now is a bag of bones. Chris Sample of SCDNR has been saving specimens for him. No luck so far. Work continues on the sicklefin redhorse. Bob also is attempting to sort out what, at first glance, appeared to be hybrid redhorses from the Pee Dee, but now might be the same as the oddball Mox from the Cape Fear River. His survey work on *Etheostoma osburni* in Virginia revealed no new populations. It is strong in Big Stony Creek and barely persisting in Laurel Fork. The introduced James River *Notropis telescopus* is sweeping through that drainage. It can now be found in the mid-Piedmont below Lynchburg. Bob has a student comparing food habits of it and *N. semperasper* which are now sympatric, a potential problem. Another student is comparing the food habits of young and small juveniles of *Moxostoma carinatum* and when they switch to mollusks.

Work at VPI under Paul Angermeier is winding down from last year. Kevin Leftwich finished his dissertation on habitat models of *Percina burtoni*. Bill Ensign and Kevin did some sampling in Russell Fork of the Ohio drainage and caught the first *Percina maculata* taken in the state since 1937. It was taken 1 km inside the border. Other species of note collected was *Etheostoma blennioides*.

Mike Pinder has taken over for Sue Bruenderman in the Virginia Department of Game and Inland Fisheries, Nongame Section. Mike and his coworkers collected 12 specimens of *Etheostoma acuticeps* at four sites in the South Fork Holston River between the confluence of Laurel Creek and the South Holston Reservoir. They snorkeled and electrofished. None were found above this point, apparently due to water temperature change. They also found a good population of *Etheostoma chlorobranchium* in Laurel Creek. They surveyed two sites (day and night) in Copper Creek, and found one *Etheostoma percnurum*, one *Noturus flavus*, and one hellbender. There was a heavy load of sediment present. Mike has a meeting planned with local landowners to discuss what they have and the need to protect the fauna. The August issue of *Virginia Wildlife* will be dedicated to Copper Creek. A state fishery biologist located two new populations of *Phoxinus tennesseensis*; a state survey 20 years ago identified them as *oreas*. *Noturus gilberti* was collected in Cowpasture River in the northwest part of the James River drainage.

John Alderman of North Carolina Wildlife, Nongame Section, has been investigating aspects of the life history of *Notropis mekistocholas*. He has found it to have two spawning periods - a primary one in mid-May and a secondary one in August. He is not sure how long it lives, but hopes to determine that this year by examining museum specimens. John also hopes to sample the Cape Fear River below Buckhorn Dam during the primary spawning period to see if it exists in that portion of the river. One issue facing North Carolina is the number of reservoirs permitted and proposed for the piedmont region, particularly in the Neuse River basin. There is one planned near Wilson which will inundate about 1000 acres of wooded wetlands and one on the Little River in Wake County which will impact 700-800 more acres of wetlands. John has been working hard to identify and protect our aquatic resources, especially the mussels and reservoirs obviously have the potential to greatly reduce the aquatic diversity found in North Carolina.

The North Carolina State Museum of Natural Sciences hopes (plans?) on publishing the endangered report on freshwater fishes this year. Ed Menhinick is the editor.

Fritz Rohde (FCR) of the North Carolina Division of Marine Fisheries and Mary Moser of the University of North Carolina at Wilmington have been conducting status surveys on various NC state-listed fishes found in the mountains. The lower French Broad River from Redmon Dam at Marshall down to the North Carolina/Tennessee border was sampled as well as two major tributaries. Also, the Cane River was searched for *Luxilus chrysocephalus*. Two interesting finds were the first capture of *Noturus flavus* from the French Broad drainage and the first state record of *Ichthyomyzon bdellium*.

Rudy Arndt of Richard Stockton College of New Jersey made three trips to South Carolina collecting fishes for the

Although it was believed to be a duskytail darter (*Etheostoma percnurum*) at the time of collection, identification of this juvenile was uncertain (which is why it was kept live). However, as it became an adult, its size, proportions and markings were different than duskytail darters, and at approximately one year of age the individual was preserved for more precise scrutiny. Dr. Robert Jenkins has concluded that this individual represents a different taxon from any previously known. At present, the ecological or taxonomic relationship between this darter and the syntopic duskytail darter is unclear, as is its distribution, or population size. CFI is contracted to the National Park Service (Big South Fork National River & Recreation Area) to do a float survey of the section of the Big South Fork between the mouth of Station Camp Creek downstream to just below the Kentucky/ Tennessee state line. This survey is specifically designed to document the distribution of the duskytail darter, but more specimens of the other *Catonotus* will certainly be looked for.

During a routine IBI survey at TVA's site in the Little Tennessee River just above Fontana Reservoir (Swain Co., North Carolina), Ed Scott collected two *Noturus flavus* (one released, one voucher specimen preserved). Although the species was reported (with some concern for accuracy of locality data) from the 1957 Abrams Creek reclamation, it has not been recorded from the Little Tennessee River system since. Stonecats are regarded as Endangered in North Carolina.

FWS funded additional attempts by Brooks Burr and David Eisenhour to collect the *Noturus elegans*-type "Chucky madtom" from Little Chucky Creek (Nolichucky River system, Greene Co., Tennessee). These attempts were finally successful, and there are now a total of 11 museum specimens. Brooks Burr and Jim Grady have conducted preliminary electrophoretic analyses and have concluded that this taxon is indeed unique. At present, however, the Chucky madtom is known only from a short reach of this one stream. Burr and Eisenhour recommended further status survey work; Burr and Grady are continuing their taxonomic work with this madtom. FWS has funded a continuation of the status survey by CFI, and the final report will be due in fall 1996.

In addition to the Chucky Madtom survey, FWS also funded status surveys on the Barrens topminnow, *Fundulus julisia*, and the Barrens darter, *Etheostoma forbesi*. Lisa Madison, at the Tennessee Cooperative Fisheries Research Unit of the NBS completed the report on the Barrens darter. She surveyed 67 sites on the Barrens Plateau of the eastern Highland Rim, and concluded that the Barrens darter is currently restricted to eight small streams in the upper Caney Fork system of the Cumberland River Drainage. There were several sites that contained hybrids between the Barrens darter and the fringed darter, *E. crossopterum*. Pat Rakes (CFI) completed the status survey of the Barrens topminnow. He surveyed 67 sites (also on the Barrens Plateau), and concluded that Barrens topminnows are currently restricted to one locality in the Elk River system of the Tennessee Drainage and three stream systems in the upper Caney Fork system. Although Pat concluded the species is apparently secure at present, it is extremely vulnerable to local extirpations. He concluded that the current status of the species is fair to poor, in comparison to Etnier's 1981-1983 status survey for that species. FWS has provided funding to CFI to survey additional localities for this species.

Ethelbert Jones, Bernard Kuhajda, and Rick Mayden (Univ. Alabama) were funded by the FWS to monitor historical populations of the Tuscumbia darter, *E. tuscumbia*, in the southern bend of the Tennessee River during 1993. They attempted to survey 13 localities (denied access to one and species extirpated from another), and concluded that populations at nine of the localities they surveyed were healthy and stable and habitat quality was good. Habitat at four localities was described as being degraded for various reasons, and populations of the species at these localities were either extirpated or reduced in abundance. They assigned each of the populations surveyed to Extirpated, Endangered, Threatened, Special Concern, or Stable categories and provided management recommendations. They also recommended a genetic study of the species to determine the amount of geographic genetic variation that may be present.

Rick Mayden and Bernard Kuhajda are also involved in a survey to determine the current status and population size of the Alabama cavefish, *Speoplatyrhinus poulsoni*. They have been successful in observing some Alabama cavefish, and also recently collected the first recorded syntopic specimen of the southern cavefish, *Typhlichthys subterraneus*, from this cave system.

Stewart McGregor and Thomas Shepard (Geological Survey of Alabama) continued their slackwater darter (*E. boschungi*) monitoring/survey work and surveyed 62 new localities for the species. As a result, they found the species at three new localities--all within the historical range of the species. This project was funded by the Alabama Dept. of Conservation and Natural Resources.

In our last year's report, we concluded that the futile attempts in 1993 to collect boulder darters from the Tennessee portion of the Elk River for the captive propagation project (conducted by Conservation Fisheries, Inc., or CFI) indicated that the species was present in very low numbers. Scott Mettee and Pat O'Neil (Alabama Geological Survey) provided data that indicated a higher relative abundance of this species in the lower portion of the Elk River. Therefore, CFI submitted an application for Fish & Wildlife Service (FWS) permit modification to allow collection from the Alabama portion of the Elk River. However, pending receipt of this modified permit, another attempt was made (check date) to look for boulder darters from the Tennessee portion of the Elk River. This labor-intensive collecting effort was partially successful, as three female boulder darters were taken. Several workers lifted, disturbed, and chased fishes into a small-mesh seine set immediately downstream and surrounding a large slabrock. Specifics of microhabitat where these individuals were collected were variable: current was moderate; depth from 25 cm to near 1 meter; cover type was large, flat slabrock to boulder; the consistent factor seemed to be the presence of a clean cavity beneath the cover rock.

National Biological Service (NBS) biologist Noel Burkhead and his Gainesville crew again attempted to locate slender chubs, *Erimystax cahni* at any historical localities in the Clinch/Powell systems in Tennessee and Virginia. Localities in the Powell River were thoroughly collected, but flooding and high water precluded their surveys in the Clinch. However, the negative data collected during this survey and during TVA's and UT's additional surveys in the Clinch River are not good indications about the current status of the slender chub.

Art Bogan was funded by FWS to review the literature and taxonomy of federal candidate aquatic snails and other endemic taxa in the Tennessee River basin. He and Malcolm Pierson have done similar reports for FWS on aquatic snails in the Coosa and Cahaba basins. These various reports are dated 1991-1993. FWS has provided funding for Art to compile a similar report on the remainder of the Ohio Basin.

The TVA River Action Teams (RAT's) have been busy collecting fish and benthic samples from their target watersheds (Hiwassee, Holston, Elk/Wheeler, and Clinch/Powell). An additional RAT has been designated for Nickajack/ Chickamauga Reservoirs and their tributaries, al- though this team hasn't performed any field reconnaissance yet.

Abrams Restoration Work -- A large cooperative effort to improve water quality in the Abrams Creek watershed is underway, involving the Park Service, UT, Trout Unlimited, TVA, Tennessee Office of Water Quality, CFI, etc. Much of the effort to date has been spent on determining baseline conditions (fish & invertebrate communities, water quality parameters), fencing to deny cattle access to the Creek in Cades Cove, and stabilizing banks. One impetus for this work was disappointment in our efforts to reintroduce smoky and yellowfin madtoms, spotfin chubs, and duskytail darters in the system. Since 1986 (when we began captive propagation and reintroduction of smoky and yellowfin madtoms) and 1993 (when captively propagated duskytail darters were first reintroduced into Abrams Creek) a total of 821 *Noturus baileyi*, 404 *N. flavipinnis*, 1328 *Cyprinella monacha,* and 136 *E. percnurum* has been stocked into lower Abrams Creek. Because of the decline of the Citico Creek yellowfin madtom population and the degraded habitats in Abrams Creek, no yellowfin madtoms were stocked there between 1989 and 1993. The situation in Citico Creek is apparently stable, and habitat in Abrams Creek appeared to be in better condition than in recent years, so in May 1994, 26 one-year-old yellowfin madtoms were released in Abrams Creek. As we have reported previously, smoky madtoms have been observed in Abrams Creek since June 1990, and during 1994 snorkel surveys at the transplant sites, four smoky madtoms and one yellowfin madtom were observed. The abundance indices for the smoky madtom calculated from the Abrams Creek survey data are comparable to those calculated for Citico Creek surveys, and they indicate a significant increase in survivorship of stocked individuals. The yellowfin madtom observed in Abrams Creek is the first transplanted individual ever observed there after stocking. The abundance index calculated for yellowfin madtoms in Abrams Creek is also comparable to that calculated for recent surveys in Citico Creek. Although reintroduced duskytail darters were observed in the transplant site in 1993, none was observed in Abrams Creek in 1994. One adult *Cyprinella monacha* was captured during a three-pass depletion population estimate in fall of 1993.

No yellowfin madtoms were observed in 1994 at the site in lower Citico Creek where 33 captively propagated yellowfin madtoms had been released in October 1993, but floods, high water, and swift currents made work very difficult throughout the 1994 spawning season.

Only a single, brief survey of the transplant locality of *Phoxinus cumberlandensis* in No Business Creek took place in 1994. No blackside dace were located during that survey. Ellis Laudermilk and Ron Cicerello of the Kentucky State Nature Preserves Commission are currently conducting a status survey for the species in Kentucky.

The attempt to induce spawning and rear offspring of bloodfin darters, *E. sanguifluum,* as surrogates for boulder darters, *E. wapiti*, was successful. Between 22 March and 17 April 1994 three separate spawns with a total of about 50-60 eggs were produced in CFI aquaria. Approximately 20 eggs were produced during a single spawning event. The eggs were 1.6 - 1.8 mm in diameter and were clumped together and wedged into crevices formed by a stack of unglazed ceramic tiles and the bottom of the aquarium. They were "glued" together by a thick gelatinous coating. The result of separate spawns were found together in one of the nests. The eggs hatched in about 14 days (water temperatures were maintained between 68 - 70 F). Of note is that apparently hatching times of eggs spawned earlier can be delayed to produce a more or less synchronous hatch with other eggs (spawned later) in the same nest. Males only casually guarded their nests. The hatchling bloodfin darters were between 8 and 9 mm TL with extremely thin bodies and elongate yolk sacs. All larvae were strongly pelagic and, although the length of time spent in this pelagic existence before transforming to their typical adult benthic lifestyle varied considerably, they remained so for at least five days. We hypothesize that bloodfin darter, and possibly boulder darter larvae, may drift in the current for some days before settling to the substrate to exhibit the benthic lifestyle of adults.

The spotfin chubs, *Cyprinella monacha*, that have been maintained in CFI aquaria since their capture in fall 1992 and summer 1993 did not exhibit signs of being sexually mature until summer 1994. The captive spotfin chubs spawned in the aquarium between 13 July and 13 September. Eggs were 1.8 - 2.0 mm in diameter and were cemented into crevices between flat rocks. Every few days more eggs could be found in these crevices, and the resultant "nests" could contain eggs in several developmental stages. There was no parental care of the eggs, with the exception of the territorial behavior of the males during the actual spawning acts. The eggs hatched in about a week (with water temperatures of 76 F), and larvae were benthic rather than pelagic. They remained benthic for several weeks post hatching. A total of about 2300 spotfin young juveniles was reared from these captive spawnings, and

700 individuals were reintroduced into Abrams Creek on 17 November 1994.

The success of the lake sturgeon *(Acipenser fulvescens)* reintroduction attempt in the lower Clinch River is still unclear. No specimens have been observed there since the initial stocking.

WBIR TV in Knoxville produced a 30-minute video on the Little River, considering its rich biota, siltation problems, etc. It won an EMMY award for documentaries of this type.

There are now two ichthyologists active in the Chattanooga area. George Benz of the Tennessee Aquarium has been teaching ichthyology at UT-Chattanooga, and Mark Schorr has joined the staff of that university and is in the process of developing a research collection of fishes there.

Questions concerning validity of records of *Rhinichthys cataractae* from the Cumberland River drainage have been put to rest. USNM 230824(4), 5 Oct 1968 and USNM 23107(17), 9 Nov 1968, are both from Dry Creek, a tributary to Smith Fork of the Caney Fork River system, collected by Ray Bouchard and Wayne Starnes. CU 47841(1) is from Elk Creek, Stewart County, Tennessee (this is downstream nearly to KY), 5 Nov 1964. We looked at the entire species list and some of the specimens for that site; nothing was out of order. Larry Page has added that INHS 86432 (1892) and INHS 84234 (1873) represent valid records of *R. cataractae* from southern Illinois. Work funded by Georgia DOT through Weston Inc., (Jerry Dinkins) resulted in significant collections of Georgia fishes: *Percina antesella* from Shoal Creek where the first specimens of this species were collected by Don Scott; *Fundulus catenatus* from West Chickamauga and Lookout creeks; and *Notropis ariommus* from South Chickamauga and West Chickamauga creeks.

New federal listings include: *Etheostoma etowahae*, Etowah darter (LE 12-94); *E. (Ulocentra)* sp., Cherokee darter (LT 12-94); *Athearnia anthonyi*, Anthony's riversnail (LE 4-94); *Pyrgulopsis ogmorhaphe*, royal snail (LE 4-94); *Alasmidonta raveneliana*, Appalachian elktoe (LE 11-94). Proposed federal listings include: five more Tennessee and Cumberland mussels (all proposed Endangered) and 11 from the Gulf coastal drainages (some proposed Threatened and some Endangered).

FWS has a new list of federal candidate species (with several southeastern fishes new to the list): 50 CFR Part 17, Endangered and threatened wildlife and plants; animal candidate review for listing as endangered or threatened species; proposed rule. Tuesday, November 15, 1994. Federal Register: 58982-59028.

New Recovery plans: Final duskytail darter recovery plan (March 1994, Asheville Field Office of FWS); Agency/draft recovery plan for relict darter (comments were due on this by 20 February 1995 to Asheville); Agency Draft recovery plan for blue shiner (May 1994 from Jackson Field Office of FWS); Agency/draft recovery plan for royal snail (comments due to Asheville by March 1995); Mobile River Basin Aquatic Ecosystem recovery plan (Oct. 1994, Jackson).

P. Shute and D. Etnier

REGION IV - South-Central

Hank Bart at Tulane University reports that the description of the upland goldline darter is progressing, as is his long-term study on factors affecting fish diversity. He and Dr. Suttkus are continuing to collect data on carp and buffalo suckers. Hank expressed his concern over the lack of progress in hiring a curator for the Auburn University fish collection.

Melvin Warren with the U.S. Forest Service Hydrology Lab in Oxford, Mississippi, continues to work on fish and mussel community structure in the Sipsey Fork of the Black Warrior River, and has added Shoal Creek in the Coosa River drainage to the study. He has organized and is chairing a symposium at the American Fisheries Society Tampa meetings on changes in fish communities inferred from long-term and large-scale fish data sets in the southeastern United States, co-sponsored by the AFS endangered species committee and SFC. Lastly, Henry Robison is working with Melvin and Bill Matthews on getting the data base from the Fishes of Arkansas book into a GIS compatible format.

Steve Ross at the University of Southern Mississippi is still working on the state fish book for Mississippi, and plans on producing a first draft this year. He has completed a survey of disjunct populations of *Phoxinus erythrogaster*, and will soon submit a manuscript to the Proceedings. His graduate students are working on projects dealing with use of floodplains by fishes, the costs and benefits of using these habitats, habitat use of *Menidia clarkhubbsi* on a barrier island, and the life history and reproductive strategy of *Pteronotropis signipinnis*.

Carol Johnston of the U.S. Forest Service Hydrology Lab in Oxford, Mississippi, has finished a study on the life history of *Etheostoma raneyi*, and is working up the data on *Pteronotropis welaka* ecology with Charles Knight. She and a student are initiating a study on movement and home ranges of fishes in the Ouachita Highlands. Carol is also working on the population dynamics of rare fishes in the Conasauga River, Coosa River Drainage, along with Conservation Fishes, Inc.

Geological Survey of Alabama biologists finished and will soon publish a four-year biological and water quality study of the upper Cahaba River; over nutrification and nonpoint pollutants are affecting the river's biodiversity. Tom Shepard finished a status survey of *Notropis cahabae* and found them to exist from Centreville to Piper Bridge in Bibb Co., Alabama, with the stronghold still at Riverbend; the results are published in GSA Circular 181. Stuart McGregor completed the final year of a status survey of *Etheostoma boschungi* and will soon publish the results in GSA Circular 184; he found the species using its known spawning sites, discovered additional spawning sites, and is describing a different type of breeding habitat. Scott Mettee and Pat O'Neil continue work on *Alosa alabamae*, which include studies on age and growth, sexual dimorphism, and spawning. Field efforts in 1995 include completion of *Alosa alabamae* sampling, initiation of fish and mussel surveys in the Tennessee River drainage, and status surveys of *Cyprinella callitaenia* and *Noturus munitus*.

Randy Haddock from the Cahaba River Society in Birmingham reports that the Society is continuing to promote greenways as buffer zones in metropolitan areas. It has helped establish the Alabama State Rivers Coalition, a group of conservation organizations promoting protection of rivers in the state, and the Society has produced an educational package about the Cahaba River for grade-school students.

Malcolm Pierson of Alabama Power continues to work on aquatic gastropods throughout the state of Alabama.

Bob Stiles at Samford University in Birmingham has noticed extensive clear-cutting in the Weogufka Creek watershed, Coosa River drainage. This is one of the few places in Alabama where *Cyprinella caerulea* is still extant, and he is concerned about the possible impact clear-cutting may have on this population.

Mary Freeman at Auburn University has a draft finished on the description of the Halloween darter, a species located in the Apalachicola River drainage. She has also undertaken a detailed habitat analysis study of the Tallapoosa River, and is still involved in the tri-state water use study which ultimately will result in habitat modeling for the region.

Carl Couret from the U.S. Fish and Wildlife Service office in Daphne, Alabama, has been studying tailwater fisheries protection and enhancement below several of the hydroelectric dams in Alabama, and he is involved in GIS system development projects.

Frank Parauka at the Service's office in Panama City, Florida, searched for, but did not locate, the Alabama sturgeon last summer and fall, and plans to continue the hunt this spring. Twenty-five gulf sturgeon, mostly subadults, were radio-tagged and released in the Choctawhatchee River last year. A few individuals moved upstream, one as far as Geneva, Alabama, but most stayed in the same area, even after last years flood. He plans to tag adults and to profile habitats on the river this year. Genetic studies of several gulf sturgeon populations from the Pearl to the Suwannee River indicate that several of these populations appear to be distinct.

Bud Freeman at University of Georgia is conducting a survey for Halloween darters and is studying the spawning behavior of *Percina antesella*. He is also identifying critical threats to the Conasauga and Etowah river systems.

Chuck Lydeard at the University of Alabama is continuing his studies on the molecular systematics and conservation genetics of freshwater snails and mussels of the southeast. Herb Boschung continues to work on a state fish book for Alabama along with Rick Mayden. Rick is also conducting survey and status studies of *Etheostoma ditrema*, *E. chermocki*, and *Speoplatyrhinus poulsoni*, as well as surveying the aquatic fauna of the Sipsey River (Tombigbee River drainage) in Fayette Co., Alabama. He is also continuing a study on the effects of malathion on an upper Tombigbee River tributary.

Bernie Kuhajda

REGION V - Northwest

Henry Robison and Bruce Thompson continue to work on the description of the longnose darter form in the Ouachita River system. Robison hopes for completion of the description and submittal of manuscript in 1995.

Henry Robison is conducting a status survey of *Notropis ozarcanus* in the Arkansas portion of its range for the U.S. Fish and Wildlife Service. Bill Pflieger is doing the same for the Missouri portion. Robison's report is due in 1995.

Jim Johnson and students continue their work with *Amblyopsis rosae* in the Logan Cave system in northwest Arkansas. Their mark and recapture work has yielded population estimates three times larger than previous estimates based on visual observation. They have found the Ozark cavefish to be very mobile, moving up to a kilometer in six months. The cavefish prefer pool habitats, and over 80% of their captures have come from major pools within the system. They have observed large scale migration into and out of Logan Cave with total replacement of the population occurring within a year. Also, Jim reports there has been a major ceiling collapse near the entrance of Cave Springs Cave which was previously thought to have the largest number of Ozark cavefish.

A major threat to water quality of Logan Cave is apparently going to be constructed in the form of the Northwest Arkansas Regional Airport. An Environmental Impact Statement has been completed and land acquisition for the project is underway. The proposed airport location is on top of the recharge area for Logan Cave, and the potential for water quality degradation from stormwater runoff and associated petroleum hydrocarbon contamination are of great concern.

Mercury contamination in higher trophic-level fishes continues to be an issue in Arkansas and Louisiana. A Mercury Task Force with funding from EPA, the Arkansas Department of Pollution Control and Ecology, and the Arkansas Game and Fish Commission was established in 1994 with a funded chairman and funds for sampling, testing and analysis of sources. Final reports are due soon. Mercury advisories continue to be in effect in south Arkansas, and additional lakes and streams in western and central Arkansas have been found with high fish flesh mercury levels.

Bill Pflieger is working on the second edition of the Missouri Fishes book. A three year re-survey project is in the works by Missouri Department of Conservation biologists with completion due in 1997. The second edition will be published sometime after that.

Kim Graham, Missouri Department of Conservation, has a graduate student performing status surveys for the sturgeon and sicklefin chubs.

The Mississippi Interstate Cooperative Resource Association (MICRA) has received a $200,000 Federal Grant to tag and study paddlefish movements in the 17-state region. MICRA hopes the study will allow for integration of good paddlefish management into long range water regulation/ allocation plans for the MICRA states.

The Corps of Engineers is re-drafting its water regulation plan for the Missouri River basin. Kim Graham reports Missouri Department of Conservation is pushing for a more natural hydrography in the plan that will allow for spring peaks, summer lows, and a fall rise. Return to a more natural hydrography should benefit some of the imperiled big river fishes of the basin.

There is good news on the stream modification front. A proposed public water supply impoundment project for the North Fork Saline River, a significant portion of *Noturus lachneri* range, has been abandoned. Opposition from the U.S. Fish and Wildlife Service, the Arkansas Game and Fish Commission, and grass roots citizens groups persuaded the Arkansas Department of Pollution Control and Ecology to uphold a protected stream designation. An alternative project to impound a North Fork Saline River tributary (Dog Creek) is in the developmental stages. Also, Arkansas Game and Fish Commission plans to impound Sullivan Creek (White River drainage) to create a public fishing lake have been abandoned due to public opposition and Corps of Engineers insistence that an Environmental Impact Statement be prepared.

There is bad news on the stream modification front. Business interests and citizens groups are promoting additional development of commercial shipping on the White River upstream to at least Newport, Arkansas. Currently, the Corps of Engineers maintains a 100-foot wide, nine foot deep navigation channel. Proponents of additional improvements are pushing the concept of a 200-foot wide navigation channel. In some upstream areas, this would encompass almost full channel width. This may be an issue that we request the SFC get involved with as it develops.

Also on the White River, there is a plan in the developmental stages to remove water from the river during high stages for storage and use in irrigation. Eastern Arkansas has experienced chronic groundwater level depletion over the last 20 years due to irrigation, and this project is sought by the agricultural community as a solution. The Arkansas Game and Fish Commission has worked to assure that water is removed only during highwater stages and minimum stream flow standards are maintained. Implications of this project are complicated by the recent discovery of the exotic zebra mussel (*Dreissena polymorpha*) in the White River.

The Arkansas Legislature is wrangling over a bill to prohibit instream gravel mining in 24 high quality Arkansas streams. These streams have been designated as extraordinary resource waters and include many of the Ozarks least disturbed water bodies. The bill was approved by the Senate on 1 March and now moves to the House. Opposition to the bill is intense and debate continues as of this writing.

The zebra mussel was found in the Arkansas River in 1992 and occurs throughout that river's mainstem in Arkansas. The zebra mussel was found in the White River at Clarendon, Arkansas in 1994 at a barge docking facility. Arkansas Game and Fish Commission biologists and a state Zebra Mussel Task Force are monitoring population levels and range expansion.

John L. Harris

REGION VI - Southwest

Neil Douglas and his students are primarily working in Mississippi, but one of his students, M'Lee Loe, has completed a study on the effect of group size and underwater structure on velocity preference on *Lepomis gulosus*. Frank Pezold has several graduate students working on freshwater fish projects. Lisa Loe is examining larval fish distributions in relation to a Little Blue Heron rookery in a swamp along Red Chute Bayou. Steve Dupre' is studying habitat associations of riffle-inhabiting darters in Trout Creek (Little River, LA drainage). Luzette Kincaid is analyzing physical habitat classification as applied to Ouachita Mountain headwater stream systems and species/physical parameter associations in those streams. Frank is working on a USFWS project focusing on seasonal and ontogenetic exploitation by fishes of a managed wetland. Work is also continuing on diet selectivity by darter species in Trout Creek.

Hank Bart is continuing his revisionary work on the ictiobine suckers with Royal Suttkus. Hank is also taking part in a DOE study of aquatic contaminants in lower Mississippi River floodplain swamps. The project is focused on the transport of toxins through the swamps and Hank is looking at the effects of the contaminants on floodplain fish communities.

In Texas, Kirk Winemiller and others at Texas A&M have been studying the Brazos River oxbow lake ecosystems for two years. The research has several foci, including the relationship between landscape features and biodiversity within the watershed and the relationship between life-history strategies, food-web structure and recruitment. For species like largemouth bass, the oxbows are species-sources and the river primarily a conduit for dispersal. A student of Kirk's, Allison Anderson, has been studying the role of life-history in determining fish assemblage response to flood control structures of the San Gabriel River. Allison, Kirk, Robert Edwards (Univ. Texas-Pan American) and Clark Hubbs have just completed a study of historical changes in the Texas freshwater fish fauna spanning a 30+ year period. Loren Moriarty, also at A&M, has studied fish assemblage/habitat relationships in Village Creek, a blackwater stream in the Roy Larson Sandylands Sanctuary (TNC) in the Neches drainage.

Major Texas Parks and Wildlife projects in eastern Texas have involved the reestablishment of paddlefish throughout their historic range and an attempt to counteract hybridization of introduced smallmouth bass with the Guadeloupe bass. Starting with Johnson Creek (Guadeloupe River drainage) and the Blanco River, the Department is trying to wash out the smallmouth genes by overwhelming local breeding populations (typified by hybrid swarms) with a massive restocking of genetically-certified Guadeloupe bass lab-reared from natural stock. Another Texas note, *Notropis girardi*, the Arkansas River shiner, only occurs over 10-20% of its natural range. Although there have been studies by Oklahoma researchers documenting the problem, apparently there is no favor to be found with Texas legislators for pursuing a solution.

F. Pezold

ANNOUNCEMENT

An invited symposium, jointly sponsored by the SFC and the Endangered Species Committee of the American Fisheries Society (AFS), has been approved for the 125th Annual Meeting of AFS, 28 Aug-1 Sep, in Tampa, FL. The day-long symposium is entitled "Imperiled Fishes and Aquatic Communities Across the Southern Landscape: Spatiotemporal Data Bases for the 21st Century." The impetus for the symposium is to highlight the application of long-term or large-scale aquatic data sets and present creative approaches to illuminating factors at multiple spatial and temporal scales that interact to affect species diversity, ecological function of aquatic communities, and habitat in southeastern running waters. Specific objectives are to: (1) availability and potential applications of existing data, including contemporary systematics, historical ecology, GIS methods; (2) enhance communication between resource agencies and researchers concerning creation, maintenance, and use of large data bases for endangered fishes and other aquatic fauna; and (3) focus on realized and potential problems attendant to the future of the southeastern aquatic fauna and germinate coordinated efforts at using the data in hand for betterment of the resource. Twelve invited papers are scheduled for the symposium as follows:

Robert C. Cashner[1] and Brooks M. Burr[2]. ([1]Dept. Biological Sciences, Univ. of New Orleans and [2]Dept. Zoology, Southern Illinois Univ.). Status of Fish Collections in the South: Their Value and Uses as Documentation Centers of Diversity.

Richard L. Mayden (Dept. Biology, Univ. of Alabama). Biodiversity and Conservation of Fishes in the South: Lessons from Historical Ecology.

Stephen T. Ross (Dept. Biology, Univ. of Southern Mississippi). A GIS Database of Mississippi Fishes: Approach, Problems, and Application to Conservation Issues.

Frank Pezold, Steven George, Robyn Jordan, Christopher Metcalf, and Neil Douglas (Dept. Zoology, Northeast Louisiana University). Dusting off the Jars: Using Museum Collections in Studies of Fish Ecology and Fisheries Management.

Paul Angermeier and Matthew R. Winston (Va. Coop. Fish and Wildlife Research Unit, National Biological Survey, Virginia Tech). Ecology and Taxonomic Approaches to Recognizing the Diversity of Fish Assemblages in Virginia.

Allison Anderson[1], Clark Hubbs[2], Kirk Winemiller[1], and Robert Edwards [3] ([1]Dept. Fish and Wildlife Science, Texas A&M Univ., [2]Dept. Zoology, Univ. of Texas, and [3]Dept. Biology, Univ. of Texas - Pan American). Texas Freshwater Fish Assemblages Following Three Decades of Environmental Change.

William J. Matthews[1], Henry W. Robinson[2], and Edie Marsh[3] (Univ. of Oklahoma Biological Station, [2]Biology Dept., Southern Arkansas Univ., and [3]Dept. Biology, Angelo State Univ.) Stream Fish Assemblages in Arkansas Uplands: Quantifying Variance in Space and Time by Use of Historical Collections.

Noel Burkhead and Stephen Walsh (Southeastern Biological Science Center, National Biological Survey). Correlates of Demise: Case of the Southern Appalachian Fish Fauna.

Joseph P. Buckley and Henry L. Bart (Museum of Natural History, Tulane Univ.). Navigation Related Changes in Alabama River Fish Communities Over a 20-Year Interval.

Christopher A. Walser and Henry L. Bart (Museum of Natural History, Tulane Univ.). Fish Community Structure and Land Use in Watersheds of the Chattahoochee River System: Historical and Present-Day Assessment.

Noel F. Ocampo, Jayne Brim-Box, James D. Williams, and Ricardo C. Lattimore (Southeastern Biological Science Center, National Biological Survey). Use of Historic Freshwater Mussel Data in the Management of Aquatic Resources of the Apalachicola River Basin.

Leo G. Nico (Southeastern Biological Science Center, National Biological Survey). Tracking Introduced Fishes in the Southeastern United States.

We urge the SFC membership to attend the AFS meeting in support of the co-sponsored symposium and to build awareness of SFC purpose, goals, and activities with our AFS colleagues. For more information contact the symposium organizer and chair, Mel Warren, at Southern Research Station, USDA Forest Service, Forest Hydrology Lab, P.O. Box 947, 1000 Front St., Oxford, MS 38655; 601/234-2744; Fax 234-8318; FSWARREN@VM.CC.OLEMISS.EDU.

Southeastern Fishes Council
PROCEEDINGS

Information For Contributors

The primary purpose of the PROCEEDINGS is to publish research papers, critical reviews of activities, area reports and other pertinent information pertaining to the biology and conservation of Southeastern fishes

Manuscripts should be submitted in duplicate. A good guide for manuscript preparation is the Fifth Edition of the *CBE Style Manual* available form the Council of Biology Editors, One Illinois Center, Suite 200, 111 East Wacker Drive, Chicago, IL 60601-4298.

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