GREAT LAKES FISHERY COMMISSION

2008 Project Completion Report[1]

Report of the Implementation Task Group on Mass Marking Hatchery-reared Salmonines in the Great Lakes

to

Council of Lake Committees

by:

Charles R. Bronte (editor)

U.S. Fish and Wildlife Service
Green Bay National Fish and Wildlife Conservation Office
2661 Scott Tower Drive, New Franken, WI 54229

January 2008

[1] Project completion reports of Commission-sponsored research are made available to the Commission's Cooperators in the interest of rapid dissemination of information that may be useful in Great Lakes fishery management, research, or administration. The reader should be aware that project completion reports have not been through a peer-review process and that sponsorship of the project by the Commission does not necessarily imply that the findings or conclusions are endorsed by the Commission. Do not cite findings without permission of the author.

Table of Contents

Executive Summary

The charge to the subject group made in April 2005 was to design an implementation plan for mass marking trout and salmon that refines marking logistics and the mark-recovery and information management strategies identified previously in April 2005, and design a strategy for coordinating hatchery operations by evaluating the logistics and costs associated with implementing mass marking at one or two hatcheries in each jurisdiction. This report outlines a vision to coded-wire tag and adipose fin-clip all 31 million salmonines stocked into the Great Lakes and to establish a cooperative data recovery, archiving and analysis system that would serve the information needs of all Great Lakes agencies. Principle features include 1) more realistic projections of equipment, manpower and fiscal requirements to implement a basin-wide program based on expert advice not available previously. If fully developed, the program will need 9 Autofish trailers and 4 manual trailers to mark and tag all 31 million fish. Total cost (2008 US dollars) for equipment would be $13.7 million and $6.5 million for operations; 2) possible marking and tagging scenarios by lake and species with building equipment inventories; 3) prototype schedules to move equipment and manpower across space and time to accomplish the marking objectives; 4) the establishment of a Great Lakes Mass Marking Laboratory, run by the U.S. Fish and Wildlife Service, that will conduct marking and recovery in U.S. waters and provide technical (statistical/analytical, head shop, database management) and administrative support to the basin-wide program. The Ontario Ministry of Natural Resources will mark and tag all fish in their jurisdiction but all technical services from the lab with be made available to them; 5) a generalized model of a multi-agency decision committee structure of comprised Great Lakes Regional Marking Committee (GLRMARC) that will be responsible for developing and prioritizing basin-wide, lake-wide and jurisdiction specific study questions, and a Data Standards Committee that will develop database specifications and standard operating procedures for transferring and archiving data; 6) a study plan for coded-wire tagging all Chinook salmon in Lake Huron and Michigan to estimate wild production, which is a high priority information need for the CLC; and 7) a generalized protocol for collecting tagged lake trout in Lake Huron and Michigan including recovery expectations. These will form the basis for planning similar activities on the other Great Lakes.

Introduction

In April 2005**,** the Council of Lake Committees (CLC)**,** Great Lakes Fishery Commission (GLFC) approved the report of the Mass Marking Task Group that outlined a series of recommendations for establishing a coordinated, basin-wide, mass marking of hatchery-reared trout and salmon stocked into the Great Lakes (http://www.glfc.org/boardcomm/clc/Mass_marking_report_CLC.pdf hereafter the April 2005 report). Important findings and management recommendations from that report were:

- An adipose fin-clipping and coded-wire tagging program (ADCWT) using manual and automated systems produced by Northwest Marine Technology is the best mass marking method for the information needs of Great Lakes agencies.
- Implement a long-term strategy of adipose clipping 100% of trout and salmon stocked into the Great Lakes each year and coded-wire tagging 50% of the salmon and 100% of the lake trout stocked each year.
- Purchase of 12 automated marking trailers and associated equipment at a cost of $12.7 million US (2008 dollars). An additional $2.8 million in annual operating costs would be needed for implementation.
- Adoption of statistically rigorous tagging and data recovery designs that will meet information needs prior to any tagging.
- The U.S. Fish and Wildlife Service (USFWS), National Fish and Wildlife Conservation Program should establish a central tag recovery and database maintenance infrastructure for the Great Lakes basin to handle all tag recovery data and process heads for agencies that require assistance. Ownership, operation, and maintence of the mass marking equipment would also be the responsibility of the USFWS.
- There is considerable commitment within the Great Lakes basin to implement a mass-marking strategy, however success hinges on the ability of the CLC and its member agencies to develop large and small-scale information needs that lead to highly coordinated tag/mark schedules, enhanced data recovery efforts, and systems to archive, analyze, and disseminate the tag recovery information to better manage Great Lakes fish comminutes, fisheries, and hatchery production, and measure impacts to the ecosystem.

To advance the mass marking initiative, the CLC established the Implementation Task Group composed of a Funding sub-group and an Implementation sub-group in April 2005. The Funding group was charged to:

1) *Develop and implement a strategy, in consultation with CLC, to secure funding from U. S. and Canadian governments for putting into action mass marking of trout and salmon stocked into the Great Lakes, and*
2) *Create a MOA among strategic plan members for the most effective and efficient use of the mass marking trailer.*

The Implementation group was charged to

1) *Design an implementation plan for mass marking trout and salmon that refines the marking logistics and the mark recovery and information management strategies identified in the April 11, 2005 mass marking report,*
2) *Design a strategy for coordinating hatchery operations by evaluating the logistics associated with implementing mass marking at one or two hatcheries in each jurisdiction.*

This report addresses the charges of the Implementation group. Herein we present

1) More realistic projections of equipment, manpower and fiscal requirements to implement a basin-wide program based on expert advice not available to the Mass Marking Task Group for the April 2005 report.
2) The establishment of a Great Lakes Mass Marking Laboratory that will conduct marking and recovery in US waters and provide technical and administrative support to the basin-wide program.
3) A generalized model of a multi-agency decision committee structure comprised of Great Lakes Regional Marking Committee that will be responsible for developing and prioritizing basin-wide, lake-wide and jurisdiction specific study questions, and a Data Standards Committee that will develop specific recommendations on relevant data fields and standard operating procedures for transferring and archiving data.
4) A study plan for coded-wire tagging all Chinook salmon in Lake Huron and Michigan to estimate wild production, which is a high priority information need for the CLC.
5) A generalized protocol for collecting tagged lake trout in Lake Huron and Michigan including recovery expectations. These will form the basis for planning similar activities on the other Great Lakes.

Engagement of Expert Assistance for Program Planning

Coded-wire tagging of salmonines has been conducted by federal, state and provincial agencies in the Great Lakes for over 15 years. In most cases experimental designs were developed only to answer specific questions for a single agency. Multi-agency or cross-jurisdictional coordination was not usually exercised, especially for species other than lake trout. Hence the level of expertise available from Great Lakes fisheries agencies was not commensurate with the spatial and numerical scale of the proposed project. The Task Group determined that outside expertise was required to develop a large-scale coordinated mass-marking program and refine the equipment, manpower, and fiscal needs for this initiative. To meet these information needs, the Task Group secured $47K over two years through the Science Transfer Program of the Great

Lakes Fishery Commission (GLFC) to contract an expert in mass marking from the Pacific Northwest. Skip Walch, a former employee of the USFWS in Vancouver, WA was contracted to assist the Task Group. Mr. Walch has over 20 years of experience in mass marking and ran a program that marked over 25 million Pacific salmon annually. A contract agreement between the GLFC and Mr. Walch to provide expertise for the development of this Mass Marking Implementation Plan was signed on August 1, 2006.

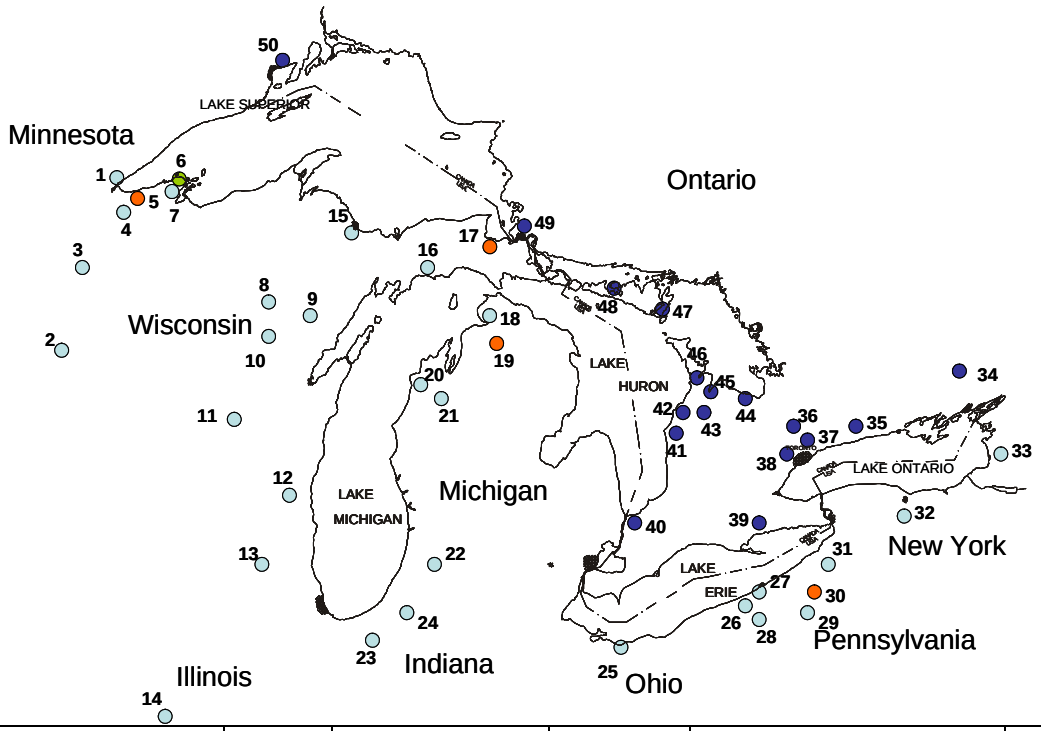
To gather additional information for development of the plan, site visits were made by Mr. Walch to state, non-governmental organizations (NGO), tribal, federal, and provincial hatcheries that stock salmonines in the Great Lakes. Twenty-six hatcheries in Minnesota, Wisconsin, Michigan, Illinois, Indiana and Ohio were visited during July 27 - August 17, 2006 (Figure 1). The remaining 24 hatcheries in Ontario, New York and Pennsylvania were visited during September 6 - 22, 2006 (Figure 1). Site visits were made to evaluate facilities for equipment needs and infrastructure to support marking/tagging equipment. Existing marking programs were reviewed and appeared to be compatible with an expanded program. All hatcheries were evaluated to determine:

- anticipated fish production by species
- a tentative marking schedule and marking time period
- the number and type of marking/tagging equipment required to accomplish the task (manual trailer vs automated trailer vs portable unit)
- current electrical supply and cost estimates to upgrade infrastructure to support the automated marking trailers
- available setup area for trailers and electrical service access
- a local mark/tag schedule and operational plan with hatchery staff input

The site visits provided detailed information previously unavailable to determine the marking/tagging equipment and space required, and to develop:

- new cost estimates and configurations for capital equipment purchases
- new estimates for manpower, including requirements of manual marker/clippers using federal/provincial pay scales
- additional costs for tags and consumables not considered previously and based on data from similar programs in the Pacific Northwest
- a proposed schedule of delivering services and equipment to each facility to mark/tag all fish, which can be scaled down to implement less complex marking missions.

Figure 1. Map of hatcheries visited for mass marking evaluations. NGO refers to sport fishing groups that grow out and release fish. State hatcheries are designated light blue, USFWS hatcheries are red, tribal are green and OMNR/NGO are dark blue.



Facility name and location number	Agency	Facility name and location number	Agency	Facility name and location number	Agency
1 French River	MNDNR	18 Oden	MIDNR	35 Harwood	OMNR
2 Crystal Springs	MNDNR	19 Jordan River	USFWS	36 Sir Sandford Fleming	NGO
3 St. Croix Falls	WIDNR	20 Platte River	MIDNR	37 Ringwood	NGO
4 Brule	WIDNR	21 Harrietta	MIDNR	38 Belfountain	NGO
5 Iron River	USFWS	22 Wolf Lake	MIDNR	39 Normandale	OMNR
6 Red Cliff (Tribe)	RCFD	23 Mixsawbah	INDNR	40 Bluewater Anglers	NGO
7 Bayfield	WIDNR	24 Bodine	INDNR	41 Kincardine	NGO
8 Lakewood	WIDNR	25 Castalia	OHDNR	42 Port Elgin	NGO
9 Thunder River	WIDNR	26 Fairview Coops	PFBC/NGO	43 Chatsworth	OMNR
10 Langlade	WIDNR	27 Fairview	PFBC	44 Georgian Triangle Angler	NGO
11 Wild Rose	WIDNR	28 Linesville	PFBC	45 Sydenham (Owen Sound)	NGO
12 Kettle Morraine Springs	WIDNR	29 Tionesta	PFBC	46 Bruce Peninsula	NGO
13 Lake Mills	WIDNR	30 Allegheny	USFWS	47 Blue Jay Creek	OMNR
14 Jake Wolf	ILDNR	31 Randolph	NYDEC	48 Gore Bay	NGO
15 Marquette	MIDNR	32 Caledonia	NYDEC	49 Tarentorus	OMNR
16 Thompson	MIDNR	33 Salmon River	NYDEC	50 Thunder Bay Salmon	NGO
17 Pendills Creek	USFWS	34 White Lake	OMNR		

Numbers of Salmonines to Adipose Clip and Coded-wire tag

The projected number of salmonines to be stocked into the Great Lakes is about 30.8 million fish (Table 1) for all tribal, state, federal, and provincial agencies, and for NGOs where sport fish organizations and community groups are permitted to rear and stock fish under agency guidelines. Eight species are regularly stocked--chinook salmon (30%), lake trout (29%), and rainbow trout (steelhead;18%) make up most of the total. The states of Michigan (27%), Wisconsin (14%), and New York (11%), the U.S. Fish and Wildlife Service (19%), and the Ontario Ministry of Natural Resources (11%) project to stock the most fish.

Table 1. Total number of salmonines proposed to be coded-wire tagged, adipose fin-clipped, and stocked each year into the Great Lakes by species and agency. (NGO are sportsman clubs that raise and release fish and RCFD is for Red Cliff Band of Lake Superior Chippewas.).

Agency	Species								Grand totals
	Atlantic salmon	Brook trout	Brown trout	Chinook salmon	Coho salmon	Lake trout	Rainbow trout	Splake	
FWS		100,000				5,900,000			6,000,000
ILDNR			100,000	250,000	300,000		100,000		750,000
INDNR				230,000	240,000		575,000		1,045,000
MIDNR		60,000	945,000	4,060,000	1,600,000	100,000	1,196,000	220,000	8,181,000
MNDNR						185,000	134,500		319,500
NGO	150,000		60,000	1,140,000			455,000		1,805,000
NYDEC	51,000		410,000	1,750,000	240,000		885,000		3,336,000
OHDNR							200,000		200,000
OMNR	550,000		255,000			2,530,000	145,000		3,480,000
PABFC							1,297,000		1,297,000
WIDNR			1,152,000	1,900,000	475,000	192,000	565,000	20,000	4,304,000
RCFD		120,000							120,000
Grand Totals	751,000	280,000	2,922,000	9,330,000	2,855,000	8,907,000	5,552,500	240,000	30,837,500

Jurisdictions that will receive the most fish are Michigan (36%), Wisconsin (20%), and Ontario (17%)(Table 2). Lakes to receive the most fish are Michigan (47%), Huron (21%), and Ontario (20%)(Table 3).

Table 2. Total number of salmonines proposed to be coded-wire tagged, adipose fin-clipped, and stocked into each state/provincial jurisdiction each year into the Great Lakes.

Species	Jurisdiction									Grand Totals
	Illinois	Indiana	Michigan	Minnesota	New York	Ohio	Ontario Canada	Pennsylvania	Wisconsin	
Atlantic salmon					51000		700,000			751,000
Brook trout			160,000						120,000	280,000
Brown trout	100,000		945,000		410,000		315,000		1,152,000	2,922,000
Chinook salmon	250,000	230,000	4,060,000		1,750,000		1,140,000		1,900,000	9,330,000
Coho salmon	300,000	240,000	1,600,000		240,000				475,000	2,855,000
Lake trout			3,630,000	185,000	1200000		2,530,000		1,362,000	8,907,000
Rainbow trout	100,000	575,000	1,196,000	134,500	885,000	200,000	600,000	1,297,000	565,000	5,552,500
Splake			220,000						20,000	240,000
Grand Totals	750,000	1,045,000	11,811,000	319,500	4,536,000	200,000	5,285,000	1,297,000	5,594,000	30,837,500

Table 3. Total number of salmonines proposed to be coded-wire tagged, adipose fin-clipped, and stocked into each Great Lake and Lake St. Clair.

Species	Lake						Grand Total
	Erie	Huron	Michigan	Ontario	St. Clair	Superior	
Atlantic salmon				751,000			751,000
Brook trout						280,000	280,000
Brown trout		546,250	1,709,250	575,000	18,750	72,750	2,922,000
Chinook salmon		1,933,000	4,497,000	2,300,000		600,000	9,330,000
Coho salmon			2,615,000	240,000			2,855,000
Lake trout	200,000	3,250,000	3,610,000	1,440,000		407,000	8,907,000
Rainbow trout	1,573,600	834,600	1,860,550	1,025,000		258,750	5,552,500
Splake		44,000	108,000			88,000	240,000
Grand Total	1,773,600	6,607,850	14,399,800	6,331,000	18,750	1,706,500	30,837,500

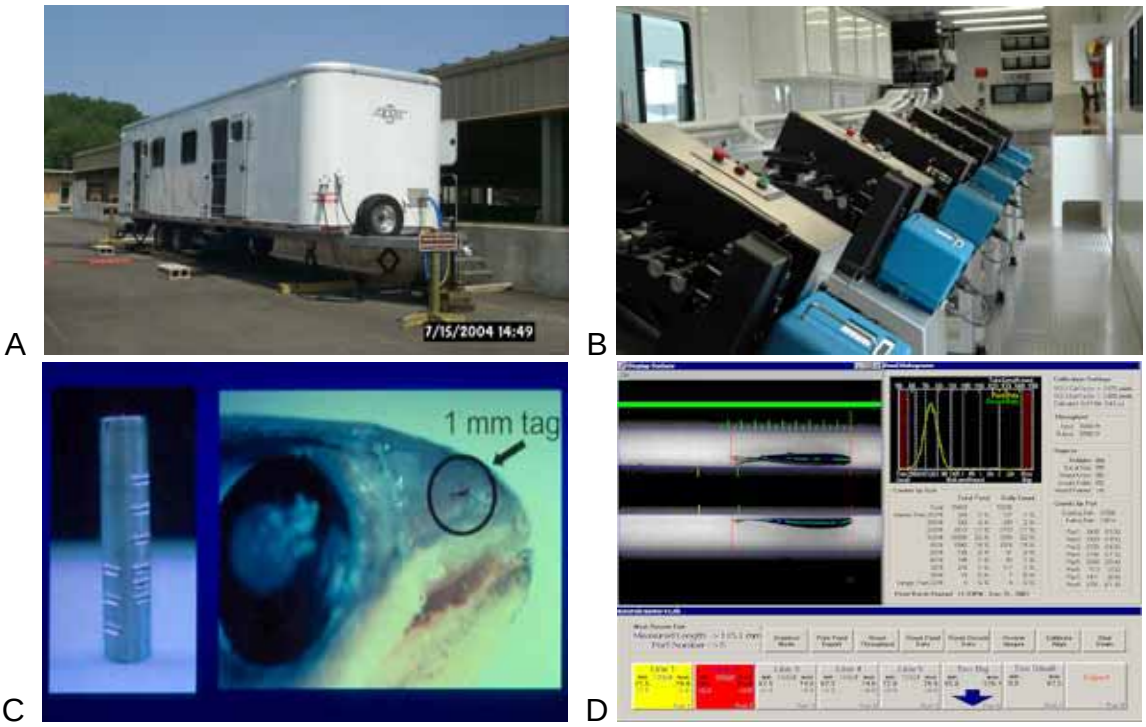
Equipment and Facility Requirements

The Autofish System

The centerpiece of the Mass Marking initiative is the automated tagging and marking trailers (Figure 2A) from Northwest Marine Technologies, which have been employed for years in the Pacific Northwest for salmon management. The AutoFish System is an alternative to manual clipping and tagging in high volume stocking applications. The AutoFish SCT6 is a self-contained mobile system contained in a 44-foot aluminum 5th wheel trailer that has one dual exit sorter and six individual processing lines (Figure 2B). The system can sort by length, adipose clip, and coded-wire tag salmonines from 57 to 142 mm without anesthetic or human handling. The fish are never completely dewatered during the process, thereby reducing fish stress. Significant features of the system are:

- Adipose clip and snout tag (Figure 2C) or adipose clip only or snout tag salmonines ranging from 57 mm to 142 mm total length.
- Over 60,000 fish processed in eight hours with one skilled operator and an assistant.
- Accurate counting and length sorting to within 1 mm of total length (Figure 2D).
- No anesthetic required and no human handling.
- Fin clipping rates and CWT placement accuracy superior to that of manual operations. Low mortality (<0.1%), very high clip rates (>99%), and excellent CWT retention rates (>98%).
- Less costly to operate than manual clipping and tagging systems.

Figure 2. The AutoFish trailer (A), the tagging lines within the trailer (B), coded-wire tag and its placement (C), and the output screen inside the trailer showing fish being optically measured and the length summaries information display(D).



Manual Trailers

The Autofish system will be used only at high production hatchery facilities, where large numbers of fish need to be marked in a short period of time. Manual trailers, which are designed for maximum efficiency and staffed by traditional fish-clipping staff, and use portable tagging equipment, will be used at hatcheries with lower production or where requirements (e.g. water supply) for AutoFish cannot be met. Northwest Marine Technologies is now able to provide a manual trailer (previous they provided only AutoFish trailers) based on a proven design developed by our contractor, Skip Walch. Manual marking trailers will be designed to house 6 ergonomic marking and clipping stations.

Portable Marking Equipment

Portable equipment refers to Mark IV Coded Wire Tag Injectors, Quality Control Devices (QCD) and supporting aluminum work stations. The QCDs are an accessory to the Mark IVs and automatically sort tagged and untagged fish as they pass through a tag detection tunnel. Although there may be no work currently scheduled for portable equipment in some regions, there may be in the future. "Portable equipment" will be used for small marking projects where a manual trailer cannot be accommodated (e.g. lack of access, insufficient space). and provide spare Mark IVs and QCDs for both the manual and AutoFish trailers.

All Mark IVs, whether designated as portable equipment or manual trailer equipment, will be AutoFish "ready" and capable of being interchangeable with six line Mark IVs in the AutoFish trailer. Both manual and AutoFish trailers will only include enough tagging equipment to support the six stations in the manual trailer and eight stations (six line units and two units for “outsize” fish processing) in the AutoFish, hence there are no spare Mark IVs. It is our intent to provide the spare equipment to be used in either function. These items are listed as “portable equipment” in the budget tables.

As in Northwest operations for large, multi species projects, we plan for marking crews to take an extra six or eight Mark IVs to change out quickly during species change over. When switching species at a hatchery, for example from chinook to coho salmon, the marking crew will need to clean, service and disinfect not only the trailer but also all the Mark IVs. By changing out the Mark IVs, crews will save about three hours of down time. Once the trailer is fine tuned and operating on the new species, the crew will disinfect and service the Mark IVs at their leisure. This particular type of "change out" is important in the manual trailer, which will involve six temporary markers waiting to return to work.

The importance of having spare Mark IV tagging machines available cannot be overstated. In the Northwest it is common for crews to drop off Mark IVs from the last project for cleaning and disinfecting, and grab serviced Mark IVs when they return to the field for anew project. In the meantime, a lab tech cleans, services, and disinfects the Mark IVs and to ready them for the next project. Old Mark IVs, already are owned by agencies, can be re-conditioned by the manufacturer and placed back into service.

Electrical Improvements at Hatcheries

AutoFish trailers require 240V electrical service for operation and strategically located plug-in receptacles, especially for facilities that occupy large areas. Most hatcheries have 480V service but many require step-down transformers to provide the correct power for the AutoFish trailers. We have identified the facilities that require electrical improvements and the estimated costs (2007 US dollars) to implement those improvements (Table 4). Total costs are about $393,000 for all hatcheries needing upgrades with $293,205 for U.S. facilities and $99,390 for those in Canada. These improvements must be made before any AutoFish trailers can be used at these facilities hence we recommend to bring all facilities to compliance in the first year of the program.

Table 4. Estimated costs for electrical improvements at Great Lakes hatcheries.

Agency	Facility	Electrical improvement cost	Improvement required
FWS	Allegheny NFH	$ 13,650.00	1 transformer 2 plug-in receptacles
	Iron River	$ 13,650.00	2 transformers 4 plug-in receptacles
	Jordan River	$ 15,875.00	1 transformer 4 plug-in receptacles
	Pendills Creek	$ 7,875.00	1 transformer 3 plug-in receptacles
FWS Total		$ 51,050.00	
ILDNR	Jake Wolf	$ 6,800.00	1 transformer 2 plug-in receptacles
ILDNR Total		$ 6,800.00	
INDNR	Bodine	$ 5,800.00	1 transformer 1 plug-in receptacle
	Mixsawbah	$ 6,025.00	1 transformer 1 plug-in receptacle
INDNR Total		$ 11,825.00	
MIDNR	Harrietta	$ 6,825.00	1 transformer 2 plug-in receptacles
	Marquette	$ 5,800.00	1 transformer 1 plug-in receptacle
	Oden	$ 10,545.00	1 transformer 2 plug-in receptacles
	Platte River	$ 13,200.00	1 transformer 3 plug-in receptacles
	Thompson	$ 8,250.00	1 transformer 1 plug-in receptacle
	Wolf Lake	$ 7,885.00	1 transformer 2 plug-in receptacles
MIDNR Total		$ 52,505.00	
MNDNR	Crystal Springs		N/A
	French River	$ 7,500.00	1 transformer 1 plug-in receptacle
MNDNR Total		$ 7,500.00	
NGO	Belfountain Hatchery		N/A
	Bluewater Anglers		N/A
	Bruce Peninsula		N/A
	Georgian Triangle Angler		N/A
	Gore Bay	$ 5,665.00	1 transformer 1 plug-in receptacle
	Kincardine		N/A
	Port Elgin		N/A
	Sir Sandford Fleming		N/A
	Sydenham (Owen S.)		N/A

Agency	Facility	Electrical improvement cost	Improvement required
	Thunder Bay Salmon	$ 5,750.00	1 transformer 1 plug-in receptacle
	Ringwood	$ 7,500.00	1 transformer 1 plug-in receptacle
NGO Total		$ 18,915.00	
NYDEC	Caledonia	$ 6,200.00	1 transformer 1 plug-in receptacle
	Randolph	$ 6,900.00	1 transformer 3 plug-in receptacles
	Salmon River	$ 8,250.00	1 transformer 2 plug-in receptacles
NYDEC Total		$ 21,350.00	
OHDNR	Castalia	$ 6,880.00	1 transformer 1 plug-in receptacle
OHDNR Total		$ 6,880.00	
OMNR	Blue Jay Creek FCS	$ 28,900.00	2 transformers 3 plug-in receptacles
	Chatsworth FCS	$ 18,300.00	2 transformers 4 plug-in receptacles
	Harwood FCS	$ 12,575.00	1 transformer 2 plug-in receptacles
	Normandale FCS	$ 5,625.00	1 transformer 2 plug-in receptacles
	Tarentorus FCS	$ 7,725.00	1 transformer 2 plug-in receptacles
	White Lake FCS	$ 7,350.00	1 transformer 2 plug-in receptacles
OMNR Total		$ 80,475.00	
PABFC	Fairview	$ 9,800.00	1 transformer 3 plug-in receptacles
	Fairview Coops		portable generator
	Tionesta	$ 13,110.00	1 transformer 4 plug-in receptacles
PABFC Total		$ 22,910.00	
WIDNR	Bayfield	$ 5,750.00	1 transformer 1 plug-in receptacle
	Brule	$ 10,500.00	1 transformer 4 plug-in receptacles
	Kettle Moraine	$ 8,375.00	1 transformer 3 plug-in receptacles
	Lake Mills	$ 7,885.00	1 transformer 2 plug-in receptacles
	Lakewood	$ 9,450.00	1 transformer 3 plug-in receptacles
	Langlade	$ 5,225.00	1 transformer 1 plug-in receptacle

Agency	Facility	Electrical improvement cost	Improvement required
	St. Croix Falls	$ 5,750.00	1 transformer 1 plug-in receptacle
	Thunder River	$ 9,450.00	1 transformer 3 plug-in receptacles
	Wild Rose	$ 50,000.00	2 transformers 4 plug-in receptacles
WIDNR Total		$112,385.00	
RCFD	Red Cliff		N/A
RCFD Total			
Grand Total		$392,595.00	

Operational Needs

Establishment of the Great Lakes Mass Marking Laboratory

Consistent with numerical and spatial scale, and the inter-jurisdictional nature of the proposed program, a centralized entity is recommended to effectively:

- provide an organizational framework to meet the marking and information needs of the partners through the CLC
- purchase, operate, and maintain mass marking equipment (US)
- provide experimental design, statistical and data analysis, database management, and tag extraction (head shop) services for all marking studies
- provide significant manpower to enhance agency efforts to recover heads from ADCWT fish captured in sport fisheries or other sources
- provide coordination between US and Canada

The extent of these services is well beyond what was recommended in the April 2005 report, and can be delivered by the establishment of the “Great Lakes Mass Marking Laboratory” operated by the U.S. Fish and Wildlife Service (Figure 3). The main lab will be co-located with the Green Bay National Fish and Wildlife Conservation Office in Wisconsin-- it will service the Western program region (see Table 8) and include support/administration capabilities. A satellite facility in Michigan will service the Central and Eastern program regions, and trailer storage facilities will be available at USFWS sites in New York or Pennsylvania.

Key support staff will include 1) a biostatistician familiar with mark-recapture experimental design and analytical techniques, 2) a database manager and programmer familiar with structure, function, output generation, and upkeep of large relational databases, and 3) a program supervisor. The program supervisor will oversee all operations for the US side and be the main interface with a Regional Mass Marking Committee that will receive direction from the

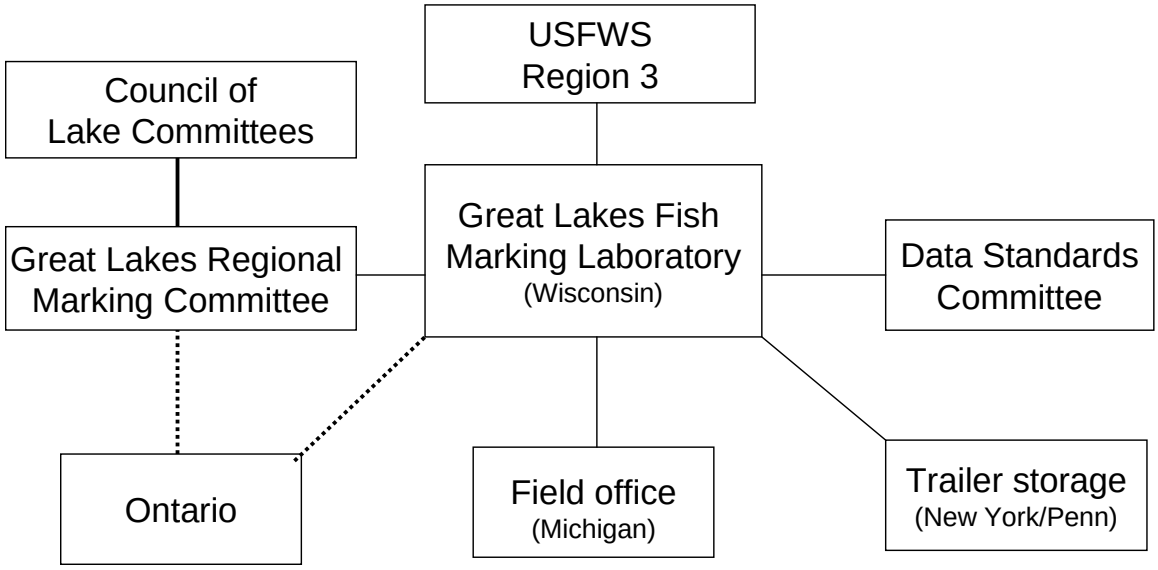
CLC. This Regional Mass Marking Committee will consist of state, provincial, tribal and FWS representatives, and will provide the major direction for the Lab. All services provided by the lab (database, programming, experimental design, tag extraction) will be available to the OMNR program, and is a natural requirement since studies in all lakes will be influenced by movement of fish across interjurisdictional boundaries.

We also recommend the establishment of a Data Standards Committee made up of data managers/biologists from all agencies (both US and Canada) that will be responsible for:

- Development of the table structure of the relational database that will house all the stocking/marking and recovery data.
- Development of protocols, timetables, and requirements for automated data transfer of recovery data from agency databases to the basin-wide shared database
- Development of standard output reports per agency or study plan requirements
- Overall guidance on data management, security, and sharing activities and capabilities.

Organizational Overview

Figure 3. Proposed organizational structure to accomplish mass-marking projects in the Great Lakes.



Region 3 - Responsible for managing and administering funds from Congress. Regional Director will have performance objectives tied to the funding that have to be met.
Council of Lake Committees - Provide overall general direction and guidance to the program to insure information needs of national, basin-wide or lake-wide interest are met.
Great Lakes Regional Marking Committee (GLRMARC) - Made up of key fishery and hatchery managers in each jurisdiction able to develop specific questions to be answered by coded-wire tag studies. Must be able to direct jurisdictional resources to facilitate tagging and data collection activities of the Great Lakes Fish Marking Laboratory. This group will insure results are reported back to CLC.
Great Lakes Fish Marking Laboratory - Staff, based on GLRMARC needs, works directly with research and field biologists to develop experimental designs specific to management questions. Key tagging staff work directly with hatchery personnel to insure efficient tagging sessions and smooth transitions among facilities. Provide marking and recovery services in US waters. **Satellite stations in Michigan and New York** will meet tagging and data collection needs for MI, OH, NY, PA; the main lab will cover MN, WI, IL, and IN.
Data Standards Committee - Database manager works directly with agency data managers to insure efficient and timely transfers of data. Team establishes data table structures to insure maximum data resolution, and meet needs of all possible study plans.
Ontario – Ministry of Natural Resources will provide tagging and data collection services in Canada and will be represented on GLRMARC. Head shop, database, and analytical services available to them as per U.S. agencies.

Head Recovery Assistance

The success of the mass marking program and its ability to provide useful information to managers is in part proportional to the number of heads recovered and examined for CWTs, and the management and analysis of the related recovery data in the basin-wide database. The April 2005 report indicated that about 21,000 salmonines are examined during creel surveys basin-wide each year, and these fish would serve as a major source for tag recovery information. This represents only 1.3% of the recent estimated harvest of about 1.6 million salmonines (Table 5) in the Great Lakes. An additional program ("head hunter") in Michigan during 2003-2004 recovered about 20,000 more heads each year from Lakes Michigan and Huron alone, and represents a model for additional tag recoveries. Significant additional sampling is required to meet the information needs and the analytical potential of a basin-wide mass marking program. We therefore recommend that seasonal and full-time staff from the Great Lakes Mass Marking Laboratory, working in close coordination with management agencies, engage in targeted headhunter surveys to complement and enhance any surveys by individual jurisdictions. These activities can take place in months when the fishery is most active or when recoveries are facilitated by life history (e.g. fall spawning stream surveys for dead adult salmon). Specific numerical, temporal, and spatial recovery requirements will be dictated by experimental designs focused on specific questions for each species in each lake. Since current agency budgets typically cannot accommodate any significant increases in creel survey or headhunter programs, the additional manpower available from the Great Lakes Mass Marking Laboratory is critical to the success of the program (see, for example, "Estimating wild production of Chinook salmon in Lakes Michigan and Huron with ADCWTs", page 37) and consistent with a previous recommendation in the April 2005 CLC report.

Table 5. Recent estimated annual harvest of salmonines by lake and species from the Great Lakes.

Lake	Species						Totals
	Brown trout	Chinook salmon	Coho salmon	Lake trout	Rainbow trout	Atlantic salmon	
Superior	800	54000	9200	61000	700	0	125,700
Huron	500	70000	4000	42000	7000	0	123,500
Michigan	54000	622000	269000	68000	116000	-	1,129,000
Erie	100	250	450	250	27000		28,050
Ontario	36,000	120,000	12,500	18,000	42,000	0	228,500
Totals	91,400	866,250	295,150	189,250	192,700	0	1,634,750

Mass Marking Possibilities with Building Equipment Inventories

Development of this program will require gradual acquisition of trailers and associated equipment, and hiring and training of staff to operate and maintain then over several years. As equipment and staff are accrued, specific lakes or species can be completely mass marked if so desired. Tables 6 and 7 provide estimates of the equipment and manpower requirements to mark all fish in each Great Lake and to mark all fish of a single species in all the Great Lakes. Specific combinations of species and or lakes could be accommodated as well depending on the information priorities established prior to full equipment and manpower inventories. Project possibilities will depend on the actual funding success and timing of funding delivery.

Table 6. Estimates of trailers and manpower required to ADCWT all salmonines by lake.

Lake	Fish (millions)	Marking days	Marking Staff	Marking Equipment
Michigan	14.1	278	14	6 AutoFish 1 manual
Huron	6.5	224	12	3 AutoFish 1 manual
Ontario	6.3	131	6	2 AutoFish 1 manual
Erie	2.1	70	4	1 AutoFish 1 manual
Superior	1.7	118	4	1 AutoFish 1 manual

Table 7. Estimates of trailers and manpower required to ADCWT all fish of a particular species in all Great Lakes.

Species	Fish (millions)	Marking days	Marking Staff	Marking Equipment
Chinook salmon	9.3	169	16	5 AutoFish 1 manual
Lake trout	8.8	231	12	4 AutoFish 1 manual
Rainbow/ steelhead	5.2	209	10	3 AutoFish 1 manual
Coho salmon	2.9	41	4	2 AutoFish 0 manual
Brown trout	2.8	119	8	2 AutoFish 1 manual
Other (BKT, SPL,ATS)	1.7	118	4	1 AutoFish 1 manual

Proposed Deployment Schedule across Great Lakes Hatcheries

Anticipated equipment needs, hatchery production numbers, and marking timetables were used to develop schedules of equipment and personnel deployment among hatcheries within each of the four geographic regions (Table 8). This exercise validated the anticipated number of trailers and other equipment necessitated by the spatial scale of the program, the numbers of fish produced and the timing of tagging windows. The following schedules (Table 9) provide a visual outline of the intensity of tagging activity as well as opportunities for trailer operators to participate in tag recovery (times when tagging is not occurring) among the four regions. These schedules were developed with current production targets and timetables, and are included here to provide a guide to potential operational profiles. Changes in species, production numbers, hatchery species profiles, and actual experience after a few years will alter and refine implementation schedules once the program is established. No tagging will occur in December or January. Ontario's schedule shows two AutoFish trailers in operation, but the budget indicates that only one trailer will be purchased. OMNR has considered options for eliminating the need for a second AutoTrailer and will revise the detailed schedule to reflect that strategy (and any change in marking requirements) once the program is in place.

Table 8. List of hatcheries assigned to each geographic region by agency.

Agency	Hatchery	Region
FWS	Allegheny NFH	Eastern
	Iron River	Western
	Jordan River	Central
	Pendills Creek	Central
ILDNR	Jake Wolf	Western
INDNR	Bodine	Western
	Mixsawbah	Western
MIDNR	Harrietta	Central
	Marquette	Central
	Oden	Central
	Platte River	Central
	Thompson	Central
	Wolf Lake	Central
MNDNR	Crystal Springs	Western
	French River	Western
NGO	Belfountain Hatchery	Ontario
	Bluewater Anglers	Ontario
	Bruce Peninsula	Ontario
	Georgian Triangle Angler	Ontario
	Gore Bay	Ontario
	Kincardine	Ontario
	Port Elgin	Ontario
	Sir Sandford Fleming	Ontario
	Sydenham (Owen S.)	Ontario

	Thunder Bay Salmon	Ontario
	Ringwood	Ontario
NYDEC	Caledonia	Eastern
	Randolph	Eastern
	Salmon River	Eastern
OHDNR	Castalia	Central
OMNR	Blue Jay Creek FCS	Ontario
	Chatsworth FCS	Ontario
	Harwood FCS	Ontario
	Normandale FCS	Ontario
	Tarentorus FCS	Ontario
	White Lake FCS	Ontario
PABFC	Fairview	Eastern
	Fairview Coops	Eastern
	Tionesta	Eastern
RDFD	Red Cliff	Western
WIDNR	Bayfield	Western
	Brule	Western
	Kettle Moraine	Western
	Lake Mills	Western
	Lakewood	Western
	Langlade	Western
	St. Croix Falls	Western
	Thunder River	Western
	Wild Rose	Western

Table 9. Monthly schedules of equipment deployment among hatcheries in the Great Lakes for mass-marking all salmonines. Dark turquoise = agency marking; Light turquoise = NGO partner marking; Yellow = transport and setup of equipment. Species key : LT=lake trout, SP=splake, RT=rainbow trout, SH=steelhead, BT=brown trout, BK=brook trout) Personnel key: Numbers in brackets refer to people needed S = mass-marking staff, M = markers, V = volunteers).

Region	Unit	FEBRUARY 2007																												
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
Ontario	AutoFish 1																													
	AutoFish 2																													
	Manual/Portable						KINCARDINE - RT (1S, 4M)						KINCARDINE - BT (1S, 4M)								BRUCE PENINSULA - RT (1S, xV)									
	Manual																													
Eastern	AutoFish 1						ALLEGHENY - LT (2S, 2M)						ALLEGHENY - LT (2S, 2M)								ALLEGHENY - LT (2S, 2M)									
	AutoFish 2						ALLEGHENY - LT (2S, 2M)						ALLEGHENY - LT (2S, 2M)								ALLEGHENY - LT (2S, 2M)									
	Manual/Portable																													
Central	AutoFish 1																													
	AutoFish 2																													
	AutoFish 3																													
	Manual/Portable																													
Western	AutoFish 1						JAKE WOLF - RT, CH (2S, 2M)														JAKE WOLF - CO (2S, 2M)									
	AutoFish 2																													
	AutoFish 3																													
	Portable																													
	Manual																													

Region	Unit	MARCH 2007																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Ontario	AutoFish 1																											RINGWOOD - CH (2S, 4M)				
	AutoFish 2																															
	Manual/Portable																															
	Manual																															
Eastern	AutoFish 1																				SALMON RIVER - CH (2S, 2M)											
	AutoFish 2																				SALMON RIVER - CH (2S, 2M)											
	Manual/Portable																															
Central	AutoFish 1						THOMPSON - CH (2S, 3M)														WOLF LAKE - CH (2S, 3M)											
	AutoFish 2																				WOLF LAKE - CH (2S, 3M)											
	AutoFish 3																															
	Manual/Portable																															
Western	AutoFish 1																							WOLF LAKE - BT (2S, 2M)								
	AutoFish 2																															
	AutoFish 3																															
	Portable																															
	Manual																															

APRIL 2007

Region	Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ontario	AutoFish 1		RINGWOOD - CH (2S, 4M)							RINGWOOD - CH (2S, 4M)																NORMANDALE - AS (2S, 2M)					
	AutoFish 2																														
	Manual/Portable			BLUEWATER - RT, CH (1S, 4M)							PORT ELGIN - CH (xS, xM)								FLEMING - AS (1S, 4M)					FLEMING - AS (1S, 4M)						
	Manual																														
Eastern	AutoFish 1		SALMON RIVER - CH (2S, 2M)															SALMON RIVER - CO, CH, SH (2S, 2M)													
	AutoFish 2		SALMON RIVER - CH (2S, 2M)															SALMON RIVER - CO, CH, SH (2S, 2M)													
	Manual/Portable																														
Central	AutoFish 1		PLATTE RIVER (2 SHIFTS) - CH (4S, 6M)															PLATTE RIVER (2 SHIFTS) - CH (4S, 6M)													
	AutoFish 2																	MIXSAWBAH - CH, CO (2S, 3M)													
	AutoFish 3																														
	Manual/Portable																														
Western	AutoFish 1		WILD ROSE - CH (1.5S, 2M)																												
	AutoFish 2		WILD ROSE - CH (1.5S, 2M)																												
	AutoFish 3																								BAYFIELD - CH (2S, 2M)						
	Portable																	CRYSTAL SPRINGS - LT (0S, 1M)						CRYSTAL SPRINGS - LT (0S, 1M)						
	Manual																								JAKE WOLF - SH (1S, 4M)						

MAY 2007

Region	Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Ontario	AutoFish 1																															
	AutoFish 2																															
	Manual/Portable	BELFOUNTAIN - AS (xS, xM)								SYDENHAM - CH (1S, 4M)					OWEN SOUND - RT		GEORGIAN - RT (1S, 4M)					GEORGIAN - RT (1S, 4M)							GEORGIAN - RT (1S, 4M)			
	Manual																														GORE BAY - CH (1S, 6M)	
Eastern	AutoFish 1																						FAIRVIEW - SH (2S, 2M)									
	AutoFish 2																						TIONESTA - SH (2S, 2M)									
	Manual/Portable																														FAIRVIEW COOPS - SH (2S, 4M)	
Central	AutoFish 1																						PLATTE RIVER - CO (1S, 3M)							PLATTE RIVER - CO (1S, 3M)		
	AutoFish 2																						PLATTE RIVER - CO (1S, 3M)							PLATTE RIVER - CO (1S, 3M)		
	AutoFish 3																															
	Manual/Portable								MARQUETTE - SP (2S, 6M)																							
Western	AutoFish 1															LAKE MILLS - CO (2S, 2M)																
	AutoFish 2																															
	AutoFish 3	BAYFIELD - CO (2S, 2M)																														
	Portable	CRYSTAL SPRINGS - LT (0S, 1M)																														
	Manual																															

Region	Unit	JUNE 2007																													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ontario	AutoFish 1																														
	AutoFish 2																														
	Manual/Portable					THUNDER BAY - CH (1S, 6M)																									
	Manual																														
Eastern	AutoFish 1																			CALEDONIA - RT, BT (2S, 2M)											
	AutoFish 2																														
	Manual/Portable				FAIRVIEW COOPS - SH (2S, 4M)															RANDOLPH - BT (1S, 4M)											
Central	AutoFish 1	PLATTE RIVER - CO (1S, 3M)											ODEN - BT, RT (2S, 3M)																		
	AutoFish 2	PLATTE RIVER - CO (1S, 3M)											ODEN - BT, RT (2S, 3M)																		
	AutoFish 3																			MARQUETTE - BT, LT (2S, 2M)											
	Manual/Portable																														
Western	AutoFish 1																														
	AutoFish 2																														
	AutoFish 3																														
	Portable																														
	Manual																														

Region	Unit	JULY 2007																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Ontario	AutoFish 1																															
	AutoFish 2																															
	Manual/Portable																															
	Manual																															
Eastern	AutoFish 1																															
	AutoFish 2																															
	Manual/Portable																															
Central	AutoFish 1																	BODINE - RT, CO (2S, 2M)														
	AutoFish 2																															
	AutoFish 3																															THOMPS
	Manual/Portable																															
Western	AutoFish 1																															
	AutoFish 2																															
	AutoFish 3																															
	Portable																															
	Manual																															

AUGUST 2007

Region	Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Ontario	AutoFish 1	CHATSWORTH - LT (2S, 2M)					CHATSWORTH - LT (2S, 2M)							CHATSWORTH - LT (2S, 2M)							CHATSWORTH - LT (2S, 2M)							CHATSWORTH - LT, BT (2S, 2M)				
	AutoFish 2	CHATSWORTH - LT (2S, 2M)					CHATSWORTH - LT (2S, 2M)							CHATSWORTH - LT (2S, 2M)							CHATSWORTH - LT (2S, 2M)							CHATSWORTH - LT, BT (2S, 2M)				
	Manual/Portable																															
	Manual																															
Eastern	AutoFish 1																															
	AutoFish 2																															
	Manual/Portable																															
Central	AutoFish 1							HARIETTA - BT, BR (2S, 3M)																								
	AutoFish 2													JORDAN RIVER - LT (2S, 3M)														JORDAN - LT (2S, 3M)				
	AutoFish 3	THOMPSON - RT (2S, 3M)												JORDAN RIVER - LT (2S, 3M)														JORDAN - LT (2S, 3M)				
	Manual/Portable																															
Western	AutoFish 1																						BAYFIELD - LT (2S, 4M)									
	AutoFish 2																															
	AutoFish 3																															
	Portable																															
	Manual																					LANGLADE - BT (2S, 6M)							THUNDER RIVER - BT (2S, 6M)			

SEPTEMBER 2007

Region	Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ontario	AutoFish 1					WHITE LAKE - LT (2S, 2M)														HARWOOD - LT (2S, 2M)											
	AutoFish 2					TARENTORUS - LT (2S, 2M)												TARENTORUS - LT (2S, 2M)								BLUE JAY - LT (2S, 2M)					
	Manual/Portable																															
	Manual																															
Eastern	AutoFish 1																															
	AutoFish 2																															
	Manual/Portable																															
Central	AutoFish 1											WOLF LAKE - RT (2S, 3M)														WOLF LAKE - RT (2S, 3M)					
	AutoFish 2				JORDAN RIVER - LT (2S, 3M)																					CASTALIA - SH (2S, 2M)					
	AutoFish 3				JORDAN RIVER - LT (2S, 3M)														MIXSAWBAH - RT (2S, 2M)													
	Manual/Portable																															
Western	AutoFish 1						WILD ROSE - BT (2S, 2M)																									
	AutoFish 2						IRON RIVER - LT (3S, 4M)												IRON RIVER - LT (3S, 4M)													
	AutoFish 3																															
	Portable																		CRYSTAL SPRINGS - LT (0S, 1M)												
	Manual					THUNDER RIVER - BT (2S, 6M)						LAKEWOOD - BT (2S, 6M)										FRENCH CREEK - SH (1S, 4M)											

OCTOBER 2007

Region	Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Ontario	AutoFish 1	HARWOOD - LT (2S, 2M)								NORMANDALE - AS, BT (2S, 2M)													NORMANDALE - RT (2S, 2M)									
	AutoFish 2	BLUE JAY - RT (2S, 2M)																														
	Manual/Portable																															
	Manual																															
Eastern	AutoFish 1																TIONESTA - SH (2S, 2M)													TIONESTA - SH (2S, 2M)		
	AutoFish 2																															
	Manual/Portable																															
Central	AutoFish 1		PENDILLS CREEK - LT (2S, 3M)																													
	AutoFish 2																															
	AutoFish 3		PENDILLS CREEK - LT (2S, 3M)																													
	Manual/Portable																															
Western	AutoFish 1																															
	AutoFish 2		IRON RIVER - LT (3S, 4M)																													
	AutoFish 3																															
	Portable	CRYSTAL SPRINGS - LT (OS, 1M)																														
	Manual		BRULE - BT (2S, 6M)														ST. CROIX FALLS - BT (1S, 6M)															

NOVEMBER 2007

Region	Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ontario	AutoFish 1																														
	AutoFish 2																														
	Manual/Portable																														
	Manual																														
Eastern	AutoFish 1																														
	AutoFish 2																														
	Manual/Portable																														
Central	AutoFish 1																														
	AutoFish 2																														
	AutoFish 3																														
	Manual/Portable																														
Western	AutoFish 1																														
	AutoFish 2																														
	AutoFish 3					KETTLE MORAINE - RT (2S, 2M)																										
	Portable																											BAYFIELD - SP (1S, 2M)			
	Manual																														

Proposed Standard head/CWT collection protocol

We recommend a standard head/CWT collection protocol to provide uniform labeling and packaging of head/snouts collected during the recovery phase. Since most heads collected in the field will be processed by a centralized "head shop", it would make recovery and tracking of CWT information much simpler if a standard protocol was used by all agencies.

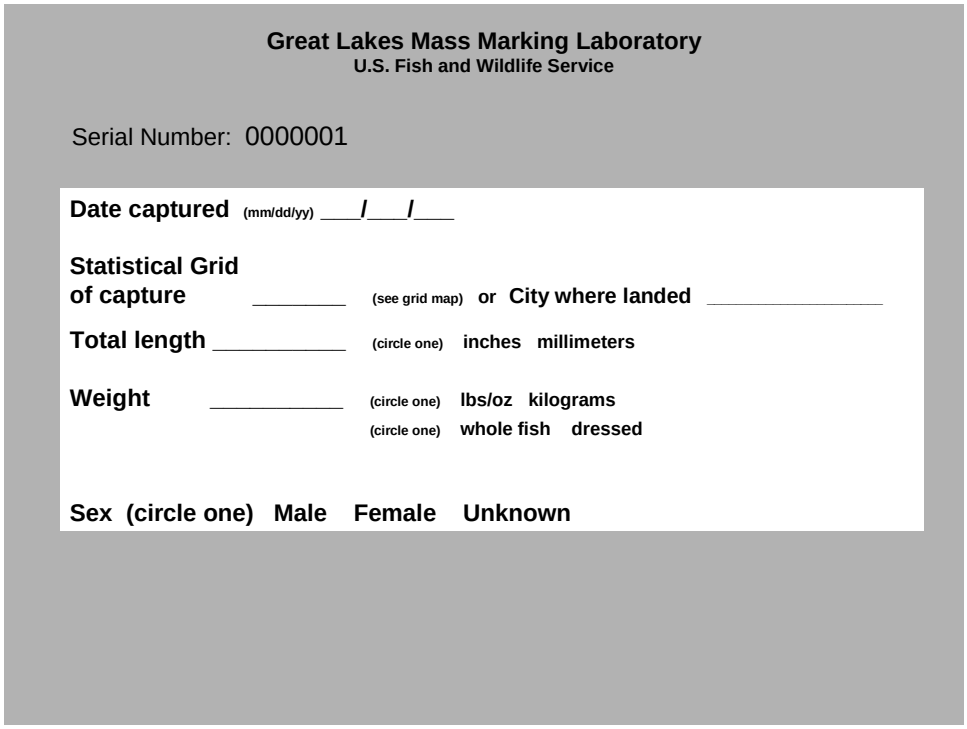
We summarized existing protocols from Great Lakes fishery management agencies to develop a standard procedure for collection/storage of heads, methods of recording data collected, and methods used to label/track the heads and CWTs. While no two agencies (or units within the same agency) use the exact same methodology, techniques were generally similar around the Great Lakes.

Recommended Protocol

In developing a single recommendation we have tried to consider things such as sampling conditions, complexity of specimen numbers, writing ability, and potential sources of errors/confusion. We have tried to limit the number of optional steps to avoid confusion and deviation. As the basin-wide program unfolds all procedures will be fine tuned and adapted as needed.

It is recommended that a pre-labeled, unique specimen number (expressed in print and bar-code) collection system be utilized. This type of a system reduces the need to label wet boxes/bags, to accidentally use the same specimen number more than once, and takes advantage of the utility of the database. All bags and shipping containers for heads will be purchased and distributed to each agency by the Great Lakes Mass Marking Laboratory. Bags would be "Ziploc" type bags (about 8" x 8" in size, 6 mil plastic or greater) and would be pre-labeled with a specimen number and corresponding bar code by the vendor (Figure 4). A unique specimen number will be assigned to each bag, improving the integrity of the data and allowing information about an individual fish to be retrieved more easily by querying on a single field. When large numbers of heads are collected or when fishermen are asked to collect samples, the use of pre-labeled specimen bags will facilitate these collections. A white write-on blank area will be provided that allows additional information to be placed on the bag for use by charter boats or fisherman at fish cleaning stations.

Figure 4. An example of labeling format on head collection bags.



Two types of specimen numbers were considered: embedded and non-embedded. An embedded specimen number is a unique alphanumeric value comprised of an agency ID (or code), year designation or other data identifiers, plus a unique alphanumeric value.

Example: M02-06-10026
Michigan DNR (M), Alpena (02), 2006 sample collection year
CWT reference number 10026

This type of number is commonly used by agencies but is harder to key punch, query, and offers more possibilities for input mistakes. It would also require the bag vendor to develop multiple series of pre-labeled bags for each agency that cannot be adapted for other collection scenarios. We therefore do not recommend this system.

We will use a non-embedded specimen number that is a unique alphanumeric value with no obvious correlation with any other collection data as database management would take care of that.

Example: 1003226
Unique value that requires querying one field of the database to determine agency, year, project etc.

Once the head has been extracted, it should be placed in CWT head collection bag, and the bag should be sealed completely. The unique CWT specimen number should be recorded in the appropriate space on each agency's data sheet (this could be a field sheet, a scale envelope, or a data logger field). Sealed bags containing the heads will be placed on ice and transported to a freezing facility as quickly as possible. Agencies that do not extract their own tags will eventually ship frozen heads over-night freight to the Great Lakes Mass Marking Laboratory for processing. Freight charges and container costs will be covered and provided by the Great Lakes Mass Marking Laboratory.

Equipment and Operational Costs

Proposed U.S. and Canadian Budgets

The following detailed budgets reflect our best estimate of the costs to implement a complete and fully-funded mass marking program for the U.S. (Table 10) and Canadian (Table 11) waters of the Great Lakes. A summary budget is provided in Table 12. Operation and management of the program is envisioned to be by the U.S. Fish and Wildlife Service (FWS) in the U.S., and by the Ontario Ministry of Natural Resources (OMNR) in Canada. Budget estimates are based equipment and consumable costs, salaries plus fringe benefits, overhead, and inflation standards available at this time. The program is designed as a "no cost" program to state and tribal agencies in the U.S., with all equipment owned, operated, and maintained by USFWS. The program in the U.S. is broken down into three geographic regions that contain specific hatcheries (Table 8) as follows:

1. Eastern Region - services all agency facilities located in New York and Pennsylvania.
2. Central Region - services all agency facilities located in Indiana, Michigan, and Ohio.
3. Western Region – services all agency facilities located in Illinois, Minnesota, and Wisconsin.

In Canada, all equipment is envisioned to be owned, operated, and maintained by OMNR and has one geographic region (Ontario).
Important features of the program budget are:

1) Costs represent a full program that delivers marking/tagging, head recovery and tag extraction, statistical and database support, and data dissemination services to the partner agencies, as opposed to just marking/tagging the fish and maintaining equipment. Costs also include mandatory improvements to electrical service at deficient hatcheries based on the power requirements of the mass marking trailers. Budgeted staff positions include full-time biologists and technicians trained in the operation and maintenance of the sophisticated mass-marking trailers that cannot be accomplished by seasonal appointments where staff turnover is frequent. These positions will be supported by seasonal technicians and a budget for manual markers and

head collectors that can be hired through temporary services, by reoccurring seasonal federal positions, or contracted out to partner states (any combination is possible).

2) Full-time biologists and technicians, when not marking fish, will operate the head shop, support data management, maintain all equipment, and collect heads. The Coordinator will serve as the point person and manager for a spatially and temporally complex program that will span the Great Lakes basin, marking and tagging about 26 million fish annually at 31 state and tribal hatcheries in U.S waters and will synchronize activities with the marking coordinator for OMNR. Statistical and computer support positions will make the development of study designs (done before any fish are marked), collection protocols to meet study objectives, and data analysis (working with key partner biologists) an integral part of the program. These data support positions are considered instrumental to the success of answering management and performance questions on the appropriate spatial and temporal scales desired by the CLC.
3) Mass marking requires significant fiscal resources; annual costs for tags, AutoFish system consumables, equipment maintenance, and operations represent 62% of the annual operating budget. Salaries and fringe benefits make up about 38% of the total budget. Given that, the entire program will cost about $0.23/fish marked and tagged in 2008, and increase to about $0.35/fish in 2017 (Figure 5).
4) Costs of services are comparable to those in the Pacific Northwest, and are based on real historical expenditures for similar programs. We estimate that our costs will run from $150-190 per 1000 marked/tagged fish, which includes head collection and tag extraction services. These latter services are not represented in cost estimates from the Pacific Northwest that run between $140-170 per 1000 fish marked/tagged. Higher per unit costs for the Great Lakes are anticipated given the spatial complexity, the higher number of low production facilities compared to the Pacific Northwest, the greater number of species, and the need for many simultaneous marking/tagging events that are widely separated geographically.
5) All salmon and trout (currently about 30.8 million) will receive a coded-wire tag (CWT) and an adipose (AD) fin clip (ADCWT), as opposed to just an AD clip. This is important since most or all recoveries will be based on collections from the sport fishery and commercial fisheries, and from routine assessments where sample sizes are small compared to collection opportunities in the Pacific Northwest. There, return data comes from large numbers of fish landed by commercial fisheries or from adults returning to hatcheries (i.e. “rack counts”) or natal streams. Partial tagging of Great Lakes fish would reduce sample sizes and add further uncertainty to any population measures derived from the samples. This is particularly important for studies that have a restricted spatial component or for performance comparisons among hatcheries, strains or other smaller lots.
6) Significant reductions in cost can only be made by tagging fewer fish in each lake or restricting the program to fewer lakes.

Figure 5. Estimated cost adjusted for inflation to ADCWT each salmonine stocked into the Great Lakes from 2008-2017.

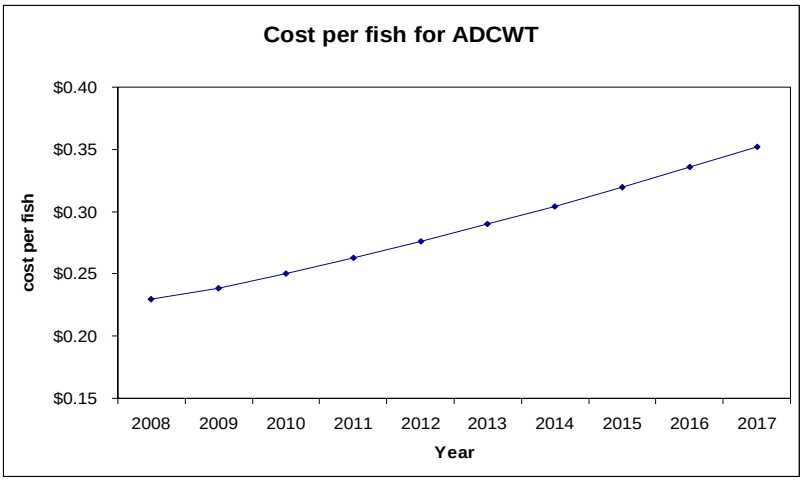


Table 10. Estimated capital and operational costs for full implementation of mass marking in U.S. waters. Includes the trailer that NYDEC will purchase.

	Eastern Regional Budget				Western Regional Budget				Central Regional Budget				
	Number	**unit cost**			**Number**	**unit cost**			**Number**	**unit cost**			**Row Totals**
Capital Equipment													
AutoFishSCT6 Trailers	2	$ 1,250,000		$ 2,500,000	3	$ 1,250,000		$ 3,750,000	3	$ 1,250,000		$ 3,750,000	
Manual Fish Mark/Tag Trailer	1	$ 370,000		$ 370,000	1	$ 370,000		$ 370,000	1	$ 370,000		$ 370,000	
Portable Mark/Tag Stations	6	$ 29,400		$ 176,400	6	$ 29,400		$ 176,400	6	$ 29,400		$ 176,400	
Portable Generator	1	$ 30,000		$ 30,000	1	$ 30,000		$ 30,000	1	$ 30,000		$ 30,000	
Fish Pump	1	$ 25,000		$ 25,000	2	$ 25,000		$ 50,000	2	$ 25,000		$ 50,000	
Total Capital Equipment				**$ 3,101,400**				**$ 4,376,400**				**$ 4,376,400**	**$ 11,854,200**
CWT Processing Lab													
V CWT Detectors	3	$ 5,000		$ 15,000	5	$ 5,000		$ 25,000	5	$ 5,000		$ 25,000	
Wand CTW Detectors	3	$ 5,000		$ 15,000	4	$ 5,000		$ 20,000	4	$ 5,000		$ 20,000	
readers,Computers, printer, misc. lab supplies				$ 15,250				$ 30,600				$ 30,600	
Total Lab Equipment				**$ 45,250**				**$ 75,600**				**$ 75,600**	**$ 196,450**
Electrical Improvements Hatcheries				**$ 57,910**				**$ 140,335**				**$ 95,000**	**$ 293,245**
Personnel wages year 1 highest grade		wages	Fringe 40%			wages	Fringe 40%			wages	Fringe 40%		
Coordinator					1	$ 89,115	$ 35,646	$ 124,761					
Programmer/database manager					1	$ 63,417	$ 25,367	$ 88,784					
Admin technician					1	$ 52,912	$ 21,165	$ 74,077					
Biostatistician					1	$ 75,414	$ 30,166	$ 105,580					
Mark crew supervisor, Biologist	1	$ 63,417	$ 25,367	$ 88,784	1	$ 63,417	$ 25,367	$ 88,784	1	$ 63,417	$ 25,367	$ 88,784	
Full Time Technician AutoFish Operators	2	$ 52,912	$ 21,165	$ 148,154	3	$ 52,912	$ 21,165	$ 222,230	3	$ 52,912	$ 21,165	$ 222,230	
Part Time Technician Assistant AutoFish Operators	1	$ 43,731	$ 17,492	$ 61,223	1.5	$ 43,731	$ 17,492	$ 91,835	1.5	$ 43,731	$ 17,492	$ 91,835	
total FTEs	4				9.5				5.5				
	days	per day			days	per day			days	per day			
Temporary Fish Markers/head collectors	400	$ 160		$ 64,000	650	$ 160		$ 104,000	750	$ 160		$ 120,000	
Total Personnel Salaries				**$ 362,161**				**$ 900,051**				**$ 522,849**	**$ 1,785,061**
	days				days				days				
Total Travel	**350**	**$ 120**		**$ 42,000**	**500**	**$ 120**		**$ 60,000**	**700**	**$ 120**		**$ 84,000**	**$ 186,000**
	fish	**$/1000**	**% marked**		**fish**	**$/1000**	**% marked**		**fish**	**$/1000**	**% marked**		
Coded Wire Tags	**5,782,000**	**$ 72**	**1.00**	**$ 416,304**	**7,293,500**	**$ 72**	**1.00**	**$ 525,132**	**12,426,000**	**$ 72**	**1.00**	**$ 894,672**	**$ 1,836,108**
Operations: supplies, equipment, vehicles and services													
Leased vehicles				$ 16,000				$ 21,000				$ 35,000	
Commercial Trailer Transport				$ 20,000				$ 36,000				$ 32,000	
Supplies: cutters, drive rollers, clippers, headmolds, needles, anesthetics, disinfectant, etc.				$ 144,550				$ 182,338				$ 310,650	
Cyclical maintenance (1% cap cost)				$ 31,467				$ 44,520				$ 44,520	
GSA space costs				$ 100,000				$ 150,000				$ 100,000	
Total Operations				**$ 312,017**				**$ 433,858**				**$ 522,170**	**$ 1,268,044**
Operations+Salaries+CWT+ Travel				$ 1,132,481				$ 1,919,040				$ 2,023,691	
Regional Grand Total				**$ 4,337,041**				**$ 6,511,375**				**$ 6,570,691**	**$ 17,419,108**

Table 11. Estimated capital and operational costs for full implementation of mass marking in Ontario waters.

								Ontario Program Costs
	Number		**unit cost**					
Capital Equipment								
AutoFishSCT6 Trailers	1	$	1,250,000				$	1,250,000
Manual Fish Mark/Tag Trailer	1	$	370,000				$	370,000
Portable Mark/Tag Stations	0	$	29,400				$	-
Portable Generator	1	$	30,000				$	30,000
Fish Pump	1	$	25,000				$	25,000
Update old Mark Ivs	6	$	2,500				$	15,000
Total Capital Equipment							**$**	**1,690,000**
CWT Processing Lab								
V CWT Detectors	4	$	5,000				$	20,000
Hand Wand CTW Detectors	4	$	5,000				$	20,000
							$	20,250
Total Lab Equipment							**$**	**60,250**
Electrical Improvements Hatcheries							**$**	**99,390**
Personnel wages year 1 highest grade								
			wages		Fringe			
Full Time Senior Resource Technician, mark crew supervisor	1	$	54,105	$	8,193		$	62,298
Full Time Resource Technician, AutoFish Operator	2	$	48,610	$	7,361		$	111,941
Part Time Resource Technician, Assistant AutoFish Operators	0.5	$	45,656	$	6,913		$	26,285
total FTEs	3.5							
	days		per day					
Temporary Fish Markers/head collectors	550	$	175				$	96,250
Total Personnel Salaries							**$**	**296,774**
	days							
Total Travel	**400**	**$**	**175**				**$**	**70,000**
	fish		**$/1000**		**% marked**			
Coded Wire Tags	**5,285,000**	**$**	**72**		**1.00**		**$**	**380,520**
Operations: supplies, equipment, vehicles and services								
GSA leased vehicles							$	35,000
Commercial AutoFish Trailer Transport							$	22,000
Supplies and Materials: Mark IV machine cutters, drive rollers, clippers, headmolds, needles, anesthetics, disinfectant, etc.							$	105,700
Cyclical maintenance (1% cap cost)							$	17,503
GSA space costs								
Total Operations							**$**	**180,203**
Operations +Salaries+CWT+Travel							$	927,496
Regional Grand Total							**$**	**2,777,136**

Cost Comparison with Estimates from the April 2005 Report

Estimated capital equipment costs and personal and operation costs are higher than originally indicated in the April 2005 report. A comparison of total programs costs is provided in Table 12. Capital equipment costs for U.S. and Canada remain similar but are distributed differently among trailer configurations, portable equipment and require auxiliary equipment. Operations costs are projected to be much higher primarily due to additional personal to provide a broader range of services, tagging and marking all fish as opposed to a percentage, and replacement costs of expendable items of the marking equipment per manufacturers' recommendations (wire cutters, injection needles, fin clipping blades etc.).

Table 12. Gross cost comparison between major program components costs specified in the April 2005 report and in this report.

Cost	Apr 2005 (millions)	Dec 2007 (millions)
1) Capital equipment (all equipment)	$ 12.2	$ 13.7
2) Electrical upgrades	$ 0.0	$ 0.4
Operations		
Personnel (perm and temp)	$ 1.6	$ 2.5
Travel	$ 0.0	$ 0.2
CWT	$ 1.2	$ 2.2
Others costs and supplies	$ 0.4	$ 1.6
3) Total annual operation costs	$ 3.1	$ 6.5
Grand total (1+2+3)	$ 15.4	$ 20.6

Major differences affecting the cost estimates include (Table 13):

1. inclusion of electrical upgrades at identified facilities (see section "*Electrical Improvements at Hatcheries"*)
2. the perceived need and number of Autofish trailers versus manual trailers
3. the number, configuration and expertise of staff required to provide services
4. more realistic travel costs for marking and head recovery crews
5. the number of fish that will receive ADCWTS (100% in this estimate)
6. space configuration and their costs
7. contracts to transport of trailers, cyclical maintence, and supply costs.

Table 13. Gross cost comparison between major program elements specified in the April 2005 report and in this report.

Cost/item	April 2005	Dec 2007
Capital equipment	12 AutoFish trailers, 0 manual trailers, no generators, fish pumps, or portable units	9 AutoFish trailers, 4 manual trailers, 4 generators and pumps, 18 portable units
Personnel (perm and temp)	16 FTE for marking, database, headshop and recovery.	22 FTE for marking, recovery, database, administration, headshop, and statistical services.
ADCWTs	18.8 million fish	30.8 million fish
Other costs/ supplies	Underestimated for trailer transport, expendable supplies, cyclical maintenance, space costs	Included realistic costs plus vehicle leases
Hatchery electrical improvements	Not included or measured.	All needs identified and costs estimated.

Recommended Implementation Plan over Five Years

U.S. Program

This section provides an overview of equipment and operational budgets to implement a mass marking program from 2008 to 2012. Forecasts for personnel needs, activities schedules, data recovery, and related analytical services are provided. The fully-funded program, operated by the USFWS, will have the capability to coded-wire tag and adipose-fin clip 25.6 million salmon and trout at 32 separate state, tribal, and federal hatcheries across 8 states within the U.S. portion of the Great Lakes. The cost, size, and complexity of this initiative will require a gradual building of equipment inventories (capital costs), personnel capabilities, and operational budgets to maintain the program. The center piece of the program will be the acquisition of 7 Autofish trailers (not including the trailer New York DEC plans to purchase) that are operated and maintained by highly trained staffs capable of implanting coded wire tags in about 60,000 fish per 8-hr day per automated trailer.

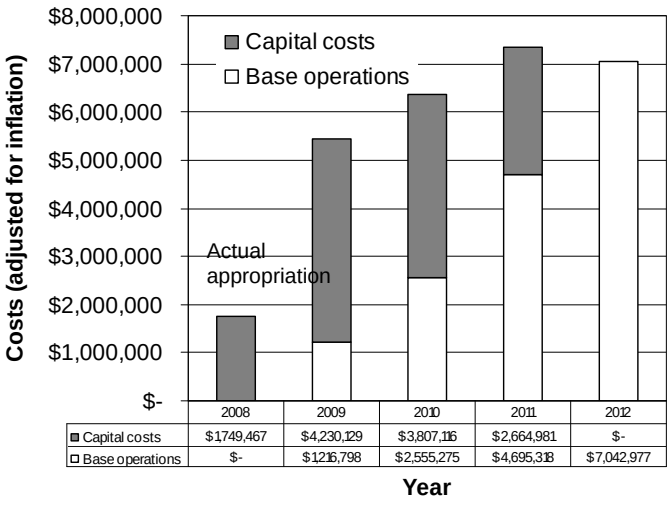
Total Cost of Program

Capital Equipment	$11.7 million (2008 dollars)
Annual operational budget	$5.8 million (2008 dollars)

Approximate Operational Budget Breakdown in 2012 (2012 dollars)

Salaries (Permanent, seasonal, temporary)	$2.2 million (31.4%)
Coded wire tags	$2.6 million (37.1%)
Operations, maintenance, and space	$2.2 million (31.4%)

Figure 6. Capital equipment and operational budget for the Great Lakes Mass Marking program in the US. Total costs to build program over 5 years with an annual inflation rate of 5%.



.

Schedule of Program Development

FY2008 - $1,750,000 (actual appropriation)

- Purchase 1 AutoFish trailer and related equipment ($1,305,000), 1 manual trailer ($370,000); upgrade electrical service at selected hatcheries ($75,000).
- Begin GSA process to meet additional space needs.

FY2009 - $5,446,927 (needed appropriation)

- Purchase 3 Autofish trailers and related equipment, 1 manual trailer.
- Hire 1 Program Coordinator to oversee equipment purchases and establish Great Lakes Regional Mass Marking Committee from partner agencies.
- Hire 1 Biostatistician to begin discussions with partner agencies on specific information needs to develop detailed tag and recover study plans that meet objectives.
- Hire and train 1 tag crew supervisor.
- Tag all lake trout and species other than Chinook as equipment becomes available.

FY2010 - $6,362,391(needed appropriation)

- Purchase 2 Autofish trailers and related equipment, 1 manual trailer.
- Hire 1 Database manager to establish Data Standards Committee with representatives from partner agencies. Establish basin-wide tag and recovery database to archive all data and make it accessible to partner agencies.
- Hire train 1 tag crew supervisor, 2 tag crew technicians.
- Hire 1 administrative technician.
- Establish laboratory (“head shop”) to process all fish recovered.
- Move into new GSA space.
- Tag all species other than Chinook as equipment becomes available.

FY2011 - $7,360,299 (needed appropriation)

- Purchase 1 Autofish trailer and related equipment.
- Hire and train1 tag crew supervisor, 4 tag crew technicians
- Begin recovery of tagged fish, tags removed and read by head shop, and recovery data entered into the database.
- Tag all species (including most Chinook) in all lakes.

FY2012 - $7,042,977 (needed appropriation)

- Hire and train 1 tag crew technician; 4 part-time assistant technicians.
- Continue recovery of tagged fish, tags removed and read by head shop, and recovery data entered into the database.
- Tag all species in all lakes (25.6 million).

Table 14. Acquisition schedule and estimated costs of permanent and part-time positions adjusted for inflation. Additional seasonal workers to be hired for manual tagging and head recovery operations.

Position	Fiscal Year				
	2008	2009	2010	2011	2012
Program Coordinator		1			
Biostatistician		1			
Database administrator			1		
Tag crew supervisor		1	1	1	
Administrative technician			1		
Tag crew technicians		1	2	4	1
Part-time assistant technicians					4
Estimated annual cost (inflation adjusted)		$ 432,521	$ 459,768	$ 462,109	$ 398,713
Cumulative cost		$ 432,521	$ 913,915	$ 1,421,720	$ 1,891,519
Cumulative FTEs		4	9	14	19

Canada/Ontario Program

CY2008- $10,000

- participate in pilot project on Lake Ontario, in cooperation with the New York Department of Environmental Conservation (NYDEC)
- complete electrical upgrades at Ringwood Fish Culture Station (operated by the Ontario Federation of Anglers and Hunters (OFAH), under agreement with OMNR)
- mark all chinook salmon destined for Lake Ontario (target – 540,000 spring yearlings); 25,000 pen-imprinted fish will have to be marked manually; balance with AutoFish unit (515,000 fish)
- NYSDEC will provide AutoFish unit and trained marking technicians; support from OMNR and OFAH staff and volunteers
- secure funding for mass-marking project in Ontario

CY2009- $1,800,000

- purchase mass-marking equipment – 1 AutoFish trailer
- upgrade / re-furbish existing portable marking units (6x NMT Mark IVs)
- complete electrical upgrades at OMNR facilities (6 stations)
- hire and train marking crew (1 crew leader, 2 technicians)

- contract with local manual markers
- review and revise marking schedule to reflect current production targets and optimize use of equipment / staff
- mark chinook salmon at Ringwood FCS (540,000 fish) and all lake trout at OMNR facilities (2,600,000 fish)
- design program for collecting heads for each species (from established assessment programs + targeted collections) that will answer important management questions

CY2010- $1,200,000

- purchase mass-marking equipment – 1 manual trailer
- contract with local manual markers
- mark all salmon and trout at OMNR and partner facilities (5,300,000 fish)
- hire contractors to collect heads (as needed to supplement sources from established programs)
- begin head collection and tag retrieval (cost of head collection will increase in future years, as number of tagged fish in the population increases)

Draft Programs for Lakes Michigan and Huron

Lake trout Collection Protocol

The primary objectives for marking all lake trout stocked into Lakes Huron and Michigan with adipose fin-clip and coded-wire-tags (ADCWTs) would be to:

1) determine the rate of natural reproduction
2) determine relative survival among strains, fish from different hatcheries, and fish stocked in different geographic areas
3) determine movement and geographic affinity to stocking locations
4) determine unbiased measures of growth and age structure

Coded-wire tags from marked lake trout will be collected primarily during the spring graded-mesh gill net surveys, fall spawning surveys, commercial catch sampling, and throughout the open water fishing season by head hunters and creel clerks. Expected numbers of lake trout to be examined for each lake and survey-type annually are given in Table 16, and are based on average survey results for recent years. Additional samples from head hunters beyond the current efforts would supplement the collections. Since 100% of all lake trout would receive an ADCWT, all lake trout collected from agency surveys would be sacrificed for analysis, and all lake trout encountered by headhunters would be available as well.

Table 15. Approximate number of lake trout encountered by survey type in Lakes Michigan and Huron. Plus signs indicate that additional heads would be available from additional headhunters deployed by the Great Lakes Mass Marking Laboratory.

Lake	Spring gillnet survey	Fall gillnet spawning surveys	Commercial fishery	Head hunter/ creel survey	Total
Michigan	1,700	2,620	500	1,600 +	6,420+
Huron	1,150	1,330	1,230	700 +	4,410+

Each head would be placed into a standard zip-lock bag (see next section) that would be pre-labeled with a unique serial number provided by the Great Lakes Mass Marking Laboratory. The serial number will also be expressed as a bar code on the bag that can be scanned for inventory purposes. That number would be used to track the head through CWT removal and data archiving into a centralized relational database, and to cross reference it with additional data collected in the field. Data collected in the field from agency surveys should include at a minimum total length, undressed weight, date of capture, statistical grid of capture, sex, maturity stage, and lamprey wounds classified as per King (1980) and modified according to the recommendations of Ebener et al. (2003, 2006). Data standards will be further developed by agreement among agencies. Heads will be stored on ice during transport to a freezer, and then shipped to the Mass Marking Laboratory or processed by the collecting agency.

Estimating wild production of Chinook salmon in Lakes Michigan and Huron with ADCWTs

Background

Natural reproduction by Chinook salmon has been previously quantified using mark/recapture studies of hatchery-released fish and by counting out-migrating wild smolts in tributaries. Since their introduction into Lake Michigan in 1967, estimated numbers of wild Chinook salmon smolts have ranged from 0 – 7 million smolts per year (Carl 1982 ,1984; Seelbach 1985, 1986; Zafft 1992; Hesse 1994; Rutherford 1997; Jonas et al. in review). This extreme variability and the added predation pressure by wild Chinook salmon highlighted the need to obtain more accurate estimates of natural production by Chinook salmon. Herein, we describe a coordinated plan for mass marking of all Chinook salmon stocked in Lakes Michigan and Huron with ADCWTs. The goal of this plan is to estimate the proportion of the total population in each lake that is naturally-produced. The plan includes: 1) fish marking procedures; 2) protocols for collection of tagged salmon; 3) sample processing / tag extraction procedures and; 4) an overview of statistical methods, reporting procedures, and involvement and commitment of agency personnel.

Marking Procedures and QAQC samples

A consistent, high quality and unambiguous mark is needed to distinguish hatchery-reared Chinook salmon from their wild counterparts. To achieve this, all hatchery-reared Chinook salmon will receive an ADCWT in the hatchery at a minimum size of 200 fish per pound. Timing of ADCWT will be based on the size of the fish as opposed to age. Marking with ADCWT will be completed using Northwest Marine Technology Autofish STC6 trailers, according to established protocols (NMT 2004). Manual marking trailers will be used at low-production facilities.

Chinook salmon will be stocked according to current plans after receiving ADCWTs. Quality assurance/quality control (QAQC) is accomplished through optical and electronic features built into the AutoFish system. Extended periods between receiving ADCWTs and stocking will require additional QAQC samples to refine estimates of tag loss, however based on the experience in the Pacific Northwest most tag loss occurs within 30 days of tagging. Fish that are tagged and clipped in manual trailers will require similar QAQC to evaluate tag retention and fin clip quality. These QAQC samples will be a minimum of 60 randomly-selected fish from each hatchery lot or rearing group that represents a treatment group, and will be inspected for tag presence and quality of the adipose fin clip. When feasible, fish for QAQC will be collected as close to the stocking date as possible (or during the net-pen phase, if applicable).

Protocol for the collection of tagged Chinook salmon

Chinook salmon will be collected during June and July in Lake Huron and Michigan by “head hunter” crews dedicated to this task at selected fishing ports. Collections are designed to estimate the proportion of each age group that are wild (Szalai and Bence 2002), with fish from each lake treated as a separate population. In addition, returns of ADCWT fish will be used to estimate mixing of Chinook salmon populations between the lakes and among jurisdictions.

These objectives require that sampling be representative of the population(s) rather than just the harvest; therefore samples must come from the recreational fishery during a time when the populations are well mixed. The Chinook salmon population is well-mixed during June-July (Szalai and Bence 2002), which is fortunately a period when the fishery experiences high catch rates. Samples of 1,500 Chinook salmon (ADCWT and non-ADCWT combined) will be collected from each of six regions of each lake, for a total of 9,000 fish from each lake each year (Table 16). This sample size should be adequate to detect spatial patterns in the proportion of wild fish in each of the lakes.

Table 16. Sample requirements to determine chinook salmon natural reproduction by lake and region.

Lake	Region	Description	Samples required	Tag collection effort (# of headhunters)
Michigan	North	Manistique, MI to St. Ignace,MI Harbor Springs, MI to Grand Traverse Bay, MI	1,500	2
	Northeast	Leland, MI to Pentwater, MI	1,500	1
	Southeast	Muskegon, MI to New Buffalo, MI	1,500	1
	Indiana/Illinois	Michigan City, IN to Waukegan, IL	1,500	1
	Southwest	Kenosha, WI to Sheboygan, WI	1,500	1
	Northwest	Manitowoc, WI to Bailey's Harbor, WI	1,500	1
Huron	North Channel	North Channel, ON	1,500	2
	Georgian Bay	Georgian Bay, ON	1,500	2
	Northeast	St. Ignace, MI to Manitoulin Island, ON	1,500	1
	Southeast	Sarnia, ON to Bruce Peninsula, ON	1,500	1
	Southwest	Port Huron, MI to Port Austin, MI	1,500	1
	Northwest	Cheboygan, MI to Tawas City, MI	1,500	1

Age-specific estimates of the proportion of wild fish in the population will be accomplished by length-stratified sampling to ensure that ages 0-4 are represented in the sample. Five hundred (500) fish will be taken from the following total length classes in each region as per Szalai and Bence (2002): < 37 cm, 38-57 cm, and > 58 cm. Because the smallest length bin corresponds to age-0 Chinook salmon that are rarely caught in the fishery, additional targeted sampling may be necessary to provide adequate samples of these fish.

The following specific protocols will apply:

- Participating agencies will be provided with zip lock bags pre-labeled with unique specimen numbers, scale cards, and appropriate data collection forms.

- Fish with a missing adipose fin will be subject to the following minimum procedures; species identification, total length and weight measurement, fin clip identification. Data sheets will accommodate the following information, and fields marked with an asterisk are required: specimen number from the corresponding sample bag*, date* (mm/dd/yyyy), length (mm)*, weight (g), clip, sex, maturity, lamprey wounds, and location (statistical district* and grid number). Once appropriate measurements are collected, the snout will be removed, behind the eyes.
- Head will be bagged using a standard protocol.
- If possible, a scale sample collected midway between the anterior insertion of the dorsal fin and the lateral line should be collected and placed in a scale envelope labeled with the corresponding unique sample number. The scale envelope can be put in the same bag with the CWT sample. Scale samples will be used to validate Chinook salmon aging techniques among Great Lakes agencies.
- Samples will be kept frozen and transferred to the CWT processing lab. Original data sheets or acceptable copies and scale samples, if collected, should accompany samples when delivered to the CWT processing lab.
- In addition to the samples and associated data indicated above, a chain of custody form will be used for transporting samples, and a data form for the processing of samples will be used to record lab results.
- Fish with an adipose fin will be subject to the following minimum procedures; assignment of specimen number, species identification, total length and weight measurement, and other fin clip identification (see above for description of data sheets and additional data collection). Fish with an adipose fin will also be inspected for a CWT using a detection wand. If a tag is detected, above procedures for tag removal, packaging, and labeling will be followed.

The following assumptions will apply:

- Chinook salmon are mixed during the months of June-July
- Survival is similar for wild and hatchery fish
- Length classes are representative of current Chinook salmon growth rates
- Natural and stocked fish are equally susceptible to capture by angling

Sample Processing / Tag Extraction Procedures

Tag extraction and reading will occur at established agency tag extraction facilities (MIDNR, USFWS, others). Samples will be kept frozen and transferred to one of the CWT processing labs. Original data sheets or acceptable copies and scale samples, if collected, will accompany tag (snout) samples. In addition to the samples and associated data indicated above, a chain of custody form for transporting samples will be completed. A standard data form for the processing of samples will be used to record lab results.

Samples will be thawed, and CWTs will be detected in the Chinook salmon snout with a “V-box detector” or a hand-held wand detector. The sample will be serially bisected, and each half of the sample will be scanned for the presence of a tag. The procedure will be repeated until the tag is visible to the unaided eye; the tag will then be removed from the snout using a magnetized “pen” or knife. Once the tag has been extracted, the “code” will be read under a high-magnification dissecting microscope, and then entered along with other fish data into the CWT database.

Statistical Analyses, Reporting, and Agency Commitments

Analysis of the proportion of wild and hatchery fish in the population of each lake will be completed according to the methods outlined in Szalai and Bence (2002), using equations 1-7. Elements of the classification error matrix will initially be assigned as follows: the classification rate of wild fish as marked equal to 0%, the classification rate of wild fish as unmarked as 100%, the classification rate of hatchery fish as marked equal to 95%, and the classification rate of hatchery fish as unmarked equal to 5% (missed clips in field and missed tags during laboratory processing). These elements will be evaluated and re-parameterized as necessary. If classification errors are ignored, then the proportion of unmarked Chinook salmon collected (p_u) is treated as an estimate of the proportion wild in the population (p_w). Area-specific, age-specific, and lake-wide estimates of the percentage of wild Chinook salmon will be calculated. Estimates will also be made of mixing among regions (Table 16) within a lake, and of mixing between lakes.

Reporting will take the form of a joint annual report from the Lake Michigan and Lake Huron Technical Committees. All agencies involved in Chinook salmon stocking on Lakes Michigan and Huron will be represented in this effort. At a minimum, this report will include the results described above (along with error estimates / coefficients of variation), and will be completed in cooperation with the Great Lakes Regional Marking Committee and staff of the Great Lakes Fish Marking Laboratory. Documentation concerning the overall marking process (not specific to the estimation of Chinook salmon natural reproduction) will be provided in the form of operational reports from the Great Lakes Fish Marking Laboratory.

Literature Cited

Carl, L. M. 1982. Natural reproduction of coho salmon and chinook salmon in some Michigan streams. *North American Journal of Fisheries Management* 4:375-380.

Carl, L. M. 1984. Chinook salmon density, growth, mortality, and movement in two Lake Michigan tributaries. *Canadian Journal of Zoology* 62: 65-71.

Ebener, M. P., J. R. Bence, R. A. Bergstedt, and K.M. Mullett. 2003. Classifying sea lamprey marks on Great Lakes lake trout: observer agreement, evidence of healing times between classes, and recommendations for reporting marking statistics. *Journal of Great Lakes Research* 29 (Supplement 1):283-296.

Ebener, M. P., E. L. King, Jr., and T. A. Edsall. 2006. Application of a dichotomous key to the classification of sea lamprey marks on Great Lakes fish. Great Lakes Fishery Commission Miscellaneous Publication 2006-002.

Hesse, J. 1994. Contribution of hatchery and natural chinook salmon to the eastern Lake Michigan fishery, 1992-1993. Michigan Department of Natural Resources, Fisheries Research Report 2013, Ann Arbor, Michigan.

Jonas, J. L., R. M. Claramunt, and E. S. Rutherford. 2008. Salmonine reproduction and recruitment. *In* The state of Lake Michigan in 2005. Edited by D. F. Clapp and W. Horns. Great Lakes Fishery Commission Special Publication.

King, E. L., Jr. 1980. Classification of sea lamprey (*Petromyzon marinus*) attack marks on Great Lakes lake trout (*Salvelinus namaycush). Canadian Journal of Fisheries and Aquatic Sciences* 37:1989-2006.

Northwest Marine Technology, Inc. 2004. AutoFish SCT5 Operators Manual. Anacortes, Washington.

Rutherford, E. S. 1997. Evaluation of natural reproduction, stocking rates, and fishing regulations for steelhead *Oncorhynchus mykiss*, chinook salmon *O. tschawytscha*, and coho salmon in Lake Michigan. Michigan sport fish restoration program annual reports for projects F-35-R-22 and F-53-R-13, April 1, 1996 to March 31, 1997.Michigan Department of Natural Resources, Fisheries Division, Lansing.

Seelbach, P. W. 1985. Smolt migration of wild and hatchery-raised coho and chinook salmon in a tributary of northern Lake Michigan. Michigan Department of Natural Resources, Fisheries Research Report 1935, Ann Arbor, Michigan.

Seelbach, P. W. 1986. Population biology of steelhead in the Little Manistee River, Michigan. Doctoral dissertation, University of Michigan, Ann Arbor, Michigan.

Szalai, E., and J. Bence. 2002. Review of procedures for estimating wild production of Chinook salmon through marking experiments: evaluation of needed sampling of marked fish on Lake Michigan. Project Completion Report, Great Lakes Fishery Commission, Ann Arbor, Michigan.

Zafft, D. J. 1992. Migration of wild chinook and coho salmon smolts from the Pere Marquette River, Michigan. Master's thesis, Michigan State University, East Lansing, Michigan.

The Implementation Task Group

Charles Bronte (U.S. Co-Chair), U.S. Fish and Wildlife Service
Marion Daniels (Canada Co-chair), Ontario Ministry of Natural Resources
Jim Bowlby, Ontario Ministry of Natural Resources
Dave Clapp, Michigan Department of Natural Resources
John Clevenger, Michigan Department of Natural Resources
John Dettmers, Great Lakes Fishery Commission
Mark Ebener, Chippewa Ottawa Resource Authority
Steve Fajfer, Wisconsin Department of Natural Resources
Steve Lapan, New York Department of Environmental Conservation
James Markham, New York Department of Environmental Conservation
Lloyd Mohr, Ontario Ministry of Natural Resources
Paul Peeters, Wisconsin Department of Natural Resources
Don Schreiner, Minnesota Department of Natural Resources
Skip Walch, U.S. Fish and Wildlife Service (retired)