STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-80-R-2

Study No.: 691 **Title:** Methods for determining safe harvest levels for fish stocks in inland lakes of northern Michigan

Period Covered: October 1, 2000 to September 30, 2001

Study Objective: To review existing methods for calculating safe harvest levels for fish stocks in inland lakes in northern Michigan; to revise these or develop new methods as needed.

Summary: I reviewed existing methods for calculating safe harvest levels in mixed-user fisheries (recreational and tribal). Techniques used in the treaty-ceded territory of northern Wisconsin appeared most appropriate for northern Michigan. I evaluated existing gamefish population survey data for northern Michigan and identified the need for current gamefish population estimates. As a result, we began gamefish tagging operations on 5 northern Michigan lakes in the spring of 2001. Tags will be retrieved in a yearlong creel survey. Analysis of the creel survey data will yield mark-recapture population estimates for adult gamefish and estimates of angler exploitation. Additional lakes will be sampled in 2002. These data will be used as the basis for building a predictive model of gamefish abundance for northern Michigan lakes.

Job 1. Title: Review existing techniques for calculating safe harvest levels and recommend which should be used in Michigan.

Findings: I reviewed existing techniques for calculating safe harvest levels in mixed-user fisheries in both Wisconsin and Minnesota. Techniques vary greatly between Wisconsin and Minnesota, largely due to the number and size of lakes subject to tribal harvest in each state.

Wisconsin DNR has developed regression models that predict adult walleye abundance from lake area for both stocked and naturally producing lakes in the 1837 and 1842 treaty-ceded areas (Hansen 1989). Safe harvest is derived from regression-based population estimates using a safety factor that limits the probability of overharvest to 1 in 40 (Hansen et al. 1991). This type of modeling approach is appropriate for calculating safe harvest over a large suite of lakes of varying sizes and recruitment sources. The treaty-ceded area in Wisconsin encompasses 22,400 mi^2 and 2,300 lakes larger than 25 acres (U.S. Department of the Interior 1991).

Minnesota DNR uses a modeling approach based on gill-net catch-per-unit-effort (CPUE) as an index of walleye abundance (Don Pereira, pers. comm.). Safe annual harvest is set at 24% of the total walleye abundance for a lake. The majority of tribal harvest in Minnesota occurs in Mille Lacs, a large 132,000 acre lake in the 1837 treaty ceded area. This gill-net based approach is appropriate for large lakes where estimating population size through mark-recapture sampling is impractical, but it may be inappropriate for small lakes where gill-nets could harm the fish population.

The 1842 treaty-ceded area in Michigan contains approximately 600 lakes greater than 25 acres, 215 lakes greater than 100 acres, and 19 lakes greater than 1,000 acres. The two largest lakes, Lake Gogebic and Portage Lake, are 13,000 and 11,000 acres respectively. All other lakes are less than 5,000 acres in size. Given the number of small lakes in the 1842 area and lack of extremely large lakes, the Wisconsin approach would be more appropriate; however, other techniques like hydroacoustic sampling will continue to be explored.

Job 2. Title: Evaluate the usefulness of existing population survey data for making harvest limit calculations.

Findings: I reviewed existing Fisheries Division data using Michigan DNR's Fish Collection System software. Very few gamefish population estimates exist for Michigan inland lakes, and many of the existing estimates are old. Current mark-recapture gamefish population estimates will be needed to build a predictive model(s) to estimate gamefish populations in unsampled lakes.

Job 3. Title: Develop procedures for calculating safe harvest levels and acquire any needed software. Explain assumptions of techniques and how to interpret results.

Findings: I devised field sampling protocols and designed data sheets for conducting inland mark-recapture estimates (see addendum). In spring 2001, we netted and jaw tagged legal sized walleye (≥15") and northern pike (≥24") in 5 inland lakes—Burt, Crooked, Pickerel, and Houghton lakes and Michigamme Reservoir. Numbers of fish tagged by lake and by species are given in Table 1. Additional lakes have already been selected for adult gamefish tagging in 2002. Field protocols will be similar to those used in 2001.

Yearlong creel surveys are underway on each of the lakes, and recaptures in the creel will be used to generate population estimates. Tag returns to date by lake and by species are given in Table 1. Numbers of returns to date indicate that enough fish were marked in each lake to obtain viable population estimates, with the exception of northern pike on Crooked and Pickerel lakes. Tagging crews did not encounter many legal sized northern pike on these 2 lakes. The creel surveys will also be used to calculate angler exploitation rates and total angler extractions.

We did not need to acquire any new software, as existing software was adequate. I designed a Microsoft ACCESS database to hold all data collected during the marking runs as well as all jaw tag return data. All data sheets were designed using TELEform by Cardiff Software. Data were mapped in ArcView GIS by ESRI.

Mark-recapture estimates are forthcoming. The year long creel surveys run through the winter of 2001-2002 on all five lakes. Design and results of creel surveys to date are given under Study 646.

Literature Cited:

Hansen, M.J. 1989. A walleye population model for setting harvest quotas. Wisconsin Department of Natural Resources, Fish Management Report 143, Madison.

Hansen, M.J., M.D. Staggs, and M.H. Hoff. 1991. Derivation of safety factors for setting harvest quotas on adult walleyes from past estimates of abundance. Transactions of the American Fisheries Society 120:620-628.

U.S. Department of the Interior. 1991. Casting light upon the waters: a joint fishery assessment of the Wisconsin ceded territory. Bureau of Indian Affairs, Minneapolis, MN.

Prepared by: Aaron P. Woldt
Date: September 30, 2001

Table 1.–Number of fish jaw tagged and returned by lake and by species, spring 2001 (WAE = walleye, NOP = northern pike).

Lake	Species	Number tagged	Number returned to date
Burt	WAE	1,877	94
Burt	NOP	64	5
Crooked	WAE	277	51
Crooked	NOP	7	0
Pickerel	WAE	224	13
Pickerel	NOP	4	0
Houghton	WAE	3,086	172
Houghton	NOP	288	10
Michigamme Res.	WAE	1,062	206
Michigamme Res.	NOP	94	5

Addendum—Study 691 Field Protocols for Inland Walleye and Pike Tagging 2001

We will be tagging legal sized walleye (15" and larger), northern pike (24" and larger), and muskie (42" and larger) on the following lakes this spring: Houghton, Burt, Crooked, Pickerel, and Michigamme Reservoir. Creel surveys are being conducted on each of these lakes, and the creel clerks will provide tag recapture information so that we can generate population estimates for walleye and pike (muskie if possible). Muskie are being tagged at the request of the managers. We may not encounter and tag enough muskies to get a population estimate, but we will hopefully gain some valuable information on this species.

Marking Goals

We used the regression models developed by WI DNR to estimate the number of adult walleye present in each of our 5 lakes. The WI models predict adult walleye abundance from lake area and yield the following estimates for our target lakes:

Houghton Lake—59,576 adult walleye
Burt Lake—52,012 adult walleye
Crooked Lake—2,794 adult walleye
Pickerel Lake—3,746 adult walleye
Michigamme Reservoir—21,961 adult walleye

We will attempt to tag 10% of the adult population in each of our target lakes. Tagging 10% of the populations will yield an estimate with good precision while still marking a relatively small percentage of the population. Our tagging goals for each lake are as follows:

Houghton Lake—5,958 adult walleye
Burt Lake—5,201 adult walleye
Crooked Lake—279 adult walleye
Pickerel Lake—375 adult walleye
Michigamme Reservoir—2,196 adult walleye

I realize that we might not meet all of the above goals in each lake; however, the closer we get to each goal the better the population estimates will be.

I do not have any idea how many pike or muskie we will encounter in our target lakes. There is no existing model we can use to predict pike and muskie abundance in MI lakes. I expect that in most of our target lakes we will see fewer pike than walleye and very few muskie. So, we will tag all pike and muskie we encounter up to the walleye targets.

Tagging Guidelines

All fish in the 5 lakes will be tagged in the same spot—the upper jaw, as far back on the jaw as possible (see pictures 1 and 2 below). Tags should be wrapped around both the maxilla and pre-maxilla. This may not be possible on some of the larger fish. Tag ends should be butted together tightly so that the tag forms a circle. This allows the tag to move without harming the tagged area of the fish, allows for growth, and makes the tag number easy to read on recaps or angler harvested fish. Tag ends can be overlapped to allow for a snug tag fit. If tags are overlapped, make sure that the tag number is on the outside.

We will be using two different sizes of jaw tags—size 10 and size 12. We will use size 10 tags on 15.0-19.9" walleye. All walleye ≥ 20", all pike, and all muskie will be tagged with a size 12 tag. If a crew runs out of size 10 tags, size 12's can be used on smaller walleye. This should be avoided whenever possible, however.

Remember, only legal sized fish are to be tagged. Sub-legal fish will be measured, spine sampled, checked for lymphocystis, sexed, and indexed for maturity but will not be tagged.

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2

Tag Description
We will be using 3 different tags: 1) size 10 reward tags, 2) size 12 reward tags, and 3) size 12 non-reward tags. We will use reward and non-reward tags in a 50:50 ratio. Each lake will be issued reward and non-reward tags, and it is the responsibility of the crews to ensure that we get as close to the 50:50 reward to non-reward ratio as possible. All reward tags are valued at $10. The reward is offered to stimulate tag returns.

Tag Retention
We will assess tag retention by fin clipping each tagged fish. We need to determine this value in order to adjust our population estimates for any tag shedding that might occur. On all species we will clip the left pelvic fin (left ventral fin for those folks from the Great Lakes). See pictures 3 and 4 below. We will clip off the entire fin as close to the body as possible, without cutting into the base of the fin.

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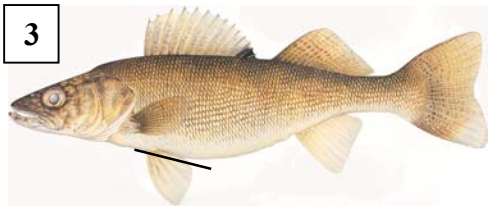

4

Age and Growth Sampling
We will be taking dorsal spine sections off walleye, northern pike, and muskie to index growth and establish length-age keys for all 5 lakes. We will take spine samples from all size ranges of walleye, pike, and muskie from our target lakes.

<u>Protocol for taking spine samples</u>:
1) Use a side cutters to remove the first 3-4 dorsal fin spines, cutting as close to the fish's body

as possible (see pictures 5 and 6 below).
2) Lay the fin ray section in a scale envelope as flat and as straight as possible. This is extremely important. If the rays are not laid flat they are difficult to section later and could be unreadable (see picture 7 below).
3) As soon as possible after the completion of field work, lay the "spine" envelopes flat to dry. Once dried, the "spine" envelopes can be stored just like scale envelopes.

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A sub-sampling regime was determined for walleye and pike for each lake based on an analysis of historic age data from each lake. The sub-sampling rates for each species in each lake are given below. These sub-sampling rates are goals, and I realize that we might not meet each goal for each species in each lake.

Houghton Lake (4 crews)
Walleye—40 males and 40 females per inch group (10 per sex per inch group per crew)
Northern Pike—32 males and 32 females per inch group (8 per sex per inch group per crew)

Burt Lake (2 crews)
Walleye—20 males and 20 females per inch group (10 per sex per inch group per crew)
Northern Pike—20 males and 20 females per inch group (10 per sex per inch group per crew)

Crooked Lake (1 crew)
Walleye—15 males and 15 females per inch group
Northern Pike—16 males and 16 females per inch group

Pickerel Lake (1 crew)
Walleye—15 males and 15 females per inch group
Northern Pike—16 males and 16 females per inch group

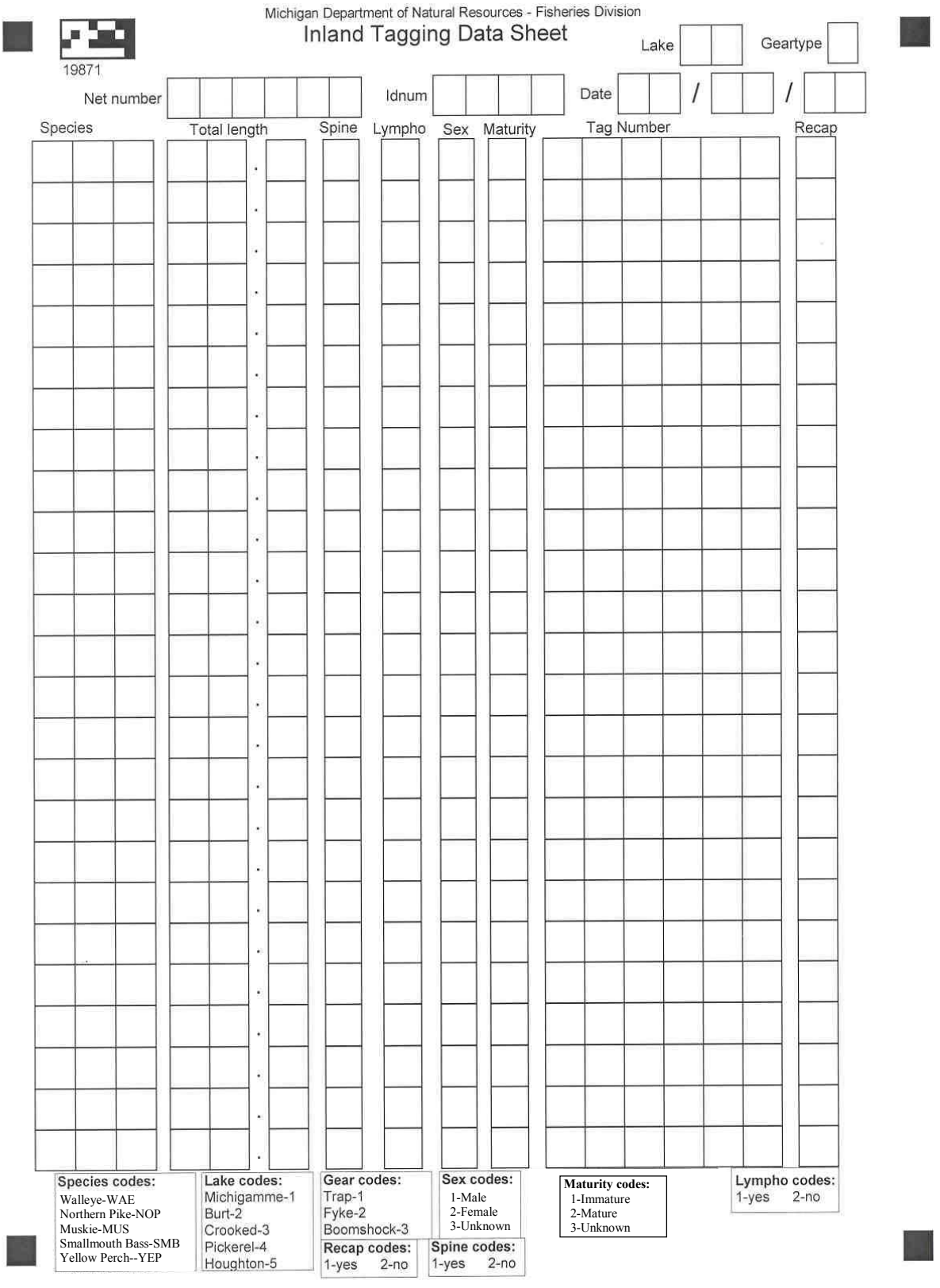
Michigamme Reservoir (2 or 3 crews)
Walleye—75 males and 75 females per inch group (if 3 crews)
50 males and 50 females per inch group (if 2 crews)
Northern Pike—30 males and 30 females per inch group

We will take spine samples from all muskie we catch. I don't expect to see enough muskie for this to be a time problem.

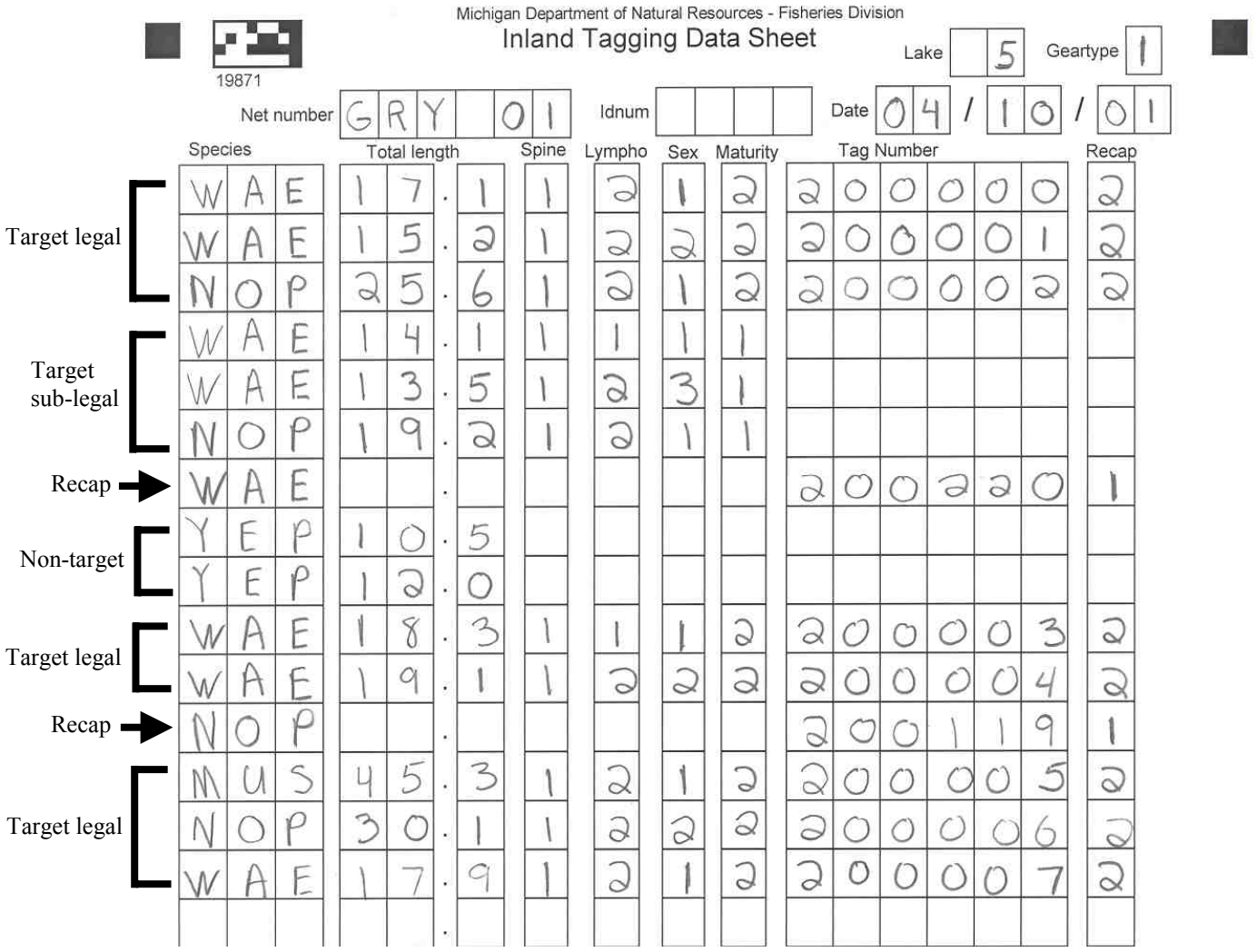
Data Sheets
I (Woldt) will provide data sheets to the crews before the beginning of the survey. All data sheets will be on Rite-in-the-Rain© paper. Data will be recorded on data sheets designed in Teleform software. This software allows for rapid data entry. The data sheet is attached below.

A separate data sheet must be used for each net lift or for each day of shocking.

BLANK DATA SHEET



EXAMPLE



As shown in the example above, you will encounter 4 types of fish: 1) target legal, 2) target sub-legal, 3) recaps, and 4) non-target. Not all information on the data sheet needs to be filled out for all types of fish. All fields must be filled out for legal sized target fish (walleye, pike, and muskie). Sub-legal target fish require only species, length, spine, lympho, sex, and maturity fields to be filled out. Recaptured tagged fish require only species, tag number, and recapture fields to be filled out. Non-target fish require only species and length.

Non-target species can be recorded on a separate data sheet, but you must use the form provided. Separating target and non-target like this makes it easier to keep track of the number of tagged fish. Data sheets will have room for 25 fish on the front side and 25 fish on the back side. I will leave this up to the discretion of the data recorder. Remember, if you do this the non-target sheet must have the lake, gear type, net number, and date fields completely filled out so that the target and non-target catch in each net lift can be pooled for data analysis.

The net number field will be filled with the net number from the brass inventory tag on each net. No net number is needed for shocking data sheets. The Id number field should be left blank. I

will fill in this field with a unique number for each net lift or shocking event after all sampling is completed. This unique identifier helps in database management.

A separate master data sheet for each lake will also be provided. This data sheet will track the locations of the gear in each lake and look similar to the table below. If a net is moved during the course of the study, a new entry for that net number must be recorded.

Date	Net number	Gear type	Latitude	Longitude
04/10/01	BC100	Trap	45 10.55 N	81 13.66 W
04/10/01	BC151	Fyke	45 09.90 N	81 04.05 W
04/16/01	BC100	Trap	45 15.10 N	82 14.01 W

Scale envelopes
Scale envelopes must be filled out with the following information: date, species, length, and sex. It is not necessary to write the jaw tag number on the scale envelope. Lake can be stamped or written on the envelope back in the lab.

Species codes
Attached below is a list of 3-letter species codes to be used in this study. Codes for the target species (and 2 others) are printed on the bottom of the data sheet for quick reference.

Common species in Fish Col. System for Houghton, Burt, Crooked, Pickerel, and Michigamme

Species	3-letter Code
Black Bullhead	BLB
Black Crappie	BCR
Bluegill	BLG
Bowfin	BOW
Brown Bullhead	BRB
Burbot	BUR
Common Carp	CAR
Largemouth Bass	LMB
Longnose Gar	LNG
Muskellunge	**MUS**
Northern Pike	**NOP**
Pumpkinseed Sunfish	PSF
Rainbow Trout	RBT
Rock Bass	RKB
Smallmouth Bass	SMB
Walleye	**WAE**
White Sucker	CWS
Yellow Bullhead	YLB
Yellow Perch	YEP

A comprehensive list of fish species and codes follows on the next pages.

Species	Code
Brook Lamprey	ABL
Arctic Grayling	AGR
Alewife	ALE
Alligator Gar	ALG
American Eel	AME
American Shad	AMS
Atlantic Salmon	ATS
Banded Darter	BAD
Black Buffalo	BBF
Blue Catfish	BCF
Black Crappie	BCR
Blackchin Shiner	BCS
Bigeye Chub	BEC
Blackfin Cisco	BFC
Bigmouth Buffalo	BIB
Banded Killifish	BKF
Brook Trout	BKT
Black Bullhead	BLB
Bluegill	BLG
Bloater	BLO
Black Redhorse	BLR
Bigmouth Shiner	BMS
Brindled Madtom	BMT
Blacknose Dace	BND
Bluntnose Minnow	BNM
Blacknose Shiner	BNS
Brown Trout	BNT
Bowfin	BOW
Brown Bullhead	BRB
Brassy Minnow	BRM
Brook Stickleback	BSB
Blackside Darter	BSD
Blue Sucker	BSK
Brook Silverside	BSS
Blackstripe Topminnow	BST
Burbot	BUR
Common Carp	CAR
Channel Catfish	CCF
Creek Chubsucker	CCS
Channel Darter	CHD
Chinook Salmon	CHS
Chestnut Lamprey	CNL
Coho Salmon	COS
Creek Chub	CRC
Species	Code

Common Shiner	CSH
Central Stoneroller	CSR
Cutthroat Trout	CTT
Common White Sucker	CWS
Freshwater Drum	DRU
Deepwater Cisco	DWC
Deepwater Sculpin	DWS
Emerald Shiner	EMS
Eastern Sand Darter	ESD
Flathead Catfish	FCF
Fathead Minnow	FHM
Finescale Dace	FSD
Fantail Darter	FTD
Goldfish	GOF
Golden Redhorse	GOR
Golden Shiner	GOS
Grass Carp	GRC
Grass Pickerel	GRP
Greater Redhorse	GRR
Greenside Darter	GSD
Green Sunfish	GSF
Gizzard Shad	GZS
Highfin Carpsucker	HCS
Horneyhead Chub	HHC
Ironcolor Shiner	ICS
Iowa Darter	IOD
Johnny Darter	JOD
Kiyi	KIY
Lake Chub	LAC
Lake Trout	LAT
Lake Chubsucker	LCS
Least Darter	LED
Lake Herring	LHR
Longjaw Cisco	LJC
Largemouth Bass	LMB
Longnose Dace	LND
Longnose Gar	LNG
Longnose Sucker	LNS
Logperch	LOG
Longear Sunfish	LSF
Lake Whitefish	LWF
Mimic Shiner	MIS
Margined Madtom	MMT
Mooneye	MOO
Species	Code
Mottled Sculpin	MOS

Mosquitofish	MQF
Central Mudminnow	MUD
Muskellunge	MUS
Northern Brook Lamprey	NBL
Northern Hog Sucker	NHS
Northern Madtom	NMT
Northern Pike	NOP
Northern Redbelly Dace	NRD
Ninespine Stickleback	NSB
Ohio Shad	OHS
Orangespotted Sunfish	OSF
Orangethroat Darter	OTD
Oriental Weatherfish	OWF
Paddlefish	PAH
Plains Carpsucker	PCS
Pallid Sturgeon	PDS
Pirate Perch	PIP
Pink Salmon	PKS
Pugnose Minnow	PNM
Pugnose Shiner	PNS
Pearl Dace	PRD
Pumpkinseed Sunfish	PSF
Menominee Whitefish	RWF
Quillback	QIL
Rainbow Darter	RBD
Rainbow Trout	RBT
River Carpsucker	RCS
Redfin Shiner	RFS
Round Goby	RGB
River Chub	RIC
River Darter	RID
River Redhorse	RIR
Rock Bass	RKB
Rosyface Shiner	ROS
Redside Dace	RSD
Redear Sunfish	RSF
Ruffe	RUF
Sand Shiner	SAS
Sauger	SAU
Smallmouth Buffalo	SBF
Sea Lamprey	SEL
Spotfin Shiner	SFS
Shorthead Redhorse	SHR
Species	Code
Spoonhead Sculpin	SHS
Silver Chub	SIC

Silver Lamprey	SIL
Silver Redhorse	SIR
Silver Shiner	SIS
Shortjaw Cisco	SJC
Skipjack Herring	SJH
Silverjaw Minnow	SJM
Slimy Sculpin	SLS
Smallmouth Bass	SMB
Suckermouth Minnow	SMM
Rainbow Smelt	SMT
Shortnose Cisco	SNC
Shortnose Gar	SNG
Shortnose Sturgeon	SNS
Sockeye Salmon	SOS
Spotted Gar	SPG
Splake	SPL
Spotted Sucker	SPS
Southern Redbelly Dace	SRD
Striped Shiner	SRS
Striped Bass	STB
Stonecat	STC
Lake Sturgeon	STN
Spottail Shiner	STS
Shovelnose Sturgeon	SVS
Tube nosed goby	TGB
Tadpole Madtom	TMT
Tiger Musky	TMU
Trout Perch	TRP
Threespine Stickleback	TSB
Walleye	WAE
Warmouth	WAR
White Catfish	WCF
White Crappie	WCR
Weed Shiner	WES
White Bass	WHB
White Perch	WHP
Yellow Perch	YEP
Yellow Bullhead	YLB