James Spinymussel
(Pleurobema collina)

Recovery Plan

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James Spinymussel *(Pleurobema collina)*

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EXECUTIVE SUMMARY
JAMES SPINYMUSSEL RECOVERY PLAN

Current Status: The endangered James spinymussel has experienced a precipitous decline over the past two decades. The species appears to be extirpated from 90% of its historic range, with survival documented only in a few small tributaries to the James River. Its restricted distribution makes the species vulnerable to threats such as water quality perturbations, disease, and displacement by the exotic Asian clam.

Habitat Requirements and Limiting Factors: This species lives in stream sites that vary in width from 10-75 feet and depth of 1/2 to 3 feet. It requires a slow to moderate water current with clean sand and cobble bottom sediments. The spinymussel is limited to areas of unpolluted water, and may be more susceptible to competition from exotic clam species when its habitat is disturbed.

Recovery Goal: To delist the James spinymussel by protecting and enhancing the habitat of existing populations and by establishing or expanding populations within its historical range.

Recovery Objectives:

1. To reclassify this mussel to threatened by (a) determining that populations in the Craig Creek drainage and 80% of all other known populations are stable or expanding (focusing on distribution of populations within four rivers or creeks) and (b) protecting all known populations and their habitat from foreseeable threats.

2. To delist the species by meeting the above conditions and by (c) re-establishing or locating new populations in two additional rivers or three segments of the James River drainage and (d) showing that habitat protection strategies have succeeded in enhancing 75% of all sites with viable populations.

Actions Needed:

Actions to protect and recover the James spinymussel initially will focus on:

- identification of essential habitat
- investigation of specific threats such as siltation, pesticide contamination, municipal and industrial effluents, and interactions with the Asian clam
- assessment of projects posing potentially negative effects on the species and its habitat, and monitoring of threats

Based on the information that results from these initial efforts, the following actions may be taken:

- methods to control Asian clams will be implemented as warranted
- protection strategies for essential spinymussel habitat will be determined and implemented
- studies of the life history and ecological requirements of this species will be conducted in order to determine the feasibility and techniques of re-introducing the species into other areas within its historic range
- populations will be re-established as warranted
- existing and introduced populations will be monitored on an ongoing basis

Costs and Time Frame: Projected costs for recovery of the James spinymussel over the next three years amount to $210,500. The main portion of this funding will go toward survey work, investigations into interactions with the Asian clam, and determination of the effects of siltation, pesticides, and effluents on spinymussels and their habitat. The cost of land acquisition in Task 2.33 has not been included because neither the amount of land to be acquired nor its cost are known at this time. The total cost of recovery and the overall time frame to achieve recovery are not possible to predict at this point. Cost and time estimates will be made following results of the studies and investigations called for in this plan.

* * *

Recovery plans delineate reasonable actions believed to be required to recover and/or protect listed species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, state agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views, official position, or approval of any individuals or agencies involved in plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the Service only after they have been signed by the Regional Director or Director as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature citations should read as follows:

U.S. Fish and Wildlife Service. 1990. James Spinymussel *(Pleurobema collina)* Recovery Plan. Newton Corner, Massachusetts. 38 pp.

Additional copies may be purchased from:

Fish and Wildlife Reference Service
5430 Grosvenor Lane, Suite 110
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Part I: INTRODUCTION

The James Spinymussel (*Pleurobema collina*) was listed as an endangered species on July 22, 1988 (53 FR 27693). Prior to its decline, the species apparently lived throughout the James River above Richmond, in the Rivanna River, and in ecologically suitable areas in all of the major upstream tributaries (Clarke and Neves 1984). Historical records indicate that the species was collected from several locations on the James River mainstem and nine sites on tributary rivers and creeks. It now survives in only a few headwater tributaries.

Although it is probable that the decline of the James spinymussel began with municipal growth and industrialization of cities and towns in the James River watershed, much of the decline has occurred in the last 20 years. The species remained widespread through the mid-1960's, but it now appears to be extirpated from approximately 90% of its historic range, with survival documented only in a few creeks and small rivers in the upper James River drainage. This restricted distribution makes the species vulnerable to threats such as water quality perturbations, disease, and displacement by expanding populations of the exotic Asian clam (*Corbicula fluminea*).

The James spinymussel was first discovered in the Calfpasture River, Rockbridge County, Virginia, by T. A. Conrad in 1836 (Conrad 1846). The species was originally described by Conrad (1837) as *Unio collinus*, but has been subsequently placed in different genera by various workers. Synonyms for this species are as follows:

- *Unio collinus* Conrad, 1837: Plate 36, Figure 2.
- *Margaron* (*Unio*) *collinus* (Conrad) - Lea 1852:23.
- *Alasmidonta collina* (Conrad) - Simpson 1900:669.

- *Canthyria collina* (Conrad) - Frierson 1927:1946; Stansbery 1971:14; Clarke and Neves 1984; Zeto and Schmidt 1984:147.
- *Elliptio* (*Canthyria*) *collina* (Conrad) - Morrison 1955:20.
- *Pleurobema collina* (Conrad) - Boss and Clench 1967:45; Heard 1970:27; Burch 1975:12.
- *Pleurobema* (*Lexingtonia*) *collina* (Conrad) - Johnson 1970:300.
- *Fusconaia* (*Lexingtonia*) *collina* (Conrad) - Johnson and Clarke 1983:296.

Clarke and Neves (1984) determined that the James spinymussel uses only its outer gills to brood glochidia and is not therefore a species of *Fusconaia*, which are currently thought to use all four gills to brood glochidia. This conclusion is supported by the observations of Hove (1990). Clarke and Neves (1984) suggested placing the species in the genus *Canthyria* due to the presence of spines on the shell and some characters of soft anatomy. Pending further taxonomic research, this plan follows Turgeon *et al.* (1988), who place the James spinymussel in the genus *Pleurobema*.

Description

The shells of juvenile James spinymussels usually bear one to three short but prominent spines on each valve. The shells of adults usually lack spines. The foot and mantle of the adult are conspicuously orange and the mantle is darkly pigmented in a narrow band around and within the edges of the branchial and anal openings.

The shell of *Pleurobema collina* is subrhomboid in juveniles (i.e., in those less than 40 mm long) with an obliquely subtruncated posterior, widely-spaced concentric striations, a shiny, straw-colored periostracum, and with or without spines on each valve. With growth the shell becomes more ovate or even arcuate, develops a

rounded posterior and a brownish-black periostracum, and in most cases loses any spines it may have had. In the adult the posterior ridge is also broad and rounded, hinge teeth are medium-sized but strong and completely developed, and nacre is whitish and with or without pink or bluish suffusions (Clarke and Neves 1984). Additional details of anatomy are provided in Clarke and Neves (1984).

Aside from the James spinymussel, only two other freshwater spined mussels are known to exist: *Elliptio* (*Canthyria*) *spinosa*, a large-shelled and long-spined species known only from the Altamaha River system in Georgia, and *Elliptio* (*Canthyria*) *steinstansana*, a species with intermediate shell size and spine length found only in the Tar River in North Carolina. The latter species was listed as endangered on June 27, 1985 (50 FR 26575). The James spinymussel is smaller and has shorter spines than these other two species.

Distribution

The James spinymussel was historically widespread in the James River drainage (see Table 1). A.H. Clarke surveyed 73 potential and/or historic locations for the species, but was able to find the spinymussel at only six of these sites: two in Johns Creek, three in Craig Creek, and one in Potts Creek (Clarke and Neves 1984). Based on this extensive field sampling of potential and historic habitats along with other more recent survey data (Hove 1990 and Neves pers. comm.), the species is now known to inhabit sites in ten streams:

<u>Craig Creek drainage - Craig and Botetourt Counties, VA</u>

1. Craig Creek
2. Johns Creek
3. Dicks Creek
4. Patterson Creek

Other drainages

5. Potts Creek - Monroe County, WV and Craig and Alleghany Counties, VA
6. Pedlar River - Amherst County, VA
7. Mechums River - Albemarle County, VA
8. Moormans River - Albemarle County, VA
9. Rocky Run (Moormans River) - Albemarle County, VA
10. Catawba Creek - Botetourt County, VA

The general locations of these extant populations are shown in Figure 1. With the exception of the Craig and Johns Creek populations, all extant populations appear to be small and very restricted in distribution.

Life History and Ecology

Information on the life history of the James spinymussel is available from thesis research completed at Virginia Polytechnic Institute and State University (Hove 1990). This spinymussel has a life cycle similar to other North American unionids (see Figure 2). Male mussels release sperm into the water column which are taken in by females during siphoning. Fertilized eggs are retained in the gills which serve as brood pouches for the developing larvae, or glochidia. The glochidia are released into the water, and within three or four days must attach to an appropriate host fish. If attachment occurs, the glochidia metamorphose and drop from the fish as free-living juvenile mussels. The James spinymussel is a tachytictic (short-term) brooder; its eggs are fertilized in the spring and glochidia are released in spring and summer. The spinymussel releases glochidia from June 3 through July 25 (Hove 1990). Glochidia are released in a formation known as a conglutinate. The glochidia of *P. collina* are arranged around the perimeter of the conglutinate with a ribbon of tan pigmentation in the center (Hove 1990).

Table 1. Historic (H) and present (P) occurrences of the James spinymussel. Data taken from Clarke and Neves 1984; Neves, in litt., 1989.

	James River Mainstem	
(H)	James River near Natural Bridge	Rockbridge County, VA
(H)	James River at Buchanan	Botetourt County, VA
(H)	James River at Columbia	Fluvana County, VA
(H)	James River at New Canton	Buckingham County, VA
(H)	James River opposite Maidens	Goochland County, VA
(H)	James River at Maidens	Goochland County, VA
(H)	James River at Rock Castle	Goochland County, VA
(H)	James River at Pemberton and Cartersville	Goochland and Cumberland Counties, VA
	Rivanna River Drainage	
(H)	Rivana River near Columbia	Fluvanna County, VA
(H)	Rivanna River near Palmyra	Fluvanna County, VA
(H)	Rivanna River at Crofton	Fluvanna County, VA
(P)	Mechums River	Albemarle County, VA
(P)	Rocky Run (Moormans River)	Albemarle County, VA
(P)	Moormans River	Albemarle County, VA
	Maury River Drainage	
(H)	Calfpasture River	Rockbridge County, VA
(H)	North (= Maury) River, Lexington	Rockbridge County, VA
(H)	Mill Creek near Millboro	Bath County, VA
	Craig Creek Drainage	
(P)	Craig Creek near New Castle	Craig County, VA
(P)	Craig Creek near Silent Dell	Botetourt County, VA
(P)	Craig Creek near Eagle Rock	Botetourt County, VA
(P)	Johns Creek near Maggie	Craig County, VA
(P)	Johns Creek along Sevenmile Mountain	Craig County, VA
(P)	Dicks Creek	Craig County, VA
(P)	Patterson Creek	Botetourt County, VA
	Jackson River Drainage	
(P)	South Fork Potts Creek	Monroe County, WVa
(P)	Potts Creek	Craig and Alleghany Counties, VA
	Other Drainages	
(P)	Catawba Creek	Botetourt County, VA
(P)	Pedlar River	Amherst County, VA

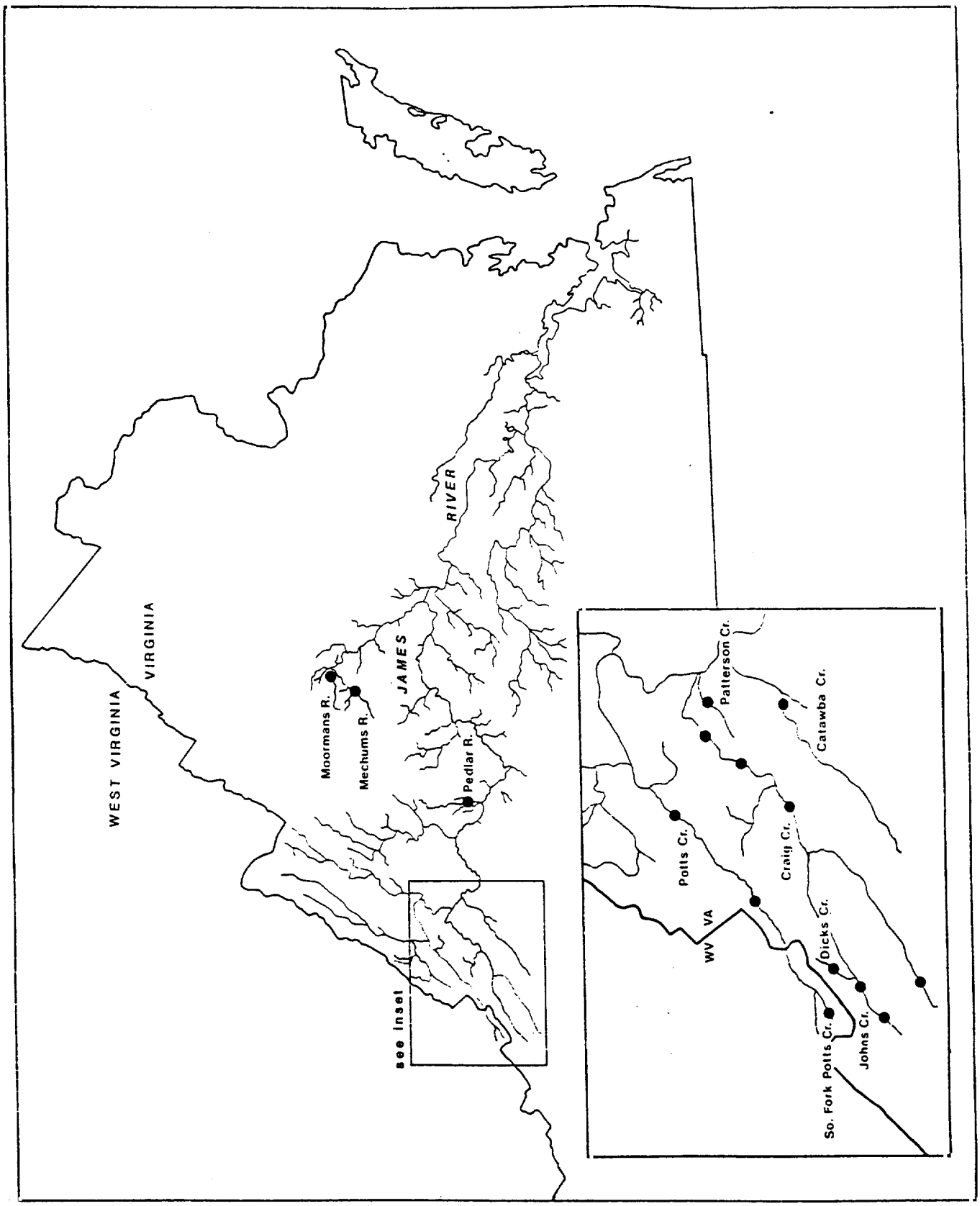

Figure 1. **James River Drainage Showing Current Distribution of James Spinymussel**

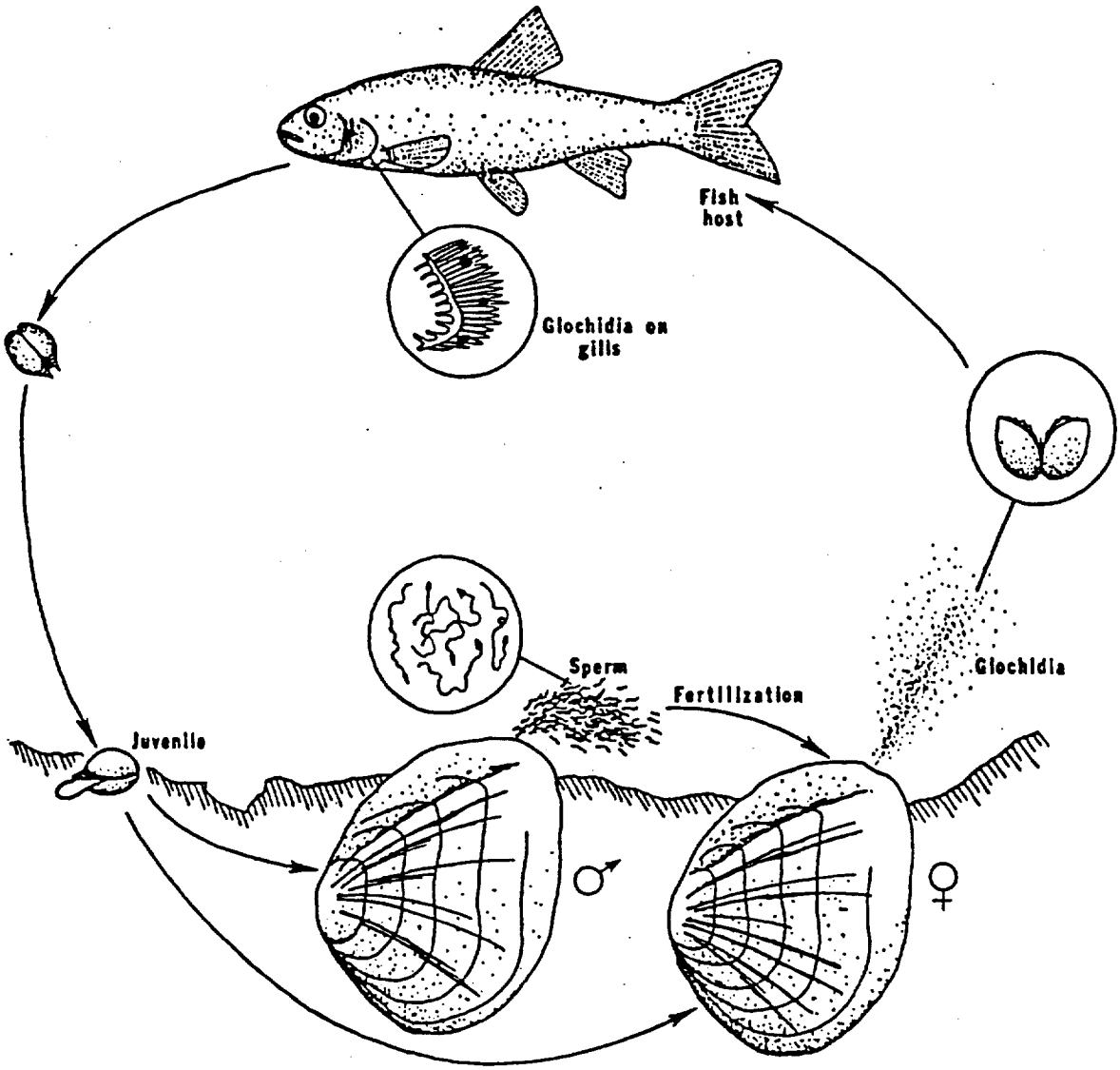

Figure 2. **Typical Life Cycle of a Freshwater Mussel**

Seven fish hosts, all in the family Cyprinidae (minnows), have been identified for the James spinymussel (Hove 1990). They are:

• Bluehead chub	*Nocomis leptocephalus*
• Rosyside dace	*Clinostomus funduloides*
• Blacknose dace	*Rhinichthys atratulus*
• Mountain redbelly dace	*Phoxinus oreas*
• Rosefin shiner	*Notropis ardens*
• Satinfin shiner	*Notropis analostanus*
• Stoneroller	*Campostoma anomalum*

A description of chemical and physical conditions at sites currently supporting this species is given in Clarke and Neves (1984). They indicate that stream width at these sites varies from 10 to 75 feet with a water depth of 0.5 to 3 feet. Historic sites on the James River were, of course, much wider -- up to 500 feet across. The water velocity at sites supporting this species is slow to moderate; bottom sediments are sand and cobble with or without boulders, pebbles, or silt.

Freshwater mussels presently co-occurring with *P. collina* include the following species: *Strophitus undulatus, Villosa constricta, Alasmidonta undulata, Elliptio lanceolata, Fusconaia masoni, Lasmigona subviridis,* and *Elliptio complanata.* The Asian clam, *Corbicula fluminea*, was noticeably absent from all of these sites. *C. fluminea* is now abundant throughout the mainstem James River and is also found in several of its tributaries including Muddy River, Rivanna River, and the Appomattox River (Clarke and Neves 1984) where the James spinymussel is absent.

Reasons For Decline And Threats To Continued Existence

Although the James spinymussel still occurs at a number of sites, its rapid decline during the past two decades as well as the small size and extent of most of its

remaining populations indicate that it is highly vulnerable to extirpation. This section provides a general discussion of activities in the James River basin and other river systems, and how they are thought to have contributed to the decline of freshwater mussels in the Southeast, including the James spinymussel.

Siltation, generated by agricultural and forestry activities and road construction, is a significant factor contributing to water quality problems and the consequent decline of the James spinymussel. Mussels are sedentary and unable to move long distances to more suitable areas in response to heavy silt loads. Natural sedimentation resulting from seasonal storm events probably does not significantly affect mussels, but human activities often create excessively heavy silt loads that can have severe effects on mussels and other aquatic organisms (USFWS 1987). For instance, reductions in mussel abundance in the Stones River in Tennessee were thought to be a partial result of siltation from gravel dredging during summer low flow conditions (Schmidt 1982). Suspended sediment can clog the gills of filter feeding mussels and eventually suffocate them, so mussels often respond by closing their valves (Ellis 1936). Kitchel *et al.* (1981) reported reduced siphoning activity, and consequently reduced feeding, by mussels placed in aquaria with suspended coal fines. Indications are that siltation can severely stress mussels and lead to chronic effects.

The invasion of the Asian clam may be one of the most significant threats to both the James spinymussel and the Tar River spinymussel (Clarke and Neves 1984). This potential problem was discussed in the Tar River Spinymussel Recovery Plan (USFWS 1987) and is restated in the following paragraphs.

The Asian clam is one of 204 introduced mollusk species in North America (Dundee 1969). It was first discovered in the United States in the Columbia River, Oregon, in 1939. It appeared in California in the 1940's and 1950's, in the Ohio/Mississippi and Gulf of Mexico drainages in the 1960's and 1970's, and in the Atlantic drainage in the 1970's and 1980's (Clarke 1988). Once established in a river, *Corbicula fluminea*

populations achieve high densities and expand rapidly. Densities of 1,000/m^2 in the James River, Virginia (Diaz 1974), the New River, Virginia (Rodgers *et al.* 1977), and the Tar River, North Carolina (Clarke 1983), and 10,000/m^2 in the Altamaha River in Georgia (Gardner *et al.* 1976) have been reported. Clarke (1988) indicates that *Corbicula* was first introduced into the James River in 1971 near Hopewell, Virginia, about 15 miles below Richmond, and by 1984 had spread upstream to the mouth of Craig Creek, a distance of about 195 miles (an average of 15 miles per year). Malacologists are now concerned about the possibility of a competitive interaction between Asian clams and native bivalves. Quantitative studies by Cohen *et al.* (1984) support the hypothesis that an extensive *C. fluminea* bed in a reach of the Potomac River removed 40-60% of the phytoplankton in this reach. It is not unreasonable to conclude that *C. fluminea* has the potential to deplete the food supply of unionids.

Disturbance of watersheds appears to play a role in the expansion of the Asian clam; it predominates in rivers altered by human activities, and may exclude native unionids even when suitable habitat exists. Because it is hermaphroditic, requires no fish host, and spawns twice each year, *C. fluminea* may be competitively superior to native mussels in disturbed habitats. However, even in undisturbed areas the Asian clam may ultimately gain a competitive advantage by producing larger broods (Kraemer 1979). Competition with unionids may not occur among adults but rather at the juvenile stage (Neves and Widlak 1987).

Impoundments on rivers in the Southeast have been responsible for the decline of many mussel populations. Mussel populations have been eliminated from large sections of the Tennessee and Cumberland Rivers in Tennessee and Kentucky by the construction of more than 50 dams (USFWS 1984a, 1984b, 1984c, 1984d, 1987). Flood control dams under consideration in the upper James River present a similar threat to the James spinymussel. The effects of impoundments on mussels are well documented. Closure of dams changes habitat from lotic to lentic conditions. Depth

increases, flow decreases, and silt accumulates on the bottom. Hypolimnetic discharge lowers water temperatures downstream. Fish communities change, and host fish species may be eliminated. Mussel communities change, as species requiring clean gravel and sand substrate are replaced by silt-tolerant species (Bates 1962).

Pollution of inland waters is one of the most important environmental concerns in the United States. Many rivers have been severely degraded by pollution from municipal, industrial, and agricultural sources. At various locations in the Southeast, freshwater mussel populations have been reduced and, in some cases, completely extirpated from lakes and streams by pollutants including effluent from chlor-alkali plants, fly ash and sulfuric acid spills (Cairns *et al.* 1971, Raleigh *et al.* 1978), acid mine drainage (Neel and Allen 1964) and organic wastes (Schmidt 1982). Salanki and Varanka (1978) found that insecticides have significant effects on mussels. Low concentrations of lindane (.006 g/l), phorate (.008 g/l), and trichlorfon (.02 g/l) caused a 50 percent reduction in siphoning activity, and 1 g/l phorate or 1 ml/l trichlorfon were lethal concentrations. Chlorinated effluent from sewage treatment plants can affect the diversity and abundance of aquatic mollusks. Recovery of mollusk populations may not occur for up to two miles below the discharge point (Goudreau 1988). Acid rain may also pose a threat to Atlantic drainage mussel populations, especially those inhabiting poorly buffered systems.

The disappearance of *P. collina* from the North River in Rockbridge County, Virginia may well have been brought about by industrial and sewage pollution (Clarke and Neves 1984). Within the present range of the species, several sewage treatment plants pose a potential threat to the spinymussel. Of these, the plant at New Castle, Virginia on Craig Creek is the most significant, because it is located in the midst of the best known population of the species.

Since 1982 biologists and commercial musselmen have reported extensive mussel die-offs in rivers and lakes throughout the United States. Kills have been documented

from the Clinch River (Virginia), Powell River (Virginia, Tennessee), Tennessee River (Tennessee), Grand River (Oklahoma), the Upper Mississippi River (Wisconsin to Iowa), and rivers in Illinois, Kentucky, and Arkansas (USFWS 1987). Lake St. Clair (Michigan), Chatauqua Lake (New York), and Court Oreilles Lac (Wisconsin) have also been affected. The cause is unknown, but numerous species of mussels are involved, including several commercially important and Federally listed species (USFWS 1987). The significance of this potential threat to the James spinymussel is indicated by the fact that personnel involved in a survey for the Tar River spinymussel in April 1986 discovered a large die-off of mussels in the Tar River in North Carolina. Hundreds of freshly dead and recently dead juvenile and adult mussels were observed at two locations below Rocky Mount, North Carolina. All species appeared to be affected and several shells (spineless) of what were believed to be Tar River spinymussels were found (USFWS 1987).

Part II: RECOVERY

Recovery Goal

The goal of this recovery plan is to maintain and restore viable populations of *Pleurobema collina* to a significant portion of its historic range and remove the species from the Federal list of endangered and threatened species. This can be accomplished by (1) protecting and enhancing habitat containing *P. collina* populations and (2) establishing or expanding populations within rivers and river corridors which historically contained this species.

Recovery Objectives

Objective 1. Reclassify *P. collina* from endangered to threatened status when the likelihood of extinction in the foreseeable future has been eliminated by meeting the following criteria:

A. Populations of *P. collina* throughout the Craig Creek drainage (including Johns Creek) and 80% of all other known populations are stable or expanding (as shown by monitoring over a 10-year period) and show evidence of recent recruitment (specimens age five or younger).

B. Populations in at least four rivers (or creeks) are distributed widely enough within their respective habitats such that it is unlikely that a single adverse event in the river would result in the total loss of that population.

The probable locations of these four populations are:

- Craig Creek and its larger tributaries from Webbs Mill downstream to its confluence with the James River, and Johns Creek from its headwaters to its confluence with Craig Creek
- Potts Creek
- Pedlar River
- Mechums River

C. All known populations of the species are protected from present and foreseeable anthropogenic and natural threats that may interfere with their survival.

Objective 2. Remove *P. collina* from the Federal list of endangered and threatened species when the following criteria have been met, in addition to A-C above:

D. Through re-establishment and/or discoveries of new populations, viable populations[1] of the species exist in two additional rivers or three river segments within the James River drainage. Each river or river segment will contain at least three population centers[2] which are dispersed to the extent that a single adverse event would be unlikely to eliminate *P. collina* from its natural or re-established location. For a re-established population, surveys must show that three year-classes, including one year-class of age 10 or older, have been naturally produced within each of the population centers.

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1 viable population - a reproducing population that is large enough to maintain sufficient genetic variation to enable it to evolve and respond to natural habitat changes.

2 population center - a single shoal or grouping of shoals which contain *Pleurobema collina* in such close proximity that they can be considered as belonging to a single breeding unit.

E. Habitat protection strategies have been successful, as evidenced by recruitment and an increase in population density and/or an increase in the population size and length of river reach inhabited at 75% of the sites with viable populations.

Recovery Tasks

Table 2 shows the step-down outline of recovery tasks for *Pleurobema collina*. This outline is included primarily for purposes of reference to the Implementation Schedule. The following narrative describes these tasks in more detail.

1. Collect basic data needed for protection of *P. collina* populations.

1.1 Conduct population and habitat surveys for *P. collina*.

1.11 Determine species' present distribution and status. Surveys will be conducted in James River tributaries and some sections of the mainstem James to determine the spinymussels' total range and relative abundance. Recent discoveries of the species in the Pedlar River, Mechums River, Moormans River, and Rocky Run demonstrate the urgent need for additional distributional surveys. The Forest Service has initiated surveys in the Potts Creek and upper Pedlar River drainages to allow assessment of impacts from planned forest management activities.

Table 2. Step-down outline of recovery tasks for the James spinymussel

1. Collect basic data needed for protection of *P. collina* populations.

   1.1 Conduct population and habitat surveys for *P. collina*.

      1.11 Determine species' present distribution and status.

      1.12 Identify essential habitat and specific areas in need of protection.

   1.2 Identify threats to species' survival.

      1.21 Determine significance of specific threats faced by the species such as siltation, pesticide contamination, and municipal and industrial effluents.

      1.22 Investigate interactions with Asian clam, and methods to control the clam's spread.

2. Preserve *P. collina* populations and occupied habitats.

   2.1 Continue to utilize existing legislation and regulations to protect the species and its habitats.

   2.2 Implement available measures to control or slow down the invasion of exotic bivalves.

   2.3 Determine and implement protection strategies for areas identified in Task 1.12.

      2.31 Encourage the establishment of mussel sanctuaries, scenic rivers, and regulations to protect water quality.

      2.32 Meet with riparian land owners, local government officials, and regulatory agency representatives to solicit support for protection of the species and mitigation of impacts to the species and its essential habitats.

      2.33 Provide long-term protection of essential habitats through acquisition, registry, management agreements, and the establishment of stream buffer zones.

      2.34 Develop an educational program using such items as slide/tape shows and brochures. Present this material to business groups, civic groups, youth groups, schools, church organizations, etc.

3. Conduct life history studies and identify ecological requirements of the species.

   3.1 Conduct life history research on the species to include reproduction, food habits, age and growth, mortality factors, etc.

   3.2 Characterize the species' habitat requirements (relevant physical, biological, and chemical components) for all life history stages.

4. Determine the feasibility of re-establishing populations within the species' historic range and, if feasible, introduce the species into such areas in the James River drainage.

   4.1 Determine the need, appropriateness, and feasibility of augmenting and expanding existing populations.

   4.2 Develop a successful technique for re-establishing and augmenting populations.

   4.3 Coordinate with appropriate Federal and state agency personnel, local governments, and interested parties to identify streams suitable for augmentation and reintroductions and those most easily protected from further threats.

   4.4 Reintroduce the species into its historic range and evaluate success.

   4.5 Implement the same protective measures for any introduced populations as outlined for established populations.

5. Periodically monitor existing populations and all introduced populations.

6. Evaluate the success of recovery activities and make revisions as necessary.

1.12 Identify essential habitat and specific areas in need of protection. Craig and Johns Creeks in Craig and Botetourt Counties, Virginia, are the most important known refugia for the species. Essential habitat can be delineated there with little additional surveying. Delineation of essential habitat in other rivers and creeks must await more definitive survey data developed during implementation of Task 1.11.

1.2 Identify threats to species' long-term survival. Reasons for the spinymussel's recent decline are not known. Until they are better understood, complete recovery of the species may be impossible.

1.21 Determine the significance of specific threats faced by the species such as siltation, pesticide contamination, and municipal and

industrial effluents. Studies will be conducted to quantify acute and chronic effects of contaminants on the species at both individual and population levels. Surrogate species would, in most cases, be utilized for any laboratory studies.

1.22 Investigate interactions with the Asian clam (*Corbicula fluminea*) and methods to control the clam's spread. The mutually exclusive distribution of the spinymussel and the Asian clam in the James River drainage indicates that competition from *Corbicula* **may** be the single greatest threat to *P. collina*. Definitive studies need to be conducted to determine the nature and significance of this competition. These studies should be coordinated with similar efforts described in the Tar River spinymussel recovery plan. Research should also be conducted on methods that hold promise for controlling the Asian clam without interfering with the survival and reproduction of native mollusks.

2. Preserve *P. collina* populations and occupied habitats.

2.1 Continue to utilize existing legislation and regulations (Federal and State Endangered Species Acts, water quality regulations, stream alteration regulations, etc.) to protect the species and its habitats. Prior to and during implementation of this recovery plan, the present populations can be protected only by the full enforcement of existing laws and regulations. Land management and regulatory agencies that may have especially important roles to play in the recovery of this species include the U.S. Forest Service, Soil Conservation Service, Army Corps of Engineers, Virginia Department of Game and Inaland Fisheries (VDGIF), Virginia Water Control Board, and county planning and zoning departments.

2.2 Implement available measures to control or slow down the invasion of exotic bivalves. To slow down the spread of *Corbicula*, it is recommended that regulations prohibiting the use of *Corbicula* as bait in specific drainages be implemented as quickly as possible (prior to definitive results from Task 1.22). Similar regulations may be needed for the zebra mussel (*Dreissena polymorpha*) if it invades the James River drainage. Any other control methods developed as a result of Task 1.22 should also be implemented.

2.3 Determine and implement protection strategies for essential habitat areas identified in Task 1.12.

2.31 Encourage the establishment of mussel sanctuaries, scenic river designations, and regulations to protect water quality. The U.S. Fish and Wildlife Service will work with state agencies in Virginia and West Virginia to assign special status to river and stream reaches providing prime habitat for the spinymussel. For instance, the Virginia Water Control Board may wish to designate specific river/stream reaches for the protection of this endangered species, as it has done for other aquatic endangered species. In addition, the state fish and game agencies may designate mussel sanctuaries or use other mechanisms to prohibit commercial or recreational collecting. The VDGIF has recently proposed regulations for this purpose, limiting collection of mussels in the upper James River and upper Tennessee River drainages.

2.32 Meet with riparian land owners, local government officials, and regulatory agency representatives to solicit support for protection of the species and mitigation of impacts to the species and its essential habitats. Riparian land owners and local governments and

regulatory agency officials will be informed of the species' presence in the river and the importance of protecting its habitat. The Virginia Division of Natural Heritage has indicated an interest in assisting with landowner contact. Landowners will also be encouraged to work with the Soil Conservation Service (SCS) and state agencies to develop measures to reduce sediment and erosion.

2.33 Provide long-term protection of essential habitats through acquisition, registry, management agreements, and the establishment of stream buffer zones. Much of the best habitat of *P. collina* is within the proclamation boundaries of the Jefferson or George Washington National Forests. Wherever possible, the Forest Service should acquire those habitat areas and their watersheds, with priority placed on the Craig/Johns Creek watershed. Such acquisition would provide the most effective protection for the species and its habitat, although a lesser degree of protection could be provided by registry and management agreements (including establishment of buffer zones) with private landowners. Management agreements or other mechanisms are needed to control erosion caused by livestock grazing, timber cutting, and other land-use activites adjacent to stream banks. Where riparian land remains in private ownership, landowners should be encouraged to install fencing to limit access by farm animals and to leave agricultural and silvicultural buffer strips along streambanks. A major role in this process could be played by SCS and Virginia Department of Soil and Water Conservation programs for installation of agricultural best management practices, and development of buffer zones under the conservation reserve program of the 1990 Food Security Act.

2.34 Develop an educational program using such items as slide/tape shows, brochures, etc. A strategy for distributing informational and educational materials to business groups, civic groups, youth groups, schools, church organizations, etc., will be developed. These materials will then be produced on a contract basis or in cooperation with state agencies.

3. Conduct life history studies and identify ecological requirements of the species.

3.1 Conduct life history research on the species to include reproduction, food habits, age and growth, mortality factors, etc. Life history research has been completed by Hove (1990).

3.2 Characterize the species' habitat requirements (relevant physical, biological, and chemical components) for all life history stages. Much of this information has been provided by recently completed research (Hove 1990). Additional habitat characterization may be needed prior to implementation of Task 4.

4. Determine the feasibility of re-establishing populations within the species' historic range and, if feasible, introduce the species into such areas in the James River drainage. The present range of the James spinymussel is much smaller than it was historically. There may be areas within the species' former range that could support re-established populations. However, implementation of this task must await the results of Task 1.11 and 1.23. If 1.23 shows *Corbicula* competition to be as significant as some malacologists believe, transplantation into most historical habitats will be unworkable.

4.1 Determine the need, appropriateness, and feasibility of augmenting and expanding existing populations. Several populations are likely below the

number needed to maintain long-term viability. These populations may be able to expand naturally if environmental conditions are improved. However, some populations may need to be supplemented to reach a viable size. Populations for this task will be selected based on present population size, habitat quality, and the likelihood of long-term benefits from the task.

4.2 Develop a successful technique for re-establishing and augmenting populations. This task is also part of the Tar River spinymussel recovery plan. Techniques developed for that species should work for the James spinymussel as well.

4.3 Coordinate with appropriate Federal and state agency personnel, local governments, and interested parties to identify streams suitable for augmentation and reintroductions and those most easily protected from further threats.

4.4 Reintroduce the species into its historic range and evaluate success.

4.5 Implement the same protective measures for any introduced populations as outlined for established populations.

5. Periodically monitor existing populations and all introduced populations. In light of the spinymussel's rapid decline, this task is especially important. This task would begin with a baseline quantitative survey and then continue with systematic monitoring of all populations every five years to keep track of their status and ensure their continued survival.

6. Evaluate the success of recovery activities and make revisions as necessary.

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Part III: IMPLEMENTATION SCHEDULE

The Implementation Schedule that follows outlines actions and estimated costs for the recovery program. It is a guide for meeting the objectives discussed in Part II of this Plan. This schedule indicates task priorities, task numbers, task descriptions, duration of tasks, the responsible agencies, and estimated costs. These actions, when accomplished, should bring about the recovery of the species and protect its habitat.

Key to Implementation Schedule Priorities (column 1)

Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2 - An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

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

James Spinymussel Recovery Plan
Implementation Schedule

September, 1990

Priority	Task Number	Task Description	Task Duration	Responsible Agencies[1] FWS Region	FWS Division	Others[2]	Estimated Fiscal Year Costs ($000) FY1	FY2	FY3	Comments
1	1.1	Conduct surveys for P. collina	2 years	5	FWE	USFS VDGIF VANHP WVDWR	10	10	--	Alternatively, may be done by contract
1	1.22	Investigate interactions with Asian clam	3 years	5	FWE	Contract	20	20	20	Same type of study called for in Tar Spinymussel Plan
1	2.1	Continue to utilize existing legislation and regulations to protect species	continuous	5	FWE	USFS VDGIF VADNH WVDWR SCS ACOE VAWCB	1	1	1	
1	2.2	Implement measures to control or slow down invasion of exotic bivalves	continuous	5	FWE	VDGIF WVDWR	--	--	--	Except for development of regulations, cannot begin until 1.22 is completed
1	2.33	Provide long-term protection of essential habitats through acquisition, registry, management agreements, etc.	10 years	5	FWE	SCS USFS VADSWC VDGIF VANHP WVNHP	--	10	1000	Funds principally for USFS land acquisition
1	3.1	Conduct life history research	2 years	4	SE	Contract	--	--	--	Completed. Funded by R4

1	5.0	Periodically monitor populations	continuous	5	FWE	Contract or VDGIF VANHP WVDWR	--	15	--	Once every 5 years
2	1.21	Determine effects of siltation, pesticides, effluents	3 years	5	FWE	Contract	25	25	25	
2	2.31	Encourage establishment of mussel sanctuaries and regulations to protect water quality	3 years	5	FWE	VAWCB VDGIF WVDWR	--	--	--	Task can begin now, but cannot be completed until Task 1.1 is done
2	2.32	Seek support from landowners, local governments, and agencies	continuous	5	FWE	SCS USFS VDGIF VANHP WVNHP WVDWR TNC	1	1	1	
2	3.2	Characterize habitat requirements	2 years	5	FWE	Contract	--	10	10	
3	4.0	Determine feasibility of re-establishing populations in historic range and, if feasible, introduce in areas of James River drainage	3+ years	5	FWE	Contracts and VDGIF VANHP WVDWR	--	--	--	
3	2.34	Develop an educational program	1 year	5	FWE	Contract or VDGIF	--	--	3	

3	6.0	Evaluate success of recovery activities and revise as necessary	continuous	5	FWE	VDGIF VANHP WVDWR	0.5	0.5	0.5

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[1] ACOE = Army Corps of Engineers
FWE = Fish and Wildlife Enhancement
FWS = Fish and Wildlife Service
SCS = Soil Conservation Service
TNC = The Nature Conservancy
USFS = U.S. Forest Service
VADNH = Virginia Division of Natural Heritage
VADSWC = Virginia Division of Soil and Water Conservation
VAWCB = Virginia Water Control Board
VDGIF = Virginia Department of Game and Inland Fisheries
WVDWR = West Virginia Department of Wildlife Resources
WVNHP = West Virginia Natural Heritage Program

[2] Other agencies' responsibility will be of a cooperative nature or projects funded under a contract or grant program. In some cases contracts may be let to universities or private enterprises.

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