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Current Status of Lake Whitefish in Maine; an Update to MDIFW's 2001 Whitefish Assessment

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INTRODUCTION

Lake whitefish are native to Maine and provide a small but valuable sport fishery for Maine anglers. The species has experienced significant declines in range and abundance, impacting both the sport fishery and the long term stability of lake whitefish persistence in Maine. In the 2001 Whitefish Management Plan, the Maine Department of Inland Fisheries and Wildlife (MDIFW) recognized the need to take action to better understand the status of lake whitefish and threats to their persistence, as well as implement management strategies to recover whitefish populations. This document provides an updated, detailed assessment of lake whitefish status in Maine, documents research and management activities since the 2001 plan, and makes corresponding recommendations for lake whitefish recovery moving forward.

LAKE WHITEFISH LIFE HISTORY

Description

The lake whitefish (*Coregonus clupeaformis*) is a species of whitefish found in large, cool-water lakes primarily in the northeastern United States, Great Lakes region, and much of Canada. Lake whitefish are part of the salmon family *Salmonidae*, bearing the distinctive adipose fin located on the back between the dorsal and caudal fins. Body coloration is silvery on the sides with a dark colored back and white belly. Lake whitefish have large scales, dark colored fins, a deeply forked tail and distinctly shaped snout which overhangs the lower jaw. A proportionately small head and small, toothless mouth are also distinct characteristics of the species.

Distribution

Lake whitefish are widely distributed across the Canadian provinces from New Brunswick and Labrador through British Columbia and the Northwest Territories. In the United States, they are found from the Great Lakes region north and east along the United States / Canadian border into Maine (Figure 1). Maine populations are now concentrated in headwater lakes of the Allagash and Penobscot River drainages in the north-central part of the state. Lakes in the St. Croix drainage in Washington County are also noted for whitefish populations. Distribution in southern and western Maine is limited to only a few lakes. A great number of lakes throughout the historic range of lake whitefish, and particularly in Maine, have seen populations disappear or dwindle to relic numbers.

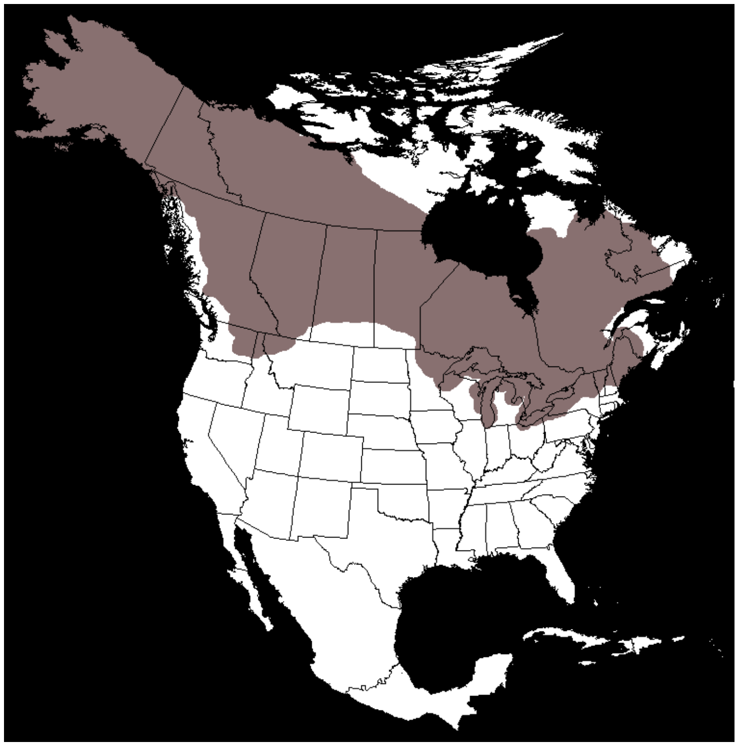

Figure 1. Approximate distribution of lake whitefish in North America.

Habitat Requirements

True to their name, lake whitefish are primarily a lake dwelling fish. They thrive best in deep, oligotrophic lakes with large volumes of cold, well-oxygenated water, rarely entering streams except to spawn. Commonly known to be a schooling fish, lake whitefish are often found in groups of similar sized fish. Where food and adequate water quality are present, they spend much of their time near the lake bottom. Segments of some populations may undergo feeding excursions in nearby streams.

Age and Growth

Lake whitefish are among Maine's more long-lived sport fish, normally living 10 or more years, with the capability to live for as long as 30 years. As typical of long-lived fish, growth is relatively rapid until the onset of sexual maturity whereupon growth slows depending on population abundance, food source, and competition with other species. Slow growth in later years results in crowding of circuli at the margin of the scale, making it most difficult to determine accurate age in slow growing whitefish using scales. Recent studies have shown the use of sagittal otoliths to more accurately age these slow growing fish, and have demonstrated that lake whitefish in many lakes are longer-lived than previously thought.

While the bulk of mature adult lake whitefish may weigh one to three pounds, some can grow considerably larger. The largest lake whitefish on record for Maine waters is a specimen weighing seven pounds, eight ounces, taken by an angler from Sebago Lake in 1958.

Reproduction

Lake whitefish typically reach sexual maturity between ages three and six, and spawn between mid-October and December, when water temperatures drop below 6 degrees C. Spawning takes place on shallow windswept lake shoals or in tributary streams where suitable water depth, water velocity and spawning substrate exist. Spawning may occur during the day or at night, over a period of several days to a week or more. The fish gather in spawning pairs, with the female broadcasting eggs mid-water where they are fertilized by the male and settle into cracks and crevices in the substrate below. Females are very fecund, with the ability to lay more than 10,000 eggs each. Fertilized eggs develop in the substrate over winter and hatch the following spring.

Food Habits

Larval and post-larval whitefish feed primarily on zooplankton and can tolerate somewhat warmer water temperature than adults. As they grow, the diet of juvenile whitefish transitions to bottom-dwelling species such as snails, insect larvae and clams, and their habitat use changes to reflect this diet shift. Where lake whitefish co-occur with rainbow smelt in Maine lakes, larger whitefish often feed on smelts, which contributes to a higher rate of growth in these fish. The ability to feed on smelts is controlled by gape limitation of the relatively small whitefish mouth, size and abundance of smelts to forage on, and likely a number of other factors. Certainly whitefish are better adapted to feed on bottom with their specialized mouth shape and a stomach well suited to digest hard shelled prey items such as snails.

Dwarf Form of Lake Whitefish

An unusual trait which is rarely found in other species but frequently seen among whitefish is the tendency to form dwarfed populations. Though still considered the same species (despite some debate), the dwarf form of lake whitefish grows to a much smaller size, matures earlier (at age one or two), and has a much shorter life span. Initially discovered in the early 1900's and further studied in the 1950's, dwarf lake whitefish populations have been found in 29 Maine waters, some of which have since become extirpated.

Decades of research by the Louis Bernatchez laboratory from Laval University in Quebec suggests that the existence of the dwarf form of lake whitefish in Maine lakes represents several unique snapshots in the long term formation of a new species. Where dwarf and normal forms of lake whitefish are found in the same lake, exclusively in the St. John River drainage, they represent a continuum of both morphological and genetic differentiation. Through the utilization of different life history tactics, dwarf lake whitefish have developed reproductive isolation from the normal form despite retaining very similar genetic makeup, probably due to the recent nature of this process of speciation. A fast growing, early maturing, ephemeral life history strategy appears to present some advantages in lakes where dwarf populations have formed, and allows whitefish to more fully utilize available habitat in a particular water. Additionally, several waters with marginal habitat for lake whitefish contain populations of only the dwarf form.

HISTORY OF LAKE WHITEFISH IN MAINE

Species History

Along with brook trout and lake trout, lake whitefish were native to many of Maine's lakes. Early findings by Maine biologists supplemented by recent genetic studies suggest that Maine is a contact site of three distinct glacial lineages of whitefish. One whitefish lineage (Mississippian) has been only found at South and Round Ponds in Greenwood, Oxford County. Another lineage (Atlantic) is only found in Clear Lake, Ross Lake and Cliff Lake, all in Piscataquis County where it occurs as normal size fish. A third strain (Acadian) occurs as both dwarf and normal forms in Crescent Pond, T9R15 WELS, Piscataquis County and East Lake, a border water with Quebec in T17R14 WELS, Aroostook County, and as the dwarf form only in Cliff Lake. Research has also uncovered whitefish populations having a genetic composition of both Atlantic and Acadian lineage.

Early Human Use

Prior to the establishment of nonnative fish species, lake whitefish commonly co-occurred with brook trout and lake trout in Maine lakes, occupied far more waters than they do presently, and were far more abundant. Lake whitefish were undoubtedly used as a food fish by Native Americans, and were important commercially around the turn of the 20th century. Being of high food value, whitefish were sold in southern Maine fish markets and throughout New England. Up until at least 1900, whitefish were caught and shipped in quantity, either frozen or pickled in salt, as a winter food supplement for logging camps in the back country of northwestern Maine. They were also used as food by frontier families in the Ashland area in Aroostook County that made annual trips to the Musquacook lakes to net, snare or spear whitefish as they ascended tributaries in dense numbers to spawn during November. Whitefish were also taken by gill net during the summer and pickled or smoked and stored in barrels.

Until 1955, when the use of gill nets in all waters was made unlawful, a November gill net fishery existed on a number of waters, including East Grand, West Grand, Hot Brook, Baskahegan, Pocumcus, Junior, Mattawamkeag, and First Debsconeag lakes.

One account of whitefish given in the Report of the Commissioners of Inland Fisheries and Game, 1867, provides excellent insight into the early fisheries for this species, its habits, and sporting qualities: "*In the Fish River region, in Moosehead Lake, in Schoodic Grand, they pronounce the whitefish the best of the fishes. On the Schoodic, they refer to Pocumpus and Grand Lakes, where the water is flowing from three to five feet deep, and the bottom sandy and gravelly. In November each year small quantities of them are taken here with the spear. One night Mr. B.W. French of Calais, set a net thirty feet long at this thoroughfare, and in the morning had a barrel of whitefish. In Moosehead Lake they sometimes take a fly. In June last we saw one taken with the fly near Mt. Kineo, by Artemas Libby, Esq. of Augusta. It weighed a pound and a half….. They can be taken with the hook at any season of the year in deep water. Almost any bait will answer, but the best is a piece of a small fish. The most of them are taken in the winter.*

Modern Lake Whitefish Sport Fishery

Though W.C. Kendall wrote of catching whitefish on a fly rod in the Fish River Chain of lakes in 1905, it took decades for the species to become a popular sport fish on a larger scale. In a 1961 *Maine Fish and Game* article titled "Whitefish – Are Anglers Missing a Bet?", fishery biologist Owen Fenderson wrote of the qualities of the species, which was often overlooked by trout and salmon anglers at the time. The modern lake whitefish sport fishery began developing sometime around the early 1970's. A 1972 article by Tom Shoener in *Maine Fish and Wildlife* magazine titled "Discover Whitefish" highlighted the growing importance of the species in the eyes of anglers at the time. What was largely considered an "almost game fish" grew into a highly sought-after species, particularly by winter anglers. The widespread use of snowmobiles made many waters more accessible to ice fishermen, and since jigging through the ice is a very effective way to catch whitefish, the species became a significant part of the catch. A limited open water fishery exists for whitefish in some locales as well.

Coinciding with increased popularity of lake whitefish among anglers was a decline in populations of the species. Today, the few waters that maintain adequate lake whitefish populations to support recreational fisheries are highly prized by anglers. The largest concentration of these waters exists in the major lakes of the Allagash River drainage in northern Maine and the network of large lakes surrounding and including West Grand Lake in downeast Maine.

CURRENT STATUS OF LAKE WHITEFISH IN MAINE

Lake whitefish are believed to currently occur in at least 52 lakes in five of the seven MDIFW fisheries management regions (Figure 2). One of the stated goals in the Department's 2001 Whitefish Management Plan was to inventory and categorize all lake whitefish waters in the state (Basley 2001). The 2001 whitefish assessment used to develop the management plan included a list of 75 'whitefish waters' that had been maintained over time. However, it became clear that the list included a wide variety of waters, ranging from those with robust whitefish populations to those where whitefish had been extirpated, and did not adequately characterize the species' true status in Maine.

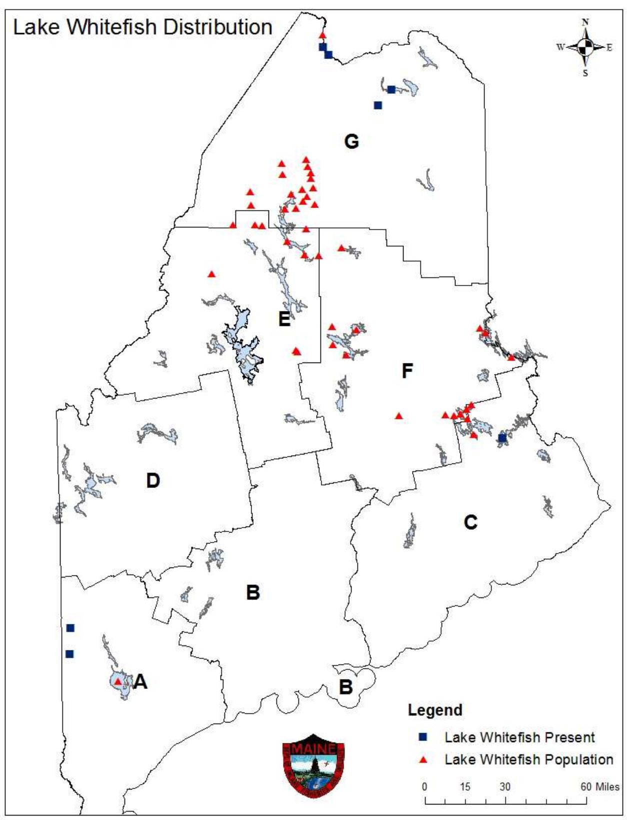

Figure 2. Current distribution of lake whitefish populations and other occurrences in Maine.

A careful review of the 75 lake whitefish waters revealed that most could be placed in the following categories:

1) Population: Lake whitefish are present in the water and a self-sustaining population exists.
2) Present: Lake whitefish are present in the water but no self-sustaining population is believed to exist. These represent either migrants from other waters or former populations that no longer experience recruitment of juvenile fish and are probably headed for extirpation.
3) Extirpated: Lake whitefish previously occurred here but have since been extirpated to the best of our knowledge, and likely no longer occur.
4) Unknown: Current data and professional judgement are inadequate to determine the status of lake whitefish in the water, and further research is required to make a determination.
5) Other: Various circumstances prevent placement in any of the previous four categories, including: a self-sustaining lake whitefish population likely never existed in the water, or a new population or occurrence was found since the 2001 species plan.

Using all available data and professional judgement, a summary was developed for each of the 75 waters, which includes water information, lake whitefish status, threats and management recommendations. These summaries are available in Appendix A, and waters in each category are listed below in Table 1.

Table 1. Current lake whitefish status in Maine waters from the 2001 Whitefish Assessment list, grouped by the following categories: Population, Present, Extirpated, Unknown, and Other.

Population (45 waters)

Region	Water	Town	Acreage
A	Sebago Lake	Sebago	28771
C	Pocumcus Lake	T6 ND BPP	2201
C	West Grand Lake	T5 ND BPP	14340
E	Johnson Pond	T8 R14	197
E	Fourth Roach Pond	TA R12	266
E	Fourth St. John Pond	T5 R17	198
E	Trout Pond	TA R12	145
E	Allagash Lake	T8 R14	4260
E	Chamberlain Lake	T7 R12	11084
E	Telos Lake (and Round Pond)	T6 R11	2276
F	Lower Jo-Mary Lake	T1 R10	1910
F	Junior Lake	T5 R1 NBPP	3866
F	Scraggley Lake	T5 R1 NBPP	2758
F	Spednik Lake	Vanceboro	17219
F	Upper Sysladobsis Lake	Lakeville Plt.	1142
F	Upper Cold Stream Pond	Lincoln	685
F	First Debsconeag Lake	T2 R10	320
F	Deering Lake	Orient	474
F	East Grand Lake	Weston	16070
F	Matagamon Lake	T6 R8	4165
F	Millinocket Lake	T1 R8	8960
F	Pemadumcook Chain Lake	T4 Indian Purch.	18300
F	Pleasant Lake	T6 R1 NBPP	1574
F	Lower Sysladobsis Lake	T5 ND BPP	5376
F	Webster Lake	T6 R10	531
G	Beau Lake	T19 R11	2003
G	Cliff Lake	T9 R12	563
G	Crescent Pond	T9 R15	320
G	Echo Lake	T9 R11	115
G	Harrow Lake	T10 R11	467
G	Haymock Lake	T7 R11	928
G	Long Lake	T11 R13	1203
G	First Musquacook Lake	T12 R11	698
G	Second Musquacook Lake	T11 R11	813
G	Third Musquacook Lake	T11 R11	397
G	Fourth Musquacook Lake	T10 R11	749
G	Big Pleasant Lake	T9 R11	979
G	Saint Francis Lake	T8 R16	322

G	Umsaskis Lake	T11 R13	1222
G	Spider Lake	T9 R12	890
G	Churchill Lake	T9 R12	3720
G	Big Eagle Lake	T8 R13	9500
G	Clear Lake	T10 R11	614
G	Ross Lake	T10 R15	2892
G	Indian Pond	T7 R12	1222

Present (7 waters)

Region	Water	Town	Acreage
A	Kezar Lake	Lovell	2600
A	Lovewell Pond	Fryeburg	1120
A	South & Round Pond	Greenwood	284
C	Big Lake	Grand Lake Stream	10305
G	Eagle Lake	Eagle Lake	5581
G	Glazier Lake	T18 R10	1120
G	Saint Froid Lake	Winterville Plt.	2400

Extirpated (10 waters)

Region	Water	Town	Acreage
E	Dole Pond	T3 R5	704
E	Harrington Lake	T3 R11	1332
E	Long Pond	T3 R5	845
E	Moosehead Lake	Greenville, etc.	74890
E	First Roach Pond	TA R13	3270
E	Second Roach Pond	TA R12	970
F	Upper Jo-Mary Lake	TA R10	1873
G	Carr Pond	T13 R8	307
G	Fish River Lake	T14 R8	2642
G	Munsungan Lake	T8 R10	1620

Unknown (9 waters)

Region	Water	Town	Acreage
E	Caucomgomoc Lake	T6 R14	5081
E	Chesuncook Lake	T3 R11	26200
E	Lobster Lake	T3 R14	3745
E	Loon Lake	T6 R15	1140
E	Third Roach Pond	TA R12	570

E	Umbazooksus Lake	T6 R13	1590
F	Mattawamkeag Lake	Island Falls	3330
G	Round Pond	T13 R12	697
G	Rowe Lake	T11 R8	252

Other (on list but likely never had a LWF population)

Region	Water	Town	Acreage
E	Hebron Lake	Monson	525
E	Big Hurd Pond	T6 R15	250
E	Indian Pond	Indian Stream Twp	3746
G	Cunliffe Lake	T12 R13	134

Other (newly discovered LWF occurrence)

Region	Water	Town	Acreage
G	Cross Lake	T18 R10	49

Of the 75 whitefish waters listed during the 2001 species planning process, 45 are believed to currently support self-sustaining populations of lake whitefish. Seven waters contain lake whitefish, but they are unlikely to be self-sustaining via natural recruitment. Lake whitefish are believed to have been extirpated from 10 waters. Extirpation likely occurred decades before 2001, but data were not adequate at the time to make this determination. Four waters likely never had a self-sustaining population, but were retained on the list pending further information needed to make that call. Finally, the status of lake whitefish is currently unknown in nine waters. These are areas where current knowledge and survey data are lacking, and are targets for increased survey efforts to make a clear determination of status.

This review of lake whitefish waters in Maine attempts to summarize the species' current status and provide a general baseline from which to measure changes over time. One of the greatest challenges in lake whitefish management is accurately describing and understanding population abundance and trends using current fishery survey methods. Water summaries in Appendix A were developed using a combination of methods, including gill netting, trap netting, angler creel survey, experimental angling and other information used to guide professional judgement. However, uncertainties surrounding lake whitefish status can vary among waters, and status in many of these waters is expected to change over time. Therefore, the current list of lake whitefish waters and their summaries should be considered a working document subject to change based on available information.

For instance, survey work in 2014 discovered lake whitefish presence in a new water, Cross Lake (T18 R10), and future surveys may reveal lake whitefish in waters where they were thought to be extirpated. New extirpations of populations are possible as well. Nevertheless, the current review provides a thorough representation of lake whitefish status in Maine based on best available knowledge, and should help guide future research and management activities for the species.

LAKE WHITEFISH DECLINES, CAUSES FOR DECLINE, AND POTENTIAL FOR RECOVERY

Lake Whitefish Declines

A significant portion of the overall fishery for lake whitefish in Maine has been lost due to declining populations. During the most recent MDIFW whitefish assessment and species plan (Basley 2001), it was believed that sport fishing opportunity for the species had declined by 30%. The most severe losses appear to have occurred during the 1980's, with some continued decline in sport fishing opportunity in select waters in more recent years.

A robust long-term dataset from MDIFW creel surveys in northern Maine waters documents the decline of lake whitefish fisheries over time. Between 1970 and 2012, angler catch rates of lake whitefish in the winter sport fishery of six Allagash waters (Spider, Big Eagle, Churchill, 1st Musquacook, 2nd Musquacook and 3rd Musquacook) fell at an alarming rate, such that virtually no sport fishery currently exists in these waters (Figure 3).

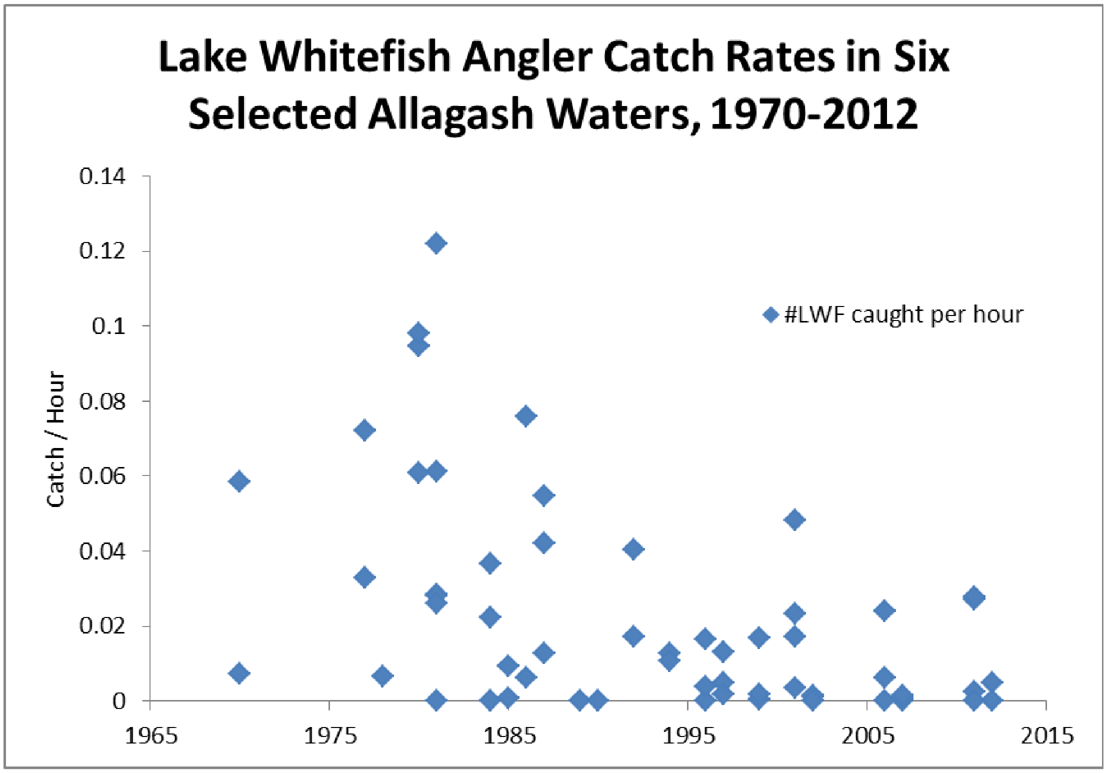

Figure 3. Lake whitefish catch rates from angler creel surveys, 1970-2012.

Two waters that still maintain sport fisheries for lake whitefish - Clear Lake and Ross Lake, have also witnessed declines in angler catch rates, although these rates remain substantially higher than those in the other six waters (Figure 4). Nearby Chamberlain Lake maintains a lake whitefish sport fishery similar in catch rates to Clear and Ross, while lake whitefish catch rates in Allagash Lake are similar to the previously mentioned waters. Data from these waters do not reveal clearly detectable trends in angler catch rates in recent years.

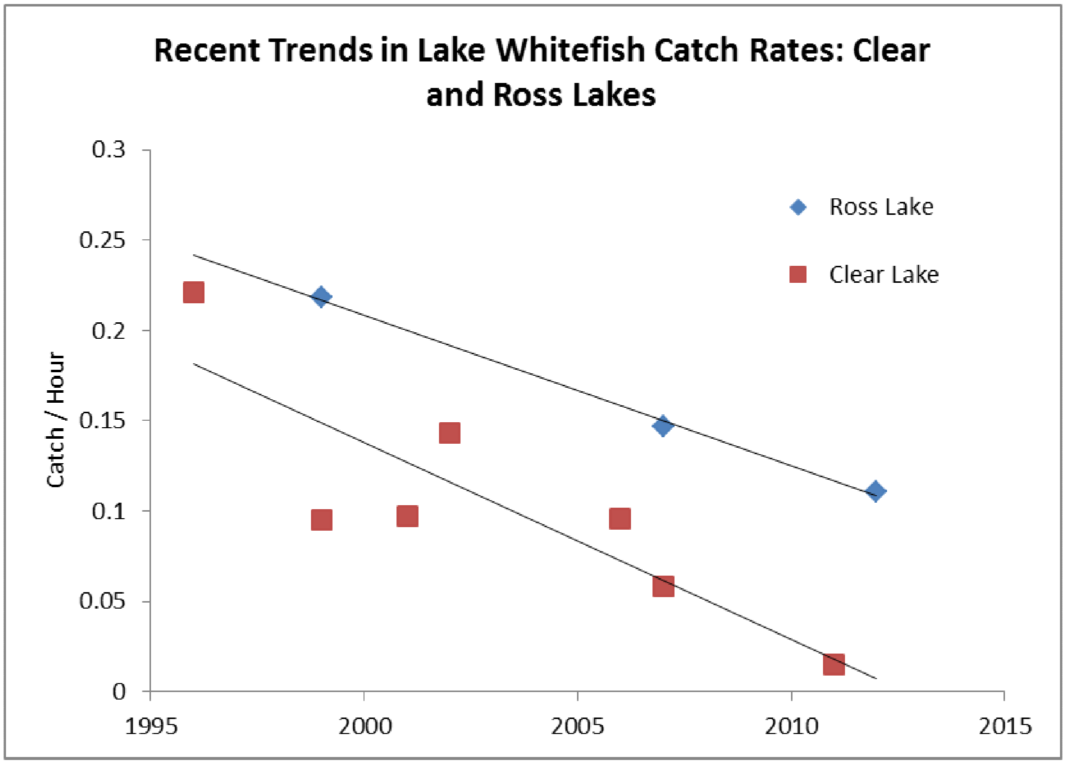

Figure 4. Lake whitefish catch rates from angler creel survey data from Clear Lake and Ross Lake, 1995-2012.

The recent drop in lake whitefish catch rates in the sport fishery (a clear indicator of declining fish densities in these Allagash waters) is part of a long term overall decline in lake whitefish populations throughout the species' range in Maine. Lake whitefish populations in Maine began to decline around the turn of the 20th century, resulting in local extirpation of populations in many Maine lakes and severely depressed numbers in others. In many waters, lake whitefish decline coincided with the introduction of landlocked salmon and rainbow smelt, two species that are native to just a small handful of lake whitefish waters in the state. Salmon and smelts were distributed widely throughout popular Maine waters in the late 1800's and early 1900's. Smelts were introduced as a forage fish for salmon, and popular sport fisheries sprouted up around these introductions. The popularity of smelts led to further introductions into new waters in later years, with smelts being introduced into lake whitefish waters as recently as the early 1980's.

Several examples of salmon/smelt introductions and subsequent lake whitefish declines are evident in Maine. For instance, the Fish River Chain of Lakes in northern Maine (including Long, Cross, Square, Eagle St. Froid and Portage lakes) once boasted abundant populations of whitefish in the late 1800's and early 1900's. Early descriptions by naturalist and U.S. Fish Commissioner W.C. Kendall identified three whitefish 'species', which correspond to what we now refer to as lake whitefish, round whitefish and the dwarfed form of lake whitefish. Landlocked salmon and rainbow smelts were introduced to the Fish River Chain in 1894. Shortly thereafter, lake whitefish populations began to decline. The last of these native lake whitefish in the lower Fish River Chain were seen during surveys in Eagle Lake in the 1950's, and the species has been extirpated from Long, Cross, Square, Eagle, St. Froid and Portage lakes for at least 50 years. More recently, Carr Pond and Fish River Lake, in the upper Fish River watershed, appear to have experienced similar extirpations.

Lake whitefish were also native to, but now considered extirpated from Maine's largest lake, Moosehead, where salmon and smelts were introduced around the 1870's. Munsungan Lake in T8R10 is another example of a lake whitefish extirpation coinciding with the introduction of salmon and smelts. There are numerous other waters with varying levels of documentation of historic lake whitefish populations that no longer exist, the common thread in these extirpations being the introduction of rainbow smelt.

The Allagash River drainage is considered a stronghold for lake whitefish, but as described earlier, many Allagash waters have experienced significant decline. While landlocked salmon are not present in the Allagash, smelts have become established in most of the larger lakes that harbor lake whitefish. The intent of smelt introductions was to improve lake trout growth, though impacts to lake whitefish populations were an unanticipated result. Table 2 gives an overview of the presence of rainbow smelt in historic lake whitefish waters of MDIFW fisheries management Region G. Note that while rainbow smelt introductions have coincided with the extirpation of lake whitefish populations in the Fish River drainage, populations have persisted, though at lower abundances, in the presence of smelts in many of the Allagash lakes. The extirpation of some populations and declines in abundance in others could be happening for a number of reasons. One real, and potentially dooming, possibility is that smelt introductions to most Allagash Lakes occurred relative recently, and the impacts to the lake whitefish population are still being borne out. Another possibility is that habitat-related factors occurring in these lakes are mediating the competitive and/or predatory impacts of smelts on lake whitefish. The fact that lake whitefish still occur in the Allagash lakes despite the serious threat posed by smelts warrants a closer look at the interactions between whitefish and smelts in these waters.

Table 2. Rainbow smelt presence in native lake whitefish waters of MDIFW Fisheries Region G.

Water	Drainage	LWF Status	Smelts Present?	smelt introduced or (colonized)
Harrow	Allagash	population	n	
Big Pleasant	Allagash	population	n	
Cliff	Allagash	population	n	
Echo	Allagash	population	n	
Haymock	Allagash	population	n	
Ross	Allagash	population	y	1941
1st Musquacook	Allagash	population	y	1972
2nd Musquacook	Allagash	population	y	1972
Spider	Allagash	population	y	1972
Crescent	Allagash	population	y	1980
3rd Musquacook	Allagash	population	y	(after 1972)
4th Musquacook	Allagash	population	y	(after 1972)
Round	Allagash	unknown	y	(after 1950's)
Umsaskis	Allagash	population	y	(1958)
Long	Allagash	population	y	(1958)
Clear	Allagash	population	y	(1980's)
Churchill	Allagash	population	y	(after 1950's)
Big Eagle	Allagash	population	y	(after 1950's)
Big Indian	Allagash	population	y	(after 1950's)
Rowe	Aroostook	unknown	y	1957
Munsungan	Aroostook	extirpated	y	1950's
Big Machias	Aroostook	extirpated	y	(after 1957)
Long	Fish	extirpated	y	1894
Cross	Fish	extirpated	y	1894
Square	Fish	extirpated	y	1894
Eagle	Fish	extirpated	y	1894
St. Froid	Fish	extirpated	y	1894
Portage	Fish	extirpated	y	1894
Fish River Lake	Fish	extirpated	y	1979
Carr	Fish	extirpated	y	1980
Glazier	St. Francis	present	y	unknown
Beau	St. Francis	population	y	unknown
St. Francis	St. John	population	n	

Contrary to the patterns being seen in lake whitefish declines in the Allagash and Fish River drainages, lake whitefish in the Penobscot and St. Croix River drainages appear to be persisting despite the presence of smelts and a whole host of other nonnative fish species. In a broad sense, these populations may be persisting due to habitat factors unique to the area – in particular, the highly complex fish habitat provided by their much rockier shorelines and lake bottoms. Understanding the habitat conditions that may promote lake whitefish persistence in the presence of invasive fishes has emerged as a top research priority, and is discussed later in this document.

Finally, it is important to note that declines in lake whitefish populations are often difficult to document via current monitoring methods until it is too late to implement effective management strategies. Past research on lake whitefish throughout the species range, as well as more recent data in Maine, have shown that adults can have very long life spans, living up to and even exceeding 30 years of age. This means that the species can experience many years of recruitment failure with adults (albeit older) still appearing prominently in the fishery. Common cases of recruitment failure result in a paucity of small fish in the catch, with a relative abundance of larger whitefish that are more desirable to anglers. This condition often gives the impression of a high quality fishery in the lake and an assumed healthy population, which in reality may be headed for extirpation as the older lake whitefish age out of the population and are not replaced by subsequent generations.

Causes for Lake Whitefish Decline – A Renewed Focus on Smelt

Reasons for the decline of lake whitefish in Maine have been speculated for many years, but are becoming more clear in recent times. Factors commonly attributed to whitefish decline include overharvest and the introduction of nonnative species, particularly rainbow smelt. The fact that whitefish numbers have not responded to severe harvest restrictions (discussed later in this paper), combined with the fact that recreational harvest is largely a self-limiting factor (low catch rates result in lowered effort) highlight the need for an intensified focus on whitefish interactions with smelts.

Lake whitefish and rainbow smelt are known to have overlapping life histories, each having pelagic fry, juveniles that are found near the bottom of the thermocline, and adults that dwell near the lake bottom. Speculation that declines may be associated with rainbow smelt interactions has been supported by several scientific findings.

In a review of rainbow smelt colonization and it impacts on other species in the Great Lakes Region, Evans and Loftus (1987) presented evidence of lake whitefish recruitment failure via predation from and/or competition with smelts. They cited several specific cases where such interactions occurred. For instance, severe declines in the lake whitefish fishery of Lake Simcoe, Ontario were attributed to the introduction of rainbow smelt. Lake Simcoe is a large (179,148 acres), deep (135 feet) water body in south-central Ontario that has long supported popular fisheries for lake whitefish, lake trout and other fishes. Smelts were first reported in Lake Simcoe in 1961, and eventually the lake whitefish population crashed due to complete reproductive failure during the period of rapid smelt population growth. Competition between fry of both species and predation by adult smelt on larval whitefish were the suspected causes, with a greater emphasis on the impact of competition. Stocking of hatchery-reared lake whitefish of advanced sizes resulted in a boost in whitefish numbers, further indicating that reproductive failure was due to factors occurring in the population at an early life history stage.

In the smaller (1,144 acres), shallower (79 feet) Twelve Mile Lake in south-central Ontario, predation by newly established smelts was the suspected cause of lake whitefish recruitment failure. Rainbow smelts became established in the late 1950's and became abundant in the 1960's. Researchers documented intense predation of larval whitefish by adult smelts, which resulted in complete recruitment failure of the lake's lake whitefish population for years (Loftus and Hulsman 1986).

More locally, two lakes in Maine's Fish River drainage demonstrate clear examples of what are believed to be extirpations of lake whitefish populations resulting from rainbow smelt introductions. Carr Pond and Fish River Lake are located at the headwaters of the Fish River watershed, with lakes lower in the drainage experiencing lake whitefish extirpations many decades prior. Smelts were introduced to Fish River Lake in 1979 and Carr Pond in 1980, and MDIFW data show a drop in lake whitefish numbers beginning around the time of smelt establishment.

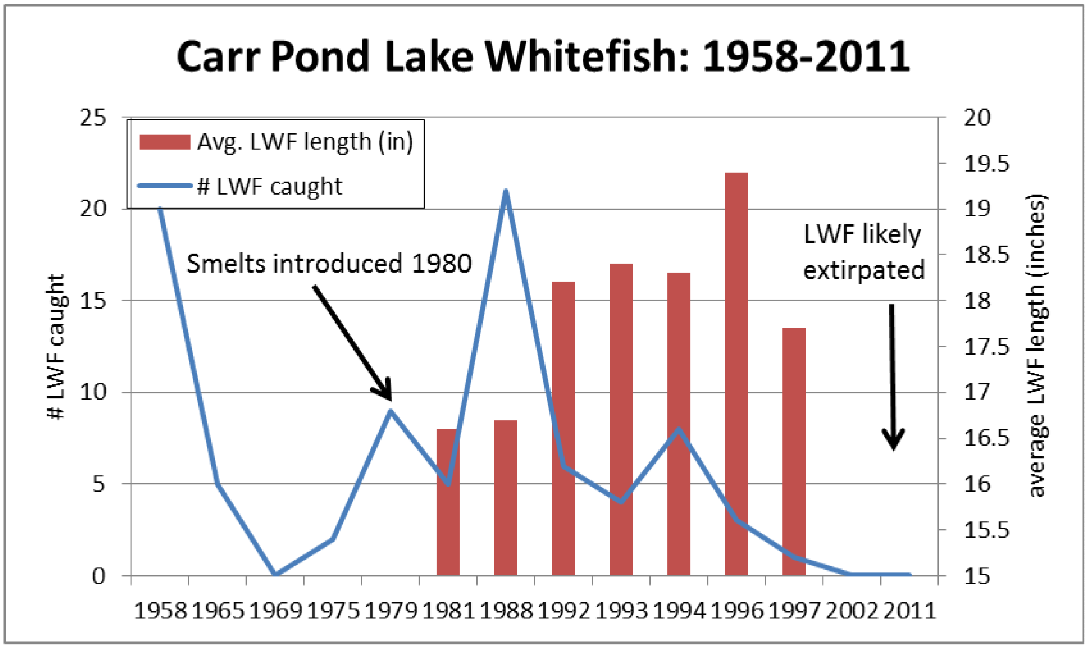

Figure 5. Trends in average length and number of LWF caught in Carr Pond, 1958-2011.

In Carr Pond (307 acres, 72 feet deep), average size of lake whitefish increased substantially in the 1990's, while the number of lake whitefish caught fell steeply, to the point where the population was believed to be absent by the early 2000's (Figure 5). The last lake whitefish seen at Carr Pond was an angler-caught fish weighing more than six pounds in 2001.

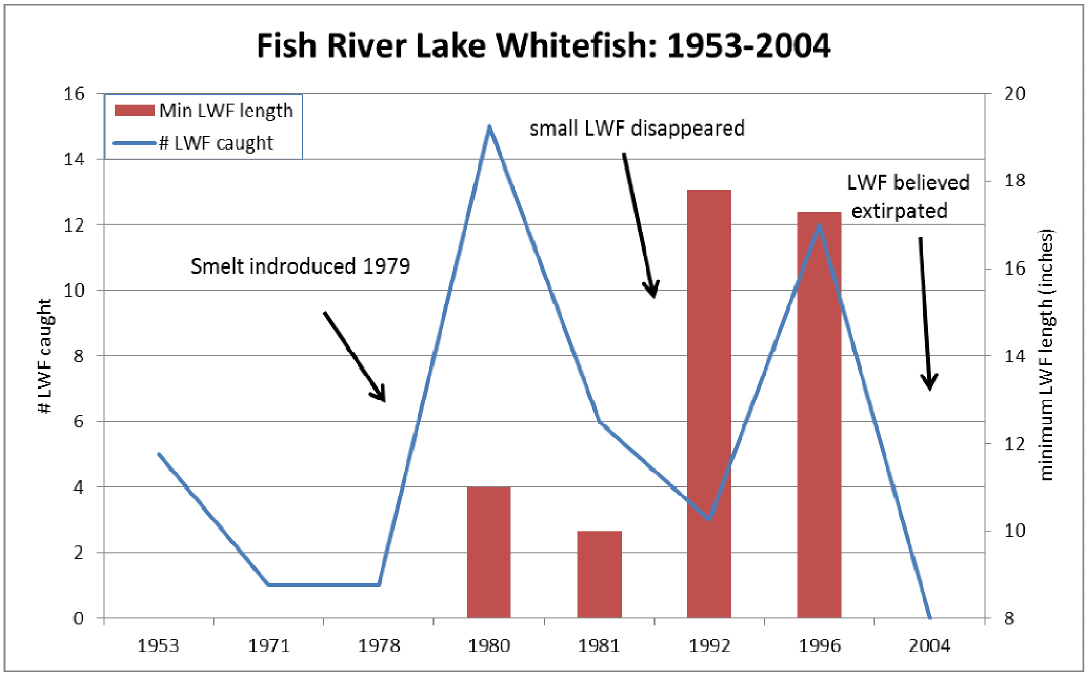

Figure 6. Minimum length and number of lake whitefish caught in Fish River Lake, 1953-2004.

In nearby Fish River Lake (2,642 acres, 46 feet deep), a similar pattern of increasing whitefish length and lack of smaller individuals was observed following smelt establishment (Figure 6). Aside from one large catch of whitefish in 1996, numbers declined to the point that no lake whitefish have been observed there since. Data from both waters signal a lack of juvenile recruitment to the populations due to impacts from smelts, and the gradual aging out of the adult lake whitefish in the population to the point of extirpation.

Persistence of Lake Whitefish Populations in the Presence of Smelts – Managing for Sporadic Recruitment

Despite the high level of impact rainbow smelts have had on lake whitefish recruitment, many populations continue to persist over time. A number of possible factors may explain this phenomenon, including the following:

- Lake whitefish persistence is only a temporary condition.
- Unique habitat conditions allow lake whitefish larvae to escape impacts from smelts.
- Longevity of lake whitefish individuals allows them to persist with only sporadic periods of successful recruitment.

The idea that sporadic periods of recruitment have been adequate to sustain many lake whitefish populations over time is supported by numerous case studies. For instance, in the previously described Lake Simcoe whitefish population, the stocking of hatchery lake trout increased their abundance and multiplied predation pressure on the rainbow smelt population. With lower smelt densities, a low level of whitefish recruitment was re-established, helping to sustain the population.

Recovery of lake whitefish populations in the Great Lakes has been aided by lake trout and salmon stockings that have reduced the abundance of alewives, rainbow smelts and white perch. Many fisheries scientists managing these lakes believe that when populations of the latter species decline, recruitment of lake whitefish increases. This concept may have proven beneficial in some Maine lakes where lake whitefish populations have remained high in the presence of smelts and large numbers of predatory lake trout.

One interesting case study in sporadic recruitment supporting lake whitefish population persistence can be found at Clear Lake (614 acres, 86 feet deep) in the Allagash River drainage. Clear Lake contains a historically abundant population of lake whitefish, a combined wild/hatchery lake trout population that has fluctuated in abundance over the years, and a smelt population that became established in the mid 1980's. A robust age and growth dataset describing 738 lake whitefish over the span of more than two decades from Clear Lake provides some interesting insight.

Lake whitefish data from Clear Lake show an incredibly distinct pattern of robust recruitment of young fish into the population, followed by years with complete recruitment failures. Table 3 displays the number of lake whitefish of each age class in each year from Clear Lake since 1990.

Data from 1990 show a robust group of younger-aged whitefish that showed up in subsequent samples all the way into the late 1990's, when these fish were aged in their low teens. These fish resulted from strong year classes of whitefish hatched in the mid 1980's, about the time smelts were becoming established. Following this, the data show a virtual lack of whitefish recruitment in the Clear Lake population up until around 1996.

The strong year classes of whitefish from the mid 1990's can be followed through the population for about a decade, while the mid 1980's-hatched whitefish were aging out of the population. This mid 1990's spike in recruitment occurred at the same time that lake trout were stocked in the lake at very high densities and were exhibiting strong predation pressure on rainbow smelts.

A lack of lake whitefish recruitment in the late 1990's and early 2000's is evident in the data, until a third spike in recruitment is detected beginning in 2006. This third spike in recruitment would have occurred around 2003, which happens to be the first year that lake whitefish fry were stocked in Clear Lake from MDIFW's hatchery project egg take.

Table 3. Number of lake whitefish sampled from each age class from Clear Lake, 1990-2011.

year	age1	age2	age3	age4	age5	age6	age7	age8	age9	age10	age11	age12	age13	age14	age15
1990				9	28	12									
1992					3	14	9	2	3						
1994					1	13	16	11	5						
1995						1	4	29	35	21	7				
1996							1	9	5	14	4	3			
1997								1	5	15	9	19			
1998	1	43						2	5	28	7	16	4		
1999		4	16						2	9	5	6	2		
2000			8	29						4	1	5		1	
2002					6	10									
2003					4	9	6							4	
2004						1	14	8				1			
2005					5	6	3	2			3				
2006			8				4	1							
2007				3					2						
2008				2	19	2		6	2	1		1			
2009					6	22		1	7			1		1	
2011							4	18	4	12	3	11	1	7	2

In summary, Clear Lake whitefish age and growth data suggest the population persisted over the past 25 years as a result of three distinct periods of high recruitment: 1) just prior to smelts becoming abundant, 2) during high lake trout densities and strong predation pressure on smelts, and 3) the initiation of lake whitefish fry stocking. The trends identified in the Clear Lake data further support the theories that: 1) smelts prevent lake whitefish recruitment, 2) management for increased predation pressure on smelts may benefit this recruitment, and 3) the mechanisms by which smelts impact lake whitefish recruitment may occur prior to the advanced fry life stage. They also suggest that because lake whitefish can live to older ages, only periodic years of successful recruitment may be adequate for population persistence. These ideas may present some interesting options for lake whitefish population management and recovery efforts moving forward.

LAKE WHITEFISH RECOVERY EFFORTS IN MAINE

MDIFW has long recognized the need to prevent further decline of lake whitefish populations in the state and has taken direct management activities to advance this goal. During the last statewide lake whitefish assessment and species management plan, several recommendations concerning lake whitefish management were made, with the focus on preventing further decline of the species and restoring past sport fisheries. Since 2001, Department biologists have taken direct management action by promulgating restrictive fishing regulations and implementing a lake whitefish hatchery program. Unfortunately, these attempts have not yet resulted in noticeable improvements in whitefish population abundance or the restoration of sport fisheries in the state. These management activities are summarized below, and the resulting information should assist in formulating new recommendations for lake whitefish recovery moving forward.

Restrictive Fishing Regulations

For more than four decades, fishing regulations have been used as a tool to protect and manage whitefish populations. The first general law fishing regulation for whitefish began in 1972, when an eight fish bag limit, with no size or weight limit, was put in place. Beginning in 1988, a three fish bag limit was adopted on some waters, and was later implemented as a broad special regulation class in the lawbook in 1990. In 2002, the statewide general law for whitefish was reduced to three fish. The only notable exception to this general law regulation was West Grand Lake, which maintained an eight fish bag limit through 2013, when declining lake whitefish numbers triggered a change to the three fish general law regulation. In addition to bag limits, regulations prohibiting the use of live fish as bait were implemented in lake whitefish waters that did not contain smelt populations to guard against the establishment of smelts.

Beginning in 2005, MDIFW began a rigorous effort to implement more restrictive fishing regulations for whitefish lakes in the Allagash drainage (Table 4). This effort was part of an attempt to stem population declines by minimizing the impact of angler harvest, and, incidentally, served as an experiment to test the actual impact of this harvest. In some waters, an effort to stock hatchery lake whitefish to bolster fishable populations coincided with these regulation changes.

Table 4. A history of fishing regulations for lake whitefish in the Allagash lakes.

Water	pre-1988	1988-2005	2005-2012	2012-2013	2014-present
Big Eagle	8 fish	3 fish	no harvest	1 fish, 18" min	1 fish, 18" min
Churchill	8 fish	3 fish	no harvest	1 fish, 18" min	1 fish, 18" min
Spider	8 fish	3 fish	no harvest	1 fish, 18" min	1 fish, 18" min
1,2,3 Musquacook	8 fish	3 fish	no harvest	1 fish, 18" min	1 fish, 18" min
Allagash	8 fish	3 fish	3 fish, 16" min	3 fish, 16" min	3 fish, 16" min
Chamberlain/Telos	8 fish	3 fish	3 fish, 16" min	3 fish, 16" min	3 fish, 16" min
Umsaskis	8 fish	3 fish	3 fish, 16" min	1 fish, 16" min	3 fish, 18" min
Long	8 fish	3 fish	3 fish, 16" min	1 fish, 16" min	3 fish, 18" min
Big Indian	8 fish	3 fish	3 fish, 16" min	1 fish, 18" min	1 fish, 18" min
Clear	8 fish	3 fish	3 fish, 16" min	1 fish, 18" min	1 fish, 18" min
Ross	8 fish	3 fish	3 fish, 16" min	1 fish, 18" min	1 fish, 18" min

Big Eagle, Churchill, Spider, and 1st,2nd & 3rd Musquacook lakes were closed to the taking of whitefish in 2005. A minimum length limit of 16 inches was implemented for whitefish in Allagash Lake, Chamberlain Lake, Telos Lake, Umsaskis Lake, Long Lake, Big Indian Pond, Clear Lake, Ross Lake and St. Froid Lake. These regulations effectively eliminated harvest in some waters, while allowing whitefish to spawn at least once prior to being harvested in others. In 2012, limited harvest was allowed in waters previously closed to taking whitefish to restore some angler opportunity and foster continued support for the lake whitefish restoration program. In other waters, more restrictive regulations were implemented in an attempt to stem further whitefish population declines.

For restrictive fishing regulations (and the resultant lower harvest) to benefit a fish population, the underlying assumption is that the population was previously being suppressed by angler harvest. This can be extremely difficult to evaluate, and often regulations are put in place on an experimental basis and their impact is determined via future monitoring of the fishery. Since the severe restriction of whitefish harvest was implemented in 2003 (reduction of statewide bag limit) and 2005 (elimination of most harvest in several Allagash waters), angler catch rates of lake whitefish have shown no appreciable increase – in fact, most have continued to decline or have remained suppressed.

The drastic overall decline in lake whitefish populations in Big Eagle, Churchill, Spider, and the Musquacook Lakes took place sometime during the 1980's (Figure 3), shortly after smelts became well established in these lakes. Restrictive fishing regulations were put in place almost two decades after this decline, when populations were already suppressed, and these populations have not responded to the change in angler harvest. This lack of a response in the fishery to restricted harvest suggests that the regulations have been ineffective, and factors other than angler harvest (i.e. smelt) have been responsible for the lake whitefish declines. However, the ineffectiveness of these regulations does not necessarily prove that angler harvest doesn't impact lake whitefish. In most cases, populations are present in such low densities that catch rates are miniscule. Regardless of the regulation, angler harvest in these waters will be minor because they simply don't catch the whitefish, meaning the harvest rate is self-regulating. However, in waters where whitefish densities are high, anglers target whitefish, and harvest them in large numbers, there is still the possibility that populations can be over-fished. Ross, Clear and Chamberlain lakes are prime examples of destination fisheries where restrictive harvest regulations provide added security to prevent possible angler harvest-related population declines. Hundreds of lake whitefish are caught on these lakes annually, and added angler harvest could be very detrimental.

When managing a sport fish suffering widespread population downturn, severely restricting or eliminating angler harvest is a common approach. Such a strategy, while noble in its conservative intent, is often unwarranted and can produce negative social impacts among the angling public. The compilation of all available information on lake whitefish in Maine and other parts of the species' range is beginning to clearly identify rainbow smelt introductions as the primary cause for whitefish species declines, and show angler harvest to be insignificant, if not completely irrelevant, in its ability to control these populations. A small but dedicated group from throughout the angling community enjoy fishing for whitefish, and most appreciate the ability to harvest a few. Moving forward, lake whitefish species management in Maine should continue to recognize the importance of allowing angling and some level of angler harvest in the sport fishery. Specific regulations should balance protection of the fishery with harvest opportunity, given the role that limited harvest plays in maintaining support for lake whitefish management as a sportfish among Maine anglers.

Lake Whitefish Introductions and Hatchery Stocking Program

Early Lake Whitefish Culture

Whitefish culture has been around for a long time. The U.S. Fish Commission stocked whitefish fry throughout the U.S., including Maine waters, as early as the late 1800's. The vast majority of these stockings did not result in the establishment of fisheries, and were discontinued after a short time. In 1881, lake whitefish fry were stocked in the Rangeley Lakes. Two were collected from Umbagog Lake in 1905 but none have been seen since. Sources of eggs were from Lake Winnepesaukee, New Hampshire and the State of Michigan (perhaps Lake Michigan). In 1885 and 1888, Hebron Lake in Monson, Maine received stockings of a species of German whitefish (*Coregonus albula*). Fish from these stocking events apparently survived and reproduced, as whitefish were captured here as late as 1968, when the establishment of rainbow smelts may have caused their demise. *Coregonus albula* were also stocked in Heart Pond in the town of Orland in 1886.

About 125,000 "White Fish" from the Caribou, Maine fish hatchery were stocked in six northern Maine waters in 1902 – Prestile Stream, Cross Lake, Madawaska Lake, Little Huston Pond, Nickerson Lake and the Aroostook River. The species stocked is unclear, but limited records of correspondence indicate they may have come from Square Lake Thoroughfare on the Fish River Chain.

Lake Whitefish Transfers

Early lake whitefish introductions in Maine were the result of transfers of adults to new waters. In his seminal research of the unique dwarf form of lake whitefish found in Maine waters, MDIFW fishery biologist Owen Fenderson carried out two major lake whitefish transfers in northern Maine. In the autumn of 1962 and 1963, Fenderson transferred approximately 230 mature dwarf lake whitefish from 2nd Musquacook Lake to nearby Haymock Lake, a water that did not contain whitefish. A population quickly became established at Haymock Lake, and provided compelling insight on the phenotypic plasticity of the dwarf form of this species. In hindsight, this introduction also proved key to lake whitefish conservation. Rainbow smelts became established in 2nd Musquacook a decade later, and the dwarf lake whitefish population plummeted there. Haymock continues to support a very robust lake whitefish population in the absence of smelts, and is a potential source population for the restoration of stocks in other waters. Fenderson's second transfer involved moving dwarf lake whitefish from 2nd Musquacook to Clear Lake, which contained a population of lake whitefish without the dwarf form. This experiment failed to result in the establishment of dwarf lake whitefish in Clear Lake. From 1975-77, MDIFW staff transferred lake whitefish from 2nd Musquacook and Spider lakes to Great East Lake in southwestern Maine, in another attempt to establish a new population, but this failed as well.

Modern Lake Whitefish Hatchery Program

Modern lake whitefish culture in Maine has a much more recent history. An egg take from wild lake whitefish in Clear Lake in 1996 marked the initial attempt at whitefish culture in the state. Eggs were reared at MDIFW's Enfield Hatchery, where they suffered a very high mortality rate. While the project proved a valuable learning experience, it only resulted in 120 fall fingerling lake whitefish stocked into 2nd Musquacook Lake in 1997. In MDIFW's 2001 Whitefish Management Plan, the Coldwater Working Group identified the maintenance and restoration of lake whitefish sport fisheries as one of the most important priorities for whitefish management in the state. Following these recommendations, then-MDIFW whitefish principal investigator, biologist David Basley, implemented a plan for an experimental lake whitefish culture and stocking program aimed at restoring these sport fisheries. Clear Lake was identified as a suitable donor source for the taking of eggs. The first egg take in 2002 resulted in the stocking of 22,300 lake whitefish in six waters (including Clear Lake) in 2003. No brood stock were maintained at the hatchery, meaning the program required annual egg takes from wild fish. Subsequent annual attempts to take eggs were successful in 2004, 2006, 2007, 2008 and 2009. This program proved highly successful in producing high hatching and survival rates of cultured lake whitefish, and resulted in the stocking of more than 85,000 fish (including about 50,000 fall fingerlings and more than 30,000 fry) from 2003 to 2010 (Table 5). Fingerling lake whitefish were marked with a fin clip prior to stocking for future identification. The program was halted to allow for follow-up evaluation of stocked waters.

Table 5. Number of LWF stocked in Maine lakes, 1997-2010, by age class.

Lake	surface acres	years stocked	total # stocked
Churchill	3720	2003,08	3200 FF, 1000 AF
Clear	614	2003,09	28934 FR
Big Eagle	9500	2003,08,09,10	15384 FF, 4000 AF, 3500 FR
2nd Musquacook	813	1997,2003,07,08,09	3856 FF
3rd Musquacook	390	2008,09,10	1200 FF
Spider	890	2003,05,07,08,09,10	7445 FF
St. Froid	2400	2003,04,05,07,08,09,10	229 SY, 18014 FF

*FF=fall fingerling, AF=advanced fry, FR=fry, SY=spring yearling

To date, the lake whitefish stocking program has not proven successful in restoring or establishing sport fisheries. In the span of more than a decade since the original stocking, very few hatchery whitefish have been observed in the Allagash waters. No marked whitefish were captured in Churchill or 3rd Musquacook Lakes in gill net sampling events subsequent to stocking. During one sampling event, six marked whitefish were caught in Big Eagle Lake, but none were caught here during four other sampling events. Only three were captured in Spider Lake, and one in 2nd Musquacook Lake. These 10 marked fish represent just 4.3% of all lake whitefish captured in the five waters since hatchery fish were stocked and considered catchable in survey gear. They also represent a very miniscule percentage of the more than 30,000 lake whitefish stocked in these waters. In contrast, 213 marked whitefish were captured in seven gill net sampling events in St. Froid Lake since hatchery fish were stocked. Only one unmarked lake whitefish was captured in St. Froid, and was likely of hatchery origin.

A growing understanding of limitations to lake whitefish survival at the early life stages should lead to the strong assumption that stocking hatchery fish to bypass these stages would be highly successful. However, hatchery lake whitefish have not shown up in most of these populations in any significant numbers, which is difficult to explain. One possible reason is that the stocking densities were too low. Figure 7 displays densities of lake whitefish stocked in six lakes from 2003 to 2010. Despite relatively similar stocking densities among St. Froid, Spider, and 2nd Musquacook Lakes, the rate of return from St. Froid whitefish was astronomically higher than the others, indicating something other than stocking rates impacted hatchery returns.

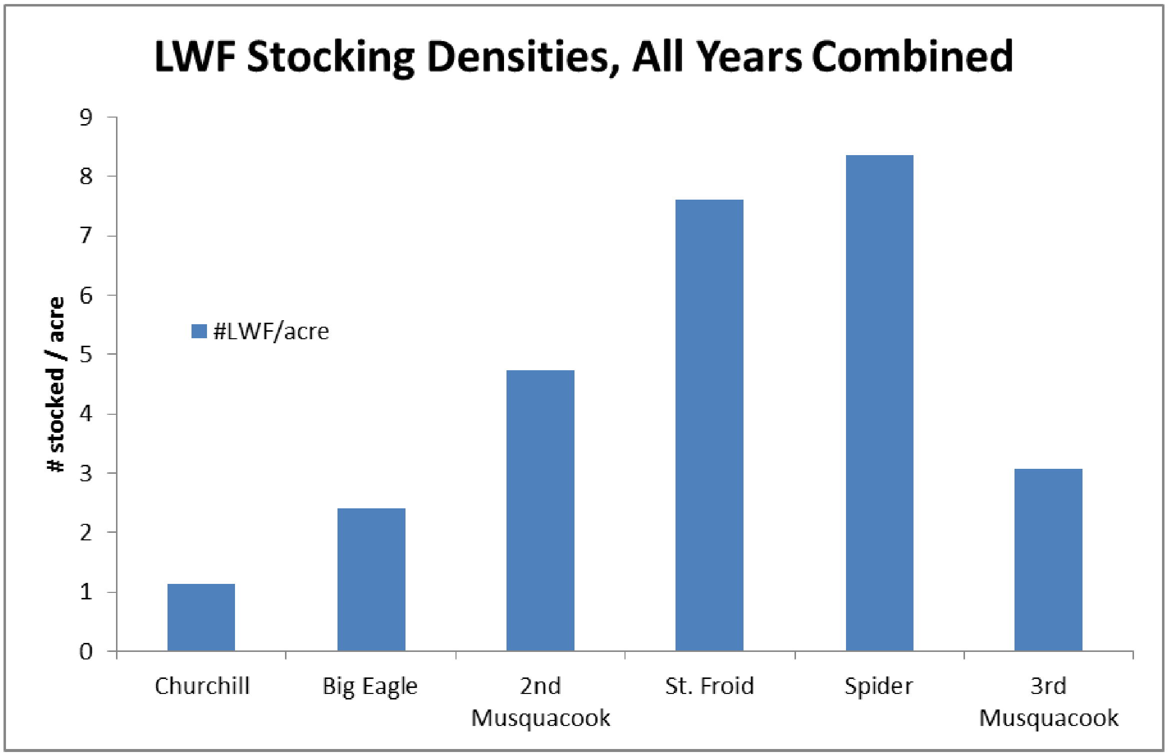

Figure 7. Densities of hatchery lake whitefish stocked in 6 Maine lakes, 2003-2010.

St. Froid Lake is the only one of the stocked waters that did not contain a population of lake whitefish prior to stocking. An abundance of unutilized lake whitefish habitat in the lake may have resulted in improved survival of hatchery fish. Lake trout numbers were extremely low during the lake whitefish stocking years, which may have sharply reduced predation pressure relative to the other waters. High vulnerability of fry and fingerling whitefish to predation may indicate the need to stock larger whitefish, perhaps growing these fish out to be stocked as spring yearlings. Additionally, many of the other waters contain populations of dwarf lake whitefish, which could have competed with the stocked fish and reduced their survival or growth to the size at which they became catchable in sampling gear. Dwarf lake whitefish are rarely caught by anglers and thus their populations may or may not reflect the trends seen in the creel survey catch rates. Finally, it is possible that not enough time has elapsed, or sample sizes are too small, to properly evaluate the returns of hatchery whitefish in these waters.

The lake whitefish hatchery program was intended to recover lost sport fisheries in the target lakes, as well as create a new fishery in St. Froid Lake. A side benefit was the potential for natural reproduction and a re-established population in St. Froid. Unfortunately, the whitefish stocked in Churchill, Big Eagle, Spider and 2nd/3rd Musquacook lakes have gone virtually undetected and have not resulted in a recovered sport fishery. Clear Lake saw the emergence of young whitefish in the population following stocking (see Table 3), but the fry stocked at Clear were unmarked and thus cannot be confirmed as being of hatchery origin. Survival of hatchery whitefish in St. Froid Lake was a great success. Unfortunately, these fish grew so slowly that after more than a decade, they still had not reached the size needed to attract a sport fishery. St. Froid lake whitefish approaching 10 years of age were still averaging only 12-13 inches long. In addition, no wild reproduction has been documented from this stocking, indicating that the biological factors (such as high smelt abundance) that led to their original extirpation are still at play.

Future Lake Whitefish Hatchery Program

The future of lake whitefish stocking in Maine will require a thoughtful review of the lessons learned from the previous program. The program's intent was to restore sport fisheries for whitefish in several key waters. Waters stocked at relatively low densities with existing lake whitefish populations (especially dwarf populations) did not see any recovery in their whitefish sport fishery. The water stocked at high densities with no existing lake whitefish population resulted in excellent survival, but very slow growth, and no immediate establishment of a sport fishery. Potential waters where the recovery of a sport fishery is more likely to meet with success include Fish River Lake and Carr Pond, where lake whitefish have been likely extirpated, but catches of large whitefish have been observed in the recent past. The proper stocking densities and time frame required for stocked lake whitefish to reach a target size for anglers in these waters is uncertain. Alternative strategies to increase lake whitefish survival and angling returns may include stocking larger, spring yearling fish.

A lake whitefish hatchery program may also be an important element of recovery efforts by re-establishing populations or adding new ones, as was proven successful in Haymock Lake. Waters targeted for such introductions must contain suitable habitat and fish species assemblages, and different strategies may be necessary to achieve successful establishment of lake whitefish through a stocking program.

Moving forward, a lake whitefish hatchery program remains a viable option for both sport fishery and species recovery efforts, but must be firmly based on 1) lessons learned from the current program, 2) future research determining the likelihood of success, and 3) a realistic understanding of the long time frames (perhaps decades) often needed to achieve the desired results.

LAKE WHITEFISH RESEARCH AND MONITORING IN MAINE

Since the 2001 whitefish species assessment and management plan, significant efforts have been made to advance research and monitoring in lake whitefish waters. Monitoring of these populations by MDIFW continues as part of, and in addition to, routine lake survey work. Data from these routine surveys are reflected in the summary of lake whitefish waters presented earlier in this document and in Appendix A. Needs for future monitoring of specific waters have been identified and will be addressed as resources allow. Beyond routine monitoring of lake whitefish occurrence and basic population trends, there exists a substantial need for research to better understand the whitefish/smelt interaction as well as some basic life history information to better direct future management needs. The following is a summary of the past and present lake whitefish research completed in Maine.

Lake Whitefish Research

Early documentation

Whitefish were documented in Maine at least as early as 1868, when a report of the Maine Fish Commission mentioned catching whitefish with hook and line on Moosehead Lake. W.C. Kendall of the U.S. Fish Commission, a Maine native and pioneer in the fisheries profession, was the first to officially document more than one species of whitefish in Maine waters. For a few years beginning around 1901, Kendall worked for the Commission surveying and recording fish species in the Fish River Chain. He identified and named three distinct species in Eagle Lake and several of the Chain's other waters: Common Whitefish, Chivy, and Stanley's Whitefish. These correspond with what we now recognize as the lake whitefish, round whitefish, and dwarf lake whitefish, respectively. The dwarf form is currently not considered a separate species but modern research is beginning to validate Kendall's classification.

Dwarf and normal lake whitefish

Lake whitefish research in Maine resumed in the 1950's, when Maine's modern Fisheries Division was formed and biologists were assigned to field offices throughout the state. Owen Fenderson, a young biologist stationed in Aroostook County, was tasked with gaining a better understanding of the dwarf form of lake whitefish, which had by that time been extirpated from Fish River waters, but was being discovered in the headwater lakes of the Allagash River. Interest lied in the introduction of dwarf whitefish as a forage fish to improve lake trout growth, but the ensuing research led to a much greater understanding of lake whitefish as a whole. After several years of intensive study, Fenderson used morphology, blood work and spawning observations to identify the distinct dwarf form of lake whitefish in 22 lakes in northwestern Maine (Fenderson 1964). The most distinguishing features of the dwarf form were their early maturity and small adult size, short life span and a frequency of gill rakers distinct from normal lake whitefish. Fenderson also experimented by transferring dwarf lake whitefish from 2nd Musquacook Lake into two nearby waters – Haymock Lake and Clear Lake. In Haymock, the dwarfs survived and matured early, but grew to a much larger size, assuming characteristics of the normal form. Decades later, however, they appeared to revert to the dwarfed condition. The dwarf form of lake whitefish transferred to Clear Lake, which had never had a population of the dwarf fish, never became established.

The study of the phenomenon of dwarfism in lake whitefish populations became the primary focus of Dr. Louis Bernatchez of Laval University in Quebec. Bernatchez worked with MDIFW's whitefish principal investigator David Basley to collect data from Maine lakes for 25 years and continues to research Maine lake whitefish today. Using cutting edge DNA technology, the Bernatchez lab identified three distinct lineages of lake whitefish in Maine, and demonstrated that the dwarf form of lake whitefish appears to represent the formation of a new species via niche partitioning and reproductive isolation. This work has produced groundbreaking results that have advanced the fields of genetics, ecology, and the process of speciation.

Lake whitefish life history and interactions with rainbow smelts

As declines in lake whitefish populations became evident in the 1980's and 1990's, the need for basic research on the biology and life history of the species, as well as their interactions with other fish species, emerged. More specifically, there was a growing need to understand the biological drivers of the lake whitefish declines, with a particular focus on the interaction with rainbow smelt.

In cooperation with MDIFW, the University of Maine at Orono began research on lake whitefish life history and interactions with rainbow smelt around 2004. Dimitry Gorsky and Joseph Zydlewski began the study with the objectives summarized below:

1) Identify daily, seasonal and spawning habitat use of lake whitefish
2) Investigate resource competition between larval lake whitefish and larval rainbow smelt
3) Determine the level of predation on larval lake whitefish by adult rainbow smelt
4) Summarize data on lake whitefish and smelt presence in Maine lakes

Lake whitefish from Clear Lake were implanted with acoustic tags and their locations were monitored in relation to water depth and temperature from 2004 to 2009. Results showed that lake whitefish exhibited seasonal patterns of depth distribution related to water temperature and daily patterns of depth distribution related to daylight (Gorsky et. al 2012). No information on spawning locations, areas of congregation or habitat overlap between lake whitefish and smelts were discovered. A similar study was attempted on Big Eagle Lake, but too few whitefish were captured to complete the work.

A laboratory study was initiated to investigate competition among lake whitefish and between lake whitefish and smelts (Gorsky 2011). Results showed that growth of larval whitefish was affected by both food availability and fish density. Higher fish densities and lower food availability resulted in slower growth among lake whitefish reared in the lab, indicating the potential for intraspecific competitive effects at the larval stage in lake whitefish populations. When larval lake whitefish were reared with larval rainbow smelt at varying proportions, whitefish growth was not negatively impacted by smelts, indicating that smelts may not impact lake whitefish via competition at the larval stage. However, the interspecific competition experiment involved only one overall fish density and level of food availability, and a constant water temperature. It is reasonable to expect that competition may be mediated by different fish densities, levels of food availability and changes in water temperature in a lake environment. While competition between larval lake whitefish and rainbow smelt seems less likely than previously thought, it cannot be ruled out and warrants further investigation.

To determine the potential for adult rainbow smelt to impact larval lake whitefish via predation, the researchers attempted to collect adult smelts in the wild and examine their stomach contents for whitefish. An adequate sample of smelts was not obtained; however, two of the four smelts captured had what was believed to be lake whitefish fry in their stomachs. This is an area of research that needs further exploration.

The smelt predation question was alternatively explored via a laboratory experiment where larval lake whitefish of varying sizes were exposed to adult rainbow smelts (four to five inches in length) and predation efficiency was observed (Gorsky and Zydlewski 2013). Results showed that smelts were highly efficient in preying on small whitefish larvae, and predation efficiency decreased with increasing whitefish size. Smelts ate small, recently hatched whitefish larvae at 100% efficiency, and were able to consume larvae up to 45 millimeters in length. This study further demonstrated the ability of smelts to control lake whitefish recruitment via predation, and indicates that factors such as adult smelt size, whitefish growth rate, timing of whitefish hatching and smelt feeding, and spatial overlap of the two species all may contribute to the level of impact smelts may have on larval lake whitefish in different lakes. More intense investigation of these variables, as well as documenting such predation in key lake whitefish waters is a critical area of research necessary for whitefish management going forward.

Following up on this work, Silas Ratten and Zydlewski investigated lake whitefish habitat use in St. Froid Lake in 2011 to 2013 (Ratten 2013). They found patterns similar to the Gorsky study, with whitefish depth distribution and spatial location within the lake being related to water temperature and daylight. The work failed to identify spawning locations or otherwise significant patterns in whitefish movement.

Ratten also documented age and growth of lake whitefish from Clear and St. Froid lakes using sagittal otoliths. He found whitefish in Clear Lake to be older than previously thought – up to 30 years of age. These results add perspective to the analysis of lake whitefish populations, indicating that adults of a particular population may represent recruitment that occurred much earlier than previously believed, oftentimes even pre-dating the establishment of smelts. This information highlights the need to collect consistent, reliable age and growth data to properly evaluate lake whitefish populations in Maine Lakes and ensure consistently adequate recruitment to sustain these populations.

Current and future research needs

Despite the increased level of research in Maine since the 2001 Whitefish Assessment, there is a substantial need for basic lake whitefish research, as well as enhanced monitoring efforts in the state. The current review of information and trends based on available data highlight the importance of several key information needs. Several of these are described below.

Are lake whitefish populations experiencing sustainable levels of recruitment?

<u>Data needs</u>

-robust age & growth samples using otoliths to document year classes

-presence and abundance of young of year and/or sub-adult lake whitefish

Do adult smelts impact lake whitefish recruitment via predation on larval whitefish?

<u>Data needs</u>

-spatial distribution of lake whitefish fry and adult smelts

-diet samples from adult smelt stomachs during predation window

-growth rate of larval lake whitefish in the lake environment

Do larval smelts and lake whitefish compete for food and space in lake environments?

Data needs

-spatial distribution, diet information and degree of overlap between larval whitefish and smelts

Why do lake whitefish populations appear to be persisting in some waters while having severely declined in others?

Data needs

-a compilation of physical habitat data, spawning locations, early life history and related information from a variety of lake whitefish waters over time, combined with answers to the questions above, to draw conclusions on factors contributing to whitefish persistence and how these may be managed to recover whitefish in waters where they are failing or have been extirpated

Recommendations for future Lake Whitefish Research and Management Activities in Maine

MDIFW and its partners have made significant advancements in the understanding of lake whitefish populations in Maine since the 2001 Whitefish Plan, and have taken on substantial management activities to recover the species. This work has resulted in the creation of a database of whitefish waters, highlighted further lake monitoring needs, created guidelines for future fishing regulation and stocking strategies, and developed a focused view on research needs. Perhaps more than anything, this work has highlighted the difficulty and complexity of lake whitefish restoration in Maine. MDIFW fisheries staff remain committed to understanding, managing and restoring whitefish and their accompanying sport fisheries, and the following are recommendations for lake whitefish management moving forward, to be pursued as staff time and resources allow:

1) **Use the newly created list of lake whitefish waters in Appendix A to help guide monitoring efforts in regional work plans, with a particular emphasis on waters where the species' status is currently unknown.**
2) **Increase efforts to collect, analyze and catalog age and growth data from lake whitefish, primarily through the use of otoliths where possible.**
3) **Implement a long-term, detailed and rigorous water-specific lake whitefish research project aimed at answering the following questions:**
    a. **What are the best tools to monitor lake whitefish recruitment in specific waters?**

   b. **How do smelts and other fish species impact lake whitefish recruitment in specific waters, and what environmental/habitat factors mediate these interactions?**
   c. **Which management strategies are most effective at reducing the impact smelts and other fish species have on lake whitefish recruitment?**

4) **Explore lake whitefish stocking strategies in waters where they are likely to be successful at restoring a fishery.**
5) **Identify waters with potential for re-introduction of extirpated lake whitefish populations or establishment of new populations.**

Future lake whitefish work in Maine should focus on the above objectives, and can be expected to result in the development of new or modified objectives as new information becomes available, staff resources change, and different circumstances develop. Maintaining a strong commitment to the recovery and conservation of lake whitefish populations and fisheries statewide should remain a top priority for MDIFW's fisheries division.

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APPENDIX A – Current inventory of Lake Whitefish Waters identified in MDIFW's 2001 Whitefish Assessment

**lakes are sorted by MDIFW management region*

**species abbreviations used below: LWF-lake whitefish, SLT-rainbow smelt, LKT-lake trout, LMB-largemouth bass, LLA-landlocked alewives, MUS-muskellunge, FLF-fallfish, LLS-landlocked salmon, BKT-brook trout, SMB-smallmouth bass, WHP-white perch, YLP-yellow perch*

REGION A

Kezar Lake (0097), Lovell, Oxford County, 2,600 acres

Summary: While LWF have been occasionally observed here in the past 15 years, it is likely that the population has not experienced any recruitment for a long period of time, and is probably in the process of becoming extirpated.

Current status: Present.

Changes: LWF still present but likely declining.

Knowledge of the LWF population: Adequate sampling data (annual surveys for the past 15+ years) to determine that LWF are extremely rare here and it is doubtful that a population still occurs. One 18"+ LWF observed here in 2000, possibly one additional LWF since then.

Future threats: If no successful recruitment takes place, the remaining LWF will age out of the population and LWF will cease to exist in Kezar.

Recommendations: Options are limited due to presence of numerous other fish species in the lake. Should continue periodic monitoring. LWF recovery here is probably not a feasible option.

Lovewell Pond (3254), Fryeburg, Oxford County, 1,120 acres

Summary: LWF are still present here but likely in very low numbers.

Current status: Present.

Changes: LWF still present but likely declining.

Knowledge of the LWF population: Limited to a few observations. Last sampling event (2006) captured 3 LWF but they were larger, potentially older LWF. It is unclear whether any recent recruitment has taken place in this population, and thus more information is needed to make a clear determination.

Future threats: Presence of invasive fish species that limit LWF recruitment.

Recommendations: Increase sampling efforts to determine whether a self-sustaining LWF population still exists here.

Sebago Lake (5786), Sebago, Cumberland County, 28,771 acres

Summary: LWF are still encountered at Sebago, but in very low numbers.

Current status: Population.

Changes: No known recent trends.

Knowledge of the LWF population: Very limited. It is unclear whether recent recruitment has taken place in this population and whether it will persist in the long term. More information is needed to make a clear determination here.

Future threats: Lack of recruitment could cause the population to become extirpated.

Recommendations: Increase sampling efforts to confirm that a self-sustaining LWF population still exists in Sebago.

South & Round Pond (9683), Greenwood, Oxford County, 284 acres

Summary: LWF are still present here, but individuals sampled are of large size and old age. It is doubtful that a self-sustaining population still exists.

Current status: Present.

Changes: N/A.

Knowledge of the LWF population: LWF caught in 2015 survey. More information is needed to determine whether a population still occurs here.

Future threats: Lack of recruitment to the population could cause it to become extirpated.

Recommendations: Increase sampling efforts to determine whether a self-sustaining LWF population still exists here.

REGION C

Big Lake (1288), Grand Lake Stream, Washington County, 10,305 acres

Summary: LWF are present in Big Lake, but it is unclear whether the lake supports a self-sustaining population. LWF caught here may be drop-downs from West Grand Lake, which flows into Big Lake and supports a large population.

Current status: Present.

Changes: None observed.

Knowledge of the LWF population: Limited – LWF are known to occur here but no evidence to determine natural reproduction.

Future threats: New populations of LMB and LLA established in recent years likely pose a threat.

Recommendations: Attempt to determine whether LWF reproduce in Big Lake by finding potential spawning sites and monitoring for juvenile LWF.

Pocumcus Lake (1110), T6 ND BPP, Washington County, 2,201 acres

Summary: LWF in Pocumcus are likely part of a large interconnected population that also occurs in West Grand, Lower Sysladobsis, Junior, and Scraggley lakes.

Current status: Population.

Changes: Some decline but still large population.

Knowledge of the LWF population: Good – observed regularly during routine sampling. A LWF sport fishery exists here in the wintertime.

Future threats: Potential overharvest and lack of recruitment due to interactions with smelts. LMB and LLA now occur in downstream lakes, and if they become established in Pocumcus, could pose a threat to LWF.

Recommendations: Continue routine monitoring. Consider research to identify LWF spawning areas within this lake network.

West Grand Lake (1150), T5 ND BPP, Washington County, 14,340 acres

Summary: West Grand Lake supports a robust LWF population and popular sport fishery, particularly during the winter months. Angler harvest is considerably high. The LWF here are likely part of a large interconnected population that also occurs in Pocumcus, Lower Sysladobsis, Junior, and Scraggley lakes.

Current status: Population.

Changes: Some decline but still healthy population.

Knowledge of the LWF population: Good – LWF seen regularly during routine sampling.

Future threats: Potential overharvest and lack of recruitment due to interactions with smelts. LMB and LLA now occur in downstream lakes, and if they become established, could pose a threat to LWF.

Recommendations: Continue routine monitoring. Consider research to identify LWF spawning areas within this lake network. Collect and analyze age and growth information to ensure that multiple age classes are present and the population is likely to persist over time.

REGION E

Caucomgomoc Lake (4012), T6R14, Piscataquis County, 5,081 acres

Summary: The status of LWF in Caucomgomoc is unknown . Because they have not been encountered here despite survey work done by regional staff, if present they would likely be in low abundance.

Current status: Unknown.

Changes: N/A.

Knowledge of the LWF population: Minimal – LWF were last taken here in 1990. Survey efforts failed to take them in 1994.

Future threats: N/A.

Recommendations: Increase survey efforts to determine if LWF are still present here.

Chesuncook Lake (0662), T3R11 etc., Piscataquis County, 26,200 acres

Summary: The status of LWF in Chesuncook Lake is unknown. Because they have not been encountered here despite intensive creel survey work done by regional staff, if present they would likely be in low abundance.

Current status: Unknown.

Changes: N/A.

Knowledge of the LWF population: Minimal – LWF were last taken here in 1970. Survey efforts have failed to take them since then.

Future threats: N/A.

Recommendations: Increase survey efforts to determine if LWF are still present here.

Dole Pond (2454), Dole Brook Twp., Somerset County, 704 acres

Summary: LWF are believed to be extirpated from Dole Pond. Extirpation likely occurred much prior to the 2001 plan update, but the pond remained on the list pending further survey work and confirmation. SLT were confirmed here in 1977. Intensive survey work in 2005 and 2010 failed to take LWF.

Current status: Extirpated.

Changes: Extirpation likely occurred decades ago.

Knowledge of the LWF population: Adequate to determine that the population no longer exists.

Future threats: N/A.

Recommendations: Periodic monitoring of other fish species may detect LWF in the slim chance that they still occur here.

Harrington Lake (0700), T3R11, Piscataquis County, 1,332 acres

Summary: LWF are believed to be extirpated from Harrington Lake. SLT became established here around 1958, and LWF were last seen in 1967. Extirpation likely occurred much prior to the 2001 plan update, but the lake remained on the list pending further survey work and confirmation. Surveys in 1982, 1991, 2009, 2010 and 2011 took no LWF.

Current status: Extirpated.

Changes: Extirpation likely occurred decades ago.

Future threats: N/A.

Knowledge of the LWF population: Adequate to determine that the population no longer exists.

Recommendations: Periodic monitoring of other fish species may detect LWF in the slim chance that they still occur here.

Hebron Lake (0301), Monson, Piscataquis County, 525 acres

Summary: *Coregonus albula*, a German species of whitefish, was introduced to Hebron Lake via stocking of fry in 1885 and 1888. Apparently, a population became established, as whitefish were taken here as late as 1968. SLT became established around 1960 and no whitefish have been observed here since.

Current status: Other – probably never had a population.

Changes: N/A.

Knowledge of the LWF population: Adequate to determine that a population does not exist.
Future threats: N/A.
Recommendations: Consider potential to introduce LWF here, as whitefish demonstrated ability to survive in the past. Unlikely to be feasible due to presence of rainbow smelt.

Big Hurd Pond (4014), T6R15, Piscataquis County, 250 acres

Summary: LWF have never been sampled in Big Hurd Pond, but it was assumed that they occurred here due to its direct connection to Loon Lake, where LWF were known to occur at the time. It is unlikely that a LWF population ever existed here.
Current status: Other – likely never a population.
Changes: N/A.
Knowledge of the LWF population: Adequate to determine that a population does not exist.
Future threats: N/A.
Recommendations: Periodic monitoring of other fish species may detect LWF in the slim chance that they occur here.

Indian Pond (4090), Indian Stream Twp, etc, Somerset County, 3,746 acres

Summary: Indian Pond is an artificial impoundment created in 1953 near the outlet of Moosehead Lake. Two LWF were surveyed here in 1957, likely dropdowns from the Moosehead Lake population at the time. LWF have not been taken here since, and there likely was never a population here.
Current status: Other – likely never had a population.
Changes: N/A.
Knowledge of the LWF population: Adequate to determine that a population does not exist.
Future threats: N/A.
Recommendations: Periodic monitoring of other fish species may detect LWF in the slim chance that they occur here.

Johnson Pond (2986), T8R14, Piscataquis County, 197 acres

Summary: Johnson Pond supports a stable population of LWF despite its relatively small size.
Current status: Population.
Changes: None.
Knowledge of the LWF population: Good – periodic surveys and professional judgement by regional biologist.
Future threats: Threat from establishment of SLT (discovered in 1983).
Recommendations: Regular population monitoring to determine impact of potential LWF/SLT interaction.

Lobster Lake (2948), T3R14, etc, Piscataquis County, 3,745 acres

Summary: The status of LWF in Lobster Lake is unknown. Because they have not been encountered here despite survey work done by regional staff from 1986 to 2007, if present they would likely be in low

abundance. Anglers did occasionally report catching LWF, however they were likely FLF, which are very abundant in the lake.
Current status: Unknown.
Changes: N/A.
Knowledge of the LWF population: Minimal – LWF were last taken here in 1958. Survey efforts have failed to take them since then.
Future threats: N/A.
Recommendations: Increase survey efforts to determine if LWF are still present here.

Long Pond (9861), Dole Brook Twp., Somerset County, 845 acres
Summary: LWF are believed to have been extirpated from Long Pond. SLT are established here and may be the reason LWF disappeared. Extirpation likely occurred much prior to the 2001 plan update, but the pond remained on the list pending further survey work and confirmation. Surveys in 1978, 1992, 2009 and 2010 took no LWF.
Current status: Extirpated.
Changes: Extirpation likely occurred decades ago.
Knowledge of the LWF population: Despite intensive survey work, LWF not seen here since 1978.
Future threats: N/A.
Recommendations: Periodic monitoring of other fish species may detect LWF if they still occur here.

Loon Lake (4024), T6R15, Piscataquis County, 1,140 acres
Summary: The status of LWF in Loon Lake is unknown. LWF were taken in the original lake survey in 1974. Data are not adequate to determine whether a population still occurs here. Loon Lake is in the Caucomgomoc Lake drainage where LWF status is also unknown.
Current status: Unknown.
Changes: N/A.
Knowledge of the LWF population: Inadequate to make a determination on status.
Future threats: N/A.
Recommendations: Increase survey efforts to determine if LWF are still present here.

Moosehead Lake (0390), Greenville, etc., Piscataquis County, 74,890 acres
Summary: LWF are believed to have been extirpated from Moosehead Lake. No LWF have been observed here since 1983. It is likely that the establishment of nonnative species, namely SLT and potentially others, played a role in their demise. Extirpation likely occurred much prior to the 2001 plan update, but the lake remained on the list pending further survey work and confirmation.
Current status: Extirpated.
Changes: Extirpation likely occurred decades ago.
Knowledge of the LWF population: Despite intensive survey work, LWF not seen here since 1983.
Future threats: N/A.
Recommendations: Periodic monitoring of other fish species may detect LWF if they still occur here.
First Roach Pond (0436), TAR13, Piscataquis County, 3,270 acres

Summary: LWF are believed to have been extirpated from First Roach Pond. No LWF have been observed here since 1987. It is likely that the establishment of nonnative species, namely SLT and potentially others, played a role in their demise. Extirpation likely occurred long before the 2001 plan update, but the pond remained on the list pending further survey work and confirmation. The lake has been extensively surveyed over the past 25 years, with no LWF taken.
Current status: Extirpated.
Changes: Extirpation likely occurred long before the 2001 plan update.
Knowledge of the LWF population: Adequate to determine population has likely been extirpated.
Future threats: N/A.
Recommendations: Periodic monitoring of other fish species may detect LWF if they still occur here.

Second Roach Pond (0452), TAR12, Piscataquis County, 970 acres
Summary: LWF are believed to have been extirpated from Second Roach Pond. No LWF have been observed here since 1956. It is likely that the establishment of nonnative species, namely SLT and potentially others, played a role in their demise. Extirpation likely occurred much prior to the 2001 plan update, but the pond remained on the list pending further survey work and confirmation. Surveys in 1974, 1982, 1988 and 1993 took no LWF.
Current status: Extirpated.
Changes: Extirpation likely occurred decades ago.
Knowledge of the LWF population: Adequate to determine population has likely been extirpated.
Future threats: N/A.
Recommendations: Periodic monitoring of other fish species may detect LWF if they still occur here.

Third Roach Pond (0482), TAR12, Piscataquis County, 570 acres
Summary: The status of LWF in Third Roach Pond is not fully known. LWF have likely been extirpated from First and Second Roach ponds, and have likely been extirpated here as well, but a population does exist in Fourth Roach Pond, just upstream of Third. It is possible that a population exists here, or LWF are simply present as a result of movement from Fourth Roach. Survey work in 1988, 1990 and 1996 took no LWF. More work is necessary to make a positive determination.
Current status: Unknown.
Changes: N/A.
Knowledge of the LWF population: Inadequate to make a determination of status.
Future threats: N/A.
Recommendations: Increase survey efforts to determine if LWF are still present here.

Fourth Roach Pond (0446), TAR12, Piscataquis County, 266 acres
Summary: LWF are believed to be common in Fourth Roach Pond, despite having been likely extirpated from the other Roach Ponds.
Current status: Population.
Changes: None known.
Future threats: The presence of SLT and other competing species likely pose a threat to LWF here.
Recommendations: Continued periodic monitoring to ensure LWF persist.

Fourth St. John Pond (2416), T5R17, Somerset County, 198 acres

Summary: LWF are believed to be common in Fourth St. John Pond. Only the dwarfed form of LWF is present here. The use of live fish as bait is restricted here in attempt to prevent potential introduction of SLT, though the establishment of MUS may have negative impacts similar to, or greater than potential smelt presence.

Current status: Population.

Changes: None known.

Future threats: MUS have become established here and will likely influence the LWF population via predation.

Recommendations: Continued periodic monitoring to ensure LWF persist despite presence of MUS.

Trout Pond (0448), TAR12, Piscataquis County, 145 acres

Summary: Trout Pond supports a LWF population, but their abundance is believed to be low. Marginal LWF habitat and competition from other species will likely continue to threaten the LWF population. The Trout Pond LWF are believed to be of the dwarfed form only.

Current status: Population.

Changes: None known.

Future threats: Competition with other fish species may impact LWF here. SLT are not present, but YLP, sunfish and other competing species are.

Recommendations: Continue periodic monitoring to ensure LWF persist here.

Umbazooksus Lake (2890), T6R13, Piscataquis County, 1,590 acres

Summary: The status of LWF in Umbazooksus Lake is unknown. LWF were considered abundant here in the 1967 lake survey, but little work has occurred here since.

Current status: Unknown.

Changes: N/A.

Future threats: N/A.

Recommendations: Increase survey efforts to determine if LWF are still present here.

Allagash Lake (9787), T8R14, Piscataquis County, 4,260 acres

Summary: An abundant, stable LWF population exists in Allagash Lake and supports a popular sport fishery.

Current status: Population.

Changes: None.

Future threats: Competitive/predatory impacts of SLT.

Recommendations: Continued periodic monitoring to ensure LWF persist here.

Chamberlain Lake (2882), T7R12 etc., Piscataquis County, 11,084 acres

Summary: An abundant, stable LWF population exists in Chamberlain Lake and supports a popular sport fishery.

Current status: Population.

Changes: Population appears to be increasing.

Future threats: The presence of SLT and other competing species.
Recommendations: Continued periodic monitoring to ensure LWF persist here.

Telos Lake (and Round Pond) (2710), T6R11, Piscataquis County, 2,276 acres
Summary: An abundant, stable LWF population exists in here and supports a popular sport fishery.
Current status: Population.
Changes: None.
Future threats: The presence of SLT and other competing species .
Recommendations: Continued periodic monitoring to ensure LWF persist here.

REGION F

Lower Jo-Mary Lake (0984), T1R10, Piscataquis County, 1,910 acres
Summary: A stable population of LWF is present here.
Current status: Population.
Changes: None known.
Knowledge of the LWF population: Good – caught LWF of all size ranges in 1959, 1969, 1995, 2004 and 2012.
Future threats: Impacts from invasive species, including SLT.
Recommendations: Continue periodic monitoring.

Upper Jo-Mary Lake (0243), TAR10, Piscataquis County, 1,873 acres
Summary: LWF historically occurred in Upper Jo-Mary, but the population appears to have become extirpated since the introduction of SLT in 1970.
Current status: Extirpated.
Changes: Extirpation likely occurred decades ago.
Knowledge of the LWF population: Caught LWF here in 1962, but none during 8 survey events from 1976 to 2012.
Future threats: N/A.
Recommendations: Future monitoring of other species may detect LWF if they do occur here.

Junior Lake (4708), T5R1, Penobscot County, 3,866 acres
Summary: LWF in Junior are likely part of a large interconnected population that also occurs in West Grand, Pocumcus, Lower Sysladobsis and Scraggley lakes.
Current status: Population.
Changes: None.
Knowledge of the LWF population: Good – multiple age classes observed regularly in creel survey and gill netting.
Future threats: Possible negative interactions with nonnative fish species.
Recommendations: Continue routine monitoring.

Mattawamkeag Lake (1686), Island Falls, Aroostook County, 3,330 acres

Summary: The status of LWF in Mattawamkeag is unknown.

Current status: Unknown.

Changes: N/A.

Knowledge of the LWF population: Minimal - LWF were captured here in 1956, 1962, 1971 and 1982, but no survey work has been done since 1982. No LWF have been reported caught here in decades.

Future threats: Unknown.

Recommendations: Survey to determine whether a LWF population still occurs here.

Scraggley Lake (9649), T5R1, Penobscot County, 2,758 acres

Summary: LWF in Scraggley are likely part of a large interconnected population that also occurs in West Grand, Pocumcus, Lower Sysladobsis and Junior lakes.

Current status: Population.

Changes: None.

Knowledge of the LWF population: Good – routinely observed in winter sport fishery surveys.

Future threats: Possible interactions with nonnative fish species.

Recommendations: Continue periodic monitoring.

Spednik Lake (0121), Vanceboro, Washington County, 17,219 acres

Summary: Spednik is a large lake on the Maine/New Brunswick border with highly complex physical habitat and an abundance of different fish species.

Current status: Population.

Changes: None known.

Knowledge of the LWF population: Minimal, but LWF last surveyed in 2007 netting.

Future threats: Interactions with invasive fish species, particularly LLA and SLT. In addition, LMB are present in the St.Croix River system below Spednic Lake, and could become established through illegal introduction.

Recommendations: Increase survey efforts to gain better understanding of the LWF population.

Upper Sysladobsis Lake (4688), Lakeville Plt., Penobscot County, 1,142 acres

Summary: Upper Sysladobsis is in the same drainage as the complex of lakes around West Grand, but contains a LWF population that is believed to be relatively isolated from the others due to the length of stream between it and Lower Sysladobsis.

Current status: Population.

Changes: None known.

Knowledge of the LWF population: Good (LWF caught in nets in 1998, 2000 and 2008), though recent recruitment (small, young fish) not documented.

Future threats: Interactions with the abundance of other fish species present here.

Recommendations: Continue periodic monitoring, look for evidence of recruitment.

Upper Cold Stream Pond (2232), Lincoln, Penobscot County, 685 acres

Summary: LWF were never historically documented in Upper Cold Stream Pond, and the population is believed to have been introduced by anglers around the 1970's.

Current status: Population.

Changes: None known.

Knowledge of the LWF population: Good – seen in surveys in 1976, 1979, 1981, 1990, 1997 and 2010.

Future threats: Presence of other fish species, small water size and limited habitat may threaten population persistence.

Recommendations: Continue periodic monitoring.

1st Debsconeag Lake (2060), T2R10, Piscataquis County, 320 acres

Summary: A healthy LWF population occurs in this small water with a direct connection to the Pemadumcook Chain.

Current status: Population.

Changes: None known.

Knowledge of the LWF population: Good – seen in surveys in 1991, 1992 and 2006.

Future threats: Presence of rainbow smelts.

Recommendations: Continue periodic monitoring and document evidence of recruitment.

Deering Lake (0507), Orient, Aroostook County, 474 acres

Summary: Deering is a small lake with numerous fish species present, including LLS and SLT. Very low numbers of LWF are caught here during each survey, and this small population may be challenged to persist.

Current status: Population.

Changes: Possibly fewer younger, smaller LWF present.

Knowledge of the LWF population: Okay – caught in 1973, 1975, 1979, 1989, 1996, 2002 and 2008, but in low numbers. Recently only large LWF have been caught.

Future threats: Challenges to recruitment due to interactions with SLT and other fish species.

Recommendations: Increase monitoring and look for evidence of recruitment to determine whether the population continues to sustain itself.

East Grand Lake (1070), Weston, Aroostook County, 16,070 acres

Summary: East Grand is a large, complex water body in the St. Croix River system along the Maine/New Brunswick border. Similar to Spednik Lake, a LWF population occurs here, but knowledge of its current status is limited. A popular LWF sport fishery occurred here historically but has waned with the introduction of LLA and explosion of the lake's LKT and CSK fishery.

Current status: Population.

Changes: None known.

Knowledge of the LWF population: Limited, but adequate to determine a population exists – LWF caught in 1969, 1984 and 2002. Observed in creel survey in 1990 and 2010.

Future threats: Interactions with other fish species, namely SLT and LLA. In addition, LMB are present in the St.Croix River system below Spednic Lake, and could become established through illegal introduction.
Recommendations: Increase gill netting efforts to target LWF and learn more about population status.

Matagamon Lake (4260), T6R8, Penobscot/Piscataquis counties, 4,165 acres

Summary: Small numbers of LWF have been consistently caught here in survey efforts over the years, and are targeted by some anglers. It is uncertain whether this is a native LWF population or was introduced from the Allagash watershed in the 1800's via the Telos Cut.

Current status: Population.

Changes: None.

Knowledge of the LWF population: Good – caught in surveys in 1954, 1962, 1963, 1965, 1966, 1971, 1974, 1977, 1981, 1988, 1990, 2008 and 2014.

Future threats: Minimal, but possible interactions with nonnative fish species and impacts from water level management at Matagamon Dam.

Recommendations: Continue periodic monitoring.

Millinocket Lake (2020), T1R8, Penobscot County, 8,960 acres

Summary: The Millinocket Lake LWF population appears to be in low abundance, but LWF have been captured here fairly consistently over the years. Numbers seem to be adequate enough to support a sport fishery.

Current status: Population.

Changes: None known.

Knowledge of the LWF population: Good – LWF caught in 1954, 1968, 1969, 1976, 1979, 1988, 1992, 1996, 2001 and 2012.

Future threats: Challenges to LWF recruitment due to limiting habitat and interactions with other species.

Recommendations: Continue monitoring and determine whether recruitment remains adequate to support population. Ensure a sport fishery is still supported by this LWF population.

Pemadumcook Chain Lake (0982), T4 Indian Purchase, Penobscot County, 18,300 acres

Summary: The Pemadumcook Chain is a very large water body with diverse fish habitat. A very robust LWF population occurs here. LWF are caught in large numbers here during survey efforts, but are not targeted by many anglers.

Current status: Population.

Changes: None known.

Knowledge of the LWF population: Very good – caught in 1957, 1977, 1980, 1987, 1992, 1996, 1999, 2004 and 2008.

Future threats: Minimal, but possible interactions with other fish species or water level management via the outlet dam.

Recommendations: Continue periodic monitoring.

Pleasant Lake (1100), T6R1, Washington County, 1,574 acres

Summary: Pleasant Lake flows into Scraggley Lake, which is part of the large complex of lakes surrounding West Grand. The LWF population in Pleasant is believed to be relatively isolated from that of the surrounding lakes due to its small outlet and distance to Scraggley. Despite an abundance of other fish species present (LLS,BKT,LKT,SLT,SMB,WHP,etc.), the LWF population appears to be stable and abundant.

Current status: Population.

Changes: Possible recent drop in recruitment.

Knowledge of the LWF population: Good – caught in 1957, 1977, 1980, 1987, 1992, 1996, 1999, 2004 and 2008.

Future threats: Lack of recruitment due to interactions with other fish species – no small LWF seen in last two sampling events.

Recommendations: Continue periodic monitoring, look for evidence of recent recruitment, consider research to determine how LWF persist in the presence of many other fish species.

Lower Sysladobsis Lake (4730), T5 ND BPP, Washington County, 5,376 acres

Summary: LWF in Lower Sysladobsis are likely part of a large interconnected population that also occurs in West Grand, Pocumcus, Junior and Scraggley lakes.

Current status: Population.

Changes: None.

Knowledge of the LWF population: Good – found as recently as 2013.

Future threats: Minimal, but potential impacts of other fish species. LMB and LLA now occur in downstream lakes, and if they become established here, could pose a threat to LWF.

Recommendations: Continue periodic monitoring.

Webster Lake (2718), T6R10, Piscataquis County, 531 acres

Summary: Webster continues to support healthy populations of both dwarf and normal LWF. It is uncertain whether these are native to Webster, or if LWF were introduced from the Allagash watershed in the 1800’s via the Telos Cut.

Current status: Population.

Changes: None known.

Knowledge of the LWF population: Good – caught regularly during monitoring efforts.

Future threats: Interactions with rainbow smelt.

Recommendations: Continue periodic monitoring.

REGION G

Beau Lake (9785), T19R11, Aroostook County, 2,003 acres

Summary: LWF were first sampled in Beau Lake during the initial survey in 1959, and have been caught here, in low numbers, in each subsequent netting survey in 1989, 1993, 1995, 1999, 2004 and 2012. The LWF population in Beau is likely small and comprised of the dwarfed form, or a combination of dwarf and normal components.

Current status: Population.

Changes: None known.

Knowledge of the LWF population: Limited, but adequate to determine that a self-sustaining population does exist.

Future threats: SLT have recently become established in Beau and appear to be rapidly increasing in abundance. This could be a serious threat to the future of the Beau Lake LWF population. Recent establishment of MUS and likely future establishment of SMB pose additional threats.

Recommendations: Continue monitoring population at regular intervals.

Carr Pond (1598), T13R8, Aroostook County, 307 acres

Summary: LWF were caught regularly in Carr Pond from the 1950's to the 1990's. SLT were introduced here in 1980. Shortly thereafter, only large LWF were caught here, indicating a lack of recruitment. No LWF have been seen in Carr Pond since 2001. They are believed to have been extirpated here.

Current status: Extirpated.

Changes: Extirpation likely occurred within the last 20 years or less.

Knowledge of the LWF population: Adequate to determine a LWF population is no longer present here.

Future threats: N/A.

Recommendations: Explore stocking LWF periodically to restore a sport fishery here. If the SLT-controlled recruitment limitations are bypassed via stocking, LWF have the ability to grow to a large size here and provide a fishery.

Cliff Lake (2780), T9R12, Piscataquis County, 563 acres

Summary: Cliff Lake continues to support a robust, abundant population of both dwarf and normal LWF. Habitat is excellent and SLT are absent from the lake. LWF are not targeted by many anglers here and the lake is closed to ice fishing. The use of live fish as bait is restricted here in attempt to prevent potential introduction of smelts.

Current status: Population.

Changes: None.

Knowledge of the LWF population: Very high level of information with robust sampling data.

Future threats: The Cliff Lake LWF population has thrived in the absence of SLT. SLT are present in nearby Churchill Lake. The outlet of Cliff, South Twin Brook, flows into Churchill. It is unlikely that SLT could migrate upstream from Churchill Lake, but the brook should be further investigated for this potential.

Recommendations: Continue monitoring at regular intervals. Investigate habitat of South Twin Brook to determine risk of SLT migration to Cliff.

Crescent Pond (2964), T9R15, Piscataquis County, 320 acres

Summary: Crescent contains an apparently small but stable population of LWF. Both dwarf and normal, or a continuum of the two LWF forms are believed to be present here.

Current status: Population.

Changes: None known.

Knowledge of the LWF population: Sampled in 1964, 1979, 1990, 1996, 1997, 2001, 2003, 2005 and 2010. Ample data to determine that population remains stable.

Future threats: SLT were introduced here in 1980 and appear to be abundant. This may provide a serious threat to LWF recruitment in future years.

Recommendations: Monitor at regular intervals to ensure population recruitment of both dwarf and normal forms. Explore options to repeat the year-2000 transfer of 170 LKT from Allagash Lake to Crescent. Few LKT from this transfer remain. Maintaining a LKT component to the fish community here may be important to controlling the SLT population and ensuring future LWF recruitment.

Cunliffe Lake (1890), T12R13, Aroostook County, 134 acres

Summary: One LWF was apparently caught during the initial survey of Cunliffe Lake in 1959. None have been caught here since. Cunliffe does not contain habitat suitable for LWF. The 1959 fish was likely a migrant from the Ross Stream drainage and not representative of a LWF population.

Current status: Other – likely never had a population.

Changes: N/A.

Knowledge of the LWF population: Follow-up sampling indicates LWF unlikely here.

Future threats: N/A.

Recommendations: None.

Eagle Lake (1634), Eagle Lake, Aroostook County, 5,581 acres

Summary: Eagle Lake supported a LWF population (likely both dwarf and normal forms) prior to LLS and SLT introductions in the late 1800's. This population was extirpated prior to the mid 1900's. LWF currently present in Eagle Lake are dropdown migrants from a stocking program aimed at restoring a LWF population in nearby St. Froid Lake. After more than a decade, this stocking has not resulted in natural reproduction or establishment of a population. Though LWF are present here, Eagle does not support a LWF population.

Current status: Present.

Changes: N/A.

Knowledge of the LWF population: Regular sampling has revealed that no population exists here.

Future threats: N/A.

Recommendations: Periodic monitoring of other species should detect a wild LWF population if one develops here. A LWF fishery may develop here as a result of LWF management in St. Froid Lake.

Echo Lake (2766), T9R11, Piscataquis County, 115 acres

Summary: Echo Lake contains a stable, abundant population of dwarf LWF despite its relatively small size, somewhat marginal habitat and competition from YLP. LWF numbers do not appear to have fluctuated much over the years. The use of live fish as bait is restricted here in attempt to prevent potential introduction of SLT.

Current status: Population.

Changes: None known.

Knowledge of the LWF population: Good – surveyed regularly over the years.

Future threats: Small threat of SLT migrating up from Munsungan/Chase lakes.

Recommendations: Monitor lake periodically, inspect outlet for possibility of SLT in-migration.

Fish River Lake (0009), T14R8, Aroostook County, 2,642 acres

Summary: The lake supported an apparently healthy population of LWF prior to the introduction of SLT in 1979. After SLT became established, small LWF were no longer captured, indicating a lack of recruitment. Despite robust sampling effort, no LWF have been documented in Fish River Lake since 1996.

Current status: Extirpated.

Changes: Extirpation likely occurred within the last 20 years.

Knowledge of the LWF population: Adequate to determine LWF were likely extirpated here.

Future threats: N/A.

Recommendations: Consider stocking LWF periodically to restore a sport fishery here. If the SLT-controlled recruitment limitations are bypassed via stocking, LWF have the ability to grow to a large size here and support a fishery.

Glazier Lake (9789), T18R10, Aroostook County, 1,120 acres

Summary: Despite periodic sampling, MDIFW fisheries personnel have never observed LWF in Glazier Lake. Notes from W.C. Kendall in the early 1900’s document LWF here. A 1972 survey by the New Brunswick government noted 1 LWF being captured. A few LWF were reportedly caught by voluntary anglers in 1988, 1990 and 1992. These were not confirmed to be LWF. A LWF population is known to exist in nearby Beau Lake, and these fish have been observed elsewhere in the St. Francis River drainage. It is unclear whether Glazier has a LWF population or if these fish are drop-downs from Beau Lake or elsewhere in the St. Francis River drainage, though the latter is far more likely.

Current status: Present.

Changes: None known.

Knowledge of the LWF population: Adequate to determine that a LWF population probably does not exist here but the occasional LWF is encountered.

Future threats: Threats to the Beau Lake LWF population, including presence of SLT, MUS and SMB, may impact whether LWF occur in Glazier in the future.

Recommendations: Intensify survey work in Glazier and the rest of the St. Francis River drainage to better understand the nature of LWF occurrence and population dynamics here.

Harrow Lake (1934), T10R11, Piscataquis County, 467 acres
Summary: A population of dwarf LWF exists here. LWF were caught in very high abundance in 1995. Additional survey work is required to better understand the current status of this population. The use of live fish as bait is restricted here in attempt to prevent potential introduction of SLT.
Current status: Population.
Changes: None.
Knowledge of the LWF population: Limited (2 survey events: 1961 and 1995).
Future threats: Unknown, but marginal water quality and competition from other species exist.
Recommendations: Update existing knowledge with additional survey work in the near future.

Haymock Lake (2814), T7R11, Piscataquis County, 928 acres
Summary: Haymock Lake did not historically contain LWF. The Haymock population was started from a stocking of dwarf LWF from 2nd Musquacook Lake in 1962. An abundant, self-sustaining LWF population is present here. No SLT are present in Haymock, and the use of live fish as bait is restricted here in attempt to prevent potential SLT introduction.
Current status: Population.
Changes: None.
Knowledge of the LWF population: Good – regular sampling indicates a healthy, robust population.
Future threats: SLT introduction or migration from Big Eagle Lake via Smith Brook.
Recommendations: Continue regular monitoring and evaluate habitat of outlet stream.

Indian Pond (2866), T7R12, Piscataquis County, 1,222 acres
Summary: Indian Pond (also referred to as "Big Indian") continues to support populations of both dwarf and normal LWF. The pond contains a large population of SLT, which supports LWF feeding and growth, but may also threaten long term population persistence.
Current status: Population.
Changes: None.
Knowledge of the LWF population: Good – regular sampling (including surveys in 2013 and 2015) indicates a relatively healthy and robust population.
Future threats: Interactions with SLT.
Recommendations: Continue regular monitoring to ensure population persists.

Long Lake (1892), T11R13, Aroostook County, 1,203 acres
Summary: Long Lake continues to support populations of dwarf and normal LWF. The normal LWF appear to be present in low abundance and recruitment may be limited (potential interactions with SLT), but they grow to a very large size.
Current status: Population.
Changes: Possible declines in normal LWF numbers.
Knowledge of the LWF population: Good – resurveyed in 2014.
Future threats: Interactions with SLT.
Recommendations: Continue monitoring, with particular focus on recruitment of the normal form. A better understanding of SLT/LWF interactions may help explain why LWF continue to persist here.

Munsungan Lake (4180), T8R10, Piscataquis County, 1,620 acres

Summary: LWF were native to Munsungan Lake but have since been extirpated. SLT were introduced in the early 1950's, shortly after LLS became established. Local camp owner Brad Hall recounts how his father Milt, of Bradford Camps, used to trap 2-3 lb LWF in the thoroughfare between Chase and Munsungan lakes. MDIFW has never physically documented LWF here.

Current status: Extirpated.

Changes: Extirpation likely began after SLT became established here.

Knowledge of the LWF population: Solid – rigorous sampling has failed to reveal a LWF population here.

Future threats: N/A.

Recommendations: Consider stocking LWF on a periodic basis to provide a sport fishery, but only if deemed consistent with other management objectives for the lake.

First Musquacook Lake (1914), T12R11, Aroostook County, 698 acres

Summary: Its direct connection to Second Musquacook Lake requires any discussion on First's LWF population to include Second. LWF are present here but likely in low numbers and inter-mixed with the population in Second Musquacook.

Current status: Population.

Changes: Decline in sport fishery and population abundance beginning in the 1980's.

Knowledge of the LWF population: Poor – need to update survey work here, but likely remains closely tied with Second Musquacook.

Future threats: Interactions with SLT.

Recommendations: Intensify monitoring efforts here in conjunction with Second Musquacook work. Seek research to understand how LWF persist in the presence of SLT. Explore past LKT management and its potential benefit to LWF via suppressed SLT numbers.

Second Musquacook Lake (1916), T11R11, Aroostook County, 813 acres

Summary: Abundant populations of both dwarf and normal LWF existed here prior to SLT introduction in 1972. Once SLT became established, dwarf LWF spawning runs disappeared and numbers of all LWF appeared to decline. LWF numbers are still low here, despite efforts beginning around 2003 to stock hatchery-reared LWF. It is unclear whether LWF will continue to persist in the presence of SLT or if we are viewing a snapshot in a long term decline to extirpation.

Current status: Population.

Changes: Decline in sport fishery and population abundance beginning in the 1980's.

Knowledge of the LWF population: Good – numerous sampling events in the recent past.

Future threats: Continued predatory and/or competitive interactions with SLT.

Recommendations: Continue regular monitoring. Seek research to understand how LWF persist in the presence of SLT. Explore past LKT management and its potential benefit to LWF via suppressed SLT numbers.

Third Musquacook Lake (1918), T11R11, Aroostook County, 397 acres

Summary: A population of both dwarf and normal LWF are present in Third Musquacook, but since the establishment of SLT (first surveyed in 1981 – migration from Second Musquacook 1972 introduction), LWF appear to be less abundant here, particularly the dwarf form.

Current status: Population.

Changes: Decline in the sport fishery and population abundance since the 1980's.

Knowledge of the LWF population: Good, but need better monitoring of LWF recruitment and age data to ensure population is stable and fish are reproducing successfully.

Future threats: Continued interactions with SLT.

Recommendations: Ramp up monitoring, with particular focus on evidence of recruitment. Seek research to understand how LWF persist in the presence of SLT. Explore past LKT management and its potential benefit to LWF via suppressed SLT numbers.

Fourth Musquacook Lake (1920), T10R11, Piscataquis County, 749 acres

Summary: LWF are present here, but status of the population, its abundance and relative component of dwarf/normal are unknown. Much of the lake has somewhat marginal habitat for LWF.

Current status: Population.

Changes: None.

Knowledge of the LWF population: Poor. Need more intense sampling to better understand this population.

Future threats: SLT, first confirmed here in 2008, pose a threat to the LWF population. It is uncertain how long SLT have been here or their origin – they likely migrated from Third Musquacook – an indirect result of the 1972 smelt introduction in Second Musquacook.

Recommendations: Intensify sampling effort here to better understand the LWF population and threats posed by SLT.

Big Pleasant Lake (2756), T9R11, Piscataquis County, 979 acres

Summary: Big Pleasant supports a healthy population of LWF that apparently continues to thrive, despite having somewhat marginal water quality during late summer. The lake does not contain SLT. The use of live fish as bait is restricted here in attempt to prevent potential introduction of SLT. This lake also has the ability to produce trophy-sized LWF. Fish up to 27 inches in length have been caught here in the past. Anecdotal reports indicate these larger LWF have become less common in the past 20 years. Big Pleasant LWF appear to be of both dwarf and normal forms, or a continuum of the two.

Current status: Population.

Changes: None known.

Knowledge of the LWF population: Good, but follow-up sampling required.

Future threats: Establishment of SLT via movement from Churchill Lake or introduction. Water quality changes that may make it difficult for LWF to survive.

Recommendations: Continue periodic monitoring. Investigate potential for SLT to migrate upstream from Churchill Lake.

Round Pond (1470), T13R12, Aroostook County, 697 acres

Summary: LWF were documented in Round Pond during the initial survey in 1958. The pond has not been surveyed since then, and the status of LWF here is unknown.

Current status: Unknown.

Changes: N/A.

Knowledge of the LWF population: Minimal.

Future threats: N/A.

Recommendations: This water is a top priority for survey work in the near future to determine whether a LWF population still occurs here.

Rowe Lake (1964), T11R8, Aroostook County, 252 acres

Summary: A population of LWF has been known to occur in Rowe Lake since the time of the initial survey. LWF have not been observed here since 1994. SLT were introduced to Rowe in 1957 and are well established. It is likely that LWF still occur here, but have not been captured because sampling methods targeted other species.

Current status: Unknown.

Changes: Removed from list of LWF waters, added to 'unknown', further survey work required.

Knowledge of the LWF population: Minimal.

Future threats: Continued interactions with SLT.

Recommendations: This water is a top priority for survey work in the near future to determine whether a LWF population still occurs here.

Saint Francis Lake (2398), T8R16, Somerset County, 322 acres

Summary: A small population of dwarf LWF resides in the lake. Deep, coldwater habitat is limited, and competition is heavy from an extremely high density of YLP. Intensive sampling in 2014 produced only one LWF. The use of live fish as bait is restricted here in attempt to prevent potential introduction of SLT.

Current status: Population.

Changes: Possible decline in abundance.

Knowledge of the LWF population: Good.

Future threats: Limited habitat and interspecific competition in such a small water could exert enough pressure to eliminate this population.

Recommendations: Continue monitoring to ensure the population persists. Consider re-introduction in future if population becomes extirpated.

Saint Froid Lake (1610), Winterville Plt., Aroostook County, 2,400 acres

Summary: LWF were native to St. Froid, but became extirpated shortly after LLS and SLT were introduced in the late 1800's. LWF were re-introduced to St. Froid beginning in 2003 as part of a LWF restoration project. The stocked fish have survived well, but have not been able to successfully reproduce, therefore a population has not become established.

Current status: Present.

Changes: None recent.

Knowledge of the LWF population: Very good – routinely monitored.
Future threats: Continued interactions with SLT will likely prevent population establishment.
Recommendations: Monitor for future reproduction. Consider stocking LWF here periodically in an effort to support a LWF sport fishery.

Umsaskis Lake (1896), T11R13, Aroostook County, 1,222 acres
Summary: Umsaskis and Long lakes are connected by a short stretch of the Allagash River, and their LWF populations are likely either closely related, or part of one large population. Umsaskis continues to support populations of dwarf and normal LWF. The normal LWF appear to be present in low abundance and recruitment may be limited (potential interactions with SLT), but they grow to a very large size.
Current status: Population.
Changes: Possible declines in normal LWF abundance.
Knowledge of the LWF population: Good – recent sampling adequate to characterize population.
Future threats: Continued interaction with SLT (confirmed in 1958, likely from 1941-42 stocking in Ross Lake).
Recommendations: Continue monitoring, with particular focus on recruitment of the normal form. A better understanding of SLT/LWF interactions may help explain why LWF continue to persist here.

Spider Lake (2758), T9R12, Piscataquis County, 890 acres
Summary: Spider Lake supports populations of both dwarf and normal LWF. SLT were introduced in 1972 and are present in high densities. LWF were stocked from 2003-10 as part of LWF restoration attempts, but these fish have not shown up in the population in great numbers. LWF continue to persist here, but their abundance appears to have been significantly altered by interactions with SLT.
Current status: Population.
Changes: Declines in sport fishery and population abundance since the 1980's.
Knowledge of the LWF population: Good.
Future threats: Interactions with SLT.
Recommendations: Continued monitoring. A strong run of dwarf LWF was documented here prior to smelt introduction and provides good baseline data to help evaluate current abundance. Spider is a good candidate water for further research of LWF/SLT interactions to help us better understand how (and if) LWF can persist in the presence of SLT.

Churchill Lake (2856), T9R12, Piscataquis County, 3,720 acres
Summary: LWF continue to be present in Churchill Lake, and the population here is likely closely related to the LWF population in nearby Big Eagle Lake, or the two lakes support one interconnected population. Both dwarf and normal forms exist here.
Current status: Population.
Changes: Declines in sport fishery and population abundance since the 1980's.
Knowledge of the LWF population: Good, but further sampling required to better determine population status and structure.
Future threats: Continued interactions with SLT (documented in 1987 but likely there prior).
Recommendations: Increase monitoring to better understand LWF population here.

Big Eagle Lake (2858), T8R13, Piscataquis County, 9,500 acres

Summary: Big Eagle Lake is one of the largest LWF waters in the state and supports a population of both dwarf and normal LWF. Normal LWF can grow to a very large size in the lake. SLT were first documented here in 1967. Because of its large size and diverse habitat, Big Eagle may be an example of a water where LWF can persist in the presence of rainbow smelt. However, populations have failed to persist with SLT in other large waters like Moosehead Lake.

Current status: Population.

Changes: Decline in sport fishery and population abundance, which has not responded to stocking of hatchery LWF.

Knowledge of the LWF population: Very good, continued recent monitoring.

Future threats: Potential interactions with SLT.

Recommendations: Continue periodic monitoring and explore the potential to research LWF/smelt interactions.

Clear Lake (1938), T10R11, Piscataquis County, 614 acres

Summary: More study has been done on the Clear Lake LWF population than perhaps all other lakes. The weight of evidence suggests that since the establishment of SLT (1980’s), LWF recruitment has been limited to periods of low SLT densities. Only the normal form of LWF occurs here.

Current status: Population.

Changes: Decline in sport fishery and population abundance in the past 20 years.

Knowledge of the LWF population: Very good, but limited knowledge of recent recruitment.

Future threats: Continued interaction with SLT.

Recommendations: Monitor for recent recruitment of juvenile LWF to the population. Explore further research of LWF/SLT interactions, as well as the potential to benefit LWF via management of LKT numbers and their subsequent impact on SLT densities.

Ross Lake (1888), T10R15, Piscataquis County, 2,892 acres

Summary: Ross Lake contains one of the most robust LWF populations in the state. The lake has long been known for producing trophy-sized LWF and is a popular destination for whitefish anglers.

Current status: Population.

Changes: Decline in sport fishery and population abundance in past 20 years, but still a strong population.

Knowledge of the LWF population: Very good.

Future threats: Potential interactions with SLT.

Recommendations: Continued periodic monitoring. Explore potential to research LWF/SLT interactions in a water where LWF have apparently continued to thrive in the presence of SLT.

Cross Lake (1494), T18R10, Aroostook County, 49 acres (not on 2001 list of LWF Waters)

Summary: Cross Lake was first surveyed in 2014, and one LWF was caught. Cross is a backwater lake to the St. Francis River downstream from Beau Lake. LWF present in Cross are likely from the Beau Lake

population, or may be part of a large population present in the deeper waters of the St. Francis River system.
Current status: Present.
Changes: Unknown – found in 2014.
Knowledge of the LWF population: Minimal.
Future threats: Threats to the persistence of the Beau Lake LWF population due to impacts from SLT and MUS could affect LWF presence in Cross Lake.
Recommendations: Continued periodic monitoring to better understand LWF status here.

COOPERATIVE

STATE FEDERAL

PROJECT

This report has been funded in part by the Federal Aid in Sport Fish Restoration Program. This is a cooperative effort involving federal and state government agencies. The program is designed to increase sport fishing and boating opportunities through the wise investment of angler's and boater's tax dollars in state sport fishery projects. This program which was founded in 1950 was named the Dingell-Johnson Act in recognition of the congressmen who spearheaded this effort. In 1984 this act was amended through the Wallop Breaux Amendment (also named for the congressional sponsors) and provided a threefold increase in Federal monies for sportfish restoration, aquatic education and motorboat access.

The program is an outstanding example of a "user pays-user benefits" or "user fee" program. In this case, anglers and boaters are the users. Briefly, anglers and boaters are responsible for payment of fishing tackle, excise taxes, motorboat fuel taxes, and import duties on tackle and boats. These monies are collected by the sport fishing industry, deposited in the Department of Treasury, and are allocated the year following collection to state fishery agencies for sport fisheries and boating access projects. Generally, each project must be evaluated and approved by the U.S. Fish and Wildlife Service (USFWS). The benefits provided by these projects to users complete the cycle between "user pays – user benefits."

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