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Upper Great Lakes Management Unit
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**A Stocking Plan for Ontario Waters
of Lake Superior**

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INTRODUCTION

Ongoing changes to the Lake Superior ecosystem, recommendations from Great Lakes Fishery Commission (GLFC) State of the Lake Reports, revisions to MNR's fish stocking approval process, and stakeholder concerns collectively precipitated a review of fish stocking on Lake Superior. This document reviews the history of fish stocking on the lake, identifies the criteria that will be used to evaluate the efficacy of stocking, and establishes strategic direction for future stocking activities on Lake Superior. Unless otherwise specified, this document will deal specifically with Ontario waters of Lake Superior when Lake Superior is referenced.

Although a variety of fish species have been stocked in Ontario waters over the past 100+ years, only Lake Trout (*Salvelinus namaycush*) and Chinook Salmon (*Oncorhynchus tshawytscha*) have been stocked in the past decade. Since there are currently no plans to stock other species, this plan will focus primarily on Chinook Salmon (*Oncorhynchus tshawytscha*). More specifically, this plan:

- summarizes the history of fish stocking in Ontario waters of Lake Superior;
- provides an analysis of the efficacy of the recent activities relative to existing plans and agreements;
- summarizes recent stakeholder consultation regarding fish stocking;
- provides a synopsis of scientific literature regarding the efficacy of fish stocking, including risks associated with the activity; and
- provides direction for future fish stocking relative to the Fish Community Objectives for Lake Superior (Horns et al. 2003);
- provides short and long-term goals and objectives for future Chinook Salmon stocking on Lake Superior;
- identifies specific direction for future Chinook Salmon stocking on Lake Superior by outlining egg collection and stocking sites, number of gametes permitted to be collected, and disease control measures;
- outlines future monitoring programs that will allow for assessment of Chinook Salmon populations in Lake Superior and the Kaministiquia River.

CHANGES IN THE LAKE SUPERIOR ECOSYSTEM

Over the past century, Lake Superior's fish community has undergone a number of changes. Historically the off-shore waters of Lake Superior were dominated by Lake Trout (Siscowet morphotype), Cisco (*Coregonus artedii*), and deepwater ciscos (*Coregonus sp.*) which were able to thrive in cold, unproductive offshore waters. Nearshore waters were dominated by Lake Trout (lean morphotypes), Brook Trout and Lake Whitefish (*Coregonus clupeaformis*). Warmer embayments with suitable habitat were also host to warm- and cool-water communities with Walleye, yellow perch, and northern pike commonly present in these areas. However, introductions of over 40 plant and animal species, as well as changing environmental conditions, have led to an altered Lake Superior ecosystem (Horns et al 2003).

During the 1900s over-fishing, habitat destruction and predation from invasive sea lamprey caused major reductions in Lake Trout numbers across Lake Superior. Rehabilitation efforts in the form of stocking, stricter regulation, as well as chemical control of larval sea lamprey have restored Lake Trout populations to near pre-collapse numbers. Current chemical treatment techniques are believed to have reduced sea lamprey abundance by 90% from pre-control levels (Hansen, 1994).

Prior to their collapse in the mid 1900s, Cisco were the most important member of the prey community in Lake Superior. Much like Lake Trout, heavy exploitation and predation by sea lamprey caused Cisco numbers to decline dramatically. To exacerbate the issue, it is believed that invasive Rainbow Smelt (*Osmerus mordax*) compete with Cisco for food resources and preys on larval Cisco. Cisco numbers have recovered since the collapse, but recruitment has been sporadic and abundance remains well below pre-collapse numbers (Bronte et al. 2003; Horns et al 2003).

Rainbow Smelt became the dominant forage fish after their invasion and the collapse of Cisco. Although they are an invasive species, Rainbow Smelt now play a major role as prey for salmonid predators. Smelt abundance peaked during the mid-to-late 1970s with estimated densities of approximately 800 individuals per hectare. Their abundance then declined during the early 1980s to less than 200 individuals per hectare and have remained low since (Bronte et al. 2003). Lake-wide bottom trawl surveys conducted since 1978 indicate a pattern of declining abundance for all major prey species, including Cisco, Bloater, Rainbow Smelt and Lake Whitefish. These declines are likely attributed to the successful recovery of Lake Trout, as well as poor and infrequent recruitment (Gorman et al. 2012).

The introduction of pacific salmonids (Rainbow Trout, Chinook Salmon, Coho Salmon, and Pink Salmon) as well other non-native species has created a number of diverse interactions in Lake Superior's food-web that were unknown a century ago (Kitchell, 2000). Non-native pacific salmonids grow much faster and mature earlier than their native counterparts like Lake Trout and members of the whitefish family. These life history characteristics allow these non-native species to respond quickly to changes such as an increase in the abundance of prey. As such it is important for fisheries managers to exercise caution and evaluate the potential impact on other species when considering stocking as a management practice (Kitchell, 2000).

A BRIEF HISTORY OF FISH STOCKING ON LAKE SUPERIOR

There is a long history of fish stocking on Lake Superior. Chinook Salmon were part of initial introductions in the 1870s, though these efforts were met with little success. The first release of Rainbow Trout (*Oncorhynchus mykiss*) into the Canadian waters of the Great Lakes was into Lake Superior in 1883 where spawning populations were established within ten years (Kerr 2010). By 1920, Rainbow Trout were competing with many Brook Trout (*Salvelinus fontinalis*) populations, which had already been diminished through overexploitation (Kerr 2010). Rainbow Trout are now naturalized in over 200 of 1,525 Lake Superior tributaries.

In 1912, Atlantic Salmon (*Salmo salar*) fry from the Port Arthur fish hatchery were stocked into McVicar Creek, a Lake Superior tributary near Thunder Bay (Kerr 2006). The earliest record of stocking Brook Trout was in the Nipigon River in 1921 (Wilson 1991). From 1921 until 1953, Brook Trout fry or fingerlings were stocked almost annually in the Nipigon River. After 1953, Brook Trout were stocked only five more times to up to 1987.

Efforts to introduce Brown Trout (*Salmo trutta*) in the 1930s were met with little success (Kerr 2006) and the activity was discontinued.

Stocking efforts to rehabilitate Lake Trout commenced in 1950 (Figure 1). Roughly 500,000 Lake Trout per year were stocked by MNRF until the mid-1970s, after which stocking increased to a peak of over 4 million in the late 1980s. The number stocked declined until 2012 when the last Lake Trout were stocked in the Ontario waters. Lake Trout are now considered rehabilitated and self-sustaining in the Ontario waters of Lake Superior and no further stocking is contemplated at the present time.

The next introduction did not take place until 1956 when Pink Salmon (*Oncorhynchus gorbuscha*) were inadvertently released into Lake Superior from the Port Arthur fish hatchery at Thunder Bay (Kerr 2010). Although first maturing at two years of age, similar to their Pacific parents, they soon adapted to spawn at ages 1 and 3, thereby producing an annual spawning run. After an initial population explosion in Lake Superior their abundance eventually declined to a low but constant level. Pink Salmon eventually spread throughout the Great Lakes from this single release (Kwain and Lawrie 1981).

In the late 1960s, after Great Lakes fish communities had experienced the collapse of most major predators, the state of Michigan commenced Chinook Salmon stocking in Lakes Michigan, Huron and Superior. This new round of introductions was very successful in terms of survival and growth, largely as a result of abundant prey in the form of invasive Alewives (*Alosa pseudoharengus*) and Rainbow Smelt (*Osmorus mordax*). Many other U.S. states fronting the Great Lakes quickly followed suit and commenced stocking programs for non-native salmon and trout. In the case of Lake Superior, Minnesota initiated Chinook Salmon stocking in 1974, followed by Wisconsin in 1978 (Figure 2). Ontario stocked Coho Salmon (*Oncorhynchus kisutch*) into Lake Superior for three years, from 1969 to 1971 (Kerr 2006).

Figure 1. Number of Lake Trout stocked into Lake Superior by the Ontario Ministry of Natural Resources and Forestry

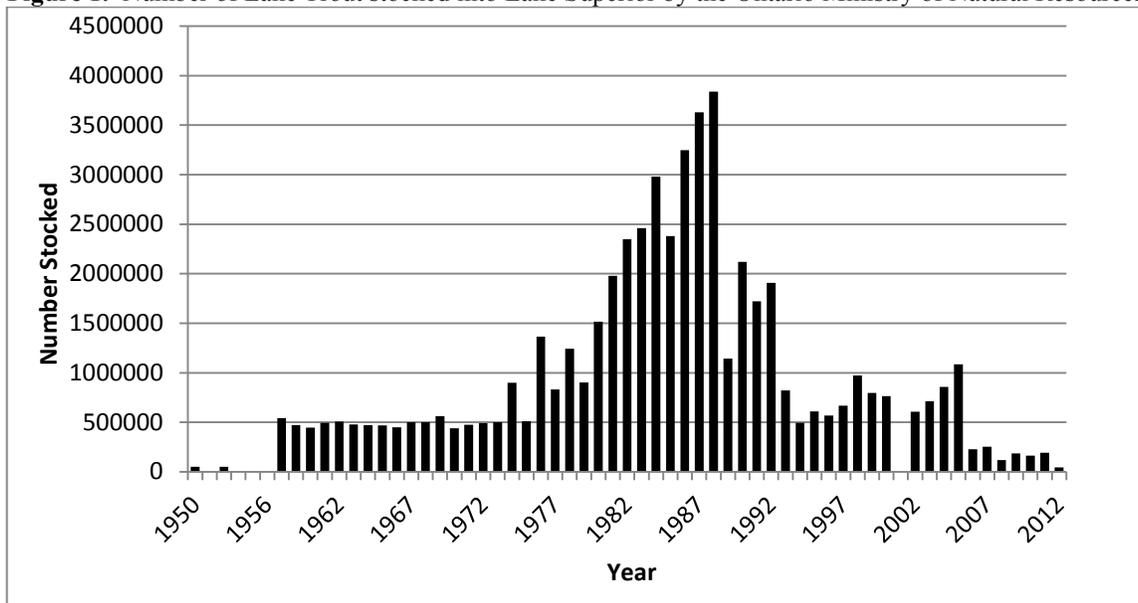
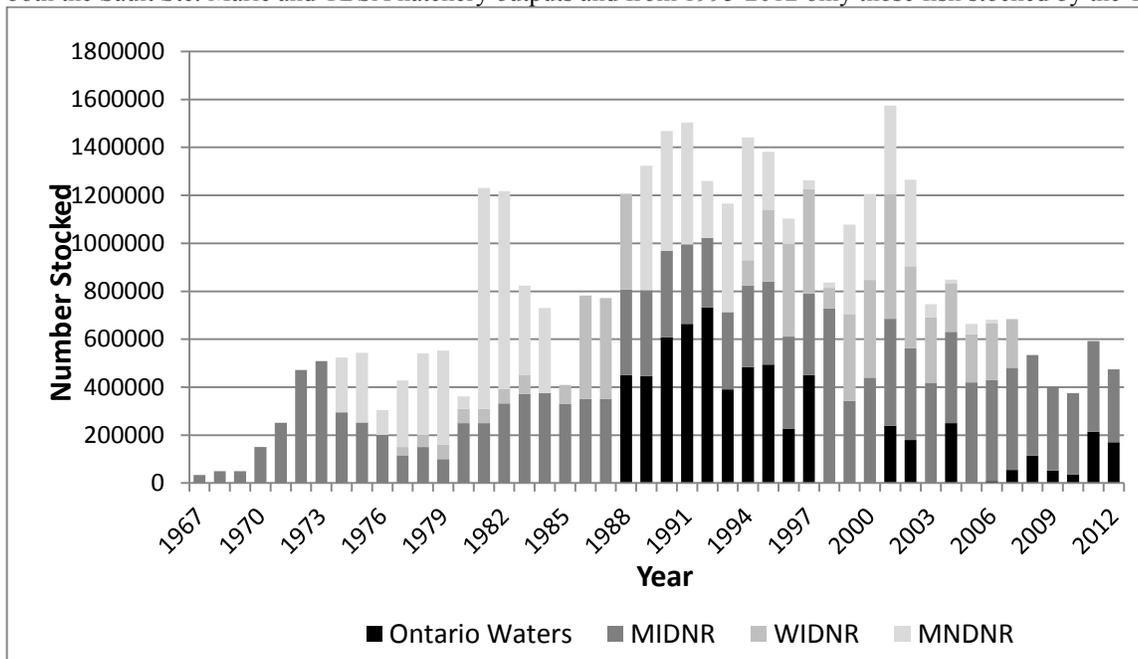


Figure 2. Number of Chinook Salmon stocked into Lake Superior by jurisdiction. Ontario values from 1988-1994 include both the Sault Ste. Marie and TBSA hatchery outputs and from 1995-2012 only those fish stocked by the TBSA.



The Walleye (*Sander vitreus*) population of Black Bay was historically one of the largest in Lake Superior (Schram et al. 1991). At the time of its demise (1967-1969) overexploitation in the commercial fishery was considered the probable cause (Schram et al. 1991). Rehabilitation of this population began in 1972 with adult transfers from the Current and Pigeon Rivers. Follow-up assessment in 1973 showed some of these fish remained in Black Bay while others returned to their point of origin off the Current

River in Thunder Bay. Walleye were first stocked as adults by MNRF into Black Bay in 1972 (Schram et al. 1991) and subsequently 798 adult Walleye were transferred from inland lakes between 1998-2000. Furthermore, 1 million fry were stocked in 2003 and 260,000 summer fingerlings in 2004-2005 as part of rehabilitation efforts. Renewed commitments to restore Walleye in Black Bay included closure of the commercial perch fishery in 2002 to reduce Walleye by-catch, the closure of the recreational fishery in northern Black Bay and the lower Black Sturgeon River in 1998.

Other stocking locations for Walleye include the Goulais River, which flows into eastern Lake Superior. U.S. state and tribal agencies continue to stock Walleye annually into Lake Superior embayments, river mouths and tributaries for rehabilitation and fishery enhancement.

Walleye stocking in the Nipigon River has also occurred and was intended to rehabilitate the severely depleted local Walleye population which had suffered serious decline from excessive harvest, degraded water quality and habitat loss prior to the establishment of Nipigon Bay as an Area of Concern (AOC) (Ontario Ministry of Environment et al. 1991). Rehabilitative stocking was initiated in 1978 before the area was listed as an AOC (Table 1) and following AOC designation in the 1980s, renewed efforts to rehabilitate Walleye included stocking of eggs, fingerlings, fry as well as a transfer of over 12,000 adult Walleye from a number of sources in the Lake Superior Basin between 1990 and 1992 (Chicoine and Friday 2002; Marshall 2013). Assessment of population recovery towards the target of 41,000 adults was conducted between 2000 and 2011 (Addison and Chicoine 2008). This target was the estimated population size prior to fishery collapse (Ryder 1968 in OMOE 1991).

Table 1: Walleye stocking history for Nipigon Bay, Lake Superior (summarized from Wilson et al. 2007)

YEAR	SOURCE	LIFE STAGE	NUMBER STOCKED
1978-1984	Current River	eggs	3,384,000
1980	Current River	fingerlings	20,800
1981-1984	Onaman Lake	eggs	4,611,000
1981-1982	Onaman Lake	fingerlings	15,455
1983	Onaman Lake	adults	347
1986-1989	Savanne Lake	fry	425,000
1986-1989	Savanne Lake	adults	1,324
1984-1985	Lake Nipigon	fry	4,757,000
1984-1985	Lake Nipigon	fingerlings	1,800
1990-1992	Lac Des Mille Lacs, Georgia Lake, Ombabika Bay, Lake Nipigon	adults	12,100

Walleye stocks in Lake Superior’s Nipigon system appear to be stable, but exist at much lower levels than in the past (Marshall 2013). Telemetry studies suggest that two discrete stocks of Walleye may now exist in the Nipigon system; an upper river and Lake Helen stock, and a lower river and Nipigon Bay stock (Marshall 2013). Assessment monitoring of the Nipigon River Walleye and the Nipigon Bay fish community will continue to track rehabilitation of this Walleye population and the changing fish community.

The growth of Great Lakes salmon fisheries in the 1970s and early 1980s, through the stocking efforts of various state agencies, did not go unnoticed in Ontario. Resident anglers benefited directly from salmon

stocking by U.S. jurisdictions through the movement of salmon into Ontario waters. This led to the growth of fisheries in Ontario waters of the Great Lakes and the introduction of an MNRF Chinook Salmon culture program on Lake Ontario in the 1970s. Interest in salmon stocking programs on other Great Lakes fronted by Ontario also mounted during this time. Specifically, municipal governments recognized the potential for tourism revenues as a result of these fisheries and lobbied the province to initiate similar stocking programs, as did members of the angling community.

In 1984, the mounting interest and pressure on MNRF culminated in a provincial decision to allow active management of Chinook Salmon on Lake Huron and Lake Ontario. Active management of Chinook Salmon on Lake Huron was defined as passage at fishway facilities and culture by Community Fish and Wildlife Involvement Program (CFWIP) partners, and on Lake Ontario as a continuance of the MNRF culture program.

This decision was followed by the release of a provincial Pacific Salmon Management Policy in 1987 that further clarified the earlier decision and also allowed CFWIP culture of Chinook Salmon on Lake Superior (OMNR 1987). District Fisheries Management Plans were referenced in the 1987 Pacific Salmon Policy as a source of further information, however, additional details were often lacking in these plans. For example, while the Thunder Bay District Fisheries Management Plan established a target to provide a total of 12,000 kg/yr of Rainbow Trout, Chinook Salmon, Coho Salmon, and Pink Salmon by the year 2000, the only relevant strategy was to “increase fish stocking for rehabilitation and to provide angling opportunities” and the only relevant tactic was to “...allow for the development of CFWIP projects to rear and release Chinook Salmon in limited quantities in selected rivers...”(OMNR 1989)

The impending release of the 1987 Pacific Salmon Policy led to increased interest in salmon stocking. A municipally run hatchery was constructed in Sault Ste. Marie, Ontario which stocked Chinook Salmon, Brown Trout and Rainbow Trout into the St. Marys River and waters of eastern Lake Superior from 1987 to 1994. The hatchery was closed due to insurmountable building maintenance costs.

The development of the Pacific Salmon policy also led to the formation of the Thunder Bay Salmon Association (TBSA) in 1986. In response to their interests in stocking Chinook Salmon in the Kaministiquia River, a tributary to Thunder Bay, MNRF requested a feasibility study which was completed in 1987 (Dextrase et al. 1987). This document set the stage for the construction of a hatchery, the collection of Chinook Salmon eggs in 1987, and the stocking of the first year class of Chinook Salmon in 1988. With the exception of three years from 1998 to 2000, the TBSA has stocked fish every year through to 2014 (Fig. 2). Chinook Salmon is the only species currently reared by TBSA. Their egg source was shifted from a Lake Huron tributary to a Lake Superior source in 2006.

Between 1988 and 2013, 5,784,701 Chinook Salmon were stocked into Lake Superior by the Sault Ste. Marie and TBSA hatcheries. Since 1994, with the closure of the Sault Ste. Marie hatchery, the TBSA is the only group stocking non-native salmonids in Ontario waters of Lake Superior.

Chinook Salmon stocking in U.S. jurisdictions in Lake Superior has been reviewed a number of times (Peck et al. 1999; Schreiner et al. 2006) and due to declining returns over time, Minnesota (2007) and Wisconsin (2010) have discontinued stocking this species. The State of Michigan continues to stock Chinook Salmon; however, the efficacy of the activity is in question in this jurisdiction and is currently being evaluated. Preliminary data suggest that a high percentage of the salmon catch in Michigan waters are wild Chinook Salmon (Phil Schneeberger, pers. Comm.).

The number of Rainbow Trout and Brown Trout stocked by the Sault Ste. Marie Municipal Hatchery into Lake Superior was small compared to the number of Chinook Salmon that were stocked. In 2009, following extensive public consultation for the management of Rainbow Trout in the Ontario waters of Lake Superior, a Rainbow Trout management plan was written (Bobrowicz 2009). The final recommendation put forward by this plan was not to stock Rainbow Trout, rather to use alternative management approaches such as promotion of catch and release fishing, conservative possession limits, enhancing access to spawning habitat (dam and perched culvert removal) and protecting tributary and lake habitat. Stocking over what are considered robust wild populations was considered potentially harmful to overall sustainability (Byrne et al. 1992).

From 1994 to 1997 Brook Trout fry were released into Thunder Bay and surrounding waters through a partnership between MNRF and the Thunder Bay Salmon Association. Each year between 125,000 and 150,000 Brook Trout of Lake Nipigon strain were released onto groundwater upwellings in hopes of establishing a self-sustaining population (Boulter 1997). In eastern Lake Superior, between 1988 and 1994, Lake Nipigon strain fry or spring yearlings were stocked mostly in Gargantua Harbour. The intent of this stocking was to re-establish lake dwelling fish and the coaster Brook Trout fishery.

In 1993, the Lake Superior Technical Committee of the Great Lakes Fishery Commission acted on the Fish Community Objectives for Lake Superior (Busiahn 1990) which included rehabilitating depleted stocks of Brook Trout. A Brook Trout Working Group was established to determine the status of Brook Trout (Newman and Dubois 1996) and write a rehabilitation plan (Newman et al. 2003). The rehabilitation plan identified appropriate strains for rehabilitative stocking, provided guidance for re-establishing populations and suggested research on available strains to determine their stocking suitability. Since the publication of the Plan in 2003, MNRF has not stocked Brook Trout either in the lake or its tributaries. Rather, work has been undertaken to learn more about Brook Trout life history, habitat requirements, lakewide presence/absence and site specific constraints on population growth. MNRF has also implemented strict harvest control measures, (a one fish limit, which must be greater than 56cm) which not only limits harvest but allows for immature fish to reach maturity. This has resulted in increased numbers of large mature fish in Lake Nipigon, the Nipigon River and Nipigon Bay. Efforts in support of rehabilitation are focused on limiting exploitation as well as habitat protection and restoration.

POLICY AND LEGAL FRAMEWORK FOR FISH STOCKING

JOINT STRATEGIC PLAN FOR MANAGEMENT OF GREAT LAKES FISHERIES AND FISH COMMUNITY OBJECTIVES FOR LAKE SUPERIOR

The Joint Strategic Plan for Management of Great Lakes Fisheries (JSP) establishes a formal commitment by the Province of Ontario, the Great Lake States, three American Tribal organizations, and several U.S. and Canadian federal government agencies to a set of procedures intended to ensure that the actions of one fishery-management agency would not jeopardize the interests of a sister agency. The plan also includes a goal statement that provides collective direction for fishery management:

“To secure fish communities, based on foundations of stable self-sustaining stocks, supplemented by judicious plantings of hatchery-reared fish, and provide from these communities an optimum contribution of fish, fishing opportunities and associated benefits to meet needs identified by society for

*wholesome food,
recreation,
cultural heritage,
employment and income, and
a healthy aquatic ecosystem.”*

One of the key commitments made in the JSP is the development of Fish Community Objectives for each lake. In the context of this review, two of the objectives for Lake Superior (Horns et al. 2003), the first for Lake Trout and the second for Pacific salmon, Rainbow Trout, and Brown Trout are relevant:

“Lake Trout

Objective: Achieve and maintain genetically diverse self-sustaining populations of Lake Trout that are similar to those found in the lake prior to 1940, with lean Lake Trout being the dominant form in nearshore waters, siscowet Lake Trout the dominant form in offshore waters, and humper Lake Trout a common form in eastern waters and around Isle Royale.”

“Pacific Salmon, Rainbow Trout, and Brown Trout

Objectives: Manage populations of Pacific salmon, Rainbow Trout, and Brown Trout that are predominantly self-sustaining but that may be supplemented by stocking that is compatible with restoration and management goals established for indigenous fish species.”

Although the goal for the Joint Strategic Plan discusses the “...judicious plantings of hatchery-reared fish...” and the FCO’s describe the use of hatchery fish for rehabilitation, neither document provides the level of tactical detail required to develop a project description for a Class EA review of non-native fish stocking. As a result, it was concluded that a stocking plan was required to provide clear direction for future fish stocking and this document would provide sufficient detail to allow for drafting of Resource

Stewardship Facility Development (RFSD) Class EA project descriptions. If no stocking will be conducted, then a Class EA review is not required.

In addition to Great Lakes Fishery Commission sponsored documents which speak to fish stocking at a high level, the Strategic Plan for Ontario Fisheries (SPOF II) (OMNR 1992) provides policy direction regarding fish stocking. A guiding principle in SPOF is that:

“naturally reproducing fish communities, based on native fish populations, provide predictable and sustainable benefits with minimal long-term cost to society.”

SPOF II goes on to note that stocking of non-native species and stocking for hatchery dependent fisheries should be thoroughly analyzed before being started. As well, SPOF II states:

“...that the technique of providing fisheries dependent on continuous stocking has been promoted and accepted with an incomplete understanding of long-term effects on the native fish community. The presence of hatchery fish in waterbodies creates the illusion that the aquatic ecosystem is in a healthy state. This false impression may lead to a loss of public support for the longer-term objective of rehabilitation...” and that “...stocking hatchery fish can dilute the genetic makeup of wild stocks. It can also displace the gene pool of wild stock with hatchery stock which has less genetic variability and therefore, less ability to adapt to a changing environment.”

Although the direction provided in SPOF II recognizes a role for fish stocking in fisheries management, this document suggests caution and contemplation of the range of positive and negative effects of the activity before proceeding.

Despite their lack of specificity in a fish stocking and Class EA RSFD context, the Fish Community Objectives for Lake Superior (Horns et al. 2003) provide important strategic guidance for fisheries management on Lake Superior. They reflect ministry policy (e.g., SPOF II) and international consensus and establish targets and milestones for the fish community. Consistent with the Lake Superior FCOs and SPOF II, MNRF has worked with its U.S. partners in the development and implementation of the Lake Trout Restoration Plan for Lake Superior (Hansen 1996). Additionally, State of the Lake Reports (SOTLRs) (Ebener 2007; Gorman et al. 2011) have been prepared which assess progress towards these FCOs, make recommendations that are current for managers and by extension, and are important to consider when making decisions regarding fish stocking.

CLASS EA FOR RESOURCE STEWARDSHIP AND FACILITY DEVELOPMENT PROJECTS

Resource management in Ontario is governed by both legislation and policy. Ontario's Environmental Assessment Act requires an environmental assessment of any major public sector undertaking that has the potential for significant environmental effects. Community Fisheries and Wildlife Program organizations that stock fish were considered agents of the Crown and their activities were therefore subject to the same requirements as the Crown. Stocking activities by Community Hatchery Partners are considered somewhat differently, however, final direction on how these groups will be treated is still pending.

Prior to 2003, MNRF used a Class Environmental Assessment for Small Scale MNRF Projects (Small Scale Class EA) to meet its obligations under the EA Act (OMNR 1992). Under this Class EA, fish stocking was dealt with in three ways:

- Stocking of exotic fish species, defined as species not present in Ontario waters, was not under the purview of the Small Scale Class EA and required different review and approval processes;
- Fish stocking in new waters, defined as "...the introduction into a body of water or watercourse of a fish species already present in the Province of Ontario, but not present in the body of water or watercourse where introduction is to be carried out.", was pre-defined as a Category B project and required full review under the Small Scale Class EA;
- Supplemental stocking, defined as "...introduction into a body of water or watercourse of a fish species already present, or that was previously present in a waterbody or watercourse where the introduction is to be carried out..." was pre-defined as a Category C project and could proceed without further review under the Small Scale Class EA. This Category C designation was used as the yearly approval process for all fish stocking in Ontario waters of the Great Lakes up until 2003.

In 2003, MNRF released the Class EA for Resource Stewardship and Facility Development Projects (RSFD) which replaced the Small Scale Class EA (OMNR 2003). As in the old Small Scale Class EA, fish stocking is dealt with explicitly in the RSFD Class EA. Specifically:

- Ongoing fish stocking, which includes fish stocking in inland lakes and native species in the Great Lakes, is pre-categorized as category A and can proceed to implementation and does not require a full screening under this Class EA. Unlike the old Small Scale Class EA, ongoing stocking of non-native fish species was not pre-categorized and therefore requires screening under the RSFD Class EA;
- Introductions of both native and non-native species require formal review under the RSFD Class EA.
- As in the old Class EA, stocking of exotic fish species, defined as species not present in Ontario waters, is not under the purview of the RSFD Class EA and requires different review and approval processes than the RSFD Class EA provides (OMNR 2003).

With the release of the RSFD Class EA in 2003, existing stocking programs for non-native species were allowed to proceed under a Transition Provision described in the Class EA. As a result of discussions regarding the implications of this new Class EA it was decided that reviews of existing fish stocking would, on a species by lake basis, be conducted concurrently with the five year cycle for Great Lakes Fishery Commission (GLFC) *State of the Lake* reports. This would allow the integration of current science and any new policy into decisions regarding fish stocking.

Class EA reviews of non-native fish stocking have never been done on the Great Lakes. Such a review of non-native fish stocking needs to be focussed on projects that follow MNRF policy and/or lake-wide planning objectives. To set policy through review and approval of individual stocking activities in the absence of policy or planning objectives would not be appropriate. To meet the needs of a Class EA review, policy documents need to provide details required for a Class EA such as numbers of each species to be stocked and egg collection and stocking sites. Documents with this level of detail do not exist for Lake Superior.

APPROACH USED TO EVALUATE THE EFFICACY OF FISH STOCKING

Stocking is a commonly used fisheries management tool that is one of a number of options available to managers. Given the magnitude of the MNRF fish culture program, it is clear that the ministry sees a role for fish stocking in Ontario. OMNR (2002) generally defines the purpose of stocking fish in 5 ways:

- Introductions
- Rehabilitation (e.g., Lake Trout stocking in the Great Lakes)
- Artificial, including supplemental and put-grow-take situations
- Research
- Stock Preservation

An objective evaluation of proposals to stock fish needs to include an assessment of progress towards stated objectives along with the potential for risk or harm to the ecosystem associated with the activity. Specifically, risks may include: the collapse of prey fish populations; negative impacts on the genetic health of naturalized/wild stocks; the disruption of spawning activities of other species during the egg collection process; and the introduction of disease into wild populations through stocking of diseased fish.

In the case of MNRF's Lake Trout stocking, the decision to terminate was guided by the Lake Trout Restoration Plan for Lake Superior (Hansen 1996), a thorough evaluation of progress towards rehabilitation objectives, and international consensus via the Lake Superior Technical Committee and Lake Committee process. In the case of salmon stocking, the situation is not as clear.

The absence of a strategic plan guiding the stocking of salmon limits our ability to assess progress towards established goals or targets. That said, prior to commencing the activity, a Feasibility Study (Dextrase et al. 1987) was conducted for the Thunder Bay Salmon Association (TBSA). It identified the following goals:

- build a Community Chinook Salmon Hatchery by the summer of 1987
- raise Chinook Salmon in the fall of 1987
- release Salmon smolts in the spring of 1988
- "to plant 100,000 Chinook Salmon smolts in a river near Thunder Bay"

It was also identified in the Feasibility Study (Dextrase et al. 1987) that:

- the TBSA "hoped that these fish will establish a naturalized population providing long term salmon angling opportunities in Thunder Bay"
- the TBSA wanted "to attract brood stock to a small stream, from which egg collections can be efficiently carried out."
- the TBSA sought to "to promote a sizeable naturalized run in the Thunder Bay area for angling opportunities."

From the perspectives of efficacy, costs and benefits, and risk to the ecosystem, one also needs to assess a proposal to stock fish relative to a number of other factors. For instance, in the case of depressed wild

fish stocks, an assessment of limiting factors (e.g., spawning habitat, over exploitation) is used to determine the appropriate management prescription. If habitat rehabilitation is required to facilitate natural reproduction, fish stocking may not be required, but if over exploitation has driven abundance to very low levels, stocking could be used to re-build a spawning stock.

Other factors that should be considered include the status of the fishery (i.e., is it performing well or poorly), and does fish stocking have the potential to address the issue. This is where the prior establishment of clear goals and objectives is beneficial. The survival of stocked fish is another important factor to consider. If there is no evidence that stocked fish are surviving and therefore are not making a contribution to the fishery, the efficacy of the activity is drawn into question. Finally, prior to undertaking the stocking of fish, the evaluation should identify any associated risks to native or naturalized fish populations and the ecosystem.

Important factors to consider when contemplating stocking:

- How are the risks and benefits of the species to be stocked evaluated in strategic fisheries management plans (such as Fish Community Objectives) for this lake/river?
- Define the need for stocking compared to other approaches:
 - Rehabilitative stocking of native or naturalized species;
 - Supplemental stocking
 - Introductions of new species (would require specific objectives);
 - Other options to manage the fishery;
- Are there adequate resources (food, space, habitat) for the species being stocked?
- How will stocked fish species compete with, predate on, or feed other native/naturalized species?
- Will genetic diversity and integrity of the species be maintained during stocking?
- Are angler expectations for harvest of the stocked or other species realistic and reflective of levels of abundance?
- Will the stocked fish be marked for evaluation of the activity?
- How is a disease/disinfection protocol to be used to minimize risks of disease transfer to the wild?
- What numbers of returning stocked fish or natural population levels will trigger the end of stocking?
- What specific time lines and stocking levels will meet the outcome target?
- How has the ecological risk (to sustainable food webs) of supplemental stocking of predator species been evaluated?

AN ASSESSMENT OF THE EFFICACY OF STOCKING CHINOOK SALMON INTO LAKE SUPERIOR AND ASSOCIATED RISKS

Chinook Salmon were already naturalized and reproducing in Ontario waters when salmon stocking commenced, therefore salmon stocking in Ontario waters of Lake Superior is most appropriately categorized as artificial in nature, intended to supplement a put-grow-take situation.

From the perspective of the Fish Community Objectives for Lake Superior, the objective for Pacific Salmon and Rainbow Trout is considered met. Chinook Salmon populations in Ontario waters of Lake Superior are now largely supported by wild fish (Peck et al. 1999) and the fisheries on which they depend are considered self-sustaining. This is also the case for Rainbow Trout in Ontario waters of Lake Superior (Bobrowicz 2009). The objective for Brown Trout is considered unmet. To date the Brown Trout fishery in Ontario waters is relatively small and the potential for Brown Trout to make a significant contribution to the Lake Superior fishery through stocking is considered to be uncertain or low.

With respect to other goals established at the time in the feasibility study (Dextrase et al. 1987), the goals to:

- build a Community Chinook Salmon Hatchery by the summer of 1987
- raise Chinook Salmon in the fall of 1987
- release Salmon smolts in the spring of 1988
- “to plant 100,000 Chinook Salmon smolts in a river near Thunder Bay”

have all been met. Dextrase et al. (1987) also identified that:

- it was “hoped that these fish will establish a naturalized population providing long term salmon angling opportunities in Thunder Bay”
- a goal was “to attract brood stock to a small stream, from which egg collections can be efficiently carried out.”
- a goal was to “to promote a sizeable naturalized run in the Thunder Bay area for angling opportunities.”

Bobrowicz (2011) notes that “by 1983, the Chinook fishery in Canadian waters was sufficiently popular that an annual fishing tournament was established at Wawa. Within four years, participation in the Wawa tournament had reached more than 300 anglers with 500 individual salmon entered in the two day event.” These reports are from an area where Chinook Salmon were not stocked prior to 1983 and before any salmon stocking had occurred in other locations suggesting that either reproduction in the wild or strays from U.S. stocking events were already providing substantial returns to the Wawa fishery. There are also media reports of an excellent Chinook Salmon fishery in Thunder Bay in 1988, at least 2 to 3 years before any returns from the first salmon stocking were expected, again suggesting that either natural reproduction in Canadian streams or hatchery strays from U.S. waters were already providing fish for the recreational fishery in the Thunder Bay area.

Although no formal assessment has been completed, anecdotal evidence suggests that no sizeable naturalized population of Chinook Salmon has been realized in the Kaministiquia River as a result of the stocking program. Consequently, the objective of promoting a naturalized run in the Thunder Bay area, at least in the Kaministiquia River, is considered unmet.

There is no evidence that the Kaministiquia River does in fact provide suitable habitat for Chinook Salmon. Dextrase et al. (1987) acknowledge that the Kaministiquia River had not been studied in detail and there does not appear to have been any subsequent investigations regarding the suitability of the river for salmon since then. It therefore remains uncertain whether the goals to “attract brood stock to a small stream” and “to promote a sizeable naturalized run in the Thunder Bay area” were ever attainable. However, examination of the Whitefish River, a tributary of the Kaministiquia River, may prove useful in this regard as what little information exists suggests that this tributary may provide more opportunities for natural reproduction.

Based on recent studies, there is evidence that few stocked salmon survive to contribute to the recreational fishery (Appendix I). Over the past 4 years, an average of 620 salmon have been entered into the TBSA derby. On an annual basis, of these, an average of 5 were stocked fish. Also, there is no evidence of any trend in terms of changes to the contribution of stocked fish to the fishery over the past 6 years. Although the stocking program for Chinook Salmon led to the establishment of naturalized populations around Lake Superior, it appears that the effectiveness of current stocking efforts has declined since the inception of the activity. This suggests that as wild production increased, the efficacy of stocking decreased. Although information on the status of the fishery is limited and opinions of anglers vary, the Chinook Salmon fishery appears to be performing very well relative to similar fisheries on Lake Huron (Appendix I). Generally, no concerns have been raised regarding the quality of the angling experience.

If there are few to no measureable benefits from stocking Chinook Salmon into Lake Superior, the question then becomes one of whether stocking poses any risk or harm to the resource, the fish community, or the ecosystem? Unfortunately, there is little information with which to evaluate the magnitude of risk. If, however, the magnitude of the contribution of stocked fish to the fishery is considered as a metric of the level of risk, it would appear to be low.

The scientific literature on the risks and benefits of fish stocking in general is mixed. Some reports highlight the positive benefits of stocking, others identify risks associated with stocking certain species, particularly over wild populations of the same species, and others provide clear evidence of harm from stocking. The benefits associated with fish stocking are best identified where there are clearly defined goals and objectives along with well-established metrics, and endpoints. Rehabilitation of Lake Trout on Lake Superior is a good example.

Cowx et al. (2010) reviewed recreational fisheries and nature conservation goals for aquatic biodiversity with specific reference to inland waters in industrialized countries. While they acknowledged that not all stocking should be curtailed, they suggested that more consideration of the objectives and risks of stocking is needed to prevent further compromises to aquatic biodiversity. Dettmers et al. (2012) noted for the Great Lakes, Lakes Michigan and Huron in particular, that managers must now make the difficult decision about whether to manage for economic returns by balancing the demand for Pacific salmon fisheries with declining alewife production that supports these recreational fisheries; or manage for rehabilitation of native fishes previously suppressed by alewife. The decision on Lake Superior is made

somewhat simpler since the fisheries for all species are supported by naturally self-sustaining populations.

Widespread examples of negative, rather than positive impacts, from other hatchery programs for salmonids suggest that risks of negative effects are plausible on Lake Superior. See Appendix 2 for a selection of scientific references in this regard.

To conclude, it is clear that Pacific salmon stocking programs on the Great Lakes, Lake Superior included, have surpassed their initial goal of rejuvenating public interest in the Great Lakes by converting nuisance, exotic prey into recreationally attractive species (Tanner and Tody 2002; Bence and Smith 1999; Whelan and Johnson 2004; Johnson et al 2010). However, ecosystem conditions have changed and levels of natural reproduction of many non-native salmonids has increased, Chinook Salmon included, since these stocking programs started (Peck et al. 1999; Johnson et al. 2010). Consequently, these changes have brought continued stocking of many species in the Great Lakes into question (Dettmers et al. 2012). Although clear evidence of negative impacts from Chinook Salmon stocking on Lake Superior has not been documented in the scientific literature, an examination of the scientific literature suggests that they are plausible.

CONSULTATION REGARDING SALMON STOCKING

Recent discussions regarding fish stocking on Lake Superior have focussed on salmon stocking and have principally been with the members of the Fisheries Management Zone 9 (FMZ 9) Council; these discussions started in 2011 and have continued to date. In addition, a “Salmon Task Team” (a sub-committee of the FMZ9) was also formed to address the issue in more detail. As part of these deliberations, FMZ 9 Council members were introduced to MNRFs requirement for a Stocking Plan and subsequent RSFD Class EA review for non-native fish stocking in the Great Lakes. These discussions included a formal request by TBSA to continue stocking Chinook Salmon. The FMZ 9 Council was advised by the MNRF that the review of TBSA stocking activities would include a decision whether Chinook Salmon stocking would continue. MNRF clarified that if the decision was to discontinue the activity, then a RSFD Class EA review would not be required.

Consensus on Chinook Salmon stocking has proven elusive. In the end, Council members decided to provide MNRF with formal position statements regarding Chinook Salmon stocking. This revealed a clear split between those opposed to the activity (four out of eight representatives) and those in support (two out of eight) of the activity. Two groups (two out of eight) were uncertain and identified the need for more information.

THE FUTURE OF SALMON STOCKING IN ONTARIO WATERS OF LAKE SUPERIOR

It is clear that interest in continued stocking of Chinook Salmon exists in Ontario waters of Lake Superior. However, it should also be clarified that stocking of Lake Trout, Rainbow Trout and Brook Trout will not be considered due to direction contained in previous management planning activities and documents that have clarified that stocking is not required. Additionally, stocking of Walleye will only be conducted when required as identified in formal resource management planning activities and documents. No other species are under consideration for stocking in Ontario waters of Lake Superior at this time.

Specific to continued stocking of Chinook Salmon, MNRF fish stocking guidelines (OMNR 2002) state that:

“Stocking hatchery-reared fish in waters which already provide adequate fishing opportunities based on natural reproduction is unnecessary. There is a considerable amount of evidence to indicate that supplemental stocking (i.e., plantings of non-native fish stocks in waters where a naturally reproducing stock of the same species exists) can have significant negative ecological impacts, is inefficient and seldom cost-effective. As a general rule, supplemental stocking should be discouraged in those waters which contain viable (i.e., where unmarked fish comprise ≥ 15 -20% of a representative sample of fish taken from the stocked waterbody) populations of native or naturalized fish of the same species.”

On Lake Superior, unmarked Chinook Salmon now comprise 98% to 99% of the fish caught in Black Bay and Thunder Bay recreational fisheries. A similar conclusion provided the principal rationale for the cessation of Chinook Salmon stocking in Minnesota and Wisconsin waters of Lake Superior and reductions in Chinook Salmon stocking in Michigan waters. Minnesota Department of Natural Resources (MNDNR) data suggests that angler catch rates of Chinooks have remained stable since stocking was discontinued in 2005, and that catch rates for all salmonid species are now increasing (D. Schreiner, MNDNR, unpublished data).

Both the TBSA feasibility study and the contemporary MNRF Pacific salmon management guidelines (OMNR 1987) specified that salmon stocking “will not be permitted in areas where the forage base becomes limiting with respect to top predators and where rehabilitation efforts might be jeopardized.” Both of these statements are in agreement with the current FCOs for Lake Superior:

“Manage populations of Pacific salmon, Rainbow Trout, and Brown Trout that are predominantly self-sustaining but that may be supplemented by stocking that is compatible with restoration and management goals for indigenous fish species.” — Horns et al. 2003.

Overstocking of Pacific salmon has been implicated in the collapse of the forage base in Lake Michigan (Dettmers et al. 2012) and Lake Huron (Bence et al. 2008). Gorman et al. (2011) observed a declining trend in Lake Trout densities in Lake Superior since 2005 and the 2010 estimate of fish community biomass was the second-lowest since the annual survey began in 1978. These declines have been attributed to changes in abundance of major prey species (Gorman et al. 2011). As a result, the status of

Lake Superior prey populations need to be considered on a regular basis when approving stocking of predators such as Chinook Salmon.

Finally, the recent establishment of the Lake Superior National Marine Conservation Area (NMCA) poses a somewhat unique challenge to MNRF, which worked with Parks Canada to establish the NMCA. The NMCA extends 140 kilometres eastward from the tip of Sleeping Giant Provincial Park near the city of Thunder Bay to Bottle Point in the east, and southward to the Canada-US border, linking with Isle Royale National Park in the United States. Section 3.1.5 of Parks Canada's Activity Policies for NMCA Policy states that, "the introduction of exotic plants or animals into the wild in a marine conservation area will not be permitted." While the authorization of salmon stocking outside the NMCA may not constitute a breach of this policy, as a good neighbor, MNRF should be mindful of activities it authorizes in areas immediately adjacent to an NMCA.

In conclusion:

For Chinook Salmon:

- Lake Superior boasts a quality fishery for Chinook Salmon;
- Either the cessation of stocking or stocking at current levels are generally consistent with MNRF's Strategic Plan for Ontario Fisheries II (OMNR 1992), MNRF stocking guidelines (OMNR 2002), the Lake Superior FCOs (Horns et al. 2003) and the Joint Strategic Plan (GLFC 2007);
- The benefits that accrue to the recreational fishery from stocking Chinook Salmon in Lake Superior are marginal and the return rates of stocked Chinook Salmon are so low that stocking at its present level is unlikely to have negative effects on other species or on naturally reproducing salmon populations;
- It is therefore recommended that stocking of Chinook Salmon in Ontario waters of Lake Superior be allowed to continue due to persistent interest in the activity and the lack of clearly identified risk in continuing the activity;
- However, the number of Chinook Salmon to be stocked annually will be reduced to 120,000 fish a year to help ensure any risks associated with the activity are minimized;
- Furthermore, additional license conditions will be applied to future permits; these conditions will be discussed in the following sections;

For Other Species:

- Stocking of Lake Trout, Rainbow Trout and Brook Trout will not be considered due to direction contained in previous management planning activities and documents that have clarified that stocking is not required;
- Stocking of Walleye will only be conducted when required as identified in formal resource management planning activities and documents;
- No other species are under consideration for stocking in Ontario waters of Lake Superior at this time.

STRATEGIC CONSIDERATIONS FOR CONTINUED CHINOOK SALMON STOCKING IN ONTARIO WATERS OF LAKE SUPERIOR

As has been discussed, past stocking of Chinook Salmon in Lake Superior was not directed by a specific ecological goal or objectives. Stocking of non-native salmonids in Lake Superior has been conducted to provide an attractive recreational sport fish species (as described by Tanner and Tody 2002). Most ministry-led stocking activities have been directed at restoration of native species. These two different perspectives regarding the stocking of fish have never been effectively rationalized and considered together on Lake Superior.

To provide a clear foundation for future stocking activities, a suite of Conceptual Foundations (Anderson 1991; ISG 1999) have been developed. These make clear the basic scientific principles and concepts that underlie a future stocking program. The Independent Scientific Group (ISG), which provides scientific advice for the Columbia River salmonid restoration program, presented a compelling case for the use of conceptual foundations in management plans and programs (ISG 1999). They defined conceptual foundations as "...the set of scientific principles and assumptions that direct management activities ..." and "...it influences how we interpret information, identify problems, and select approaches to their resolution..." (ISG 1999). Developing conceptual foundations for the stocking program on Lake Superior is a useful way to identify a unified direction for future fish stocking. It is important to identify conceptual foundations to clearly document the biological limitations for future fish stocking activities. These Conceptual Foundations will provide guidance and direction for development of a goal and time specific objectives for future fish stocking.

A number of documents have guided the development of the following concepts and assumptions which form the basis of a conceptual foundation for continued salmon stocking in Lake Superior. These documents include MNRs Strategic Plan for Ontario Fisheries (SPOF 2) (OMNR 1992), the Lake Superior Fish Community Objectives (Horns et al 2003), MNRs Guidelines for Stocking Fish in Inland waters of Ontario (2002), the Great Lakes Fishery Commission's Joint Strategic Plan (GLFC 2007) and MNRs Our Sustainable Future (OMNR 2011). General guidance was also taken from two documents that discuss hatchery programs in the Columbia River basin, namely the ISG's paper published in Fisheries (ISG 1999) and the Hatchery Scientific Review Groups report to the US Congress on their review of the Columbia basin hatchery programs (HSRG 2009).

CONCEPTUAL FOUNDATIONS FOR FISH STOCKING IN ONTARIO WATERS OF LAKE SUPERIOR

- 1. Lake Superior must be managed as an ecosystem and the effects of all fish stocking activities, whether they are positive or negative, need to be considered together when planning a fish stocking program.*
- 2. Stocking activities will focus on facilitating the creation of stable, self-sustaining fish populations. This approach will ensure that stocked fish are used in an effective manner and that predator populations are in balance with prey production.*

- 3. Fish stocking activities need clear goals and objectives and include social and economic considerations. These will provide a framework for assessment which will help determine if stocking programs are meeting their intent or not and additionally, are not causing any ecological harm.***

This suite of principles and assumptions form the basis for a stocking program focussed on facilitating natural reproduction while also recognizing ecosystem limitations in Lake Superior. They are necessarily broad in nature but provide a common understanding for the development of goals and objectives for fish stocking.

Adaptive Management of Stocking

An important component of these Conceptual Foundations and the goal and objectives below is the use of an adaptive approach to continued stocking of Chinook Salmon. It is expected that an adaptive approach to the stocking program, which incorporates change over time, will be necessary to ensure that the goal and objectives are met. This approach is likely to include changes to stocking sites or other practises as necessary.

GOAL

Continued discussion with stakeholders regarding stocking of Chinook Salmon in Ontario waters of Lake Superior has indicated that, although returns of stocked fish to the fishery are low, interest in continued salmon stocking exists. This would indicate there is a continued social or economic objective to stock this species for recreational purposes. However, continuing to stock salmon needs to be directed by a goal and objectives as discussed within the context of Conceptual Foundations. This will help balance continued local interest in the activity with biological limitations. A clear goal and objectives will also assist in future reviews of salmon stocking.

With the Conceptual Foundations concepts in mind, the following goal for continued salmon stocking in Ontario waters of Lake Superior is:

“To establish a self-sustaining population of Chinook Salmon in the Kaministiquia River while not negatively impacting other species in the Kaministiquia River and Lake Superior.”

A common concept associated with rehabilitative stocking is the progression from populations consisting of predominantly hatchery origin fish to a population sustained entirely by natural reproduction (OMNR, 2009b). This progression generally starts with hatchery origin adults spawning in the wild and producing young. An approach similar to rehabilitative stocking will be taken for establishing a self-sustaining population in the Kaministiquia River. In order to monitor attainment of this goal, a series of objectives will guide progress towards a self-sustaining population. These objectives will serve as measurable points over the short, mid, and long-term. Meeting these objectives will be essential in achieving the end goal of a self-sustaining population of Chinook Salmon in the Kaministiquia River while not negatively impacting other species.

OBJECTIVES

The following objectives are based on the typical life history of Chinook Salmon in the Great Lakes and more specifically Lake Superior. The majority of Chinook Salmon in Lake Superior mature at age 4 and upon reaching maturity the adults will return to their natal stream or stocking site to spawn between October and November (UGLMU unpublished data). Eggs will hatch in late winter and fry will emerge from the gravel by late March to early April. By June, fry will have begun to smolt out to the lake where they will remain until the onset of the spawning run; this results in only a 6-8 month stream residency period for the juvenile life stages (Gerson, 2012). The life history of Chinook Salmon in Lake Superior is important as it forms the biological timeframe by which the formation of a self-sustaining population in the Kaministiquia River will operate.

Short-term Objective

Based on the typical life history of Chinook Salmon in Lake Superior where most adults mature at age four, and the fact that there is likely some natural reproduction taking place in the Kaministiquia River given the past stocking history, a short-term objective for continued stocking is as follows:

Develop a spawning population in the Kaministiquia River and its tributaries comprised of an equal proportion of hatchery (50%) and wild fish (50%) which return to spawn on an annual basis, starting four years after the onset of continued stocking with:

- *a “spawning population” defined as an aggregation of sexually mature Chinook Salmon spawning in habitats with substrates suitable for egg deposition and rearing;*
- *this proportion is based on an annual, minimum sample of 100 fish;*
- *this proportion evident over at least four consecutive years.*

Mid-term Objective

A typical Chinook Salmon from the first year class of fish stocked as directed by this Plan will reach maturity at age four, five years after stocking. If it is assumed fish from this first year class produce wild young, then wild Chinook Salmon offspring would be present in the Kaministiquia River six years after the onset of continued stocking. This year class of wild fish would then return as sexually mature adults four years later, ten years after the onset of continued stocking. As a result, a mid-term objective that reflects the transition from a population that is supplemented by both stocking and natural reproduction to a population that relies more heavily on natural reproduction is as follows:

Generate sustained natural reproduction of Chinook Salmon by the 6th year after the onset of stocking and recruitment of these wild fish to the spawning population in the Kaministiquia River starting by the 10th year after the onset of continued stocking such that:

- *the spawning population is comprised of 25% hatchery fish and 75% wild fish on the 10th year;*

- *this proportion is based on an annual, minimum sample of 100 fish;*
- *this proportion is evident over at least four consecutive years.*

Long-Term Objective

Based on the typical life history of Lake Superior Chinook Salmon it is anticipated that after ten years, wild offspring produced from hatchery origin parents would be present as sexually mature fish in the spawning run, in the Kaministiquia River and tributaries. Following this initial transition, a long-term objective that reflects a complete transition to a population sustained by natural reproduction is as follows:

Establishment of a self-sustaining population of Chinook Salmon returning to the Kaministiquia River and its tributaries on an annual basis with over 75% of the fish of wild origin where:

- *this proportion is based on an annual, minimum sample of 100 fish;*
- *this proportion is evident over at least four consecutive years.*

The transition from a spawning population based on adults of hatchery origin to one based on fish produced in the wild is of crucial importance to attainment of the goal and objectives. Given the life history of Chinook Salmon in Lake Superior, this process will take a minimum of ten years to occur. As a result, stocking efforts directed by this document will be reviewed in ten years' time. This review will need to focus on whether the goal and objectives are being met and what further process should be implemented pending the outcomes of this review.

Disease Monitoring Objective

Recent outbreaks of viral and bacterial infections such as Viral Hemorrhagic Septicaemia (VHS) and Infectious Hematopoietic Necrosis (IHN) in the Great Lakes have made it necessary to exercise caution when transferring gametes within the lake. Although the VHS virus has not yet been found in Lake Superior, it is highly recommended that best management practices are followed by all fish culture operations. Thus it is suggested that:

All hatcheries follow the protocol for egg disinfection from the Ontario Ministry of Natural Resources – Fish Culture Technical Bulletin 2009-01 (OMNR 2009a), which recommends disinfecting eggs during water hardening, using a solution containing Ovadine.

- *this protocol will be made available with all egg collection permits.*
- *additionally, an annual disease test prior to stocking out will be performed to ensure that fish being reared are disease free and will not be transferring disease into the wild.*

ASSESSMENT

Annual assessment and monitoring of the Chinook Salmon population will be essential in measuring progress towards obtaining the goal and objectives. Annual fall spawning assessments will be conducted on the Kaministiquia River and suitable tributaries beginning in the fall of 2015. The purpose of these studies will be to assess the relative abundance of returning mature adult Chinook Salmon in the Kaministiquia River; as well as to monitor the ratio of wild versus hatchery reared fish. A number of fixed sites will be selected to be monitored on an annual basis. Assessment will consist of a single pass

of a 50-75 meter stretch of river using a backpack electro fishing and/or boat electro-fishing unit where suitable. Upon capture, fish will be weighed and measured, sexed, and assessed for fin-clips.

The UGLMU will also continue a series of long running projects monitoring trends and health of the Chinook Salmon population in Lake Superior. Currently the TBSA, with support from the UGLMU, conducts an annual creel survey in Thunder Bay and Black Bay; this creel will continue to be conducted pending continued TBSA interest to do so. The purpose of this survey is to collect catch, effort, and harvest data from the recreational fishery. These data are then used to estimate the fishing quality in the area which is an indication of overall abundance and health of the Chinook Salmon population. UGLMU staff will also continue to conduct biological sampling and creel interviews at the annual TBSA salmon derby in Thunder Bay, Ontario. This project is an opportunity for the UGLMU to collect a significant amount of data regarding the Chinook Salmon population, including catch, effort, and information regarding the efficacy of the stocking program. These data will be analyzed and summarized by UGLMU staff and made available in reports on an annual basis.

SUMMARY AND RECOMMENDATIONS FOR FUTURE STOCKING OF CHINOOK SALMON

The stocking of fish in the Ontario waters of Lake Superior is focused on interest in one species in one area of the lake, leading to the goal:

“To establish a self-sustaining population of Chinook Salmon in the Kaministiquia River while not negatively impacting other species in the Kaministiquia River and Lake Superior.”

Lake Trout, Rainbow Trout and Brook Trout targets in Lake Superior have been achieved. These species are not being considered for any additional stocking efforts by Ontario. Walleye stocking may be permitted in the future but is not planned at this time.

This plan recommends Chinook Salmon can continue to be stocked and licenced through the Community Hatchery Program process. It is also recommended that annual stocking of 120,000 fish or fewer can achieve the fisheries objectives and continued stocking depends on annual reviews of progress towards the goal and objectives and the condition that negative effects on other species do not develop.

Specific aspects of egg collection and release of fish will be outlined in conditions on appropriate licences. Conditions and specific activities should be guided by the following technical considerations:

- The Kaministiquia River should remain the principal stocking site. Due to low returns of hatchery fish, in part likely as a result of post-stocking mortality issues, it is recommended that different stocking sites within the river be chosen. More specifically, it is recommended that fish be released into appropriate sections of the Kaministiquia River and/or its tributaries to avoid high densities of warm water predators that inhabit some portions of the river. These species are likely contributing to significant post stocking mortality and should be avoided if possible. Staff

from the UGLMU will be available to help locate suitable stocking locations on the Kaministiquia River and/or its tributaries.

- Egg collection sites will be limited to the following rivers which are ranked according to the order where egg collection attempts should occur:
 - Kaministiquia River
 - Nipigon River
 - Wolf River
- If a viable gamete source exists on the Kaministiquia River, egg collection from the Kaministiquia River and tributaries is encouraged in order to retain genetic traits of fish returning to the Kaministiquia River and avoid negative impacts on naturalized populations in other locations.

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APPENDIX I: EVALUATION OF NON-NATIVE SPECIES STOCKING IN LAKE SUPERIOR

Since MNRF has discontinued Lake Trout stocking, the only remaining stocking of fish is Chinook Salmon in Thunder Bay. That activity is reviewed in detail below.

On a lake-wide basis, uncertainty regarding the abundance of wild salmon in Lake Superior relative to contributions from stocking programs led to concern regarding the sustainability of predator-prey relationships. As a result, all agencies marked stocked Chinook Salmon with agency specific fin clips from 1987-1996. In Ontario waters, MNRF monitored returns of marked hatchery salmon and wild fish at two competitive fishing events from 1987-1996 (Figures 3 and 4) and through a cooperative angler diary program from 1987-1995 (Figure 5). Monitoring was initially terminated in 1997 when the TBSA hatchery closed (from 1997-1999). Although lake-wide results varied slightly across jurisdictions, it was clear from this assessment program that wild salmon dominated the lake-wide population (Peck et al. 1999). Data from Ontario waters confirmed this lake-wide conclusion (Figures 3-6). More recently, Bronte et al. (2003) noted that population dynamics of non-native salmonids are largely driven by climatic fluctuations and that “stocking programs are of limited value.”

More recent monitoring of the efficacy of salmon stocking has been conducted through collections of biological data from Chinook Salmon entered in a competitive catch and kill derby run by the TBSA in Thunder Bay, Ontario. Upper Great Lakes Management Unit (UGLMU) staff have collected biological data from fish brought ashore every day the derby has ran from 2008 to 2013. This assessment has fulfilled a 5 year commitment for monitoring made by the UGLMU.

Results from this more recent monitoring clearly indicate that stocked fish do not contribute in a meaningful way to the local fishery (Figure 6). Since 2008 stocked salmon have represented less than 1% of the catch in the annual summer derby in Thunder Bay. It is assumed that contributions of stocked fish to the fishery outside of Thunder Bay are even lower as distances increase from stocking sites on the Kaministiquia River.

Figure 3. Proportion of wild (no fin clips) and marked Chinook Salmon sampled during the Thunder Bay Fishing Festival from 1987 to 1996. Origin of marked fish noted with 'Other' indicates fish from U.S. jurisdictions.

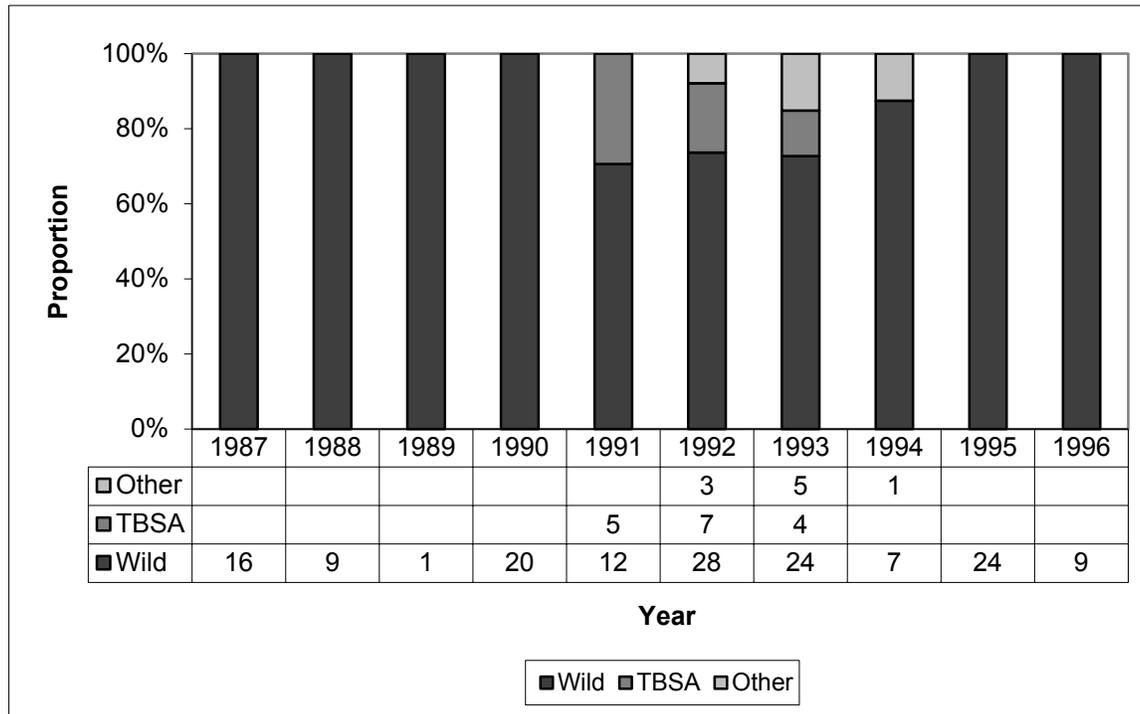


Figure 4. Proportion of wild (no fin clips) and marked Chinook Salmon sampled during the Stanley Hotel Slammin' Salmon Derby (Kaministiquia River) from 1991 to 1996. Origin of marked fish noted with 'Other' indicates fish from U.S. jurisdictions.

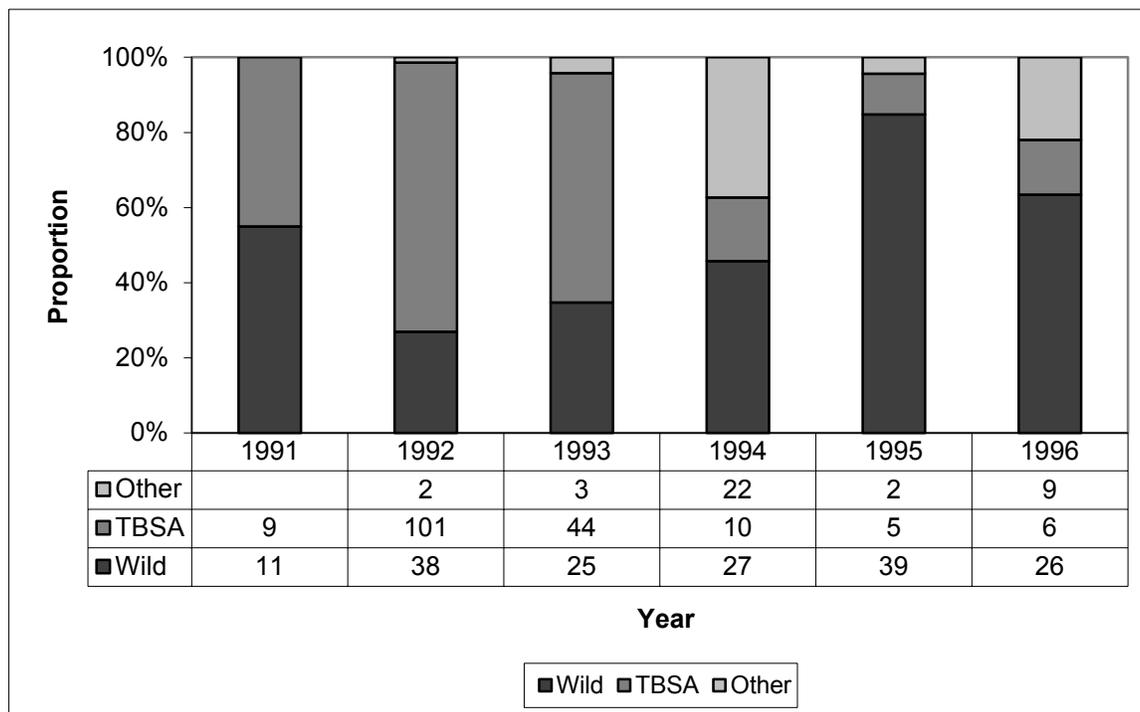


Figure 5. Proportion of wild (no fin clips) and marked Chinook Salmon sampled during the Lake Superior Co-Operative Angler Program from 1987 to 1995 and 2012. Origin of marked fish noted with 'Other' indicates fish from U.S. jurisdictions. Origin of marked 2012 samples is unknown as both TBSA and MiDNR currently mark fish with an adipose fin clip.

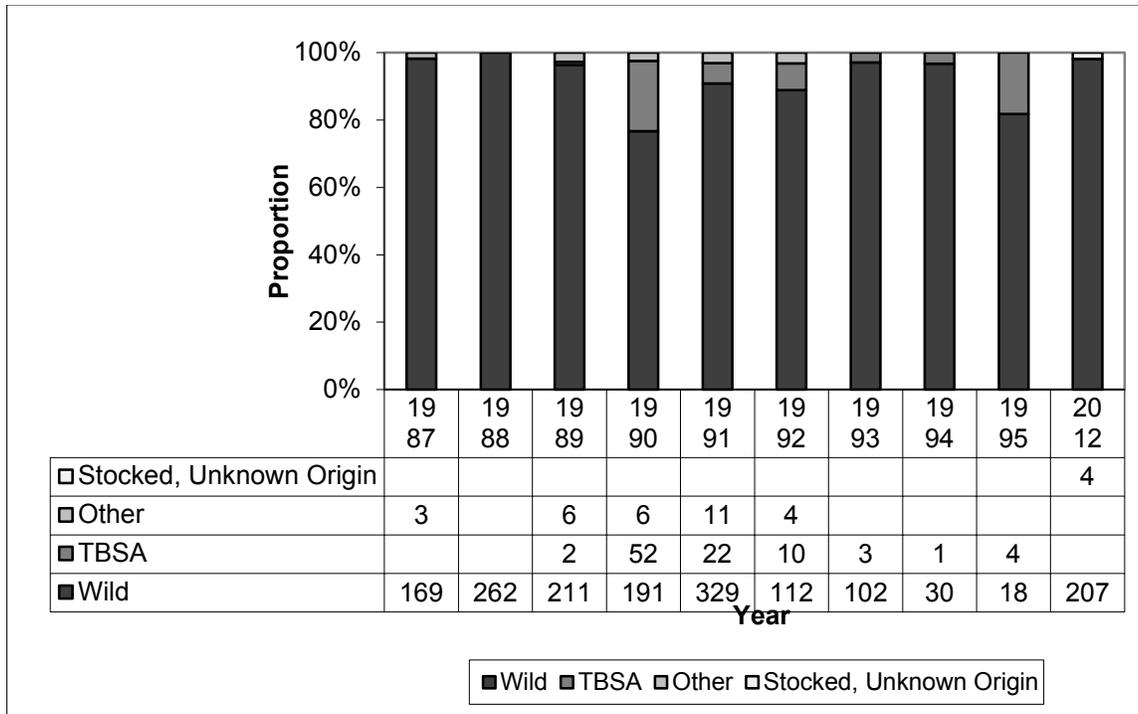
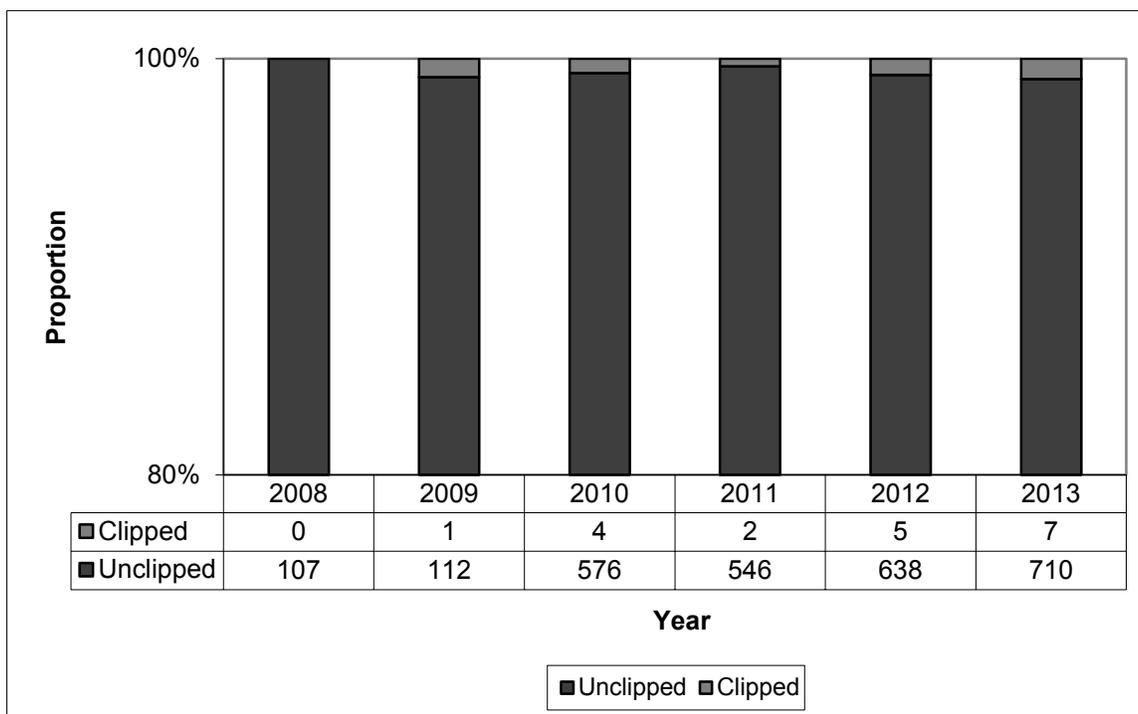


Figure 6. Proportion of marked and unmarked, presumed wild (no fin clips) Chinook Salmon sampled during the TBSA salmon derby from 2008 to 2013.

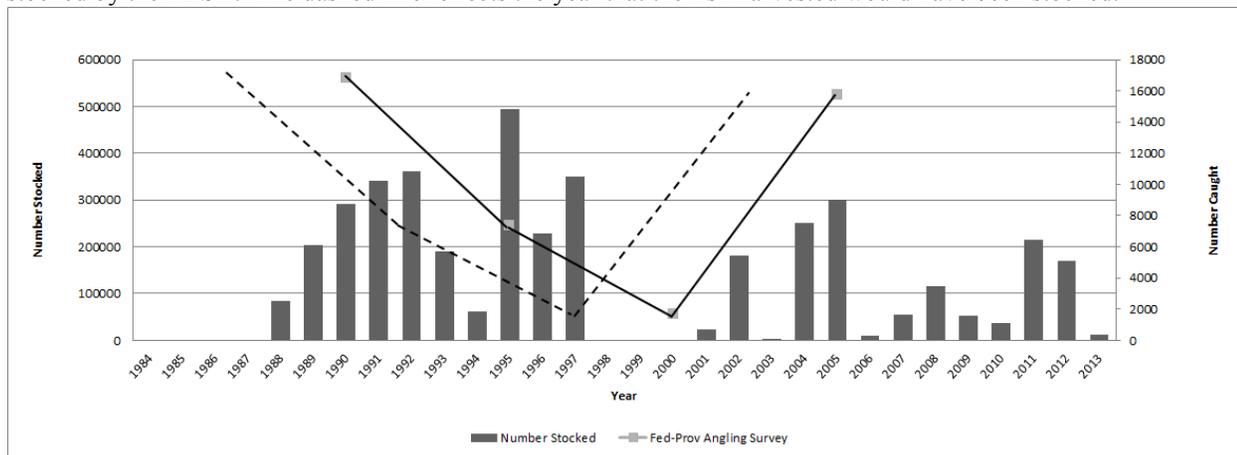


The proportion of stocked fish in the fishery paints only one picture of the efficacy of stocking. Another important factor to consider is the status of the recreational fishery. While there is not a great deal of information on the Lake Superior Chinook Salmon fishery, some information is available that can help inform decisions related to fish stocking.

The federal and provincial governments conduct a mail-in survey of anglers every 5 years. This approach provides a high level picture of angling across Canada (DFO <http://www.dfo-mpo.gc.ca/stats/rec/great-lakes-eng.htm>) and at the provincial level. Selected results for the Great Lakes have also been prepared since 1995. Based on these reports, a picture of the recreational fishery over time can be gleaned for Lake Superior. The estimate of the number of Chinook Salmon caught by all anglers, for instance, has varied over time with the number declining from 1995 to 2000 and then increasing again in 2005 (Fig. 7).

The survey does not collect information related to fish marking, therefore the contribution of stocked fish is not known. A comparison of the number of salmon stocked and angler catch, however, appears to exhibit an inverse relationship. If one compares the number of fish caught with the number of fish stocked 3 years prior (i.e. most fish are harvested at 3 years of age), the catch appears to decline as the number of fish stocked increases. Caution should be taken in inferring too much from these results since the catch figures are for the entire lake and fish are only stocked in the west end of the lake. Unfortunately, the results for the Great Lakes from the 2010 survey are not yet available.

Figure 7. Estimate of the number of Chinook Salmon caught by all anglers in Lake Superior relative to the number of fish stocked by the TBSA. The dashed line reflects the year that the fish harvested would have been stocked.



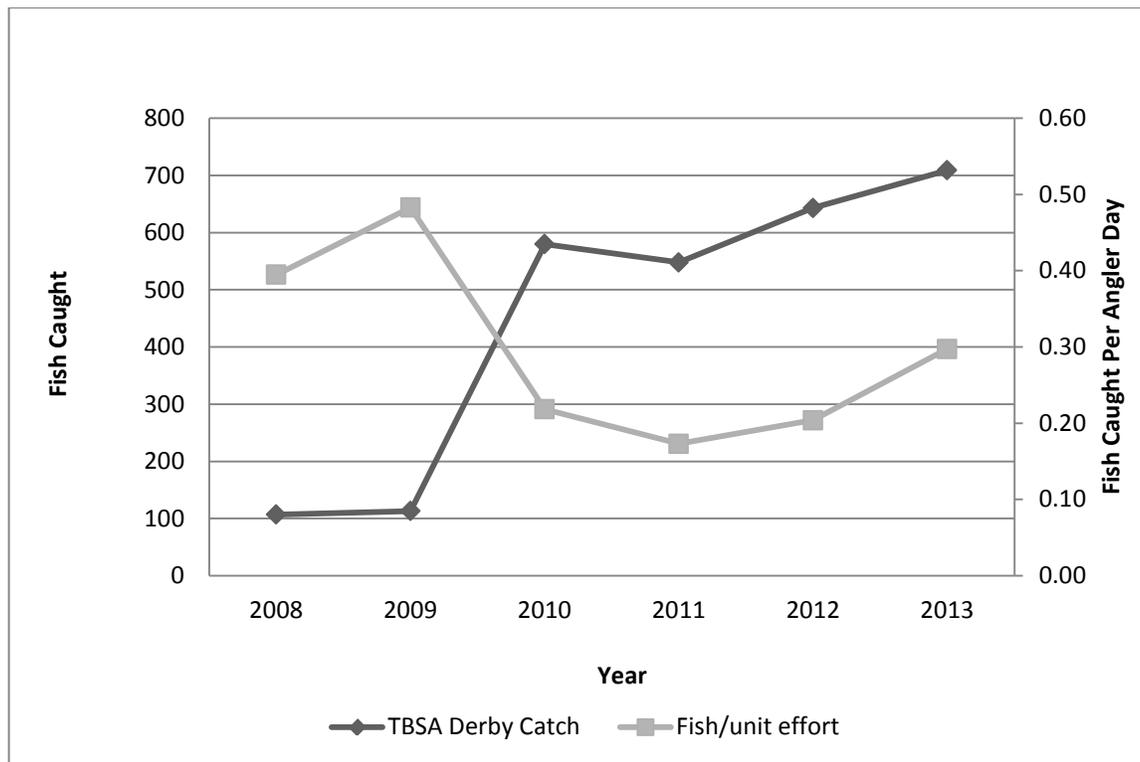
Another source of information on the status of the Chinook Salmon recreational fishery is the annual Thunder Bay Salmon Association Derby. MNR has worked with the TBSA to collect biological information on fish entered into this event from 2008 to the present. The duration of the derby increased from 1 day in 2008 and 2009 to 8 days in 2010 and beyond. In addition to the increase in duration, the number of derby participants also increased slightly from an average of 253 to 355.

For the first two years of the derby an average of 110 salmon were caught per year. The increase in the participation rate and duration of the derby to 8 days saw a concomitant and substantial increase in the

catch to 580 in 2010, followed by a small decrease to 548 in 2011, and increases to 643 and 709 in 2012 and 2013 respectively (Figure 8). Taken together, the increase in the number of days and the increased participation represents over a 10 times increase in angling effort. When the number of participants in the derby is factored in, a standard unit of effort (fish caught per angler day) can be calculated thus providing a Catch Per Unit of Effort (CPUE). Comparing the catch per angler day between the 1 day and 8 day derbies revealed a 50% reduction in the catch per angler day (4.4 average number of fish/angler day (1 day derby) to 2.2 fish/angler day (8 day derby)). Again, no relationship to stocked fish is implied here since 98% or more of the fish caught are wild.

The Sydenham Sportsmen’s Association (SSA) has been running a derby (The Salmon Spectacular) in Owen Sound for many years and while caution needs to be exercised, it can serve as a comparable event. The derbies target the same species, they are of similar duration (the SSA event is nine days long versus eight for the TBSA sponsored event), and the number of participants is somewhat similar (790 in the SSA Derby and 620 for the TBSA derby). A comparison of the catch per angler day of the two derbies reveals that the catch rate of the one day TBSA derby was 3.7 times that of the SSA derby and the catch rate of the 8 day derby is on average, 1.2 times that of SSA derby. Again, caution should be exercised on the interpretation of derby data CPUE. This does suggest, however, that the recreational Chinook Salmon fishery on Lake Superior is as good or better than the fishery on Lake Huron.

Figure 8. Number of fish caught and fish caught per angler day in the TBSA Salmon Derby.



Another source of information comes from recreational fishing surveys (creels). In 2012 and 2013 the TBSA partnered with MNR to conduct angler surveys in Thunder Bay and in 2013, MNRF conducted an angler survey in Black Bay. The results of these surveys indicate that the salmon fishery is as good, or better than others.

Comparing the two creels from Thunder Bay and the Black Bay Creel with several similar surveys on Lake Huron reveals that the CPUE on Superior is higher than any from Lake Huron. Black Bay in particular exhibited a catch rate that is 3 times higher than any from Lake Huron while the CPUE in Thunder Bay was double than observed on Huron. A smaller percentage of Superior anglers keep the Chinook they catch, which may partially explain the robustness of this stock.

APPENDIX 2: REFERENCES REGARDING NEGATIVE IMPACTS OF STOCKING

A growing body of scientific literature suggests that negative impacts from stocking are possible and do occur. Some pertinent examples include: Cowx et al. 2010; Hewlett et al., 2009; van Zyll de Jong et al., 2004; Eby et al., 2006; Almod'ovar & Nicola, 2004; Hickley & Chare, 2004; Van Zyll de Jong et al., 2004; Byrne et al. 1992; Cowx & Gerdeaux, 2004; Evans et al. 1991; Evans and Willox 1991; Hilborn 1992; Meffe 1992; Sterne 1995; Levin et al. 2001; ISAB 2002; Salmon Recovery Science Review Panel 2003; Kleiss 2005; Pearsons 2008; Chilcote et al. 1986; Hilborn 1992; Hilborn and Eggers 2000; Chilcote 2003; Kostow et al. 2003; Nickelson 2003; Kostow and Zhou 2006; Araki et al. 2007; Araki et al. 2009; Buhle et al. 2009; Goodman 1990; Reisenbichler and Rubin 1999; Einum and Fleming 2001; Kostow 2008; McMichael et al. 1999; Chilcote 2003; Kostow et al. 2003; Kostow and Zhou 2006; Araki et al. 2007; Nickelson 2003; Buhle et al. 2009; Hilborn and Eggers 2000; Kreuger and May 1987; Kreuger et al. 1994; Negus 1996; Close 1999; Miller et al. 2004; Bartron and Scribner 2004; Weeder et al. 2005; Bartron and Scribner 2004; Dueck and Danzmann 1996; Gatt 2002; and Gerson 2012.