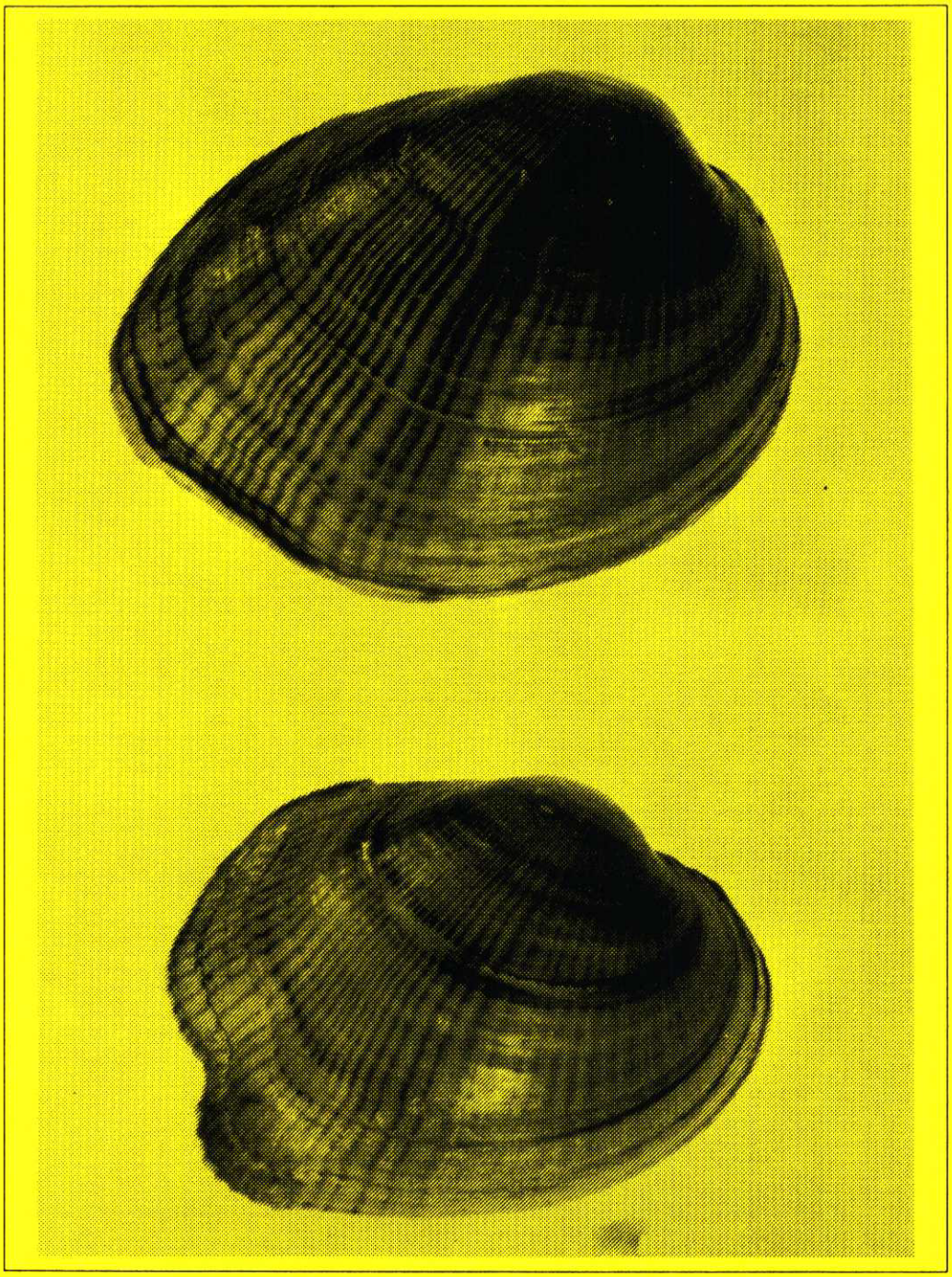
RECOVERY PLAN

WHITE CAT'S PAW PEARLY MUSSEL



U.S. Fish and Wildlife Service

Twin Cities, Minnesota 55111

RECOVERY PLAN FOR THE WHITE CAT'S PAW PEARLY MUSSEL

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for
Region 3
U.S. Fish and Wildlife Service
Twin Cities, Minnesota 55111

Approved: _____
Acting Regional Director,
U.S. Fish and Wildlife Service

Date: 1-25-90

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ACKNOWLEDGEMENTS

The following individuals provided willing and helpful assistance throughout the formulation of this plan. Dr. D. H. Stansbery, The Ohio State University Museum of Zoology, provided access to collections and negatives from which the photographs used in this plan were made. Mr. A. E. Spreitzer took the original photographs and prepared the prints used on the cover and in Figure 1. Dr. J. B. Burch, The University of Michigan Museum of Zoology, provided access to collections. This plan was improved by the comments of many individuals concerned with the continued existence of this and many other freshwater mollusks.

LITERATURE CITATIONS SHOULD READ AS FOLLOWS:

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EXECUTIVE SUMMARY: THE RECOVERY PLAN FOR THE WHITE CAT'S PAW PEARLY MUSSEL

Current Status: This mussel is believed to exist only in a three mile portion of Fish Creek in Ohio. Since 1970 only three living specimens and three recently deceased individuals have been collected. The low population level makes the mussel extremely vulnerable to extinction due to deteriorating water quality from contaminants, as well as habitat destruction due to increased siltation, stream channelization, and gravel dredging operations.

Habitat Requirements and Limiting Factors: Small to medium-sized streams, with areas of coarse gravel and sand substrate within fast flowing riffles and runs, are believed to be the preferred habitats. Loss of habitat, reduction or elimination of host fish, or other unknown factors may be limiting the population of this little-studied mussel.

Recovery Objective: Protecting the only known population of this mussel is the immediate objective of the plan. Delisting of this mussel is unlikely in the foreseeable future.

Downlisting Criteria: Downlisting to threatened status can occur when 1) the population in Fish Creek is shown to be sufficiently large and diverse to adapt to natural habitat changes, 2) three similar additional populations are discovered or established, and 3) the mussel, its habitat, and its host(s) are protected from any foreseeable threats which would impede survival.

Actions Needed:

1. Work with agencies and landowners to identify projects and land use practices deleterious to the mussel, and implement less damaging alternatives. Land acquisition and management agreements are likely.
2. Monitor the Fish Creek population and its habitat.
3. Survey other streams locate additional populations.
4. Determine preferred habitat characteristics and the fish host for the glochidia.
5. Establish new populations, if none are discovered, and monitor them.
6. Develop an educational program to alert the public to the needs and value of endangered mussels.

Estimated Cost of Maintaining the Mussel

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Need 6	Total
1991	*	50.0	50.0	63.0	45.0	20.0	228.0
1992	*	40.0	50.0	50.0	10.0	0	150.0
1993	*	50.0	50.0	10.0	10.0	0	120.0
1994	*	0	0	0	0	0	0
1995	*	10.0	0	10.0	10.0	0	30.0
1996	*	0	0	0	0	0	0
1997	*	10.0	0	10.0	10.0	0	30.0
1998	*	0	0	0	0	0	0
....	*	10.0	0	10.0	10.0	0	30.0
....	*	0	0	0	0	0	0

* Costs of land protection (fee acquisition, easement, management agreement) are to be determined.

Date of Recovery: Recovery is not anticipated for this mussel. Downlisting may occur by the year 2000.

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PART I

INTRODUCTION

The streams of eastern North America possess a rich molluscan fauna. Stansbery (1970) estimated that this fauna numbered over one thousand species of bivalves and gastropods combined while Simpson (1900) recognized over 500 species of Unionidae alone. Currently, 33 species of freshwater mussels are listed as endangered by the U.S. Department of the Interior (CFR 17.11, January 1, 1989). Sixty-one additional species are being reviewed for listing (Federal Register 54(4):554-579).

The white cat's paw pearly mussel was listed as an endangered species on 14 June 1976 (Federal Register 41(115):24064) under the name Epioblasma (=Dysnomia) sulcata delicata (including perobliqua) (Conrad, 1836). This lengthy designation has since been shortened to Epioblasma (=Dysnomia) sulcata delicata. However, Morrison (1942) and Stansbery et al. (1982) examined the holotype of Truncilla sulcata delicata Simpson, 1900 (USNM 160853) and concluded that the specimen is an old, stunted, abnormal male of Epioblasma rangiana (Lea, 1829). Therefore, since the name under which this subspecies was listed (E. s. delicata) is unavailable for the white cat's paw pearly mussel, and because Conrad's species description is more than sixty years prior to that of Simpson's, the name Epioblasma obliquata perobliqua (Conrad, 1836) will be used in this

recovery plan. The species name sulcata Lea, 1829 is replaced by obliquata Rafinesque, 1820 following Johnson (1978), Stansbery (1979) and Bogan and Parmalee (1983). See Johnson (1978) for the justification for this change in nomenclature.

Conrad (1835-1838:51) described Unio gibbosus variety perobliquus as, "perhaps a mere variety of U. gibbosus, Raf. [=E. rangiana], but it is much more oblique, the beaks [are] nearer the anterior margin, the posterior basal emargination [is] much less profound, and the central tubercles are obsolete." He suggests that the outline of this species, "resembles U. obliquatus, but that species is always of a purple colour within, though the tint is sometimes pale." Stansbery et al. (1982: E. o. perobliqua, pg. 3) characterized this subspecies as follows:

> Shell small to medium size, subcompressed to subinflated, solid; male irregularly high-ovate, with a narrow shallow sulcus just anterior to the posterior ridge; female subquadrate, with a narrow, slightly swollen postventral expansion bearing a comb-like row of small, sharp denticles on its margin; female shell narrowly sulcate posterior to postventral expansion, emarginate posteriorly; umbos moderately high, sculpture double-looped; periostracum greenish yellow to greenish brown, with regular fine green rays; hinge moderate, cardinal teeth small, triangular, lateral teeth moderately thick; nacre white.

Epioblasma obliquata perobliqua differs from Epioblasma obliquata obliquata (Rafinesque, 1820) by being less ovate and less solid than that subspecies. Epioblasma obliquata obliquata is further characterized by heavier hinge

dentition, more terminal umbos and purple, rather than white, nacre. Male E. rangiana, often confused with E. o. perobliqua, are more widely sulcate and possess diffuse rays. Generally, it is only the very old, slow growing males of E. rangiana found in Lake Erie and its tributaries that are confused with the white cat's paw pearly mussel. Male and female shells of E. o. perobliqua are illustrated in Figure 1.

Distribution

Epioblasma obliquata perobliqua is an Ohioan or Interior Basin mollusk (Wabash River drainage) that became established in the St. Lawrence River system (Maumee River drainage) during Wisconsin glaciation. This mussel probably entered the St. Lawrence system in the same manner as many other Ohioan species; when its host, infected with the parasitic larval stage, moved from glacial Lake Maumee to the Erie River through the Wabash Outlet (Stansbery, 1961). The subspecies probably inhabited tributary streams of the Erie River at that time as well. As this river became flooded due to uplift of the Niagra Escarpment, and eventually was transformed into Lake Erie (Clarke and Stansbery, 1988), this mollusk was eliminated from these habitats and remained only in the free flowing tributary streams.

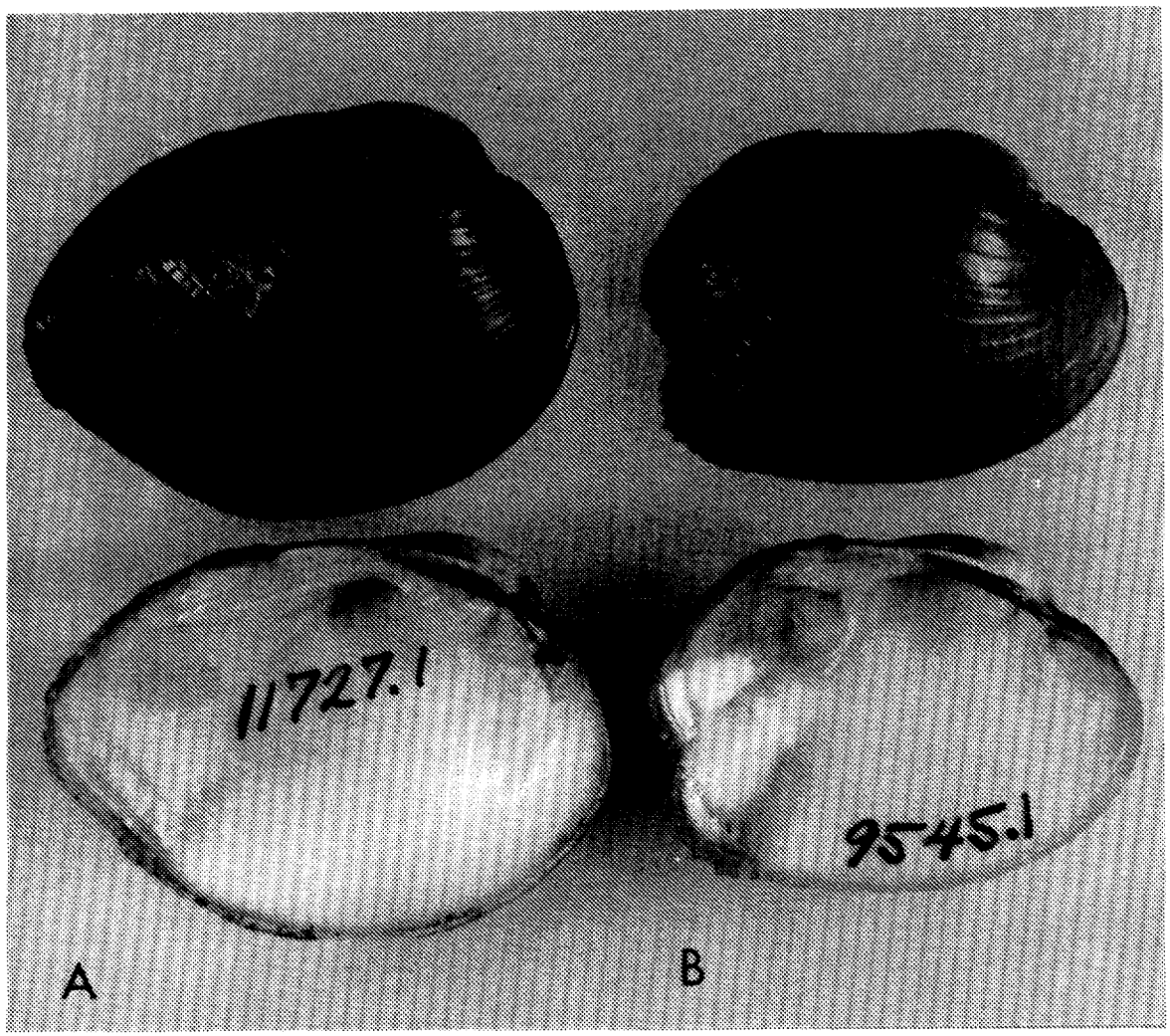

Figure 1. Adult male and female shells of Epioblasma obliquata perobliqua; A. Male shell, OSUM 11727.1, St. Joseph River at Co. Rt. 60A and railroad bridge east of St. Joe, Concord Twp., Dekalb Co., Indiana, 12 June 1964, D.H. Stansbery. B. Femal shell, OSUM 9545.1, St. Joesph River near village of St. Joe, Concord Twp., Dekalb Co., Indiana, 22 Septmeber 1962, D.H. Stansbery. Photograph by A.E. Spreitzer.

A compilation of published distribution data for E. o. perobliqua indicates it has been recorded from 10 river systems from New York state to Indiana and Lake Erie (Table 1). However, Stansbery et al. (1982) suggested that some of these records may be the result of misidentified E. rangiana (Table 2). Based on voucher specimens in the collections of The Ohio State University Museum of Zoology (OSUM) and The University of Michigan Museum of Zoology (UMMZ) (Table 3) the white cat's paw pearly mussel appears to have been distributed only in the Ohio River (?); Wabash River, Indiana; White River, Indiana; Tippecanoe River, Indiana; Maumee River, Indiana and Ohio; St. Joseph River, Indiana and Ohio; and Fish Creek, Ohio (Figure 2). The Ohio River record is questionable since this subspecies is usually restricted to smaller streams. It is interesting to note that there are no voucher specimens from the Detroit River even though Conrad (1836) included "Detroit River" in the type locality designation. Freitag (1984) has also questioned the validity of Detroit River specimens and although van der Schalie (1986:32) lists Dysnomia sulcata from the Detroit River near Cobo Hall, his included synonymy ("Dysnomia sulcata = D. perplexa rangiana; D. torulosa rangiana") suggests that his specimens were E. rangiana rather than E. o. perobliqua.

The subspecies, E. o. obliquata is more southern in distribution. Literature records indicate that this subspecies once occurred in the Ohio River at Cincinnati

Table 1. Literature records for Epioblasma obliquata perobliqua.

River	Reference
Ohio River, Illinois	Call, 1900 Daniels, 1903 Baker, 1906 Goodrich and van der Schalie, 1944 Johnson, 1978 Bogan and Parmalee, 1983
White River, Indiana	Call, 1894, 1896, 1897, 1900 Daniels, 1903 Goodrich and van der Schalie, 1944 Johnson, 1978 Bogan and Parmalee, 1983
Tippecanoe River	Cummings et al., 1987
Wabash, River, Indiana	Call, 1900 Daniels, 1903 Goodrich and van der Schalie, 1944 Johnson, 1978 Stansbery et al., 1982 Bogan and Parmalee, 1983 Cummings et al., 1988
Lake Erie, Ohio, Michigan	Sterki, 1907 "Lake Erie drainage" Wilson and Clark, 1912 La Rocque, 1967 Johnson, 1978 Bogan and Parmalee, 1983
Maumee River, Ohio, Indiana	Wilson and Clark, 1912 Goodrich and van der Schalie, 1944 Johnson, 1978 Stansbery et al., 1982 Bogan and Parmalee, 1983 Watters, 1988
Blanchard River, Ohio	Wilson and Clark, 1912 (as Auglaize River) Clark, 1977 (as Auglaize River) Johnson, 1978 Bogan and Parmalee, 1983
St. Joseph River, Indiana	Johnson, 1978 Bogan and Parmalee, 1983 Watters, 1988

Table 1. Continued

River	Reference
St. Marys River, Indiana	Wilson and Clark, 1912 Johnson, 1978 Bogan and Parmalee, 1983
Fish Creek, Ohio	Clark, 1977 Hoggarth, 1986 Watters, 1988
Detroit River, Michigan and Ontario, Canada	Conrad, 1836 Simpson, 1900, 1914 Goodrich, 1932 La Rocque, 1967 Stansbery, 1970 ("Lake St. Clair tributary") Johnson, 1978 Stansbery et al., 1982 Bogan and Parmalee, 1983 van der Schalie, 1986
Otter Creek, Michigan	Johnson, 1978
River Rasin, Michigan	Johnson, 1978
Niagra River, New York	Johnson, 1978 Bogan and Parmalee, 1983

Table 2. Museum specimens misidentified as *Epioblasma obliquata perobliqua*.

Catalog #	Locality	Species identity
UMMZ 35	Detroit River	*Epioblasma rangiana*
UMMZ 91402	Blanchard River	*Epioblasma rangiana*
UMMZ 91414	Niagra River	*Obovaria olivaria*
UMMZ 91415	Detroit River	*Epioblasma rangiana*
UMMZ 91416	Detroit River	*Epioblasma rangiana*
UMMZ 91417	Detroit River	*Epioblasma rangiana*
UMMZ 91418	Detroit River	*Epioblasma rangiana*
UMMZ 91419	Lake Erie	*Epioblasma rangiana*
UMMZ 91420	River Rasin	*Epioblasma rangiana*
UMMZ 91421	Lake Erie	*Epioblasma rangiana*

Table 3. Museum records of *Epioblasma obliquata perobliqua* deposited at The Ohio State University Museum of Zoology (OSUM) and The University of Michigan Museum of Zoology (UMMZ).

Locality	Collector	Catalog #	Date	Number
"Ohio River System"	Unknown (ex. USNM)	OSUM 36897	18--	1
Wabash [River, Indiana and Illinois]	Unknown (ex. Santa Barbara Museum)	OSUM 39006	18--	4
Wabash [River, Indiana and Illinois]	Unknown (ex. Santa Barbara Museum)	OSUM 39007	18--	1
Wabash River, Indiana	Bryant Walker Collection "L.E. Daniels"-"Sampsom"	UMMZ 91410	18--	6
Wabash River, New Harmony, Posey Co., Indiana	Bryant Walker Collection	UMMZ ?	19--	2
Wabash River, Lafayette, Tippecanoe Co., Indiana	Bryant Walker Collection	UMMZ 91406	18--	1
Tippecanoe River, at St. Rt. 35 bridge, Pulaski Co., Indiana	W. Haag	OSUM 29779	20 Sept. 1987	1
White River, Indiana	Unknown (ex. C. Leonard Richardson Collection via Mr. Daniel Bereya)	OSUM 34803	?	1
White River, Indiana	Bryant Walker Collection Whetherby Collection	UMMZ 91401	19--	4
White River, Indiana	Bryant Walker Collection	UMMZ 91411	18--	1
White River, Indianapolis, Marion Co., Indiana	Bryant Walker Collection	UMMZ 91402	18--	6

Table 3. Continued

Locality	Collector	Catalog	Date	Number
Maumee River, Ft. Wayne, Allen Co., Indiana	Bryant Walker Collection	UMMZ 91409	19--	3
Maumee River, "Near Defiance" Defiance Co., Ohio	H.R. Eggleston Coll.	OSUM 46256	14 Aug. 1936	1
Maumee and St. Joseph River, Ft. Wayne, Allen Co., Indiana	Bryant Walker Collection	UMMZ 91407	1900	4
Maumee River, below St. Rt. 101, 4.9 mi. S of Halls Corners, Monroe Twp., Allen Co., Indiana	G.T. Watters	OSUM Uncat.	1 Sept. 1988	1
Maumee River, at Bull Rapids Rd., 3.5 mi. SE of Harlan, Maumee Twp., Allen Co., Indiana	G.T. Watters	OSUM Uncat.	1 Sept. 1988	2
St. Joseph River above and below Halter Road bridge, near Cedarville, Cedar Creek Twp., Allen Co., Indiana	D.H. Stansbery	OSUM 7547	21 Sept. 1962	1
St. Joseph River at bridge just east of Spencerville, Spencer Twp., Dekalb Co., Indiana	D.H. Stansbery	OSUM 10669	21 Sept. 1962	1
St. Joseph River near village of St. Joe, Concord Twp., Dekalb Co., Indiana	D.H. Stansbery	OSUM 9545	22 Sept. 1962	5
St. Joseph River at Co. Rt. 60A and railroad bridge east of St. Joe, Concord Twp., Dekalb Co., Indiana	D.H. Stansbery	OSUM 11727	12 June 1964	10
St. Joseph River at St. Rt. 8, city of Newville, Dekalb Co., Indiana	D.H. Stansbery	OSUM 11661	12 June 1964	2
St. Joseph River at Newville at bridge, Newville Twp., Dekalb Co., Indiana	D.H. Stansbery	OSUM 10999	22 Sept. 1962	2
St. Joseph River at bridge "near Ind. border." [6.8 mi. NNW of Hicksville, 24.3 mi. WNW of Defiance, Sec. 18, Milford Twp.,] Defiance Co., Ohio	H.R. Eggleston Coll.	OSUM 46602	15 Aug. 1936	4
St. Joseph River above Co. Rt. 79 bridge, 2.5 mi. NE of Newville, Stafford Twp., Dekalb Co., Indiana	G.T. Watters	OSUM Uncat.	6 July 1988	1

Table 3. Continued

Locality	Collector	Catalog	Date	Number
St. Joseph River at Johnny Appleseed Park below dam in Fort Wayne, Washington Twp., Allen Co., Indiana	G.T. Watters	OSUM Uncat.	13 July 1988	1
St. Joseph River above Halter Rd., 0.4 mi. S of Cedarville, Cedar Creek Twp., Allen Co., Indiana	G.T. Watters	OSUM Uncat.	13 July 1988	1
St. Joseph River at Co. Rt. 68, 0.4 mi. ESE of Spencerville, Spencer Twp., Dekalb Co., Indiana	G.T. Watters	OSUM Uncat.	18 July 1988	1
St. Joseph River at Co. Rt. 60, 1.2 mi. E of St. Joe, Concord Twp., Dekalb Co., Indiana	G.T. Watters	OSUM Uncat.	27 July 1988	3
Fish Creek, Sec. 16, St. Joe Twp., Williams Co., Ohio.	C.F. Clark	UMMZ 24390	15 Oct. 1975	1
Fish Creek, R.M. 0.4-0.8, above Oh. Rt. 49 bridge, 1.1 mi. N of Edgerton, 10.4 mi. W of Bryan, Sec. 12/16 St. Joseph Twp., Williams Co., Ohio	B. Forrer	OSUM 29087	Sept. 1985	1
Fish Creek, R.M. 2.3, at [Edon Road] bridge 2.1 mi. NNW of Edgerton, 11.5 mi. W of Bryan, T6N, R1E, Sec. 16/17, St. Joseph Twp., Williams Co., Ohio	M.A. Hoggarth, D. Rice	OSUM 55689	2 Oct. 1985	1
Fish Creek above Edon Road 2.0 mi. NNW of Edgerton, St. Joseph Twp., Williams Co., Ohio	G.T. Watters	OSUM Uncat.	26 July 1988	1
Fish Creek along Co. Rt. C-60, 1.2 mi. N of Edgerton, St. Joseph Twp., Williams Co., Ohio bridge, 2.1 mi. NNW of Edgerton, 11.5 mi. W of Bryan, St. Joseph Twp., Williams Co., Ohio	G.T. Watters	OSUM Uncat.	18 Aug. 1988	1

OSUM Uncat. - Specimens are deposited at OSUM but they are not yet cataloged into the collection.

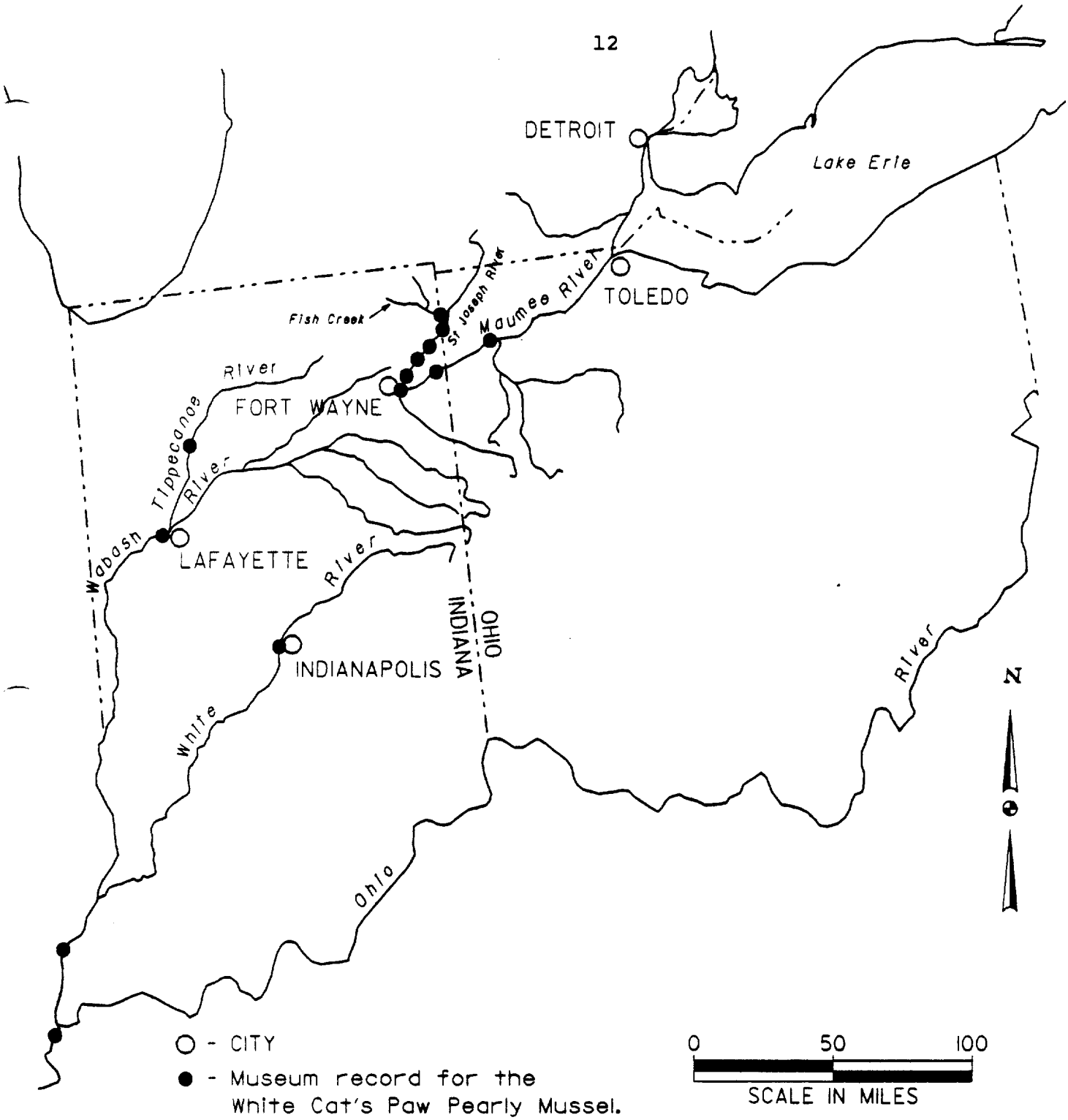

FIGURE 2
Historic distribution of Epioblasma obliquata perobliqua confirmed by voucher specimens deposited at The Ohio State University Museum of Zoology and The University of Michigan Museum of Zoology.

(Stansbery et al., 1982) and in its lower reaches bordering Illinois (Bogan and Parmalee, 1983), the lower Muskingum River in Ohio (Stansbery et al., 1982), the Licking, Kentucky and Green Rivers in Kentucky (Bogan and Parmalee, 1983), Caney Fork, Harpeth River and Cumberland River in Kentucky and Tennessee (Johnson, 1978; Bogan and Parmalee, 1983), and the Tennessee River near Muscle Shoals, Alabama (Johnson, 1978). Its current range apparently includes only short reaches of the Cumberland and Green Rivers. There is little doubt today that the two subspecies are sufficiently isolated from each other to warrant separate listing and recovery activity by the U.S. Fish and Wildlife Service.

Since 1970, fresh specimens of E. o. perobliqua have been taken only from Fish Creek in Ohio, a tributary of the St. Joseph River. Clark collected one living female (the authors private collection) and one fresh dead female (UMMZ 24390) in 1975. Since then, Forrer took a living male in 1985 (OSUM 29087), Hoggarth and Rice found a fresh dead female in 1985 (OSUM 55689), and Watters found and replaced one living male and took one fresh dead male (OSUM uncataloged) in 1988. Whether this subspecies is extant in any other portion of its range is undetermined at present, however recent surveys of the St. Joseph River and its tributaries in Indiana and Ohio, the Maumee River in Indiana and the Wabash and Tippecanoe Rivers in Indiana failed to find living or fresh dead shells anywhere else (Hoggarth, 1986; Cummings et al., 1987, 1988; Watters, 1988). If the

population in Fish Creek represents the last remnant of this subspecies, then the white cat's paw pearly mussel is one of the most critically endangered animals listed by the U.S. Department of the Interior.

Life History and Ecology

The life history of the white cat's paw pearly mussel is unknown; however it probably follows that exhibited by other unionid mollusks (Figure 3). Figure 3 contrasts the life cycles of two common Ohioan species; one with hookless glochidia, the other with hooked glochidia. Sperm released by the male enters the female through the incurrent aperture. Fertilized eggs are retained in the gills where they eventually develop into the characteristic larval stage of the Unionacea, known as a glochidium. Following development, glochidia are released into the water. For their life cycle to continue they must encounter suitable hosts, come in contact with suitable host tissue, clamp down and become encapsulated, and transform into juveniles. Following transformation the juveniles must break out of the capsules and drop from the host into suitable habitat. Hookless glochidia (like E. o. perobliqua) generally attach to gill filaments while hooked glochidia clamp down on fins or the epidermis of their hosts.

Lea (1863) characterized the glochidium of E. o. obliquata as pouch-shaped, without hooks, and Surber (1912)

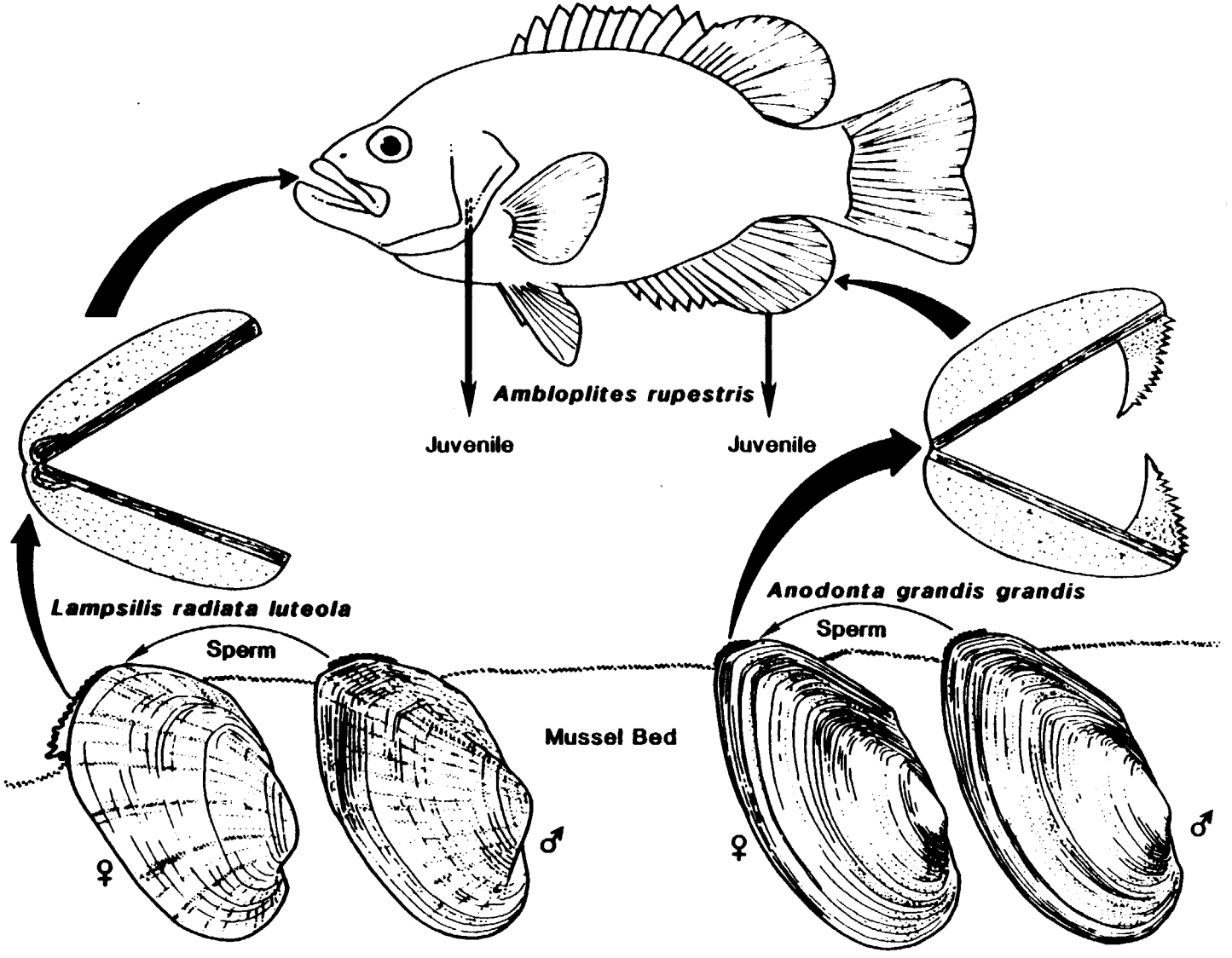

Figure 3. Typical unionid life cycles. Drawing of Ambloplites rupestris (Rafinesque, 1817) after Trautman (1981). Drawings of adult shells of Anodonta ~~grandis~~ ~~grandis~~ Say, 1829 and Lampsilis radiata luteola (Lamarck, 1819) after Burch (1973).

gave a length of 200 um and a height of 205 um for this glochidium. Hoggarth (1988) found that glochidia of this genus are depressed - subelliptical with subequal length and height. Epioblasma glochidia also have very large adductor muscles (in cross-sectional area) and possess supernumerary hooks along the ventral margin of the valve (see Hoggarth 1988, Figures 76-79 for electron micrographs of Epioblasma glochidia). No fish hosts are known for this subspecies, but Yeager (1986) produced laboratory transformations of glochidia from Epioblasma brevidens (Lea, 1831), Epioblasma capsaeformis (Lea, 1834) and Epioblasma triquetra (Rafinesque, 1820) on darters and the banded sculpin. The host of the white cat's paw pearly mussel is also likely to be a riffle dwelling species such as a darter or a sculpin.

Specific habitat requirements for E. o. perobliqua are also unknown, although it has been reported most frequently from riffle-run reaches of small to moderately large rivers. Clark (1977:33) found a single living female, "lying on the surface of the gravel bottom, completely exposed." Watters (personal communication) described the habitat of the single living specimen found as completely buried in stable gravel and sand substrate. Stansbery et al. (1982) concluded that the habitat of this subspecies is similar to that of E. o. obliquata. Both are found in or on the coarse substrates of fast flowing riffles and runs.

Reason for Decline

There is no single reason for the decline in numbers and diversity of unionid mollusks. Likewise, no single factor can be cited as responsible for the apparent range reduction of E. o. perobliqua. The white cat's paw pearly mussel has apparently always been rare (Call, 1900; Wilson and Clark, 1912; Clark, 1977) but never before so close to extinction.

Channelization for flood control and other forms of substrate disturbance (e.g. gravel dredging operations, channel maintenance dredging, instream construction, and the removal of logs and other obstructions to flow) have contributed substantially to the decline of unionid mollusks. This is perhaps nowhere a more serious problem than in the intensely cultivated Wabash and Maumee River basins. Call (1894) cited deforestation, altered flow regimes, drainage of swamps and the increase in tilled farm lands as factors contributing to the decline of mussels in Indiana. Gravel dredging operations were cited by Clark (1976) as contributing to the abundance of shifting, unstable sand substrate in the lower Wabash River. Watters (personal communication) found that one of the largest mussel beds in the St. Joseph River (at Co. Rt. 60A and railroad bridge) had been destroyed and now produces only old dead shells, including many E. o. perobliqua. He attributes much of this decline to instream construction

centered on the mussel bed. Furthermore, Hoggarth (1986) noted that stream clearing operations have reduced the amount of stable gravel substrate in the upper St. Joseph River basin. Stansbery (1983) stated that obstructions to flow such as logs, fallen trees and gravel bars create areas of protected stable substrate immediately downstream similar to that found in water-willow beds.

Siltation is another factor that has contributed to the decline in unionid mollusks. Fuller (1977) cited siltation associated with poor agricultural practices and deforestation as the most significant factor affecting mussel communities. Ellis (1936) reported that many species of mussels are unable to survive overlays of silt greater than 0.6 cm and Marking and Bills (1980) found that mussels either emerged from overlays of silt within a few hours or died. Reductions in mussel abundance in the Wabash River (Clark, 1976) and the Stones River (Schmidt, 1982) were attributed, in part, to increased siltation caused by gravel dredging operations. High silt loads also have been found to reduce filter feeding efficiency (Loosanoff, 1961) and can irritate, damage or clog the gills of feeding mollusks (Loar et al., 1980).

Epioblasma obliquata perobliqua is probably not a silt tolerant species. Although Clark (1977) described the single living female he found as completely exposed (as many females in this genus are during the release of glochidia) fresh shells generally lack algal growth or marl deposition

and Watters' (personal communication) specimen was completely buried. This evidence suggests that E. o. perobliqua normally lives buried in the gravel. Silt deposited over the substrate would quickly cover members of this subspecies.

The effect of pollutants on unionid mollusks are still poorly understood. Nonetheless, reduced or eliminated beds of mussels downstream from industrial centers (Ortmann, 1918; Williams, 1969), municipal sewage outfalls (Schmidt, 1982), and mining operations (Neel and Allen, 1964) are probably the result of reduced water quality downstream from these sources of pollution. In some instances the contaminants produced mussel-die-offs by direct toxic effects. In other instances reduced populations of mussels are the indirect result of the elimination of fish hosts or food items. Havlik and Marking (1987) have reviewed the effects of contaminants on the Unionidae.

PART II

RECOVERY

A. Recovery Objectives

The immediate objective of this recovery plan is to protect the only extant population of E. o. perobliqua known. Secondary objectives are to increase the present distribution of the subspecies and add to our knowledge on its life history. With such a low population level and restricted distribution, recovery to the point that this subspecies no longer requires protection under the Endangered Species Act is unlikely. However, we may be able to prevent the extinction of the white cat's paw pearly mussel.

Since the present status of this mollusk may preclude its recovery, this recovery plan will focus on the actions that must be taken to prevent extinction, as well as the steps that must be taken to consider the mussel for downlisting.

Epioblasma obliquata perobliqua can be downlisted from endangered to threatened when the following criteria are met:

1. The population of E. o. perobliqua in Fish Creek, Williams County, Ohio is protected. This population must be large enough to maintain sufficient genetic variation to enable it to evolve and respond to

natural habitat changes.

2. Three additional populations are discovered or established. These populations must meet the conditions of criterion 1.
3. The subspecies, its habitat and its host(s) are protected from any foreseeable threats that would impede the survival of any of the populations.

B. Step-Down Outline

1. Preserve the existing population of E. o. perobliqua in Fish Creek and protect its habitat from further disturbance.
   1.1 Identify and eliminate specific threats that jeopardize this mollusk.
      1.1.1 Work with appropriate agencies to identify projects with potential negative effects and recommend project modifications that eliminate adverse effects.
      1.1.2 Work with landowners and farmers in the basin to identify deleterious land use and flood control practices, develop alternatives and assist with their implementation.
      1.1.3 Monitor the levels of siltation and pesticide run-off in the basin and enforce strict compliance with EPA standards.

1.1.4 Close Fish Creek to all mussel sampling and collecting except for that required in conjunction with life history research approved by the state Department of Natural Resources.

1.2 Conduct status surveys every other year to monitor the Fish Creek population.

1.2.1 Determine the population status and range of this mussel in Fish Creek.

1.2.2 Determine whether this population is self sustaining or if it represents stray specimens from a larger St. Joseph River population.

1.3 Identify the habitat characteristics necessary for the survival of the mussel.

2. Determine if E. o. perobliqua is living in any other portion of its historic range.

2.1 Conduct surveys of the Maumee River, the St. Joseph River and their tributaries in Indiana and Ohio.

2.2 Conduct surveys of the Wabash, White and Tippecanoe Rivers and their tributaries in Indiana.

3. Investigate the life history of this mollusk.

3.1 Examine fish distribution data within the known range of E. o. perobliqua.

3.2 Describe the glochidium of this subspecies and

determine probable host fish species.

3.3 Conduct artificial infection experiments with glochidia of E. o. perobliqua on suspected fish hosts.

4. Establish new populations of E. o. perobliqua.

4.1 Identify potential introduction sites.

4.2 Introduce adults, fish infected with glochidia or juveniles produced using artificial rearing techniques in sites identified for introduction.

4.3 Protect and monitor newly established populations.

5. Develop an educational program that addresses the specific needs of endangered mussels and describes the actions required to protect them.

C. Narrative Outline

1. Preserve the existing population of E. o. perobliqua in Fish Creek and protect its habitat from further disturbance. Fish Creek from Edon Road bridge to its mouth (approximately three stream miles) may contain the last remaining population of this subspecies. It must be protected if any of the remaining tasks are to be accomplished.

1.1 Identify and eliminate specific threats that jeopardize this mollusk. Flowing water

environments possess a myriad of potential problems for essentially nonmotile animals. Development within the watershed, the diminishing wooded riparian corridor, habitat destruction, and water quality degradation potentially threaten this population. The impacts of these activities must be assessed and measures taken to protect the subspecies.

1.1.1 Work with appropriate agencies to identify projects with potential negative effects and recommend project modifications that eliminate adverse effects. Regulations included in Section 7 of the Endangered Species Act, the Federal Water Pollution Control Act, and the Fish and Wildlife Coordination Act provide protection for this species and its habitat. Full enforcement of the laws and regulations resulting from these acts and a cooperative effort between the U.S. Fish and Wildlife Service and Indiana and Ohio natural resource departments to monitor this watershed and enforce these acts will be necessary.

1.1.2 Work with landowners and farmers in the basin to identify deleterious land use and flood control practices, develop

alternatives and assist with their implementation. The most immediate threats to the population in Fish Creek are reduction of the wooded riparian corridor and clearing of the stream for flood control. Recent evidence of both of these activities is present in the reach from Edon Road bridge downstream. Land owners in this basin must be made aware of the potential threat these activities pose to this mollusk. The possibility of land acquisition, management agreements, registry with The Nature Conservancy, and other means of setting aside land near the stream should be considered.

1.1.3 Monitor the levels of siltation and pesticide run-off in the basin and enforce strict compliance with EPA standards. Nonpoint sources of pollution, such as these, are very difficult to assess and also very difficult to control. Nonetheless, the levels of these substances should be monitored to determine compliance with state and federal clean water legislation. It is suggested that water quality monitoring occur throughout the year to determine

yearly fluctuations. Furthermore, it will be necessary to determine the concentrations of these substances following episodes of significant precipitation when run-off from adjacent land areas will be greatest.

1.1.4 Close Fish Creek to all mussel sampling and collecting except for that required in conjunction with life history research approved by the state Department of Natural Resources. The collection of mussels for bait, food, for private collections, or for any other purpose other than that specified by this plan and approved by the appropriate state Department of Natural Resources should not be allowed. Any of these activities could deplete the population and disturb the substrate.

1.2 Conduct status surveys every other year to monitor the Fish Creek population. The only true measure of our success with this population will be the documentation of its survival over time. Recent studies by Hoggarth (1986) and Watters (1988) have shown that this subspecies is limited to the first three miles of Fish Creek.

1.2.1 Determine the population status and range of this mussel in Fish Creek. Since this subspecies is rare, even in Fish Creek, it is expected that at least three surveys, conducted every other year, will be needed to document the range of distribution of this mussel. Any living specimens encountered should be promptly returned following positive identification and the collection of any pertinent biological data such as sex, age, whether gravid if a female, and other life history and habitat characteristics.

1.2.2 Determine whether this population is self sustaining or if it represents stray specimens from a larger St. Joseph River population. Epioblasma obliquata perobliqua may have optimal habitat requirements more in line with those of its nearest relative, E. o. obliquata, and therefore may normally inhabit larger streams. If this is true, then a larger population of this mussel may occur in the St. Joseph River near the mouth of Fish Creek. Surveys of the St. Joseph River from Montpelier to Edgerton should be conducted.

1.3 Identify the habitat characteristics necessary for the survival of the mussel. Habitat monitoring should be conducted during the surveys described above. Detailed notes on location of individuals, substrate composition, associated faunal community, and water quality would help develop biological, chemical and physical criteria for monitoring changes in the habitat in Fish Creek and to assess future introduction sites.

2. Determine if E. o. perobliqua is living in any other portion of its historic range. Although recent surveys, within the historic range of E. o. perobliqua, failed to find evidence of a population of this subspecies anywhere except Fish Creek, continued effort to find this mollusk should be made. This subspecies has apparently always been rare and it is expected that periodic or annual surveys over a multi-year period may be required to discover other populations. All recent evidence suggests that this subspecies has never been found in the Detroit River and that all records of this subspecies for that river are the result of misidentified specimens. Since the Detroit River is apparently outside of the historic range of this mussel it no longer need be considered in this plan.

2.1 Conduct surveys of the Maumee River, the St. Joseph River and their tributaries in Indiana and Ohio. This encompasses the historic range of this mussel within the Maumee River basin documented by voucher specimens deposited at OSUM and UMMZ.

2.2 Conduct surveys of the Wabash, White and Tippecanoe Rivers and their tributaries in Indiana. This encompasses the historic range of this subspecies within the Wabash River basin documented by voucher specimens deposited at OSUM and UMMZ.

3. Investigate the life history of the mollusk. An examination of the essential habitat requirements of this mollusk will only be complete when the requirements of all of the life stages are understood. Caution must be taken to eliminate the unnecessary sacrifice of any living specimens. The following activities can be conducted using a small portion of the contents of the marsupial gills of a gravid female. These activities do not require the sacrifice of the animal.

3.1 Examine fish distribution data within the known range of E. o. perobliqua. This may help limit the number of potential host fish species.

3.2 Describe the glochidium of this subspecies and determine probable host fish species. An

examination of the gills of naturally infected fish may reduce the list of potential host species. Fish deposited in museum collections, from the historic range of this subspecies, might be examined for glochidia of the genus Epioblasma. If the glochidium of this species can be found and described then it can be determined if these infections are the result of E. o. perobliqua or another species (ie. E. rangiana). The use of museum specimens rather than the collection of fish from a stream like Fish Creek, where infection might still be occurring, eliminates the effect collecting these fish would have on the extant population.

3.3 Conduct artificial infection experiments with glochidia of E. o. perobliqua on suspected fish hosts. This must be done to confirm the host-parasite relationship.

4. Establish new populations of E. o. perobliqua. The success of this type of activity is questionable but may be necessary if the subspecies is ever to be downlisted. A single catastrophic event could eliminate the Fish Creek population whereas multiple populations would not be eliminated by such an occurrence. Sites chosen for introduction of this mussel should be similar to those that currently support the subspecies. It is also suggested that

the introduction of specimens into established populations be avoided to reduce the probability of spreading disease. Although it is generally the policy of the U.S. Fish and Wildlife Service to establish populations only within the historic range of a species, it is suggested that more flexibility in introduction sites is warranted in this case due to the limited distribution of this subspecies in the past. Newly established populations of this mussel, whether inside or outside of its historic range, should only be considered after it has been established that suitable habitat exists for each stage of the mussel's life cycle.

4.1 Identify potential introduction sites. Introduction sites must possess the necessary habitat requirements to enable survival of the adults and completion of the reproductive cycle.

4.2 Introduce adults, fish infected with glochidia or juveniles produced using artificial rearing techniques in sites identified for introduction. Introducing adults allows for a more reliable monitoring program since they are easier to locate than juveniles released from fish. However, this activity necessitates a large initial population from which the adults can be removed for introduction somewhere

else. Introducing fish infected with glochidia increases the probability that the juveniles will be deposited in a habitat frequented by the host, and does not require the removal of adult individuals from the donating population. However, it does require knowledge of the host-parasite relationship and this information is often very difficult to obtain. The production of juveniles using artificial rearing techniques has been shown to be successful (Isom and Hudson, 1982; Hudson and Isom, 1984) and might be employed in this case. The advantages of this technique are that adult specimens need not be relocated, percent transformation, compared to natural infection and transformation, is high, no knowledge of the fish host is required to produce the juveniles, and the juveniles can be grown to a size that will enhance their survivability in their new habitat. The disadvantage is that monitoring may be difficult due to the small size of the specimens.

4.3 Protect and monitor newly established populations. Newly established populations must be afforded the same protection as the Fish Creek population and monitored to determine the success or failure of the introduction.

5. Develop an educational program that addresses the specific needs of endangered mussels and describes the actions required to protect them. The Unionidae are an important part of our natural history. They have played a prominent role in the cultures and affairs of human-kind and continue to be an important resource for industry, scholarly investigation and aesthetic appreciation. These aspects, along with basic biology, habitat preservation, rarity of the species, and the steps that must be taken to protect the species should be addressed. The format could be a booklet, slide show or movie presentation similar to that developed by the Ohio Department of Natural Resources for their nongame programs. This program could be presented in town meetings, local schools, to wildlife conservation groups and to other groups interested in preserving our natural heritage.

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PART III

KEY TO IMPLEMENTATION SCHEDULE COLUMNS 1 AND 4

General Category (Column 1):

Information Gathering - I and R (Research)

1. Population status
2. Habitat status
3. Habitat requirements
4. Management techniques
5. Taxonomic studies
6. Demographic studies
7. Propagation
8. Migration
9. Predation
10. Competition
11. Disease
12. Environmental contaminant
13. Reintroduction
14. Other information

Acquisition - A

1. Lease
2. Easement
3. Management agreement
4. Exchange
5. Withdrawal
6. Fee title
7. Other

Other - O

1. Information and education
2. Law enforcement
3. Regulations
4. Administration

Management - M

1. Propagation
2. Reintroduction
3. Habitat maintenance and manipulation
4. predator and competitor control
5. Depredation control
6. Disease control
7. Other management

Priorities (Column 4)

Priority 1 - Actions that must be taken to prevent the extinction of the species.

Priority 2 - Actions that must be taken to prevent a significant decline in species population or habitat quality.

Priority 3 - All other actions necessary to provide for full recovery of the species.

Implementation Schedule

White Cat's Paw Pearly Mussel
Epioblasma obliquata perobliqua

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency			Estimated FY Costs			Comments/Notes
					FWS		Other	FY1	FY2	FY3	
					Region	Program					
M-3	Preserve the existing population of E. o. perobliqua in Fish Creek and protect its habitat from further disturbance.	1	1	Continuous	3	SE	IDNR ODNR	-----	-----	-----	Existing program funding
I-2, I-12	Work with agencies to identify projects with potential negative effects and recommend modifications.	1.1.1	1	Continuous	3	SE	IDNR ODNR	500	500	500	
O-1, O-4 A-1, A-3	Work with landowners and farmers to develop less destructive land use and flood control practices.	1.1.2	1	Continuous	3	SE	TNC IDNR ODNR	TBD	TBD	TBD	Possible land acquisition, registry and management agreements
R-12, M-3	Monitor the levels of siltation and pesticide run-off in the system.	1.1.3	1	3 years	3	SE	Contract	40,000	40,000	40,000	
M-5, O-3	Close Fish Creek to taking of mussels except as approved by the appropriate state Department of Natural Resources.	1.1.4	1	Continuous	3	SE	ODNR	-----	-----	-----	ODNR has closed Fish Creek in Ohio.
R-1, R-2 R-3	Conduct surveys for E. o. perobliqua in Fish Creek and St. Joseph River.	1.2	1	2 years	3	SE	Contract	10,000	-----	10,000	Funding was provided to Mr. G.T. Watters in 1988 through IDNR.
R-3	Identify habitat characteristics necessary for this subspecies.	1.3	1	2 years	3	SE	Contract	10,000	-----	10,000	

Key to abbreviations: SE - Federal Endangered Species Program; TNC - The Nature Conservancy; ODNR - Ohio Department of Natural Resources; IDNR - Indiana Department of Natural Resources; TBD - To Be Determined.

Implementation Schedule

White Cat's Paw Pearly Mussel
Epioblasma obliquata perobliqua

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency			Estimated FY Costs			Comments/Notes
					FWS						
					Region	Program	Other	FY1	FY2	FY3	
R-1	Conduct surveys for E. o. perobliqua in Maumee River basin.	2.1	2	3 years	3	SE	Contract	20,000	20,000	20,000	
R-1	Conduct surveys for E. o. perobliqua in Wabash River drainage.	2.2	2	3 years	3	SE	Contract	30,000	30,000	30,000	
I-7	Examine fish distribution data within the known range of E. o. perobliqua.	3.1	2	1 year	3	SE	Contract	3,000	-----	-----	
R-7	Describe glochidium of this species and determine probable fish hosts.	3.2	2	2 years	3	SE	Contract	10,000	10,000	-----	Examine glochidial infection on fish deposited at museums.
R-7	Conduct artificial infection experiments using suspected fish hosts.	3.3	2	2 years	3	SE	Contract	40,000	40,000	-----	
R-13	Identify potential introduction sites.	4.1	3	1 year	3	SE	Contract	25,000	-----	-----	
M-2	Introduce adults, fish with glochidia or juveniles into selected sites.	4.2	3	2 years	3	SE	Contract	10,000	10,000	-----	
I-1, M-5 O-3	Protect and monitor newly established populations.	4.3	3	Continuous	3	SE	Contract ODNR IDNR	10,000	-----	10,000	Bi-annual surveys.
O-1	Develope educational program for endangered mussels.	5	3	1 year	3	SE	Contract	20,000	-----	-----	

Key to abbreviations: SE - Federal Endangered Species Program; TNC - The Nature Conservancy; ODNR - Ohio Department of Natural Resources; IDNR - Indiana Department of Natural Resources; TBD - To Be Determined.

APPENDIX

PUBLIC NOTICE OF RECOVERY PLAN DEVELOPMENT

AND REVIEWERS

The Federal Register published a notice of the availability of the draft recovery plan for public review and comment on July 10, 1989. In addition, a public notice of the availability of the draft recovery plan was placed in the following newspapers between July 22 and July 26, 1989:

Ft. Wayne Journal-Gazette
Ft. Wayne, Indiana

Toledo Blade
Toledo, Ohio

Defiance Crescent-News
Defiance, Ohio

Angola Herald-Republican
Angola, Ohio

Although these notices resulted in several requests for copies of the draft recovery plan, no comments were received from these individuals.

In addition, the following individuals and organizations received copies of the draft recovery plan for review and comment:

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