



**Trapping Activities and Population Estimates of
Adult Sea Lamprey in Tributaries of
Lake Superior
During 2001 and 2002**

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ABSTRACT

The Great Lakes Section of the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) has conducted a cooperative sea lamprey (*Petromyzon marinus*) trapping project with the U.S. Fish and Wildlife Service Sea Lamprey Control Station in Marquette, Michigan (USFWS-SLC) since 1986. The purpose of the project is to gather information on adult spawning-phase sea lamprey ascending various tributaries to Lake Superior. Results of the 2001 and 2002 trapping seasons are reported.

The six rivers sampled in both 2001 and 2002 were the Amnicon, Middle, and Bad rivers in Wisconsin, and the Silver, Firesteel, and Misery rivers in Michigan. In 2001 and 2002, 4,441 and 4,906 lamprey, respectively were captured. These catches were twice the thirteen-year average of 2,452 from 1988 to 2000.

Schaefer estimates of adult spawner abundance were calculated for 4 of the 6 tributaries in 2001 and for 5 of the 6 tributaries in 2002. In 2001, spawner abundance estimates ranged from 904 in the Amnicon river to 8,679 in the Bad river and in 2002 they ranged from 212 in the Firesteel to 13,678 in the Bad river.

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INTRODUCTION

The Great Lakes Section of the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) has conducted a cooperative sea lamprey (*Petromyzon marinus*) trapping project with the U.S. Fish and Wildlife Service Sea Lamprey Control Station (USFWS-SLC) in Marquette, Michigan since 1986. Results of this work have been reported in a series of administrative reports of GLIFWC's Biological Services Division. The purpose of the project is to gather information on and estimate the population size of adult spawning-phase sea lamprey ascending various tributary streams of Lake Superior during their May-June spawning run. Objectives of the project are: (1) to monitor the upstream spawning movements of sea lamprey, (2) to collect data on the biological characteristics of spawning sea lamprey, (3) to estimate the number of lamprey spawning in each tributary, and (4) to reduce the spawning potential of sea lamprey by removing a portion of the run.

Information collected by GLIFWC supplements that collected by USFWS-SLC and other agencies, and is included in a lake wide management plan to control and reduce the lamprey population. Results of the mark-recapture study are used in a Discharge Regression model developed by USFWS-SLC to estimate total number of spawning-phase lamprey in United States waters of Lake Superior, and to evaluate the effectiveness of regional lamprey control efforts. This report presents results of the 2001 and 2002 trapping seasons.

Tributaries selected for trapping by GLIFWC were known to contain spawning runs of adult sea lamprey and represent a range of stream sizes based on in-stream flows. Several of these tributaries contained natural or man-made barriers. The number of tributaries trapped by GLIFWC has varied from 5 rivers in 1986 and 1987 to 13 rivers in 1990 and 1991. Due to sampling difficulties and low catch in several streams, the number of rivers trapped was reduced to eight in 1992. These eight rivers were among those sampled annually between 1988 and 1996. In 1997, the Traverse river was dropped from the sampling schedule due to low catch rates since 1993. The Falls river was added in 1997 because of its comparability to the Traverse river in mean annual discharge and to determine if lamprey catches would be sufficient to calculate a mark-recapture population estimate. In 1998, the Falls and Huron rivers were dropped from the sampling schedule while the West Branch of the Ontonagon was added. These changes were made in response to a report by an independent review panel released in August 1997 which recommended sampling fewer small streams and more large streams. In 2001, the West Branch of the Ontonagon river was dropped from sampling due to low catches (Mattes 2003). In 2001 and 2002, six streams were trapped; the Amnicon, Middle, and Bad rivers in Wisconsin and the Firesteel, Misery, and Silver rivers in Michigan.

METHODS

Rivers and Trapping Sites

Three tributaries in Wisconsin and three tributaries in the Upper Peninsula of Michigan were trapped from late April through early July (Figure 1). The Middle and Misery rivers possessed man-made barriers that were specially built to prevent the upward movement of sea lamprey. The Amnicon and Silver rivers possess natural barriers which prevent sea lamprey from moving through the entire system. The Bad and Firesteel rivers possess no impassable barriers. Traps were placed below barriers where they occurred and in the lower portion of rivers in which no barriers existed.

Location and type of traps used within tributaries depended on the suitability of the site for trapping (Table 1). The man-made barriers on the Middle and Misery rivers allowed portable steel cage traps to be abutted against the barriers. On the Bad river portable steel cage traps were placed directly below and against a natural rock shelf which transects the rivers. The Amnicon, Firesteel, and Silver rivers were trapped using fyke nets.

Data Collection

Traps or fyke nets were emptied at least three times per week (i.e., Monday, Wednesday, and Friday) in the Firesteel and Silver rivers, five days per week in the Bad and Misery rivers, and seven days per week in the Middle and Amnicon rivers. Live lamprey were transported downstream (Table 1), and a sub-sample was marked by clipping one or both dorsal fins then released back into the river (Table 2). The fins were clipped with a v-notch tool and a different combination of clips was used to identify the week of capture and release within the year (Table 3). Lamprey not marked and released were destroyed, except in the Misery and Middle rivers where male lamprey were placed in holding cages in the rivers and later transported for use in the sterile male release program. Water and air temperature were recorded at the time traps or nets were emptied (Table 4).

The number of live and dead marked and unmarked lamprey captured each sampling day was counted, along with the number of other fish species in the traps or nets. Lamprey or a sub-sample of lamprey were measured to the nearest millimeter, weighed to the nearest gram, and sex determined each day in all rivers except the Middle and Misery. The fin clip combination on recaptured lamprey was also recorded.

Population Estimates

Mark-recapture population estimates were attempted based on the tagging procedure described above. When sample size was sufficient population estimates were calculated using the modified Schaefer method (Ricker 1975, 3.18). When the number of recaptures was deemed too low, no such estimate was calculated. Population estimates of adult spawning lamprey in these and other streams are made and combined to estimate the population in U.S. waters of Lake Superior for determining the effectiveness of efforts to control lamprey and extractions of lean lake trout.

RESULTS AND DISCUSSION

Trap Catches

In 2001 and 2002, 4,441 and 4,906 lamprey, respectively were captured. These catches were twice the thirteen-year average of 2,452 from 1988 to 2000 (Table 4). The majority of lamprey captured came from the Middle and Misery rivers in 2001 and from the Middle and Bad rivers in 2002. In 2001, 2,633 and 1,100 lamprey were captured in the Middle and Misery rivers, respectively and in 2002, 3,026 and 1,050 were captured in the Middle and Bad rivers, respectively.

Trap catch in the Middle river has increased dramatically since 1998 (Table 4). From 1986-1997 the twelve-year average annual catch was 65 lamprey, whereas from 1998 to 2002 the average annual catch was 3,357 lamprey. Starting in 2000, four traps were set in the Middle river in an increased effort to capture male lamprey for the sterile male release technique program (SMRT).

Other than sea lamprey, 26 fish species, 8 fish genera, and 3 other taxa were captured during 2001 while 27 fish species, 11 fish genus, and 9 other taxa were collected during 2002 (Tables 5 and 6). Suckers (*Catostomus sp.*) were captured most often (N=1,459 in 2001 and N=1,522 in 2002). Other taxa commonly captured in the traps or nets were minnows (*Cyprinidae sp.*), creek chub (*Semotilus atromaculatus*) and crayfish (*Procambarus sp.*). Also, 252 burbot (*Lota lota*) were captured in 2001 primarily from the Middle river and 284 brook trout (*Salvelinus fontinalis*) were captured in 2002 primarily from the Misery river.

Biological Characteristics

Male lamprey (N=119 in 2001 and N=229 in 2002) comprised 38% and 34% of the total lamprey sexed in 2001 (N=313) and 2002 (N=679), respectively (Table 7, Figure 2). These percentages were within the range for the fifteen-year period 1986-2000 (range: 18% to 53%). In 2001 and 2002 the overall female to male sex ratio was 1.6:1 and 2.0:1, respectively.

The mean lengths of male lamprey were 433 mm and 417 mm in 2001 and 2002, respectively, while the mean lengths of female lamprey were 432 mm and 419 mm (Table 7). These lengths were within the range of lengths observed during the previous fifteen years (Figure 3).

The mean weights for male lamprey were 181 g and 194 g in 2001 and 2002, respectively, while female lamprey were 188 g and 211 g (Table 7). These weights were within the range of weights observed during the previous fifteen years. Mean weight of male and female lamprey has been similar within years but has varied considerably between years (Figure 4).

Population Estimates

Schaefer estimates of adult spawner abundance were calculated for 4 of the 6 tributaries in 2001 and for 5 of the 6 tributaries in 2002 (Table 8). In 2001, spawner abundance estimates ranged from 904 in the Amnicon river to 8,679 in the Bad river and in 2002 they ranged from 212 in the Firesteel to 13,678 in the Bad river. The population estimate for the Bad river in 2002 was the highest during the 17 year time series (Table 9).

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Ricker, W.E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations. Bulletin of the Fisheries Research Board of Canada. Department of Fisheries and Oceans. Bulletin 191.

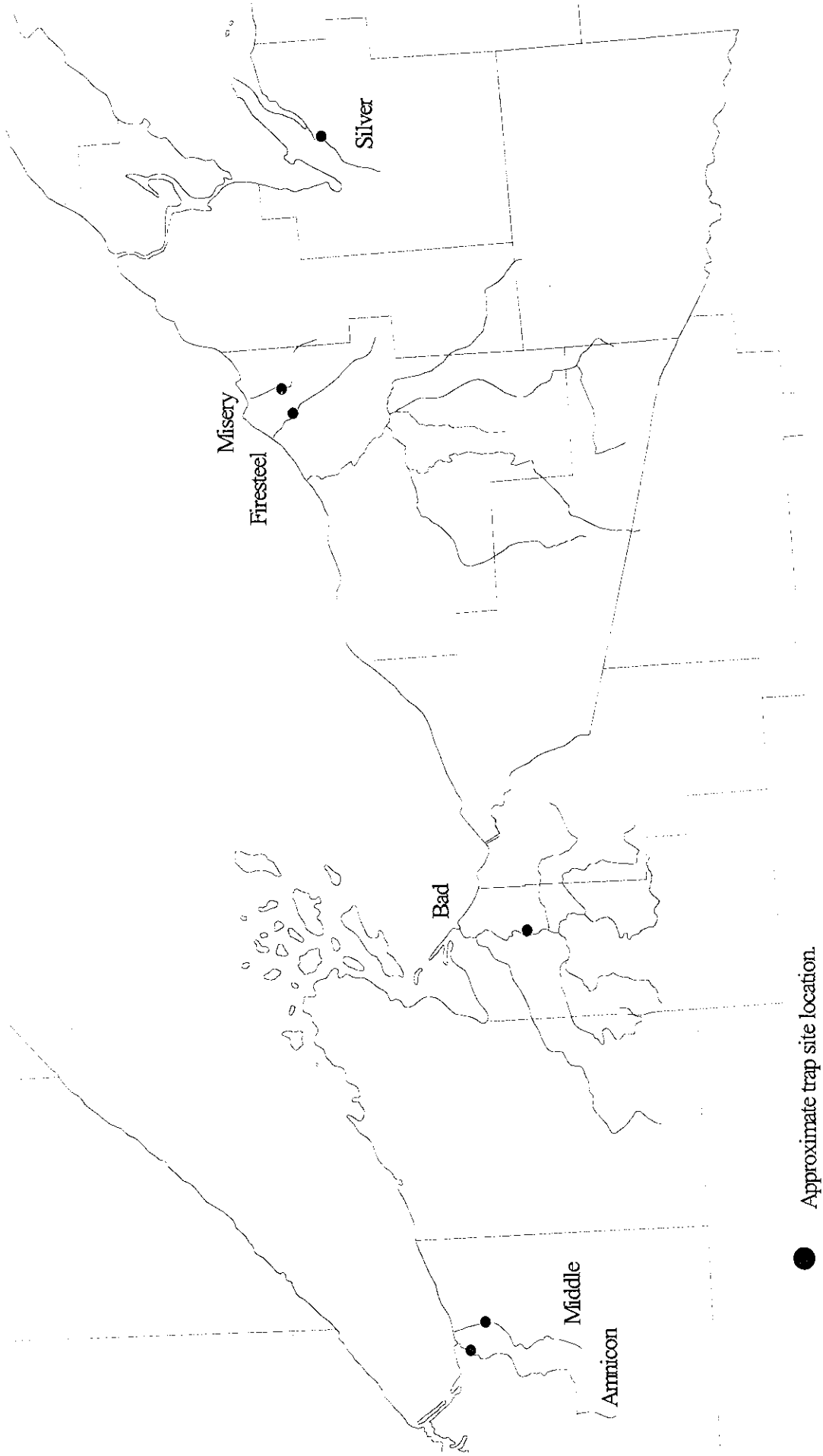


Figure 1. Location of tributaries in which spawning-phase lamprey were trapped in 2001 and 2002.

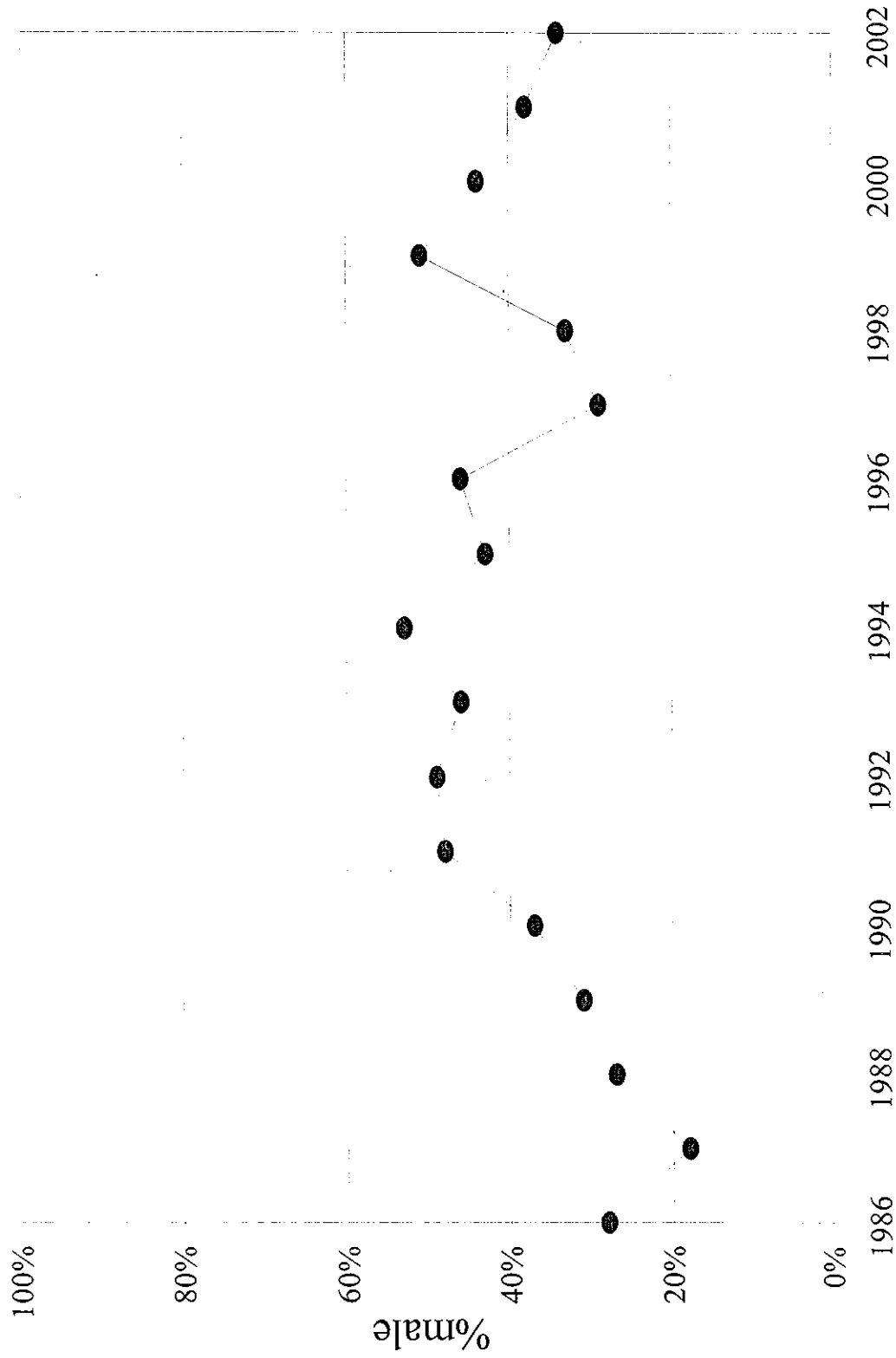


Figure 2. Percent male lamprey from rivers trapped during 1986-2002, excluding the Misery and Middle rivers in 2000.

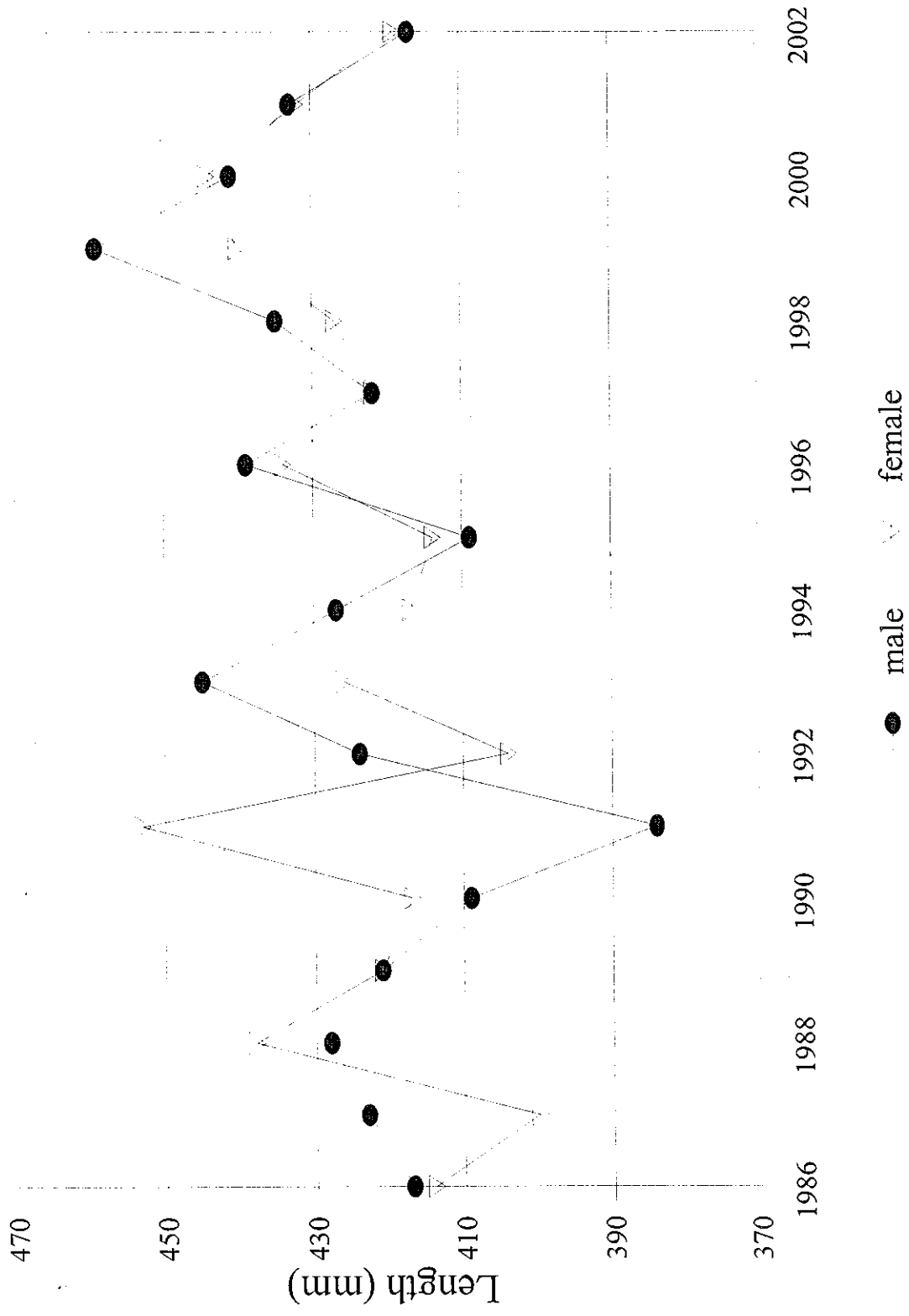


Figure 3. Mean length (mm) for male and female lamprey from rivers trapped during 1986-2002.

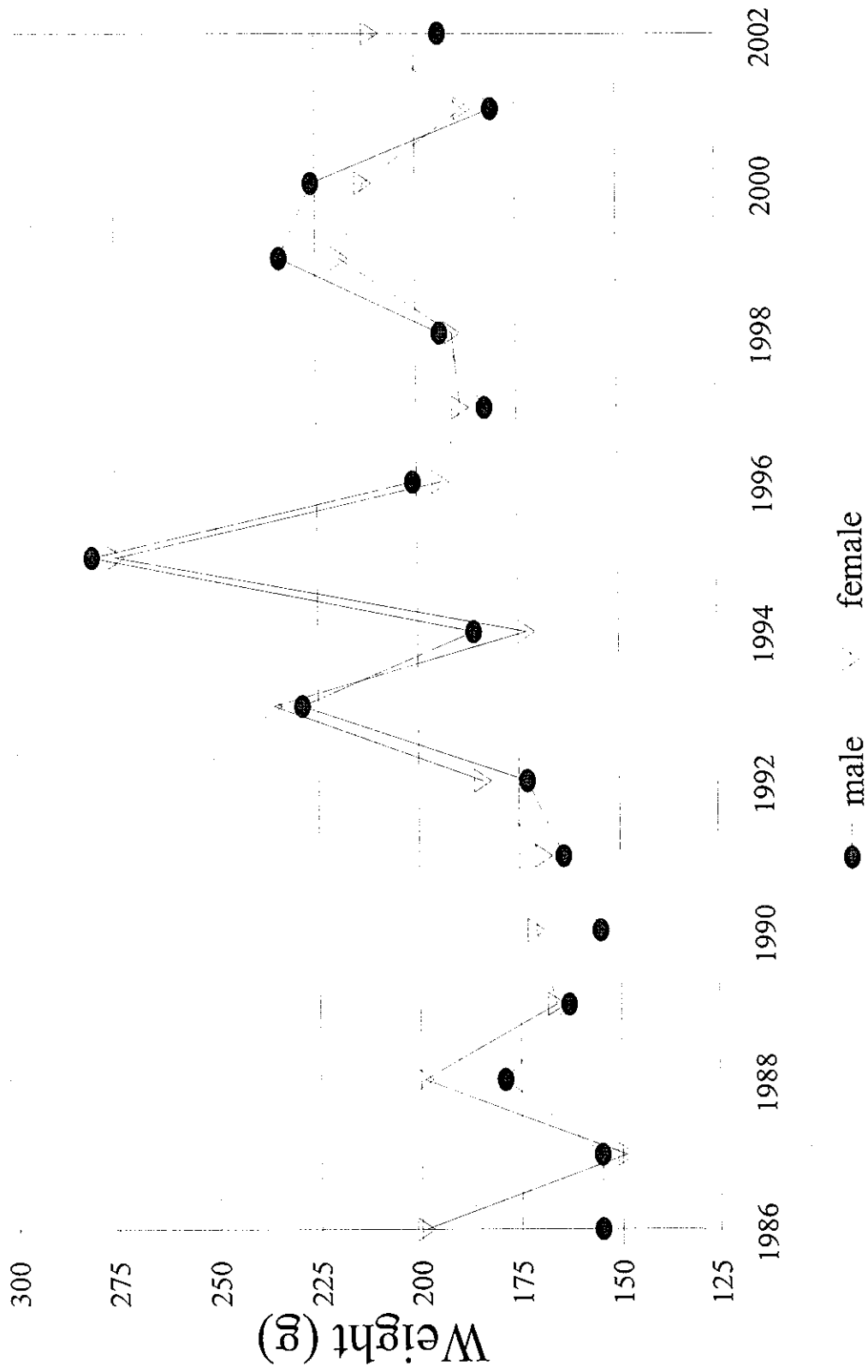


Figure 4. Mean weight (grams) for male and female lamprey from rivers trapped during 1986-2002.

Table 1. Information on location of lamprey trapping conducted on Lake Superior tributaries during 2001 and 2002.

Tributary	State/County	Location trapped	Gear	Trap site distance from mouth	Barrier distance from mouth	Release site
Amnicon	WI/Douglas	T48N, R12W, Sec 8, SE 1/4	1-fyke net	5 km (3 miles)	11 km (7 miles)	0.1 km downstream from net
Middle	WI/Douglas	T48N, R12W, Sec 13, NE 1/4	2-4 traps	5 km (3 miles)	5 km (3 miles)	HWY 13 bridge
Bad	WI/Ashland	T47N, R3W, Sec 36, NE 1/4	3-traps	30 km (19 miles)	no barrier	0.8 km downstream from trap
Firesteel	MI/Ontonagon	T51N, R38W, Sec 27, SE 1/4	1-fyke net	11.2 km (7 miles)	no barrier	bridge 0.4 km below trap
Misery	MI/Ontonagon	T52N, R37W, Sec 15, NE 1/4	2-traps	1.6 km (1 mile)	1.6 km (1 mile)	0.4 km below trap
Silver	MI/Baraga	T51N, R31W, Sec 13, SE 1/4	1-fyke net	1.6 km (1 mile)	5 km (3 miles)	0.4 km below trap

Table 2.A Type and combination of marks used on adult lamprey by week for Wisconsin and Michigan rivers trapped during 2001.

Week of trapping	Dates in 2001	Mark (anterior, posterior)	Week of trapping	Dates in 2001	Mark (anterior, posterior)
1	4/29-5/5	(3,0)	6	6/03-6/09	(0,2)
2	5/06-5/12	(2,2)	7	6/10-6/16	(1,2)
3	5/13-5/19	(2,1)	8	6/17-6/23	(0,3)
4	5/20-5/26	(2,0)	9	6/24-6/30	(3,2)
5	5/27-6/02	(1,1)			

Table 2.B Type and combination of marks used on adult lamprey by week for Wisconsin and Michigan rivers trapped during 2002.

Week of trapping	Dates in 2002	Mark (anterior, posterior)	Week of trapping	Dates in 2002	Mark (anterior, posterior)
1	5/05-5/11	(2,2)	6	6/09-6/15	(1,2)
2	5/12-5/18	(2,1)	7	6/16-6/22	(0,3)
3	5/19-5/25	(2,0)	8	6/23-6/29	(3,2)
4	5/26-6/01	(1,1)	9	6/30-7/06	(3,3)
5	6/02-6/08	(0,2)	10	7/07-7/13	(1,3)

Table 3. Water and air temperature (degrees Centigrade) for six tributaries to Lake Superior in 2001 and 2002.

Tributary	Code	Water Temperature 2001					Water Temperature 2002				
		N*	average	S.D.	min	max	N*	average	S.D.	min	max
Michigan Tributaries											
Firesteel	289	23	18.9	4.1	12	28	21	22.1	4.3	15	30
Misery	284	35	15.6	3.6	9	24	26	16.7	4.6	8	23
Silver	190	25	17.8	4.2	11	26	19	19.2	5.5	8	27
Wisconsin Tributaries											
Amnicon	705	30	15.4	2.2	12	19	29	15.2	4.0	9	24
Bad	611	26	16.0	2.9	9	21	23	14.8	4.0	7	21
Middle	703	46	14.3	2.4	10	20	27	14.6	4.2	9	22
Air Temperature 2001											
Air Temperature 2002											
Michigan Tributaries											
Firesteel	289	23	20.3	6.1	9	29	21	22.6	5.9	10	32
Misery	284	33	18.8	6.8	8	31	26	21.6	7.2	10	36
Silver	190	25	20.8	6.5	10	31	19	24.5	7.2	10	35
Wisconsin Tributaries											
Amnicon	705	29	18.2	4.6	7	26	29	17.0	6.7	8	33
Bad	611	24	16.9	4.7	6	26	23	16.7	7.0	7	33
Middle	703	44	17.3	4.9	7	27	27	19.5	6.7	10	31

*N= number of days where measurement was recorded.

Table 4. Annual catches of unmarked adult sea lamprey in spring spawning assessment traps and nets, in tributaries to Lake Superior monitored by GLJWC from 1986-2002.

Tributary	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Wisconsin Tributaries																	
<i>Primary</i>																	
Ammicon	61	14	3	118	67	101	7	39	24	40	83	83	79	278	132	31	
Bad	184	439	972	684	465	121	236	84	114	280	316	272	471	646	293	563	1,050
Middle	315	16	11	249	1	4	12	46	11	24	42	47	408	2,235	8,481	2,633	3,026
<i>Secondary</i>																	
Arrowhead	1																
Black				3	8												
Nemadji				0	1												
Poplar	0				0												
Raspberry																	
Red Cliff Cr.				14	15												
Subtotal-3 primary	499	516	997	936	584	192	349	137	164	328	398	402	962	2,960	9,052	3,328	4,107
Total-WI	500	516	997	936	601	216	349	137	164	328	398	402	962	2,960	9,052	3,328	4,107
Michigan Tributaries																	
<i>Primary</i>																	
Firesteel		17	40	44	86	43	74	24	21	0	37	79	35	375	7	97	
Huron	1	51	6	9	14	41	54	2	35	2	18						
Misery		261	265	164	336	907	4,871	455	197	672	1,131	406	1,753	1,238	1,100	695	
Silver	0	4	0	6	26	29	36	0	20	6	42	42	59	243	6	7	
<i>Secondary</i>																	
Traverse		10	10	31	33	11	4	0	0	1							
Falls												3					
Ontonagon				56	18								0	9	13		
Otter				0	0												
Subtotal-4 primary	0	5	329	317	243	465	1,027	4,999	487	273	680	1,228	527	1,847	1,856	1,113	799
Total-MI	0	5	339	327	274	498	1,038	5,003	487	273	681	1,228	527	1,847	1,856	1,113	799
<i>Primary total</i>																	
			1,326	1,253	827	657	1,376	5,136	651	601	1,078	1,630	1,489	4,807	10,908	4,441	4,906
Grand total	500	521	1,336	1,263	875	714	1,387	5,140	651	601	1,079	1,630	1,489	4,807	10,908	4,441	4,906
<i>Average catch after 1988:</i>																	
			1,300	1,158		1,115	1,786	1,624	1,496	1,450	1,450	1,468	1,470	1,748	2,452	2,691	2,971

Table 5. Number of fish and other taxa captured during trapping on six Lake Superior tributaries in 2001.

<i>Fish Species</i>	Wisconsin Tributaries			Michigan Tributaries				Grand Total	
	Bad	Amnicon	Middle	Total-MI	Firesteel	Misery	Silver		Total-MI
Sea lamprey	563	132	2,633	3,328	7	1,100	6	1,113	4,441
Silver lamprey			7	7		1		1	8
Black bullhead		3	11	14				0	14
Brook trout			1	1	2	21	3	26	27
Brown bullhead		1	27	28				0	28
Brown trout	1		3	4				0	4
Burbot			251	251	1			1	252
Coho salmon				0			2	2	2
Common shiner		10	337	347	11			11	358
Creek chub		5	63	68	75	124	18	217	285
Hornyhead chub			4	4				0	4
Johnny darter			2	2				0	2
Lake chub				0		1		1	1
Log perch			2	2				0	2
Longnose dace			159	159		15		15	174
Longnose sucker			40	40				0	40
Rainbow trout			1	1	7	170	13	190	191
Redhorse sucker				0	4			4	4
River chub				0	1			1	1
Rock bass	1	1		2	21		16	37	39
Ruffe		33		33				0	33
Smallmouth bass	4	1		5				0	5
Trout perch			5	5			1	1	6
Walleye		2		2	2			2	4
White sucker		16	914	930	7	12	14	33	963
Yellow bullhead		9	6	15				0	15
Yellow Perch				0	1			1	1
<i>Fish Genus</i>									
Bullhead sp.		28	8	36	1			1	37
Catfish sp.		5		5				0	5
Chub sp. (Cyprinidae)	1	7	317	325		2		2	327
Dace sp.	3		16	19		18		18	37
Sculpin sp.			51	51		27	2	29	80
Shiner sp.		5	79	84				0	84
Sucker sp.			10	10	90	344	8	442	452
Sunfish sp.	1	1		2				0	2
<i>Other taxa</i>									
Crayfish		1	100	101	2	16	31	49	150
Frogs			2	2		10		10	12
Bull frog				0		1		1	1

Table 6. Number of fish and other taxa captured during trapping on six Lake Superior tributaries in 2002.

<i>Fish Species</i>	Wisconsin Tributaries				Michigan Tributaries				Grand Total
	Bad	Amnicon	Middle	Total-WI	Firesteel	Misery	Silver	Total-MI	
Sea lamprey	1,050	31	3,026	4,107	97	695	7	799	4,906
Silver lamprey			4	4				0	4
Black bullhead		12	10	22				0	22
Blacknose dace			3	3				0	3
Brook trout				0	13	245	26	284	284
Brown trout			2	2				0	2
Burbot				0		1		1	1
Central mudminnow			1	1				0	1
Coho salmon				0				0	0
Common shiner		4	20	24				0	24
Creek chub		25	172	197				0	197
Homyhead chub			2	2				0	2
Log perch			1	1				0	1
Longnose dace			18	18				0	18
Mottled sculpin			8	8				0	8
Rainbow trout			2	2	27	17	6	50	52
Red shiner				0	2			2	2
Redhorse sucker			3	3		3		3	6
Rock bass	9	18		27	72		12	84	111
Round goby				0		1		1	1
Ruffe		7		7				0	7
Slimy sculpin			1	1				0	1
Smallmouth bass	1			1	1		2	3	4
Trout perch			1	1				0	1
Walleye	1	1		2	5			5	7
White sucker	19	3	402	424	119	67	14	200	624
Yellow bullhead			3	3				0	3
Yellow perch				0			3	3	3
<i>Fish Genus</i>									
Bullhead sp.		4		4	8	1		9	13
Catfish sp.		14	18	32		1		1	33
Chub sp. (Coregonus)		2		2			9	9	11
Chub sp. (Cyprinidae)		9	145	154				0	154
Dace sp.			40	40		10		10	50
Minnow family			240	240				0	240
Sculpin sp.			12	12		21		21	33
Shiner sp.		38	383	421	68	84	1	153	574
Sucker sp.				0	331	489	72	892	892
Sunfish sp.				0	19	1	13	33	33
Trout sp.				0			3	3	3
<i>Other taxa</i>									
Crayfish		31	269	300	23	12	10	45	345
Frogs			1	1		3		3	4
Toads or frog		1	1	2				0	2
American toad			1	1				0	1
Northern leopard frog			1	1				0	1
Tadpole (toad or frog)			4	4				0	4
Snapping turtle				0	1			1	1
Wood turtle		2		2				0	2

Table 7. Calculated percent, female:male sex ratio, average length (mm), weight (grams), and standard deviation (S.D.) for male and female lamprey during 2001 (a) and 2002 (b).

a.

River	River		Count	Percent	F:M Ratio	Length			Weight		
	Code	Sex				Number	Average	S.D.	Number	Average	S.D.
Misery	284	Female	98	64%	1.8	98	429	41	98	181	48
		Male	56	36%		56	425	34	56	157	40
		All	154			154	427	39	154	172	46
Bad	611	Female	34	69%	2.3	34	417	38	34	170	61
		Male	15	31%		15	424	40	15	182	45
		All	49			49	419	39	49	173	56
Middle	703	Female	55	54%	1.2	55	445	37	55	212	54
		Male	47	46%		47	444	40	47	208	68
		All	102			102	444	38	102	210	60
Amnicon	705	Female	7	88%	7.0	7	443	33	7	193	39
		Male	1	13%		1	489		1	250	
		All	8			8	448	35	8	200	42
All Rivers		Female	194	62%	1.6	194	432	40	194	188	54
		Male	119	38%		119	433	38	119	181	58
		All	313			313	432	39	313	186	55

b.

River	River		Count	Percent	F:M Ratio	Length			Weight		
	Code	Sex				Number	Average	S.D.	Number	Average	S.D.
Misery	284	Female	98	92%	10.9	98	417	43	98	161	48
		Male	9	8%		9	401	46	9	148	59
		All	107			107	416	43	107	160	48
Firesteel	289	Female	15	83%	5.0	15	452	43	15	226	57
		Male	3	17%		3	448	19	3	186	15
		All	18			18	451	40	18	220	54
Bad	611	Female	109	48%	0.9	109	413	28	0		
		Male	119	52%		119	416	35	0		
		All	228			228	415	32	0		
Middle	703	Female	228	70%	2.4	228	419	32	228	231	110
		Male	97	30%		97	419	39	97	199	97
		All	325			325	419	34	325	221	107
Amnicon	705	Female	0			0			0		
		Male	1			1	374		1	132	
		All	1			1	374		1	132	
All Rivers		Female	450	66%	2.0	450	419	34	341	211	99
		Male	229	34%		229	417	38	110	194	93
		All	679			679	418	36	451	206	98

Table 8. Population estimates for spawning phase sea lamprey in GLIFWC monitored streams tributary to Lake Superior during 2001 and 2002.

Tributary	2001 Population Estimates	2002 Population Estimates
	Schaefer Method Mark/Recapture	Schaefer Method Mark/Recapture
Wisconsin Tributaries		
Bad	8,679	13,678
Middle	2,327	3,327
Amnicon	904	552
Michigan Tributaries		
Firesteel	N/A	212
Misery	1,975	602
Silver	N/A	N/A

Estimates provided by the USFWS- Sea Lamprey Control Program in Marquette, Michigan.
 N/A=Not available, population estimate could not be calculated due to low sample size.

Table 9. Population estimates for spawning lamprey from six GLIFWC monitored tributaries to Lake Superior from 1986-2002.

River	Year																
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Amnicon		647 S			1,368 S	413 SM	1,394 SM	1,216 SM		58 SM	673 SM	605 SM	600 SM	3,380 SM	904 SM	552 SM	
Bad	6,026 S	4,654 S	7,762 S	9,818 S	3,138 S	3,806 SM	2,651 SM	2,428 SM	2,135 SM	2,048 SM	8,513 SM	4,700 SM	4,064 SM	12,552 SM	2,767 SM	8,679 SM	13,678 SM
Middle	1,080 S	20 S	21 S	1,328 S			172 SM	184 SM		82 SM	31 SM	186 SM	1,081 SM	13,515 SM	6,900 SM	2,327 SM	3,327 SM
Misery			610 S	1,124 S	800 S	737 SM	1,771 SM	8,859 SM	748 TE	413 TE	951 TE	2,881 TE	1,073 TE	2,339 SM	1,764 SM	1,975 SM	602 SM
Firesteel				220 P	462 S	265 SM	113 SM	256 SM				76 SM	274 SM	84 SM	1,036 SM		212 SM
Silver					56 S	61 SM	110 SM					170 SM	157 SM	651 SM	937 SM		

Method of estimation:

- Schaefer=S
- Schaefer, Modified=SM
- Peterson, adjusted=P
- Trap Efficiency=TE