Michigan Department of Natural Resources
Fisheries Division

Status Review Response: Petition to List Coaster Brook Trout Under the Endangered Species Act

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I. Distribution, Ecology, and Status of Adfluvial[1] Brook Trout

Brook trout *Salvelinus fontinalis* are found throughout northeastern North America. Their natural range extends west to Minnesota, north to Hudson Bay, and as far south as Georgia in the Appalachian Mountains (Scott and Crossman 1973). Their range has been greatly expanded through stocking efforts and the species is now found in western North America as well as in Europe, Asia, Africa, and South America (MacCrimmon and Campbell 1969).

Today brook trout are ubiquitous throughout Michigan wherever habitat is suitable. Brook trout can only survive in relatively cold and well-oxygenated water. These are, therefore, two primary factors that determine if brook trout can survive in a specific inland stream or lake in Michigan. Since sustained water temperatures above about 25°C (77°F) are lethal to trout species, brook trout are most abundant in Michigan streams where mean July water temperatures do not exceed 19°C (66°F) (Wehrly *et al*. 2003). It is likely that a majority of Michigan's approximately 5,400 miles of designated trout streams fall within this temperature regime because smaller tributaries are typically colder and constitute more mileage than larger main stem trout streams. Brook trout are also found on both peninsulas of Michigan in thermally stratified lakes that have sufficiently high levels of dissolved oxygen in the hypolimnion.

Historical and Current Distribution

Historically, wild populations of adfluvial and lake-dwelling brook trout were found in Lake Superior (Roosevelt 1884; Newman *et al*. 2003), northern Lake Huron (Enterline 2000), and northern Lake Michigan. In Michigan, brook trout were found primarily in the Upper Peninsula until around 1850 (Vincent 1962). At that time Arctic grayling *Thymallus arcticus* inhabited the coldwater river systems in the Lower Peninsula that today support populations of brook trout, brown trout *Salmo trutta*, and rainbow trout *Oncorhynchus mykiss*. Tables 6 through 8 in (Vincent 1962) reference many articles and reports that indicated brook trout were well established in streams of the northwest Lower Peninsula by the 1880s, including the Jordan River, Boardman River, and Boyne River. Some writers (*e.g.*, Smedley 1938) speculated that the expansion of brook trout into the Lower Peninsula was facilitated by the decline of populations of Arctic grayling that occurred due to logging activities, overharvest, and other factors during the latter half of the 1800s. Brook trout were clearly established in streams of the northwest Lower Peninsula from the Straits to Grand Traverse Bay before they were ever stocked by the State of Michigan (Bissell 1890).

Natural colonization of streams in the northern Lower Peninsula by brook trout was most likely attributable to fish that exhibited an adfluvial life history strategy. Brook trout that emigrated from Upper Peninsula streams into lakes Michigan or Huron presumably strayed into Lower Peninsula streams where they spawned and established new populations. Brook trout were also stocked by the State of Michigan beginning in 1879 (Smedley 1938; MacCrimmon and Campbell 1969). Due to their adfluvial behavior, brook trout were well established throughout coldwater rivers and tributary streams of the Lower Peninsula by the turn of the century (Smedley 1938). Brook trout filled the open coldwater niche left by extirpation of Arctic grayling in the Lower Peninsula in a remarkably short period of time, even though almost all fish stocked in the two decades after 1879 were fry, which generally demonstrate poor survival.

[1] The term "adfluvial" is defined as "migrating between lakes and rivers or streams". The term "anadromous" is defined as "spawning in freshwater and migrating to the ocean to feed". We use the term "migratory" when collectively describing both adfluvial and anadromous forms of brook trout.

In Michigan's waters of Lake Superior today, the largest concentration of adfluvial brook trout is near the Salmon Trout River in northern Marquette County (Huckins and Baker *in press*). Adfluvial and lake-dwelling brook trout are also known to inhabit waters around Isle Royale (Quinlan 1999) and tributaries to Lake Superior in the Pictured Rocks National Lakeshore (Stimmell 2006). In Canada, adfluvial and lake-dwelling brook trout are found most notably in Lake Nipigon, Province of Ontario and in Assinica and Temiscamie lakes, Province of Quebec (Behnke 1994). The largest concentration of adfluvial brook trout in Lake Superior is found in the Nipigon River region of Ontario in northern Lake Superior.

In addition to natural populations, progeny of brook trout from known adfluvial or lake-dwelling populations have also been stocked in several locations throughout Lake Superior. In Michigan, the Fisheries Division of the Michigan Department of Natural Resources (MDNR) stocked the Nipigon strain of brook trout in three tributaries to Lake Superior, including the Gratiot, Little Carp, and Anna rivers. The Tobin Harbor strain of brook trout has been stocked in the Hurricane and Mosquito rivers, and in Sevenmile Creek (MDNR Fisheries Division fish stocking database *unpublished data*). Stocking of the Nipigon strain of brook trout has also occurred in Whittlesey Creek, Wisconsin (Newman 2000) and at Grand Portage, Minnesota (Newman *et al*. 1999).

Based on the above discussion, we use the phrases "historical range of brook trout in Michigan" or "brook trout in their historical range in Michigan" throughout the remainder of this document to mean all of the State's waters of Lake Superior and the tributaries to lakes Superior, Michigan, and Huron that originate in the Upper Peninsula of Michigan, and all of the State's waters of that portion of Lake Michigan and its tributaries that originate in the northern Lower Peninsula from the Straits of Mackinac to the Jordan River watershed.

Ecology

In general, the ecology of brook trout in the Great Lakes basin is not well understood, but recent research has improved our understanding of some aspects of their ecology. At Isle Royale, lake-dwelling brook trout have been found in Tobin, Washington, and Grace harbors, and in Siskiwit Bay and the Siskiwit River on the southeast end of the island (Quinlan 1999). The brook trout found in Tobin Harbor spawn on shoals since there are no rivers large enough to support spawning of brook trout in the area, but there is suitable spawning substrate in the harbor itself. Conversely, brook trout inhabiting Washington and Grace harbors and Siskiwit Bay are adfluvial and use streams for spawning. These different strategies likely represent adaptations to available local habitats suitable for spawning, and illustrate the plasticity in behavior of brook trout.

There is no indication that adfluvial brook trout display the physiological indicators of anadromy typically displayed by other landlocked populations of anadromous salmonids (Sreenivasan 2005). In addition, adfluvial brook trout with access to Lake Superior do not demonstrate clear or consistent patterns of adfluvial behavior. For example, Stimmell (2006) documented brook trout from tributaries within the Pictured Rocks National Lakeshore making regular and repeated movements back and forth from tributary streams and the nearshore coastal waters of Lake Superior throughout the year. In contrast, some brook trout from the Salmon Trout River appear to leave when young and only return to the river as mature brook trout when they are approximately 30 cm in length and ready to spawn. After spawning, a fraction of those adults quickly leave the river and return to Lake Superior (Huckins and Baker *in press*). Some of the brook trout leaving the Salmon Trout River into Lake Superior have been documented to travel in both directions from the river's mouth, and may travel up to 40 km along the shoreline of Lake Superior (Huckins and Baker *in press*). Whether adfluvial brook trout from the Salmon Trout River also enter other nearby streams, and if they do the reasons for entering those streams, is unknown. Carlson (2003) studied movement of Nipigon strain of brook trout that had been fin clipped and stocked into the Gratiot River on the western side of the Keweenaw Peninsula. Based on returns of brook trout with fin clips collected during electrofishing surveys, three year classes were captured (N=112) in 16 different streams, some of which were up to 98 km from the mouth of the Gratiot River. Carlson speculated that dispersal patterns were more complex than simply being explained by the distance from stocking origin, and suggested the possibility for strong physical, chemical, or biological cues triggering stocked brook trout to ascend other streams.

One of the more commonly accepted traits of adfluvial brook trout is that they may have greater longevity and may grow to a much larger size than brook trout that remain resident in streams, but these observations are not universally true. The potentially greater longevity and larger size of adfluvial brook trout in the open waters of Lake Superior are likely a benefit of the additional feeding opportunities available in Lake Superior proper. Lake-dwelling and adfluvial brook trout tend to mature at approximately 3 years of age and may live for up to six years, which is typically longer than the longevity observed for stream-resident brook trout (Quinlan 1999; Huckins and Baker *in press*). Although adfluvial brook trout that spawn in the Salmon Trout River or around Isle Royale do attain a larger size than stream-resident brook trout, few exceed 20 inches in length (Quinlan 1999; Huckins and Baker *in press*). This is not the case, however, for brook trout inhabiting streams of the Pictured Rocks National Lakeshore (Sreenivasan 2005; Stimmell 2006). In contrast, adfluvial brook trout from streams tributary to Lake Superior in the Pictured Rocks National Lakeshore achieve only a relatively small maximum size (Stimmell 2006).

Adfluvial brook trout are sympatric with stream-resident brook trout (Stimmell 2006; D'Amelio and Wilson *in press*; Huckins and Baker *in press*). Although several investigators have examined genetic characteristics of adfluvial brook trout, there are no data to suggest that adfluvial brook trout are a distinct strain. D'Ameilio and Wilson (*in press*) concluded that adfluvial brook trout in the Nipigon River region of Lake Superior are simply a life-history variant. Likewise, Scribner *et al*. (2006) were not able to conclude that adfluvial brook trout are genetically distinct from stream-resident brook trout in the Salmon Trout River.

Habitats selected by adfluvial brook trout during their stream residency have been shown to be similar to habitats used by stream-resident brook trout. One possible exception is that certain individual fish adopting a migratory life-history strategy may use microhabitats with higher water velocities than other individuals that spend their entire life in a stream environment (Morinville and Rasmussen 2003). Habitats used by brook trout in lakes have been studied at Isle Royale (Newman 2000) and in Minnesota's waters of Lake Superior near Grand Portage (Newman *et al*. 1999). Generally speaking, these brook trout occupied the nearshore waters of the lake. At Isle Royale, brook trout in Tobin Harbor stayed within 6.4 km of their original capture location and were never located more than 150 m away from shore (Newman 2000). At Grand Portage, radio-tagged brook trout also stayed within 150 m of shore and in waters less than 7 m depth. The maximum linear distance traveled by brook trout along the shoreline of Lake Superior at Grand Portage, Minnesota was 32 km, which was greater than the observed maximum distance traveled by brook trout at Isle Royale and less than the observed maximum distance traveled by brook trout along the western shore of the Keweenaw Peninsula (Carlson 2003). Newman *et al*. (1999) also documented consistent use of "microhabitats" (particular rock, dock, *etc*.) by some of the radio-tagged brook trout at Grand Portage. Use of habitats by brook trout in Michigan's coastal waters of the Great Lakes has not been documented to date.

Adaptability and Plasticity

Biological studies and genetic analyses of various populations of brook trout support the hypothesis that adfluvial brook trout are a life history variant rather than a genetically distinct group. Brook trout are broadly adapted to live in freshwater streams and lakes, and in salt water environments in some parts of their range. Anadromous sea-run brook trout are not considered to be distinct from freshwater brook trout (Scott and Crossman 1973). For example, Smith and Saunders (1958) reported that 12% to 35% of the brook trout inhabiting Ellerslie Brook on Prince Edward Island moved to salt water over a 6-year period. They further reported that when comparing progeny of brook trout that had been to sea with brook trout that had been isolated from sea water by dams, similar percentages of both groups moved to sea water after being stocked into a stream with access to the ocean. They concluded that:

> *"There appears no need to postulate races of brook trout with heritable differences to explain their seaward movements and occurrence in salt water."*

Wilder (1952) examined meristic counts and other physical characteristics of sea-run and non-migrating brook trout from the Moser River system in Nova Scotia and concluded that they did not differ in their taxonomy. Recent genetic analyses of brook trout stocks collected in the Lake Superior basin from locations including Isle Royale, the Salmon Trout River, and Nipigon Bay, further support the hypothesis that adfluvial behavior exhibited by brook trout constitutes an adaptable and plastic variation in life history strategy and is not a result of genetic distinctness (D'Amelio 2002; D'Amelio and Wilson *in press*).

Brook trout that spend their entire life in streams in Michigan are typically short-lived with few individuals surviving to age 3, even in streams protected by regulations that restrict anglers to the use of artificial flies while fishing and prohibit all harvest of brook trout (MDNR Fisheries Division Streams Status and Trends Program *unpublished data*). Conversely, the same genetic strains can exhibit much higher growth and survival rates in lakes. For example, only four percent of young-of-year (YOY) brook trout in the East Branch of the Fox River in the Upper Peninsula survived to age 2 (MDNR Fisheries Division Streams Status and Trends Program *unpublished data*), but up to 68% of brook trout survived for two years when YOY brook trout from this river were transferred into small lakes and protected from angling (Nuhfer and Alexander 1994). The minimum size limit imposed on anglers who were fishing for trout in the East Branch of the Fox River should have protected brook trout from harvest until age 3. Therefore, it is unlikely that the dramatically higher mortality rate observed for brook trout in this river was attributable to harvest by anglers.

Brook trout prefer spawning sites where groundwater wells up through the substrate. This allows them to spawn successfully in lakes as well as streams. It also allows them to successfully reproduce even in very small streams without coarse substrates such as gravel. As brook trout grow they often emigrate downstream to larger waters. For example, in the watershed of Hunt Creek Michigan Carbine and Shetter (1945) used fish counting weirs to estimate that during 1943, 1,161 brook trout moved downstream compared to 292 that moved upstream. Hunt (1965) also documented a net downstream movement of fingerling brook trout in Lawrence Creek Wisconsin, and further observed that emigration of fingerlings increased when their populations were denser.

Brook trout that emigrate to, or are stocked into, lakes generally grow considerably faster than those that remain stream residents throughout their lives. Higher growth rates for the same stock of brook trout in habitats with different levels of productivity in Michigan can be clearly demonstrated from several data sets. Fingerling brook trout hatched in the North Branch of the Au Sable River averaged 3.1 inches long in fall 1987 and 8.8 inches long in fall 1989, a two-year growth increment of 5.7 inches. Fall fingerling brook trout transferred from this site in fall 1987 into three small oligotrophic lakes in the Pigeon River State Forest accrued 2-year growth increments of 6.7 inches in the least productive lake, 7.7 inches in a more productive lake, and 9.5 inches in the most productive lake (Nuhfer and Alexander 1994). Although we have little data on growth rates of brook trout in even more productive habitats such as the Great Lakes, the effect of habitat productivity on growth rates of hatchery strains of brown trout stocked into inland lakes versus those stocked into the Great Lakes can be used to demonstrate the plasticity of *Salmonidae* growth rates by genetically identical stocks. Wild Rose and Seeforellen strains of brown trout stocked as yearlings in the early 1990s into small, oligotrophic inland lakes in Michigan grew to approximately 13 to 14.5 inches in length by age 3 (fall), while the same strains stocked into Lake Huron at that time grew to total lengths of 24.9 inches (Wild Rose) and 27.8 inches (Seeforellen) by age 3 (Johnson and Rakoczy 2004; Nuhfer 1996).

Since studies of adfluvial brook trout have shown that this life history variant is not biologically or genetically distinct from resident brook trout in the same natal rivers, it is therefore most probable that the adfluvial behavior exhibited by brook trout is a life history strategy that occurs in many locations throughout the range of the species.

Migratory Behavior of Chars

Although species of the genus *Salvelinus* are less likely to be migratory than Pacific salmon *Oncorhynchus* or members of the genus *Salmo* (Ryther 1997), most species of the genus *Salvelinus* commonly move between small stream habitats to larger rivers, lakes, or the ocean. Arctic char *Salvelinus alpinus* are anadromous where freshwater rivers are connected to the sea. The species also exhibits adfluvial behavior, however, where rivers connect only to inland lakes, while some populations are restricted entirely in landlocked lakes. Bull trout *Salvelinus confluentus* live in a variety of habitats ranging from small headwater streams to large rivers, reservoirs, and lakes. Bull trout produced in small streams typically move into larger rivers or lakes when they are two or more years old, presumably to take advantage of better conditions for growth. Dolly varden *Salvelinus malma*, which are particularly abundant in Alaska, are likewise adapted to a broad variety of habitats and exhibit different life history strategies depending upon whether their local habitat is connected to other waters. Thus, dolly varden are found in the ocean, in landlocked lakes, in small and large rivers, and above and below barriers that block the movement of fish. Like the other chars, the growth rates of dolly varden are related to the productive capacity of the rearing waters. Brook trout also exhibit alternative life history forms across most of their native range. Even within a genus (review in McDowall 2001) and within populations of brook trout (Ryther 1997), there is considerable variability in the extent to which migratory behaviors are exhibited.

The expression of migratory or residency behaviors in char is thought to be determined in part by consideration of the fitness consequences of these alternative behavioral patterns (Gross 1987). Such patterns can be described in terms of probabilities of current and future reproductive success, which in turn are based on probabilities of survival and fecundity that result from whether char occupy stream, lake, or ocean habitats. Costs and/or benefits vary spatially (*e.g.*, among different populations or drainages) and within a population over time according to environmental circumstances. Expression of either migratory or residency behaviors in char, therefore, would be expected to vary in like fashion (Hendry *et al*. 2004, Quinn 2005).

Status

It is not possible to directly compare current abundance of adfluvial brook trout to their historical level of abundance. Although there are accounts describing angling for brook trout in newspapers and other popular press articles from the 1800s and early 1900s, there are no quantitative data from which to estimate abundance of adfluvial brook trout during this time period. The historical distribution of adfluvial brook trout, however, has been reconstructed from these sources (Newman *et al*. 2003). Adfluvial brook trout were allegedly present along much of the shoreline of Lake Superior in Michigan, and were associated with approximately 33 tributaries to Lake Superior in Michigan (Newman *et al*. 2003). The historical distribution of adfluvial brook trout in northern Lake Michigan and northern Lake Huron is not as well documented as for Lake Superior, but adfluvial brook trout were apparently present in northern Lake Huron (Enterline 2000). Accounts by many observers in the 1800s indicated that adfluvial brook trout colonized tributaries to Lake Michigan, including the Jordan, Boyne, and Boardman rivers in the northwest Lower Peninsula, beginning around the middle of the century. Brook trout were the predominant salmonid species in these rivers by around 1880 (Vincent 1962).

The best information on populations of adfluvial brook trout in Michigan has been collected from the Salmon Trout River in northern Marquette County, which has been extensively studied since 1976 (*e.g.*, Enk 1977; Diana 1983; Huckins 2005; Scribner *et al*. 2006; Huckins and Baker 2006; Superior Watershed Partnership 2006; Huckins and Baker 2007; Huckins and Baker *in press]*). Recent data indicate that the population of brook trout in the Salmon Trout River has increased since the mid 1970s. In July 1976, Enk calculated that there were 0.0062 brook trout/m^2 of stream (Enk 1977). In October 1983, Diana (1983) surveyed the entire reach of the Salmon Trout River with electrofishing gear from the County Road 550 bridge crossing upstream to the lower falls (approximately 7 km of river) and only captured 41 brook trout, which ranged from 3-13 inches in length. Sampling in July and August 2001-04, Huckins and Baker (*in press*) calculated an average of 0.025 brook trout/m^2 of stream in the same reach sampled by Enk in 1976, a more than fourfold increase in abundance of brook trout. More recent work in the Salmon Trout River has included continuous video monitoring of movements of fish during July to November. Results of the video monitoring indicate that the population of brook trout in the Salmon Trout River appears to have increased again between 2004 and 2006. The net number of large, presumably adfluvial, brook trout captured on video was 118 in 2004, 149 in 2005, and 243 in 2006 (Huckins 2005; Huckins and Baker 2006, 2007). The increasing number of large brook trout observed on the video may be, in part, a result of recent changes in regulations established by Michigan for anglers fishing in Lake Superior. Beginning in 2005, the minimum size limit for brook trout was raised from 10 inches to 20 inches and the daily bag limit was reduced from three to one per day for anglers fishing in Lake Superior. Based on these survey data that span 30 years and the regulatory actions put in place by Michigan, the population of brook trout in the Salmon Trout River has been increasing since the low levels documented in 1976 and 1983.

The status of populations of adfluvial brook trout in other tributaries of Lake Superior, northern Lake Michigan, and northern Lake Huron is not as well known. Brook trout are known to be present in Lake Superior's waters around Isle Royale (Quinlan 1999) and in streams in the Pictured Rocks National Lakeshore (Stimmell 2006) that are tributary to Lake Superior. At Isle Royale, the population of brook trout residing in Tobin Harbor was estimated to be between 228 and 505 fish in 1996-97 (Quinlan 1999). In addition, creel survey data and entries for brook trout in Michigan's Master Angler program indicate that large brook trout are found throughout Michigan's waters of Lake Superior, as well as in northern Lake Michigan and northern Lake

Huron (see Section III regarding creel survey data and entries for brook trout registered in our Master Angler Program).

II. Consideration of Adfluvial Brook Trout as a Distinct Population Segment

The petitioners have requested the Federal government to list the naturally spawning, adfluvial "coaster" brook trout as a threatened or endangered species throughout its known range in the lower 48 states. The petitioners base part of their request on the following statements: a) the Salmon Trout River adfluvial brook trout population is reproductively isolated from the in-stream resident brook trout population and is considered a Distinct Population Segment; and b) adfluvial brook trout are distinguished from resident brook trout by behavior and physiology.

Within this Section, we discuss the concept of Distinct Population Segment (DPS), review criteria typically used to identify a DPS, and examine evidence relative to the following two criteria for listing as a DPS: a) whether adfluvial brook trout are markedly discrete from sympatric resident brook trout; and b) whether adfluvial brook trout represent an evolutionarily significant component of the brook trout species.

"Distinct Population Segment" or DPS

Current applications of the Federal Endangered Species Act use the concept of a Distinct Population Segment as a basic conservation unit. Mostly simply, a DPS is a sub-unit of a species that interbreeds and is at risk of extinction in a specific portion of the species' range (Pennock and Dimmick 1997). The concept of an Evolutionary Significant Unit (ESU) has been applied to tighten the definition of a DPS to focus on the best biological evidence and to provide clear and biologically meaningful criteria (Waples 1991; Moritz 1994; Waples 1997). This approach requires a DPS to be reproductively separate and have unique or different adaptations. Identification of a DPS under this approach typically requires evidence of either morphological or genetic distinctiveness, or occupancy of a distinct habitat. The current standard for DPS identification is to satisfy the two criteria of: a) discreteness of the population segment; and b) significance of the population segment. We address these two criteria below.

When available, genetic data are widely used in DPS listing decisions to assess degree of distinctiveness. Interpretation of genetic data, however, is very sensitive to several factors, including sample size, amount of data, choice of genome sampled, and choice and number of molecular markers (Fallon *et al*. 2007). Most genetic studies are based on either neutral (do not affect the fitness of the individual) microsatellite markers or mitochondrial DNA markers. Fallon *et al*. (2007) recommended that multiple markers be used whenever possible, and that care be taken not to apply comparatively less polymorphic markers that are best suited for discrimination among taxa of higher systematic levels (*e.g.*, species- or genus-levels) to questions aimed at the population level (most DPS questions). Analyses that use neutral markers are best suited for definition of degree of inter-population differentiation because variance in the frequency of alleles at neutral genetic markers generally accrue in a time-dependent manner as a function of time and degree of reproductive isolation, and the effective population size.

The majority of DPS designations for fish species have been made for populations residing in regions of relatively stable geological history (*i.e.*, not subjected to repeated extirpation and re-colonization due to glaciations). Population segments that have existed in such stable regions have had sufficient time to co-evolve suites of traits, behaviors, and ecologies that are tightly adapted to local conditions. In contrast, fish populations currently found across northern latitudes, including the Great Lakes region, have only re-colonized lake and riverine habitats following the evolutionarily recent retreat of the last glacier (Bailey and Smith 1981). Although observable differences in fish behavior, morphology, physiology, and ecology have evolved during this time period (including for brook trout; see Fraser and Bernatchez 2005a), levels of genetic differentiation are generally weak and unlikely to indicate genetic incompatibility between populations (Bernatchez and Wilson 1998; Fraser and Bernatchez 2005b). Any analyses of population differences must be interpreted in the context of this recent bio-geographical history that includes re-colonization patterns and sequences of connectivity among various post-glacial habitats (Fraser and Bernatchez 2005a).

Considering Population Discreteness

To see if adfluvial brook trout are markedly separated or unique from sympatric resident populations, we examined evidence for physical, physiological, ecological, and behavioral factors. Starting with the question of physical separation, neutral genetic data suggested that brook trout in isolated (by a barrier waterfall) headwater reaches of Michigan's Salmon Trout River are more genetically similar to resident brook trout in other nearby, physically separated but likewise isolated above waterfall systems, than they are to the sympatric resident and adfluvial brook trout found downstream of the waterfall (Scribner *et al*. 2006). This implies that re-colonization history and current physical separation is more important in distinguishing genetic differences than a specific, more recently developed life history strategy. Jones *et al*. (1997) used mitochondrial DNA and allozymes to compare sympatric resident and migratory brook trout from the same drainage and hatchery strains to their progenitor populations. These authors found that sympatric river resident and migratory brook trout from the same stream were genetically more similar than either form was to brook trout from other drainages. The authors suggested that resident and migratory individuals were not reproductively isolated. Many scientists have concluded that migratory brook trout are not a physically-separated, genetically cohesive group that is divergent from other resident brook trout, but are instead a life history variant found in brook trout populations (D'Amelio and Wilson *in press*; Ryther 1997; Wilson *et al*. *in press*).

Sympatric stream resident and adfluvial brook trout are also not reproductively isolated in space or time, nor is there any physical separation in their habitat use when adfluvial brook trout occupy lotic habitat (Huckins and Baker 2006). Overlap in habitat use, particularly for spawning, occurs among stream resident and adfluvial brook trout and is illustrated by data collected from the Salmon Trout River. Scribner *et al*. (2006) demonstrated that interbreeding among the two life history variants does occur. This is not a unique finding for brook trout, and is consistent with the high levels of inter-breeding that have been found between migratory and resident populations of brook trout elsewhere (Theriault *et al*. 2007). These authors specifically documented frequent matings between male resident and female anadromous brook trout, as is common for the chars (Stearley 1992).

It is apparent that adfluvial brook trout are not markedly separated or unique from sympatric resident populations due to physical factors, and we found that the same holds true for physiological, ecological, and behavioral factors. Although the petitioners assert that adfluvial brook trout are distinguished from resident brook trout by their behavior (adfluvial migrations) and physiology (they grow larger and may be longer lived), we argue that a) significant migratory behaviors are widespread in the salmonid family, including the char genus, and b) successful organisms take advantage or adapt to their environment, such as taking advantage of available food resources in another habitat some distance away, and thus increased growth or longevity are more a product of habitat rather than a unique physiological trait. Significant evidence and numerous examples from peer-reviewed literature, as well as our own surveys and research, support both of these arguments.

Migratory tendencies are ubiquitous among fishes but also vary among families, genera, species, and populations of fishes. Numerous parameters such as gender, habitat, population size, and even temporal factors work to generate and maintain variation for migratory behavior (Hendry *et al*. 2004). Gross (1987) eloquently described a model of the life history tradeoffs between survival and growth that lead to an individual fish's decision to migrate; when growth, and therefore subsequent reproductive, advantages to be gained in another distant habitat outweigh the serious mortality risks of two long migrations, they are likely to go. Schlosser (1991) explained that essentially all fishes attempt to survive and flourish by migrating between essential and often distinct reproductive, growth, and refuge habitats during completion of their life cycle.

Historically, migratory behavior has been the primary characteristic used to differentiate between adfluvial and resident brook trout. One cannot, however, simply divide brook trout into two discrete population segments based on this behavior because essentially all salmonid populations display some degree of movement throughout their life (Gowan *et al*. 1994, Northcote 1997, Ryther 1997). The degree of this movement forms a patterned gradient across different salmonid genera, species, and even among populations. For example, species that belong to the genus *Oncorhynchus* (salmon) show consistent, predictable migrations and physiological changes throughout their entire life cycle that are predictably tied to a combination of biotic and abiotic triggers. In contrast, *Salvelinus* (char) species display a consistent suite of life history characters that describe a more flexible, plastic migratory tendency; char: a) do not migrate far out to sea, staying close within the estuary; b) stay at sea less only 2-6 months; c) display great variation in age at emigration; d) do not reliably spawn upon return (*i.e.*, the reproductive cycle is not tightly coupled to the migratory cycle); e) do not reliably spawn in successive years; f) achieve higher longevity (Stearley 1992; Ryther 1997), and g) do not rely on physiological smoltification (McCormick *et al*. 1985). A tendency of a river population of brook trout to migrate upstream in the summer to seek thermal refuge is one type of migratory response (Hayes *et al*. 1998). Fraser and Bernatchez (2005a) described two brook trout populations from the same Canadian lake, where one migrated up an inlet river to spawn while the other migrated down an outlet river to spawn; members of both populations returned to complete their life cycle in the lake. On the other end of the spectrum, an example of a migratory response can be observed for brook trout in Atlantic coastal rivers that migrate to ocean estuaries to take advantage of increased food resources (Gross *et al*. 1988; Morinville and Rasmussen 2003; Morinville and Rasmussen 2008).

There are resident brook trout that spend their entire lives in streams, others that spend their entire lives in lakes, and some that exhibit varying degrees of adfluvial and anadromous behaviors, moving between riverine and lake or ocean habitats (Curry *et al*. 1997, 2002; Ryther 1997; Huckins *et al*. *in press*). The observed adfluvial movements of brook trout between Lake Superior and the Salmon Trout River is not at all unique. This nomadic behavior has been observed in other Great Lakes tributaries. Enterline (2000) summarized the historical and current presence of brook trout in many Lake Huron coastal tributaries and suggested these individuals used Lake Huron to utilize increased food resources. Enterline (2000) summarized her views on migratory brook trout by saying:

> *"Whether they are called salters or coasters, all these strains of brook trout (if indeed they are strains) are simply brook trout taking advantage of their environment."*

To support this further, we have provided many Master Angler awards to anglers for catching especially large brook trout from Lake Huron and even from many large inland lakes (*e.g.*, Black, Gogebic, Millecoquins, and South Manistique lakes and Bond Falls Flowage). These lakes are fed by variable-sized tributaries that contain brook trout populations. We have captures brook trout of various sizes in these lakes (albeit in low numbers) during fish community surveys. It is clear that small percentages of the tributary populations of brook trout migrate downstream into these large lakes. We speculate that they move to these inland lake environments due to tradeoffs between stresses in the stream environments (low flow, thermal increases, intra- or inter-specific competition) and feeding and growth advantages in the lakes. Regardless of the exact mechanism, adfluvial migration is commonly observed in brook trout populations in Michigan and elsewhere, and demonstrates life history plasticity inherent in this species.

A related example would include brown trout of the Sturgeon River watershed in Michigan's northern Lower Peninsula. This watershed drains to Burt Lake and the naturally reproducing population of riverine brown trout is considered abundant. It has been well documented our surveys that a significant number of these fish are adfluvial and utilize Burt Lake for part of their life cycle. These "lake-run" fish return at different lengths and ages to the river to either spawn or to live out the remainder of their life. In addition, it has been shown that brown trout that use the lake at some stage are genetically identical to those that have remained in the river (K. Scribner, *Personal Communication*, Michigan State University, East Lansing).

In some instances, brook trout use lakes as migration corridors to access other tributary streams. This life history strategy has been described for stocked brook trout strains (which were considered migratory) in Michigan's Keweenaw Peninsula (Carlson 2003) and the Pictured Rocks National Lakeshore (Stimmell 2006).

Research conducted in the Pictured Rocks National Lakeshore demonstrates the role of environmental factors in inducing adfluvial behavior in brook trout. Stimmell (2006) examined the movement patterns of stocked Tobin Harbor strain of brook trout and wild brook trout in 3 streams within the Pictured Rocks National Lakeshore. Brook trout from both strains exhibited similar movement patterns with low numbers of fish from each strain moving into Lake Superior. Although the migratory behavior of the two strains was similar, brook trout from different streams exhibited markedly different movement patterns, suggesting that pressures in the stream environment strongly influences adfluvial behavior (Stimmell 2006).

Do comparisons of physiologies and morphologies help us understand whether sympatric adfluvial and resident brook trout are discrete? Although some differences in the physiology and morphology of resident and adfluvial brook trout have been noted (Boula *et al*. 2002; Morinville and Rasmussen 2003; Sreenivasan 2005), the basis and ecological significance of these differences is not well understood (Morinville and Rasmussen 2008). Differences such as early-life food consumption, metabolic rates, and body and pectoral fin shapes have been documented and linked to habitat differences in both riverine and ocean systems. A genetic basis for these observed differences, however, has not been established and we contend that they represent another demonstration of population plasticity and adaptation to specific local environments (D'Amelio and Wilson *in press*).

Since the expression of migratory versus resident life histories is thought to be determined largely by consideration of the fitness consequences of alternate behavioral patterns (Gross 1987; Hendry *et al*. 2004; Quinn 2005), it is expected that individuals that migrate for enhanced growth will exhibit differences in age-at-maturity, longevity, and fecundity. Observations of such differences between adfluvial and resident variants are not evidence for discreteness; but rather are evidence of the expected expression of life history plasticity.

It has been postulated that there is some degree of heritability of migratory behavior. Differences in embryo and alevin characteristics may in part be dictated by egg size or other maternal effects (Perry *et al*. 2004; Perry *et al*. 2005), which are ultimately a product of environmental conditions. Thus, such maternal effects could be evident based on dietary differences between resident and migratory brook trout. This is important to consider because while some maternal heritabilities of migratory versus resident behavior have been documented in sympatric brook trout (Theriault *et al*. 2007), genetic analyses to date have not factored in appropriate variables such as female age and body size, the latter of which is known to vary due to environmental conditions. Migration may be heritable, but ultimately it is a characteristic inherent to all brook trout individuals which allows them to take best advantage of unique habitats or situations.

It should not be surprising that adfluvial brook trout would display differences in growth, survival, and ultimately body size and longevity as a product of migration into an improved environment. Power (1980) and Barton (1996) described higher growth rates, larger body size, and increased longevity of migratory brook trout relative to resident fish, and explained those observations as a product of superior food resources in a sea or lake environment. Past (Nuhfer and Alexander 1994, see Section I above) and current research in Michigan support this notion. Recently, equal numbers of brook trout from three established strains (including Nipigon, which is considered to be migratory) were stocked in three inland lakes in Michigan that were closed to fishing. The lakes were free of any piscivores for over ten years, thus food resources were abundant. All of the brook trout, regardless of strain, grew to large sizes in the three lakes. Thus, habitat and food availability were much more important in determining body size than genetic differences. Brook trout from the adfluvial strain actually displayed the lowest survival and were the shortest-lived fish compared to a stream resident (Iron River) and domesticated (Assinica) strain. This is contradictory to the petitioner's assertion that adfluvial brook trout live longer, and provides evidence that such strains within the same taxon show a high degree of overlap in habitat utilization and are not unique in their behavior.

The assertion that adfluvial brook trout have higher fecundity is also questionable as the literature is conflicting and inconclusive. Some authors have suggested that adfluvial brook trout may be slightly more fecund than resident fish, while other authors have not found any differences in this physiological trait among groups (Power 1980; Naiman *et al*. 1987). We believe that fecundity typically increases with size in all species of fish, regardless of strain.

Evolutionary Significance of the Population Segment to its Taxon

The second criteria for distinguishing a Distinct Population Segment is demonstration of evolutionary significance of the population segment to the taxon, in this case "species", to which it belongs. We first examined whether adfluvial brook trout persist in, or depend upon, an ecological setting that is unusual or unique for the taxon. Adfluvial brook trout are a life history variant of brook trout found in many populations living in connected tributary-lake systems; they represent a small proportion of each tributary population (D'Amelio and Wilson *in press*; Wilson *et al*. *in press*). As a species, brook trout are rather ubiquitous, inhabiting colder streams, rivers, and lakes throughout northeastern North America. They continue to be stocked beyond their native range in the United States and are now established in the western United States, Europe, Asia, Africa, and South America (MacCrimmon and Campbell 1969). Accordingly, brook trout are broadly adapted to live in and migrate between lotic, lentic, and estuarine environments with acceptable thermal and reproductive habitats. These habitat requirements are consistent across the species' range; for example, adfluvial brook trout in coastal waters of northern Lake Superior utilize similar habitats as do those in coastal waters of southern Lake Superior or those found in inland lake settings. Given this information, and the fact that the United States Fish and Wildlife Service (USFWS) has previously determined that the existence of a species in a different drainage (or a different river or lake) from other drainage locations were the same species also exists is not necessarily evidence of a unique ecological setting (72 FR 20312, April 24, 2007), we conclude that the adfluvial behaviors observed in portions of many brook trout populations are not maintained by any unique or unusual ecological setting.

Secondly, we considered whether the potential loss of the adfluvial component of brook trout populations in the U.S. waters of Lake Superior would create a major gap in the North American range of this taxon. As previously stated, adfluvial brook trout are a life history variant of brook trout populations that remain widespread throughout their native range. They comprise a small portion of many brook trout populations. Under the hypothetical scenario that this portion was indeed lost, it is assumed that the sympatric resident populations would continue to flourish, so no new gap in the distribution of the taxon would occur. In addition, as the scientific literature consistently stresses that plastic, migratory behavior is a consistent trait in brook trout as it is in the char genus in general, we have no reason to think that the tendency to migrate would be removed from these populations.

Third, we assessed whether adfluvial brook trout along the south shore of Lake Superior indeed represent the only surviving natural occurrence of this life-history variant. It is clear they do not. Adfluvial brook trout have been found at various locations around Lake Superior, northern Lake Huron (Enterline 2000), the entire northern and eastern shorelines of Lake Michigan, and in numerous inland lakes in Michigan and Canada (*e.g.*, Fraser and Bernatchez 2005b). Numerous streams along the Atlantic Coast of North America also produce anadromous brook trout that show parallel migratory behaviors. Large sea-run populations still exist in New Brunswick, Nova Scotia, Quebec, Labrador, and Newfoundland (Ryther 1997; Boula *et al*. 2002; Theriault and Dodson 2003). Smaller populations of adfluvial brook trout occur in U.S. coastal streams from Maine to New York (Ryther 1997).

In addition to the key points asserted in the three previous paragraphs, it is also imperative for us to articulate that we believe our assessment of the entire North American range of the taxon is further supported by legal precedent. In its 2008 90-day finding, the USFWS claims that the loss of the adfluvial "coaster" brook trout of the Lake Superior basin would result in a significant gap in the range of the taxon, as they believe these fish are the only extant adfluvial "coaster" brook trout population in the contiguous United States (73 FR 14953, March 20, 2008). However, the Ninth Circuit Court has previously rejected this argument as a misconstruction of this criterion in the case of National Association of Home Builders *v*. Norton, 340 F. 3d 835, 852 (9th Cir. 2003) concerning the cactus ferruginous pygmy-owl *Glaucidium brasilianum cactorum* (70 FR 44551, August 3, 2005, as cited in 72 FR 20312, April 24, 2007). The Court found that in designating a DPS under the DPS policy, the USFWS must find that a discrete population is significant to the species' entire North American distribution, not to the United States distribution.

Finally, we looked at whether the genetic characteristics of sympatric migratory and resident brook trout differ markedly. Recent genetic analyses consistently have demonstrated that adfluvial brook trout do not differ markedly in genetic characteristics from sympatric resident brook trout populations. Genetic analyses have revealed that: a) there is no separate adfluvial genome (D'Amelio 2002; Wilson *et al*. *in press*); b) adfluvial brook trout are genetically much more similar to sympatric resident brook trout than either form is to brook trout from other drainages or isolated segments of the same rivers (Scribner *et al*. 2006; Jones *et al*. 1997); c) adfluvial brook trout serve as vectors for gene flow between populations in neighboring river systems (D'Amelio and Wilson *in press*; D'Amelio *et al*. *in review*); and d) there is substantial interbreeding between adfluvial and resident brook trout, with resident males breeding with migratory females (Theriault *et al*. 2007), as is common in the chars (Stearley 1992). The findings that migratory forms have arisen independently in numerous drainages and that there are greater genetic similarities of brook trout within a stream, compared to those from other drainages (D' Amelio 2002; Scribner *et al*. 2006) show that migratory behavior in brook trout does not represent an independent evolutionary lineage. This suggests that, given suitable stream conditions and large population sizes consistent with the maintenance of genetic variation, the migratory form may be expected to manifest itself in order to allow individual fish to take advantage of a variety of habitat types as was demonstrated by Curry *et al*. (1997, 2002). This again is a plastic life tactic and is a defining characteristic of the species (Power 1980).

Analysis of DPS decisions since publication of the 1996 Federal DPS policy

Between the publication of the Federal Joint DPS policy in 1996 and 2005, the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (together, the Agencies) published seventeen final rules listing or delisting DPSs. After reviewing those rules, Hausrath (2005) concluded:

> *"…that the Agencies do not consistently apply the factors as outlined in the Joint Policy."*

The following text is excerpted from Hausrath (2005):

> *"The Agencies mainly use geographical separation to prove discreteness. Fourteen of the seventeen final rules relied entirely or in part on geographical separation to prove discreteness. Genetic differences and the international border criteria are used less often. Nine of the seventeen final rules applying the Joint Policy also have relied in whole or part on genetic research to establish discreteness. Eight of the seventeen final rules applying the Joint Policy have relied in whole or part on international boundaries to show discreteness.*
>
> *The Agencies depend primarily on the gap the loss of a DPS would create in the range of a taxon when deciding whether a population is significant. Twelve of the seventeen final rules regarding DPSs utilized the "significant gap" factor in whole or part to prove significance. The Agencies use the "genetic difference" factor to a lesser extent. The Agencies relied on evidence that the discrete population segment differed markedly in its genetic characteristics in only nine listing decisions.*
>
> *The Agencies rarely use the other remaining factors to prove significance. The Agencies found significance based on a species representing the only surviving natural occurrence of a taxon in only one DPS listing decision. Four of the seventeen final rules proved significance in whole or part by finding that the DPS persisted in an unusual or unique ecological setting.*

> *While geographic isolation is clearly an important factor to consider in identifying a DPS, the Agencies' listing decisions vary greatly in the amount of evidence required to determine geographic isolation. Out of the seventeen final rules regarding DPSs, fourteen of the rules used geographic isolation to wholly or partially prove discreteness. An examination of the Agencies' final rules reveals inconsistencies in the evidence utilized to establish geographic isolation of a population. The listing decisions vary vastly; some decisions clearly outline the number of miles or geographic features that separate the DPSs, while other decisions simply state that the DPS are geographically separated without providing additional information."*

Based on the findings of Hausrath (2005) and information summarized Table 1, any particular past DPS decision on an individual basis might support a decision to either designate or not designate adfluvial brook trout as a DPS. The body of past DPS decisions considered as a whole, however, does not provide clear guidance on the question of whether designation of adfluvial brook trout as a DPS is appropriate. This situation derives from two factors. First, the Federal DPS policy has not been applied consistently (Hausrath 2005). Second, each population segment considered for DPS status reflects a unique interplay of geography and biology, which limits the utility of comparisons across populations and taxa. As a result, we believe that the USFWS is not compelled to designate brook trout as a DPS based on past precedent.

Conclusion: Consideration of Adfluvial Brook Trout as a Distinct Population Segment

The life history form of adfluvial brook trout does not meet the criteria for listing as a Distinct Population Segment. The migratory behavior of this form is quite common in connected tributary-lake systems, and is controlled mostly by environmental variables. Genetic evidence strongly supports the conclusion that adfluvial "coaster" brook trout are a life history variant of the species, and that sympatric river resident and migratory brook trout are not reproductively isolated. It is consistently argued in the scientific literature that numerous ecological factors such as food availability, habitat types and connectedness, population size, and gender work together to influence the migratory behavior, and thus physiology, of brook trout regardless of the specific waterbody or geographic setting. As a species, brook trout will continue to persist and even thrive across their North American range, regardless of the status of the adfluvial form in Lake Superior. Likewise, the tendency to migrate is not at risk of being lost across this range. The brook trout is primarily well adapted to cold, spring-fed, headwater stream environments (hence its common and Latin names) and will continue to persist in this form. These types of habitats are plentiful in northern latitudes, despite their sensitivity to human development. In Michigan, abundant, naturally-reproducing populations of brook trout exist from the northern Lower Peninsula throughout the Upper Peninsula in a variety of inland streams, lakes, and coastal tributaries of the Great Lakes. In addition, this species is common and even considered abundant throughout much of eastern Canada. Brook trout populations across North America will continue to persist and retain their plasticity for migration, despite stresses and declines in specific locations.

III. Listing Factors

The petitioners have requested the Federal government to list the naturally spawning, adfluvial "coaster" brook trout as a threatened or endangered species throughout its known range in the lower 48 states. The petitioners base part of their request on the following assertions: a) that dams and river diversions; toxic pollution related to organophosphorus compounds (as used in pesticides), deoxygenation via decomposition of organic material and other effluents from paper mills and other sources, and mercury (from fungicides and wood pulp treatment); stream acidification via acid rain, acid spills, and the proposed Kennecott's sulfide mine; changes in water temperature and flow due to deforestation and reservoir release, and dams and diversions, and changes in water temperature and flow in general; b) sportfishing and commercial fishing threaten adfluvial "coaster" brook trout; c) no single government entity with overall program authority for managing adfluvial "coaster" brook trout: inadequate authority to prevent conflicting government policies and programs, land-use practices, and toxic pollution, over-reliance on hatchery production and stocking, inadequate program funding, lack of public education and involvement in adfluvial "coaster" brook trout restoration, and inadequate existing programs for the long-term viability of brook trout in the U.S. and the restoration and protection of its habitat; and d) competition with rainbow trout, coho salmon *Oncorhynchus kisutch*, and brown trout and a small population size of adfluvial "coaster" brook trout.

In our discussion below, we evaluate each of the five factors that are used to determine whether listing adfluvial "coaster" brook trout under the Endangered Species Act (ESA) is warranted. Threats germane to each factor that could potentially limit adfluvial brook trout in their historical range in Michigan are identified and evaluated using historical and current information. Finally, we assess the management and conservation strategies that are in place today to address each threat.

Factor A: Present or threatened destruction, modification, or curtailment of species habitat or range

Little is known about the habitat conditions in streams prior to the extensive logging that took place in the 1800s in Michigan. Pre-settlement riverine habitats in Michigan, however, probably included abundant sand and sediment because these are naturally occurring materials across much of Michigan. The periodic advance and retreat of glaciers across Michigan left a diverse landscape made up of various glacial tills and moraines (Farrand 1988). Common among these tills and moraines are extensive deposits of sands, clays, and silts. Because these are the dominant surficial materials across much of Michigan it is likely that Michigan's fish fauna, including brook trout, adapted to these conditions.

Stream and lake habitats throughout Michigan underwent substantial change as the State was settled and forests were cleared, roads were built, and agricultural and urban development increased. Habitat changes included flow alterations and river fragmentation due to the building of dams, altered temperature regimes in rivers due to forest clearing and the accompanying loss of shading, channelization of rivers for agriculture, and increased rates of erosion and sedimentation from land clearing and road building. These modifications to habitat led to some changes in the composition of fish communities in streams across Michigan, most notably the extirpation of Arctic grayling in Michigan. Despite widespread changes to physical and biotic habitat, however, brook trout continue to thrive throughout Michigan. Current habitat conditions in Michigan's streams are improved over what they were in the years immediately following widespread logging in the 1800s. Forest regeneration, habitat improvement projects, and increased environmental protections have all contributed to improved habitat conditions in rivers.

<u>Threats from Sedimentation</u>

River siltation and sedimentation from road crossings is specifically cited by the petitioners as a listing factor due to the present or threatened destruction, modification, or curtailment of the habitat or range of adfluvial "coaster" brook trout. River siltation and sedimentation are known to have detrimental effects on fish populations (Waters 1995), and on brook trout in particular (Alexander and Hansen 1986). The siltation and sedimentation occurring in the Salmon Trout River and other rivers supporting adfluvial brook trout, however, is commonly occurring in streams across the historical range of brook trout in Michigan. Despite the widespread change to river habitats in Michigan that occurred as the landscape was cleared, brook trout are still widespread and common and are not in danger of extinction. In fact, the population of brook trout in the Salmon Trout River is more abundant now than it was in the 1970s and 1980s (Enk 1977; Huckins and Baker *in press*), and it supports a recreational fishery without the need for stocking. This increase in abundance of brook trout since the mid 1970s may be due to improved habitat in the river since that time, although no habitat data are available to compare current habitat conditions in the Salmon Trout River to conditions present in 1976. A road washout did occur in the headwaters of the Salmon Trout River in 2005 and resulted in a large volume of sand being washed into the river. There is no expectation, however, that road washouts will occur in the future and with the increased implementations of best management practices (BMPs) for road crossing, this threat will be reduced.

Logging, as cited in the petition, is known to contribute sediment to streams when proper BMPs are not employed. Historically, timber harvest operations were unregulated and as a result erosion from harvested sites was a major source of sediment to streams. Much of the area in the historical range of brook trout in Michigan is held by landowners that may choose to log the areas at some time in the future.

Construction and development within riparian corridors is also known to cause erosion and sedimentation to occur in streams. Data are not readily available at this time to quantify this threat to rivers in the historical range of brook trout in Michigan.

Another potential source of sedimentation issues comes with in-channel dredging activities for the purposes of navigation or recreational boating. Nearshore dredging occurs for marinas and docks, channel dredging occurs in navigational channels both in the rivers and the Great Lakes. Dredging activities have the capacity to suspend fine sediments and potentially interfere with migrating trout and salmon or act as a lethal or sublethal stressor to larval fish or young fish that are emigrating during times of dredging. While effects of suspended sediment are well documented in riverine environments, information pertaining to dredging activities and sedimentation is scarce. Most brook trout streams, however, do not have navigation projects associated with them; therefore this threat is low in the historical range of brook trout in Michigan.

<u>Sedimentation: Management and Conservation Efforts</u>

Road Crossings

In particular to the Salmon Trout watershed, road-stream crossings are being improved that will reduce the contributions of sediment to streams. A watershed management plan has been completed for the Salmon Trout River (Superior Watershed Partnership 2006). Partners in the planning process included representatives from the Superior Watershed Partnership, the

Michigan Departments of Environmental Quality and Natural Resources, Trout Unlimited, Huron Mountain Club, Keweenaw Bay Indian Community, Northern Michigan University, Michigan Technological University, and the United States Fish and Wildlife Service. The watershed management plan includes an inventory of road-stream crossings, recommendations for habitat improvement projects, and other data about the Salmon Trout watershed.

As a result of the planning process, projects have been undertaken to improve road-stream crossings by replacing culverts with bridges and improving road approaches to limit sediment inputs to the streams. Additional projects are planned for the future as funding becomes available. In particular, the two culverts at the road-stream crossing on the East Branch of the Salmon Trout River at Northwestern Road will be replaced in May or June 2008 with a single aluminum culvert that will span the bankfull width of the stream, a project that will eliminate input of approximately 11 tons of sediment annually (Geraldine Larson, *Personal Communication*, Superior Watershed Partnership). The Superior Watershed Partnership will also be improving road-stream crossings on the Main Branch of the Salmon Trout River and Murphy's Creek. The overall goal of these projects is to reduce input of sediment to the Salmon Trout watershed.

Efforts to improve road-stream crossings are not unique to the Salmon Trout River and are occurring across the historical range of brook trout in Michigan. These efforts are all expected to bring long-term benefits to river and stream habitats throughout Michigan, including to the Salmon Trout River system.

Harvest of Timber

Approximately 3.9 million acres in Michigan are comprised of State Forest and much of that area is subject to commercial timber harvest that is managed by MDNR Forest, Mineral, and Fire Management Division (MDNR FMFMD). The State Forest lands are managed in 15 separate forest management units, and each unit is divided into compartments for specific management treatments. Each compartment is reviewed for management actions including commercial logging every ten years (MDNR FMFMD 2005; MDNR FMFMD 2006). The compartment reviews incorporate multi-disciplinary consideration of multiple resources and land uses on the landscape. During compartment reviews, fisheries biologists provide direct input regarding sensitive areas such as coldwater streams and riparian habitat. During the public review process, stakeholders can also bring forward interests and concerns regarding logging in particular areas. Commercial timber harvesters in Michigan that harvest on State land are required to implement BMPs to minimize erosion from harvested landscapes, and riparian buffer strips are required as part of the BMPs. Those harvesting on private lands are strongly encouraged to follow BMPS to avoid issues of erosion and sedimentation.

The MDNR has recently its manual regarding BMPs. The draft manual has been modified to include additional information, clearer descriptions of BMPs, and specifications and better illustrations of BMPs compared to the BMP manual that was published in 1994 (MDNR and Michigan Department of Environmental Quality *in review*). Of particular importance, we highlight some of the revisions that have strengthened the protections provided by the BMPs:

1. Protection practices regarding soil and site productivity are included as well as practices protecting surface water quality.
2. The manual introduces the Match, Extend, Set, Bury, Offset, and Align method (MESBOA) for sizing and placement of stream crossing culverts, based on the stream's physical characteristics. The MESBOA method helps to decrease the effects on stream hydrology created by the placement of culverts and improves fish passage

through culverts. The Michigan Department of Environmental Quality (MDEQ) endorses that the MESBOA method be used by individuals when applying for permits to place culverts in streams.

3. The manual has guidelines for using native grasses and forbs to re-vegetate bare soils.
4. The manual has guidelines for construction of roads through forested wetland areas that the MDEQ uses to aid in determining if such roads are constructed in a manner that minimizes "adverse effects on the wetland."

Soil Erosion and Sediment Control Act

From a statewide regulatory perspective, the MDEQ is charged to promulgate rules to carry out Part 91, Soil Erosion and Sedimentation Control of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. To protect aquatic resources from sedimentation in response to construction and earth-moving activities, the intent of this statute is to minimize soil erosion and control sedimentation by requiring permits for any activity that disturbs one or more acres or is within 500 ft of a lake or stream. Guidance on this is provided in policies at the Department and Division levels (Table 2; Appendix A). In addition, the application process provides an opportunity for public input to ensure the protection of aquatic habitat in the historical range of brook trout in Michigan.

Dredging for Maintenance of Navigational Channels

MDEQ shares authority with the U.S. Army Corp of Engineers (ACOE) for permitting dredging activities to maintain navigational channels, and MDEQ has authority for permitting privately-funded dredging activities. The MDNR plays a vital role in review of these permits and in coordination with the ACOE on dredging projects. In additional reviews for overall habitat degradation, we have developed a calendar of dredging windows during which times dredging can occur outside of sensitive life history stages for fish (MDNR Fisheries Division Policy 02.02.010, Appendix A). While no specific window has been determined for adfluvial brook trout, the windows are presumed to be protective of young fish migrating in and out of tributaries to the Great Lakes in the spring and fall.

<u>Threats Related to Water Quality</u>

High quality habitat for trout and, therefore, healthy populations of trout, are dependent upon good water quality and quantity. While sedimentation is addressed above, other water quality threats include both point source discharges, which are controlled by National Pollution Discharge Elimination System (NPDES) permits, and non-point source inputs. Point source discharges include, but are not limited to, industrial facility effluents along with thermal inputs from power plants and dams. The vast majority of the historical range of brook trout in Michigan is unaffected by point source inputs and the remaining areas have point source discharges strictly regulated by NPDES permits.

The non-point sources inputs include nutrient loading through runoff or waste water and sedimentation. Non-point source inputs are controlled using MDEQ's permitting processes and BMPs.

Water Quality: Management and Conservation Efforts

Special Water Quality Management Consideration

Designation as a trout stream currently provides water quality protection through the implementation of coldwater standards for dissolved oxygen and temperature under the authority delegated to MDEQ by the Environmental Protection Agency (EPA) to implement the Clean Water Act of 1977. Streams that are designated as trout streams (MDNR Fisheries Order FO-210.08) receive special protections for temperature and dissolved oxygen to maintain or achieve temperature and dissolved oxygen levels capable of supporting a coldwater community under Water Quality Standards as provided by statute (Part 31, PA 451 of 1994). Furthermore, the Water Quality Standards designate several streams and waters in the Upper Peninsula as Outstanding State Resource Waters to prevent degradation of water quality. This listing includes Federally-listed Wild and Scenic Rivers, Michigan Natural Rivers (MDNR Fisheries Division, 2002a, 2002b, 2002c, 2002d), and waters in and near National Forests and National Parks (*e.g.*, sections of the Carp River, Ontonagon River, Sturgeon River, Tahquamenon River, Yellow Dog River, and Big Two-Hearted River).

Point Source Discharges

The evolution of water quality protection legislation, starting with the 1948 Water Pollution Control Act through the Clean Water Act of 1977 and various amendments through time, has lead to a permitting process for discharges that contain pollutants or injurious organisms. Under the rules of the NPDES program, all facilities that discharge pollutants from any point source into waters of the United States are required to obtain a permit, including industrial, municipal, and agricultural discharges. There are several types of permits based on the substances being discharged and the type of facility being permitted. These categories are outlined in the Clean Water Act of 1977.

Included in the language of the EPA's regulations is the authority to delegate management of permitting to States that have compiled appropriate water quality standards and have the governmental infrastructure to implement such programs. MDEQ has been granted authority to issue, monitor, and manage NPDES permits by the EPA. According to publicly available documents, Michigan is authorized to handle 4 of the 5 categories listed by the EPA for NPDES-related programs, including:

1. NPDES Permit Program
2. Regulation of Federal Facilities
3. State Pretreatment Program
4. General Permits Program.
5. Michigan is not listed for an approved biosolids (sludge) program.

MDEQ maintains a full listing of the NPDES permits issued in Michigan. For example, there are currently 28 such permits in the Cheboygan and Black River systems (HUC 4070004 and 4070005) in the northern Lower Peninsula (Table 3), that range from waste water treatment facilities to marinas servicing recreational boating. Our Oden State Fish Hatchery is located in this watershed and participates in the program to maintain water quality standards in the watershed.

As a result of the NPDES Permitting Program and its associated public input process, point source discharges are controlled in the historical range of brook trout in Michigan and are not a threat to populations of brook trout.

Non-point Source Discharges

The MDEQ Land and Water Management Division has regulatory authority for environmental management of the State's aquatic resources Parts 301 (Inland Lakes and Streams), 303 (Wetland Protection), 315 (Dam Safety), 323 (Shoreland Protection and Management), and 325 (Great Lakes Bottomlands) of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. MDEQ authorizes all dredging, shoreland modifications, and marina and dock construction in lakes and streams; all crossings, closures, and relocations of streams; all new construction and modifications of dams; and dredge and fill activities in wetlands. We have an obligation to preserve and protect its resources as prescribed by Article 4, § 52 of the Michigan Constitution. Fish and other aquatic organisms in the public waters of Michigan are entrusted to the State for the use and enjoyment of the public, present and future. As such, we annually investigate and make recommendations to protect aquatic habitats and populations by reviewing thousands of environmental permit applications. Environmental permit reviews are conducted primarily by biologists in our Management Units. All reviews and comments are guided by various policies within the Construction Impact Assessment and Resource Management chapters of our Policies and Procedures (Table 2; Appendix A).

Michigan provides assistance to local units of government and non-governmental agencies for planning and implementation of projects to mitigate negative impacts from non-point source pollution events. These grants are funded by a variety of sources from non-point source pollution control grants (Federal Clean Water Act Section 319) to Clean Michigan Initiative bond grants. Since 1990, there have been 66 grants awarded in the Upper Peninsula and 78 grants in the northern Lower Peninsula in the historical range of brook trout in Michigan (Appendices B and C). The funding for these grants to date has been approximately $11 million with matching funds of over $15 million for the Upper Peninsula and approximately $11 million with matching funds of over $6 million for the northern Lower Peninsula.

These grants cover a variety of planning and protection measures for water bodies that host populations of brook trout or are capable of maintaining populations of brook trout. Of particular interest are the Section 319 grants, which fund projects to mitigate non-point pollution sources and often specifically include mitigation for excessive soil eroding into streams. A total of 38 grants have been awarded to address these habitat issues (Appendices B and C). Through this process, water quality is both protected and improved and non-point source discharges are minimized in the historical range of brook trout in Michigan.

Threat from Mining Activities

Approximately one-half of the historical range of brook trout in Michigan is in potential mining areas for ferrous and non-ferrous metals in Michigan found in the Upper Peninsula west of a line from Marquette to Vulcan to the Wisconsin border. This area is dominated by rock formations that have been mined for metals by Native Americans for thousands of years and by Europeans since the 1840s. Current world demand for ferrous and non-ferrous metals has lead to a re-evaluation of potential mining sites in Michigan. Rising prices for metals provide the economic potential to develop low grade or disperse ore bodies feasible. More advanced mining techniques using a chemical process have reduced some of the costs for extracting specific materials from the earth. Of particular concern with this mining in the historical range of brook trout in Michigan is a resulting condition known as acid mine drainage in which the pH of the water is sufficiently lowered with significant negative impacts to aquatic biota.

Of particular interest in the historical range of brook trout in Michigan is the potential to develop mining for nickel and uranium. Currently one large mining operation is proposed for development near Marquette, Michigan.

This proposed mining project is located in the area referred to as the Yellow Dog Plains, Marquette County, and has the potential to negatively affect streams in the area. While advocates for the industry have presented plans to protect such water bodies from any negative effects from the extraction processes, local citizen groups have been vocal in expressing opposition and concern over the potential for negative impacts if there is some form of failure of the proposed water treatment and containment system.

An advocacy group of local citizens (www.savethewildup.org) suggests that there are at least ten other locations under review for development potential. While this is not based on direct intent specifically expressed by industry, it is based on control of mineral rights, both owned outright or under lease.

Mining Activities: Management and Conservation Efforts

The current permit process used by the State to review all applications for mining development projects is based on new and unique statutes that provide significant protections for the State's natural resources that might otherwise result from mining activities (Part 631, Reclamation of Mining Lands of the Natural Resources and Environmental Protection Act, 1994 PA 451; Part 632, Nonferrous metallic mineral mining of the Natural Resources and Environmental Protection Act, 1994 PA 451), as amended. The review process for permits as required by these statutes is detailed and open to the public. Appropriate water and waste treatment requirements will be conditions of any activities permitted and will minimize the effects of those activities in the historical range of brook trout in Michigan.

Threat from Habitat Fragmentation

The ability of brook trout to move within and between watersheds in their historical range in Michigan has changed over time. The influence of humans has significantly increased the number of obstacles preventing movement of brook trout, both within and between streams (*e.g.*, dams near river mouths that prevent entry to rivers) and between streams and the Great Lakes. Many of these obstacles originated during the days of extensive lumbering that occurred in the late 1800s and early 1900s in Michigan. Virtually every watershed was affected, although some more than others. In many cases rivers were used to float logs to mills and many of the early mills were first powered by water. Later, dams were built to generate hydroelectric power or for recreational reasons. As human settlement occurred across the historical range of brook trout in Michigan, more and more roads were built. Many of the early stream crossings were poorly designed and did not prevent sediment and storm water from directly entering the stream. Many were constructed with undersized culverts, or culverts placed with incorrect slopes, causing water to flow at velocities too great for fish to navigate the culverts. Often, the plunge pool downstream of the culvert eroded away and the culverts became perched, which resulted in a barrier to movement of fish.

The USFWS' Fish Passage Database indicates there are at least 550 dams that restrict movement of fish in the historical range of brook trout in Michigan, affecting movement in over

18,000 miles of streams (Table 4, Appendix D). Of these barriers, 350 are reported to be over six feet in height.

In the historical range of brook trout in Michigan, there are approximately 413 tributaries to the Great Lakes. Of these, 82 tributaries have been identified as having man-made barriers present in the stream network. In 11 of these cases, however, there is a natural barrier below any man-made barriers, leaving 71 streams with man-made barriers that may be blocking an estimated 3,381 miles of streams to movement of adfluvial brook trout (Table 5). The average distance blocked in these 71 streams is 47 miles and the median distance is almost 5 miles.

In addition to barrier dams, the USFS conducted a field evaluation of 55 culvert crossings in two counties in northern Wisconsin that border the Upper Peninsula of Michigan. Culverts were on public roads, had been installed recently (2000 to 2006) and had received approval from the Wisconsin Department of Natural Resources (WDNR). Using FishXing software to perform their analyses, the USFS found that 20% of the culverts would not allow an adult brook trout to pass through the culvert. From this analysis, the USFS speculates that an inventory of all crossings would show a much higher failure rate, especially if there is concern about all species of fish and all life stages (Mark Fedora, *Personal Communication*, USFS).

The Great Lakes Fishery Commission (GLFC) was established in 1955 under the Canadian/U.S. Convention on Great Lakes Fisheries, a bi-national treaty. The GLFC has, over time, developed a broad, integrated strategy for controlling sea lamprey *Petromyzon marinus* (GLFC 2001), which are parasitic predators on salmonids in the Great Lakes. As a part of this strategy, barriers that are currently in existence on tributaries to the Great Lakes are kept in place to prevent sea lamprey from moving upstream into productive spawning areas, while on other tributaries to the Great Lakes new low-head barriers are being designed and constructed. In the latter case, design specifications require acknowledgement and incorporation of strategies that allow for salmonids to move upstream past the barriers. The GLFC's integrated strategy has been implemented to eliminate the need chemical treatments that have previously been used to control populations of sea lamprey in many tributaries to the Great Lakes. It is unclear whether current designs of these low-head barriers will allow adfluvial brook trout to move upstream past the barriers, thus potentially fragmenting the habitat available to the species.

Habitat Fragmentation: Management and Conservation Efforts

We, along with MDEQ, have aggressive programs in place to improve conditions for passage of fish at road-stream crossings. Many culverts are being converted from tubes to large bottomless arches or clear span bridges. The goal is to increase the width of the span to cover the bankfull width of the stream and to install culverts at a slope that matches the slope of the stream at the locations of the culvert. This allows for the stream to function properly and transport sediment and debris downstream, while allowing fish the ability to move upstream and downstream as their behavior may dictate. As a result of these programs, the overall negative effects of culverts on fish passage will be reduced over time.

The MDNR has clear authority to require fish passage at dams (Public Act 123 of 1929) when it is required for protection, rehabilitation, or enhancement of populations of fish, including for populations of brook trout in their historical range in Michigan. We have also aggressively recommended the inclusion of fish passage structures in permits issued by the MDEQ for projects to reconstruct dams that act barriers to movement of fish. For example, MDEQ required the installation of a Denil fishway at the Trout Creek Dam in the Ontonagon River watershed.

In addition, we sponsor Inland Fisheries Grants to provide funding ($200,000 per year) for stream habitat improvement throughout Michigan. For the past several years, the focus of this program has been on projects to remove dams and we actively participate in projects to remove dams. These funds have also been used to improve road-stream crossings, including the addition of fish passage structures at problem culverts.

We also support a Heavy Equipment Unit and a Habitat Management Unit that provide support and assistance to our Management Unit personnel and to other constituent groups for the purposes of rehabilitating habitat in streams. Numerous projects have occurred throughout the State, including the addition of sediment basins in streams, rehabilitation of river channels, removal of dams, and mitigation of soil erosion and sediments that enter the State's streams. The technical expertise of the staff in the Habitat Management Unit, combined with the experience of the staff in the Heavy Equipment Unit in working in sensitive environments, provides the Department with a powerful resource for protecting, rehabilitating, and enhancing coldwater habitats throughout the State. These Units are another indication of the emphasis we place on aquatic habitat.

In the case of barriers to stop sea lamprey, we are recommending that passage structures for specific species of fish be incorporated into all new sea lamprey barriers. These recommendations include the design of trap-and-transfer facilities at some locations to facilitate the movement of non-jumping species of fish in tributaries to the Great Lakes, and fishways that exclude sea lamprey but allow the passage of other species of fish such as brook trout. These measures minimize the effect of sea lamprey barriers on brook trout in their historical range in Michigan.

Threat from Hydropower Projects

In response to changes in the Federal Power Act (FPA), the MDNR has participated in the licensing process for many Federally-licensed hydropower projects present in the historical range of brook trout in Michigan. Historically, these hydropower projects operated in various modes to maximize power output or other perceived benefits (*i.e.*, flood control or flow augmentation for power production) without much regard for the negative effects on fish and other organisms on either side of the barrier. Generally, these projects affect entire watersheds and by focusing our efforts on these potential habitat impairments, landscape scale changes in aquatic habitat quality have been made.

Typical negative effect of dams are changes in water quality, fragmentation of habitats, disruption of fish migrations or movements, interruption in transport of sediments, interruption in transport of large woody debris, entrainment and mortality of fish, and seasonal and disruption of daily flows, to name a few. The cumulative effects of these changes have been shown to be harmful to populations of fish. Through the Federal Energy Regulatory Commission (FERC) licensing process, the MDNR along with other resource agencies and non-governmental groups have successfully implemented many provisions that help reduce the negative effects of dams in systems in the historical range of brook trout in Michigan.

Currently, 28 licensed, three exempted, and one unlicensed (pending FERC approval) hydropower projects exist in the historical range of brook trout in Michigan (Appendix E). Of these hydropower projects, three projects on the Boardman River in the northwestern Lower Peninsula of Michigan have surrendered their licenses, are no longer generating power, and the dams are under consideration for removal. One project (Sturgeon Project, FERC No. 2471) was removed as part of the re-licensing process on the Menominee River system. Copies of these licenses and supporting documentation of the licensing process are available on the FERC website through their e-library system (www.ferc.gov).

Hydropower Projects: Management and Conservation Efforts

Through the FERC licensing process, the MDNR has used several approaches to improve conditions in the rivers affected by hydropower projects. The FPA provides the opportunity for input from agencies into the FERC licensing process through Sections 10(a), 10(j) and the 401 Water Quality Certification process. The MDNR and MDEQ have used this process successfully to implement a number of improvement measures. In addition to specific rights under the FPA, the MDNR has used settlements to work out amicable protection and enhancement measures that are included in license documents.

The primary protection and enhancement measures included in licenses concern improvements in operations, reductions in water level fluctuations in impoundments, improvements in water quality, and addition of fish passage structures, to name a few. Other important improvements include management of large woody structure, erosion control, and management of buffer zones. Key habitat protection, mitigation, and enhancement measures have been implemented for each FERC license in the historical range of brook trout in Michigan, which again demonstrates the strong commitment of the MDNR to protect and rehabilitate aquatic habitats via FERC licensing process (Table 6). Overall, the effects of hydropower projects on populations of brook trout in their historical range in Michigan have been minimized to a great degree.

Other Regulatory, Programmatic, and Planning Efforts For Protection, Rehabilitation, and Enhancement of Aquatic Habitat

In addition to the measures noted above, a large amount of land is in public ownership or set aside through conservation measures in the historical range of brook trout in Michigan. The MDNR also has several other programs and planning efforts in place that are used to recognize and address issues pertaining to high quality trout habitat, such as that required by brook trout. These efforts include: protected areas, the Natural Rivers Act, the Groundwater Act, the Great Lakes and inland Consent Decrees for the 1836 Native American treaty-ceded areas (U.S. *v*. Michigan 2000; U.S. *v*. Michigan 2007), River Assessments, Eco-regional Planning efforts, Forest Certification, and the State Forest and Regional Forest planning efforts.

Protected Areas

Approximately 41% of the land area, or 7,376 square miles, in the historical range of brook trout in Michigan is either in public ownership or in private ownership that has conservation easements associated with the lands (Table 7). These lands are protected through a variety of mechanisms by the owners, and include National Parks and Seashores, State and County Parks, State Natural Areas, USFWS' Federal Refuges, and preserves managed by the Nature Conservancy and other conservancy-type groups. The uses of these lands are greatly restricted and include activities that are primarily focused on recreation or scientific studies. Additional lands open to the public that have various protective measures in place include National and State forests, which provide for a wide range of uses from timber harvest to recreational activities. Finally, a sizable amount of privately-owned land in the historical range of brook trout in Michigan has conservation easements that protect riparian zones and tributaries to the Great Lakes. The high degree of protection for public and private lands, coupled with management processes that are open to the public, ensures that efforts to protect, rehabilitate, and improve habitat for brook trout by public and private landowners will continue. These ongoing efforts greatly reduce the risk of habitat degradation in the historical range of brook trout in Michigan.

Rivers with Special Protections

Within the historical range of brook trout in Michigan, a total of 773.7 miles of rivers are protected by designation under either the Federal Wild and Scenic River Act (61.6%) or Michigan's Natural Rivers Act (38.4%). Designations under the Federal Wild and Scenic River Act provide include: Presque Isle River (Gogebic County), Ontonagon River (Baraga, Gogebic, and Ontonagon counties), Paint River (Iron County), Black River (Gogebic County), Sturgeon River (Baraga County), Yellow Dog River (Marquette County), Tahquamenon River (Chippewa County), Whitefish River (Alger and Delta counties), Sturgeon River (Delta County), Indian River (Alger and Schoolcraft counties), and Carp River (Mackinac County).

The Natural Rivers Act (Part 305, P.A. 451of 1994) authorized the Michigan Natural Resources Commission to establish a system of "natural" rivers in the State and provide for their preservation, protection, and enhancement. Rivers that are designated through this process receive special protection and land-use zoning to preserve their natural state. Actions in the zoning and management plans can include designated setback distances for structures, setback distances for utilities, require a buffer zone where no cutting or only limited trimming of vegetation can occur in the riparian area. Statewide, there are sixteen designations under the Natural Rivers Act to date. Within the historical range of brook trout in Michigan, portions of three rivers, including tributaries, have been designated as Natural Rivers: the Jordan River (Antrim and Charlevoix counties), Big Two-Hearted River (Luce County), and the Fox River (Alger, Luce, and Schoolcraft counties), which is a tributary to the Manistique River (MDNR 2002a, 2002b, 2002c, 2002d). An additional 168 miles of rivers have been protected under the Natural Rivers Act in areas that are speculated to be in the historical range of brook trout in Michigan, including the Boardman (Grand Traverse and Kalkaska counties) and Pigeon (Otsego and Cheboygan counties). The MDNR aggressively pursues violations of the Natural River zoning ordinances on these rivers.

The protections provided by designation of Federal Wild and Scenic River and Natural Rivers, therefore, have maintained existing habitat for brook trout and have minimized the threat from changes related to land use.

Protection of Groundwater Resources

Groundwater contribution is critical to maintaining high quality brook trout habitat. High capacity groundwater withdrawals have the potential to reduce groundwater delivery to streams, thereby potentially altering the thermal character of the stream. Recent legislation in Michigan was posed to address this issue for the protection of aquatic resources from large groundwater withdrawals. Public Act 34 of 2006 charged the Michigan Groundwater Conservation Advisory Council to design a new State Water Withdrawal Assessment Process that would prevent any adverse impacts to the water-dependent natural resources of the State (Groundwater Conservation Advisory Council 2007).

Michigan's proposed Water Withdrawal Assessment Process specifically aims to prevent any large-quantity (100,000 gpd or more) water withdrawals from impacting the hydrology and ecology of any nearby river system, as indexed by expected natural base flows and maintenance of expected fish assemblages. Target base flows and fish assemblages are set for the classes of cold streams and rivers that support brook trout. Recent policy discussions have shown such trout assemblages to be highly valued and we expect the new law to set protective restrictions on withdrawals of water from these systems. New legislation is pending to implement the recommended process.

1836 Treaty of Washington Inland Consent Decree of 2007

Management with Tribal nations on inland fisheries habitat issues is conducted and coordinated through Section XXII of the 2007 Inland Consent Decree. Section XXII refers specifically to habitat rehabilitation or enhancement issues with the five Tribes that are Federally-recognized under the 1836 Treaty of Washington. The goal of Section XXII of the Decree is to "…minimize or avoid duplication of, or interference with, restoration, reclamation, and enhancement activities". Section XXII of the Decree is to ensure collaboration and further states that "In carrying out restoration, reclamation, and enhancement projects, the Tribes shall utilize qualified biologists or other appropriately trained personnel."

The Decree provides a legal mandate for effective and efficient aquatic habitat management among the parties to the Decree. The intent of the Decree includes a clear message concerning the importance of habitat to protect and rehabilitate populations of fish in the treaty-ceded lands, including brook trout in their historical range in Michigan.

Policies of the MDNR Fisheries Division

In addition to the specific programs mentioned above, we have developed numerous policies to protect the State's aquatic resources that are used by our staff when developing habitat projects, making recommendations on habitat projects, or working as expert witnesses in legal proceedings. Our policies address log salvage, artificial structures, wetlands, dams and barriers, marinas and docks, mineral leases, shorelines, stream crossings, culverts, pipelines, stream relocation and enclosure, artificial reefs, coastal wetlands, fish passage, riparian vegetation, sediment traps, and soil erosion and sediment control (Table 2; Appendix A). These policies as a group work to minimize threats to stream habitat in the historical range of brook trout in Michigan.

River Assessments

To fully understand the impairments to aquatic habitats, it is critical to conduct in-depth analyses of watershed-level threats. We produce a series of inventory and planning documents known as River Assessments. The focus of River Assessments is to identify the functions and problems in the system by developing a better understanding of the structure and functions of various aquatic ecosystems, documenting their history, and understanding changes that have occurred. Management opportunities are identified to provide and protect sustainable aquatic benefits while maintaining, and at times rehabilitating, system structures or processes.

River assessments are based on ten guiding principles described in our Strategic Plan (MDNR Fisheries Division 2000). These are:

1. recognize the limits on productivity in the ecosystem;
2. preserve and rehabilitate fish habitat;
3. preserve native species;
4. recognize naturalized species;
5. enhance natural reproduction of native and desirable naturalized fishes;
6. prevent the unintentional introduction of exotic species;
7. protect and enhance threatened and endangered species;
8. acknowledge the role of stocked fish;
9. adopt the genetic stock concept, protecting the genetic variation of fish stocks; and

10. recognize that fisheries are an important cultural heritage.

River assessments also provide a mechanism for public involvement in management decisions, allowing citizens to learn, participate, and help direct decisions. In addition, these assessments provide an organized reference for our personnel, other agencies, and citizens who need information about a particular aspect of the river system.

The following are components of a River Assessment: geography, history, geology, hydrology, soils and land use patterns, channel morphology, dams and barriers, water quality, special jurisdictions, biological communities, fishery management, recreational use, and citizen involvement. Management options follow the river assessment sections of the report, and list alternative actions that will protect, rehabilitate, and enhance the integrity of the river. These options are intended to provide a foundation for discussion, setting of priorities, and planning the future of the river system. A fisheries management plan is developed after completion of the river assessment.

In the historical range of brook trout in Michigan, River Assessments for the Jordan, Manistique, and Manistique rivers have been completed (Hay and Meriwether 2004; Madison and Lockwood 2004; Waybrant and Zorn 2008). River Assessments are in development for the Cheboygan, Menominee, and Ontonagon rivers, and River Assessments for the Escanaba, Big Two-hearted, and Dead and Carp rivers are slated to begin in 2009-2010.

River Assessments and their resulting Management Plans provide a template for future actions to protect, rehabilitate, and improve habitat for fish in the historical range of brook trout in Michigan. The information and options provided in these planning documents will minimize the overall risks of habitat degradation by focusing the efforts of a wide range of partners on critical processes needed to protect brook trout populations in their historical range in Michigan.

Eco-regional Planning and Assessment

For the purposes of planning and addressing multi-stakeholder interests, the MDNR is pursuing eco-regional planning efforts to incorporate the social, biological, and economic interests into planning efforts statewide. Four Eco-regions have been identified as the Eastern Upper Peninsula, Western Upper Peninsula, Northern Lower Peninsula, and Southern Lower Peninsula, each with an appointed Eco-team. It is the duty of the Eco-teams to plan and coordinate the management of all of the natural resources in each of the four major Eco-regions in Michigan utilizing ecosystem management principles.

Eco-regional planning has the following three broad objectives:

1. To sustain fundamental ecological processes and functions that, in turn, support representative, diverse, and productive biological assemblages. To practice sustainable, ecosystem-based management, conserve geophysical processes and biodiversity, and maintain biotic productivity.

2. To provide for a variety of ecosystem services that help sustain human civilization. To maintain essential ecosystem services including purification of air and water, carbon storage, provision of habitat, and moderation of drought and flood conditions.

3. To provide for a variety of sustainable human values derived from ecosystems; including economic, recreational, and intrinsic values. To sustain social-economic values, provide public access and recreational and educational opportunities, and allow for cultural uses.

Planning efforts are currently underway and will use a collaborative process with stakeholders and the general public to develop these plans. Protection, rehabilitation, and enhancement of aquatic habitats, including habitats for brook trout, will be considered in the development of these plans. These plans will help to protect intact habitats for brook trout and minimize and reduce impairments to habitat for brook trout statewide.

Forest Certification, State Forest Plan, and Regional Forest Plans

In 2004, Act No 125, Public Acts of 2004 was signed into law. The "Sustainable Forestry Act" required the MDNR to seek and maintain forestry certification by at least one credible, non-profit, non-governmental certification program. Forest certification has developed as a way to verify sustainable forest management and to have forest managers demonstrate responsible, healthy, and sustainable management of forests. Forest Certification provides for a) review of on-the-ground forest practices against standards that address environmental, social and economic issues, b) provision of an independent, third party view attesting how effectively current management maintains forest health and productivity, and c) periodic verification and recertification after initial certification of the forest.

The MDNR sought and received dual certification of State Forest lands under the Sustainable Forestry Initiative (SFI) and the Forest Stewardship Council (FSC) certification programs. The SFI program has its origins in the United States. It is focused on applied forest management and on maintaining a high standard of forestry performance. The FSC program is an international system that emphasizes social values and is focused on minimizing the negative impacts of forestry practices.

Certification of the State's forest system demonstrates to interested stakeholders and markets that natural resource management practices are sound and comprehensive. The State will maintain markets for the State's forest timber, and continue managing habitats for wildlife, recreation opportunities, and maintenance of forest health. Certification will promote long-term improvements in program efficiency, and empower staff of MDNR at all levels to identify weaknesses and initiate positive change in the sustainable management of forest ecosystems.

Requirements of certification included development and implementation of forest management plans. The MDNR uses a 3-tiered planning structure for the management of Michigan's State forest resources: statewide, regional, and forest management unit levels. The Michigan State Forest Management Plan (SFMP) (MDNR 2008) and four Regional State Forest Management Plans (RSFMPs, expected by January 2009) provide landscape-level analyses and direction to enable tactical decisions for management of forest stands and compartments at the unit level. The Michigan SFMP, in conjunction with the RSFMPs that are under development, is intended to achieve the planning requirements of Part 525 and forest certification standards. The drafting of these plans are joint efforts by the FMFMD, Wildlife, Fisheries, Law Enforcement, and Parks and Recreation divisions of MDNR. The SFMP outlines approaches for implementing landscape ecosystem management, with a deliberate, multi-level and integrated approach to planning. This approach provides strategic planning and direction at both statewide and Eco-regional levels, and facilitates decentralized tactical planning at the forest management unit level. When used with other plans, inventories and projects, it will provide multi-dimensional biological and social-economic data to forest managers, which will help shape management options. The result of this effort is the application of holistic management to the State's managed forests, thus requiring the strong consideration of aquatic resource protection in terms of high quality habitat management and brook trout populations statewide. This approach will reduce and minimize any affects of timber harvest, road operation, and land use on populations of brook trout in their historical range in Michigan.

Conclusion: Present or threatened destruction, modification, or curtailment of species habitat or range

Similar to just about everywhere in the U.S., threats to aquatic habitat from outright destruction or deleterious modifications are ubiquitous in the historical range of brook trout in Michigan. Through the use of holistic management and planning that addresses ecosystem function and not just localized instream habitat conditions, however, the State is progressively and effectively addressing Factor A. We have demonstrated a committed focus on habitat protection through the development of better BMPs, issuance of policies on resource protection and guidance for consistent application of those policies throughout the State, pursuit of proactive legislation for groundwater protection and forest certification, active involvement in water quality and construction permit reviews, aggressive standards for mine application reviews, and have undertaken creative efforts to address issues pertaining to hydropower operations. We continue to pursue habitat rehabilitation through collaborative and coordinated planning and assessment documents that incorporate input and involvement of other agencies and stakeholder groups, funding of on-the-ground projects, and by providing technical and heavy equipment expertise whenever possible.

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Michigan's waters of the Great Lakes are subject to commercial fishing, recreational fishing, and Tribal subsistence fishing. Inland waters are subject to recreational fishing and Tribal subsistence fishing. When unregulated and unmanaged, any of these sources of mortality from fishing could impair populations of brook trout in their historical range in Michigan. As we will show, however, this is not currently the case in Michigan.

<u>Threat from Overharvest</u>

Brook trout are highly vulnerable to angling because of their aggressive behavior toward prey. It was not uncommon for a single angling party to catch more than 100 brook trout per day during the mid 1800s (Roosevelt 1884). Additionally, commercial fisheries broadly employed gills nets in the Great Lakes until the early 1970s, resulting in high mortality rates for brook trout that were captured by the nets. Thus, it is not surprising that overfishing has been identified as one of the major causes for the historical decline in abundance of adfluvial brook trout in their historical range in Michigan (Schreiner *et al*. *in press*; Newman *et al*. 2003).

Sport Harvest

While overharvest was clearly a threat in the past, current harvest rates by recreational anglers are low for adfluvial brook trout in their historical range in Michigan (Appendix F). We have been monitoring harvest of important game fish species at numerous ports throughout the Great Lakes since 1985 (Table 8). Very few brook trout have been observed by creel survey clerks at any of the ports within the Great Lakes. For example, estimates of the combined harvest of brook trout for ports on Lake Superior varied from 0 to 59 fish per year during 1997-2006 (Table 8). During that same period, estimates of the combined harvest of brook trout for ports on Lake Michigan ranged from 0 to 64 fish per year. No brook trout were observed during most creel surveys in northern Lake Huron, but a few fish (estimated harvest of 19 fish) were harvested near the Les Cheneaux Islands in 2002.

A creel survey was conducted on Lake Superior's waters of Isle Royale National Park during June-August, 1998. No brook trout were reported in the catch for this period, but the harvest estimate for splake (hybrid lake trout *Salvelinus namaycush* x brook trout) was 41 fish (Lockwood *et al*. 2000). Because the nearest stocking site for splake was 50 miles away, Lockwood *et al*. (2000) speculated that some, perhaps all, of these splake were misidentified lake trout or brook trout.

Huckins and Baker (*in press*) attempted to determine harvest mortality of adfluvial brook trout from the Salmon Trout River. During 2000-2001, 33 large (>11.4 inches) brook trout from the Salmon Trout River were marked with t-bar anchor tags prior to release. Three of these fish were harvested by anglers by June 2002, and an additional fish was turned in by a commercial fishing company that reportedly purchased the fish from a Tribal fishing operation. Thus, the minimum exploitation rate was 12.1% overall with 9.1% due to recreational fishing (Huckins and Baker *in press*). It is important to note, however, that all of the brook trout tagged during this study (maximum size = 19.6 inches) would be protected from harvest under the new 20-inch minimum size limit for Michigan's waters of Lake Superior.

Additional information on capture of brook trout has been collected as part of our Master Angler Program (Tables 9, 10, and 11). Through this program, anglers receive certificates for brook trout that meet the minimum length (17 inches for catch-and-release entries) or weight (2.0 lb for catch-and-keep entries) requirements. Since 1988, 49 entries have come from Michigan's waters of the Great Lakes (Tables 9 and 10). Most of these fish were captured in Lake Superior (N = 23) and Lake Michigan (N = 22), while only four fish were caught in northern Lake Huron.

Data from our creel survey and Master Angler programs provide information regarding the distribution of adfluvial brook trout in Michigan. For example, only 52% of the Lake Superior Master Angler entries were from Marquette County (*i.e.*, near the Salmon Trout River), and Master Angler entries for brook trout were reported throughout the western Upper Peninsula. In Lake Michigan, half of the Master Angler entries for brook trout came from northern Green Bay or Little Bay de Noc. We have maintained intensive stocking programs for brook trout in tributaries to Green Bay through the 1990s, and it is likely that these stocking programs contributed to relatively high catches of adfluvial brook trout in this region. An alternative or complementary explanation is that the shallow, productive waters of Green Bay and Little Bay de Noc provide especially attractive habitat for adfluvial brook trout. The remaining 11 Lake Michigan Master Angler entries for brook trout came from the Lower Peninsula, and brook trout were reported at creel survey ports as far south as St. Joseph. Most of the brook trout caught in Lake Huron were taken along the Upper Peninsula coastline, but one Master Angler fish was captured near Alpena. Additional Master Angler entries indicate the presence of adfluvial brook trout in several inland lakes (Table 11).

Some of the fish identified as brook trout during creel surveys or registration of Master Angler entries could actually have been splake. Splake have been stocked at several different Great Lakes ports since the 1980s, and some of the "hotspots" that generated Master Angler entries for brook trout also coincide with stocking locations for splake (*e.g.*, Marquette, Copper Harbor, and Green Bay/Little Bay de Noc). Although some misidentification is probable, this caveat does not detract from the overall patterns revealed by the data from the creel survey and Master Angler programs. For example, splake were not stocked into Green Bay or Little Bay de Noc until 1987, but our files indicate that dozens of large brook trout were caught in this area during 1974-1987. The presence of brook trout at creel survey ports in southern Lake Michigan also cannot be explained by splake stocking, as no splake have been stocked in the Lower Peninsula waters of Lake Michigan.

Harvest by State-licensed Commercial Fishing Operations

Commercial fishing has been a long practiced activity on the open waters of the Great Lakes. We oversee the State-licensed commercial fishing operations through licensing, harvest allocation, catch report data, and fisheries assessments on the Great Lakes. During the 1900s, large-mesh gill nets were used to harvest fish in the Great Lakes. Michigan prohibited the use of large-mesh gill nets in the State-licensed commercial fishery during the period of 1972-1974, and required the use of large-mesh trap nets instead (Brege and Kevern 1978).

Since the early 1900s, State-licensed commercial fishing operations have not targeted brook trout, although brook trout have been taken as bycatch. Records from 1971 through 1989 show only 90 instances when brook trout were caught by State-licensed commercial fishing operations (Appendix G), and all brook trout captured were returned to the water. Of the brook trout taken in nets used for commercial fishing, only one fish was caught in Lake Huron and while 89 brook trout were taken in Lake Michigan. (Philip Schneeberger, *Personal Communication*, MDNR). State-licensed commercial fishing operations continue to submit bycatch information to us, but no brook trout have been reported since 1989 Appendix G.

The lack of reports of brook trout taken in nets used for commercial fishing since 1989 is not surprising. As a result of two Consent Decrees negotiated with the 1836 Tribes in Michigan for fishing on the Great Lakes (U.S. *v*. Michigan 1985; U.S. *v*. Michigan 2000), a majority of the State-licensed commercial fishing operations that existed in Michigan's waters of the upper Great Lakes were purchased by the State and retired. Several others were relocated outside of the 1836 treaty-ceded area into lower Lake Huron. These changes effectively removed most of the State-licensed commercial fishing effort from the historical range of brook trout in Michigan. In addition, special provisions are now included in the license issued to the only State-licensed commercial fishing operation located in the area of the Salmon-Trout River, which prohibit the setting of nets in the embayment into which the river flows.

Scientific Collectors Permits

Another potential source of controllable mortality is the collection of fish, reptiles, amphibians, crustaceans, or mollusks for scientific study purposes, which we regulate under authority of Act 451 of 1994, part 457. From 2001 until 2007 (inclusive), 70 different permits reported some sort of collection activity for brook trout. These 70 permits reported 516 different sampling events for brook trout (*i.e.*, sampling different sites and/or multiple sampling events at the same site per year or over multiple years).

Of the 516 reported encounters with brook trout, 89.9% (464) were reported as catch-and-release activities only (Table 12). The number of brook trout specimens reported as being sampled and released alive per these 464 sampling events ranged from 0 to 1,065. The total number of brook trout reported as collected and released alive by individuals with a scientific collector's permit for the 7 year period was 13,307.

Of the 516 reported encounters with brook trout, 10.1% (52) reported lethal forms of sampling. The number of brook trout specimens reported as being kept per these 52 sampling events ranged from 1 to 62. The total number of brook trout reported as "kept" by individuals with a scientific collector's permit for the 7 year period was 411.

Overharvest: Management and Conservation Efforts

Regulations and Management for Recreational Fishing

During the last century, the MDNR has instituted a variety of regulations for recreational anglers to protect populations of brook trout from overexploitation (Table 13). As Michigan's human population has increased, these regulations have been revised to ensure adequate protection for lake- and stream-resident brook trout. By 1950, the daily possession limit of brook trout for recreational anglers in the Great Lakes had been reduced to 5 fish, a marked difference from the 1800s when catches exceeded 100 fish per day. In recent years, a combination of high minimum size limits, low possession limits, and fishing season closures have been enacted for recreational anglers to protect populations of adfluvial brook trout in Lake Superior. In 2005, regulations for recreational anglers were changed, including an increase in the minimum size limit for brook trout in Lake Superior to 20 inches and a reduction in the daily bag limit to 1 fish. For Lake Superior's waters within 4.5 miles of Isle Royale National Park, a catch-and-release season has been instituted for recreational anglers fishing for brook trout from May 1 to Labor Day. No fishing for brook trout is allowed in Isle Royale National Park during the rest of the year. Special regulations for recreational anglers fishing for brook trout are also in place on the Salmon Trout River and two streams within the Pictured Rocks National Lakeshore (Table 13). These measures have greatly decreased the threat of overharvest of adfluvial brook trout in their historical range in Michigan by recreational anglers.

Tribal Harvest Regulations

Native American Tribes have treaty-ceded rights to harvest brook trout in Michigan's waters ceded under the treaties of 1836 and 1842. Nearly all of the historical range of brook trout in Michigan is within the 1836 and 1842 treaty-ceded areas. Tribes in these treaty areas have enacted regulations governing fishing opportunities for their members (Table 14). Information on the estimated Tribal harvest of brook trout is not available at this time, and no harvest of brook trout has been reported in Tribal commercial or subsistence fisheries in either the 1836 and 1842 treaty-ceded areas (Nicholas Popoff, *Personal Communication*, MDNR).

State-licensed Commercial Fishing Regulations and Management

The commercial harvest, possession, and sale of brook or speckled trout by State-licensed commercial fishermen have been illegal since the first commercial fishing law was enacted in 1929 (MCL1929 Sec. 6322). These prohibitions have been retained in three subsequent laws (MCL 1948 Sec. 308.16, MCL 1970 Sec. 308.16, and MCL 1979 Sec. 308.16) and six Public Acts (PA 1933 No. 255, PA 1939 No. 339, PA 1947 No. 324, PA 1951 No. 194, PA 1957 No. 277, and PA 451 No 324.47321 of 1995). Through the passage of all these acts and laws, the language prohibiting the commercial harvest, possession, and sale of brook trout has remained intact.

Changes in the license provisions of State-licensed commercial fishing operations have afforded additional protections for brook trout and other non-target fishes, through restrictions in locations where nets could be placed and restrictions on the types of netting gear authorized. With the State's elimination of large-mesh gill nets in the early 1970s and the subsequent requirement that only large-mesh trap nets could be used by State-licensed commercial fishing operations, bycatch of brook trout by these operations has been virtually eliminated. Bycatch has been reduced further by the retirement of licenses and the relocation of several State-licensed commercial fishing operations out of the historical range of brook trout in Michigan. Changes to provisions in licenses, such as for the State-licensed commercial fishing operation located near Marquette County's Salmon Trout River, have also afforded more protection to brook trout by prohibiting the setting of trap nets in the embayment into which the Salmon-Trout River flows.

Scientific Collectors Permits

We regulate the collection of fish, reptiles, amphibians, crustaceans, or mollusks for scientific study purposes under authority of Act 451 of 1994, part 457. Individuals or groups seeking to collect specimens are required to obtain a Scientific Collector's Permit issued by us (Table 2; Appendix A). Proposals for specimen collection are submitted by the applicant to us, whereby the proposal is peer reviewed to ensure that there would not be any deleterious effects to aquatic species or aquatic resources, resulting from this endeavor. When a proposal that may have questionable parameters is received, applicants are contacted to provide clarification. Staff biologists review issues related to biology, location, collection season, and specimen removal to ensure that no harm to the aquatic assemblages or habitats will result from the activity. Permits are then issued or denied, with the reasons for the denial provided to the applicant. The allocated take of brook trout for any specific stream or water body is kept to low numbers by conditions of the permit (Thomas Goniea, *Personal Communication*, MDNR).

Law Enforcement Efforts

Adherence to and enforcement of regulations are an important part of fisheries management. A strategic approach involving work planning and response to complaint areas provides the MDNR Law Enforcement Division with the ability to provide for protection of overharvest of brook trout in their historical range in Michigan. MDNR Law Enforcement Division has 4 Districts in the historical range of brook trout in Michigan, and each District is responsible for developing a comprehensive work plan to address law enforcement issues. Input from local staff is incorporated into the work planning process to allow for Conservation Officers to target key areas of concern. An example of a work plan issue would be, "the protection of spawning trout in the fall by conducting patrols to address issues associated with the snagging or foul hooking and spearing of fish". In response to this work plan issue, specific enforcement plans are developed for the area that include the scheduling and conducting of group patrols utilizing a combination of both high profile (visible) and plain-clothes officers. The patrols are scheduled to ensure maximum enforcement coverage. At times, assistance from outside the Districts is requested during peak periods of fishing and citizen patrols may also be utilized.

Criteria used to determine key areas requiring attention from law enforcement include:

1. traditional spawning areas;
2. areas where fish are highly vulnerable, such as dams and fish ladders;
3. areas of heavy fishing activity;
4. areas of spearing activity; and
5. spawning closure areas.

As an example of quantifying enforcement efforts in the historical range of brook trout in Michigan, enforcement efforts of 47 Conservation Officers was tracked through the reporting of number of complaints received, number of group and directed patrols, and number of citations issued. For fishery-related issues during the periods when brook trout are spawning in the fall and during spring migrations, Conservation Officers patrolled for more than 3,500 hours on fishery-related issues, addressed 200 fisheries-related complaints, conducted 159 arrests, and held 108 group and directed patrols.

Enforcement efforts are vital in reducing the threat of overutilization of brook trout in their historical range in Michigan.

Conclusion: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Brook trout provide a valuable and popular opportunity for fishing in their historical range in Michigan. Both adfluvial and resident brook trout are protected by conservative regulation of recreational fishing that includes restrictive size and bag limits and harvest closures during spawning. Commercial fishing for brook trout is prohibited and by-catch is minimal and rarely lethal with trap net operations. Overutilization resulting from collections obtained for scientific purposes is minimal as demonstrated by the less than 3% retention rate in scientific investigations and our Scientific Collector's Permit Program that is rigorously monitored. These regulations, combined with an active and strategic law enforcement presence, provide considerable protection against overutilization of brook trout in their historical range in Michigan.

Factor C: Disease and Predation

In this Section we will analyze vectors for pathogens and the potential risk for pathogens to move into populations of brook trout in their historical range in Michigan. In addition, we will develop a comparative analysis of pathogens and diseases of fish in the historical range of brook trout in Michigan and the estimated risk of each to populations of brook trout.

Key Diseases of Fish

Whirling Disease

Whirling disease is caused by a myxozoan parasite that can infect brook trout (O'Grodnick 1979; Thompson *et al*. 1999; Vincent 2002; Gilbert and Granath 2003). High prevalence rates of this parasite can be found in wild situations, such as documented in Big Spring Creek, Pennsylvania in 1978 when a prevalence rate of 77% was detected in brook trout. This is atypical because the high organic loadings needed to support the tubifex worm *Tubifex tubifex*, which is an intermediate host that is required for whirling disease to survive, are rarely found in association with populations of brook trout in Pennsylvania (Kaeser *et al*. 2006).

Whirling disease was first documented in Michigan's waters in 1968 and was introduced via infected fish from an Ohio fish farm. Currently, this parasite is found in approximately 10% of all waters inhabited by trout in Michigan (Gary Whelan, *Personal Communication*, MDNR). Extensive sampling for whirling disease was conducted by the MDNR from 1995-2003, and 47 different water bodies in the historical range of brook trout in Michigan were sampled (Table 15). In the Lake Superior basin, 12 water bodies were sampled and only two were positive for whirling disease, the East Branch of the Ontonagon River and the AuTrain River (MDNR *unpublished data*). Whirling disease was found in brook trout only in the AuTrain River. In the Lake Michigan basin, 26 water bodies were sampled and only the Black River (Mackinaw County) and Jordan River were found to be positive for whirling disease (MDNR *unpublished data*). Whirling disease was found in brook trout only in the Jordan River. In the Cheboygan River watershed of Lake Huron, 8 water bodies were sampled for whirling disease, and the Little Sturgeon and Pigeon rivers were found to be positive (MDNR *unpublished data*). Whirling disease was found in brook trout that inhabited the only the Upper Pigeon River. Whirling disease was found in the Sturgeon River in the late 1960s and 1970s, but the disease was detected in the most recent sampling of the river. Clinical signs of whirling disease have not been documented in the historical range of brook trout in Michigan, and generally infection levels are very low (MDNR *unpublished data*).

Similar to observations in Pennsylvania, the high organic loadings needed to support tubifex worms are generally not found in the historical range of brook trout in Michigan, and therefore significantly lowers the risk that whirling disease will affect brook trout. Although whirling disease is present in the historical range of brook trout in Michigan, it does not cause disease expression and is not seen in high intensities. Thus, it should not be considered a significant threat to populations of brook trout in their historical range in Michigan at this time.

Furunculosis

This bacterial disease is caused by *Aeromonas salmonicida* and is widespread throughout the State. Brook trout are known to be very susceptible to the disease, and historically it caused significant fish health problems in brook trout be reared at the Marquette State Fish Hatchery. A number of steps have been taken in Michigan's State fish hatchery system to control this disease and these are discussed elsewhere. The disease has been documented coho salmon, Chinook salmon, and steelhead at egg-take stations on the Great Lakes (MDNR *unpublished data*). It is rarely found in inland waters and there has not been an epizootic event attributed to this disease in Michigan's waters.

Overall, this pathogen should not be considered a high risk at this time since it is at very low levels in the wild, except in Pacific salmon from lakes Michigan and Huron that were sampled at egg-take stations. Furunculosis has not been documented to cause any epizootic events in Michigan's waters. With the implementation of biosecurity measures in the State's fish hatcheries, this pathogen is not expected to create any significant disease issues.

Infectious Pancreatic Necrosis Virus (IPNv)

This viral pathogen typically causes epizootic events in hatchery systems but epizootic events are rare in the wild. IPNv is a highly contagious viral disease of salmonids that usually strikes very young fish, and brook trout have been documented with the disease (Winton 2001). The disease is transmitted both vertically and horizontally and disinfection of the egg's surface is only partially effective because the virus can be found inside the eggs of salmonids. IPNv is known to have a number of strains, and virulence varies widely among strains. Since the virus can not be completely controlled with standard hatchery disinfection methods, biosecurity and the prevention of infection are the critical methods to prevent transmission of the disease.

To date IPNv has only been documented in two locations in the historical range of brook trout in Michigan, in rainbow trout in the private Watersmeet Fish Hatchery on the Upper Ontonagon River, Gogebic County in 2001 and in brook and rainbow trout in 47 Mile Creek in Menominee County in 2000 (MDNR *unpublished data*). After disinfection and de-population, the Watersmeet Fish Hatchery has tested negative for IPNv since 2003. IPNv has been detected in a handful of other locations outside of the historical range of brook trout in Michigan, but there is no evidence it has caused an epizootic event anywhere in Michigan.

Given the current distribution of the virus and lack of evidence for any large-scale mortality events in Michigan's waters from the virus, IPNv should be considered a low risk pathogen at this time.

Bacterial Kidney Disease (BKD)

BKD is caused by *Renibacterium salmoninarum*, and in acute cases causes the kidney and other internal organs to fail. The pathogen can be passed either vertically or horizontally, making BKD more difficult to manage in fish culture operations since it can be transmitted inside the egg by the female (Winton 2001). The strains in Michigan are known to be slow growing but virulent. When fish are in a highly stressed condition, this pathogen can cause epizootic events such as that seen in Lake Michigan in the 1980s that resulted in the collapse of the Chinook salmon fishery (Keller *et al*. 1990). Brook trout are known to be highly susceptible to the pathogen and large-scale fish health problems have been documented at the Marquette State Fish Hatchery in the 1990s (MDNR *unpublished data*). In 1999, an entire lot of 60,000 brook trout was destroyed because of high infection rates of BKD.

BKD has been documented in the historical range of brook trout in Michigan in the Iron River, Iron County in 2006. A long history of BKD has been documented in Pacific salmon at the egg-take stations, including the Swan River weir on Lake Huron (Presque Isle County) and the four weirs on Lake Michigan: the Little Manistee River weir (Manistee County), Platte River weir (Benzie County), Boardman River weir (Grand Traverse County), and Medusa Creek weir (Charlevoix County). Other information has been collected on levels of BKD in lake whitefish from northern Lake Huron, with a high percentage of the whitefish collected showing positive results for BKD (Dr. Mohamed Faisal, *Personal Communication*, Michigan State University Aquatic Animal Health Laboratory). BKD levels populations of fish in Lake Superior are lower in comparison to the levels in populations of fish in the other Great Lakes.

Since the BKD epizootic event in Chinook salmon in Lake Michigan during the 1980s, all of the resource agencies on the Great Lakes have actively been managing against this pathogen. Measures implemented include active culling of infected fish during egg-takes, disinfection of eggs, use of prophylactic treatments of erythromycin, a broad hatchery inspection program, and destruction of lots with unacceptable prevalence rates of the bacteria. The recent implementation of extensive biosecurity and preventative fish health measures to protect brook trout in production at the Marquette State Fish Hatchery is documented in Table 16. This combination of measures has greatly reduced the prevalence of BKD in returning wild broodstocks, along with reducing BKD to incidental levels in the Marquette State Fish Hatchery (Figures 1 and 2).

Given the intense management of this pathogen and declining prevalence rates in wild fish, this pathogen should continue to be watched and actively managed but should not be considered a high risk pathogen at this time.

Viral Hemorrhagic Septicemia Virus (VHSv)

This viral pathogen is known to cause large-scale epizootic events in populations of fish in the Great Lakes, but has not caused epizootic events and has not been detected in brook trout in the Great Lakes basin to date. Initial laboratory challenge experiments have determined, however, that brook trout are susceptible to this pathogen (Dr. Mohamed Faisal, *Personal Communication*, Michigan State University Aquatic Animal Health Laboratory).

The pathogen likely arrived in waters of the Great Lakes around 2002 based upon archived samples of muskellunge *Esox masquinongy* from Lake St. Clair, and epizootic events that began in the spring of 2005 in freshwater drum *Aplodinotus grunniens* in the Bay of Quinte. The virus strain (Strain IVb) in the Great Lakes is very similar to Strain IVc, which has been documented from the Maritime Region of Canada. The virus likely arrived via the discharge of infected ballast water. The current known range in the Great Lakes basin is in southern Green Bay and waters around Door County in Lake Michigan in Wisconsin; northern Lake Huron from Cheboygan to Thunder Bay; and from the St. Clair River to the Thousand Island Region in Lake Ontario. VHSv has been documented from two inland locations in the upper Great Lakes, Lake Winnebago in Wisconsin and Budd Lake in Clare County, Michigan.

Current data on VHSv obtained through surveillance surveys indicates that the prevalence of the virus in northern Lake Michigan and Lake Huron is very low, and nearly all samples from lakes Michigan and Huron, including the St. Marys River, have been negative for the virus (MDNR *unpublished data*). VHSv has not been documented from the Lake Superior watershed to date.

At this time, it is our opinion that VHSv Strain IVb poses only a potential threat as the pathogen has not been found in brook trout anywhere in the Great Lakes, is at low prevalence rates in the few locations it has been documented in the historical range of brook trout in Michigan, and is under surveillance throughout Michigan and in public and private hatcheries.

<u>Vectors for Pathogens</u>

We have identified 12 potential vectors by which pathogens of fish could potentially move into the historical range of brook trout in Michigan. The probability of these vectors contributing to the movement of an epizootic-causing pathogen is significantly dependent upon several factors, including the life cycle of the pathogen, the timing of movement via the vector, the amount of pathogen moved, the survival of the pathogen while in transit via the vector, the susceptibility of the aquatic community to the pathogen, and the potential reservoirs in the system for the disease.

The likely risk of these twelve potential vectors to affect adfluvial brook trout is as follows:

1. Preserved bait – this is a highly unlikely contributor to the movement of pathogens of brook trout because the chemicals used in preserving bait are highly effective disinfectants (Gary Whelan, *Personal Communication*, MDNR).
2. State and Federal fish stocking – The Great Lakes Fish Disease Control Policy and Model Program (Great Lakes Model Program) (Hnath 1993) provides for specific control measures for listed pathogens of fish, quarantine measures for new fish stocks, importation requirements, annual fish health inspections, and criteria for the stocking of fish with certain pathogens. Fish reared in each State, Provincial and Federal hatchery in the Great Lakes region are tested for a range of key diseases of salmonids. Recently, coolwater fish raised by public hatcheries have been added for testing for Viral Hemorrhagic Septicemia virus (VHSv). As a result of the Great Lakes Model Program, the risk of fish being stocked by State, Provincial or Federal agencies with key pathogens of brook trout is greatly reduced and generally should be considered a very low-risk management action. We have been a strong advocate of the Great Lakes Model Program and we are compliant with the program.
3. Private fish stocking – Individuals wishing to stock fish in public waters of Michigan must obtain a fish stocking permit, which requires the fish be certified free of VHSv, Whirling Disease *Myxobolus cerebralis*, Infectious Hematopoietic Necrosis virus (IHNv), and Infectious Pancreatic Necrosis virus (IPNv). These are the most likely and most harmful pathogens that could be spread via the private stocking of fish into Michigan's public waters. The risk of spreading diseases from this source is low for the tested diseases but higher for other diseases not currently tested.
4. Fish-eating birds and mammals – Most pathogens for brook trout do not survive mammal or avian gut passage. This is particularly true for viral and bacterial pathogens. It is unclear for fungal diseases and not true for parasites. Many parasites use mammals or fish-eating birds as part of their life history strategy for dispersal. For viruses and bacteria, transmission via fish-eating birds and mammals is

a low risk vector. For fungi and parasites, this vector ranges from low to a high risk vector.

5. Bilge water in recreational boats – The amount of bilge water that most boats move is very small, which limits the potential effect of this vector. The ability to move pathogens is directly dependent on the concentration of pathogen picked up, the survival of the pathogen in the bilge water in transit, and the availability of susceptible species in the receiving water. While nearly any pathogen could be moved by this vector, the overall risk is likely be low because of the low probability of all of the dependent factors occurring together, and can be lowered to nearly zero by simple best management practices such as bilge drainage and disinfection.
6. Livewell water in recreational boats – The risk from this potential vector is similar to that for bilge water as the same factors are involved. Risk is likely to be slightly higher than bilge water as live wells do typically carry more water with direct contact from fish hosts. While nearly any pathogen could be moved by this vector, the overall risk is likely be low because of the low probability of all of the dependent factors and can be lowered to nearly zero by simple best management practices such as live well drainage and disinfection.
7. Frozen bait – Many pathogens of fish can survive freezing at commercial or home freezer temperatures. Time is a key, however, to the amount of the pathogen still viable. The longer the bait has been frozen the less likely it will be a vector to move fish pathogens. Viruses, bacteria, fungi, and encysted parasites are all likely to be less viable with freezing time and freezing will kill some of them. Encysted parasites such as *Myxobolus cerebralis* can survive very long periods of freezing. The risk posed by this vector likely ranges from low to medium for most pathogens, except for encysted parasites that remain viable for very long periods.
8. Commercial fishing – Commercial fishing operations use very large fishing gear to capture and concentrate fish for capture. The nature of this gear unnaturally concentrates and stresses captured fish. This increases the likelihood that pathogens will be moved horizontally between fish and will cause disease to be expressed from stress, even though the population as a whole is not expressing any signs of a disease. This scenario has been documented with VHSv in Green Bay for lake whitefish *Coregonus clupeaformis* (Susan Marquenski, *Personal Communication*, WDNR) and in Lake Erie for yellow perch *Perca flavescens* (David Inslay, *Personal Communication*, Ohio Department of Wildlife). Captured fish that are undersized or non-target are released and could also spread pathogens to the population as a whole. The nature of commercial fishing gear makes it a medium to high risk vector to move pathogens and create disease conditions for virulent pathogens.

Another potential vector is waste products from the slaughter of infected fish from commercial fishing or aquaculture operations. We conducted an analysis of this vector in 2007 (MDNR Fisheries Division *unpublished data*). All of the known fish processors and fish cleaning stations were contacted about their water handling practices and 35 responses were obtained from 64 businesses. Most of those without data are not cleaning any fish. Fish carcass wastes were landfilled (86%), sent to fertilizer companies (14%), placed on local farm fields (11%), composted on site (6%), buried on site (3%), municipally composted (3%), or given to bear hunters (3%). The total percentage exceeds 100% as some processors use multiple methods. All of the waste water was treated in septic/drain fields (49%) or in municipal sewer systems (51%). Additionally, it is illegal to dump fish offal into the State's waters so the overall pathogen transmission risk from commercial fish processing is very low.

9. Ballast Water from Great Lakes shipping – Commercial shipping on waters of the Great Lakes typically use between 1 million gallons for ships from salt water and 10 million gallons for ships from within the Great Lake for ballast purposes. The overall probability of ballast water moving pathogens is likely low as the following conditions must be met: a) ballast water must be taken up at a location with an active disease event; b) the pathogen must stay viable in the ballast tank; and c) must be discharged in a high enough concentration in a location that a susceptible species can be exposed to it. While the probability of all three factors occurring together is likely low, the movement of the disease when all of the conditions are met is very high because of the large volumes of water used for ballast. It is strongly suspected that VHSv was moved from the Canadian maritime region to the Great Lakes via commercial shipping. The overall risk from this vector must be considered to be medium to high because of the very large volumes moved but, each individual event is likely to have a low probability.
10. Harvesting of weeds – Many waters in Michigan employ commercial weed harvesting operations to remove undesirable weed growth, particularly in lakes. These operations frequently move from lake to lake and often move large amounts of vegetation and live organisms with them, as cleaning and disinfection practices are not always done with the appropriate care. The movement of organic material and live organisms is a very high risk vector for the transport of pathogens, when it occurs, as the pathogen is in a concentrated state in a live host. Many commercial harvesters have employed cleaning and disinfecting protocols in their operations, which greatly reduces the risk from this vector. Overall, this vector is considered to be medium to high risk depending on the cleaning and disinfecting protocols used in the operation.
11. Movement of live fish by humans – The movement of live gamefish or baitfish that may carry a disease poses the highest risk for spreading pathogens of fish. The behavior of anglers to dispose of live gamefish or live baitfish that may be diseased into public waters poses a high risk of transmitting diseases of fish. Introduction of ornamental fish to public waters poses a similar risk and trade in ornamental fish is not currently regulated in Michigan.
12. Natural fish movement – This factor poses a similar risk to that for fish that are moved by humans. Most pathogens in fish are found at low prevalence rates and are typically in low abundances in aquatic systems. Unless fish are concentrated, horizontal transmission resulting from natural fish movements is a relatively low probability event. High concentrations of fish resulting from unique behaviors, spawning congregations, or forced by barriers or commercial fishing gear, however, can create conditions where a few infected fish can move pathogens into populations of fish generally. Thus, this can be a high risk vector for some pathogens under certain conditions.

Diseases of Brook Trout

While brook trout can be the host for many bacterial, viral, fungal and parasitic pathogens, the Great Lakes Model Program lists four emergency diseases and six restricted fish disease for the Great Lakes basin. Our analysis will address pathogens that are considered to be of higher concern than other diseases. Hnath (1993) define emergency diseases of fish as those that are caused by virulent pathogens that have not been detected in the Great Lakes basin. Restricted pathogens are those currently enzootic in the Great Lakes basin, but whose range is restricted or is of particular concern with respect to epizootic events, thus requiring control measures.

The emergency diseases listed include VHSv, IHNv, *Ceratomyxosis*, and Proliferative Kidney Disease (PKD). Only VHSv is currently found in the Great Lakes. The other emergency diseases are currently not threats to brook trout as they are not found in the Great Lakes region. The restricted diseases include Whirling Disease, IPNv, Bacterial Kidney Disease (BKD), Furunculosis, Enteric Redmouth, and Epizootic Epitheliotropic Disease virus (EEDv). Of the emergency and restricted diseases, five are considered to be larger threats to brook trout and include Whirling Disease; Furunculosis; IPNv; BKD; and VHSv. This group of diseases is known to cause epizootic events either in fish culture facilities or in wild populations in the Great Lakes basin.

Enteric Redmouth is generally not seen in brook trout in the State (Martha Wolgamood, *Personal Communication*, MDNR; MDNR *unpublished data*). EEDv has caused large scale mortality events in lake trout at the Marquette State Fish Hatchery in the 1980s, but brook trout were not affected by this virus. All fish were destroyed at the Marquette State Fish Hatchery after the epizootic event with EEDv and the pathogen has not been observed in fish reared at this facility since that time. A suspected case of EEDv was documented in lake trout at a facility run by the WDNR in 2006, but again brook trout were not affected.

A key physiological disorder that is found in fish in the Great Lakes is Early Mortality Syndrome (EMS). EMS is caused by the consumption of prey items by adult salmonid predators that are high in thiaminase, particularly alewives *Alsosa pseudoharengus* and smelt *Osmerus mordax*. The thiaminase causes the adult fish to be very low in thiamine levels, an essential protein for proper egg development. EMS is not considered to be a factor in recruitment of brook trout at this time because brook trout do not consume enough prey with thiaminase to create conditions for EMS expression (Martha Wolgamood, *Personal Communication*, MDNR; Dale Honeyfield, *Personal Communication*, U.S. Geological Survey).

Diseases of Brook Trout: Management and Conservation Efforts

Fish Health Measures of the MDNR Fisheries Division

We have implemented a broad range of policies, strategies, and procedures to prevent the spread of potentially epizootic disease of fish (Table 2; Appendix A). For our State's fish hatcheries, measures implemented include, but are not limited to, the active culling of infected fish during egg-takes for key diseases, isolation and quarantine of new broodstock fish, implementation of the Great Lakes Model Fish Health program, increased cleaning and biosecurity of facilities and stocking trucks, reduction of stress by reducing rearing densities and covering raceways, source water disinfection, disinfection of eggs, use of prophylactic antibiotic treatments when appropriate, a broad hatchery inspection program, a general bias against moving fish between hatcheries, and destruction of lots with unacceptable prevalence rates of key diseases. For private stockings in the State's waters, the MDNR requires all fish be stocked under permit and all fish must be inspected and certified free of key diseases. Personnel in our field-based Management Units are required to disinfect equipment, gear, and boats and are prohibited from transferring fish between water bodies unless the fish have undergone testing and been certified free of disease. Our large research vessels are prohibited from moving between Great Lakes except under specific conditions, and equipment is disinfected and cleaned after each cruise. These actions, along with others, have greatly reduced the risk of exposing brook trout to pathogens that could cause an epizootic in their historical range in Michigan.

We have also engaged the angling and boating public to assist in reducing the movement of pathogens, in particular VHSv but others as well, using targeted regulations that provide these groups a set of best management practices MDNR Fisheries Order 245. Fisheries Order 245 addresses a broad range of vectors for movement of pathogens of fish.

High Profile Disease Control: Great Lakes Model Program

Under the aegis of the GLFC, the Great Lakes Fish Health Committee (GLFHC) developed the Great Lakes Model Program in 1993, which continues to provide a consensus approach to fish health issues across the Great Lakes basin. The Great Lakes Model Program provides clear guidance on fish health inspections, importation of fish from outside of the basin, identification of fish health officials, key pathogens of concern, hatchery disease classifications, procedures for the control and management of disease agents, and reporting. All of the State, Provincial, Tribal, and Federal agencies, who are signatories to "*A Joint Strategic Plan for Management of Great Lakes Fisheries*" (Joint Strategic Plan) (GLFC 1997), have agreed to implement this program in their respective jurisdictions. Additionally, the GLFHC provides a forum to evaluate and develop actions for emerging fish health issues. It is thorough the institutional actions of the GLFHC and the implementation of the Great Lakes Model Program that fish pathogens in general are of a low risk to brook trout in their historical range in Michigan.

The cornerstone of the Great Lakes Model Program is that all member agencies will take appropriate measures to prevent the introduction and spread of emergency diseases of fish, and prevent the spread of restricted diseases of fish from their known range. The ultimate goal is for the combined actions of the member agencies to eliminate diseases as potential threats to fish populations in the Great Lakes basin. Emergency diseases of fish are those that are clear threats to populations of fish in the Great Lakes but have not yet been found in the basin, including Infectious Hematopoietic Necrosis virus (IHNv), Ceratomyxosis, and Proliferative Kidney Disease. Restricted diseases are pathogens of fish that are not yet widespread in the Great Lakes basin, including Viral Hemorrhagic Septicemia virus (VHSv), Whirling Disease, Infectious Pancreatic Necrosis virus (IPNv), Bacterial Kidney Disease (BKD), Furunculosis, Enteric Redmouth, and Epizootic Epitheliotropic Disease virus (EEDv). Additional diseases of coolwater fish will be added to both the emergency and restricted disease lists with a soon to be released revision of the Great Lakes Model Program.

All of the agencies who are signatory to the Joint Strategic Plan have agreed to minimize the prevalence of diseases in the Great Lakes basin. All agencies are required to conduct standardized inspections of their fish production facilities, regardless of whether they are in the Great Lakes basin proper, and report on the disease status using a standardized coding system. The management protocols established for BKD by the GLFHC are a prime example of how the Great Lakes Model Program has been implemented to reduce the effects of BKD on the fish communities of the Great Lakes. Another example of activities to minimize diseases of fish in the Great Lakes basin is a requirement to notify all member agencies of any importation of fish into the Great Lakes basin, and a subsequent opportunity for each agency to comment on the transfer before any movement of fish is initiated.

In summary, the GLFHC provides an institutional forum for the Great Lakes basin to discuss and act on fish health matters. The Great Lakes Model Program provides the necessary framework for all member agencies to ensure control of emergency and restricted diseases of fish. As a result of this institution and its guidance, the risks of pathogens infecting populations of brook trout have been minimized, and will continue to be so with the continued operation of the GLFHC.

Regulations to Control Diseases in Fish

In response to the imminent threat to populations of fish both in the Great Lakes and in inland waters, we developed a set of regulations to address the potential distribution and spread of diseases of fish in general, with a particular focus on VHSv. These regulations were implemented through a multi-faceted regulation (MDNR Fisheries Order FO 245). Under this order, boaters must now empty their bilge and live wells prior to leaving a boat ramp, bait fish are managed for disease through a wholesaler certification process, and anglers must now assume responsibility for using only disease-free baitfish in waters not listed as positive for VHSv. These actions will also slow the movement of other pathogens of fish, and will protect brook trout from unnecessary exposure to epizootic-causing pathogens of fish in their historical range in Michigan.

Threats due to Predation

No evidence in the petition or in published scientific literature exists to suggest that predation is adversely affecting populations of adfluvial brook trout in their historical range in Michigan. We have been evaluating the diets of fishes in the Great Lakes for many years. In Lake Superior, we examined 8,939 stomachs from various fish species, including lake trout and burbot *Lota lota* from 1990-2005 (Philip Schneeberger, *Personnel Communication*, MDNR). No brook trout were found in any of the stomach samples. Systematic diet studies have been conducted in Lake Huron since 1972 and again no brook trout were observed during these surveys from a range of potential predators including lake trout, walleye *Sander vitreus*, and Chinook salmon *Oncorhynchus tshawytscha* (James Johnson, *Personal Communication*, MDNR). Similarly, no brook trout have been found in nearly 7,000 stomach samples of piscivores collected from Lake Michigan (David Clapp, *Personal Communication*, MDNR).

Predation on fish by the double-crested cormorant *Phalacrocorax auritus* has dramatically increased in northern lakes Huron and Michigan during the last 30 years, as a result of significant increases in the abundance of this bird. Fisheries managers have expressed concerns regarding the proliferation of these birds in popular fishing areas, and researchers have attempted to determine the diet composition and potential effects of double-crested cormorants on fish populations in the Great Lakes. Ludwig and Summer (1997) summarized the results of diet studies conducted on double-crested cormorants in northern lakes Huron and Michigan during 1995. Salmonids composed <1% of the double-crested cormorant's prey items in the North Channel and Georgian Bay regions of Lake Huron, and no salmonids were observed in the diet of double-crested cormorants from colonies in the Les Cheneaux Islands region of northern Lake Huron or from colonies in northern Lake Michigan (Ludwig and Summer 1997). In a more recent study, researchers from Lake Superior State University analyzed stomach samples from double-crested cormorants collected at four locations in northern Michigan: Les Cheneaux Islands, Brevoort Lake (Mackinac County), Thunder Bay, and Big and Little bays de Noc. Of the 49,978 prey items that were identified during this study, only 11 were determined to be salmonids and no prey items were definitively identified as brook trout (Daniel Traynor, *Personal Communication*, Lake Superior State University).

Considering the relatively low abundance of brook trout in waters of the Great Lakes, it is not surprising that brook trout have not been found during recent diet studies. Brook trout abundance is much higher in tributaries to the Great Lakes and many inland lakes, so more information is available regarding predation on brook trout in these habitats. A wide variety of animals are known to consume brook trout, including common loon *Gavia immer*, great blue heron *Ardea herodias*, mergansers *Mergus* spp., belted kingfisher *Ceryle alcyon*, water snakes *Nerodia* spp., snapping turtle *Chelydra serpentina*, mink *Neovison vison*, river otter *Lutra canadensis*, brown trout, largemouth *Micropterus salmoides* and smallmouth bass *Micropterus dolomieui*, and northern pike *Esox lucius* (Matkowski *et al*. 1989; Shetter and Alexander 1970; Becker 1983; Alexander 1979). In addition, various species of fish (*e.g.*, sculpins *Cottidae*) prey on eggs and fry of brook trout (Mirza *et al*. 2001). Most of these predators are native to the Great Lakes region and have co-existed with brook trout for thousands of years.

Of the exotic species of fish introduced into Michigan's waters, the brown trout is the most notable predator of stream-dwelling brook trout. Efforts to reduce populations of brown trout and mergansers on the North Branch of the Au Sable River resulted in a modest increase in abundance of brook trout larger than 9 inches (Shetter and Alexander 1970). Alexander (1979) speculated that the removal of one predator species (*e.g.*, brown trout) would have little effect on survival of brook trout because consumption of brook trout by other predators would increase in a compensatory manner. Although brown trout are common in many streams of the northern Lower Peninsula, they are much less abundant in tributaries to Lake Superior. Thus, even if brown trout are able to reduce the abundance of brook trout through predation, it is unlikely to be observed in the Lake Superior watershed given the very low abundances of brown trout in that basin.

One invasive species that could have a direct effect on brook trout in their historical range in Michigan is sea lamprey. Whether sea lamprey attack and kill adfluvial brook trout in Lake Superior is unknown. Few lamprey wounds have been reported on brook trout inhabiting Lake Superior and overall wounding rates appear to be low (Schreiner *et al*. *in press*).

Conclusion: Disease and Predation

Mortality of individual brook trout due to either threats of disease or predation is present in the historical range of brook trout in Michigan, but population effects from these threats are difficult to substantiate. Threats from disease for fish are pervasive throughout both wild populations and in hatchery facilities (Nehring and Walker 1996). Careful analyses of vector- and disease-management strategies will be important in understanding and addressing vulnerabilities to disease in both wild and hatchery-reared fish. We have employed proactive and contemporary preventative measures statewide through our policies, disease monitoring program, prophylactic measures at hatcheries, and disease surveillance of populations of wild fish. Adherence to the Great Lakes Model Program further enhances a collaborative approach to disease management throughout the basin. Furthermore, by enacting a Fish Disease Order, we have reached out to stakeholders statewide to provide stewardship in the prevention of spreading fish diseases across the State. Lastly, there is little evidence to suggest that widespread predation exists as a factor limiting abundance of brook trout, in spite of extensive monitoring data.

Factor D: Inadequacy of Existing Regulatory Mechanisms

The petitioners suggest that inadequate regulatory mechanisms exist due to a) lack of a single agency for management of coaster "adfluvial" brook trout, b) inadequate authority to prevent conflicts in management among jurisdictions, c) land-use practices and toxic pollution, d) over-reliance on stocking, e) inadequate program funding, and f) lack of public education and involvement in restoration of adfluvial "coaster" brook trout.

In analyses of Factor A and Factor B, we provide both statutory and programmatic evidence for addressing land-use practices, pollution, and programmatic funding. In regard to stocking, petitioners suggest an over-reliance on the use of fish reared in hatcheries in management activities. In general, brook trout reared in MDNR"s hatcheries have been used judiciously in a few streams that are tributary to Lake Superior for the express purpose of determining if rehabilitation of adfluvial brook trout could be improved. Progeny reared in our hatcheries for this purpose have come from specific locations where brook trout have exhibited adfluvial behavior in the wild. In addition, stocking of other salmonids is limited in both number and location in Lake Superior (MDNR Fisheries Division fish stocking database *unpublished data*). We can provide data on stocking upon request and as available. Therefore, we suggest that there is not an over-reliance on the use of fish reared in hatcheries in management activities that occur in the historical range of brook trout in Michigan

In this Section, we outline Michigan's statutory authorities and obligations, as well as interjurisdictional collaboration. Further elaboration on coordination and implementation of fisheries management programs as they pertain to brook trout can be found in Section IV of this document.

Regulatory Authorities and Institutions in the State of Michigan for Protecting and Managing Aquatic Resources

Michigan has a broad range of clear regulatory authorities and responsible institutions to manage and protect the State's aquatic resources. Since the State's fish and wildlife resources are public trust resources granted by the Federal government to the State of Michigan upon statehood, the State has a direct property interest in those resources and they are held in public trust for all of its citizens. This concept is codified in Michigan Compiled Laws § 324.47301 and 324.48702(1), which provide that:

> *"All fish of whatever kind found in the waters of Lakes Superior, Michigan, Huron, and Erie, commonly known as the Great Lakes, the bays of the Great Lakes, and the connecting waters between those lakes within the jurisdiction of the State are property of the State…"*

and

> *"All fish found in any of the inland waters of this State are hereby declared to be the property of the State of Michigan…"*

Under Michigan law, all fish found in Michigan's inland waters "may only be taken at such time and in such manner as prescribed by law" (M.C.L. § 324.48702(1)). Similar language is stated for the Great Lakes in M.C.L. § 324.47301 which states "All fish in the waters described in this section shall be taken, transported, sold and possessed only in accordance with this part.". The ownership of the fish resources was reaffirmed in the Court of Appeals ruling in Attorney General *v*. Hermes, 127 Mich. App. 777: 339 N.W. 2d 545 (1983). The Court of Appeals concluded that the State has a definite, but less than complete, interest in the fish in the waters of the State, while those who unlawfully capture fish in contravention of State regulations have "no ownership or possessory rights.".

In addition to the State having clear authority over aquatic resources, the MDNR has an obligation to protect the State's fish resources. Under the public trust doctrine, all fish within the jurisdictional waters of Michigan are held in trust by Michigan for the benefit of the people of the State. Other jurisdictions have likewise held that the public trust doctrine places an affirmative fiduciary obligation on States to protect fish resources and to seek compensation for diminution of the trust corpus (*e.g.*, New Jersey DEP *v*. Jersey Central Powers and Light Company, 356 A.2d 750, 759 (1975); Ohio *v*. Bowling Green, 313 N.E.2d 409, 411 (1974); Maryland DNR *v*. Amerada Hess Corporation, 350 F. Supp. 1060 (D. Md. 1972).

Michigan's obligation to preserve and protect its resources is prescribed by Article 4, § 52 of Michigan's Constitution as stated in the following:

> *"The conservation and development of the natural resources of the State are hereby declared to be of paramount public concern in the interest of the health, safety and general welfare of the people. The Legislature shall provide for the protection of the air, water and other natural resources of the State from pollution, impairment and destruction."*

The Michigan Legislature has implemented this constitutional mandate by establishing the Michigan Department of Natural Resources to, in pertinent part:

> *"[P]rotect and conserve the natural resources of the State of Michigan; provide and develop facilities for outdoor recreation; … prevent and guard against the pollution of lakes and steams within the State, and enforce all laws provided for that purpose with all authority granted by law; and foster and encourage the protection and propagation of game and fish." M.C.L. § 324 (emphasis added).*

While the Legislature retains broad authority to set fishing regulations, the MDNR and its Director have authority under Act 451 of 1994 (M.C.L. § 324) to create, rescind, or modify fishing regulations through the use of MDNR Fisheries Orders. When implementing MDNR Fisheries Orders, the Department may not be more liberal than limits set by statutes. Recommendations for changes to MDNR Fisheries Orders are generally initiated by biologists in our Management Units. Recommendations then undergo an internal review within MDNR Fisheries Division, an external review by stakeholders and the public either in focused consultation or through the forum provided by the Michigan Natural Resources Commission (NRC). Regulations are then moved formally to the NRC for their consideration, which results in a recommendation to the Director on what action should be taken. A multitude of opportunities are therefore available for public comment through direct communication to the MDNR or via the monthly NRC meetings. Thus, there is a clear and long established institutional process, strongly founded in Michigan law, to develop and support MDNR regulations and management strategies to protect and rehabilitate populations of brook trout in their historical range in Michigan.

Great Lakes Coordination of Brook Trout Management

Processes of the Great Lakes Fishery Commission

The desire for coordinated management of fisheries on the Great Lakes was recognized decades ago. The GLFC facilitates basin-wide, collaborative management of fisheries in the Great Lakes. The approach to managing fish in the Great Lakes, and the habitats that support those fish, is an inclusive and collaborative effort among 8 States, 2 Federal governments, 1 Canadian Province, and 13 Federally recognized Native American Tribes based on the Joint Strategic Plan. Implementation of the Joint Strategic Plan is facilitated by the GLFC with active participation by all signatories to the Joint Strategic Plan, and includes a conflict resolution process to arbitrate disagreements between jurisdictions. Management of the fishery on the Great Lakes is highly regarded throughout the world as a model for inter-jurisdictional collaboration and effectiveness (Dochoda and Jones 2002).

Under the aegis of the GLFC, each individual lake has a Lake Committee that is comprised of senior management biologists from each State, Provincial, and Tribal agency that has jurisdiction on a respective Great Lake. The Lake Committees generally facilitate management decisions that affect all jurisdictions, and provide consistency and accountability for management activities. Each Lake Committee also has a Technical Committee, and often several task groups, that are comprised of biologists who conduct the research and inventories of fish and habitat. The Technical Committees serve as resources to provide the data and information necessary to make proper management decisions at the Lake Committee level.

Demonstration of this coordination can be found in the workshops and management plans produced by the various Lake Committees. These work products can be found at www.glfc.org and numerous successful management outcomes are cited in Dochoda and Jones (2002). Thus, there is a clear and long established international, institutional process, strongly founded in treaty law, for the joint development of regulations to protect brook trout throughout the Great Lakes. This coordination is illustrated in the adoption of nearly identical regulations for adfluvial brook trout in Lake Superior (Table 17).

Conclusion: Inadequacy of Existing Regulatory Mechanisms

Given the above discussion on the broad range of interagency and collaborative efforts, we believe that there are clearly existing and effective regulatory mechanisms and institutions in place to protect, rehabilitate, and enhance populations of brook trout in their historical range in Michigan. These mechanisms and institutions include: a) clear constitutional and statutory mandates for protection of natural resources in Michigan, b) clear legal underpinnings for the MDNR's authorities to protect and manage the State's aquatic resources, including populations of adfluvial brook trout; c) effective and collaborative interagency processes prescribed in the Joint Strategic Plan; and d) a broad range of collaborative efforts undertaken by MDNR to protect and rehabilitate populations of brook trout in their historical range in Michigan.

Factor E: Other Natural and Man-made Factors

The petitioners raise two issues, competition from other species of fish and low population size, as potential risks to adfluvial brook trout in their historical range in Michigan. We will address both of these factors, even though it is stated in the petition that it is likely ''competition played a large role in reducing coaster brook trout and there is no direct evidence to suggest that this has happened along large areas of the Lake Superior shoreline''.

<u>Competition</u>

Huckins *et al*. (*in press*) summarized the four potential mechanisms proposed by Peterson and Fausch (2003) whereby non-native species of fish could displace adfluvial brook trout, including disrupting spawning, and therefore potentially reduce survival at one or more life stages through a) competition or predation, b) forcing native species to emigrate to less favorable habitat, or c) introducing diseases or parasites. We have discussed most of these mechanisms previously and in this Section we will focus on competition for space and food between brook trout and non-native species.

There are two types of habitats where competitive interactions between brook trout and other native and non-native salmonids are likely to occur in the historical range of brook trout in Michigan. The first is in tributaries to Lake Superior where habitat that is necessary for spawning and rearing can be limited because of natural falls that block the upstream migration of fish. In these areas, habitat used by adfluvial brook trout for spawning and rearing is often restricted to a relatively short reach, thus increasing the potential for competitive interactions between non-native salmonids and adfluvial brook trout (Huckins *et al*. *in press*). The second type of habitat important to adfluvial brook trout is the nearshore, coastal areas of Lake Superior. Huckins *et al*. (*in press*) indicate that during the lake-phase of their life history, adfluvial brook trout occupy the narrow band of primarily shallow, near-shore habitat. In Lake Superior, these coastal waters are again limited by local geology, and competitive interactions between non-native species of fish and adfluvial brook trout could be more likely. Unfortunately no data are available, however, concerning the effects of competitive interactions between larger salmonids and adfluvial brook trout in the Great Lakes proper (Schreiner *et al*. *in press*).

Several species of fish have become naturalized in the Great Lakes, including coho salmon, Chinook salmon, steelhead, Atlantic salmon *Salmo salar*, pink salmon *Oncorhynchus gorbuscha*, and brown trout. These species all utilize tributaries to the Great Lakes during a portion of their life cycle and represent potential competitors with brook trout, both in tributaries and in coastal areas of the Great Lakes. Rose (1986) indicated that Pacific salmon may have reduced abundance of brook trout in some tributaries to the Great Lakes, but overall changes in distribution of brook trout were not observed. Adfluvial brook trout in the Nipigon River, however, coexist with these other species of salmonids and have apparently increased in abundance in recent years, likely due to protective harvest regulations (R. Swainson, *Personal Communication*, as cited in Huckins *et al*. *in press*) along with improved operation of hydropower dams (Huckins *et al*. *in press*).

In the particular case of steelhead, which were introduced into Michigan's waters in 1880s, the coexistence of brook trout and steelhead in tributaries might be the result of the long time period the two species have been together in the Great Lakes. In addition, Rose (1986) observed that brook trout hatched earlier than steelhead in a tributary to Lake Superior in Ontario. On the other hand, steelhead grew faster than brook trout and, based on this increased growth rate, may have dominated brook trout by late summer, thus allowing both species to coexist but causing the abundance of brook trout to be lower than was observed historically (Huckins *et al*. *in press*).

There are a number of studies that have been done on the displacement of brook trout in streams by non-native brown and rainbow trout (Nyman 1970; Fausch and White 1981; Waters 1983; Larson and Moore 1985; Clark and Rose 1997). Most of these results, however, were confounded by the effects related to degraded habitats that favor the non-native salmonids, thus making possible competitive interactions difficult to interpret.

Some information is available concerning potential interactions between stream-resident brook trout and coho salmon and steelhead, as well as a good deal of speculation about the competitive interactions between adfluvial brook trout and salmonids. Peck (1994) and Newman *et al*. (2003) both speculated that introduced salmonids have affected populations of adfluvial brook trout, particularly in Lake Superior, but provide no evidence to support their statements. Fausch and White (1986) and Newman *et al*. (2003) all indicated there are potential negative interactions between non-native salmonids and brook trout. Fausch and White (1986) stated that coho salmon are likely to have competitive interactions with brook trout because they share similar life histories, although coho salmon spawn earlier and hatch earlier, thus giving them a size advantage in some situations. Based on their laboratory experiments, they showed that coho salmon could dominate brook trout or brown trout of equal size. They concluded that faced with limited resources, coho salmon may have an advantage over brook trout. Conversely, an analysis of a 20-year dataset on salmonids collected from tributaries to Lake Superior in Wisconsin showed no changes in populations of stream-resident brook trout as a result of the introduction of coho salmon (B. Swanson, *Personal Communication*, WDNR).

The literature is equally contradictory on the competitive interactions between rainbow trout and brook trout. Clark and Rose (1997) used individual-based models in an attempt to understand why rainbow trout displaced brook trout in Appalachian streams. They found that brook trout had more frequent year-class failures and, when combined with lower fecundities, rainbow trout had a competitive advantage. They eliminated other factors as likely explanations for the dominance of rainbow trout in that area, including warmer water temperatures due to latitude, limited habitat for spawning habitat, and competitive advantages for rainbow trout in selecting feeding sites. Nuhfer (2007) reported that cohorts of yearling brook trout were depressed in comparison to allopatric cohorts when steelhead were present in the stream, but growth rates were not significantly different in a study in Hunt Creek, Michigan. Contradictory results were reported by Cunjak and Green (1984) who found that brook trout can dominate and grow faster than rainbow trout in habitats with low water velocities, while neither species was dominant in habitats with higher water velocities. Similar to Cunjak and Green (1984), Magoulick and Wilzbach (1998) also documented better growth and feeding performance by brook trout when compared to rainbow trout over a specific range of temperatures in a laboratory stream. Carlson (2003) found significantly positive relationships between the abundance of rainbow trout and brook trout in an analysis of densities of these two species in 23 tributaries to Lake Superior.

Limited information is also available that details the competitive interactions between brook trout and brown trout. Fausch and White (1981) observed that adult brown trout could force adult brook trout into sub-optimal habitats, but later work by Fausch (1986) showed that brook trout were more dominant when coexisting with similar-sized brown trout. Carlson (2003) documented a weak negative relationship between the abundance of brown trout and brook trout in an analysis of densities of these two species in 23 tributaries to Lake Superior.

Newman et al (2003) summarized the known information concerning competitive interactions between adfluvial brook trout and introduced salmonids, stating “many unanswered questions remain about the extent to which adfluvial brook trout can co-exist with different salmonine species at various densities and in smaller systems where habitat availability may be a strongly limiting factor”. Given the current contradictory information about competition between brook trout and other salmonids in streams, we conclude that competition is generally not a limiting factor, but could affect some localized populations of brook trout in situations where resources are severely limited.

A number of invasive and exotic species have also become naturalized (*e.g.*, ruffe *Gymnocephalus cernuus*, alewife, rainbow smelt, *etc*.) and have altered the ecosystem of the Great Lakes. Whether potential competitive interactions between these species and adfluvial brook trout occur is unknown, but likely improbable. It should also be noted that while these invasive and exotic species have historically influenced the native fish community in the Great Lakes, the historic fish community assemblage appears to be re-emerging at least in Lake Superior (Bronte *et al*. 2003; Horns *et al*. 2003).

<u>Low Population Size</u>

Concerns regarding the possible threat posed by low population size on the continued survival of populations of adfluvial brook trout are discussed in both the petition and the Federal Register. The petition indicates that adfluvial brook trout were abundant based on Roosevelt’s (1884) travel-log account, but this publication provides little in the way of substantial evidence on actual abundance of adfluvial brook trout. About the best that can be concluded from Roosevelt (1884) is that adfluvial brook trout inhabited Lake Superior in a number of locations, based on his description of huge catches by other anglers. His own documented catches, however, could not be classified as significant in most of the locations he fished. It is highly likely that adfluvial brook trout were broadly distributed, but in low abundance in most areas because of the very low productivity of streams in the historical range of brook trout in Michigan and particularly in Lake Superior (Bronte *et al*. 2003). Carlson (2003) provides support for the low productivity of streams in the Keweenaw Peninsula and measured an average conductivity of 177.8 μs in 23 tributaries to Lake Superior. We will also provide data on productivity in streams within the historical range of brook trout in Michigan upon request and as available.

Streams tributary to Lake Superior in areas of pre-Cambrian outcrops generally have very limited area available for spawning (Bronte *et al*. 2003). This factor limits overall production of adfluvial brook trout even in optimal conditions. Carlson (2003, see Figure 8) substantiated this concept, and we estimate that densities of wild brook trout averaged approximately 150 fish per acre in the 23 tributaries to Lake Superior based on Carlson's data. This density is about one-third (mean = 507.9 per acre) of the average density of wild brook trout in 42 northern Lower Peninsula streams in their historical range in Michigan (MDNR *unpublished data*). Similarly, Huckins and Baker (*in press*) reported densities of brook trout of approximately 105 fish per acre in the Salmon-Trout River. We will provide additional data on densities of brook trout within their historical range in Michigan upon request and as available. Generally, we do not expect that large populations of adfluvial brook trout occur in most Michigan's tributaries to the great Lakes, and it is likely that populations with low numbers of adfluvial brook trout are more the norm rather than the exception.

Concerns were raised by the petitioners that the total number of brook trout spawning in some systems may be less than 500 adult fish in any given year, which is a benchmark frequently used by experts in population genetics as the minimum number of spawning fish required to prevent issues of self-sustainability from a genetics perspective. We believe, however, that in the Salmon-Trout River the total population size of adult brook trout is greater than 500 fish (Huckins and Baker 2004; MDNR *unpublished data*). It is important again to note that adfluvial brook trout are not generally identifiable, and certainly not genetically unique or isolated from stream-resident brook trout. While the number of adfluvial brook trout may be below 500 in the Salmon-Trout River, these fish often occupy the same riverine habitat as stream-resident fish and substantial spawning occurs between adfluvial and stream-resident brook trout in the Salmon-Trout (Huckins and Baker 2006; Theriault *et al*. 2007; D'Amelio and Wilson *in press*). Thus, both adfluvial and stream-resident brook trout must be counted together when calculating effective population size. Effective population sizes may also be much larger than 500 fish for populations of brook trout that are completely protected from fishing in Isle Royale National Park and this is certainly the case in the Nipigon River (Curry *et al*. 1994; D'Amelio *et al*. *in review*). Overall, brook trout are abundant in their historical range in Michigan and numerous streams have combined populations of adfluvial and stream-resident brook trout that exceed 500 individuals (MDNR *unpublished data*).

Much of the information in the petition and the Federal Register is based on population data for brook trout from the Salmon-Trout River and Isle Royale National Park. It is important to note that evidence exists to suggest that these populations have increased in recent years. Researchers have been using a counting weir to annually estimate the run size of adfluvial brook trout in the Salmon-Trout River since 2000 (Huckins and Baker *in press*). During the 2006 field season, more large (> 300 mm) brook trout were counted at the weir on the Salmon-Trout River than in any previous year (243 fish compared to the previous record of 161 fish). In addition, a project-wide record number of large (presumably adfluvial) brook trout were observed on the spawning grounds of the Salmon-Trout River in 2006 (Huckins and Baker 2007).

In conclusion, it is our opinion that many populations of brook trout are relatively small, particularly in those streams with low productivity such as the streams cited in the petition. Additionally, we expect that low population sizes are the norm for a specific life history strategy within a population of fish. It is also our opinion that populations of potentially adfluvial brook trout are actually higher than the number reflected by simple observation of the size of an annual spawning run since all adult fish, including stream-resident adults, must be accounted for when estimating the size of a population. Thus, we conclude that low population size is not a threat to the long-term success of populations of adfluvial brook trout in their historical range in Michigan.

Conclusion – Other Natural and Man-Made Factors

Given the above discussion and measures taken by the jurisdictions on Lake Superior to protect brook trout and improve the condition of habitat for brook trout, it is our opinion that other natural and man-made factors, raised in the both the petition and Federal Register, are relatively low risk factors for brook trout in their historical range in Michigan. We have provided substantial evidence that neither competition nor perceived low population sizes are threatening or suppressing populations of adfluvial brook trout in their historical range in Michigan. It is our opinion that many populations of brook trout are relatively small, particularly in those streams with low productivity such as the streams cited in the petition. Additionally, we expect that low population sizes are the norm for a specific life history strategy within a population of fish. It is also our opinion that populations of potentially adfluvial brook trout are actually higher than the number reflected by simple observation of the size of an annual spawning run since all adult fish, including stream-resident adults, must be accounted for when estimating the size of a population. Thus, we conclude that low population size is not a threat to the long-term success of populations of adfluvial brook trout in their historical range in Michigan.

IV. Michigan's Collaborative Management Programs for the Conservation of Brook Trout

The MDNR was established in 1873 and is, therefore, one of the oldest agencies in Michigan's State government. The mission and goals of the MDNR Fisheries Division are to protect, rehabilitate, and enhance the State's aquatic resources and the habitats upon which they depend. The mission and goals are applied to the management of all aquatic resources, including populations of adfluvial "coaster" brook trout in their historical range in Michigan. Over time, we have developed a broad range of institutional and regulatory structures to successfully accomplish our mission and goals. We document, implement, and disseminate our management activities through a framework of regulatory, programmatic, and management strategies that are linked by common goals and objectives. The framework consists of three elements:

1. Collaborative identification of the protection, rehabilitation, and enhancement goals, objectives, and research priorities for species of fish and fish habitat in the Great Lakes and inland waters;
2. Identification of specific measures to fulfill the mission and goals; and
3. Dissemination of results through peer and public review.

We believe this framework has proven successful in providing a suitable management program for the conservation of brook trout and their habitat, including adfluvial brook trout in their historical range in Michigan. Effective collaboration and communication among diverse natural resource agencies and organizations are touchstones of our success. We are able to devote appropriate effort to the holistic management of populations of brook trout and their habitat today and for future generations.

Within this Section, we discuss the three elements of our management program relative to the conservation of brook trout, and examine the indispensable roles of collaboration and communication in conserving the ecosystems upon which persistence of the species depends.

Element 1: Collaborative Identification of the Protection, Rehabilitation and Enhancement Goals, Objectives, and Research Priorities for Species of Fish and Habitat in the Great Lakes and Inland Waters

There are numerous natural resource agencies, organizations, and educational institutions contributing to the protection, rehabilitation, enhancement, and assessment of brook trout populations in the Great Lakes and inland waters of Michigan. As a result of these collaborative efforts, goals and objectives are coordinated on both watershed and basin scales, and are founded in sound research initiatives that provide information to support sound management strategies to protect, rehabilitate, and enhance of populations of adfluvial brook trout and their habitat.

Collaborative Efforts

Open communication and active participation in discussions amongst the various natural resource agencies, organizations, and educational institutions provide a wide range of expertise for determining appropriate management strategies for those populations and their habitat. Despite differences in management, regulatory, and enforcement responsibilities among the groups, a common set of goals, objectives, and research priorities have been integrated into the collaborative management of brook trout populations by adopting a watershed-based, ecosystem approach.

The guiding document for such management of fish populations and habitat in the Great Lakes is the Joint Strategic Plan (GLFC 2007). The Joint Strategic Plan was developed by the agencies with management jurisdiction for fisheries on the Great Lakes and others under the aegis of the GLFC. The mission and goals of the Joint Strategic Plan have guided development of specific lakewide objectives for Lake Michigan (Eshenroder *et al*. 1995), Lake Huron (DesJardine *et al*. 1995), and Lake Superior (Busiahn 1990), that incorporate the concerns and interests of each agency with responsibility for managing populations of brook trout in these three Great Lakes; including MDNR. The mission and goals of our Division's Strategic Plan also provide guidance for determining appropriate planning, regulatory, and management mechanisms for populations of brook trout and their habitats using a watershed-based, ecosystem approach. Both documents promote collaboration within the fisheries research and management communities of the Great Lakes basin to ensure that study results have clear strategic, as well as practical, relevance for fishery management programs across the basin.

We maintain a research program aimed at providing a strong scientific basis for our varied aquatic ecosystems and programs to manage fisheries and habitat in Michigan. Central to our research program is a desire to work closely with and learn from other researchers and managers in the Great Lakes basin. Often, we collaborate with researchers and managers from other parts of the Great Lakes to develop hypotheses or to design investigations. For example, our salmonid research program has been in existence since the 1930s, and has always included active research into the ecology of brook trout and the effects of management actions on populations of brook trout. In fact, we have consistently exchanged ideas and knowledge with others to form consensus about the best methods for protecting, rehabilitating, enhancing, and managing populations of brook trout and habitat.

In many ways, Michigan has led the way in research on brook trout. One of the largest, long-term data sets on brook trout in the United States is from our Hunt Creek Research Station located in central Michigan, where populations of brook trout in Hunt Creek have been monitored and studied every year since 1949. Through a combination of long-term data sets, individual case studies, and statewide analyses, much has been learned about the population dynamics and ecology of brook trout as well as the effects of management actions, including stocking, harvest regulations, and habitat manipulations. Experimental designs for these studies have incorporated treatment-and-control methodologies, high replication, large sample sizes, and collection of data for long periods of time so that natural variation in populations of brook trout can be distinguished from variation due to experimental factors.

Cooperative studies with universities and other research partners have fostered detailed investigations that could not be accomplished by us alone, and have resulted in new knowledge that advances the scientific understanding and appropriate management of populations of brook trout across the entire Great Lakes basin. Results from our studies are regularly shared with the scientific community, our fisheries management partners, and the public through research and technical reports, in peer-reviewed fisheries journals, and at technical and fisheries management meetings with our agency partners around the Great Lakes basin. That same information forms the scientific basis for our regulatory and management strategies to protect and rehabilitate populations of brook trout and their habitats in Michigan's waters.

Research Priorities

Early fisheries management in Michigan often depended on stocking of hatchery reared fish. Some of the earliest research on brook trout focused on the effects of stocking programs. That research clearly demonstrated that habitat protection and enhancement were preferable over stocking programs for improving populations of brook trout. When brook trout that had been stocked failed to meet the expectations of fisheries managers in the 1940s and 1950s, researchers began marking fish and examining the effectiveness of different stocking regimes. It quickly became apparent that stocking hatchery trout into streams with populations of healthy reproducing fish was counterproductive to management goals and should be curtailed (*e.g.*, Shetter and Hazzard 1941), however the implications of stocking brook trout into inland lakes wasn't as clear cut (Institute for Fisheries Research 1953). Research into the growth and survival of different strains of brook trout stocked into inland lakes continues to this day, and informs management decisions for stocking of fish in Michigan's waters and beyond.

Since the 1980s and 1990s research has focused more on the role genetics plays in stocking programs and other fisheries management programs. Findings from this body of work have had important implications for fisheries management. Results from one study showed that high harvest rates by anglers may reduce the genetic fitness of some stocks of brook trout (Nuhfer and Alexander 1994). As a result, fisheries managers still carefully weigh the appropriateness of harvest regulations where brook trout populations are highly vulnerable to angling, such as adfluvial brook trout are in the Lake Superior basin. During the same period researchers speculated that as survival of hatchery reared trout increases the potential for stocked fish to breed with wild populations also increases, eventually leading to reduced genetic fitness of those wild populations. The possibility that such things could happen has led to judicious use of brook trout stocking as a management tool. Today, brook trout are only stocked into systems when specific factors like poor reproductive success are clearly known to be limiting trout production (Dexter and O'Neal 2004).

The considered use of scientific modeling is fundamental for supporting many of the decisions we make regarding both regulatory changes and strategies for managing fisheries and habitat in Michigan, as well as the ones we share with our partners around the Great Lakes. To examine the outcome of various angling regulations on populations of brook trout, research staff across the basin designed and conducted many studies on the effects of regulations during the period from about 1950 to the turn of the century. The effects of different regulations, including size limits, creel limits, no-kill regulations, and restrictions on legal tackle types were studied extensively over the years in a suite of Michigan's rivers (Clark *et al*. 1981). Models developed during those studies continue to be updated and used to form expectations for populations of brook trout subjected to various fishing regulations.

Early research revealed that habitat protection and enhancement has far greater potential for improving populations of brook trout than stocking. Studies conducted from the 1970s to the 1990s focused on measuring the effects of environmental degradation on populations of brook trout and the development of techniques to mitigate those effects. A long-term study conducted during the 1970s and 1980s conclusively demonstrated that relatively small increases of sand into streams severely degrades trout habitat quality and can reduce populations of brook trout by as much as 75% (Alexander and Hansen 1986). The study, and other cooperative research conducted with the United States Forest Service (USFS) provided evidence that sediment traps could be an effective tool for rehabilitating or improving habitat for brook trout in streams degraded by excessive erosion (Hansen *et al*. 1983; Alexander and Hansen 1983). The study also raised awareness of the need to better control erosion into streams from common sources such as road crossings and pipelines.

Today, other agencies, private groups, and partners maintain sediment traps on streams throughout Michigan and the Great Lakes region to restore and enhance habitat for brook trout. Ongoing studies on the effects of sediment in streams seek to determine the effectiveness of sediment traps in rivers that vary in their size and hydrology and improve our management decisions about when and where to take such habitat rehabilitation measures.

The effects of water withdrawals from trout streams during hot, low-flow periods in summer were studied during the 1990s. This research experimentally reduced summer stream flow in a section of Hunt Creek, and compared abundance of brook trout, growth, and food resources (*i.e.*, insect populations) with sections having natural flow regimes (Nuhfer and Baker 2004, Wills *et al*. 2006a). The study also developed models for extrapolating results observed at Hunt Creek to other waters. These results continue to inform fisheries management decisions that affect water quality and quantity in rivers and streams across Michigan and throughout the Great Lakes basin.

Many aspects of research guide our management decisions today. First, our fisheries research emphasizes competitive interactions between migratory rainbow trout and stream resident brook and brown trout, as well as the development of more sophisticated analyses to guide broader-scale or higher-level ecosystem management decisions for all salmonids throughout Michigan. Analyses to quantify relationships between distributions of fish and geology or other landscape features are ongoing. Second, as human populations continue to expand into previously undeveloped areas of Michigan, we are working towards developing better models to predict the effects of land-use changes on habitat and on the abundance, distribution, and movement of brook trout. The statewide monitoring of populations of brook trout throughout Michigan, which is necessary to generate much of the data required for the current work, is satisfied by our Stream Status and Trends Program (Wills *et al*. 2006b). Third, this program uses a network of long-term, fixed monitoring sites throughout the state to monitor trends in populations of brook trout through time. Long-term data have played an important role in directing new research and evaluating our management of brook trout throughout Michigan. Finally, data from our Stream Status and Trends Program along with future studies of the affects of management actions will continue to play this role, helping to ensure that populations of brook trout will persist in Michigan and around the Great Lakes.

Our research and management of brook trout populations and their habitats in Michigan has been characterized by one salient point: to successfully protect, rehabilitate, and enhance populations of brook trout in their historical range in Michigan we must engage with others in the fisheries research and management communities around the Great Lakes Basin who want to do the same thing. Fortunately, processes that cultivate effective collaboration and communication, and that build relationships among the numerous agencies, organizations, and institutions interested in conserving brook trout populations in the inland waters of Michigan and across the Great Lakes are well established. Those processes are embodied in the Joint Strategic Plan (GLFC 1997) and our Strategic Plan. We believe those processes are fully functional and more than able to protect, rehabilitate, and enhance populations of brook trout in their historical range in Michigan.

Element 2: Identification of Specific Objectives and Management Actions to Fulfill the Mission and Goals

The Brook Trout Rehabilitation Plan for Lake Superior (Newman *et al*. 2003) outlines specific objectives that have been implemented, documented, and evaluated by a consortium of natural resource agencies in the Lake Superior, Lake Huron, and Lake Michigan basins. The specific objectives in the plan provide an appropriate framework to assess the historic, current, and future progress of protection, rehabilitation, and enhancement efforts for brook trout within Lake Superior. The objectives and associated initiatives that we have in progress or have finalized and were outlined in the Brook Trout Rehabilitation Plan for Lake Superior include:

1. We protect and rehabilitate riverine and lake habitats that support populations of adfluvial brook trout. Migratory brook trout have been documented in the Lake Huron watershed (Enterline 2000), the Lake Superior watershed (Newman *et al*. 2003), and the Lake Michigan watershed (Vincent 1962). The protection, rehabilitation, and enhancement of populations of brook trout and habitat occur through regulatory, programmatic, and management actions among a consortium of natural resource agencies and organizations.
2. We survey and quantify stream reach-scale, watershed-scale, and lake-scale habitat requirements of fish populations. The habitat requirements of brook trout are well documented in their historical range in Michigan and the mechanisms to obtain these data are discussed earlier in Element 1.
3. We have described pre-disturbance conditions in order to gain additional insight into the habitat requirements of adfluvial brook trout. By combining this information with the characteristics of the contemporary conditions where adfluvial brook trout are found, we are able to better describe the suite of conditions that are conducive to the continued survival of adfluvial brook trout. The spatial distribution of brook trout and clarifying materials are presented in Section I.

4. We have identified potential sites where suitable habitat for adfluvial brook trout could exist today, and protect and rehabilitate these habitats. Suitable habitat for adfluvial brook trout in their historical range in Michigan is well documented. Seventeen sites have been identified for rehabilitation in the Lake Superior basin alone (Wiland *et al*. 2006).
5. We protect critical habitats, such as spawning areas, riparian zones, headwater reaches, estuaries, nearshore areas, and other critical habitats, as identified in the habitat survey initiative. Suitable habitat for brook trout is well documented, and is protected by the policies and regulatory mechanisms described in Section III for Factor A.
6. We have identified immediate and long-term threats, such as land-use patterns or the presence of contaminants, to existing habitat and development of strategies to limit damage over the long term. Through our planning and operations processes, potential threats are addressed in our River Assessment plans, eco-regional plans, regional and State forest management plans, and our Division's Strategic Plan.
7. We rehabilitate watershed-scale habitat by developing and implementing strategies for managing watersheds that maintain and improve riverine habitat. Watershed-scale habitat will continue to be the focus of our River Assessment Program and strategies for maintaining and improving watershed function will be provided.
8. We take every opportunity to have discussions and provide educational materials to the public, and specifically to landowners, about best management practices for watersheds.

The regulatory actions that we administer and implement to protect, rehabilitate, and enhance populations of brook trout and habitat are founded in our policies (Table 2), which provide Division-wide guidance for determining the benefits or detriments of potential development projects proposed within land and water habitats that are regulated by the MDEQ. The MDEQ's Water Programs establish water quality standards, assess water quality, provide regulatory oversight for all public water supplies, issue permits to regulate the discharge of industrial and municipal waste water, monitor the State's water resources for water quality, quantity, and quality of aquatic habitats, the health of aquatic communities, and compliance with the State's laws. We provide expert consultation to the MDEQ and make recommendations on development proposals to ensure that the integrity of the habitat or associated populations of fish are not harmed. Additional policies provide guidance for protection of key elements of habitat for brook trout (Table 2).

Our programmatic actions define specific management objectives that support the mission and goals of our Division's Strategic Plan, as well as the Fish Community Objectives for each Great Lake. Management objectives that specifically relate to brook trout and their associated habitat are documented in our Special Reports, such as the River Assessments. We have completed River Assessments and associated Management Plans for three watersheds within the historical range of brook trout in Michigan with an additional three under development (See Section III). River Assessments are intended to provide a comprehensive reference for citizens and agency personnel, focusing on maintenance and rehabilitation of the watershed from a watershed-based, ecosystem perspective. The Assessments and Plans identify opportunities and problems related to the aquatic resources within specific watersheds; provide a mechanism for public comment into decisions regarding direction of management for fisheries and habitat; and serve as a reference document for those seeking information about specific watersheds. We develop River Assessment Management Plans for the purpose of guiding the Division's management actions within the watershed over the short term. Management actions are reviewed and Plans are updated every five years.

An example of proactive management of brook trout that was achieved through the River Assessment process is currently occurring within the Jordan River watershed, which is within the historical range of brook trout in Michigan. A management action item in the Jordan River Assessment (Hay and Meriwether 2004) was to "rehabilitate fish migration through the electric sea lamprey barrier." The Jordan River supports natural populations of brook trout, and removal of this barrier will decrease fragmentation of the population of brook trout within the watershed. We have been collaborating with the Conservation Resource Alliance and USFWS to remove the barrier since 2007. Removal and subsequent rehabilitation of the habitat will be finalized by December 2008.

In addition to participating and consulting in specific projects that involve populations of brook trout and habitat, we provide guidance to the general public and other resource agencies and organizations to enhance and protect populations of brook trout through stocking (Dexter and O'Neal 2004) and habitat protection, enhancement, and rehabilitation (Alexander *et al*. 1995; O'Neal and Soulliere 2006).

Additional programmatic actions that protect, rehabilitate, and enhance populations of brook trout and habitat include: a) we actively participate and consult on dam removal and fish passage projects in the historical range of brook trout in Michigan, b) we disperse funds through our Inland Fisheries Grant Program to support projects that protect, rehabilitate, or enhance populations of fish or habitat, and c) we collaborate with MDNR Wildlife, Parks and Recreation, and FMFM divisions through the Forest Compartment Review Program to assure that management on State-owned lands does not negatively affect populations of brook trout or habitat by adhering to BMPs (MDNR and MDEQ *in review*).

The management actions we conduct are directly linked to the mission and goals of our Division's Strategic Plan and the Fish Community Objectives for each Great Lake through specific management objectives within the programmatic actions described above. Examples of management actions that protect, rehabilitate, and enhance populations of brook trout and habitat include: a) we oversee the maintenance of 35 sediment basins in the historical range of brook trout in Michigan to effectively remove excess sediment from rivers, which enhances habitat suitability for brook trout, and b) we consult with Local, Federal, and State units of government and non-profit environmental groups to enhance and rehabilitate habitat for brook trout through the replacement and rehabilitation of road/stream crossings.

The above discussion of specific objectives identified and management actions taken by MDNR to protect, rehabilitate, and enhance populations of brook trout and their habitat in the historical range of brook trout in Michigan clearly illustrates the collaborative underpinnings of our efforts. Each of our efforts, which are founded in the objectives identified within the Brook Trout Rehabilitation Plan for Lake Superior (Newman et al. 2003), are the product of participating with our partners around the Great Lakes and pooling our resources towards achieving our common goal of conserving adfluvial brook trout populations across the basin.

Element 3: Dissemination of Results through Peer and Public Review

We use a peer review process to publish research and management reports. We produce reports internally that are readily accessible to the public, including Status of the Fishery Reports (Table 2), Research Reports, Technical Reports, River Assessments, and Special Reports. Much of our research is also published in scientific journals.

We work with our many partners to diligently provide messages about work related to adfluvial brook trout through press releases, magazine articles, and interviews. We conduct outreach and education efforts with private landowners and maintain interpretative displays regarding life history and management of brook trout in our State-owned fish hatcheries. For example, visitors come to our Marquette State Fish Hatchery, the only of Michigan's State-owned hatcheries at which brook trout are reared, to see the big fish. While we have such visitors at the hatchery, we provide them with a series of watershed messages, including information on brook trout and their historical range in Michigan and how the public can be better stewards of habitat for brook trout.

We also regularly conduct internal basin team meetings in each of the upper Great Lakes basins that include staff from our Inland and Great Lakes Research Section, our Fish Production Section, and our Field Operations Section. Our field biologists meet twice each year to discuss ongoing issues related to the management of fisheries resources around the State, including brook trout. We have a Trout Committee within Fisheries Division dedicated solely to developing sound, scientific management for populations of trout in Michigan's waters. These teams and committees form the basis for inter- and intra-basin project collaboration, research planning, and communication. Often these meetings serve as a sounding board to review results of prior management actions or research studies, which in turn generate new ideas for efforts to conserve brook trout. Once developed, these efforts go through rigorous public review, thereby ensuring the soundness of such ideas within the larger framework of conserving brook trout in Michigan.

Generally speaking, we invest significant time, effort, and funds in sharing what we learn with partners, organizations, and institutions interested in conservation of brook trout. Sharing that of knowledge is at the heart of our learning about what is still needed to protect, rehabilitate, and enhance populations of brook trout in their historical range in Michigan. Collaboration is the prevailing condition from which strategic planning, holistic management, prudent use of resources, and sensible actions for conserving populations of adfluvial brook trout and their habitats arise. Communication is essential for sharing information and knowledge about what is needed and what can be done to keep adfluvial brook trout common in their historical range in Michigan. Taken together, collaboration and communication provide a standard through which conservation of adfluvial brook trout will continue in the future.

Conclusion: Michigan's Collaborative Management Programs for the Conservation of Brook Trout

A determination to list the adfluvial brook trout under the Endangered Species Act is not required to guarantee management programs that will conserve this life history form in the future. Nor will listing provide any measurable improvement beyond the management programs already in place for conserving populations of adfluvial brook trout and their habitats. Significant collaboration and communication already exist among the fisheries research and management communities of the Great Lakes basin. Their combined commitment to ensuring that adfluvial brook trout remain a common component of the fish community of the Great Lakes is undeniable. Moreover, a body of evidence based on historical and ongoing conservation research and management strongly supports the conclusion that populations adfluvial of brook trout will continue to persist in their historical range in Michigan. As previously noted in this document, abundant, naturally-reproducing populations of brook trout exist in Michigan from the northern Lower Peninsula throughout the Upper Peninsula in tributaries to and coastal waters of the Great Lakes, as well as in a variety of inland streams and lakes. We assert that populations of adfluvial brook trout in their historical range in Michigan and across North America will continue to persist and retain their plasticity for migration, despite stresses and declines in specific locations. Our mission and goals are guiding us to successfully accomplish that task.

V. Conclusions and Summary Regarding the Potential Listing of Coaster Brook Trout Under the Endangered Species Act

In this document, we have provided a broad range of evidence for consideration in the status review of adfluvial "coaster" brook trout as required by the Endangered Species Act. Based on our review of the best science available, it is our position that the petition falls short of the justification necessary for the USFWS to render a determination that listing of adfluvial "coaster" brook trout is warranted at this time. Furthermore, listing would not provide significant additional protection given the statutory programs, regulations, and planning strategies that are currently in place for the conservation, rehabilitation, and enhancement of aquatic resources in Michigan.

Distinct Population Segment: One of the key determinants for listing is whether adfluvial "coaster" brook trout constitute a "Distinct Population Segment". Using the best analytical tools available for classifying individuals based on genetics, physiology, and behavior, it is currently impossible to determine which individuals in a population of brook trout are likely to exhibit adfluvial behavior from those who will remain resident in streams. In addition, the evidence we have provided makes obvious that adfluvial behavior in fishes is a life history strategy that is commonly expressed in the char family. This evidence supports the concept that such behavior is not a determining factor in ensuring the long-term preservation of brook trout in their historical range in Michigan. Finally, the conservation status of the life history strategy used by adfluvial "coaster" brook trout is continuously improving due to the focused attention on brook trout and their habitat necessary to protect and enhance the species in their historical range in Michigan. We have provided substantial evidence that adfluvial "coaster" brook trout are not a discrete population segment of the taxon. Our analyses of the data and information that are currently available indicate that adfluvial "coaster" brook trout do not meet the criteria set out in 61 FR 4722, February 7, 1996.

We have also provided substantial evidence for each of the five listing factors as set forth in 50 CFR Part 424. We summarize our conclusions for each of these factors as follows.

Factor A) Present or threatened destruction, modification, or curtailment of species habitat or range: We have provided information to demonstrate that broad-based, landscape-scale efforts are underway to protect, rehabilitate, and enhance habitat for brook trout in their historical range in Michigan. As stated in this document, special focus is being given to address excessive sedimentation inputs and water quality issues that were raised in the petition. Therefore, the evidence provided, in conjunction with ongoing habitat work, indicate that the risk to populations of brook trout in their historical range in Michigan as posed by Listing Factor A is significantly reduced and will remain so in the future.

Factor B) Overutilization for commercial, recreational, scientific, or educational purposes: We have provided substantial evidence to refute that overharvest of brook trout is currently occurring in their historical range in Michigan. In addition, proactive management strategies have been implemented to protect adfluvial "coaster" brook trout, including conservative and restrictive regulations for both recreational anglers and commercial fishing operations. Therefore, the evidence provided, in conjunction with our proactive regulatory strategies, indicate that the risk to populations of brook trout in their historical range in Michigan as posed by Listing Factor B is minimal.

Factor C) Disease and predation: We have provided detailed analyses and discussion of potential threats posed by pathogens of brook trout that suggest all of the key diseases have low, or very low, prevalence rates in the historical range of brook trout in Michigan. Additionally, we have implemented a wide range of management strategies to ensure that fish pathogens are not spread by our management activities or by the public. The evidence we have provided also demonstrates that mortality of brook trout from predation is not beyond the realm of normal mortality for populations of fish. Therefore, the evidence provided, in conjunction with proactive strategies to manage diseases in our hatcheries and in the wild, minimize these risks to populations of brook trout as posed by Listing Factor C.

Factor D) Inadequacy of existing regulatory mechanisms: We have substantially documented that a broad range of legal and institutional processes are in place to properly regulate and manage activities with respect to brook trout in Michigan. In addition, we have demonstrated governance structures that maintain collaborative and coordinated approaches with other jurisdictions to manage and protect brook trout in the Great Lakes basin. These processes are open and transparent to the public with ample opportunities for public input and discussion, prior to final rulings or changes in management activities that may affect brook trout in their historical range in Michigan. Therefore, the evidence provided, in conjunction with proactive strategies to engage the public and others with a vested interest in management of brook trout, indicate that the risk to populations of brook trout in their historical range in Michigan as posed by Listing Factor D is significantly reduced.

Factor E) Other natural and man-made factors: We have analyzed the potential for competition and low population size and provided evidence that neither factor currently suppresses populations of brook trout in their historical range in Michigan. Overall, competition between brook trout and other species of fish does not appear to be a significant factor in limiting populations of brook trout. In addition, low population size is not unusual in brook trout populations in general, and certainly is not unusual for an expressed life history strategy as exhibited by adfluvial “coaster” brook trout. Therefore, the evidence provided indicates that the risk to populations of brook trout in their historical range in Michigan as posed by Listing Factor E is not significant.

Summary: Given the evidence presented herein, the ongoing management and regulatory strategies implemented both in Michigan and by other jurisdictions across the Great Lakes basin, and the governance structures in place today, it does not appear that any of the factors required for listing adfluvial “coaster” brook trout under the Endangered Species Act are significant enough to warrant listing. Furthermore, the life history strategy exhibited by adfluvial “coaster” brook trout is not in jeopardy in their historical range in Michigan. Finally, we assert that the MDNR has a public trust responsibility to actively manage and protect brook trout in their historical range in Michigan on behalf of current and future citizens of the State. In our judgment, all of the necessary protections and mechanisms are in place, and are effectively and efficiently functioning, to ensure success of our public trust duty. Therefore, it is our opinion that listing adfluvial “coaster” brook trout under the Endangered Species Act is not warranted at this time.

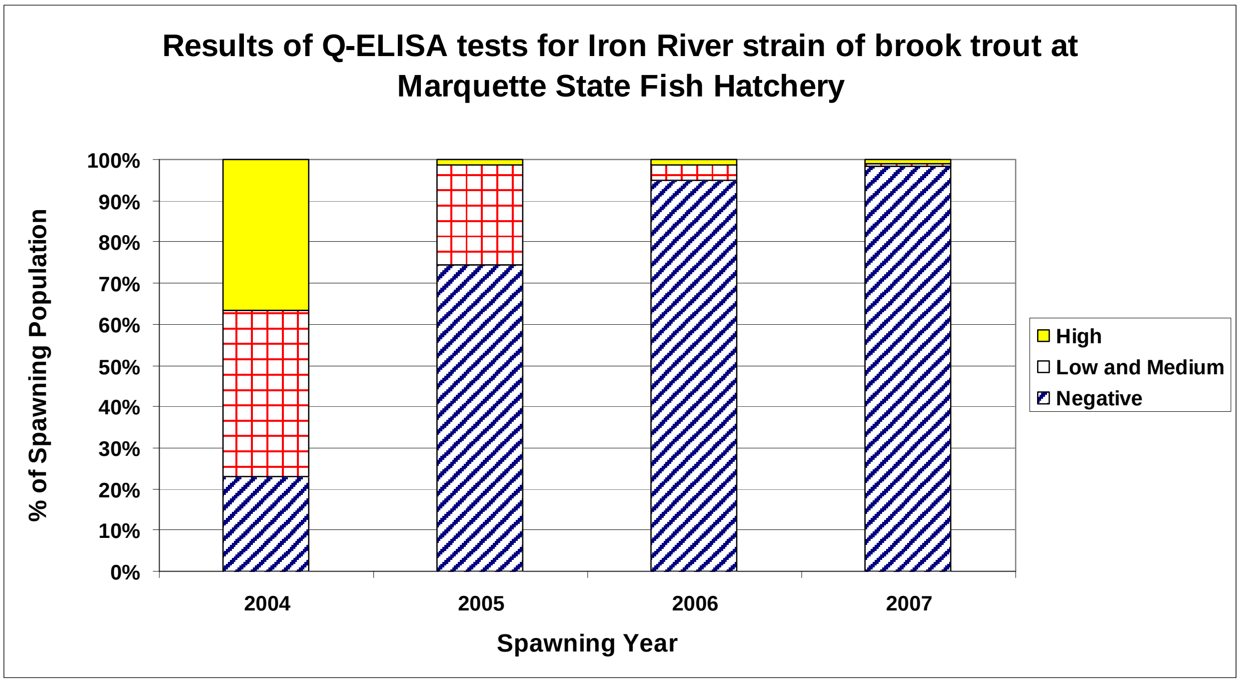

Figure 1.—Results of testing for Bacterial Kidney Disease in the Iron River strain of brook trout reared at the Marquette State Fish Hatchery from 2004-2007 (MDNR Fisheries Division *unpublished data*).

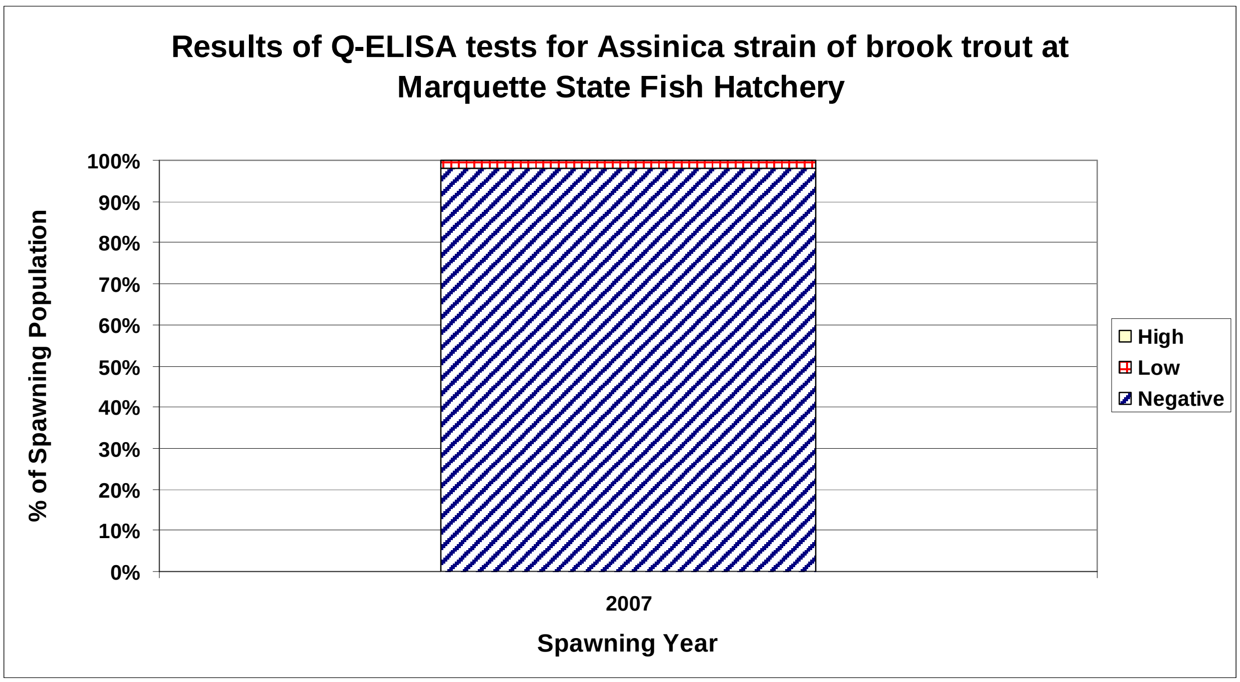

Figure 2.—Results of testing for Bacterial Kidney Disease in the Assinica strain of brook trout reared at the Marquette State Fish Hatchery in 2007 (MDNR Fisheries Division *unpublished data*).

Table 1.—Subset of decisions regarding "Distinct Population Segements" since publication of the 1996 Federal DPS policy.

Proposed DPS	**Scientific name**	**Discreteness** [1]	**Significance** [1]	**Decision**
Missouri River fluvial Arctic grayling	*Thymallus arcticus*	Discrete. Markedly separated from adfluvial and other populations due to physical and behavioral features: reproductively isolated, genetic data consistent with hypothesis of two genetic groups in upper Missouri River, heritable differences in swimming behavior between fluvial and adfluvial populations; not discrete due to physiological or ecological features.	Not significant. Not found in unique ecological setting (fluvial and adfluvial forms occur in the upper Missouri River drainage; fluvial form found in both Arkansas and Montana). Loss would not result in significant range gap (upper Missouri River is a very small portion of entire taxon range). Not the only surviving natural occurrence. Do not differ markedly in genetic characteristics from adfluvial populations in the same drainage (differences detectable but not deemed "significant").	Does not qualify as a DPS.
Puget Sound steelhead	*Oncorhynchus mykiss*	Discrete. Substantially reproductively isolated from other west coast *O. mykiss* "…based on phylogenetic groupings, available population genetic data, differences in migration and spawn timing, patterns in the duration of freshwater and marine residence, and geographic separation." Despite some exchange between resident and anadromous forms, the two forms are markedly separated by physical (adult size and fecundity), physiological (smoltification), ecological (preferred prey and principal predators), and behavioral (migration strategies) features.	Significant. "An important component in the evolutionary legacy of the *O. mykiss* species based on its unique life-history, genetic, and ecological characteristics, as well as the unique glacial and fjord-like characteristics of the eco-region it occupies." Loss of Puget Sound steelhead would represent: "…the loss of unusual or unique habitats occupied by the species; a significant gap in the taxon's range; significant loss of the ecological, life-history and genetic diversity of the taxon."	Designated as a DPS.
Bull trout (entire species – five DPSs; see two DPS examples below)	*Salvelinus confluentus*	Each of five DPSs including the entire species distribution considered discrete. All are disjunct and geographically isolated with no genetic exchange due to natural and artificial barriers.	Each of five DPSs including the entire species distribution considered significant.	Entire species listed as five separate DPSs.

Table 1.—Continued.

Proposed DPS	**Scientific name**	**Discreteness** [1]	**Significance** [1]	**Decision**
Coastal Puget Sound bull trout (bull trout DPS example 1)	*Salvelinus confluentus*	Discrete. Geographically separated from other subpopulations by the Pacific Ocean and the Cascades.	Significant. Occurs in unique ecological setting (thought to contain the only anadromous forms of bull trout in coterminous U.S.). Loss of population would represent significant gap in taxon range.	Designated as a DPS.
St. Mary-Belly River bull trout (bull trout DPS example 2)	*Salvelinus confluentus*	Discrete. Geographically separated from other subpopulations by the Continental Divide.	Significant. Only bull trout found east of Continental Divide in coterminous U.S. Its loss would represent a significant reduction in the taxon range.	Designated as a DPS.
Southwestern Washington/ Columbia River coastal cutthroat trout	*Oncorhynchus clarki clarki*	All life-history forms grouped together as a single DPS. Individual life-history forms not considered discrete ("Coastal cutthroat trout appear to exhibit very flexible life history strategies. The extent to which individuals expressing these various strategies are isolated from other life history forms is largely unknown, though there is growing evidence that individuals may express multiple life history behaviors in their life time. For convenience we refer to individuals that migrate to marine waters as anadromous or anadromous life form. In doing so, we do not intend to imply that they represent a separate population from freshwater forms. We are treating all forms as part of a single population in this analysis.")	All life-history forms grouped together as a single DPS. Individual life-history forms do not meet criteria for significance ("The significance of the various life history strategies, the extent to which each strategy is controlled by genetic versus environmental factors, and the extent of isolation among individuals expressing these various strategies is largely unknown, though there is growing evidence that individuals may express multiple life history behaviors over time. The few existing studies show that…the portions of the population displaying different life history strategies are generally more closely related within a drainage than are populations from different drainages. These results indicate that migratory and non-migratory portions of the population of cutthroat trout represent a single evolutionary lineage in which the various life history characteristics have arisen repeatedly in different geographic regions.")	DPS not listed due to ongoing conservation efforts.

Table 1.—Continued.

Proposed DPS	**Scientific name**	**Discreteness** [1]	**Significance** [1]	**Decision**
Lower Kootenai River burbot	*Lota lota*	Discrete. Historically isolated from upper Kootenai River burbot by natural barriers. Genetic differences between upper and lower populations. Behaviorally different from other burbot populations due to adfluvial life-history strategy. Discrete as a consequence of physical, ecological and behavioral factors. Not discrete due to physiological features.	Not significant. Not found in unique ecological setting ("…burbot likely occupy a wide variety of habitats throughout their range, and that there are no indications of any unique or unusual ecological features within the lower Kootenai R. basin."). Loss would not result in significant range gap (would result in loss of <1% of the taxon range). Not the only surviving natural occurrence. Do not differ markedly in genetic characteristics from the rest of the taxon (differences detectable but not deemed "significant").	Does not qualify as a DPS.
Western Great Lakes gray wolf	*Canis lupus*	Discrete. Markedly separated from other wolves in coterminous U.S. by hundreds of miles of unsuitable habitat. Delimited by an international boundary, with significant management differences between U.S. and Canada.	Significant. Unique ecological setting (only wolves in the U.S. to occupy the Mixed Laurentian Forest Province). Loss would represent significant gap in taxon range (only U.S. population east of Rocky Mountains; includes ~80% of wolves in coterminous U.S.).	Designated as a DPS.
Douglas County Columbian white-tailed deer	*Odocoileus virginianus*	Discrete. Separated from the one other population by more than 200 miles of unsuitable habitat. Detectable genetic differences.	Significant. Loss would represent significant gap in taxon range. Genetic differences also cited.	Designated as a DPS.
Central California DPS of the California tiger salamander	*Ambystoma californiense*	Discrete. Geographically separated from other conspecifics by a mountain range, a river, and straits comprising a gap of roughly 45 miles. Genetic differences also cited. Delimited by an international boundary, with significant management differences between U.S. and Mexico.	Significant. Loss would represent significant gap in taxon range. Genetic differences also cited.	Designated as a DPS.

Table 1.—Continued.

Proposed DPS	**Scientific name**	**Discreteness** [1]	**Significance** [1]	**Decision**
Northern population of copperbelly water snake	*Nerodia erythrogaster neglecta*	Discrete. Separated from the southern population by 180+ miles of unsuitable habitat.	Significant. Loss would represent significant gap in taxon range.	Designated as a DPS.
Peninsular Ranges desert bighorn sheep	*Ovis canadensis nelsoni*	Discrete. Geographic separation. Genetic differences. Delimited by an international boundary, with significant management differences between U.S. and Mexico.	Significant. Loss would represent significant gap in taxon range. Genetic differences also cited. Unique ecological setting.	Designated as a DPS.
Mississippi gopher frog	*Rana sevosa*	Discrete. Geographically separated from the rest of the species by 125 miles of unoccupied habitat and a river delta.	Significant. Genetic differences cited.	Designated as a DPS.
Columbia basin pygmy rabbit	*Brachylagus idahoensis*	Discrete. Geographically separated from conspecifics by unspecified barriers/distance. Genetic differences.	Significant. Genetic differences and unique ecological setting.	Designated as a DPS.

[1]Quotes taken directly from the Federal Register notice.

Table 2.—Policies and Procedures of the MDNR and the MDNR Fisheries Division (FD) pertaining to the protection and management of habitat for brook trout, disease management, and fisheries surveys and reporting. The actual polices and procedures are found in Appendix A.

Policy number	Title
	Habitat Protection and Management
MDNR 26.04-04	Use of State-Owned Lands Administered by the Michigan Department of Natural Resources
MDNR 26.27-02	Shorelands-Enforcement of Act 245, Public Acts of 1970, as amended
MDNR 26.27-03	Natural Rivers
MDNR 26.27-04	Wilderness and Natural Areas
MDNR 28.46-02	Soil Erosion and Sedimentation Control Procedures
MDNR 29.20-05	Management of State Owned Island Properties
MDNR 38.45-03	Inland Lakes and Streams Act-Procedure for Administering Act 346, Public Acts of 1972
MDNR 39.21-20	Beaver Management
FD 02.01.001	Wetland Alteration
FD 02.01.002	Dams and Barriers
FD 02.01.004	Marinas and Docks
FD 02.01.005	Mineral Lease Management
FD 02.01.006	Shoreline Modification
FD 02.01.007	Stream Crossings (Bridges, Culverts, and Pipelines)
FD 02.01.008	Stream Enclosure
FD 02.01.009	Stream Relocation
FD 02.02.001	Artificial Reefs in Great Lakes Waters
FD 02.02.002	Artificial Structures for Inland Lakes
FD 02.02.004	Coastal Wetland Protection
FD 02.02.005	Fish Passage
FD 02.02.006	Hydropower (FERC) Licensing Review
FD 02.02.009	Log Salvage
FD 02.02.010	Navigational Maintenance Dredging
FD 02.02.011	Riparian Vegetation Protection
FD 02.02.012	Sediment Traps and In-Stream Detention Basins
FD 02.02.013	Water Withdrawal from Lakes or Streams
FD 02.02.014	Aquatic Nuisance Control
FD 02.02.015	Soil Erosion and Sedimentation Control

Table 2.—Continued.

Policy number	**Title**
Disease Management	
FD 02.020	Interim Policy for Preventing the Spread of Viral Hemorrhagic Septicemia (VHSv) by Fisheries Division's Survey Equipment
Scientific Collectors Permit, Surveying, and Reporting	
FD 01.01.005	Scientific Collectors Permit Program
FD 01.08.002	Status of the Fishery Resources (SFR) Reports and Management Plans
FD 02.02.017	Conducting and Recording Management Unit Fisheries Surveys
FD 02.02.018	Conducting Status and Trends Surveys
FD 02.02.019	Development of Fish Stocking Recommendations
FD 03.01.002	Marking of Fish for Evaluation

Table 3.—Listing of permits authorized under the National Pollutant Discharge Elimination System for the Cheboygan River watershed (MDEQ *unpublished data*).

				Facility GPS location				
Facility name	**City**	**Township**	**County**	**Latitude**	**Longitude**	**Permit No.**	**Expiration date**	**Receiving water**
Anchor In Marina	Cheboygan	Benton	Cheboygan	45.60221	-84.46145	MIS210058	4/1/2012	Cheboygan River
Blarney Castle Oil Co.	Cheboygan	Benton	Cheboygan	45.634722	-84.482777	MIG081014	4/1/2010	Cheboygan River
BP Amoco	Cheboygan	Benton	Cheboygan	45.651388	-84.469722	MIS220015	4/1/2012	Cheboygan River
BP Products NA, Inc.	Cheboygan	Benton	Cheboygan	45.653	-84.4711	MIG670203	4/1/2008	Cheboygan River
Burt Lake Marina	Indian River	Tuscarora	Cheboygan	45.404166	-84.6125	MIS210059	4/1/2007	Sturgeon River
Cheboygan Cement	Cheboygan	Benton	Cheboygan	45.629166	-84.4625	MIS210061	4/1/2012	Cheboygan River
Cheboygan WWTP	Cheboygan	Benton	Cheboygan	45.6571	-84.47125	MI0020303	10/1/2006	Unnamed Stream
Circle M Ranch	Wolverine	Wilmot	Cheboygan	45.420833	-84.608333	MIS210460	4/1/2012	Sturgeon River
Great Lakes Tissue Co.	Cheboygan	Benton	Cheboygan	45.637222	-84.481388	MI0002496	10/1/2006	Unnamed Stream
Howe Marine	Indian River	Tuscarora	Cheboygan	45.414444	-84.608333	MIS210066	4/1/2012	Indian River
Inverness Dairy, Inc.	Cheboygan	Inverness	Cheboygan	45.6325	-84.519722	MIG250186	4/1/2008	Unnamed Stream
Karriger Eng and Mfg, Inc.	Alanson	Littlefield	Emmet	45.440833	-84.784444	MIR14R00 1	1/31/1999	Unnamed Stream
Link Industries	Indian River	Tuscarora	Cheboygan	45.416111	-84.621111	MIS210070	4/1/2012	Unnamed Stream

Table 3.—Continued.

				Facility GPS location				
Facility name	**City**	**Township**	**County**	**Latitude**	**Longitude**	**Permit No.**	**Expiration date**	**Receiving water**
MACTEC Eng and Con, Inc.	Vanderbilt	Corwith	Otsego	45.156944	-84.648333	MI0047392	10/1/2011	Unnamed Stream
MDNR-Oden State Fish Hatchery	Alanson	Littlefield	Emmet	45.432777	-84.839166	MI0035726	10/1/2006	Unnamed Stream
Rieth-Riley	Afton	Koehler	Cheboygan	45.38282	-84.47788	MIG490286	4/1/2010	Little Pigeon River
Ryde Marine Inc.	Alanson	Littlefield	Emmet	45.419722	-84.803888	MIS210689	4/1/2007	Crooked Lake
Treetops Resort	Gaylord	Dover	Otsego	45.034722	-84.584722	MIG250203	4/1/2008	Pigeon River
Treetops Resort	Gaylord	Dover	Otsego	45.034722	-84.584722	MIG960024	4/1/2010	Pigeon River
UM Biological Station	Pellston	McKinley	Emmet	45.563611	-84.753611	MI0050598	10/1/2011	Maple River
Up North Industries	Petoskey	Little Traverse	Emmet	45.405277	-84.872777	MIS210067	4/1/2007	Round Lake
Walstrom Marine	Cheboygan	Benton	Cheboygan	45.646666	-84.472777	MIS210471	4/1/2007	Cheboygan River
WSM Ent, Indian River Marina	Indian River	Tuscarora	Cheboygan	45.416666	-84.608333	MIS210078	4/1/2007	Indian River
Baumgarten Forest Products	Tower	Forest	Cheboygan	45.357777	-84.316666	MIS210459	4/1/2012	Welch Creek
Elk Run Landfill	Onaway	Allis	Presque Isle	45.283333	-84.208333	MIS210181	4/1/2007	Little Rainy River

Table 3.—Continued.

				Facility GPS location				
Faciity name	**City**	**Township**	**County**	**Latitude**	**Longitude**	**Permit No.**	**Expiration date**	**Receiving water**
Moran Iron Works	Onaway	Forest	Cheboygan	45.374444	-84.252222	MIS210069	4/1/2012	Bowen Creek
Onaway WWTP	Onaway	Allis	Presque Isle	45.36296	-84.24598	MI0055522	10/1/2006	Bowen Creek
Wolverine Power Supply	Tower	Forest	Cheboygan	45.3875	-84.294722	MIG250448	4/1/2008	Black River

Table 4.—Locations and summary of information for dams in the historical range of brook trout in Michigan (from USFWS' Fish Passage Database).

			Number of dams		
County	**Great Lakes watershed**	**Brook trout range [1]**	**Total**	**Greater than six feet in height**	**Stream miles**
Gogebic	Superior	Core	20	15	810
Ontonagon	Superior	Core	19	16	1,792
Keweenaw	Superior	Core	9	6	555
Houghton	Superior	Core	32	25	1,665
Baraga	Superior	Core	13	12	980
Marquette	Superior	Core	58	42	2,035
Alger	Superior	Core	23	9	800
Luce	Superior	Core	23	11	792
Chippewa	Superior and Huron	Core	56	24	1,322
Iron	Michigan	Core	30	17	803
Dickinson	Michigan	Core	37	28	1041
Menominee	Michigan	Core	16	10	818
Delta	Michigan	Core	24	14	738
Schoolcraft	Michigan	Core	53	39	726
Mackinac	Michigan and Huron	Core	28	15	1,000
Emmet	Michigan and Huron	Core	14	10	435
Charleviox	Michigan	Core	14	7	634
Antrim	Michigan	Core and Secondary	13	4	461
Grand Traverse	Michigan	Secondary	31	19	156
Cheboygan	Huron	Secondary	25	20	833
Presque Isle	Huron	Secondary	12	7	490
Totals			**550**	**350**	**18,886**

Table 4.—Continued.

	Purpose							
County	**Hydroelectric**	**Irrigation**	**Recreation**	**Water supply**	**Flood control**	**Agriculture**	**Other**	**Unknown**
Gogebic	3	1	9				3	4
Ontonagon	2		7				8	2
Keweenaw			4				1	4
Houghton	1	3	9			5	9	5
Baraga	2	2	4	1			2	2
Marquette	8		18	5		1	24	2
Alger	1		12			1	2	7
Luce		2	10			1	6	4
Chippewa			20			2	11	23
Iron	7		10			1	6	6
Dickinson	6	1	21		1	1	7	
Menominee	3		7			1	1	4
Delta	4		8			3	9	
Schoolcraft	1	1	8	2			32	9
Mackinac	1		12				10	5
Emmet	2		6				6	
Charleviox	3	3	6		1			1
Antrim	3		5			1	1	3
Grand Traverse	4	2	24				1	
Cheboygan	5		10	1	4	1	3	1
Presque Isle			9				3	
Totals	**56**	**15**	**219**	**9**	**6**	**18**	**145**	**82**

[1]The historical range of brook trout in Michigan is signified by "Core" for purposes of this table. "Secondary" is defined as those areas that might possibly be included in the historical range of brook trout in Michigan based on some of the available anecdotal information.

Table 5.—Estimated number of river miles blocked by barrier dams on tributaries to the Great Lakes in the historical range of brook trout in Michigan (MDNR *unpublished data*).

Waterbody	County	Great Lakes watershed	Brook trout range [1]	Estimated stream miles blocked
Cheboygan River	Cheboygan	Huron	Secondary	741.0
Mill Creek	Cheboygan	Huron	Secondary	7.1
Little Black River	Cheboygan	Huron	Secondary	16.2
Caribou Creek	Chippewa	Huron	Core	0.0
Joe Straw Creek	Chippewa	Huron	Core	2.1
Little Munuscong River	Chippewa	Huron	Core	2.7
Munuscong River	Chippewa	Huron	Core	3.1
Trout River	Presque Isle	Huron	Secondary	11.0
No Name	Presque Isle	Huron	Secondary	1.1
Grand Lake Outlet	Presque Isle	Huron	Secondary	6.9
Elk River	Antrim	Michigan	Secondary	188.1
Lake Charlevoix Outlet	Charlevoix	Michigan	Core	91.4
Bichler Creek	Delta	Michigan	Core	366.1
Sturgeon River	Delta	Michigan	Core	1.4
Whitefish River	Delta	Michigan	Core	68.4
Rapid River	Delta	Michigan	Core	1.6
Days River	Delta	Michigan	Core	30.5
Carp Lake River	Emmet	Michigan	Core	6.9
Wycamp Creek	Emmet	Michigan	Core	0.3
Bear River	Emmet	Michigan	Core	41.8
Acme Creek	Grand Traverse	Michigan	Secondary	0.9
Yuba Creek	Grand Traverse	Michigan	Secondary	5.4
Boardman River	Grand Traverse	Michigan	Secondary	139.4
Bakers Creek	Grand Traverse	Michigan	Secondary	1.7
Lower Millecoquins River	Mackinac	Michigan	Core	72.6
Paquin Creek	Mackinac	Michigan	Core	4.8
Crow River	Mackinac	Michigan	Core	4.9
Brevoort River	Mackinac	Michigan	Core	22.0
Pine River	Mackinac	Michigan	Core	32.2
Ozark Creek	Mackinac	Michigan	Core	2.9
Flowers Creek	Mackinac	Michigan	Core	4.1

Table 5.—Continued.

Waterbody	County	Great Lakes watershed	Brook trout range [1]	Estimated stream miles blocked
Wilson Creek	Menominee	Michigan	Core	64.3
Walton River	Menominee	Michigan	Core	38.0
Menominee River	Menominee	Michigan	Core	62.1
Milakokia River	Schoolcraft	Michigan	Core	1.1
Orr Creek	Schoolcraft	Michigan	Core	1.1
Bulldog Creek	Schoolcraft	Michigan	Core	3.2
Thompson Creek	Schoolcraft	Michigan	Core	2.2
Parent Creek	Schoolcraft	Michigan	Core	2.4
Manistique River	Schoolcraft	Michigan	Core	882.4
Carpenter Creek	Alger	Superior	Core	0.4
Sullivan Creek	Alger	Superior	Core	1.5
Beaver Creek	Alger	Superior	Core	3.6
Laughing Whitefish River	Alger	Superior	Core	2.6
Miners River	Alger	Superior	Core	1.3
Sand River	Alger	Superior	Core	16.5
Rock River	Alger	Superior	Core	28.5
Sixmile Creek	Baraga	Superior	Core	3.1
Shelldrake River	Chippewa	Superior	Core	18.9
Pendills Creek	Chippewa	Superior	Core	3.6
Waiska River	Chippewa	Superior	Core	3.6
Nighthawk Creek	Gogebic	Superior	Core	2.9
Salmon Trout River	Houghton	Superior	Core	47.2
Mud Lake Creek	Houghton	Superior	Core	0.2
Unnamed Creek	Houghton	Superior	Core	0.1
Portage River	Houghton	Superior	Core	3.0
Sturgeon River	Houghton	Superior	Core	13.7
Eliza Creek	Keweenaw	Superior	Core	2.3
Garden City Creek	Keweenaw	Superior	Core	1.3
Eagle River	Keweenaw	Superior	Core	0.9
Two Hearted River	Luce	Superior	Core	11.3
Chocolay River	Marquette	Superior	Core	21.9
Little Huron River	Marquette	Superior	Core	36.8
Yellow Dog River	Marquette	Superior	Core	61.8
Big Garlic River	Marquette	Superior	Core	1.4
Misery River	Ontonagon	Superior	Core	83.4
East Sleeping River	Ontonagon	Superior	Core	5.5

Table 5.—Continued.

Waterbody	**County**	**Great Lakes watershed**	**Brook trout range** [1]	**Estimated stream miles blocked**
Bear Creek	Ontonagon	Superior	Core	0.5
Union River	Ontonagon	Superior	Core	1.2
West Branch Ontonagon River	Ontonagon	Superior	Core	33.2
South Branch Ontonagon River	Ontonagon	Superior	Core	33.3

[1]The historical range of brook trout in Michigan is signified by "Core" for purposes of this table. "Secondary" is defined as those areas that might possibly be included in the historical range of brook trout in Michigan based on some of the available anecdotal information.

Table 6.—Major environmental enhancements to hydropower licenses issued by the Federal Energy Regulatory Commission to projects in the historical range of brook trout in Michigan.

Project	**River**	**Key enhancement measures**
Bond Falls	Ontonagon	Reduced seasonal impoundment drawdown from 14 feet to 8.5 feet. Establish minimum flow from Bergland structure. Eliminate fluctuations at the Cisco Lake structure. Switch from peaking to run-of-river operation during the spring spawning season.
Lower Paint	Paint	Increased minimum flows to the Paint River based on season. LWD management plan. Buffer zone protection.
Michigamme Falls	Michigamme	Switch from peaking to re-regulation of flows from Peavy Falls Project seasonally. Enhanced fish habitat.
Hemlock Falls	Michigamme	Switch from peaking to run-of-River operation.
Prickett	Sturgeon	Switch from peaking to run-of-river operation. 54 day flow in the bypass reach during spring spawning season. 30 cfs flow in bypass reach the rest of the year.
Escanaba	Escanaba	Switch from peaking to run-of-river operation. Flow augmentation for water quality improvements during the summer.
City of Marquette	Dead	Reduced reservoir fluctuations. Removal of dam remnant. Minimum flow increase.
Saxxon Falls	Montreal	Minimized reservoir fluctuations. Switch from peaking to pseudo run-of-river operation.
Brown Bridge (Currently surrendered)	Boardman	Switch from peaking to run-of-river operation.
Elk Rapids	Elk	Switch from peaking to run-of-river operations. Minimized reservoir fluctuations.
Boyne USA	Boyne	Run-of-river operation.
Tower-Kleber	Black	Switch from peaking to run-of-river operation. Erosion control measures.
Cataract	Escanaba	Switch from peaking to run-of-river operation Organic/LWD transport
Hoist/McLure	Dead	New higher minimum flows. Reduced reservoir fluctuations.

Table 6.—Continued.

Project	River	Key enhancement measures
Au Train	Au Train	Change from peaking and leakage to 50 cfs minimum flow. Minimize drawdown. 10 cfs during period of equipment shutdown. Erosion survey.
Crystal Falls	Paint	Switch from peaking to run-of-river operation. Fish protection barrier. LWD transport. Minimize reservoir fluctuations.
Alverno	Black	Switch from peaking to pseudo run-of-river operation. Erosion control. Organic matter transport.
Peavy Falls	Michigamme	Modified peaking mode. Seasonal reservoir elevation requirements.
Brule	Brule	Switch to run-of-river from peaking operation. Reduce impoundment fluctuations. Minimum flow in the spillway channel.
Chalk Hill	Menominee	Switch to run-of-river from peaking operation. Reduce impoundment fluctuations. LWD management. Buffer zone protection.
Grand Rapids	Menominee	Maintain run-of-river. Reduce impoundment fluctuations. LWD management. Buffer zone protection.
Sturgeon Falls	Menominee	Maintain re-regulation operation mode.
Superior Falls	Montreal	Run-of-river operation Reduced reservoir fluctuations. Shoreline protection Minimum flows in falls bypass reach.
Way Dam and Michigamme Reservoir		Reduced seasonal impoundment drawdown. Increased minimum flows.
Big Quinnesec Falls	Menominee	Limited reservoir fluctuations. Seasonal run-of-river operation. Seasonal minimum flows.
Little Quinnesec	Menominee	Limited reservoir fluctuations. Buffer zone protection. Erosion control.

Table 6.—Continued.

Project	**River**	**Key enhancement measures**
Menominee and Park Mills	Menominee	Run-of-river operation Fish passage (upon proper plans and approvals by FERC). Erosion control.
Twin Falls	Menominee	Limited reservoir fluctuations. Seasonal run-of-river operation. Seasonal minimum flows.
White Rapids	Menominee	Maintain run-of-river operation. Reduce impoundment fluctuations. Buffer zone protection.
Lower Paint	Paint	Minimum flow requirements.
Kingsford	Menominee	Limited reservoir fluctuations. Seasonal run-of-river operation. Seasonal minimum flows.
Sabin (Currently surrendered)	Boardman	Run-of-river operation.
Boardman (Currently surrendered)	Boardman	Run-of-river operation.
Cheboygan	Cheboygan	Run-of-river operation.

Table 7.—Major land ownership and protected acreage in the historical range of brook trout in Michigan.

					Square miles of multiple-use lands under protection						Unprotected lands
Basin	**Brook Trout Range [1]**	**Total square miles**	**Square miles protected**	**Percent protected**	**Federal**	**State**	**County**	**Local**	**Non-Gov't Orgs**	**Lands with Conserv. Easements**	**Private lands (square miles)**
Superior	Core	7,706	3,361	44%	1,900	1,080	867	18	85	191	4,375
Michigan	Core	8,537	3,402	40%	1,118	2,114	6	13	12	139	5,141
Michigan	Secondary	933	169	18%	0	156	1	4	3	6	765
Huron	Core	1,749	613	35%	335	239	0	16	14	9	1,155
Huron	Secondary	3,368	895	27%	18	830	1	3	20	23	2,474
Totals		**22,293**	**8,440**	**38%**	**3,371**	**4,419**	**95**	**54**	**134**	**368**	**13,910**

[1] The historical range of brook trout in Michigan is signified by "Core" for purposes of this table. "Secondary" is defined as those areas that might possibly be included in the historical range of brook trout in Michigan based on some of the available anecdotal information.

Table 8.—Estimates of harvest of brook trout by recreational anglers from Michigan's waters of Lake Superior (Upper Peninsula ports), Lake Michigan (Upper Peninsula ports), and northern Lake Huron (Lower Peninsula ports from Mackinac City to Cheboygan) from 1997-2006. Data were collected as part of the Statewide Angler Survey Program of the MDNR Fisheries Division. Ports where brook trout were observed by creel survey clerks are identified in parentheses.

	Harvest		
Year	**Lake Superior**	**Lake Michigan**	**Lake Huron**
1997	59 (Ontonagon, Marquette)	51 (St. Joseph, Manistee)	0
1998	0	0	0
1999	0	32 (Grand Haven)	0
2000	0	64 (Frankfort, St. Joseph, Menominee)	0
2001	0	0	0
2002	0	30 (Frankfort)	19 (Les Cheneaux Islands)
2003	0	0	0
2004	51 (Traverse Bay)	3 (Grand Haven)	0
2005	7 (Keweenaw Bay, Munising)	0	0
2006	22 (Munising)	0	0

Table 9.—Adfluvial brook trout registered in the Master Angler Program of the MDNR Fisheries Division from 1988-2007. For the purpose of this table, only brook trout that were captured in the Great Lakes were considered to be adfluvial brook trout.

Date	Lake	County	Weight (lb)	Length (in)
7/17/88	Lake Michigan, Green Bay	Menominee	6.76	24.50
4/28/90	Lake Michigan, Little Bay de Noc	Delta	3.38	21.50
3/25/91	Lake Michigan, Little Bay de Noc	Delta	6.76	26.00
7/27/91	Lake Michigan, Green Bay	Menominee	2.96	17.13
10/09/91	Lake Superior	Marquette	2.22	17.75
1/27/92	Lake Michigan	Delta	2.38	16.00
3/06/92	Lake Michigan, Green Bay	Menominee	2.97	17.60
4/10/92	Lake Michigan	Grand Traverse	3.45	20.13
7/08/92	Lake Michigan	Emmet	4.50	21.50
12/08/92	Lake Michigan, Grand Traverse Bay	Grand Traverse	2.79	18.25
4/30/93	Lake Superior	Marquette	2.17	18.50
5/05/93	Lake Superior	Marquette	---	19.63
11/04/93	Lake Huron	Alpena	3.00	19.50
3/30/94	Lake Superior	Baraga	2.94	19.40
4/08/95	Lake Michigan	Delta	4.50	21.50
9/18/95	Lake Superior	Marquette	3.12	20.00
9/28/95	Lake Superior	Marquette	3.12	19.50
3/24/96	Lake Superior	Marquette	5.46	21.70
8/10/96	Lake Superior	Marquette	3.44	20.00
8/18/96	Lake Michigan	Manistee	4.60	20.00
10/08/96	Lake Huron	Mackinac	4.90	23.00
2/23/97	Lake Michigan, Grand Traverse Bay	Grand Traverse	3.69	23.00
6/26/97	Lake Superior	Marquette	2.96	19.50
10/16/97	Lake Michigan	Benzie	3.75	20.00
10/19/97	Lake Michigan	Manistee	2.72	18.25
2/01/98	Lake Michigan, Little Bay de Noc	Delta	3.75	21.25
2/04/98	Lake Michigan, Little Bay de Noc	Delta	8.85	29.00
3/30/98	Lake Michigan	Mason	2.19	19.50
5/03/98	Lake Superior	Marquette	2.23	18.94
4/10/99	Lake Michigan, Green Bay	Delta	4.44	22.00
10/28/99	Lake Michigan, Little Traverse Bay	Emmet	4.56	22.50
2/6/00	Lake Superior	Marquette	3.66	21.75
3/14/00	Lake Superior	Gogebic	6.83	26.38
12/31/00	Lake Michigan, Little Bay de Noc	Delta	3.75	21.00
6/06/01	Lake Superior	Houghton	---	19.50
6/22/01	Lake Superior	Keweenaw	---	18.5
6/22/01	Lake Superior	Keweenaw	---	18.0

Table 9.—Continued.

Date	Lake	County	Weight (lb)	Length (in)
10/19/01	Lake Michigan	Oceana	2.75	17.50
10/25/01	Lake Superior	Marquette	5.50	25.25
5/04/02	Lake Huron	Mackinac	6.63	24.80
6/14/02	Lake Superior	Keweenaw	---	19.5
6/17/02	Lake Superior	Keweenaw	---	18.88
9/09/04	Lake Superior	Marquette	5.25	22.50
6/30/05	Lake Superior	Ontonagon	3.12	20.00
10/28/05	Lake Huron	Mackinac	6.94	26.70
5/09/07	Lake Superior, Keweenaw Bay	Baraga	3.47	19.00
7/02/07	Lake Superior	Houghton	3.00	19.00
10/02/07	Lake Superior, Keweenaw Bay	Baraga	2.31	18.70

Table 10.—Summary of adfluvial brook trout registered in the Master Angler Program of the MDNR Fisheries Division by county for lakes Superior, Michigan, and Huron from 1988-2007. For the purpose of this table, only brook trout that were captured in the Great Lakes were considered to be adfluvial brook trout.

Lake	County	Number of Entries
Superior	Gogebic	1
	Ontonagon	1
	Houghton	2
	Keweenaw	4
	Baraga	3
	Marquette	12
Michigan	Oceana	1
	Mason	1
	Manistee	3
	Benzie	1
	Grand Traverse	3
	Emmet	2
	Delta	8
	Menominee	3
Huron	Alpena	1
	Mackinac	3

Table 11.—Selected inland entries for brook trout registered in the Master Angler Program of the MDNR Fisheries Division from 1990 to 2005.

Date	Lake	County	Weight (lb)	Length (in)
1/30/90	Otter Lake	Houghton	4.50	23.70
6/14/93	Lac La Belle	Keweenaw	2.77	17.25
8/12/94	Salmon Trout River	Marquette	4.06	19.75
2/22/97	Millecoquins Lake	Mackinac	3.21	20.00
5/23/97	Bond Falls Flowage	Ontonagon	2.78	19.50
2/23/98	Millecoquins Lake	Mackinac	4.38	24.38
4/25/98	Lake Gogebic	Gogebic	2.67	19.25
4/30/00	Black Lake	Presque Isle	2.02	17.75
7/31/04	Carp River (near mouth)	Ontonagon	---	24.50
5/18/05	South Manistique Lake	Mackinac	2.63	---

Notes:

-Lake Superior: Adult brook trout were stocked in Keweenaw Bay and tributary streams by Keweenaw Bay Indian Community in 2003, 2005, and 2006. In 2003, stocked brook trout were 8” to -10”. Stocked brook trout averaged 13.7” in 2005 and 15.4” in 2006. Most, but not all, of the adult brook trout stocked in Keweenaw Bay were marked with fin clips.

-Lake Michigan: Intensive brook trout stocking in the Cedar (Menominee County) and Bark (Delta County) rivers during the 1990s.

-Lake Huron: No apparent link between Master Angler entries and stocking of adult brook trout.

Table 12.—Scientific collector permit brook trout harvest summary for the period 2001-2007 (MDNR *unpublished data*).

		Brook trout collected		
Great Lakes watershed	**Sampling events**	**Harvested**	**Released**	**Percent harvested**
Erie	1	5	0	100.0
Michigan	188	5	3,493	0.1
Huron	32	3	531	0.6
Superior	260	398	9,063	4.2
Superior and Michigan [1]	35	0	200	0.0
Totals	**516**	**411**	**13,287**	**3.0**

[1]Specific collection locations were not reported for this Scientific Collector's permit that was issued to the USFWS in 2004. Therefore, the data reported by the USFWS cannot be assigned to a specific watershed.

Table 13.—Summary of regulations for recreational fishing for brook trout in Michigan from 1950-2008. (Format of table: Minimum size limit; Daily bag limit; Possession season)

Year	Great Lakes	Designated inland lakes	Designated streams	Comments
1950	7" minimum 5/day (but none >10 lb) Last Saturday in April – Sept 10	7" minimum 5/day (but none >10 lb) Last Saturday in April – Sept 10	7" minimum 5/day (but none >10 lb) Last Saturday in April – Sept 10	
1951	---	---	---	
1952	---	---	---	
1953	---	---	---	
1954	---	---	---	
1955	---	---	---	
1956	---	---	---	
1957	---	---	---	
1958	---	---	---	
1959	---	---	---	
1960	---	---	---	
1961	---	---	---	
1962	---	---	---	
1963	---	---	---	
1964	---	---	---	
1965	---	---	---	
1966	---	---	---	
1967	---	---	---	
1968	10" minimum 5/day (but none >10 lb) April 6 – Nov 30	7" minimum 5/day (but none >10 lb) Last Saturday in April – Sept 8	7" minimum 10/day (but none >10 lb) Last Saturday in April – Sept 8	

Table 13.—Continued.

Year	Great Lakes	Designated inland lakes	Designated streams	Comments
1969	10" minimum 5 singly or in combination per day, except an additional 5 brook trout may be taken Year round	7" minimum 5 singly or in combination per day, except an additional 5 brook trout may be taken Last Saturday in April – Sept 30	7" minimum 5 singly or in combination per day, except an additional 5 brook trout may be taken Last Saturday in April – Sept 30 (year-round in extended season streams)	Bag limits combined for all trout and salmon species. Season opened year round in the Great Lakes and selected Great Lakes tributaries
1970	---	---	---	
1971	---	---	---	
1972	---	---	---	
1973	---	---	---	
1974	---	---	---	
1975	---	---	---	
1976	---	---	---	
1977	---	---	---	
1978	---	---	---	
1979	---	10" minimum 5 singly or in combination per day, except an additional 5 brook trout may be taken Last Saturday in April – Sept 30	---	

Table 13.—Continued.

Year	Great Lakes	Designated inland lakes	Designated streams	Comments
1980	---	---	7" minimum in Upper Peninsula; 8" minimum in Lower Peninsula 5 singly or in combination per day, except an additional 5 brook trout may be taken Last Saturday in April – Sept 30 (year-round in extended season streams)	
1981	---	---	---	
1982	---	---	---	
1983	---	---	---	
1984	---	---	---	
1985	---	---	---	
1986	---	---	---	
1987	---	---	---	
1988	---	---	---	
1989	10" minimum 5 in combination per day, no more than 3 brook trout Last Year round	10" minimum 5 in combination per day, no more than 3 brook trout Last Saturday in April – Sept 30	7" minimum in Upper Peninsula; 8" minimum in Lower Peninsula; 16" during extended season 10 singly or in combination per day, but no more than 3 > 16" Last Saturday in April – Sept 30 (year-round in extended season streams)	Extended season: Oct 1 through the Friday before the last Saturday in April

Table 13.—Continued.

Year	Great Lakes	Designated inland lakes	Designated streams	Comments
1990	---	---	7” minimum in Upper Peninsula; 8” minimum in Lower Peninsula; 16” during extended season 10 singly or in combination per day, but no more than 3 > 16”; 3 fish during the extended season Last Saturday in April – Sept 30 (year-round in extended season streams)	
1991	---	---	---	
1992	---	---	---	
1993	---	---	---	
1994	---	---	---	
1995	---	---	---	
1996	---	---	---	For Lake Superior waters within 4.5 miles of Isle Royale: 15” minimum 1 fish per day
1997	---	---	---	Salmon Trout River (Lower Falls to mouth): Last Saturday in April – Sept 1
1998	---	---	---	
1999	---	---	---	For Lake Superior waters within 4.5 miles of Isle Royale: 18” minimum May 1 – Labor Day

Table 13.—Continued.

Year	**Great Lakes**	**Designated inland lakes**	**Designated streams**	**Comments**
2000	---	**See note 1**	7” minimum in Upper Peninsula; 8” minimum in Lower Peninsula 5 fish, but no more than 3 fish ≥15” **(See note 2)** Last Saturday in April – Sept 30	Salmon Trout River (Lower Falls to mouth): 10” minimum Last Saturday in April – Aug 14
2001	---	**See note 1**	---	
2002	---	**See note 1**	---	Salmon Trout River (Lower Falls to mouth): 18” minimum 1 fish Pictured Rocks National Lakeshore streams **(See note 3)** 18” minimum 1 fish Last Saturday in April – July 31
2003	---	**See note 1**	---	
2004	---	**See note 1**	---	
2005	---	**See note 1**	---	Lake Superior: 20” minimum 1 fish. For Lake Superior waters within 4.5 miles of Isle Royale: Brook trout fishing becomes catch-and-release only.
2006	---	**See note 1**	---	
2007	---	**See note 1**	---	

Table 13.—Continued.

Year	Great Lakes	Designated inland lakes	Designated streams	Comments
2008	---	**See note 1**	---	Research regulations removed for the Hurricane River in the Pictured Rocks National Lakeshore

[1]Beginning in 2000, designated trout lakes were grouped into 6 different types. Minimum size limits vary from 8" to 15"; Daily bag limits for lakes vary from 1 fish to 5 fish; some trout lakes are open to fishing year-round, while others are open from the last Saturday in April – Sept 30.

[2]Beginning in 2000, designated trout streams were grouped into 7 different types. The majority of Michigan's trout streams are classified as Type 1 waters, so only Type 1 regulations are recorded in this table.

[3]Research regulations have been instituted on portions of 3 streams within the Pictured Rocks National Lakeshore (Mosquito River, Seven Mile Creek, and Hurricane River). The research regulations on the Hurricane River were removed on April 1, 2008.

Table 14.—Regulations promulgated by the 1836 and 1842 Tribes for harvest of brook trout in treaty-ceded waters (Nicholas D. Popoff, *Personal Communication*, MDNR). Brook trout regulations in the 1842 treaty-ceded area are from the Great Lakes Indian Fish and Wildlife Commission.

1836 treaty-ceded waters – Tribal Brook Trout Regulations

	Inland Waters				
Tribe [1, 2, 3]	**Lake**	**Stream**	**Lake Michigan**	**Lake Huron**	**Lake Superior**
Little River Band	10“ minimum 5 fish/day but only 3 > 16”	8” minimum 5 fish/day but only 3 > 16”	100 lb daily by-catch bag limit	100 lb daily by-catch bag limit	100 lb daily by-catch bag limit
Grand Traverse Band	10“ minimum 5 fish/day but only 3 > 16”	8” minimum 5 fish/day but only 3 > 16”	10” minimum No closed season 5 fish/day	10” minimum No closed season 5 fish/day	10” minimum No closed season 5 fish/day
Little Traverse Bay Band	10“ minimum 5 fish/day but only 3 > 16”	8” minimum 5 fish/day but only 3 > 16”	10” minimum No closed season 5 fish/day	10” minimum No closed season 5 fish/day	10” minimum No closed season 5 fish/day
Sault Ste. Marie Tribe	10“ minimum 5 fish/day but only 3 > 16”	8” minimum 5 fish/day but only 3 > 16”	10” minimum No closed season 5 fish/day	10” minimum No closed season 5 fish/day	10” minimum No closed season 5 fish/day
Bay Mills Indian Community	10” minimum 5 fish/day	8” minimum 5 fish/day	10” minimum No closed season 5 fish/day	10” minimum No closed season 5 fish/day	10” minimum No closed season 5 fish/day

[1]State stream Types 5, 6, 7, and lake Type D - Respective Tribe adheres to State regulations.

[2]State stream Types 1, 2, and 4 – Tribal seasons: 12/1 – 10/14 in the Lower Peninsula and 11/16 – 9/30 in the Upper Peninsula.

[3]State Type 3 – No closure.

1842 treaty-ceded waters – Tribal Brook Trout Regulations

Trout and Salmon (except Lake Trout) in Lake Superior tributaries	Generally, 1st Saturday in May at 5:00 a.m. to September 30. Special early and extended seasons apply to some Lake Superior tributaries.	10 per person per day in aggregate, of which only 2 may be rainbow trout	Generally, 6" minimum size. Other size limits apply on the Brule River (Douglas County) and during early and extended seasons.
Trout and Salmon (except Lake Trout) all other waters except spring ponds	January 1 to September 30	5 per person per day in aggregate	None
Trout and Salmon (except Lake Trout) in spring ponds	1st Saturday in May at 5:00 a.m. to September 30	5 per person per day in aggregate	None

Table 15.—Results of surveys for whirling disease from 1995-2003 in the historical range of brook trout in Michigan (MDNR Fisheries Division *unpublished data*).

Waterbody	**County**	**Sites sampled**	**Species** [1]	**Pos/Neg**
Presque Isle River	Gogebic	3	BKT	Neg
Iron River	Ontonagon	1	BKT	Neg
Ontonagon River	Ontonagon/Gogebic	9	BKT, BNT, RBT	BKT Neg BNT Neg RBT Pos in one sample from the East Branch of the Ontonagon River
Otter River	Houghton	3	BKT, RBT	Neg
Cherry Creek	Marquette	1	BKT, RBT	Neg
Silver Lead Creek	Marquette	1	BKT	Neg
Chocolay River	Marquette	1	BKT, RBT	Neg
AuTrain River	Alger	1	BKT, RBT	BKT Pos RBT Neg
Anna River	Alger	1	BKT, RBT	Neg
Sucker River	Alger	1	BKT, RBT	Neg
Two Hearted River	Luce	1	BKT, BNT, RBT	Neg
East Branch Two Hearted River	Luce	1	BKT, RBT	Neg
Cooks Run	Iron	1	BKT	Neg
South Branch Paint River	Iron	1	BKT	Neg
South Branch Iron River	Iron	1	BKT	Neg
Iron River	Iron	2	BKT	Neg
Brule River	Iron	2	BKT, BNT	Neg
Ned Lake Creek	Iron	1	BKT	Neg
Fence River	Iron	2	BKT	Neg
Two Mile Creek	Dickinson	1	BKT	Neg
Ford River	Dickinson	1	BKT	Neg
West Branch Sturgeon River	Dickinson	1	BKT	Neg

Table 15.—Continued.

Waterbody	**County**	**Sites sampled**	**Species** [1]	**Pos/Neg**
Big Cedar River	Menominee	1	BKT	Neg
47 Mile Creek	Menominee	1	RBT, BKT	Neg
Sturgeon River	Delta	1	BKT, RBT	Neg
Thompson Creek	Schoolcraft	2	BNT, RBT, BKT	Neg
Black River	Mackinac	4	BKT, RBT, BNT	BKT Neg BNT Neg RBT Pos in one Sample
Hog Island Creek	Mackinac	1	BKT	Neg
Davenport Creek	Mackinac	2	RBT, BKT	Neg
Pacquin Creek	Mackinac	1	RBT, BKT	Neg
Pine River	Chippewa	2	BNT, RBT	Neg
Carp River	Mackinac	3	BKT, RBT, BNT	Neg
Albany Creek	Chippewa	1	RBT	Neg
West Branch Maple River	Emmet	3	BKT, RBT, BNT	Neg
Little Sturgeon River	Cheboygan	4	BKT, RBT, BNT	BKT Neg BNT Neg RBT Pos in one Sample
Sturgeon River	Cheboygan	2	BKT, BNT	Neg
Club Creek	Otsego	1	RBT, BKT	Neg
Pigeon River	Cheboygan	3	BKT, RBT, BNT	Neg
Little Pigeon River	Cheboygan	1	BKT	Neg
Pigeon River	Otsego	3	BKT, RBT	BKT Pos in one sample RBT Pos in two samples
Black River	Cheboygan	1	BKT	Neg
Boyne River	Charlevoix	3	BKT, RBT, BNT	Neg

Table 15.—Continued.

Waterbody	**County**	**Sites sampled**	**Species [1]**	**Pos/Neg**
Jordan River	Antrim	3	BKT, RBT, BNT	BKT Pos in one sample RBT Pos in one sample BNT Neg
Green River	Antrim	1	BKT, RBT, BNT	Neg
Kids Creek	Grand Traverse	3	RBT, BNT	Neg
Beitner Creek	Grand Traverse	1	BKT, RBT, BNT	Neg
Boardman River	Grand Traverse	3	BKT, BNT	Neg

[1]Species codes: BKT – brook trout; RBT – rainbow trout; BNT – brown trout.

Table 16.—Chronology of changes in biosecurity measures and summary of fish health information for the Marquette State Fish Hatchery.

1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**Biosecurity changes and fish health information** [1, 2]
				■	■	■	■	■	■	■	■	■	■	Furogen dip vaccination of BKT fingerlings
				■	■	■	■	■	■	■	■	■	■	Broodstock BKT stay on well water and isolation for first two years
				■	■	■	■	■	■	■	■	■	■	Production yearling BKT stay indoors on well water until October
								■	■	■	■	■	■	Furogen dip vaccination of LAT and Splake fingerlings
								■	■	■	■	■	■	Complete production area and equipment disinfection between each brood year
						■		■	■	■	■	■	■	Replaced BKD infected LAT brood stocks and maintained a BKD free stock
								■	■	■	■	■	■	Stopped importation of salmonid species (*i.e.*, BNT, BKT-NI in 2007)
								■	■	■	■	■	■	Reduced production raceway densities
								■	■	■	■	■	■	Isolation of equipment between raceways
								■	■	■	■	■	■	Furogen injection on all LAT and BKT 2+ year old broodstock
								■	■	■	■	■	■	Erythromycin treatment on water hardening eggs
									■	■	■	■	■	QELISA test all breeding BKT-IR
									■	■	■	■	■	Erythromycin injection or treatments on broodstock before spawning
										■	■	■	■	Annual BKD vaccination of all BKT-IR fingerlings and future broodstock
										■	■	■	■	Annual BKD vaccination of all LAT-LS future broodstock
											■	■	■	UV treatment of broodstock water
												■	■	QELISA test all breeding BKT-AS
													■	Annual BKD vaccination of all BKT-AS fingerlings and future broodstock
													■	Surplus out older male BKT-AS stocks to reduce densities and disease rates
						█	█	█	█	█	█	█		BKD positive results in BKT-IR broodstock fish

Table 16.—Continued.

1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Biosecurity changes and fish health information [1, 2]
						■	■	■					■	BKD positive results BKT-IR production fish
						■	■	■	■	■	■	■	■	BKD positive results in BKT-AS broodstock fish
				■	■	■		■	■	■	■	■	■	BKD positive results in BKT-AS production fish
	■	■	■											Furunculosis is positive results for all species

[1]Species codes: BKT – brook trout; BKT-NI – Nipigon strain of brook trout; BKT-IR – Iron River strain of brook trout; BKT-AS – Assinica strain of brook trout; LAT – lake trout; LAT-LS – Lake Superior strain of lake trout; Splake – cross between lake trout and brook trout; BNT – brown trout.

[2]BKD – Bacterial Kidney Disease.

Table 17.—Summary of regulations restricting recreational fishing for brook trout in the Great Lakes by State and Provincial jurisdiction.

		Lake Superior		
Jurisdiction	**Area**	**Season**	**Catch and Possession Limit**	**Size restriction**
Province of Ontario	Lake Superior and tributaries below identifiable landmark	Fourth Saturday in April - Labor Day	1 per day	Minimum size of 22” (559 mm)
State of Michigan	Isle Royale: within 4.5mi (7 km) and tributaries	Open all year	Catch and release	No keep
	Lake Superior	Open all year	1 per day	Minimum size of 20” (508 mm)
	Tributaries of Lake Superior	Last Saturday in April - Sept 30	5 per day; no more than 3 > 15”	Varies from 7” to - 15” (178 mm to - 381 mm)
State of Wisconsin	Lake Superior	Open all year	1 per day	Minimum size of 20” (508 mm)
	Tributaries of Lake Superior below barrier or landmark	May 3 - Sept 30	5 per day	Minimum size of 8” (203 mm)
State of Minnesota	Lake Superior and tributaries below posted boundaries	April 12 – Sept 3	1 per day	Minimum size of 20” (508 mm)
		Lake Michigan		
Jurisdiction	**Area**	**Season**	**Catch and Possession Limit**	**Size restriction**
Province of Ontario	Ontario does not have any jurisdiction on waters of Lake Michigan.			
State of Michigan	Lake Michigan	Open all year	Three per day	Minimum size of 10” (254 mm)
	Tributaries of Lake Michigan	Last Saturday in April - Sept 30	5 per day; no more than 3 > 15”	Varies from 7” to 15” (178mm to 381 mm)
State of Wisconsin	Lake Michigan	Open all year	5 per day	Minimum size of 10” (254 mm)
	Tributaries to Lake Michigan and major Green Bay tributaries	Open all year	5 per day	Minimum size of 10” (254 mm)
	Tributaries to Green Bay	May 3 – March 1		
State of Minnesota	Minnesota does not have any jurisdiction on waters of Lake Michigan.			

Table 17.—Continued.

Lake Huron				
Jurisdiction	**Area**	**Season**	**Catch and Possession Limit**	**Size restriction**
Province of Ontario	Lake Huron	Not present-closed all year	None	Closed fishery
	Inland zone 11	Feb 15 – Sept 30	5 per day	No more than 1 greater than 12.2” (310 mm)
	Inland zone 10 and 15	January 1 - Sept 30		
	Inland zone 16	Fourth Saturday in April - Sept 30		
State of Michigan	Lake Huron	Open all year	3 per day	Minimum size of 10” (254 mm)
	Tributaries of Lake Huron	Last Saturday in April - Sept 30	5 per day; no more than 3 > 15”	Varies from 7” to 15” (178 mm to 381 mm)
State of Wisconsin	Wisconsin does not have any jurisdiction on waters of Lake Huron			
State of Minnesota	Minnesota does not have any jurisdiction on waters of Lake Huron			

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Appendices

The following appendices are included here for reference only. The information for each appendix is found on the enclosed "Supporting Information" CD in the "Supporting_Information\Appendices" folder. Except for Appendix A, which is a subfolder within the "Supporting_Information\Appendices" folder that contains multiple files, the actual file name is included in parentheses at the end of the citation for each appendix.

Appendix A.—Policies and Procedures of the MDNR and the MDNR Fisheries Division (FD) pertaining to the protection and management of habitat for brook trout, disease management, and fisheries surveys and reporting.
(Appendix_A with multiple .pdf files)

Appendix B.—Summary of grants for Non-Point Source projects awarded by the Michigan Department of Environmental Quality in the Upper Peninsula of Michigan.
(Appendix_B.xls)

Appendix C.—Summary of grants for Non-Point Source projects awarded by the Michigan Department of Environmental Quality in the Lower Peninsula of Michigan.
(Appendix_C.xls)

Appendix D.—Summary of barriers to fish movement and structures in place to allow movement of fish around some barriers in Michigan.
(Appendix_D.ppt)

Appendix E.—FERC license information for hydropower projects in the historical range of brook trout in Michigan.
(Appendix_E.xls)

Appendix F.—Summary of harvest of brook trout by recreational anglers from MDNR Creel Survey Program.
(Appendix_F.xls)

Appendix G.—Bycatch of brook trout in large-mesh trap nets used by State-licensed commercial fishing operations in Michigan.
(Appendix_G.xls)