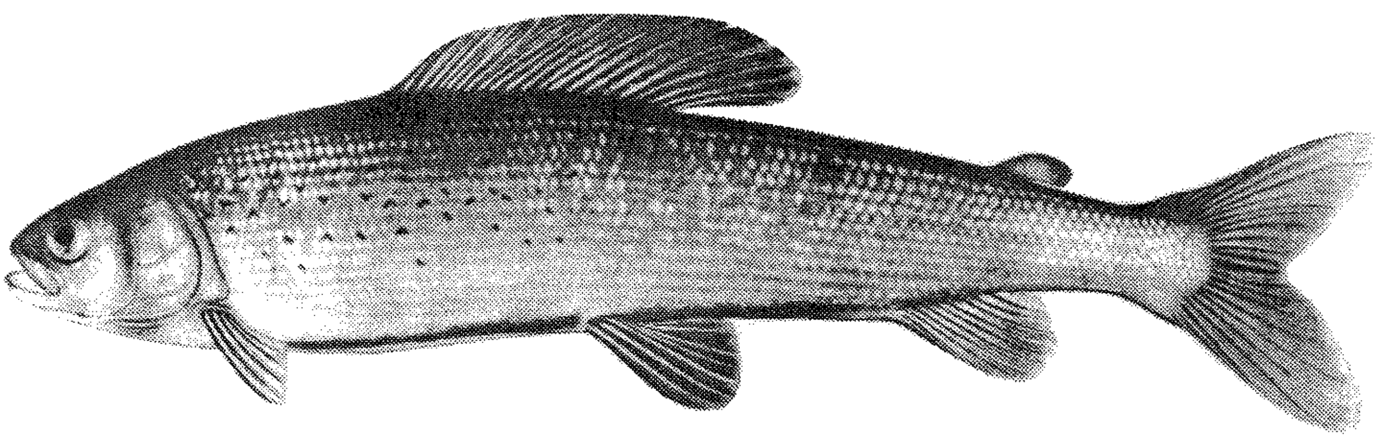
DRAFT

FLUVIAL ARCTIC GRAYLING RECOVERY PLAN

MAY 1, 1993



Prepared by: FLUVIAL ARCTIC GRAYLING WORKGROUP

TABLE OF CONTENTS

I. INTRODUCTION

Montana's fluvial Arctic grayling, formerly widely distributed in the Missouri River upstream of Great Falls and its major tributaries, is today confined to the Big Hole River. In the mid to late 1980's, population densities of grayling in the Big Hole declined, causing concern among resource agencies about the future of this population. As a result, a number of actions were initiated, beginning in 1987, in an attempt to insure the protection and restoration of this population.

In October 1991, the U.S. Fish and Wildlife Service (USFWS) received a petition to list the fluvial Arctic grayling throughout its historic range in the lower 48 states under the Endangered Species Act.

II. CONSERVATION GOALS

Because of the uniqueness and importance of fluvial Montana grayling, and because of their critically low numbers, they have been designated a fish of "Special Concern" by the Endangered Species Committee of the American Fisheries Society, the Montana Chapter of the American Fisheries Society, the Montana Department of Fish, Wildlife and Parks, and the Montana Natural Heritage Program (Holton 1980; Williams et al. 1989; Clark et al. 1989). The United States Forest Service has classified the grayling as a sensitive species. The USFWS classifies fluvial Montana grayling as a Category 1 species, which indicates that there is enough information on file to support a proposal to list it as threatened and endangered.

Such designations of special, protective status indicate the need to restore fluvial Montana grayling within their historic range. The Montana Fluvial Arctic Grayling Workgroup, whose membership includes representatives of Montana Department of Fish, Wildlife and Parks (MDFWP), U.S. Fish and Wildlife Service (USFWS), U.S. Forest Service (USFS), U.S., Bureau of Land Management (USBLM), Montana Natural Heritage Program (MNHP), Montana Council of Trout Unlimited (MCTU), Montana State University (MSU), University of Montana (UM), Montana Chapter of the American Fisheries Society (MCAFS) and Montana Power Company (MPC) recommends the following conservation goal:

> The conservation goal for fluvial Montana grayling is the presence of at least five stable, viable populations distributed among at least three of the major river drainages (e.g., Big Hole, Jefferson, Beaverhead, Madison, Gallatin, Sun, Smith) within the historic range of the Missouri River system upstream from Great Falls by the year 2020. A population will be considered stable and viable in a stream when monitoring confirms that, for at least 10 years, all age classes from age-0 to

reproducing adults are present, and the density or biomass of age-1+ (older than young-of-year) grayling remains at a level corresponding to at least 35% of the combined density or biomass of age-1+ trout and grayling sustainable by that stream. The density or biomass sustainable by each stream will be estimated through applying either: (a) the highest available estimate of trout (plus grayling, if present) in the same stream prior to grayling restoration or enhancement, or (b) estimates of trout (plus grayling, if present) in other streams that have similar dimensions and characteristics, and that are considered not seriously degraded by human activities.

With respect to the two other populations that may also have fluvial characteristics, the Madison River - Ennis Reservoir population and the Turnbull Drops (Sunny Slope Canal) population, we recommend the following:

(1) The Madison River - Ennis Reservoir population is currently being intensively studied, to elucidate its population and life history characteristics. At some time in the future, the Montana Fluvial Grayling Workgroup should discuss both the history of this population and results of the present and forthcoming investigations. If warranted, this population could be included toward fulfillment of recovery goals.

(2) The Turnbull Drops (Sunnyslope Canal) population should be further investigated and discussed. Although the canal is artificial, this population inhabits water diverted from the Sun River drainage, which is within the historic range of fluvial grayling. If investigations and discussions so warrant, then this population could also be included toward fulfillment of recovery goals.

The purpose of this document is to describe the activities currently underway or planned to meet the conservation goal. The specific conservation tasks and their status are listed in Table 1. These tasks are described in detail in the text following the number scheme in the table. This document constitutes the conservation plan of the Montana Fluvial Arctic Grayling Workgroup.

III. BACKGROUND

The status of fluvial (permanently stream-dwelling) Arctic grayling, Thymallus arcticus, in Montana has been of increasing concern in recent years. Once widely distributed in the Missouri River and its tributaries upstream from Great Falls, fluvial Montana grayling are now restricted to the upper reaches of a

Table 1. Specific Conservation Tasks.

single tributary, the Big Hole River. They inhabit the river, from about the town of Jackson downstream to the mouth of the Big Hole. The highest density of grayling is concentrated in the area from Wisdom downstream to Divide. This is the only confirmed fluvial grayling population still remaining south of Canada and Alaska. Using the limited information available, Varley and Schullery (1983) estimated that fluvial Montana grayling are reduced in distribution to only about 8% or less of their historical range. The only other "southern" grayling were formerly found in streams in Michigan, but underwent a similar, earlier decline and disappeared about 1936 (McAllister and Harington 1969). Repeated attempts to establish or restore stream populations in Michigan and Montana have not succeeded.

In marked contrast to fluvial populations, lacustrine (lake dwelling) grayling in Montana have greatly increased in distribution and abundance within the present century. Native lacustrine populations in Montana may have been confined to Red Rock lakes (Upper and Lower), and possibly nearby Elk Lake (Vincent 1962), which were the only lakes in the upper Missouri drainage naturally accessible to fishes. With the initiation of hatchery culture of grayling in 1898 (Henshall 1906) and continuing to the present, the species has been widely introduced to lakes in Montana and other states. They are thus present in drainages outside the native range of the upper Missouri drainage. Within Montana alone, there appear to be at least 30 lakes with viable populations of grayling, including the native waters of Upper Red Rock Lake.

The remnant population of the Big Hole River is unique and of much concern because of a combination of at least four characteristics: (1) it is the last confirmed fluvial population of Montana grayling; (2) the grayling of the Big Hole River drainage are genetically identifiable from other Montana grayling, and Montana grayling are in turn genetically diverged from those in Alaska and Canada (Lynch and Vyse 1979; Everett and Allendorf 1985); (3) the population appears unique among Montana grayling, in being adapted to a riverine existence (Shepard and Oswald 1989; Kaya 1991); and (4) the population has declined to critically low levels (Oswald 1990).

A recent evaluation of the status of Montana grayling confirmed that the only population proven to be completely fluvial, with fish spending their entire lives in a stream environment, is that of the upper Big Hole River (Kaya 1990). However, there are two other populations with at least partially fluvial characteristics. One is the population that inhabits the Madison River and Ennis Reservoir. Grayling are found in the Madison River upstream from the reservoir throughout the summer and into at least early fall, well beyond the spawning season (R. Vincent, MDFWP, pers. comm.; Byorth and Shepard 1990). The Madison River is native habitat for fluvial grayling, and the reservoir fills an area originally occupied, in part, by a small, shallow lake.

The other population is found in an unusual habitat, Sunny Slope Canal below Pishkun Reservoir in the Teton River drainage. Observations by Bill Hill (MDFWP, pers. comm.) suggest that these fish live in a fluvial environment during the irrigation season, generally from early May to September, when water flows in large volumes through the canal. Since grayling are virtually absent from Pishkun reservoir, it is apparent that the young are produced and persist within a fluvial environment during this period of the year. However, during the remaining seven months of the year, much of the canal goes dry and the grayling live in isolated pools.

Although all Arctic grayling are considered to belong to the same species and no subspecies are currently recognized, protein electrophoretic techniques have demonstrated divergence of Montana populations from those in Alaska and Canada (Lynch and Vyse 1979; Everett and Allendorf 1985). Everett and Allendorf (1985) also concluded that grayling from the Big Hole River were genetically diverged from all other populations they had examined from Montana, Alaska, and Canada. The Madison River-Ennis Reservoir population was not examined by these earlier studies, and more recent comparisons indicate that this population is very similar, although not identical, to that of the Big Hole River (R. Leary, U. Montana, pers. comm.). Possible reasons for this similarity include perpetuation of an original resemblance in the native stocks, random genetic changes in the Madison River population, and, least likely, successful introductions of Madison River fish into the Big Hole drainage.

Two recent studies have provided evidence for adaptation of Big Hole River grayling to a riverine environment. Shepard and Oswald (1989) described extensive annual migrations of adults in the river. Spawning occurs in upstream reaches near Wisdom, and some fish migrate downstream to overwinter in deep pools. Others remain in upstream reaches through winter, in deep pools, or areas of groundwater recharge, or tributaries. Similar seasonal patterns of upstream and downstream migrations have been described for populations in Alaska, and appear to be adaptations for utilizing conditions in different parts of river systems for spawning, feeding and overwintering (Hubert et al. 1985).

Another recent study demonstrated that young Big Hole River grayling have innate, apparently genetically controlled behavioral responses to water current that are advantageous to riverine existence. Young Big Hole River grayling have a significantly greater tendency to hold position in water current and lesser tendency to move downstream than do those from an inlet-spawning population. Such a behavioral tendency would allow the young to remain within the stream, and thereby enable the population to maintain a permanent, life-long presence in flowing water. The genetic basis for such behavior was also indicated by another study (Kaya 1989) which demonstrated differential responses between young from inlet- and outlet-spawning populations, and intermediate responses of young resulting from reciprocal crosses between the populations. Field studies of distribution and habitat utilization by young-of-year grayling in the Big Hole River have confirmed that they do remain within stream reaches close to the spawning areas, and use both riffle and pool habitats (Skaar 1989; McMichael 1990; Streu 1990).

Decline and Present Status of Big Hole River Grayling

Concerns over the status of the remnant fluvial grayling population of the Big Hole River have been heightened in recent years by the low numbers and densities observed in population surveys. Recent surveys indicate that estimated numbers of age-1+ grayling (age 1 and older, excluding only the young-of-the-year) in the Wisdom section of the Big Hole River, have declined to very low levels where they appear to have stabilized (Table 2).

Estimates have gone from about 111 per mile in 1983 to about 22 to 34 per mile in 1989 to 1991. These are estimates for the stream sections near the town of Wisdom, where grayling appear most abundant. If these recent estimates of about 30 per mile are extrapolated to the approximately 50 to 70 miles of stream inhabited by grayling, this leads to an estimate of approximately 1,500 to 2,100 age-1+ grayling in the entire Big Hole River. The small size of this remnant population is placed into perspective by the fact that some Montana streams contain as many or more age-1+ trout per single mile.

Reasons for declines of fluvial grayling populations, either within the entire upper Missouri River drainage or within the Big Hole River, are not well understood but are thought to include a combination of competition from non-native salmonids, overfishing, drought and habitat degradation (Vincent 1962; Kaya 1990). Grayling have the reputation of being easily caught by anglers, and this may have contributed in the past to overharvest of these fish in Montana streams (Vincent 1962; Wipperman 1965). Regulations have allowed only catch-and-release fishing on the Big Hole River since 1988-89. Non-native salmonids have been widely introduced to virtually all former grayling streams in Montana, and have probably been a major factor contributing to the decline of fluvial grayling (Vincent 1962; Kaya 1990).

Montana has been in a drought situation since the mid-1980's. Flows in the fall/winter and spring/summer have ranged from 80-86% and 42-54% of the long term average monthly flows respectively (Table 3). This broad scale environmental change, with consequent reductions in spawning, rearing and winter habitat, could well explain the decline of all fish population densities shown in Table 3. The current low population densities may be a natural response by all three salmonid species to drought related low flows. These low flows certainly exacerbate some of the habitat problems, described below, associated with irrigated agriculture.

Table 2. Big Hole River monthly average flows at Melrose (cubic feet per second).

	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept
1984	554	539	459	394	386	400	1842	2555	1601	322	322	465
1985	604	410	333	334	363	958	1919	2842	3775	966	346	584
1986	643	556	335	296	352	530	1258	1379	826	434	240	175
1987	240	293	252	228	290	317	1425	1920	1601	302	88	114
1988	241	330	240	222	212	439	1371	1726	2065	600	325	298
1989	390	454	374	374	326	426	1542	1173	2223	649	372	298
1990	357	432	258	268	278	333	855	2108	4239	1099	269	231
1984-1990 Ave.	433	431	322	302	315	486	1459	1958	2333	625	280	309
Long term Ave. (1937-1986)	530	520	400	350	370	470	1500	3600	4400	1500	520	410
1984-1990 % of long term average flow	82%	83%	80%	86%	85%	103%	97%	54%	53%	42%	54%	75%

Table 3. Estimated densities (number per mile) of age-1+ grayling, age-2+ brook trout, and age-1+ rainbow trout in McDowell (8.0 km in length) and Wisdom (9.8 km in length) sections of the Big Hole River upstream and downstream from the town of Wisdom (Oswald 1990, Byorth 1991).

		Estimated Number per Mile		
Section	Year	Grayling	Brook	Rainbow
McDowell	1978	69	109	0
Wisdom	1983	111	234	14
Wisdom	1984	74	274	11
McDowell	1985	38	208	26
Wisdom	1985	33	331	5
McDowell	1986	51	211	27
McDowell-Wisdom	1987	30	82	3
McDowell-Wisdom	1989	22	62	3
McDowell-Wisdom	1990	34	65	6
McDowell-Wisdom	1991	34	-	-

According to Vincent (1962), agricultural activities have been the most important contributors to degradation of fluvial grayling habitat in Montana. Such habitat degradation in Montana appears most frequently to have been related directly or indirectly to agricultural irrigation. The most important disturbances have been reduction in stream flows through withdrawals of water for irrigation, blockage of streams by dams for reservoirs and diversions, and flooding of streams by reservoirs. Partial dewatering of streams reduces habitat available for fish and the invertebrates they feed on, and can also result in increased water temperatures during summer. Dams to impound or divert stream waters can block migrations of salmonids to spawning, wintering, or feeding areas. As previously mentioned, recent findings have provided evidence for extensive seasonal migrations of grayling within the Big Hole River (Shepard and Oswald 1989). Blockage of such migrations by dams may have been an important factor contributing to declines of fluvial grayling populations in Montana (Vincent 1962).

Another factor commonly cited as being detrimental to fluvial grayling in Montana is partial dewatering of rivers and tributary streams during summer by irrigation diversions (Heaton 1960; Vincent 1962; Liknes 1981; Shepard and Oswald 1989). In addition to reduction in available habitat for grayling of all ages, other possible effects of dewatering include interference with seasonal migrations, stranding of incubating eggs or young fish, increased predation on young through their being concentrated in remnant waters with adults and other fishes, reduced food availability through habitat reduction for aquatic invertebrates, and increased maximum daily temperatures. The mechanisms through which reductions in stream discharge volume may influence Big Hole River grayling have not been investigated, but it appears that weak year classes are associated with lower flows and strong year classes with flows normal to slightly above average (Shepard and Oswald 1989). Also, during years of low flow, many adults move downstream after spawning instead of remaining in upstream areas through the summer. This suggests that low flows may be altering their migration patterns by making them leave their summer feeding areas.

In addition to stream dewatering, irrigation diversions can also cause loss of grayling, especially young fish. Grayling fry and juveniles are found in diversion ditches and may be carried into irrigated fields or left stranded in the ditches when headgates are closed at the end of the irrigation season (Shepard and Oswald 1989). While the magnitude of this loss is not known, an earlier study of trout in irrigation diversions from Montana streams indicates that such loss can be substantial (Clothier 1953).

Information is not available on whether other parameters such as stream temperatures have been increased through human activities and have contributed to the decline of fluvial grayling. Water withdrawals from streams can aggravate warm temperatures during summer, through a relationship between reduced flows and increased stream temperatures (Dorris et al. 1963). Present midsummer water temperatures in the upper Big Hole River may be at times marginal for grayling, and drought combined with stream dewatering may be contributing to elevated temperatures. Liknes and Gould (1987) suggested that higher numbers of grayling in the Wisdom area than in areas further downstream could be related to cooler temperatures. However, temperatures may also become marginal in the Wisdom section. For example, continuous recordings by the U.S. Geological Survey (1989) indicate that maximum daily water temperatures in the Wisdom area consistently exceeded 20°C during July 1988 and reached a maximum of 24.5°C. Although 24.5°C is below levels that would produce a thermal kill of grayling (Feldmuth and Eriksen 1978), temperatures above 20°C are not optimum for the species (Hubert et al. 1985).

Interactions between grayling and non-native fishes, especially salmonids, could include competition or predation. Competition occurs through common use of limited resources including food, shelter, and spawning areas and can lead to decline or elimination of less successful competitors. Grayling may be highly susceptible to predation, especially in early stages of development. Eggs are broadcast over the substrate instead of being buried, and young grayling fry are smaller and are weaker swimmers than trout fry.

Observations by Lee (1985) provide evidence that Arctic grayling can compete effectively with native sympatric salmonids. In a study of age-0 grayling and two other species in Alaska, chinook salmon (Oncorhynchus tshawytscha) and round whitefish (Prosopium cylindraceum), Lee found that grayling was the most aggressive species and dominated equal-sized individuals of the other two species. Grayling appeared able to displace round whitefish from preferred habitat. In the field, spatial segregation among the three species appeared to reduce their interactions and competition.

According to Vincent (1962), fluvial grayling of the upper Missouri River drainage were originally sympatric with only ten other species of fish, including two native salmonids, westslope cutthroat trout (Oncorhynchus clarki lewisi) and mountain whitefish (Prosopium williamsoni). Additionally, lake trout (Salvelinus namaycush) may have also been sympatric with lacustrine grayling in Elk Lake. Rainbow, brown and brook trout were introduced into grayling streams of the upper Missouri River drainage by 1900. All three species had been introduced into tributaries of the upper Madison River within Yellowstone Park by 1890 (Jordan 1891), and brown and rainbow trout were common in the upper and middle (near Ennis) parts of the river by about 1915 (Vincent 1962). The Madison River became known for its rainbow and brown trout fisheries and by about 1940 the once-abundant grayling of the Madison River had become rare, except in Ennis Reservoir.

Introductions of brook, rainbow and brown trout began in the Gallatin and Smith River drainages in 1897-1898, and into the Sun River in 1913 (Vincent 1962). The introduction of non-native fishes, especially salmonids, may be the most critical factor affecting the decline of fluvial grayling in Montana. One "common denominator" underlying all streams in Montana from which grayling have disappeared, is the presence of one or more introduced salmonids - rainbow trout, brown trout, or brook trout.

IV. CONSERVATION TASKS

A. MANAGEMENT

In 1987, the Fluvial Arctic Grayling Workgroup was formed to coordinate research and recovery efforts designed to stabilize and enhance the last known fluvial Arctic grayling population in Montana. In addition to coordinating population estimates and sponsoring investigations into grayling spawning and rearing habitat requirements, representatives of MDFWP, MNHP, MSU, USBLM, USFWS, USFS, UM and MCAFS developed a long-term restoration plan, began development of a refuge population in a barren lake and a broodstock at the U.S. Fish and Wildlife Service Fish Technology Center.

In 1991, the MDFWP, USFWS, USFS, USBLM, MCTU and MCAFS signed a five year Memorandum of Understanding establishing the Big Hole Recovery Plan. A technical subcommittee was established which oversees the research/recovery program and approves workplans. A financial subcommittee, which has obtained 501-C-3 nonprofit corporation status, has begun fund raising and public information efforts.

The activities described below have and are being undertaken as part of normal management tasks and the grayling recovery plan.

1. Big Hole River Management Plan

Management of the fisheries of the Big Hole River corresponds to direction set in the Big Hole River Management Plan. This document was completed in 1989 and is operative for the period spanning Sept. 1989 to Sept. 1994. The management plan is updated or modified on a five year basis. It was developed with public input and hopefully reflects the approval of most anglers who use the river. Grayling are given high priority throughout the management plan under their current designation as a "Species of Special Concern". As such, the plan specifies that grayling are to be managed under catch and release protection throughout the Big Hole drainage.

For purposes of practical management planning, the Big Hole River was divided into four reaches. The two downstream reaches contain few Arctic grayling although that segment of the population is also under the protection of catch and release regulation. Reach 3, Divide to Dickie Bridge, supports populations of grayling estimated to be between 10 and 25 per mile. While the primary management emphasis within this reach is not centered on grayling, present management, which favors populations of larger rainbow and brown trout, is being evaluated. Grayling are managed under a catch and release regulation within management reach three.

Reach 4, Dickie Bridge to Jackson, supports the highest densities of grayling in the Big Hole system. It also provides all of the known spawning and rearing habitat for the species. The stated management objective for this reach is the protection and enhancement of grayling habitat and grayling populations over all other species. This management reach provides the focal point of grayling research in the Big Hole. In addition to catch and release protection, the plan commits MDFWP to several other management options that favor grayling over other species. An annual plant of catchable hatchery rainbow trout in the vicinity of a large popular campground was permanently discontinued to provide a better competitive advantage to grayling in the area. The population of eastern brook trout, thought to compete with grayling, is managed under a very liberal limit, 20 fish or 10 pounds, to encourage harvest and control or reduce numbers. Finally, all tributary streams from Pintlar Creek upstream remain open year round for brook trout to further encourage harvest of that species.

2. Population Monitoring - Big Hole River

The grayling population in the Big Hole River is monitored seasonally using electrofishing techniques. Fall population estimates are conducted in three reaches of the Big Hole River in the vicinity of Wisdom. A series of pool habitats are also sampled in the Fall as an index of age class strength and movements. A large-scale estimate of the grayling population within approximately 40 miles of the Big Hole River will be completed when flows are favorable. Spring surveys of the spawning population occur annually within known spawning habitats. Population sections in the Wisdom area are surveyed in years when June flow conditions are favorable to assess post-spawning grayling densities.

3. Madison River

The status of the Madison River grayling is described above under the heading Background. A program for recovery of the Madison River grayling has been initiated and is being funded by Montana Power Company (MPC). MPC is in the process of re-licensing their hydropower projects on the Madison and Missouri Rivers. The two facilities that MPC owns and operates on the Madison River are Hebgen and Madison dams.

As part of the re-licensing process, MPC is working with the public and management agencies to develop a mitigation and enhancement plan. The plan includes several features directly tied to Madison River grayling management as outlined below.

A. MPC will fund a fisheries biologist and technician (including all operations) to work on fisheries issues related to reservoir and river management. It is anticipated that these positions will begin in 1995. A significant portion of this crew's efforts will be directed toward grayling recovery.

B. Since 1990, MPC has funded a researcher and a fisheries fieldworker on the Madison to work strictly on grayling research/recovery. This position is funded through 1994. It is anticipated that grayling recovery will be well on its way when the mitigation and enhancement biologist is hired in 1995.

C. MPC is studying movement of grayling downstream over Madison Dam. Using radio telemetry, it will be determined if grayling are moving downstream and are, thereby, lost to the upstream spawning population. If this study indicates that downstream movement is a significant problem, MPC will investigate two options to correct the problem. A fish ladder would be considered, as would a weir where fish could be trapped and manually moved up into the reservoir.

B. HABITAT PROTECTION/ENHANCEMENT

Habitat protection is a critical component of grayling recovery. Efforts in the Big Hole to work with private landowners are described below. Similar efforts are being initiated in the Madison River drainage. Water reservations and water leasing are aspects of this effort.

Habitat protection on public and private lands within the historic range of the grayling is and will be accomplished largely through existing programs. The Montana Stream Protection Act and Natural Streambed and Land Preservation Act are designed to protect the bed and banks of Montana streams. These acts are administered by MDFWP and the local conservation districts, respectively.

Public lands within the historic range of the grayling are held largely by the USFS and BLM. Both federal agencies have recognized the fluvial Arctic grayling as a "Species of Special Concern". Administrative guidelines have been developed to protect Species of Special Concern during land management activities.

The BLM has established land acquisition along the Big Hole as one of its highest priorities. Since 1988, the BLM has acquired over 1700 acres of land, primarily river frontage, for fisheries habitat management along the Big Hole.

C. HABITAT MANAGEMENT AND IMPROVEMENT

1. Big Hole River Habitat Management Projects

Several habitat protection and improvement projects have been undertaken and completed on the Big Hole River through a blend of participants from the public and private sector and have, in some cases, included grant monies specified for habitat improvement or soil and water conservation. One such project maintained streamflow and brought stability to a two channel system near Melrose. This project resulted in the maintenance of known grayling pool habitats throughout a three mile reach of river. Another project resulted in the removal of a barrier dam and a considerable conservation of water by remodeling an irrigation system near Glen. A third project resulted in the installation of bank barbs to maintain grayling habitat and stop bank erosion in known grayling habitat near Wisdom. This project was undertaken as an alternative to rock rip rap which probably would have destroyed existing grayling habitat at the site.

Three other projects, undertaken by private landowners with MDFWP cooperation, have sought to stabilize grayling habitat in the Wisdom and Wise River areas. One project used bank barbs and rock shears to concentrate streamflow and stabilize banks in major channels where prior disturbance had resulted in an unstable braided channel. This project will provide better grayling habitat along a three to four mile reach. A second private project returned flow to an approximately four mile river reach through excavation of a gravel plug and rebuilding of an old gravel bar. This project saved important adult habitat as well as critical spawning and rearing habitat for grayling. The third project used rock shears to replace a bank to bank fill dam which blocked migration corridors and caused extreme dewatering. The project also improved grayling summer and winter habitat in a pool immediately upstream. Conservation easements, which include protection of riparian corridors, have been granted on two contiguous ranch properties spanning a reach of about eight miles with in grayling habitat up- and downstream from the mouth of the North Fork of the Big Hole River.

Future projects being discussed for funding with the Big Hole River Foundation include a vegetative and rock\vegetation bank stabilization project near Melrose and a riparian protection/enhancement project near Wisdom. The grayling biologist will continue to identify and work with landowners to implement habitat improvement projects.

2. Madison River Habitat Projects

MPC will provide $50,000 annually for habitat restoration/enhancement activities on the Madison River. These funds are not earmarked for grayling, but could be used on grayling projects. A possible project is on North Meadow Creek which at one time harbored a thriving grayling population. Habitat projects combined with possible reintroduction of Madison River grayling could be a long term project.

3. Ennis Reservoir Winter Water Levels

Winter management of Madison Reservoir will be changed to better protect grayling habitat. In the past, the reservoir, which has a maximum depth of approximately 20 feet, has been dropped 2-4 feet in the fall and held at this level through spring ice breakup. This was done to minimize shore erosion. This operation reduced the amount of habitat available during winter months. The new operation will consist of dropping the reservoir level 1 foot in the fall. The reservoir level will be dropped in the spring, just prior to ice-off, the second foot. This will lead to increased habitat during the winter.

D. WATER MANAGEMENT

1. Cooperative Water Management

Through the process of informational meetings with the upper Big Hole landowners, methods of cooperative water management have been pursued. Such meetings have been conducted from 1988 to the present. The changes in irrigation methods benefit grayling and are designed to still fit within irrigation management.

In 1989, the upper river ranchers adopted a policy under which flows are not fluctuated dramatically for irrigation during the critical grayling spawning period near the end of April. In cold or normal springs, irrigation withdrawal is not a factor. In warm or dry springs, irrigation withdrawal commences before or after the period marked by the trough between the lowland and upper elevation runoff peaks. This effort is coordinated by the ranchers.

In response to impending drought conditions during the 1992 summer, the ranchers acted upon an MDFWP request to coordinate and minimize withdrawals after the first week of July to insure sufficient flow to maintain critical grayling habitat in the Wisdom area. This effort is also led and coordinated by the local landowners in cooperation with MDFWP.

There is a continuing need to work with irrigators on individual diversions. This will be a high priority, on-going task for the grayling recovery biologist.

2. Water Reservations and Leasing

The concept of water leasing (as authorized by the Montana Legislature) was investigated as an option to improve grayling habitat in the Big Hole River through its tributary streams. Swamp

Creek, a tributary in the Wisdom vicinity, was studied intensively because of its flow contribution to critical river grayling habitat in the Big Hole and the spawning - rearing habitats and summer adult habitats represented in the stream. It has been determined that a water lease in Swamp Creek would be feasible due to the interest of a water rights holder whose right is large enough, old enough, and far enough downstream to fit leasing criteria. This lease has been pursued but has not been perfected to date. Lines of communication and negotiation are still open and the lease is still being pursued.

Instream flow requirements for habitats supporting grayling in both the Big Hole River and all of its major tributaries were calculated and applied for as flow reservations by MDFWP. The reservation process was established by the Montana Legislature and the instream flow reservations were granted, largely as applied for, by the Board of Natural Resources and Conservation in 1992. These reservations set a priority date to which any future water use developments will be junior and, as such, ensure that grayling habitat in the mainstem and tributaries will not be further impaired due to additional consumptive water withdrawal. These minimal instream flows as reserved for fish and wildlife needs are defined in documents associated with the reservation application (MDFWP 1989).

E. REINTRODUCTION

The most important component of this conservation and restoration plan, beyond protection of the Big Hole and Madison populations and their habitat, is reintroduction of grayling. This must be successfully accomplished to meet the recovery goal. There are several tasks underway and planned to achieve successful reintroduction.

1. Broodstock Development

A broodstock is currently being developed for Big Hole grayling. In order to preserve the genetic integrity of fluvial grayling in Montana, a Big Hole River broodstock is being developed to guard against extinction and to provide a source of fluvial grayling for future reintroduction and enhancement efforts. Development of the broodstock is being guided by a plan developed by the University of Montana Wild Trout and Salmon Genetics Lab which will insure that the genetic variation within the Big Hole River grayling population is replicated in the broodstock.

The plan calls for a broodstock derived from gametes taken from spawning Big Hole grayling. Currently, reserve stocks are held at USFWS Fish Technology Center, and the 1988 year class was planted in one of the Axolotl Lakes in the Gravelly Range. An effective founding population of 50 parent grayling (25 pairs) is considered necessary to capture the genetic variability of the wild population. When a sufficient parent population is acquired, year classes will be crossed to convert between-year-class-variability to within-population-variability. To prevent domestication of the brood, wild genes will be infused at least every ten years.

Gametes are to be collected from reserve stocks and wild Big Hole grayling annually. Fertilized eggs will be hatched at the USFWS Fish Technology Center. Progeny of eggs taken will be used to augment brood reserve stocks and for reintroduction.

MPC will provide $50,000 annually for grayling recovery. This money can be spent as deemed appropriate by a technical advisory committee. One suggestion is to develop an egg taking station and develop a Madison River broodstock. This broodstock could be used for making re-introductions within the Madison River drainage if considered appropriate and necessary.

2. Identification of Streams Suitable for Reintroduction/Introduction

Dr. Cal Kaya, Professor of Biology at Montana State University, conducted a study identifying suitable re-introduction sites. This study, funded by several groups, was completed in the spring of 1993. The recommendations will be reviewed annually as additional data is collected and stocking decisions are made. Figure 1 displays the present distribution and potential restoration sites identified by Dr. Kaya.

3. Development of Planting Protocols

When streams are identified as candidates for re-introductions, plants will be proposed through the MEPA process. Techniques for re-introduction are currently being investigated through plants in the West Gallatin River and the Big Hole River, as outlined below. Plants will be designed to prevent genetic contamination of extant stocks, with a goal of establishing self-sustaining populations throughout the historic range. Long-term monitoring will be incorporated into each reintroduction plan.

4. Reintroduction Efforts

A. <u>West Gallatin River</u> - On July 1, 1992, approximately 5,400 yearling grayling from the Big Hole reserve stock were released in the West Gallatin River above the Taylor's Fork. This reach was chosen on the basis of available habitat, low resident fish populations, and no possibility of genetic contamination of other grayling stocks. Grayling were planted there in the 1940's, apparently with an adfluvial stock, which failed after 3 years. The success of the current plant will be monitored in fall 1992, spring and fall 1993. A plant of approximately 10,000 yearling grayling will be made in 1993. Information gathered from monitoring will be used to guide future reintroductions.

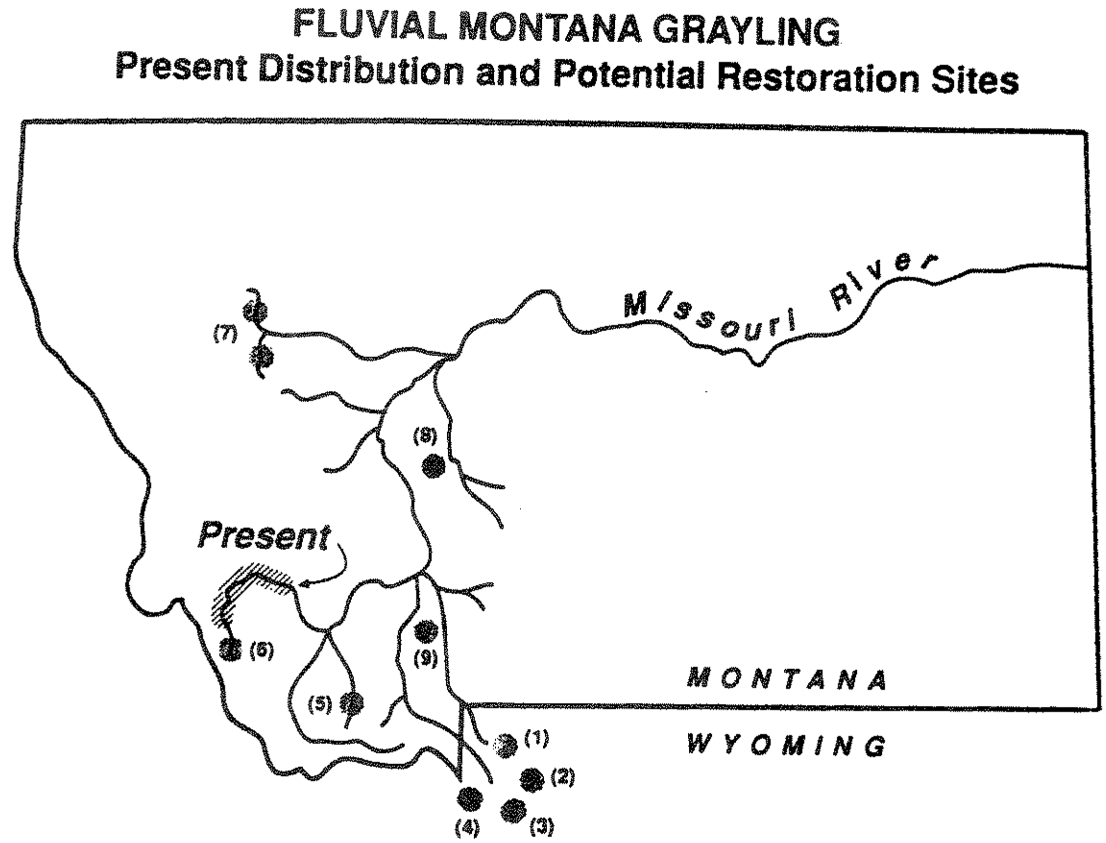


Figure 1 Present distribution of fluvial Arctic grayling in the upper Big Hole River, and potential restoration sites within the native range of the Missouri River basin above Great Falls. (1) Cougar Creek, (2) Virginia Meadows reach of the Gibbon River, (3) Canyon Creek, tributary of the Gibbon River, (4) Firehole River above Kepler Cascades, (5) upper Ruby River above Ruby Reservoir, (6) Big Hole River above Jackson, (7) North Fork and South Fork of the Sun River, (8) Elk Creek, tributary of Hound Creek of the Smith River, (9) Butler Reach of Cherry Creek, tributary of the Madison River. Not indicated on the map are the populations of Madison River/Ennis Reservoir, and the Sunny Slope Canal, both discussed in this report.

B. Big Hole River - On July 2, 1992, 214 yearling grayling of the Big Hole reserve stock were released into the Big Hole River. Each fish was marked with a numbered VI (visible implant) tag. The goal of this plant is to test the survivability of the planted fish and observe their movements. The small number planted will minimize possible genetic impact to the wild population. Information from monitoring efforts will assist in developing techniques for future plants.

C. Cougar Creek - A plant has been proposed for Cougar Creek, Yellowstone National Park. The plant is proposed to take place in 1994. Cougar Creek supports a population of westslope cutthroat trout, which coexisted with grayling historically. This plant would, therefore, allow researchers to observe an introduction into a native assemblage of fishes. No threat of genetic contamination of Madison grayling exists because Cougar Creek becomes subterranean before reaching the confluence with any other stream.

D. Additional waters being considered for reintroduction in 1993 and 1994 include the East Gallatin River and Cherry Creek in the Madison drainage.

F. Research

1. Habitat Assessment

Grayling habitat will be quantified and rated in the Big Hole basin from the Jackson area downstream to Dickie Bridge. This study will use mapping, instrumental measurement, existing data and survey methods to describe, quantify, and compare existing and potential grayling habitat in the Big Hole River. This survey is necessary to determine grayling carrying capacity versus existing population, determine limiting factors, identify habitat problems and determine potential habitat improvement projects. The inventory will consist of habitat mapping in a Geographic Information System format compatible with the Montana Rivers Information System.

2. Effects of Angling

To determine the influence that angling has on the Big Hole grayling population, a comprehensive research project will be conducted. Components of the project include a creel census, hooking mortality study and analysis of hooking wound frequency in the population. This research will determine the proportion of the population affected by anglers and mortality attributable to angling.

3. Winter Movements and Habitat

A sample of Big Hole River adult grayling was fitted with radio transmitters in 1992 to follow their movements to winter habitats. The study will continue through spring 1993. Preliminary results indicate that grayling winter throughout the upper Big Hole Basin and may undergo long migrations to winter habitats. Winter habitats will be characterized and applied to the habitat assessment program outlined above.

4. Interactions with Non-Native Salmonids

A. Big Hole Basin Lakes - A number of lakes in the Big Hole River drainage contain Arctic grayling (Table 4). Because of differences in life history characteristics, it is believed that these lake populations may threaten the genetic character of the Big Hole River population. The lakes containing grayling and the potential genetic risk to fluvial grayling from these populations has been evaluated (Table 4). In 1992, sampling and genetic analysis of fish from Pintlar, Hamby and Schwinegar lakes was undertaken.

Electrofishing of Wyman and Odell creeks will be undertaken to determine migration of grayling downstream from Odell Lake. Management actions will be developed to reduce or eliminate the threat from those populations that pose a potential effect on Big Hole fluvial grayling.

B. Experimental Brook Trout Removal - To investigate the potential competitive influence of brook trout on grayling, a section of the Big Hole River will be chosen for experimental removal of brook trout. The study section will be chosen based on integrity of barriers, such as beaver dams.

As many brook trout as possible will be removed from the section by electrofishing. Response by grayling through habitat selection and growth will be compared with control sections. This study is scheduled for the 1993 field season.

5. MPC will fund a two year Arctic grayling graduate study with Dr. Cal Kaya. The study is "Behavioral Responses on Water Current of Arctic Grayling (Thymallus arcticus) from the Madison River, and Their Use of Stream Habitats." This study will begin in 1993.

G. PUBLIC INFORMATION

Several projects to inform the public about the grayling recovery project and to raise funds to help defray costs of the project have been undertaken.

The July 1992 issue of Fly Fisherman contained an article describing the Big Hole River grayling and the recovery project. Written by a Financial Committee member, this article has generated numerous offers to help financially.

A T-shirt was developed and is selling well in local stores in southwestern Montana. In addition, MCAFS has produced a limited edition grayling belt buckle which is also selling well. Proceeds

Table 4. Big Hole River drainage lakes containing Arctic grayling.

LAKE	GENETIC THREAT	ACCESS TO BIG HOLE	VEHICLE ACCESS	COMBINED THREAT
Bobcat South	none	yes	no	none
Bobcat North	none	yes	no	none
Bobcat West	none	yes	no	none
Hamby	unknown	may	no	unknown(1)
Miner	minor	yes	yes	may
Mussigbrod	minor	may	yes	may(4)
Odell	threat	yes	no	yes
Schwinegar	unknown	yes	no	yes
Twin	unknown	yes	yes	no(2)
Grayling	unknown	-	no	no(3)
Pintlar	unknown	-	yes	-
Agnus	threat	yes	no	yes(4)

(1) No grayling found in 1981 survey.

(2) No grayling found in 1964, 1970, 1980, 1986, 1990 surveys

(3) It is believed that the grayling are now extinct in this lake.

(4) Access to the Big Hole River would be very difficult especially during the summer irrigation season.

from these sales go directly into grayling recovery.

The Financial Committee has commissioned nationally known artist Monte Dolack to paint a Big Hole Grayling poster. Dolack's poster of wolves in Yellowstone has greatly increased awareness nationwide of this issue and sales have generated a great deal of money for the sponsors. We expect a similar result for the grayling poster which is due out in the spring of 1993.

VI. SUMMARY

Through the cooperative efforts of several state and federal agencies and private companies, organizations and individuals, recovery efforts for fluvial Arctic grayling are well underway in the Big Hole and Madison rivers. Efforts are underway to identify appropriate streams and reintroduce grayling to meet the recovery goal of this plan. The first such reintroduction occurred in July 1992.

The grayling recovery plan will continue to focus on re-introduction within the fish's historic range in Montana, habitat protection, public information and education.

References Cited

Clark, T. W., A. H. Harvey, R. D. Dorn, D. L. Genter, and C. Groves, eds. 1989. Rare, sensitive, and threatened species of the Greater Yellowstone Ecosystem. Northern Rocky Conservation Cooperative, Montana Natural Heritage Program, The Nature Conservancy, and Mountain West Environmental Studies.

Byorth, P. A. 1991. Population surveys and analysis of fall and winter movements of grayling in the Big Hole River: 1991 Annual Report. Submitted to: Fluvial Arctic Grayling Workgroup, Helena, Montana.

Byorth, P. A. and B. B. Shepard. 1990. Ennis Reservoir/Madison River Fisheries Investigation. Draft Final Report: 1990. Submitted to: Montana Power Company, Butte, Montana.

Clothier, W. D. 1953. Fish loss and movement in irrigation diversions from the West Gallatin River, Montana. Journal of Wildlife Management 17:144-158.

Dorris, T. C., B. J. Copeland and G. L. Lauer. 1963. Limnology of the middle Mississippi River. IV. Physical and chemical limnology of river and chute. Limnology and Oceanography 8:79-88.

Everett, R. J. and F. W. Allendorf. 1985. Population genetics of Arctic grayling: Grebe Lake, Yellowstone National Park. Genetics Laboratory Report 85/1, Zoology Department, U. of Montana, Missoula, MT. 27 pp.

Feldmuth, C. R. and C. R. Eriksen. 1978. A hypothesis to explain the distribution of native trout in a drainage of Montana's Big Hole River. International Vereinigung fur theoretische und angewandte Limnologie Verhandlungen 20:2040-2044.

Heaton, J. R. 1960. Southwestern Montana fishery study. Federal Aid Project F-9-R-8, Job No. I. Montana Department of Fish, Wildlife and Parks, Helena.

Henshall, J. A. 1906. Culture of the Montana grayling. Report of the Commissioner of Fisheries for the Fiscal Year 1906 and Special Papers. U.S. Bureau of Fisheries, Document 628, Washington, D.C.

Holton, G. D. 1980. The riddle of existence: fishes of "special concern". Montana Outdoors 11(1):2-6.

Hubert, S. A., R. S. Helzner, L. A. Lee, and P. C. Nelson. 1985. Habitat suitability index models and instream suitability curves: Arctic grayling riverine populations. U.S. Fish and

Wildlife Service Biological Report 82(10.110). 34 pp.

Jordan, D. S. 1891. A reconnaissance of the streams and lakes of the Yellowstone National Park, Wyoming in the interest of the United States Fish Commission. Bulletin of the U.S. Fish Commission 9:41-63.

Kaya, C. M. 1989. Rheotaxis of young Arctic grayling from populations that spawn in inlet of outlet streams of a lake. Transactions of the American Fisheries Society 118:474-481.

Kaya, C. M. 1990. Status report on fluvial Arctic grayling (Thymallus arcticus in Montana. Report to: Montana Department of Fish, Wildlife and Parks, Helena. 97 pp.

Kaya, C. M. 1991. Rheotactic differentiation between fluvial and lacustrine populations of Arctic grayling (Thymallus arcticus), and implications for the only remaining indigenous population of fluvial "Montana grayling". Canadian Journal of Fisheries and Aquatic Sciences 48:53-59.

Lee, K. M. 1985. Resource partitioning and behavioral interactions among young-of-year salmonids, Chena River, Alaska. M.S. Thesis, University of Alaska, Fairbanks

Liknes, G. A. 1981. The fluvial Arctic grayling (Thymallus arcticus) of the upper Big Hole River drainage, Montana. M.S. Thesis, Montana State University, Bozeman.

Liknes, G. A. and W. R. Gould. 1987. The distribution, habitat and population characteristics of fluvial Arctic grayling (Thymallus arcticus) in Montana. Northwest Science 61:122-129.

Lynch, J. C. and E. R. Vyse. 1979. Genetic variability and divergence in grayling, Thymallus arcticus. Genetics 92:263-278.

McAllister, D. E. and C. R. Harington. 1969. Pleistocene grayling, Thymallus, from Yukon, Canada. Canadian Journal of Earth Sciences 6:1185-1190.

McMichael, G. A. 1990. Distribution, relative abundance and habitat utilization of the Arctic grayling (Thymallus arcticus) in the upper Big Hole River drainage, Montana. Submitted to: Montana Natural Heritage Program, Helena, Montana.

Montana Department of Fish, Wildlife and Parks. 1989. Application for reservation of water in the Missouri River Basin above Fort Peck Dam. Submitted to: Montana Department of Natural Resources and Conservation, Helena, MT. 3 vols.

Oswald, D. 1990. Big Hole grayling field work report, fall field season 1990. Submitted to: Montana Fluvial Arctic Grayling Workgroup, Helena, Montana.

Shepard, B. B. and R. A. Oswald. 1989. Timing, location and population characteristics of spawning Montana Arctic grayling (Thymallus arcticus montanus [Milner]) in the Big Hole River drainage, 1988. Report to: Montana Department of Fish, Wildlife and Parks; Montana Natural Heritage Program - Nature Conservancy; and U.S. Forest Service, Northern Region.

Skaar, D. 1989. Distribution, relative abundance and habitat utilization of the Arctic grayling (Thymallus arcticus) in the upper Big Hole River drainage, Montana. Submitted to: Montana Natural Heritage Program, Helena, Montana.

Streu, J. M. 1990. Select aspects of the life history and ecology of the Montana Arctic grayling (Thymallus arcticus montanus) [Milner] in the upper Big Hole River drainage, Montana. Submitted to: Montana Natural Heritage Program, Helena, Montana.

U.S. Geological Survey. 1989. Water Resources Data, Montana, Water Year 1988. U.S.G.S., Federal Office Building, Helena, Montana.

Varley, J. F. and P. Schullery. 1983. Freshwater wilderness, Yellowstone fishes & their world. Yellowstone Library and Museum Association, Yellowstone National Park, Wyoming.

Vincent, R. E. 1962. Biogeographical and ecological factors contributing to the decline of Arctic grayling, Thymallus arcticus Pallas, in Michigan and Montana. Ph.D. Dissertation. University of Michigan, Ann Arbor.

Williams, J. E., J. E. Johnson, D. A. Hendrickson, S. Contreras-Balderas, J.D. Willliams, M. Navarro-Mendoza, D. E. McAllister, and J. E. Deacon. 1989. Fishes of North America endangered, threatened, or of special concern: 1989. Fisheries 14:2-21.

Wipperman, A. H. 1965. Southwest Montana Fishery Study, Federal Aid Project F-9-R-8, Job No. I-A. Montana Department of Fish, Wildlife and Parks, Helena.