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Status and distribution of *Phenacobius teretulus*, *Etheostoma osburni*, and "*Rhinichthys bowersi* " in the Monongahela National Forest, West Virginia

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ABSTRACT

We examined the status and distribution of *Phenacobius teretulus* (Kanawha minnow), *Etheostoma osburni* (candy darter), and "*Rhinichthys bowersi*" (Cheat minnow) in the Monongahela National Forest, West Virginia. We collected fishes using backpack electroshocking equipment at sites where previous investigators collected these species. Patterns of abundance were compared between historic and recent collections and examined for evidence of species decline. Results indicated that *P. teretulus* and *E. osburni* may be less abundant or absent in several streams that supported populations in 1978 and 1979. In addition, "*R. bowersi*" remains rare to infrequent in streams of the Monongahela National Forest.

INTRODUCTION

Information about the status, location, and distribution of rare and endemic species enables us to develop effective management strategies, establish priorities for conservation of species, monitor changes in status, and identify the progress of restoration attempts (Jenkins, 1988). In 1974, the National Forest Management Act required the USDA Forest Service to maintain biological diversity on U.S. Forest Service lands. As a result, regional lists of sensitive plants and animals have been developed for U.S. Forest Service lands.

Five fishes are designated as 'sensitive' in the Monongahela National Forest (MNF), West Virginia. Historically, three of these, the candy darter *(Etheostoma osburni)*, the Kanawha minnow *(Phenacobius teretulus)*, and the Cheat minnow *("Rhinichthys bowersi"*, a presumed hybrid *R. cataractae* X *Nocomis micropogon*), were collected in the MNF (Goldsborough and Clark, 1908; Addair, 1944; Hocutt et al., 1978; Hocutt et al., 1979; Stauffer et al., 1979;). Of the other two species, the redside dace *(Clinostomus elongatus)* maintains a limited distribution near MNF boundaries, whereas the presence of the longhead darter *(Percina macrocephala)* has not been verified from streams in the MNF (Dan Cincotta, West Virginia Division of Natural Resources, pers. com.).

The Kanawha minnow and the candy darter are endemic to the upper Kanawha River system which includes the Greenbrier and Gauley River drainages in the

1 The Unit is jointly sponsored by the U. S. Fish and Wildlife Service, the West Virginia Division of Natural Resources, West Virginia University, and the Wildlife Management Institute.

MNF (Figure 1). Endemism in the upper Kanawha River is reportedly high and is believed to be associated with a waterfall 7.3 m high, which isolates this system from the lower Kanawha River drainage (Hocutt et al., 1979).

The Cheat minnow occurs primarily in the Monongahela River Basin, which includes the Cheat River system. The Cheat River drainage is located in the northwestern section of the MNF (Figure 1).

We examined the status and distribution of sensitive fishes in the MNF, and when possible, compared distribution and abundance with historical information for evidence of species decline. In addition, we identified human activities that may be affecting these species' distributions and abundances.

METHODS

Study Area

The Monongahela National Forest is located in the mountainous, eastern part of West Virginia. The topography consists of low valleys interspersed with north-east-southwest ridges. Elevation ranges from 274 m at Petersburg, WV to 1,219 m along North Mountain in Pendleton County, WV (USDA, 1986).

The Monongahela National Forest contains about 857 km of permanently flowing streams. Native brook trout *(Salvelinus fontinalis)* populate approximately 310 km of streams. About 220 km of streams are considered suitable for warmwater fisheries. Eighty km of streams are considered acidic and do not have fish populations (USDA, 1986).

Field Methods

We sampled a total of 55 stations on 19 streams between May and August 1991. We sampled locations where previous investigators collected these sensitive fish species (Hocutt et al., 1978; Hocutt et al., 1979; Stauffer et al. 1979; and Stauffer, 1986 unpublished data). If we did not collect sensitive fish species at historic locations, additional sampling attempts were made at stations above and below the original site. Other stations were chosen based on proximity to historic locations and presence of suitable habitat.

We collected fish with a backpack electroshocking unit (AC current) and two 5-mm-mesh dip nets. At each station, we delineated all available meso-habitats (eg. riffle vs. run vs. pool) and sampled each habitat type separately. Upstream and downstream block nets (4-mm mesh) were used to delimit each meso-habitat type and sampling was conducted in an upstream direction. We sampled fishes until additional effort yielded few or no specimens. This was usually accomplished after three to four consecutive passes were made through a site. Density was determined by calculating the areal dimension (width x length) of each meso-habitat type and expressed as fish/1,000 m^2. Density estimates are based only on the meso-habitat area in which a sensitive fish species was collected and not the total area sampled at each station.

We identified and counted all fishes before releasing them. Specimens that could not be identified in the field were fixed in 10% formalin and returned to the laboratory for identification.

Because results from historic surveys were qualitative in design (i.e. no CPUE indices, densities, etc.), we could not perform statistical comparisons between our

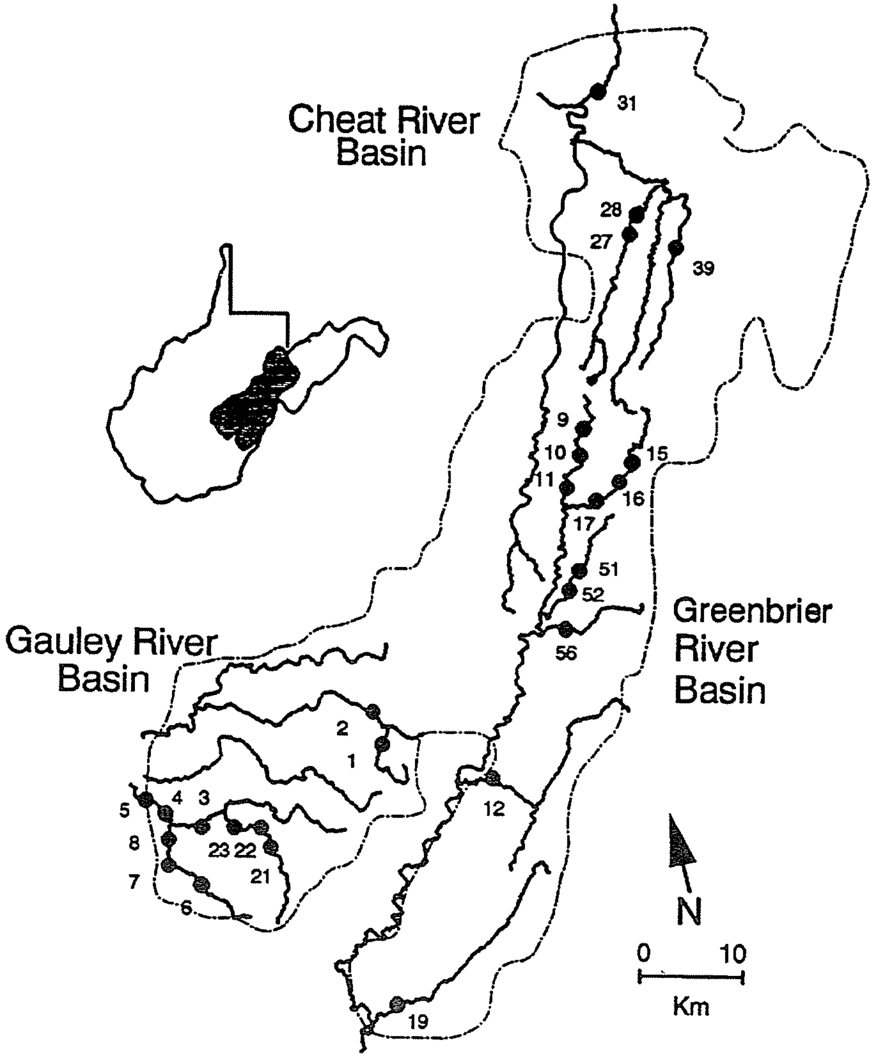

FIGURE 1. Map of streams sampled in the Monongahela National Forest, WV. All stations, with the exception of 1 and 51, represent successful collection sites during the 1991 survey.

results and the earlier reports. Instead, we examined patterns in raw abundance data for evidence of species decline. We assumed that our sampling efficiency (i.e. depletion effort) was equal to or exceeded that of the earlier investigations and provided at least a conservative measure for comparison. For example, during historic surveys, sampling effort was aimed at collecting a representative sample of all species present (Hocutt et al., 1978; 1979). With the exception of larger streams and rivers (i.e. the Greenbrier and Gauley rivers), samples were collected with seines (3.2 and 3.6 mm mesh) or AC/DC electroshocking equipment (Hocutt et al., 1978; 1979).

RESULTS AND DISCUSSION

Kanawha Minnow

Kanawha minnows (N=37) were obtained from four stations in the East and West forks of the Greenbrier River (Table 1). We collected over half (19) of these specimens at Station 16 in the East Fork Greenbrier River (Table 1; Figure 1). The abundance of Kanawha minnows was highest at this station; density was estimated as 30 fish/1000 m^2. Although we found this species in the West Fork Greenbrier River (Station 11), its density was very low (1 specimen collected). The Kanawha minnow was not captured at stations in the Williams River (Addair, 1944) or Laurel Creek (Hocutt et al., 1978).

The Kanawha minnow, an endemic to the upper Kanawha River system, is generally distributed throughout the New River drainage in Virginia, West Virginia and North Carolina. In North Carolina, the Kanawha minnow is considered an endangered species (Williams et al., 1989). In West Virginia, it is rare in both the Greenbrier and Gauley River drainages. Hocutt et al. (1978) reported 2 specimens from the West Fork of the Greenbrier River and 1 specimen from the East Fork Greenbrier River. In their later survey of the Gauley River system, Hocutt et al. (1979) reported only 2 specimens from Laurel Creek, a tributary of the Cherry River.

Addair (1944) reported finding the Kanawha minnow in Indian Creek (Monroe County, WV), a tributary of the New River. Its present occurrence in this drainage, however, is questionable. It was not found in Indian Creek during surveys by Stauffer et al. in 1980 (unpublished data) (Dan Cincotta, pers. com.).

We believe that the Kanawha minnow is well established in the upper East Fork Greenbrier River. Our collection of 36 specimens is the largest record from West Virginia. The single specimen captured in the West Fork Greenbrier River, combined with historic reports of infrequent specimens, suggests that the Kanawha minnow is less abundant in the West Fork Greenbrier River.

The presence of an industrial tannery approximately 2 km below Station 17 on the East Fork Greenbrier River should generate concern for this species. Only tolerant species (i.e. creek chub, *Semotilus atromaculatus*, sunfish, *Lepomis spp*., fantail darter, *E. flabellare*) occur directly downstream of the tannery discharge. Hence, water quality conditions below the tannery may be limiting the dispersal of the East Fork Greenbrier population. This isolation could have an important influence on the re-establishment of Kanawha minnow populations in West Virginia. Small, isolated populations, such as those of the Kanawha minnow, are more likely to lose genetic variation and suffer from inbreeding depression (Hedrick, 1992).

The status of the Kanawha minnow in Laurel Creek is unknown. In this stream, where Hocutt et al. (1979) reported two specimens, we did not collect the Kanawha minnow. The water quality in Laurel Creek appears to have been affected by strip mining operations downstream from the historic collection site (Station 6). Acidic conditions (pH = 3.4) were measured near the mid-section of the stream. Water quality improved below the mid-section and supported tolerant species. These conditions, which impacted nearly half of the stream, may have had adverse affects

TABLE 1. Kanawha minnow collection sites by stream in the Monongahela National Forest. Abundance data from historic and recent investigations are given. Fish densities (fish/1000 m^2) from the 1991 survey are in parentheses.

No. collected (Hocutt et al., 1978;1979)	No. collected (This study; 1991)		Location and Station No.
Not sampled	5	(6)	East Fork Greenbrier River, 2.4 km above Pocahontas 4H Camp. Station 15.
Not sampled	19	(30)	East Fork Greenbrier River, 1.6 km below Pocahontas 4H Camp on USFS access road. Station 16.
1	12	(13)	East Fork Greenbrier River, 28/19 bridge, Thornwood. Station 17.
2	1	(1)	West Fork Greenbrier River, Rt. 250 bridge. Station 11.
2	0	(0)	Laurel Creek, confluence with McMillon Run. Station 6.

on the Kanawha minnow, which presumably prefers streams with circumneutral pH (Hambrick et al. 1975).

The Kanawha minnow has not been reported from the Williams River since the mid 1930's (Addair, 1944). Hocutt et al. (1979) did not collect the Kanawha minnow in the Williams River during their survey of the Gauley River System. It is unclear what factors have led to the apparent absence of the Kanawha minnow in the Williams River. Silviculture is the predominant land use in this watershed but is not believed to have a significant impact on water quality (George Hudack, U.S. Forest Service, pers. com.). During our investigation, we observed turbid water conditions in the Williams River, particularly following rainfall. Excessive siltation is considered an important factor limiting usable fish habitat (Berkman and Rabeni, 1987).

The Williams River is also managed as a premier trout fishery. It annually receives 27,000 pounds of trout and ranks fourth among trout-stocked streams in West Virginia (Wildlife Resources Division, 1989). Studies by Krueger and Menzel (1979), suggest that hatchery trout exert selective pressures on wild stocks induced by ecological interactions between species. Competition for space between introduced brown trout (*Salmo trutta*) and a native galaxiid species was demonstrated in studies by McIntosh et al. (1992). Additionally, Lemly (1985) has shown that native fish populations were suppressed when green sunfish (*Lepomis cyanellus*) were introduced into streams. To date, however, the effects of trout stocking on native West Virginia fishes has not been studied.

Acidic precipitation may also be a limiting factor. Acidic precipitation is particularly detrimental in the Appalachian region (Dillon et al., 1984).

Hocutt et al. (1978) suggested that the West Virginia Division of Natural Resources list the Kanawha minnow as a threatened species. Though the Kanawha minnow ranges from infrequent to common in the East Fork Greenbrier River, our data suggest that its distribution in West Virginia is declining. Because we did not collect the Kanawha minnow from either the Williams River or Laurel Creek, we believe that the Kanawha minnow warrants a status survey for potential federal listing, pursuant to the Endangered Species Act as a threatened or endangered species.

Candy Darter

We collected candy darters (N = 96) at 20 sampling stations in 10 streams (Table 2). These stations were located in all previously sampled streams (Addair, 1944; Hocutt et al., 1978; Hocutt et al., 1979). Fourteen specimens were collected at Station 6 in Laurel Creek and at Station 4 in the Cherry River (Table 2; Figure 1). The highest density, 33 fish/1000 m^2, was at Station 6 in Laurel Creek. The Williams River, Deer Creek, and Anthony Creek yielded only one specimen each.

The candy darter is distributed throughout the lower New River drainage in West Virginia and Virginia. Burkhead and Jenkins (1991) suggest that the species is disappearing in the lower New River (upper Kanawha) system of Virginia. The candy darter has been listed as a species of "special concern" over its entire range in Virginia and West Virginia (Williams et al., 1989).

The candy darter is well established in the Cherry River system of the upper Gauley River, where it ranges from infrequent to common. It is also common in the East and West forks of the Greenbrier River. We are concerned about its status in Deer Creek (Station 51), Anthony Creek (Station 19), and the Williams River (Station 2). These streams were among the most productive in yielding candy darters during the late 1970's. For example, at Stations 2 and 19 where Hocutt et al. (1978; 1979) reported 25 and 10 specimens, we collected only one specimen at each station. Moreover, our collections in Deer Creek (Station 51) resulted in only one specimen, whereas Hocutt et al. (1978) collected 11 specimens at a nearby locality. Of 11 stations (10 streams) sampled in the late 1970's, only 3 stations (3 streams) produced more specimens during the 1991 investigation (Table 2). These data indicate that the candy darter may be declining in several streams that supported populations in 1978 and 1979.

The major threat to candy darter populations may be siltation (Berkman and Rabeni, 1987; Burkhead and Jenkins, 1991). Excessive siltation characterized areas where the candy darter was absent or much diminished. Trout stocking may also negatively affect the candy darter (Kuehne and Barbour, 1983). In addition, wading by anglers may exert some control on darter populations, especially in heavily-fished streams (Burkhead and Jenkins, 1991).

The brightly colored candy darter may also be more susceptible to predation. Brightly colored darters are often more conspicuous and may therefore be constrained by predation (Page and Swofford, 1984). The fact that we did not collect this species in pools or areas inhabited by large, piscivorous fish (e.g. centrarchids and salmonids) is consistent with the predation risk hypothesis (Power, 1987).

TABLE 2. Candy darter collection sites by stream in the Monongahela National Forest. Abundance data from historic and recent investigations are given. Fish densities (fish/1000 m^2) from the 1991 survey are in parentheses.

No. collected (Hocutt et al., 1978;1979)	No. collected (This study; 1991)		Location and Station No.
Not sampled	3	(6)	East Fork Greenbrier 2.4 km above 4H Camp. Station 15.
Not sampled	5	(14)	East Fork Greenbrier River, 1.6 km below Pocahontas 4H Camp on USFS access road. Station 16.
11	12	(22)	East Fork Greenbrier River, at Route 28/19 bridge, Thornwood Road. Station 17.
Not sampled	3	(2)	West Fork Greenbrier River, at Iron Bridge. Station 9.
Not sampled	1	(2)	West Fork Greenbrier River, below Fill Run. Station 10.
9	3	(2)	West Fork Greenbrier River, at Route 250 bridge. Station 11.
11	0	*	Deer Creek, Pocahontas County below Rt. 28 bridge *c* 120 meters. Station 51.
Not sampled	1	(1)	Deer Creek, Route 66 bridge. Station 52.
21	3	**	Sitlington Creek, Route 28 bridge, Dunmore. Station 56.
5	3	(5)	Knapp Creek, 5.3 km E. of Marlinton on US Route 39 bridge. Station 12.
10	1	(1)	Anthony Creek, at Anthony. Station 19.
25	0	(0)	Williams River, 4.8 km from Handley on Williams River Road. Station 1.
0	1	(1)	Williams River, below Rt. 150 Scenic Highway. Station 2.
Not sampled	6	(15)	South Fork Cherry River 7.2 km above bridge on Johnstown Road. Station 21.

CONTINUED

TABLE 2 CONTINUED.

No. collected (Hocutt et al., 1978;1979)	No. collected (This study; 1991)	Location and Station No.
7	6 (17)	South Fork Cherry River, 5.3 km above bridge on Johnstown Road. Station 22.
Not sampled	9 (21)	South Fork Cherry River, 4 km above bridge on Johnstown Road. Station 23.
7	14 (33)	Laurel Creek, confluence with McMillon Run. Station 6.
Not sampled	1 (1)	Laurel Creek, 1.6 km below Island Creek Coal Company. Station 7.
Not sampled	2 (4)	Laurel Creek, at Route 20/13 bridge. Station 8.
Not sampled	6 (12)	Cherry River, at Pratt Park, Richwood. Station 3.
5	14 (23)	Cherry River, Rt. 20 Bridge at Holcomb. Station 4.
3	2 (3)	Cherry River, confluence with Gauley River. Station 5.

* This station located 0.5 km upstream of historic site.
** This station was sampled in September 1991 and was located immediately downstream of Rt. 28 bridge. Density estimates were not calculated for this site.

We believe that the candy darter may be less abundant in several West Virginia streams that supported populations in the late 1970's. This, combined with a lack of recent records in Virginia (Burkhead and Jenkins, 1991), warrants a more comprehensive status survey of the candy darter for potential federal listing.

Cheat Minnow

Cheat minnows (N=8) were collected at four stations in three streams (Table 3). Three specimens were obtained from Station 28 in Glady Fork, 3 from Station 31 in Horseshoe Run, 1 from Station 39 in the Dry Fork River, and 1 specimen from Station 27 in Glady Fork (Table 3; Figure 1). The highest density was at Station 31 of Horseshoe Run with 10 fish/1000 m^2. We failed to collect the Cheat minnow at the historic localities reported by Stauffer et al. (1979). Thus, we were unable to compare collections by date as we did with the Kanawha minnow (Table 1) and the candy darter (Table 2).

TABLE 3. Cheat minnow collection sites by stream in the Monongahela National Forest.

Number of specimens	Density; fish/1000 m^2	Location and Station No.
1	1	Dry Fork, 0.6 km below WV Natural Heritage building off of US Route 32. Station 39.
1	1	Glady Fork, above confluence with Three Springs Run. Station 27.
3	4	Glady Fork, 0.8 km below gate on USFS Route 162. Station 28.
3	10	Horseshoe Run, at Horseshoe Campground. Station 31.

The Cheat minnow has been collected in the upper Cheat River system since 1899 (Stauffer et al. 1979). Recent accounts of the Cheat minnow in the MNF include surveys by Cincotta et al. 1986, Stauffer (1986, unpublished data), and the West Virginia DNR in 1990 (Dan Cincotta, pers. comm.). Stauffer's 1986 unpublished report on the status and distribution of the Cheat minnow in the Monongahela Basin did not include collections from the Dry Fork River (Goldsborough and Clark, 1908; Stauffer et al., 1979) or Horseshoe Run (Stauffer et al., 1979). Our recent records from Dry Fork River and Horseshoe Run reaffirm occurrence of the Cheat minnow in these drainages.

Data on previous records of the Cheat minnow indicate that abundance of this fish was relatively high in the upper Shaver's Fork of the Cheat River drainage (Raney, 1940; Stauffer et al., 1979). Stauffer (1986, unpublished data) suggested that a threat to the Cheat minnow population in Shaver's Fork was a coal washing plant located near the Route 250 bridge. In addition, acidic precipitation and increased siltation (from road construction) may have the most adverse effects on fish populations in the upper Shaver's Fork (Dan Cincotta, pers. com.).

The Dry Fork River has been subjected to channel modifications through periodic dredging near Harman, WV (Cal Casipit, U.S. Forest Service, pers. com.). It is unclear whether these activities have adverse effects on Cheat minnow populations in the Dry Fork. Portt et al. (1986), however, showed that in general, fish biomass and production were much reduced in channelized areas.

Cheat minnow populations in Horseshoe Run and Glady Fork are not subjected to obvious cultural perturbations. These streams are managed by U.S. Forest Service guidelines.

At present it is unclear whether the Cheat minnow represents a distinct species. Stauffer et al. (1979) discussed meristic and morphometric characteristics of the Cheat minnow. Their findings suggest that the Cheat minnow is a hybrid between the longnose dace *Rhinichthys cataractae* and the river chub *Nocomis micropogon*. Stauffer et al. (1979) also stated that the Cheat minnow showed all the characters of a valid species. Goodfellow et al. (1984) provided biochemical evidence that indicates the Cheat minnow is a valid species.

The Cheat minnow remains rare and infrequent in the MNF and warrants consideration as a protected species. We believe that the Cheat minnow should also be evaluated for protective status in streams of the Monongahela River Basin.

SUMMARY

Our observations indicate that the Kanawha minnow and the candy darter may be reduced or absent in several streams in the MNF. In addition, the Cheat minnow remains rare and infrequent in MNF streams.

The fragmentation of existing populations, caused by continued human disturbances, may pose the greatest threat to sensitive and endemic fish species in West Virginia. The effects of acidic precipitation combined with increasing siltation in many streams appear among the most significant disturbances. The introduction of exotic species should also be carefully considered, because their influence on native fishes is not well understood. Until there is a better understanding of these species' distributions and tolerance to human perturbations, responsible management of these fishes should aim at preserving existing populations and maintaining areas necessary for their production by designating protected habitat.

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LITERATURE CITED

Addair, J. 1944. The fishes of the Kanawha River System in West Virginia and some factors which influence their distribution. Ph.D. Dissertation, Ohio State University, Columbus, Ohio. 225 pp.

Berkman H. E., and C. F. Rabeni. 1987. Effect of siltation on stream fish communities. Environ. Biol. Fishes 18:285-294.

Burkhead, N. M. and R. E. Jenkins. 1991. Fishes. Pp. 321-409 *in*: K. Terwilliger (ed.), Virginia's Endangered Species. McDonald and Woodward Publishing Co. Blacksburg, Virginia.

Cincotta, D. A., R. Miles, M. Hoeft, and G. Lewis. 1986. Discovery of *Noturus eleutherus* and *Percina peltata* in West Virginia with discussion of other additions and records. Brimleyana 12:101-121.

Dillon, P. J., N. D. Yan, and H. H. Harvey. 1984. Acidic deposition: effects on aquatic ecosystems. Pp. 167-194 *in* :Critical Reviews in Environmental Control, Vol. 13. CRC Press Inc., Boca Raton, Florida.

Goldsborough, E. L. and H. W. Clark. 1908. Fishes of West Virginia. Bull. Bur. Fisheries, Washington 27:29-39.

Goodfellow, W. L., C. H. Hocutt, R. P. Morgan II, and J. R. Stauffer, Jr. 1984. Biochemical assessment of the taxonomic status of *Rhinichthys bowersi*. Copeia 1984:652-59.

Hambrick, P. S., R. E. Jenkins, and J. H. Wilson. 1975. Distribution, habitat and food of the cyprinid fish *Phenacobius teretulus*, a New River drainage endemic. Copeia 1975:172-176.

Hedrick, P. W. 1992. Genetic conservation in captive populations and endangered species. App. Pop. Biol. 1992:45-68.

Hocutt, C. H., R. F. Denoncourt, and J. R. Stauffer, Jr. 1978. Fishes of the Greenbrier River, West Virginia, with drainage history of the central Appalachians. Jour. Biogeog. 5:59-80.

Hocutt, C. H., R. F. Denoncourt, and J. R. Stauffer, Jr. 1979. Fishes of the Gauley River, West Virginia. Brimleyana 1:47-80.

Jenkins, R. E. 1988. Information management for the conservation of biodiversity. Pp. 231-239 *in*: E.O. Wilson (ed.), Biodiversity. National Acad. Press, Washington D.C. 521 pp.

Krueger C. C., and B. W. Menzel. 1979. Effects of stocking on genetics of wild brook trout populations. Trans. Am. Fish. Soc. 108:277-287.

Kuehne, R. A., and R. W. Barbour. 1983. The American darters. University of Kentucky Press, Lexington, Kentucky. 189 pp.

Lemly, D. A. 1985. Suppression of native fish populations by green sunfish in first-order streams of Piedmont North Carolina. Trans. Am. Fish. Society 114:705-712.

McIntosh, A. R., C. R. Townsend, and T. A. Crowl. 1992. Competition for space between introduced brown trout *Salmo trutta* and a native galaxiid *Galaxias vulgaris* in a New Zealand stream. J. Fish Biol. 41:63-81.

Page, L. M. and D. L. Swofford. 1984. Morphological correlates of ecological specialization in darters. Environ. Biol. Fishes 11:139-159.

Portt, C. B., E. K. Balon, and D. L. G. Noakes. 1986. Biomass and production of fishes in natural and channelized streams. Can. J. Fish. Aquat. Sci. 43:1926-1934.

Power, M. E. 1987. Predator avoidance by grazing fishes in temperate and tropical streams: importance of stream depth and prey size. Pp. 333-351 *in*: W.C. Kerfoot & A. Sih (ed.), Predation: Direct and indirect impacts on aquatic communities, University Press of New England, Hanover.

Raney, E. C. 1940. *Rhinichthys bowersi* from West Virginia, a hybrid *Rhinichthys cataractae* X *Nocomis micropogon*. Copeia 1940:270-271.

Stauffer, J. R., Jr. 1986. Status of the Cheat minnow, *Rhinichthys bowersi*, in the Monongahela River drainage. Report to G. A. Moser, U. S. Fish and Wildlife Service, Delmarva Area Office, Annapolis, MD.

Stauffer, J. R., Jr., C. H. Hocutt, and R. F. Denoncourt. 1979. Status and distribution of the hybrid *Nocomis micropogon* x *Rhinichthys cataractae*, with a discussion of hybridization as a viable mode of vertebrate speciation. Amer. Mid. Nat. 101:355-365.

United States Department of Agriculture, Forest Service. 1986. Final environmental impact statement: Land and resource management plan, Monongahela National Forest. USDAFS, Elkins, WV. 58 pp.

Wildlife Resources Division. 1989. West Virginia Trout Fishing Guide. WV Department of Natural Resources, Charleston. 40 pp.

Williams, J. E., J. E. Johnson, D. A. Hendrickson, S. Conteras-Balderas, J. D. Williams, M. Navarro-Mendoza, D. E. McAllister and J. E. Deacon. 1989. Fishes of North America; endangered, threatened, or of special concern. Fisheries 14:2-20.