Aquatic Nuisance Species Research Relevant to the Great Lakes Basin: Research Guidance and Descriptive Inventory

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I. Acknowledgments

The aquatic nuisance species (ANS) research inventory initiative was a cooperative effort conducted on a binational and, in fact, an international basis. A wide array of individuals and agencies from throughout the binational Great Lakes Basin contributed to, or assisted in, developing both the inventory and the associated findings and recommendations.

Leadership was provided by the Great Lakes Panel on Aquatic Nuisance Species and, more specifically, by the Panel's Research Coordination Committee. The Panel authorized development of the inventory in 1995, after which the Research Coordination Committee provided oversight and project guidance under the direction of Committee Chair, Commander Eric Reeves of the U.S. Coast Guard.

Great Lakes Commission staff support for the inventory project was a team effort. Project Manager Lori Reynolds designed and implemented the inventory methodology and conducted much of the detailed analysis with substantial support from Matthew Doss. Executive Director Mike Donahue and Program Manager Tom Crane led the development of the research findings and recommendations.

Individual Panel members—particularly the eight Great Lakes states and the province of Ontario—provided significant in-kind contributions through staff support and other services.

Specific funding for the research inventory effort was provided by the U.S. Fish and Wildlife Service, whose overall support for the Panel and ANS prevention and control efforts has been vitally important.

The research inventory project benefited from several other important partners. The National Sea Grant College Program, and the Great Lakes Sea Grant Network in particular, have provided critical support for both ANS research and dissemination of findings and results. Their publications and staff were helpful in identifying ANS research relevant to the Great Lakes Basin. Finally, Commission staff coordinated closely with the International Joint Commission's (IJC) Council of Great Lakes Research Managers in developing and distributing the inventory survey form. This cooperative relationship will be maintained in future years as the inventory effort will be institutionalized as a regularly updated service on the Internet.

Appreciation also is extended to the multitude of researchers who took the time to respond to the inventory survey request. Their detailed overviews of their research significantly enhanced the value of this report. We applaud their dedication, professionalism and commitment to sound science in providing the foundation for successful prevention and control efforts.

We thank all who contributed to this effort and welcome comments and suggestions on the inventory format, substance, and associated findings and recommendations.

Mark Coscarelli, Chair (MI)
Great Lakes Panel on Aquatic Nuisance Species

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Great Lakes Panel on Aquatic Nuisance Species

II. Introduction and Review of the Research Inventory Report

This report presents information in three areas: 1) an overview of the collective ANS research effort; 2) a series of findings and recommendations to help guide future ANS research; and 3) a descriptive inventory of ANS research relevant to the Great Lakes Basin.

Section III provides an overview of inventory methodology and a summary of results, including a statistical breakdown of research funding allocation among the aquatic nuisance species of primary concern in the Great Lakes Basin. During the summer of 1996, the Great Lakes Panel conducted a final review of the draft inventory originally presented at the April 1996 research symposium (discussed in Section III below). Minor revisions were made to the draft inventory; however, they do not change the overall conclusions reported in the draft inventory and associated briefing paper.

Section IV presents the full text of the Panel's formal policy position titled *Research Guidance for the Prevention and Control of Nonindigenous Aquatic Nuisance Species in the Great Lakes*. It includes a series of findings and recommendations for consideration by Panel members, the national ANS Task Force, and other public and private sector entities that fund, conduct, manage or apply ANS research. The policy position is based on the results of the inventory, the research symposium sponsored by the Great Lakes Panel in April 1996, and the collective experience and expertise of the Panel membership. The policy position was formally adopted by the Panel at its December 4, 1996, meeting.

Section V is the heart of the inventory report, providing a descriptive listing for each of the 250 ANS research projects. Projects are subdivided according to six major species of concern in the Great Lakes Basin (zebra mussel, sea lamprey, ruffe, round goby, purple loosestrife and Eurasian watermilfoil), other species (alewife, carp, *Corbicula fluminea*, *Daphnia lumholtze*, flowering rush, quagga mussel, red shiner, smelt, and spiny water flea), and aquatic nuisance species general, for projects relating to the ANS issue in general but not a specific species. Within each subsection, the projects are listed by research category: 1.0 Biology and Life History; 2.0 Control and Mitigation; 3.0 Ecosystem Effects; 4.0 Prevention of Introduction; 5.0 Socioeconomic Considerations; and 6.0 Analysis and Spread of Established ANS Populations. The actual listing refers to a subcategory within the six major categories (e.g., 1.2 - Population Dynamics, under the overall category of Biology and Life History).

Each project listing includes the following information: title, research category, overview, principal investigator(s), start and end date, funder, total cost, publication/citation, geographic area, and the name and address of the individual who submitted the project. With the exception of minor edits made for consistency and grammatical accuracy, the information is listed as submitted. Specific information not provided is indicated with "--". Readers may contact the principal investigator to request additional information or to clarify the material provided.

The projects are numbered sequentially from 1 to 250. Appendix 1 includes indices which cross reference the projects—using this reference number—by research category and geographic area. In addition, a limited number of research projects address more than one species. In these cases, the project is listed under the species that is the project's primary focus. A brief note is provided at the beginning of the subsection for the project's secondary species directing the reader to the project. Finally, reference numbers indicating the range of projects listed on each page are provided in the upper corner of each page in Section V.

Appendices 2, 3 and 4 provide membership lists for the Great Lakes Panel on Aquatic Nuisance Species and the national Aquatic Nuisance Species Task Force, and an overview of the Great Lakes Commission, respectively.

III. Overview of Aquatic Nuisance Species Research Relevant to the Great Lakes Basin

The Great Lakes and connecting channels form the largest, surface freshwater system in the world. The water-related resources are an integral part of activities, such as recreation and tourism, valued at $15 billion annually, $6.89 billion of which is related to the fishing industry. This valuable fishery is threatened by the infestation of harmful nonindigenous aquatic nuisance species, which alter the number and distribution of native species, and have broad economic and societal impacts that extend well beyond shoreline residents and recreational users of regional water resources.

The Laurentian Great Lakes have been subject to the invasion of nonindigenous aquatic nuisance species since the settlement of the region by Europeans. Since the 1800s, at least 139 nonindigenous aquatic organisms have become established in the Great Lakes. The bulk of these organisms have been represented by plants (59), fish (25), algae (24), mollusks (14) and oligochaetes (7). About 55 percent of these species are native to Eurasia, while 13 percent are native to the Atlantic Coast. Approximately 10 percent of the Great Lakes' nonindigenous species have had significant economic and ecological impacts.

The Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 specifically recognized the Great Lakes as a valuable resource and included provisions to protect it. Section 1203 of the Act established the Great Lakes Panel on Aquatic Nuisance Species to ensure effective coordination of ANS activities in the Great Lake region. The Panel is required to identify ANS priorities for the Great Lakes, assist in coordinating federal and nonfederal programs, provide advice to public and private individuals and entities concerning methods of controlling aquatic nuisance species, and report annually on progress to a national ANS Task Force (also established under the 1990 legislation).

In early 1995, the Panel identified a need for a comprehensive research inventory to assess current and recently completed ANS research relevant to the Great Lakes Basin, identify research gaps and needs, highlight key findings and, in general, promote technology transfer to benefit the Great Lakes ecosystem. This need was also identified in a 1993 report to Congress from the Office of Technology Assessment titled *Harmful Nonindigenous Aquatic Nuisance Species in the United States.* The report concluded that "continued research and development of new ways to manage harmful nonindigenous species remains essential."

Acting on this need, the Panel developed a three-part project involving: 1) development and distribution of a research survey form; 2) conduct of a research symposium to analyze the inventory results and reach consensus on research gaps and future needs; and 3) documentation of research symposium findings and the development of recommendations. The following is an outline of the methodology used in collecting the ANS research information and a general overview of inventory results.

METHODOLOGY

The Great Lakes Panel's Research Coordination Committee assumed lead responsibility for developing and analyzing the ANS research inventory.

i) Survey Content

The survey form requested that projects be classified according to six research categories originally defined by an ad-hoc ANS committee that preceded the establishment of the Great Lakes Panel. The research categories are: Biology and Life History; Control and Mitigation; Ecosystem Effects; Prevention of Introduction; Socio-economic Considerations and Analysis; and Spread of Established ANS Populations. These categories are also used by the International Joint Commission (IJC) and the National Sea Grant Program for classifying ANS research. The content of the survey form was coordinated closely with the IJC's Council of Great Lakes Research Managers to ensure compatibility with the IJC's larger research inventory effort.

The survey form was targeted at researchers, administrators and managers involved in, conducting or

sponsoring basic or applied ANS research. Information on recently completed (within the last three years), ongoing and upcoming research projects was requested.

ii) Distribution

All research relevant to the Great Lakes Basin was included in the inventory irrespective of where the research was conducted. The following methods were used to distribute the survey form:

Electronic distribution

A survey form and instruction sheet were placed on the Internet via the Great Lakes Information Network (GLIN).
Global e-mail messages promoting the online survey form were posted via GLIN-Announce and the Canadian Coastal Science and Engineering Association.

Conferences

The survey form was included in registration packets for the *Sixth Annual International Zebra Mussel and other Aquatic Nuisance Species Conference* held in March 1996.
The survey form was distributed at the Goby Conference held in Chicago in February 1996.

Mailing Lists

The survey form and accompanying correspondence were mailed in January 1996 to research contacts provided by the Research Coordination Committee, the IJC, the International Association for Great Lakes Research and attendees of the *Fifth Annual International Zebra Mussel Conference.*

iii) Survey Responses

All survey results were entered via the online survey form and downloaded into a database using Microsoft Excel software.

INVENTORY RESULTS

i) Tabulation Process

Two hundred seventy-one research projects were received from 18 states and four countries (United States, Canada, Netherlands, England). Several duplicate and non-research projects were received bringing the total number of relevant projects to 250. Of these, 140 are ongoing and 86 have been completed (24 respondents did not provide the start and end dates).

Respondents were asked to report expenditures on a total-cost basis over the life of the project. Total costs were calculated for those projects that provided a yearly cost and project start and end dates. If an end date was not provided the project cost was not included in the summary totals. For the Summary Tables 1-9, Canadian expenditures were converted to U.S. dollars at a rate of 0.715 (April 2, 1996, bank rate). Respondents were asked to check only one research classification box. If more than one was entered, the first entry was recorded.

Several incomplete survey forms were received. The most common information omitted was the start and end dates (25 projects or 10 percent), followed by the funding source (19 projects/8 percent), and total cost (12 projects/5 percent).

Several research projects addressed more than one species. In these instances, the total cost of the project was applied to the species that appeared to be the primary focus of the project.

ii) Findings

The total budget for the 250 projects is **$29,836,639** (U.S. dollars). The U.S. projects comprise 89 percent or

approximately $26.6 million of the ANS research budget. Canadian projects totaled just over $3.1 million (in U.S. dollars) or approximately 11 percent.

Forty percent of all projects fall within the Ecosystem Effects research category. Zebra mussel research accounts for 59 percent of total research expenditures. Projects in the Prevention of Introduction category account for only 4 percent of total research expenditures. Table 1 summarizes research projects by species. Table 2 summarizes projects by research category.

The average length of research projects is two to four years. The largest number of research projects were received from the years 1994 (44), 1992 (42), 1995 (35), and 1993 (29). Table 3 summarizes projects by year.

A brief overview of research on the more common ANS species (zebra mussel, round goby, ruffe, sea lamprey, purple loosestrife and Eurasian watermilfoil) is presented below. A species-specific breakdown by research category is provided in Tables 4 - 9.

Zebra Mussel (Tables 4, 4a)

The zebra mussel, a native of the Black and Caspian seas, has received the largest amount of research attention. One hundred forty-eight zebra mussel projects were identified totaling more than $17.5 million from 1972 to 1997. Of these, 64 have been completed (43 percent). The majority of the projects were initiated in 1991, 1992 and 1994.

Research on the zebra mussel has focused on Ecosystem Effects, with nearly $12 million (64 percent of total zebra mussel expenditures) being spent in this area. Biology and Life History, and Control and Mitigation have received similar expenditures of approximately $2.5 million each. Very little is being spent on Prevention of Introduction and Socio-economic Considerations.

Round Goby (Tables 5, 5a)

The Round Goby, also a native of the Black and Caspian seas, was first observed in the St. Clair River in 1990 and has recently received more attention as its range has expanded to all five Great Lakes. Eight research projects were identified, totaling $609,498 from 1993 to 1996. The bulk of the research is on Biology and Life History, with an unspecified amount of work being conducted on Ecosystem Effects.

Ruffe (Tables 6, 6a)

The ruffe, a native of Europe and western Asia, was introduced to North America via the ballast water of ocean-going ships, probably in the early 1980s. Ruffe were first found in 1988, in Duluth-Superior Harbor. Twenty research projects have been funded from 1990 to 1996. Sixty percent of the research, or approximately $1.3 million, has focused on Ecosystem Effects and 23 percent has been spent on Control and Mitigation. Limited funds have been spent on Prevention of Introduction and Spread of Established ANS Populations, approximately 3 percent combined.

Sea Lamprey (Tables 7, 7a)

The sea lamprey, a predacious, eel-like fish native to the coastal regions of both sides of the Atlantic Ocean, first entered the Great Lakes through the Welland Canal during the early part of this century and has contributed greatly to the decline of the whitefish and lake trout in the Great Lakes. Twenty-five research projects were identified, totaling $2,309,981 from 1990 to 1996. The bulk of sea lamprey research projects has been in Control and Mitigation (60 percent) and Biology and Life History (32 percent) as scientists continue to examine ways control the spread of the sea lamprey in the Great Lakes. Few project summaries were received on Spread of Established ANS Populations (4 percent) and Ecosystem Effects (4 percent).

Purple Loosestrife (Tables 8, 8a)

Purple loosestrife, a wetland plant originating in Europe, was introduced to the east coast of North America in

the 1800s. The plant's range has expanded throughout the Great Lakes, replacing valuable wetland plants. Five research projects were identified totaling $905,635 from 1992 to 1996. Of the five projects, two have been completed. The bulk of the research has focused on Ecosystem Effects and Spread of Established ANS Populations (40 percent each). The remaining research examined Control and Mitigation (20 percent).

Eurasian Watermilfoil (Tables 9, 9a)

Eurasian watermilfoil, a wetland plant originating in Europe, has spread westward into inland lakes primarily by boats and waterfowl. In shallow areas, the plant can interfere with water recreation, such as boating, fishing and swimming, and can crowd out important native water plants. Five research projects were identified, totaling $392,889 from 1991 to 1995. Research projects cover the areas of Biology and Life History (51 percent), Control and Mitigation (37 percent), and Ecosystem Effects (12 percent).

SUMMARY

The response to the survey was excellent. A considerable amount of research is underway, with much of it focused on the zebra mussel and, in particular, the research categories of Ecosystem Effects, Biology and Life History, and Control and Mitigation. With the exception of sea lamprey and zebra mussel research, most ANS research tends to be oriented toward the study of a specific species (Biology and Life History) and its interactions with the ecosystem (Ecosystem Effects), as opposed to methods for preventing ANS introductions (Prevention of Introduction) and minimizing their impacts (Control and Mitigation). Because many federal, state and private entities are working on ANS research, there is a need to periodically review current research, and to identify gaps and future needs.

To this end, the Great Lakes Panel conducted a research symposium in April 1996 titled *Aquatic Nuisance Species Research Relevant to the Great Lakes Basin: Enhancing Prevention and Control Efforts* to assess current research, examine gaps and future needs, and develop recommendations to strengthen prevention and control efforts. A product of the symposium was the Panel's policy position statement titled *Research Guidance for the Prevention and Control of Nonindigenous Aquatic Nuisances Species in the Great Lakes*. This policy position was formally adopted by the Great Lakes Panel on ANS on Dec. 4, 1996. The research guidance features four general recommendations that are directed at agencies and institutions that conduct, manage, fund or apply ANS research. The guidance also contains 34 additional recommendations directed toward research gaps and needs in the areas of biology and life history; control and mitigation; ecosystem effects; prevention of introductions; socio-economic considerations and analysis; spread of ANS populations; and strengthening the research infrastructure. The full text of the policy position is provided in Section IV of this report.

Current plans call for the continued development and expansion of this ANS research inventory, enhancing its application to prevention and control efforts, and fostering access to the information it contains.

Table 1: Summary of Research Projects by Species

Number of Research Projects				Species	Total Expenditure		
U.S.	CAN	NETH	Total		U.S.	CAN ($US 0.715)	Total
125	21	2	148	Zebra mussel	$17,162,540	$404,690	$17,567,230
7	1		8	Round Goby	$597,343	$12,155	$609,498
20			20	Ruffe	$2,057,711		$2,057,711
21	4		25	Sea lamprey	$1,816,690	$493,291	$2,309,981
4	1		5	Purple loosestrife	$842,000	$63,635	$905,635
5			5	Eurasian watermilfoil	$189,500		$189,500
1			1	Flowering rush	$5,000		$5,000
	2		2	Carp		$1,787,500	$1,787,500
1			1	Alewife	$103,783		$103,783
2			2	Smelt	$35,000		$35,000
1			1	Crayfish	$1,000		$1,000
	2		2	Spiny waterflea		$28,600	$28,600
2	2		4	Quagga mussel	$107,794	$7,844	$115,638
1			1	*Daphnia lumholzi*	NS		NS
1			1	Red shiner	$343,154		$343,154
1			1	*Corbicula*	$1,523		$1,523
192	33	2	227	GRAND TOTAL:	$23,263,038	$2,797,715	$26,060,753*

NS = Not Specified

*This figure is less than the figure for total ANS research funding because it does not include projects classified as “Aquatic Nuisance Species General.”

Table 2: Summary of Research Projects by Research Category

Number of Research Projects					Research Category	Total Expenditure				
U.S.	CAN	UK	NETH	Total		U.S.	CAN ($US 0.715)	UK	NETH	Total
51	10		2	63	1.0 Biology and Life History	$4,494,495	$578,140		NS	$5,072,635
47	2			49	2.0 Control and Mitigation	$4,650,170	$71,500			$4,721,670
80	19		1	100	3.0 Ecosystem Effects	$13,712,336	$2,219,217		NS	$15,728,053
7	1	1		9	4.0 Prevention of Introduction	$1,324,784	$128,700	$90,000		$1,543,484
4	2			6	5.0 Socio-economic Considerations and Analysis	$392,551	$14,300			$406,851
18	5			23	6.0 Spread of Established ANS Populations	$2,018,518	$141,928			$2,160,446
207	39	1	3	250	GRAND TOTAL:	$26,592,854	$3,153,785	$90,000	NS	$29,836,639

NS = Not Specified

Table 3: Research Expenditure by Year

Number of Research Projects					Year	Total Expenditure				
US	CAN	UK	NETH	Total		U.S.	CAN ($US 0.715)	UK	NETH	Total
	1			1	1972		$10,725			$10,725
1				1	1983	$30,000				$30,000
1				1	1986	NS				NS
	2			2	1988		$46,475			$46,475
9	5			14	1990	$1,162,294	$1,982,695			$3,144,989
23	2			25	1991	$5,947,349	$39,325			$5,986,674
39	3			42	1992	$6,262,244	$95,453			$6,357,697
26	3			29	1993	$3,168,992	$13,442			$3,182,434
34	9	1		44	1994	$2,679,580	$334,384	$90,000		$3,103,964
30	5			35	1995	$4,275,388	$272,943			$4,548,331
24	3			27	1996	$2,887,007	$348,333			$3,235,340
1				1	1997	$30,000				$30,000
17	5		3	25	XXX	NS	$10,010		NS	$10,010
2	1			3	other	$150,000	NS			$150,000
207	39	1	3	250	Grand Total:	$26,592,854	$3,153,785	$90,000	NS	$29,836,639

NS = Not Specified

Table 4: Zebra Mussel Research Relevant to the Great Lakes Basin (1972-1997)

Number of Research Projects				Project Classification	Total Expenditure			
U.S.	CAN	NETH	Total		U.S.	CAN ($US 0.715)	NETH	Total
				Biology and Life History				
5		2	7	1.1 Life History	$620,000		NS	$620,000
9	4		13	1.2 Population Dynamics	$525,000	$96,525		$621,525
5			5	1.3 Environmental Requirements/Tolerance	$116,377			$116,377
				1.4 Parasites and Diseases				
3			3	1.5 Genetics	$510,704			$510,704
				1.6 Biomanipulation				
6			6	1.7 Physiology and Behavior	$829,392			$829,392
28	4	2	34	Subtotal for 1.0:	$2,601,473	$96,525		$2,697,998
				Control and Mitigation				
2			2	2.1 Habitat Manipulation	$70,000			$70,000
2			2	2.2 Biological Interactions-Predator/Prey, Parasite/Disease	$330,000			$330,000
6	1		7	2.3 Physical Measures	$439,651	$71,500		$511,151
4			4	2.4 Chemical Measures	$489,584			$489,584
1			1	2.5 Consequences of Control	$203,389			$203,389
5			5	2.6 Integrated Control Strategy	$873,720			$873,720
20	1		21	Subtotal for 2.0:	$2,406,344	$71,500		$2,477,844
				Ecosystem Effects				
20	3		23	3.1 Community Structure	$5,341,745	$24,310		$5,366,055
10	3		13	3.2 Habitat (physical/chemical)	$449,652	$95,095		$544,747
21	4		25	3.3 Nutrient/Contaminant Cycles	$3,572,158	$78,650		$3,650,808
8	2		10	3.4 Food Web Structure	$491,663	$22,165		$513,828
4	1		5	3.5 Predator/Prey Interactions	$1,231,000	$9,653		$1,240,653
63	13		76	Subtotal for 3.0:	$11,086,218	$229,873		$11,316,091
				Prevention of Introduction				
1			1	4.1 Identification of Potential Invaders	$3,000			$3,000
				4.2 Definition of Vectors of Introduction (Shipping, Bait, Aquaria, Canals, Biological Vectors)				
1			1	4.3 Determination of Preventive Measures	NS			NS
1			1	4.4 Establishment of International Protocols	$108,184			$108,184
3			3	Subtotal for 4.0:	$111,184			$111,184
				Socio-economic Considerations and Analysis				
1			1	5.1 Human Health Aspects	$15,000			$15,000
1			1	5.2 Recreation/Tourism Impacts	$133,292			$133,292
				5.3 Shipping and Navigation				
	1		1	5.4 Water Use-Agricultural, Industrial, Municipal		$3,575		$3,757
				5.5 Policy and Law Determinants				
1			1	5.6 Resource Management Issues	$17,039			$17,039
3	1		4	Subtotal for 5.0:	$165,331	$3,575		$168,906
				Spread of Established ANS Populations				
				6.1 Improvement of Initial Detection				
	1		1	6.2 Mechanisms of Spread		NS		NS
2			2	6.3 Rate of Spread	$208,508			$208,508
	1		1	6.4 Range of Spread		$3,217		$3,217
				6.5 Natural Barriers				
6			6	6.6 Predictive Models	$583,482			$583,482
8	2		10	Subtotal for 6.0:	$791,990	$3,217		$795,207
125	21	2	148	GRAND TOTAL:	$17,162,540	$404,690	NS	$17,567,230

NS = Not Specified

Table 4a: Zebra Mussel Research Expenditure by Year

Number of Research Projects				Year	Total Expenditure			
U.S.	CAN	NETH	Total		U.S.	CAN ($US 0.715)	NETH	Total
	1		1	1972		$10,725		$10,725
1			1	1983	$30,000			$30,000
1			1	1986				
	2		2	1988		$46,475		$46,475
5	3		8	1990	$435,500	$66,495		$501,995
19	1		20	1991	$5,569,330	$14,300		$5,583,630
32	3		35	1992	$5,443,353	$95,453		$5,538,806
11	2		13	1993	$1,009,741	$6,793		$1,016,534
21	3		24	1994	$2,127,066	$125,840		$2,252,906
14	1		15	1995	$1,704,033	$28,600		$1,732,633
9			9	1996	$663,517			$663,517
1			1	1997	$30,000			$30,000
10	5	2	17	NS		$10,010	NS	$10,010
1			1	other	$150,000			$150,000
125	21	2	148	GRAND TOTAL:	$17,162,540	$404,690	NS	$17,567,230

NS = Not Specified

Table 5: Round Goby Research Relevant to the Great Lakes (1993-1996)

Number of Research Projects			Project Classification	Total Expenditure		
U.S.	CAN	Total		U.S.	CAN ($US 0.715)	Total
			Biology and Life History			
2	1	3	1.1 Life History	$265,000	$12,155	$277,155
3		3	1.2 Population Dynamics	$332,343		$332,343
			1.3 Environmental Requirements/Tolerance			
1		1	1.4 Parasites and Diseases	NS		NS
			1.5 Genetics			
			1.6 Biomanipulation			
			1.7 Physiology and Behavior			
6	1	7	Subtotal for 1.0:	$597,343	$12,155	$609,498
			Control and Mitigation			
			2.1 Habitat Manipulation			
			2.2 Biological Interactions-Predator/Prey, Parasite/Disease			
			2.3 Physical Measures			
			2.4 Chemical Measures			
			2.5 Consequences of Control			
			2.6 Integrated Control Strategy			
			Subtotal for 2.0:			
			Ecosystem Effects			
1		1	3.1 Community Structure	NS		NS
			3.2 Habitat (physical/chemical)			
			3.3 Nutrient/Contaminant Cycles			
			3.4 Food Web Structure			
			3.5 Predator/Prey Interactions			
1		1	Subtotal for 3.0:	NS		NS
			Prevention of Introduction			
			4.1 Identification of Potential Invaders			
			4.2 Definition of Vectors of Introduction (Shipping, Bait, Aquaria, Canals, Biological Vectors)			
			4.3 Determination of Preventive Measures			
			4.4 Establishment of International Protocols			
			Subtotal for 4.0:			
			Socio-economic Considerations and Analysis			
			5.1 Human Health Aspects			
			5.2 Recreation/Tourism Impacts			
			5.3 Shipping and Navigation			
			5.4 Water Use-Agricultural, Industrial, Municipal			
			5.5 Policy and Law Determinants			
			5.6 Resource Management Issues			
			Subtotal for 5.0:			
			Spread of Established ANS Populations			
			6.1 Improvement of Initial Detection			
			6.2 Mechanisms of Spread			
			6.3 Rate of Spread			
			6.4 Range of Spread			
			6.5 Natural Barriers			
			6.6 Predictive Models			
			Subtotal for 6.0:			
7	1	8	GRAND TOTAL:	$597,343		$609,498

NS = Not Specified

Table 5a: Round Goby Research Expenditure by Year

Number of Research Projects			Year	Total Expenditure		
U.S.	CAN	Total		U.S.	CAN ($US 0.715)	Total
			1972			
			1983			
			1986			
			1988			
			1990			
			1991			
			1992			
2		2	1993	$143,000		$143,000
1	1	2	1994	NS	$12,155	$12,155
2		2	1995	$189,343		$189,343
1		1	1996	$265,000		$265,000
			1997			
1		1	NS			
7	1	8	**GRAND TOTAL:**	$597,343	$12,155	$609,498

NS = Not Specified

Table 6: Ruffe Research Relevant to the Great Lakes (1990-1996)

Number of Research Projects			Project Classification	Total Expenditure		
U.S.	CAN	Total		U.S.	CAN ($US 0.715)	Total
			Biology and Life History			
3		3	1.1 Life History	$247,150		$247,150
2		2	1.2 Population Dynamics	$30,000		$30,000
			1.3 Environmental Requirements/Tolerance			
			1.4 Parasites and Diseases	NS		NS
			1.5 Genetics			
			1.6 Biomanipulation			
			1.7 Physiology and Behavior			
5		5	**Subtotal for 1.0:**	$277,150		$277,150
			Control and Mitigation			
			2.1 Habitat Manipulation			
2		2	2.2 Biological Interactions-Predator/Prey, Parasite/Disease	$100,000		$100,000
			2.3 Physical Measures			
3		3	2.4 Chemical Measures	$383,138		$383,138
			2.5 Consequences of Control			
			2.6 Integrated Control Strategy			
5		5	**Subtotal for 2.0:**	$483,138		$483,138
			Ecosystem Effects			
3		3	3.1 Community Structure	$1,144,212		$1,144,212
			3.2 Habitat (physical/chemical)			
			3.3 Nutrient/Contaminant Cycles			
1		1	3.4 Food Web Structure	$7,827		$7,827
2		2	3.5 Predator/Prey Interactions	$87,784		$87,784
6		6	**Subtotal for 3.0:**	$1,289,823		$1,289,823
			Prevention of Introduction			
			4.1 Identification of Potential Invaders			
1		1	4.2 Definition of Vectors of Introduction (Shipping, Bait, Aquaria, Canals, Biological Vectors)	$13,600		$13,600
1		1	4.3 Determination of Preventive Measures	NS		NS
			4.4 Establishment of International Protocols			
2		2	**Subtotal for 4.0:**	$13,600		$13,600
			Socio-economic Considerations and Analysis			
			5.1 Human Health Aspects			
			5.2 Recreation/Tourism Impacts			
			5.3 Shipping and Navigation			
			5.4 Water Use-Agricultural, Industrial, Municipal			
			5.5 Policy and Law Determinants			
			5.6 Resource Management Issues			
			Subtotal for 5.0:			
			Spread of Established ANS Populations			
			6.1 Improvement of Initial Detection			
			6.2 Mechanisms of Spread			
			6.3 Rate of Spread			
2		2	6.4 Range of Spread	$44,000		$44,000
			6.5 Natural Barriers			
			6.6 Predictive Models			
2		2	**Subtotal for 6.0:**	$44,000		$44,000
20		20	**GRAND TOTAL:**	$2,057,711		$2,057,711

NS = Not Specified

Table 6a: Ruffe Research Expenditure by Year

Number of Research Projects			Year	Total Expenditure		
U.S.	CAN	Total		U.S.	CAN ($US 0.715)	Total
			1972			
			1983			
			1986			
			1988			
1		1	1990	$66,294		$66,294
			1991			
3		3	1992	$170,000		$170,000
1		1	1993	$13,600		$13,600
4		4	1994	$129,317		$129,317
8		8	1995	$1,673,500		$1,673,500
1		1	1996	$5,000		$5,000
			1997			
2		2	NS			
20		20	Grand Total:	$2,057,711		$2,057,711

NS = Not specified

Table 7: Sea Lamprey Research Relevant to the Great Lakes (1990-1996)

Number of Research Projects			Project Classification	Total Expenditure		
U.S.	CAN	Total		U.S.	CAN ($US 0.715)	Total
			Biology and Life History			
	2	2	1.1 Life History		$244,373	$244,373
1		1	1.2 Population Dynamics	$60,000		$60,000
	1	1	1.3 Environmental Requirements/Tolerance		$223,893	$223,893
			1.4 Parasites and Diseases			
			1.5 Genetics			
			1.6 Biomanipulation			
4		4	1.7 Physiology and Behavior	$300,991		$300,991
5	3	8	Subtotal for 1.0:	$360,991	$468,266	$829,257
			Control and Mitigation			
			2.1 Habitat Manipulation			
5		5	2.2 Biological Interactions-Predator/Prey,	$336,500		$336,500
			Parasite/Disease	$44,100		$44,100
1		1	2.3 Physical Measures	$690,199		$690,199
8		8	2.4 Chemical Measures	$300,000		$300,000
1		1	2.5 Consequences of Control			
			2.6 Integrated Control Strategy			
15		15	Subtotal for 2.0:	$1,370,799		$1,370,799
			Ecosystem Effects			
			3.1 Community Structure			
			3.2 Habitat (physical/chemical)			
			3.3 Nutrient/Contaminant Cycles			
	1	1	3.4 Food Web Structure		$25,025	$25,025
			3.5 Predator/Prey Interactions			
	1	1	Subtotal for 3.0:		$25,025	$25,025
			Prevention of Introduction			
			4.1 Identification of Potential Invaders			
			4.2 Definition of Vectors of Introduction			
			(Shipping, Bait, Aquaria, Canals,			
			Biological Vectors)			
			4.3 Determination of Preventive Measures			
			4.4 Establishment of International Protocols			
			Subtotal for 4.0:			
			Socio-economic Considerations and Analysis			
			5.1 Human Health Aspects			
			5.2 Recreation/Tourism Impacts			
			5.3 Shipping and Navigation			
			5.4 Water Use-Agricultural, Industrial,			
			Municipal			
			5.5 Policy and Law Determinants			
			5.6 Resource Management Issues			
			Subtotal for 5.0:			
			Spread of Established ANS Populations			
			6.1 Improvement of Initial Detection			
			6.2 Mechanisms of Spread			
			6.3 Rate of Spread			
1		1	6.4 Range of Spread	$84,900		$84,900
			6.5 Natural Barriers			
			6.6 Predictive Models			
1		1	Subtotal for 6.0:	$84,900		$84,900
21	4	25	GRAND TOTAL:	$1,816,690	$493,291	$2,309,981

Table 7a: Sea Lamprey Research Expenditure by Year

Number of Research Projects			Year	Total Expenditure		
U.S.	CAN	Total		U.S.	CAN ($US 0.715)	Total
			1972			
			1983			
			1986			
			1988			
3		3	1990	$660,500		$660,500
2	1	3	1991	$93,130	$25,025	$118,155
			1992			
2		2	1993	$144,900		$144,900
3		3	1994	$335,674		$335,674
1	1	2	1995	$81,000	$183,568	$264,568
9	2	11	1996	$501,486	$284,698	$786,184
			1997			
1		1	NS	NS		NS
21	4	25	Grand Total:	$1,816,690	$493,291	$2,309,981

NS = Not Specified

Table 8: Purple Loosestrife Research Relevant to the Great Lakes (1992-1996)

Number of Research Projects			Project Classification	Total Expenditure		
U.S.	CAN	Total		U.S.	CAN ($US 0.715)	Total
			Biology and Life History 1.1 Life History 1.2 Population Dynamics 1.3 Environmental Requirements/Tolerance 1.4 Parasites and Diseases 1.5 Genetics 1.6 Biomanipulation 1.7 Physiology and Behavior			
			Subtotal for 1.0:			
1		1	**Control and Mitigation** 2.1 Habitat Manipulation 2.2 Biological Interactions-Predator/Prey, Parasite/Disease 2.3 Physical Measures 2.4 Chemical Measures 2.5 Consequences of Control 2.6 Integrated Control Strategy	$150,000		$150,000
1		1	Subtotal for 2.0:	$150,000		$150,000
1		1	**Ecosystem Effects** 3.1 Community Structure	$627,000		$627,000
1		1	3.2 Habitat (physical/chemical) 3.3 Nutrient/Contaminant Cycles 3.4 Food Web Structure 3.5 Predator/Prey Interactions	$50,000		$50,000
2		2	Subtotal for 3.0:	$677,000		$677,000
			Prevention of Introduction 4.1 Identification of Potential Invaders 4.2 Definition of Vectors of Introduction (Shipping, Bait, Aquaria, Canals, Biological Vectors) 4.3 Determination of Preventive Measures 4.4 Establishment of International Protocols			
			Subtotal for 4.0:			
			Socio-economic Considerations and Analysis 5.1 Human Health Aspects 5.2 Recreation/Tourism Impacts 5.3 Shipping and Navigation 5.4 Water Use-Agricultural, Industrial, Municipal 5.5 Policy and Law Determinants 5.6 Resource Management Issues			
			Subtotal for 5.0:			
1		1	**Spread of Established ANS Populations** 6.1 Improvement of Initial Detection	$15,000		$15,000
	1	1	6.2 Mechanisms of Spread 6.3 Rate of Spread 6.4 Range of Spread 6.5 Natural Barriers 6.6 Predictive Models		$63,635	$63,635
1	1	2	Subtotal for 6.0:	$15,000	$63,635	$78,635
4	1	5	GRAND TOTAL:	$842,000	$63,635	$905,635

Table 8a: Purple Loosestrife Research Expenditure by Year

Number of Research Projects			Year	Total Expenditure		
U.S.	CAN	Total		U.S.	CAN ($US 0.715)	Total
			1972			
			1983			
			1986			
			1988			
			1990			
			1991			
1		1	1992	$50,000		$50,000
3		3	1993	$792,000		$792,000
			1994			
			1995			
	1	1	1996		$63,635	$63,635
			1997			
4	1	5	Grand Total:	$842,000	$63,635	$905,635

Table 9: Eurasian Watermilfoil Research Relevant to the Great Lakes (1991-1996)

Number of Research Projects			Project Classification	Total Expenditure		
U.S.	CAN	Total		U.S.	CAN ($US 0.715)	Total
1		1	**Biology and Life History** 1.1 Life History 1.2 Population Dynamics 1.3 Environmental Requirements/Tolerance 1.4 Parasites and Diseases 1.5 Genetics 1.6 Biomanipulation 1.7 Physiology and Behavior	$200,000		$200,000
1		1	Subtotal for 1.0:	$200,000		$200,000
1		1	**Control and Mitigation** 2.1 Habitat Manipulation 2.2 Biological Interactions-Predator/Prey, Parasite/Disease 2.3 Physical Measures 2.4 Chemical Measures	$84,889		$84,889
1		1	2.5 Consequences of Control 2.6 Integrated Control Strategy	$60,000		$60,000
2		2	Subtotal for 2.0:	$144,889		$144,889
2		2	**Ecosystem Effects** 3.1 Community Structure 3.2 Habitat (physical/chemical) 3.3 Nutrient/Contaminant Cycles 3.4 Food Web Structure 3.5 Predator/Prey Interactions	$48,000		$48,000
2		2	Subtotal for 3.0:	$48,000		$48,000
			Prevention of Introduction 4.1 Identification of Potential Invaders 4.2 Definition of Vectors of Introduction (Shipping, Bait, Aquaria, Canals, Biological Vectors) 4.3 Determination of Preventive Measures 4.4 Establishment of International Protocols			
			Subtotal for 4.0:			
			Socio-economic Considerations and Analysis 5.1 Human Health Aspects 5.2 Recreation/Tourism Impacts 5.3 Shipping and Navigation 5.4 Water Use-Agricultural, Industrial, Municipal 5.5 Policy and Law Determinants 5.6 Resource Management Issues			
			Subtotal for 5.0:			
			Spread of Established ANS Populations 6.1 Improvement of Initial Detection 6.2 Mechanisms of Spread 6.3 Rate of Spread 6.4 Range of Spread 6.5 Natural Barriers 6.6 Predictive Models			
			Subtotal for 6.0:			
5		5	GRAND TOTAL:	$392,889		$392,889

Table 9a: Eurasian Watermilfoil Research Expenditure by Year

Number of Research Projects			Year	Total Expenditure		
U.S.	CAN	Total		U.S.	CAN ($US 0.715)	Total
			1972			
			1983			
			1986			
			1988			
			1990			
1		1	1991	$84,889		$84,889
			1992			
3		3	1993	$248,000		$248,000
			1994			
1		1	1995	$60,000		$60,000
			1996			
			1997			
5		5	Grand Total:	$392,889		$392,889

IV. Research Guidance for the Prevention and Control of Nonindigenous Aquatic Nuisance Species in the Great Lakes

A Policy Position of the Great Lakes Panel on Aquatic Nuisance Species*

Background

In late 1990, Congress passed the Nonindigenous Aquatic Nuisance Prevention and Control Act (P.L. 101-646) for the purpose of preventing unintentional introductions; coordinating research, control and information dissemination; developing and carrying out environmentally sound control methods; minimizing economic and ecological impacts; and establishing a research and technology program to benefit state governments. The Act specifically recognized the Great Lakes as a valuable resource and, in Section 1203, called upon the Great Lakes Commission, an interstate compact agency, to convene a Great Lakes Panel on Aquatic Nuisance Species to assist a national Aquatic Nuisance Species (ANS) Task Force in Great Lakes-related prevention and control efforts.

The Great Lakes Panel is comprised of 35 individuals drawn from U.S. and Canadian federal agencies; the eight Great Lakes states and province of Ontario, regional agencies; concerned citizen groups, municipal representatives, tribal authorities, commercial interests, and the university/research community. The Panel is responsible for identifying Great Lakes priorities, making recommendations to the ANS Task Force, assisting the Task Force in coordinating federal programs, coordinating nonfederal programs in the region, advising on control efforts, and reporting on prevention, research and control activities in the Great Lakes region.

In September 1995, the Great Lakes Panel identified the need for a comprehensive research inventory to assess current and recently completed ANS research relevant to the Great Lakes region, identify research gaps and needs, highlight key findings and, in general, promote technology transfer to benefit the Great Lakes ecosystem.

Acting on this need, the Panel developed and broadly distributed an ANS research survey to relevant individuals throughout the binational Great Lakes region and beyond. Results of the survey were used as background material for an ANS research symposium titled *Aquatic Nuisance Species Research Relevant to the Great Lakes Region: Enhancing Prevention and Control Efforts* held April 17, 1996, in Ann Arbor, Mich. The following policy position, adopted by the Panel membership, summarizes the findings of the research symposium.

POLICY POSITION

The Research Symposium was attended by more than 30 carefully selected U.S. and Canadian research scientists, managers, policymakers and resource users. Drawing upon an analysis of a descriptive research inventory (consisting of more than 250 entries from 18 states and five countries) along with the participants' collective expertise on ANS prevention and control, ANS research gaps and needs were identified as well as recommendations on ways to strengthen the current research infrastructure to improve linkages between research, policymakers and the management community.

The following recommendations have been reviewed and approved by the Great Lakes Panel to be used as general guidance for the Panel membership, the national ANS Task Force, and other public and private sector entities that fund, conduct, manage or apply ANS research. These recommendations will be broadly disseminated among the research, management and policy communities to guide future ANS research efforts.

**Adopted by the Great Lakes Panel at its Dec. 4, 1996, meeting.*

General Recommendations

Several recurring themes of a general nature emerged at the research symposium and are reflected in the following recommendations.

i) Enhance research on prevention efforts to provide a better balance with research on established species (proactive versus reactive). Findings from the 1995 research inventory indicated that 40 percent of all projects received examined the ecosystem effects of species already present, while only 4 percent of the total expenditure was on prevention of introductions.

ii) Make the public aware of the potential impacts of aquatic nuisance species and thereby gain their support for prevention and control efforts. Research has shown that ecosystem changes caused by the invasion of nonindigenous species (a form of biological pollution) can be more rapid, and in some cases more significant, than changes caused by nutrient and toxic loading. Therefore, there is a need to avoid making the assumption, both in the public and private sector, that a species is "innocent until proven guilty" before action is taken.

iii) Secure and maintain base funding for broad, multidisciplinary nonindigenous aquatic nuisance species research that is flexible and provides contingencies for shifting research emphases on short notice (in the event of a new invasion). Research priorities, for example, should reflect the recommendations of the national ANS Task Force and/or the Great Lakes Panel on Aquatic Nuisance Species and other relevant organizations.

iv) Encourage the transfer of information generated through research in a timely manner, so that management and control measures are conducted on the basis of the most recent scientific information. Ideally, managers and researchers should interact at all stages in planning of research, management and control projects.

ANS Research Gaps and Needs

Recommendations on ANS research gaps and needs have been classified by six research categories adopted by the Great Lakes Panel on Aquatic Nuisance Species, as well as the national ANS Task Force.

Biology and Life History

Findings: Research on population dynamics, environmental requirements and tolerances, parasites and diseases, genetics, biomanipulation, physiology and behavior all need to be examined in order to develop effective control measures and predict the potential range of spread. In many cases this information exists in the species' native country and therefore a timely literature review may provide the information necessary for managers to react quickly in implementing prevention and control measures. Research inventory results revealed that 17 percent of ANS funds have been spent on biology and life history, in particular the biology and life history of the zebra mussel (55 percent).

Recommendations:

Perform a timely literature review and translation of information on all newly introduced species to eliminate duplication of research.
Determine and prepare potential range maps for all new introduced species in a region.
Prepare risk assessments to determine impacts on native species.
Study genetic characterization of invaders and source populations.

Control and Mitigation

Findings: Once a species has invaded the Great Lakes it is essential that an effective control strategy or management plan is in place to contain the species and prevent further spread. The strategy or plan may include physical (filters), chemical (biocides), biological (parasites, predators) or physiochemical (pH, heat, salinity) control measures working singularly or in combination; a description of the consequences of the control measures taken; and an effective public information/education program to alleviate public concern and increase public cooperation. Sixteen percent of ANS research expenditures have been spent on control and mitigation, particularly on the zebra mussel and the sea lamprey.

Recommendations:

Increase education and research activities for alternate control options and eradication of aquatic nuisance species.

Develop a model plan for eradication of a nonindigenous aquatic nuisance species that outlines the necessary procedures to be undertaken in the event of a new invasion.

Improve documentation and transfer of private sector research.

Enhance bioengineering of species-specific pathogens.

Develop and examine containment options for species already present.

Explore the technical feasibility of integrated pest management (IPM). IPM integrates various control measures and examines the economic benefits versus costs in determining whether control is beneficial.

Ecosystem Effects

Findings: Introduction of a new species into an ecosystem may disrupt the balance of that ecosystem by altering existing predator-prey relationships, food web structure, community structure, nutrient and contaminant cycles and existing habitat. These changes may ultimately lead to the demise of a native species. By researching the effects of an invading species (at its various life stages) on the ecosystem, researchers can develop models to assist management in making decisions on the mitigation of impacts and the control of established nonindigenous aquatic nuisance species. The majority of ANS funds (53 percent) have been spent on trying to understand the ecosystem effects caused by the invasion of the zebra mussel to the Great Lakes.

Recommendations:

Enhance/maintain monitoring programs to establish pre-invasion data on native species and to provide a better understanding of the community structure in the Great Lakes region. This will allow for more informed decisionmaking on potential control options in the event of an invasion of a nonindigenous aquatic nuisance species.

Determine the ecosystem response (environmental and social) to the control/containment of nonindigenous aquatic nuisance species.

Develop the theory of ecosystem resilience toward the establishment and dominance of nonindigenous aquatic nuisance species.

Develop more reliable ecosystem models to assist management in making decisions on mitigation of impacts or on the control of established nonindigenous aquatic nuisance species, if control is possible.

Prevention of Introductions

Findings: The most effective defense against nonindigenous aquatic nuisance species is the defense against their initial introduction. Preventive research, however, tends to be the weakest link in implementing a nonindigenous aquatic nuisance species program. Limited dollars are directed toward researching those high-profile species (such as the zebra mussel) that are already present, as opposed to research on the next likely invaders, pathways of introduction, existing laws and regulations and international protocols. Only 5 percent of ANS research expenditures have been dedicated to prevention of introduction of nonindigenous aquatic nuisance species.

Recommendations:

Identify, understand and perform risk assessments of pathways, next likely invaders (including pathogens), and likely sources of origin for new invasions.

Identify maritime transportation routes that have demonstrated or have the potential capability to advance the spread of aquatic nuisance species. Develop and evaluate prevention and control options, including exploring ballast water management technologies.

Examine current legislation regulating the importation of nonindigenous aquatic nuisance species to ensure proper prevention and control measures are in place (e.g., aquarium and pet trade industry, aquaculture)

Socioeconomic Considerations and Analysis

Findings: The potential social and economic effects caused by the invasion of nonindigenous aquatic nuisance species can be enormous. Invading organisms may introduce disease, concentrate pollutants, contaminate drinking water, and negatively impact recreation/tourism, shipping and navigation, and municipal and agricultural water users. These types of impacts must be quantified in order to assist resource managers in prioritizing research, and developing policy and law. Results from socioeconomic research are useful in raising public awareness of the severity of the nonindigenous aquatic nuisance species problem and for gaining public support for future prevention efforts. Once the public is aware of the potential hardship they may incur, they will be more apt to support and/or participate in research and prevention efforts. Findings from the research inventory indicate that minimal funding (only 1 percent) is spent on socioeconomic research.

Recommendations:

Estimate the economic costs of current and historical damage (physical, biological, industrial, recreational, ecosystem) to the Great Lakes caused by the invasion of nonindigenous aquatic nuisance species.

Estimate the costs and benefits (economic and social) of adopting new prevention and control technologies, including an examination of ways to minimize these costs to the affected industry.

Utilize the concept of biological pollution when referring to the introduction of nonindigenous aquatic nuisance species.

Spread of ANS Populations

Findings: Once an invasive species has become established in the Great Lakes, the challenge becomes preventing its spread throughout the Great Lakes system including inland lakes and rivers. Early detection of a species increases the likelihood of successful containment or potential eradication. Understanding dispersal mechanisms and tolerable habitats allows for the development of safeguards and international protocols to prevent and or slow the spread of invaders to uninfested areas.

Recommendations:

Identify, understand and perform risk assessments of potential dispersal pathways within the Great Lakes region.

Monitor and review federal, state and provincial laws and regulations to ensure that prevention and control measures address all pathways of concern (e.g., aquaculture, aquarium, pet trade) in a consistent manner from one jurisdiction to the next. Gaps and inconsistencies should be resolved accordingly.

Prepare potential range maps for species already present.

Institute programs in the U.S. and Canada for early detection and reporting with incentives for participation.

Require containment guidelines for all research projects handling aquatic nuisance species (public and private sector research).

Examine dispersal barriers, i.e., choke points to control the spread of established populations (e.g.,

Chicago River).

Strengthening the Research Infrastructure

A basic research infrastructure was established through the Nonindigenous Aquatic Nuisance Prevention and Control Act (P.L. 101-646) of 1990. The Act provides for the dissemination of research grants conducted or funded by the federal government as well as the coordination of research activities among the national ANS Task Force membership, which includes the National Oceanic and Atmospheric Administration, U.S. Fish and Wildlife Service, U.S. Coast Guard, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Department of Agriculture and ex-officio members as designated by the chairperson (i.e., state agencies, the Great Lakes Commission, tribal agencies and other governmental entities).

Below is a list of recommendations to strengthen the current research infrastructure, both in the U.S. and Canada.

Develop a national research strategy for nonindigenous aquatic nuisance species that is interjurisdictional in scope and contains three fundamental goals that operate simultaneously: prevention of new introductions; control of already introduced species; and restoration of the aquatic ecosystem as well as recognize research needs identified in state management plans for aquatic nuisance species.

Develop an overarching coordinated action plan or regional policy agreement (with short- and long-term agendas) to ensure a commitment to collective multijurisdictional action on ANS prevention and control. This may include the commitment of interjurisdictional cooperation in prevention and control; development of consistent state/provincial laws and programs; sharpened delineation between agency roles and responsibilities; establishment of a regional emergency response team; and establishment of a center for invasive species control.

Develop and institute pre-clearance regulations for the importation of aquatic shipments (fish, plants). This would ensure that cargo is inspected for nonindigenous aquatic nuisance species before it leaves its destination.

Increase interest/concern about other less highly publicized species by designating them as aquatic nuisance species or by identifying them as regional priorities for prevention and control.

Institute a national program for early detection and reporting with incentives for participation.

Develop and link ANS research databases nationally and internationally on the Internet to foster better communication among researchers.

Enhance communication on ANS issues between scientists and Sea Grant agents, as well as the general public.

Continue ANS research by reauthorizing the federal Nonindigenous Aquatic Nuisance Prevention and Control Act, via the National Invasive Species Act of 1996, and appropriating adequate funds for its implementation. Research priorities should reflect the recommendations of the national ANS Task Force and/or the Great Lakes Panel on Aquatic Nuisance Species and other relevant organizations.

IV. Descriptive Inventory for Aquatic Nuisance Species Research Relevant to the Great Lakes Basin

Zebra Mussel; for additional research projects addressing the Zebra Mussel, see listings 193, 198, 200 and 219.

1 ***Title:*** **Laboratory studies of the effects of zebra mussels (*Dreissena polymorpha*) on Lake Erie whitefish egg incubation**

Research Category: 1.1 Life History

Overview: The object of this study was to determine if incubation of lake eggs was negatively impacted by the presence of zebra mussels. Fertilized Lake Erie whitefish eggs were placed in twenty 37.5 l aquaria containing rock rubble from Lake Erie. Ten aquaria contained rubble colonized by zebra mussels and ten aquaria contained rubble after zebra mussels had been removed. A total of 150 eggs per aquarium were incubated on the rubble and another fifty were placed in screened floating chambers.

Principal Investigator(s): David Wolfert, Kenneth Muth, Michael Bur, and Charles Madejian; National Biological Service, Lake Erie Biological Station, 6100 Columbus Ave., Sandusky, OH 44870-9701

Start Date: --

End Date: --

Funder: --

Total Cost: $0 (US)

Publication/Citation: --

Geographic Area: Lake Erie

Summary Submitted by: Michael T. Bur, National Biological Service, Lake Erie Biological Station, 6100 Columbus Ave., Sandusky, OH 44870-9701, ph: 419/625-1976, fax: 419/625-7164

2 ***Title:*** **Zebra mussel research program (ZMRP) -- Information system for infestation and control**

Research Category: 1.1 Life History

Overview: The ZMRP will be generating qualitative and quantitative data for assessing potential, present, and future impacts of zebra mussel infestations and the subsequent application of appropriate control methods. There is a need for a microcomputer-based information system/expert system to assemble the collected data into a logical framework and provide an interactive planning/management tool to field personnel. The objective is to develop a microcomputer-based information system/expert system that incorporates the accumulated data collected in the ZMRP on the biology of zebra mussels, risks of infestation at facilities, control options, contaminants, and predictive simulations.

Principal Investigator(s): Michael Grodowitz, U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, GRODOWM@EX1.ARMY.MIL

Start Date: 1992

End Date: 1999

Funder: U.S. Army Corps of Engineers

Total Cost: $50,000 (US)

Publication/Citation: Zebra Mussel Technical Notes - U.S. Army Engineer Waterways Experiment Station

Geographic Area: --

Summary Submitted by: Larry Sanders, U.S.AE Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199

3 ***Title:*** **Zebra mussel research program -- settling requirements**

Research Category: 1.1 Life History

Overview: There has been considerable interest in the ZMRP on the ability of zebra mussels to settle and attach to natural (lotic and lentic substrates, native mussels) and man-made (industrial facilities, locks, dams) structures. However, there is little known concerning

		the interaction between near-bed hydrology, water column hydrology, and larval settlement and attachment. Objectives are to 1) quantify hydraulic habitat of zebra mussel populations in the field on both natural and man-made substrates; 2) determine near-bed hydraulic conditions associated with zebra mussel attachment and translocation in a lab flume; and 3) recommend intake and piping system designs that prevent or minimize fouling.
	Principal Investigator(s):	Barry S. Payne, U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, PAYNEB@EX1.ARMY.MIL
	Start Date:	1993
	End Date:	1996
	Funder:	U.S. Army Corps of Engineers
	Total Cost:	$120,000 (US)
	Publication/Citation:	Zebra Mussel Technical Notes - U.S. Army Engineer Waterways Experiment Station
	Geographic Area:	--
	Summary Submitted by:	Larry Sanders, USAE Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199
4	***Title:***	**--**
	Research Category:	1.1 Life History
	Overview:	Examine morphological differences of newly settled zebra mussels and quagga mussels. Examine size of *Prodissoconch* shell at settling in the zebra and quagga mussels at different locations and water depths in Lake Erie.
	Principal Investigator(s):	Ander Martel, Museum of Nature, Ottawa, Ontario, Trevor Claxton, Department of Zoology, Univ. of Guelph, ONT, Ronald Dermott, Great. Lakes Lab, Fisheries and Oceans Canada
	Start Date:	--
	End Date:	--
	Funder:	--
	Total Cost:	$0 (US)
	Publication/Citation:	--
	Geographic Area:	Lake Erie
	Summary Submitted by:	Ronald Dermott, Fisheries and Oceans Canada, Gt. Lakes Lab 867 Lakeshore Rd., Burlington, ONT L7R 4A6, ph: 905/336-6437, fax: e-mail: Dermott@BURFisheries and Oceans.BUR.Fisheries and Oceans.CA
5	***Title:***	**Direct observation on the trophic ecology of *Dreissena* early life stages -- The critical planktonic period**
	Research Category:	1.1 Life History
	Overview:	1) Determine nutritional requirements of *Dreissena* larvae to develop a general culture method and to understand what limits them in nature. 2) Determine vulnerability of Dreissena eggs and larvae to zooplankton predation.
	Principal Investigator(s):	Henry A. Vanderploeg, Great Lakes Environmental Research Lab, vanderploeg@glerl.noaa.gov
	Start Date:	1991
	End Date:	1995
	Funder:	--
	Total Cost:	$450,000 (US)
	Publication/Citation:	J. Great Lakes Research
	Geographic Area:	--
	Summary Submitted by:	H.. Vanderploeg, Great Lakes Environmental Research Lab/National Oceanic and Atmospheric Administration, 2205 Commonwealth Blvd., Ann Arbor, MI 48105, ph: 313/741-2235, fax: e-mail: vanderploeg@glerl.noaa.gov

6 ***Title:*** **Exotics in the River Rhine**

Research Category: 1.1 Life History

Overview: The role of invasions of exotics in functioning of the Rhine ecosystem in the Netherlands -- dominance, consequences for the food web, other impacts, etc. Examples--*Dreissena polymorpha, Potamopyrgus antipodarum, Corophium curvispirium, Dikerogammarus villosus, Orconectes limosus, Echiogammorus ischnus*, etc.

Principal Investigator(s): G. van der Velde/S. Rajagopal, Laboratory of Aquatic Ecology, Department of Ecology, University of Nymegen, Toernooiveld 1, 6525 ED Nymegen, Netherlands

Start Date: --

End Date: --

Funder: --

Total Cost: --

Publication/Citation: Contact Principal Investigator

Geographic Area: Rhine River

Summary Submitted by: G. van der Velde, Laboratory of Aquatic Ecology, Department of Ecology, University of Nymegen, Toernooiveld 1, 6525 ED Nymegen, Netherlands, ph: 31 (0) 24 3652621, fax: 31 (0) 24 3652134

7 ***Title:*** **Biofouling animals in the Netherlands**

Research Category: 1.1 Life History

Overview: Biofouling animals -- origin, tolerance, population dynamics, dispersal and mitigation. Focus until now on *Corophium currispinum, Dreissena polymorpha, Mytilopsis leucophaeta, Ficopomatus enigmaticus, Corbicula fluminalis, Corbicula fluminea, Balanus improvisus, Cordylophora cospia*.

Principal Investigator(s): G. van der Velde, M. van der Gaag, A. J. Kempers, S. Rajagopal, Laboratory of Aquatic Ecology, Department of Ecology, University of Nymegen, Toernooiveld 1, ED Nymegen, Netherlands

Start Date: --

End Date: --

Funder: --

Total Cost: --

Publication/Citation: Contact Principal Investigator

Geographic Area: Netherlands

Summary Submitted by: G. van der Velde, Laboratory of Aquatic Ecology, Department of Ecology, University of Nymegen, Toernooiveld 1, 6525 ED Nymegen, Netherlands, ph: 31 (0) 243652621, fax: 31 (0) 243652134

8 ***Title:*** **Ecology of zebra mussels in inland lakes**

Research Category: 1.2 Population Dynamics

Overview: Measure the population dynamics (larval abundance, settling rates and adult growth rates) in a series of inland lakes in northeastern Indiana and southeastern Michigan. Five study lakes have been selected representing a wide range of environmental conditions. The goal of this research is to identify the likely factors that determine rate of population increase and ultimate mussel density following mussel invasion into inland lakes.

Principal Investigator(s): David W. Garton, Indiana University Kokomo, 2300 S. Washington St., dgarton@iukfs1.iuk.indiana.edu; Ladd Johnson, Laval University, ladd.johnson@laval.ca

Start Date: Nov-94 *End Date:* Oct-97

Funder: National Sea Grant College Program

Total Cost: $132,000 (US)

Publication/Citation: --

Geographic Area: Northern Indiana/southern Michigan; Lakes Wawasee, Loon, Silver, Clark & Vineyard
Summary Submitted by: David W. Garton, Indiana University Kokomo, 2300 S. Washington St., Kokomo, IN 46904, ph: (317) 455-9244, fax: (317) 455-9528, e-mail: dgarton@iukfs1.iuk.indiana.edu

9 ***Title:*** **Seasonal variations in *Dreissena polymorpha* veliger or settling densities in selected locations**

Research Category: 1.2 Population Dynamics
Overview: Monthly and/or weekly sampling frequency to determine seasonality of zebra mussel veliger density and settling events.
Principal Investigator(s): Thomas Ferro, Harold Keppner, and David Adrian, Aqua Tech Environmental, Inc., P.O. Box 402, Clarence, NY 14031
Start Date: --
End Date: --
Funder: --
Total Cost: $0 (US)
Publication/Citation: Conference Proceedings 4th-6th Zebra Mussel Conferences
Geographic Area: Niagara River, Buffalo, NY; Lake Erie, Buffalo, NY; upper Mississippi River, Iowa; lower Mississippi River, Louisiana; Ohio River, Kentucky, Ohio; Lake Cumberland, Kentucky
Summary Submitted by: Thomas Ferro, Aqua Tech Environmental Inc., P.O. Box 402, Clarence, NY 14031, ph: 716/893-0917, fax: 716/893-6780

10 ***Title:*** **Zebra mussel study on Lake Michigan**

Research Category: 1.2 Population Dynamics
Overview: Document the areas of the Illinois shoreline of Lake Michigan which will favor zebra mussel colonization. Determine substrate preferences of zebra mussel larvae during and after settlement. Establish zebra mussel monitoring stations along the Illinois shoreline of Lake Michigan. Collect pre- and post-invasion data on native benthic and planktonic populations.
Principal Investigator(s): J. Ellen Marsden, Illinois Natural History Survey
Start Date: Jul-91
End Date: Jun-93
Funder: Illinois Department of Conservation
Total Cost: $135,000 (US)
Publication/Citation: --
Geographic Area: Illinois, Lake Michigan Shoreline
Summary Submitted by: J. Ellen Marsden, Illinois Natural History Survey, Lake Michigan Biological Station, 400 17th St., Zion, IL 60099, ph: 708/872-8677, fax: 708/872-8679, e-mail: jmarsden@uiuc.edu

11 ***Title:*** **Recruitment and distribution of zebra mussels in the St. Lawrence River system**

Research Category: 1.2 Population Dynamics
Overview: Determine the distribution of recruiting zebra mussels (0+year) along the St. Lawrence River in relation to hydrodynamic factors and larval supply. The area of interest is from Cornwall to Quebec City. Project was initiated in 1990 and is still active.
Principal Investigator(s): Dr. Yves DeLaFontaine, Centre Saint-Laurent, 105 McGill St., Montreal,Quebec,H2Y2E7
Start Date: 1990
End Date: 1994
Funder: Environment Canada
Total Cost: $40,000 (CAN)
Publication/Citation: --
Geographic Area: St. Lawrence River from Cornwall to Quebec City

Summary Submitted by: Dr. Yves DeLafontaine, Environment Canada, Centre Saint-Laurent, 105 McGill, Suite 700, Montreal, QUE H2Y 2E7, ph: 514/497-5025, fax: 514/496-7396

12 ***Title:*** **Zebra mussel research Program - Ecological factors affecting control**

Research Category: 1.2 Population Dynamics

Overview: The recent introduction and spread of zebra mussels through the inland navigation system has required government agencies, municipalities, and private organizations to develop strategies to control these pests. It is important that control strategies are environmentally sound and do not damage native biota. The effects of zebra mussel colonization on economically, recreationally, and ecologically valuable native fauna and their habitats must be quantified, and to the extent possible, minimized. The objective is to obtain quantitative data on the effects of zebra mussels and zebra mussel control methods on native biota.

Principal Investigator(s): Andrew C. Miller, U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, MILLERA3@EX1.ARMY.MIL

Start Date: 1992

End Date: 1996

Funder: U.S. Army Corps of Engineers

Total Cost: $40,000 (US)

Publication/Citation: Zebra Mussel Technical Notes - U.S. Army Engineer Waterways Experiment Station

Geographic Area: --

Summary Submitted by: Larry Sanders, USAE Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199

13 ***Title:*** **Zebra mussel research program -- biological control of zebra mussels**

Research Category: 1.2 Population Dynamics

Overview: The recent introduction of zebra mussels and subsequent expansion of their population in inland waters of the U.S. is causing manifold problems. Massive encrustations formed by the attachment of large number of individuals impact various hydraulic structures, municipal water intakes, boats, hydroelectric facilities, and other industrial facilities that utilize sources, as well as communities, of native aquatic flora and fauna. The objective is to research and develop viable biological control techniques for the management of zebra mussel populations.

Principal Investigator(s): Michael Grodowitz, U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, GRODOWM@EX1.ARMY.MIL

Start Date: 1995

End Date: 2000

Funder: U.S. Army Corps of Engineers

Total Cost: $50,000 (US)

Publication/Citation: Zebra Mussel Technical Notes - U.S. Army Engineer Waterways Experiment Station

Geographic Area: --

Summary Submitted by: Larry Sanders, USACE Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199

14 ***Title:*** **Zebra and quagga mussel population dynamics at Long Point, Lake Erie**

Research Category: 1.2 Population Dynamics

Overview: 1) Monitor distribution and abundance of zebra and quagga mussels, 2) monitor impact on submerged macrophyte and macrobenthos communities of dreissenids, 3) determine waterfowl diet, re: dreissenids.

Principal Investigator(s): Dr. Richard Knapton, Department of Zoology, Univ. of Western Ontario, London, ONT.; and Env. Res. Studies, Univ. of Waterloo, Waterloo, ONT

Start Date: 1992

End Date: open-ended

Funder: Long Point Waterfowl & Wetlands research Fund
Total Cost: $20,000 (CAN)
Publication/Citation: --
Geographic Area: Long Point, Lake Erie, Ontario
Summary Submitted by: Dr. Richard Knapton, Long Point Waterfowl & Wetlands Research Fund, c/o Long Point Bird Observatory, P.O. Box 160 Port Rowan, ONT N0E 1M0, ph: 519/586-3531, fax: 519/586-3532

15 ***Title:*** **Zebra mussel population dynamics in the Erie Canal, New York**
Research Category: 1.2 Population Dynamics
Overview: The objective is to follow the population dynamics of zebra mussels along the Erie Canal in New York state. Mussels have been sampled (1993-1996) at up to 20 sites along the Canal from Buffalo, NY, to Syracuse, NY. Along with examining shifts in the size frequency distributions, I have also monitored the advance of the quagga mussel (*Dreissena bugensis*) into sections of the Canal dominated originally by the regular zebra mussel (*D. polymorpha*).
Principal Investigator(s): Dr. Kenton M. Stewart, Department Biological Science, State University of New York, Buffalo, NY 14260
Start Date: --
End Date: --
Funder: --
Total Cost: --
Publication/Citation: --
Geographic Area: Erie Canal, Buffalo, NY
Summary Submitted by: Dr. Kenton M. Stewart, Department of Biological Sciences, State University of New York, Buffalo, NY 14260, ph: 716/645-2898, fax: 716/645-2975

16 ***Title:*** **Metabolic physiology of the zebra mussel and density changes in native mussels**
Research Category: 1.2 Population Dynamics
Overview: 1) Monitor changes in the population of native mussels in Lake St. Clair as a result of the zebra mussel invasion. 2) Determine seasonal respiration, ammonia excretion, and body composition (lipids, C, N, and dry weight).
Principal Investigator(s): Thomas F. Nalepa, nalepa@glerl.noaa.gov
Start Date: 1990
End Date: 1995
Funder: National Oceanic and Atmospheric Administration
Total Cost: $15,000 (US)
Publication/Citation: J. Great Lakes Res., Can. J. Fish. Aquat. Sci.
Geographic Area: Lake St. Clair
Summary Submitted by: H. Vanderploeg, Great Lakes Environmental Research Lab/National Oceanic and Atmospheric Administration, 2205 Commonwealth Blvd., Ann Arbor, MI 48105, ph: 741-2235, fax: e-mail: Vanderploeg@glerl.noaa.gov

17 ***Title:*** **Reproduction and recruitment of zebra mussels in the St. Lawrence River**
Research Category: 1.2 Population Dynamics
Overview: Annual recruitment of zebra mussels is monitored by the abundance of newly attached mussels on navigation buoys along the St. Lawrence River. Veliger production is also estimated at fixed station using daily sampling between June and November. Larval mortality is calculated. Relationship between mussels recruitment and water characteristics is investigated.
Principal Investigator(s): Yves DeLafontaine, Environment Canada, Centre Saint-Laurent, 105 McGill, Montreal, QC H2Y 2E7
Start Date: Apr-95
End Date: Apr-97

Funder: Environment Canada
Total Cost: $40,000 (CAN)
Publication/Citation: --
Geographic Area: St. Lawrence
Summary Submitted by: Yves DeLafontaine, Environment Canada, Environment Canada, Centre Saint-Laurent, 105 McGill, Montreal, QC H2Y 2E7, ph: 514/496-5025, fax: 514/496-7398

18 ***Title:*** **Population dynamics and ecology of zebra mussels in inland lakes**
Research Category: 1.2 Population Dynamics
Overview: Determine population dynamics of mussels in inland lakes by measuring their reproduction, growth, and settlement. Provide information of the dispersal success of zebra mussels as they invade inland lakes, and the possible role of these lakes as "stepping stones" in the geographic spread of zebra mussels across North America.
Principal Investigator(s): David W. Carton, Indiana University at Kokomo, Indiana; Ladd E. Johnson, Universite Laval, Quebec
Start Date: Sep-94
End Date: Aug-97
Funder: Illinois-Indiana Sea Grant Program
Total Cost: $132,000 (US)
Publication/Citation: --
Geographic Area: Indiana
Summary Submitted by: Great Lakes Commission, 400 Forth Street, Ann Arbor, MI, ph: 313-665-9135, fax: 313-665-4370, e-mail: glc@great-lakes.net

19 ***Title:*** ***Dreissena polymorpha*** **pull -- post veligers in submersed beds of Put-in-Bay, Ohio as related to rate and density of settlement, Macrophyte preferences, water depths and position within beds**
Research Category: 1.2 Population Dynamics
Overview: Determination of *Dreissena* post settlement on submersed macrophytes in Put-in-Bay Harbor and Bass Island area. Will continue work spring-fall 1996 via SCUBA sampling to determine fate of pre-seasonal macrophyte beds as related to dreissean overwintering, mortality.
Principal Investigator(s): Dr. David L. Moore, Department of Biology, Utica College of Syracuse University, 1600 Burrstone Rd., Utica, NY 13502-4892
Start Date: Jul-94
End Date: Dec-94
Funder: --
Total Cost: $21,000 (US)
Publication/Citation: Proceedings of 5th International Zebra Mussel and Other Aquatic Nuisance Organisms Conf. 1995
Geographic Area: Put-in-Bay, Ohio
Summary Submitted by: Dr. David L. Moore, Utica College of Syracuse University, Department of Biology, Utica, NY 135, ph: 315/792-3137, fax: 315/792-3292

20 ***Title:*** **Population dynamics and potential impacts of dreissenid mussels in Lake Erie**
Research Category: 1.2 Population Dynamics
Overview: To measure the population trends of zebra and quagga mussels in Lake Erie through abundance of pelagic larvae and adults and settling and growth rates of juvenile and adult mussels. To measure possible impacts on water transparency, phytoplankton and zooplankton with weekly sampling at four fixed sites in each of the western basin and west central basin of Lake Erie from April through November.
Principal Investigator(s): Stephen Nepszy, Ontario Ministry of Natural Resources, Lake Erie Fisheries Station, RR#2, Wheatley, ONT N0P 2P0, nepszyst@epo.gov.on.ca
Start Date: 1988

End Date: ongoing
Funder: Ontario Ministry of Natural Resources
Total Cost: $35,000 (CAN)
Publication/Citation: --
Geographic Area: Lake Erie, Western basin, central basin
Summary Submitted by: Stephen J. Nepszy, Ontario Ministry of Natural Resources, Lake Erie Fisheries Station, R.R. 2, Wheatley, ONT N0P 2P0, ph: 519-825-4684, fax: 519-825-3163, e-mail: nepsyst@epo.gov.on.ca

21 ***Title:*** **Physical chemical limits to zebra mussel reproduction**
Research Category: 1.3 Environmental Requirements/Tolerance
Overview: Determine water quality parameters that limit zebra mussel reproduction, with emphasis on temperature and total calcium levels. Lab experiments will mimic conditions found in upper St. Croix and Namekagon Rivers (northern Wisconsin).
Principal Investigator(s): Dr. Mary Balcer, U W Superior
Start Date: May-94
End Date: May-96
Funder: National Park Service
Total Cost: $18,000 (US)
Publication/Citation: --
Geographic Area: upper St. Croix and Namekagon Rivers (northern Wisconsin)
Summary Submitted by: Rich Klukas, National Park Service, 1709 Jackson, Omaha, NE 68102, ph: 402/221-3603, fax: 402/221-3480, e-mail: Richard_Klukas@NPS.gov

22 ***Title:*** **Zebra mussel research program -- Physiological factors affecting control**
Research Category: 1.3 Environmental Requirements/Tolerance
Overview: Although chlorine and other chemicals can kill zebra mussels, there is a need to investigate the applicability of low dissolved oxygen, high and low temperature, and desiccation as control options. The efficiency of control methods used in the field will vary with both ecological and physiological conditions. Optimum use of control methods depends on an understanding of major ecological and physiological factors that affect control. The present ubiquitous distribution of zebra mussels in North America demands that a thorough evaluation be made of adaptation and acclimation patterns. The objective is to analyze factors causing measurable stress of zebra mussels to devise environmentally sound control strategies.
Principal Investigator(s): Barry S. Payne, U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, PAYNEB@EX1.ARMY.MIL
Start Date: 1992
End Date: 1996
Funder: U.S. Army Corps of Engineers
Total Cost: $50,000 (US)
Publication/Citation: Zebra Mussel Technical Notes - U.S. Army Engineer Waterways Experiment Station
Geographic Area: --
Summary Submitted by: Larry Sanders, USAE Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199

23 ***Title:*** **Zebra mussel research program -- Attachment mechanisms**
Research Category: 1.3 Environmental Requirements/Tolerance
Overview: The tenacious byssal attachment ability of zebra mussels is unique among freshwater bivalves. The especially troublesome biofouling capability of zebra mussels is a direct consequence of byssal attachment. Zebra mussel control will benefit greatly from an improved understanding of means of attacking the byssal attachment process. The objective is to evaluate the chemistry, mechanics, and physiological ecology of byssal attachment in order to identify methods of interfering with attachment to control infestations.

Principal Investigator(s): Barry S. Payne, U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, PAYNEB@EX1.ARMY.MIL
Start Date: 1993
End Date: 1996
Funder: U.S. Army Corps of Engineers
Total Cost: $25,000 (US)
Publication/Citation: Zebra Mussel Technical Notes - U.S. Army Engineer waterways Experiment Station
Geographic Area: --
Summary Submitted by: Larry Saunders, USAE Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199

24 ***Title:*** **Zebra mussels in the Susquehanna -- Yes or no? Why or why not?**
Research Category: 1.3 Environmental Requirements/Tolerance
Overview: 1) To verify the presence of *Dreissena* veligers in the Susquehanna River at Johnson City. 2) To determine the location(s) of colonies of adults upstream from that site. 3) To locate habitats in nearby drainage basins chemically and physically similar to the Susquehanna at Johnson City, exposed to veligers, not supporting colonies of adults. 4) To propose a plan of study to ascertain why further colonization has not occurred in the Susquehanna River.
Principal Investigator(s): Dr. Willard N. Harman, SUNY College at Oneonta, Biological Field Station, Cooperstown, NY 13326, harman@snyoneva.cc.oneonta.edu
Start Date: Sep-94
End Date: Aug-95
Funder: National Oceanic Atmospheric Administration-Sea Grant
Total Cost: $23,377 (US)
Publication/Citation: --
Geographic Area: Susquehanna River, NY
Summary Submitted by: Trent R. Schneider, New York Sea Grant, 115C Nassau Hall, SUNY, Stony Brook, NY 11794-5001, ph: 516-632-9123, fax: 516-632-6917, e-mail: tschneider@ccmail.sunysb.edu

25 ***Title:*** **Habitat suitability of nearshore areas for zebra mussels**
Research Category: 1.3 Environmental Requirements/Tolerance
Overview: Determine if habitat in shallow water (<1m) is suitable for establishment of zebra mussels -- suitable substrates (rocks) are provided for zebra mussel colonization; rocks that have been colonized in deep water are moved to shallow water and any changes in mussel density are measured and compared to existing densities in deep and shallow water. This is being conducted on Governor's Island, Clayton, NY, in the St. Lawrence River.
Principal Investigator(s): John E. Cooper, State University of NY, Environmental Science and Forestry, 1 Forestry Drive, Syracuse, NY 13210,
Start Date: --
End Date: --
Funder: --
Total Cost: $0 (US)
Publication/Citation: --
Geographic Area: Governor's Island, Clayton, NY
Summary Submitted by: John E. Cooper, 1444 Co. Rt. 23, Constantia, NY 13044, ph: 315/623-9694

26 ***Title:*** **Genetics of zebra mussel populations -- critical data for ecological studies and development of effective long-term control strategies**
Research Category: 1.5 Genetics

Overview: Determine whether zebra mussels within the Great Lakes represent a single, genetically uniform population or multiple discrete sub-populations. Determine whether disjunct populations of zebra mussels within the Great Lakes represent separate introductions from Europe. Determine whether genetically discrete sub-populations exhibit differential responses to control methods and environmental variables.
Principal Investigator(s): J. Ellen Marsden, Illinois Natural History Survey; Bernie May, UC Davis
Start Date: Aug-91
End Date: Jul-93
Funder: U.S. Environmental Protection Agency
Total Cost: $102,113 (US)
Publication/Citation: Can. J. Fish. Aquat. Sci.
Geographic Area: Great Lakes
Summary Submitted by: J. Ellen Marsden, Illinois Natural History Survey, Lake Michigan Biological Station, 400 17th St., Zion, IL 60099, ph: 708/872-8677, fax: 708/872-8679, e-mail: JMARSDEN@UIUC.EDU

27 ***Title:*** **Development and utilization of genetic probes for studying the planktonic ecology of the zebra mussel**

Research Category: 1.5 Genetics
Overview: 1) To adapt methods for the extraction and purification of genomic DNA from the zebra mussel and to design species specific oligonucleotide probes for the zebra mussel; 2) To develop methods for the use of species specific molecular probes in the environment; and 3) To utilize a zebra mussel specific probe to determine the degree and source of transport of eggs and veligers from a zebra mussel infested lake (Lake Champlain) into a pristine one (Lake George).
Principal Investigator(s): Dr. Sandra Nierzwicki-Bauer, Rensselaer Polytechnic Institute, Troy, NY, nierzs@rpi.edu; Dr. Marc Frischer, Skidaway Institute of Oceanography (formerly at RPI), Savannah, GA 31411, marc@skio.peachnet.edu
Start Date: Sep-94
End Date: Aug-96
Funder: New York Sea Grant
Total Cost: $208,678 (US)
Publication/Citation: --
Geographic Area: Lake George, NY
Summary Submitted by: Trent R. Schneider, New York Sea Grant, 115C Nassau Hall, SUNY, Stony Brook, NY 11794-5001, ph: 516-632-9123, fax: 516-632-6917, e-mail: tschneider@ccmail.sunysb.edu

28 ***Title:*** **Genetics of the zebra and quagga mussels --- A comparative analysis of mitochondrial DNA sequence data**

Research Category: 1.5 Genetics
Overview: The objectives are: 1) to determine genetic differences between the zebra and quagga mussels and to develop rapid screening methods; 2) to analyze whether or not there are additional cryptic species in this North American nonindigenous complex; 3) to test whether there are differences in overall amount of genetic variation in populations from the Old versus New World; 4) to determine where in Europe the parental stocks originated; and 5) to analyze whether there are different genetic strains and/or subpopulations in North America and, if so, which ones are most successful in which habitats and on the various invasive fronts.
Principal Investigator(s): Carol A. Stepien, Assistant Prof. of Biology, Case Western Reserve University, Cleveland, OH 44106-7080, cas20@po.cwru.edu
Start Date: Sep-92
End Date: Aug-97
Funder: Sea Grant

Total Cost: $199,913 (US)
Publication/Citation: --
Geographic Area: North America
Summary Submitted by: Carol A. Stepien, Ph.D., Case Western Reserve Univ., Department of Biology, Cleveland, OH 44206-7080, ph: 216/368-5346, fax: 216/368-4672, e-mail: cas20@po.cwru.edu

29 ***Title:*** **The neuropeptides of the zebra mussel, *Dreissena polymorpha***
Research Category: 1.7 Physiology and Behavior
Overview: The object of this project is to identify the neuropeptides used by the zebra mussel for nervous and hormonal control. Once these have been identified we will examine the effects of these peptides on the smooth muscles and other tissues which exposed to these molecules in animals.
Principal Investigator(s): Kevin Krajniak, SIUE, Department of Biological Sciences, SIUE, Edwardsville, IL 62026-1651, kkrajni@siue.edu
Start Date: As soon as funded
End Date: Three years after initiation
Funder: No current funding
Total Cost: $150,000 (US)
Publication/Citation: --
Geographic Area: Mississippi River near Alton, IL
Summary Submitted by: Kevin Krajniak, Southern Illinois University at Edwarsville, Department of Biological Sciences, SIUE, Edwardsville, IL 62026-1651, ph: 618-692-3467, fax: 618-692-3174, e-mail: kkrajni@siue.edu

30 ***Title:*** **Effects of migration conditions on the zebra mussel**
Research Category: 1.7 Physiology and Behavior
Overview: 1) Define stress in *Dreissena*; 2) identify new mulluscicides; 3) define the basic biology of the zebra and quagga mussel and compare to other freshwater mussels; 4) define bioaccumulation of heavy metals in the zebra/quagga mussel.
Principal Investigator(s): John I. Scheide, Ph.D., Biology Department, Central Michigan University, Mt. Pleasant, MI 48859, 3zdomxr@cmich.edu
Start Date: Jun-92 *End Date:* Sep-96
Funder: Research Excellence Fund of the State of Michigan
Total Cost: $131,000 (US)
Publication/Citation: Nautilus
Geographic Area: --
Summary Submitted by: John I. Scheide, Biology Department, Central Michigan University, Mt. Pleasant, MI 48859, ph: 517/774-3291, fax: e-mail: 3zdomxr@cmich.edu

31 ***Title:*** **Physiology of zebra mussels**
Research Category: 1.7 Physiology and Behavior
Overview: We investigate mechanisms regulating reproduction, gill function, ion regulation, and respiration in zebra mussels. We are primarily concerned with mechanisms that mediate cellular responses. For example, we are presently determining structures of activators of spawning and the receptors for these chemicals. Animals for these studies are obtained from the Detroit River and Lake Erie.
Principal Investigator(s): Jeffrey L. Ram, Ph.D., Department of Physiology, Wayne State University, Detroit, MI 48201
Start Date: --
End Date: --
Funder: --
Total Cost: $0 (US)
Publication/Citation: J. Inv. Reprod. Devel., J. Exp. Zool., Comp. Bioc. Physiol., Can. J. Zool., Biol. Bull.

Geographic Area: Detroit River and Lake Erie
Summary Submitted by: Jeffrey L. Ram, Wayne State University, Department of Physiology, Detroit, MI 48201, ph: 313/577-1558, fax: 313/577-5494, e-mail: jram@shiffman.med.wayne.edu

32 ***Title:*** **Influence of temperature and diet on the growth and reproduction of *Dreissena polymorpha***
Research Category: 1.7 Physiology and Behavior
Overview: Determine the role of temperature, food quality and food quantity on the growth and reproduction of zebra mussels.
Principal Investigator(s): David W. Garton, Indiana University Kokomo, 2300 S. Washington, Kokomo, IN 46904, dgarton@iukfs1.iuk.indiana.edu
Start Date: Feb-92 *End Date:* Jan-95
Funder: National Oceanic and Atmospheric Administration, Sea Grant College Program
Total Cost: $87,143 (US)
Publication/Citation: --
Geographic Area: Lake Erie
Summary Submitted by: David W. Garton, Indiana University Kokomo, Department of Biology & Physical Sciences, 2300 S. Washington Street, Kokomo, IN 46904

33 ***Title:*** **A bioenergetics model for the zebra mussel**
Research Category: 1.7 Physiology and Behavior
Overview: This project examines the effects of sediment load on the physiological energetics of the zebra mussel. The first half of this study utilized algal cells and ashed sediment to distinguish between food and non-food particles. The second half utilized natural seston pumped into the laboratory from a nearby tributary of the Illinois River. Parameters measured include filtration, ingestion, clearance, and respiration rates, assimilation efficiency, and feces and pseudofeces production rates. We are also developing techniques which allow us to estimate in-situ respiration rates of field-collected mussels based on electron transport system (ETS) enzyme activity. Results of this study are being incorporated into an existing bioenergetics model, which will be used to predict zebra mussel growth in turbid river systems, as well as in the less turbid lake environments.
Principal Investigator(s): Daniel Schneider, Illinois Natural History Survey, Center for Aquatic Ecology, 607 East Peabody, Champaign, IL 61820, ddws@ux1.cos.uiuc.edu; Sharook Madon, Department of Bio. Sciences, Pace University, 861 Bedford Road, Pleasantville, NY 10570
Start Date: Oct-92 *End Date:* Sep-96
Funder: U.S. Environmental Protection Agency
Total Cost: $326,064 (US)
Publication/Citation: --
Geographic Area: Illinois River
Summary Submitted by: Jim Stoeckel, Illinois Natural History Survey, Forbes Biological Station, 17500 East CR North, P.O. Box 590, Havana, IL 62644-0590, ph: 309/543-3950, fax: 309/543-4999, e-mail: stoeckel@ux1.cso.uiuc.edu

34 ***Title:*** **Influences of temperature and diet on physiological energetics of growth and reproduction of *Dreissena polymorpha***
Research Category: 1.7 Physiology and Behavior
Overview: Determine how water temperature and food quantity and quality affect growth and reproduction in zebra mussels. Identify environmental factors that limit mussel distribution. Identify "weak links" in the zebra mussel life cycle periods when resistance to environmental stress is low or when reproduction could be reduced.
Principal Investigator(s): Daniel Schneider, Illinois Natural History Survey, Center for Aquatic Ecology, 607 East Peabody, Champaign, IL 61820, ddws@ux1.cos.uiuc.edu; Sharook Madon, Department of Bio. Sciences, Pace University, 861 Bedford Road, Pleasantville, NY 10570

Start Date: Oct-92
End Date: Sep-96
Funder: U.S. Environmental Protection Agency
Total Cost: $326,064 (US)
Publication/Citation: --
Geographic Area: Illinois River
Summary Submitted by: Jim Stoeckel, Illinois Natural History Survey, Forbes Biological Station, 17500 East CR North, P.O. Box 590, Havana, IL 62644-0590, ph: 309/543-3950, fax: 309/543-4999, e-mail: stoeckel@ux1.cso.uiuc.edu

35 ***Title:*** **Zebra mussel research program -- Field verification of promising control methods**

Research Category: 2.1 Habitat Manipulation
Overview: The Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (P.L. 101-646) required that the U.S.ACE develop and demonstrate environmentally sound zebra mussel control methods at public facilities. At many facilities along inland waterways, zebra mussels will probably reach nuisance levels in the late 1990s. Many control methods are now available; appropriate ones need to be identified as soon as possible. A thick covering of zebra mussels will corrode metal, damage plants and is difficult and expensive to remove and transport from the site. The objective is to demonstrate a selected list of environmentally sound, proactive and reactive zebra mussel control methods.
Principal Investigator(s): Mr. E.A. (Tony) Dardeau, U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, DARDEAE@EX1.ARMY.MIL
Start Date: 1996
End Date: 1999
Funder: U.S. Army Corps of Engineers
Total Cost: $30,000 (US)
Publication/Citation: --
Geographic Area: U.S. inland waterways
Summary Submitted by: Larry Sanders, USAE Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199

36 ***Title:*** **Zebra mussel research program -- Continuous Backwash Filters**

Research Category: 2.1 Habitat Manipulation
Overview: The state-of-the-art for the protection of raw water systems is by chlorination. Although effective, this method requires expensive system retrofit, increases operation and maintenance costs, and may have cumulative adverse environmental impacts.
Principal Investigator(s): E.A. Dardeau, U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, DARDEAU@EX1.ARMY.MIL
Start Date: 1995 *End Date:* 1998
Funder: USACE
Total Cost: $40,000 (US)
Publication/Citation: Zebra Mussel Technical Notes - U.S. Army Engineer Waterways Experiment Station
Geographic Area: --
Summary Submitted by: Larry Sanders, USAE Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199

37 ***Title:*** **Determine protocols for relocation of native mussels**

Research Category: 2.2 Biological Interactions - Predator/prey, Parasites/Diseases
Overview: Native mussel (unionids) species in the Great Lakes and other areas of Eastern U.S. face extinction from invasion of zebra mussels. Research is needed to determine effective and safe means of handling and relocating unionids to habitats where zebra mussels could be excluded or would not survive. (St. Paul, MN).

38 -40 Zebra Mussel

Principal Investigator(s): Dr. Greg Cope, National Biological Service, LaCrosse, WI
Start Date: May-96
End Date: May-98
Funder: National Park Service/National Biological Service
Total Cost: $180,000 (US)
Publication/Citation: --
Geographic Area: St. Paul, MN
Summary Submitted by: Rich Klukas, National Park Service, 1709 Jackson, Omaha, NE 68102, ph: 402/221-3603

38 ***Title:*** **Ecological relationship between diving ducks and zebra mussels in Lake Erie**
Research Category: 2.2 Biological Interactions - Predator/prey, Parasites/Diseases
Overview: 1) Determine which waterfowl species consume zebra mussels and what proportion of their diet that zebra mussels constitute; 2) determine distribution of waterfowl and whether this relates to zebra mussel distribution; 3) determine organochlorines and trace elements in waterfowl that consume zebra mussels on Lake Erie and Lake St. Clair.
Principal Investigator(s): Dr. Chrisine M. Custer, Dr. Thomas W. Custer, Upper Mississipi Science Center, P.O. Box 818, LaCrosse, WI 54602
Start Date: Sep-91
End Date: Sep-96
Funder: National Biological Service
Total Cost: $150,000 (US)
Publication/Citation: --
Geographic Area: Lake Erie, Lake St. Clair
Summary Submitted by: Dr. Christine M. Custer, National Biological Service, P.O. Box 818, La Crosse, WI 54602, ph: 608-783-6451, fax: 608-783-6066, e-mail: christine_custer@nbs.gov

39 ***Title:*** **Zebra mussel research program -- Coating and material control methods**
Research Category: 2.3 Physical Measures
Overview: The emphasis of the Program is focused on development of technology to manage zebra mussels in and around public facilities. Objective of this research is to evaluate coatings and materials which prevent the attachment of zebra mussels. Non-toxic, foul release coatings have been placed in tests in the lower Mississippi River and the Niagara River.
Principal Investigator(s): Mr. Tim Race, U.S. Army Construction Engineering Research Laboratory, P.O. Box 9005, Champaign, IL 61826-9005, T-Race@CECER.ARMY.MAIL
Start Date: 1991
End Date: 1998
Funder: U.S. Army Corps of Engineers
Total Cost: $50,000 (US)
Publication/Citation: Zebra Mussel Technical Notes, U.S. Army Corps of Engineers
Geographic Area: Lower Mississippi River, Niagara River
Summary Submitted by: Larry Sanders, U.S.AE Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, ph: 601/634-2976, fax: 601/634-2398, e-mail: sanderl@ex1.arm.mil

40 ***Title:*** **Zebra mussel research program cathodic protection for the control of zebra mussels**
Research Category: 2.3 Physical Measures
Overview: Emphasis is focused on development of technology to manage zebra mussels in and around public facilities. Objective of this research is to determine the effectiveness of cathodic protection systems for the prevention and control of zebra mussel infestations.
Principal Investigator(s): Ms. V. Van Blaricum, U.S. Army Construction Engineering Research laboratory, P.O. Box 9005, Champaign, IL 61826-9005, V-VANBLARICUM@CECER.ARMY.MIL
Start Date: 1996 *End Date:* 1999
Funder: U.S. Army Corps of Engineers

Total Cost: $50,000 (US)
Publication/Citation: Zebra Mussel Technical Notes - U.S. Army Engineer Waterways Experiment Station
Geographic Area: --
Summary Submitted by: Larry Sanders, U.S.AE Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199

41 ***Title:*** **Electric-bubble method of controlling zebra mussels at water intakes**
Research Category: 2.3 Physical Measures
Overview: 1) Study of effect of electric currents on zebra mussel veligers --short and long term effects of electricity; and 2) study of performance of bubble screen --development of electric bubble deterrent for zebra mussels.
Principal Investigator(s): Prof. R.E. Baddour, The University of Western Ontario, Department of Civil Engineering, London, ONT N6A 5B9, rbaddour@julian.uwo.ca
Start Date: 1992
End Date: 1994
Funder: Government of Ontario
Total Cost: $100,000 (CAN)
Publication/Citation: --
Geographic Area: Port Stanley
Summary Submitted by: Prof. R.E. Baddour, The University of Western Ontario, Department of Civil Engineering, London, ONT N6A 5B9, ph: 519/661-2139, fax: 519/661-3779, email:rbaddour@julian.uwo.ca

42 ***Title:*** **Zebra mussels and round gobies, trophic interactions affecting**
Research Category: 2.3 Physical Measures
Overview: Measure contaminant transfer via a 2-link (zebra mussel-goby) vs a 5-link (algae-zebra mussel-feces-invertebrates-goby) food chain in order to test Rasmussen biomagnification hypothesis.
Principal Investigator(s): S.W. Fisher, Department of Entomology, 1735 Neil Ave., Ohio State University, Columbus, OH 43210, fisher.14@postbox.ocs.ohio.state.edu
Start Date: Mar-97
End Date: Feb-98
Funder: Ohio Sea Grant
Total Cost: $30,000 (US)
Publication/Citation: --
Geographic Area: Lake Erie
Summary Submitted by: Susan Fisher, Ohio State University, 1735 Neil Ave., Columbus, OH 43210, ph: 614/292-2133, fax: 614/292-2180, e-mail: fisher.14@postbox.acs.ohio.state.edu

43 ***Title:*** **Design and test of a novel device for control of zebra mussel infestation in water piping systems**
Research Category: 2.3 Physical Measures
Overview: Develop a strategy for zebra mussel control that relies on physical rather than chemical methods. Capitalize on the observation that reduction in dissolved oxygen was effective in removing zebra mussels from an infested pipe. Design and test the effectiveness of a device that mechanically reduces the dissolved oxygen in a zebra mussel infested piping system.
Principal Investigator(s): Tiao J. Chang, Ohio University, Department of civil engineering, 147 Stocker Center, Athens, OH 45701-2979, tjchang@bobcat.ent.ohiou.edu
Start Date: Sep-94
End Date: Aug-95
Funder: Ohio Sea Grant
Total Cost: $73,851 (US)
Publication/Citation: --

44 - 47 Zebra Mussel

Geographic Area: --

Summary Submitted by: Great Lakes Commission, 400 Fourth St., Ann Arbor, MI 48103, ph: 313-665-9135, fax: 313-665-4370, e-mail: glc@great-lakes.net

44 ***Title:*** **Utilization of plasma sparker technology to prevent zebra mussel settlement**

Research Category: 2.3 Physical Measures
Overview: Test and optimize sparker technology in a "kill zone" environment relative to zebra mussel control within water treatment facility surface water intake lines.
Principal Investigator(s): Champlain Water District, 403 Queen City Park Road, South Burlington, VT 05403
Start Date: spring '96
End Date: fall '96
Funder: Green Mountain Power Corporation
Total Cost: $91,500 (US)
Publication/Citation: --
Geographic Area: Lake Champlain, Burlington, Vermont
Summary Submitted by: John Chorate, Champlain Water District, 403 Queen City Park Road, South Burlington, VT 05403, ph: 802-864-7454, fax: 802-864-0435

45 ***Title:*** **Approaches to zebra mussel control through intervention in reproduction**

Research Category: 2.3 Physical Measures
Overview: The long-term objective is to reduce zebra mussel population density by blocking or inappropriately activating species-specific spawning cues.
Principal Investigator(s): Jeffrey L. Ram, Wayne State University (Department of Physiology), 40 East Canfield Avenue, Wayne State University, Detroit, MI 48201
Start Date: Sep-91
End Date: Feb-95
Funder: Michigan Sea Grant
Total Cost: $144,300 (US)
Publication/Citation: J. Inv. Reprod. Devel. 22:77-86; J. Exp. Zool. 265:587-598; J. Exp. Zool. 266:79-83; Comp. Bioc. Physiol. 105C: 409-414; J. Exp. Zool; Lewis Publishers. pp. 307-314; J. Inv. Reprod. Devel. 22:77-86; J. Exp. Zool. 265:587-598; J. Exp. Zool. 266:79-83.
Geographic Area: --
Summary Submitted by: Jennifer Smith, Michigan Sea Grant, 2200 Bonisteel Blvd., Ann Arbor, MI 48109-2099, ph: (313) 763-1437, fax: (313) 747-0768, e-mail: jsjean@umich.edu

46 ***Title:*** **Portsmouth, Ohio water treatment plant**

Research Category: 2.4 Chemical Measures
Overview: The long-term objective is to reduce zebra mussel population density by blocking or inappropriately activating species-specific spawning cues.
Principal Investigator(s): Michael J. McGourty, Emark Marine Systems Corp., S3566 Benling Rd., Orchard Park, NY 14127
Start Date: Jun-95
End Date: Jul-95
Funder: City of Portsmouth, OH
Total Cost: $166,000 (US)
Publication/Citation: --
Geographic Area: Portsmouth, OH
Summary Submitted by: Michael J. McGourty, Emark Marine Services Corp., S3566 Benling Road, Orchard Park, NY 14127, ph: 716/662-1704, fax: 716/662-6687

47 ***Title:*** **Zebra mussel research program -- Chemical control of zebra mussels**

Research Category: 2.4 Chemical Measures
Overview: Chemicals currently available for controlling zebra mussels include chlorine and metal-based (tri-butyltinoxide, copper, silver, mercury, zinc, lead) and nonoxidizing

(polyethelene, dichlorides, benzothiazole, cyanurac acid) biocides. Although efficacious

against zebra mussels, use of these compounds can result in undesirable effects, such as environmental persistence and toxicity to non-target organisms. Since zebra mussel populations are expanding in CE-managed waters, development of ecologically-sound chemical techniques for controlling infestations in mission-critical sites is necessary. The objective of this research is to identify potential compounds that control zebra mussels in an environmentally compatible manner, evaluate efficacy of most promising compounds in small-scale systems, and provide guidance for appropriate use of chemical techniques for control.

Principal Investigator(s): Kurt D. Getsinger, U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, GETSINK@EX1.ARMY.MIL

Start Date: 1995

End Date: 1997

Funder: U.S. Army Corps of Engineers

Total Cost: $25,000 (US)

Publication/Citation: Zebra Mussel Technical Notes (U.S. Army Engineer Waterways Experiment Station)

Geographic Area: --

Summary Submitted by: Larry Sanders, USAE Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199

48 ***Title:*** **Toxicity of chlorine dioxide to adult zebra mussels**

Research Category: 2.4 Chemical Measures

Overview: Side-stream tests were conducted at a Cleveland, OH municipal water plant to evaluate the toxicity of ClO_2 to adult zebra mussels. Single dose, intermittent dose and continuous exposure tests were conducted.

Principal Investigator(s): Gerald Matisoff, Department Geological Sciences, Case Western Reserve Univ., Cleveland, OH 44106, gxm4@po.cwru.edu; Gary Brooks, Exxon Chemical Co., Environmental Services, P.O. Box 4321, Houston, TX 77210-4321

Start Date: Feb-92

End Date: Nov-93

Funder: Exxon Chemical Co. (private)

Total Cost: $100,000 (US)

Publication/Citation: Journal AWWA

Geographic Area: Cleveland, OH

Summary Submitted by: Gerald Matisoff, Department Geological Sciences, Case Western Reserve University, Cleveland, OH 44106, ph: 216/368-3677, fax: 216/368-3691, e-mail: gxm4@po.cwru.edu

49 ***Title:*** **The use of potassium in control of the zebra mussel**

Research Category: 2.4 Chemical Measures

Overview: Evaluate the potassium salts as molluscicides. Determine whether low levels of potassium deter zebra mussel attachment. Measure potassium's toxicity to nontarget animals.

Principal Investigator(s): Susan W. Fisher, Ohio State University, Department of Entomology, 1735 Neil Avenue, Columbus, OH 43210, fisher.14@osu.edu; Paul C. Stromberg, Ohio State University, Veterinary Pathobiology Goss Lab, 1925 Coffey, Road, Columbus, OH 43210, stromberg.1@osu.edu

Start Date: Feb-92

End Date: Jan-94

Funder: Ohio Sea Grant

Total Cost: $198,584 (US)

Publication/Citation: --

50 -51 Zebra Mussel

Geographic Area: --

Summary Submitted by: Great Lakes Commission, 400 Fourth St., Ann Arbor, MI 48103, ph: 313-665-9135, fax: 313-665-4370, e-mail:glc@great-lakes.net

50 ***Title:*** **Environmental and economic benefits from zebra mussel harvesting through contaminant reduction and product development**

Research Category: 2.5 Consequences of Control

Overview: 1) To assay levels of contaminants in zebra mussels (*Dreissena polymorpha*) harvested from the Great Lakes; 2) to compost ground zebra mussels; 3) to hydrolyze zebra mussels; 4) to test ultrasound as a methodology whereby zebra mussel contaminants may be reduced or destroyed; 5) to evaluate the economics of harvesting methods for zebra mussels; and 6) to evaluate and develop markets for zebra mussel products.

Principal Investigator(s): Dr. Joe Regenstein, Cornell Universtiy, Ithaca, NY 14853, jmr9@cornell.edu; Dr. Susan Goldhor, Center for Applied Regional Studies, Cambridge, MA 02138-1921

Start Date: Sep-91

End Date: Aug-95

Funder: New York Sea Grant

Total Cost: $203,389 (US)

Publication/Citation: --

Geographic Area: Laboratory

Summary Submitted by: Trent R. Schneider, New York Sea Grant, 115C Nassau Hall, SUNY, Stony Brook, NY 11794-5001, ph: 516-632-9123, fax: 516-632-6917, e-mail: tschneider@ccmail.sunysb.edu

51 ***Title:*** **Biological control of zebra mussels**

Research Category: 2.6 Integrated Control Strategy

Overview: The objective of this project is to provide protocols, techniques and application strategies for an integrated pest management program incorporating molluscicidal bacterial agents for biological control of the zebra mussels.

Principal Investigator(s): Dr. Sam Singer, Western Illinois University, Biology Department, Macomb, IL 61455

Start Date: Oct-92

End Date: Mar-96

Funder: U.S. Environmental Protection Agency

Total Cost: $277,451 (US)

Publication/Citation: --

Geographic Area: --

Summary Submitted by: Dr. Fred Genthner, U.S. Environmental Protection Agency, 1 Sabine Island Drive, Gulf Breeze, FL 32561, ph: 904/934-9342, fax: 904/934-2401, e-mail: genthner-fred@wpmail.gbr.epa.gov

51 ***Title:*** **Zebra mussel research program -- Susceptibility of public facilities**

Research Category: 2.6 Integrated Control Strategy

Overview: Within the inland waterway system, encrustations of zebra mussels are likely to disrupt equipment and operating procedures at public facilities. There is a need to develop environmentally sound control strategies to deal with zebra mussel infestations. The objective is to develop environmentally sound zebra mussel control strategies for components of public facilities.

Principal Investigator(s): E.A. (Tony) Dardeau, U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, DARDEAE@EX1.ARMY.MIL

Start Date: 1992

End Date: 1996

Funder: U.S. Army Corps of Engineers

Total Cost: $100,000 (US)

Publication/Citation: Zebra Mussel Technical Notes - US Army Engineer Waterways experiment Station

Geographic Area: --

Summary Submitted by: Larry Sanders, USAE Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199

52 ***Title:*** **Application of underwater robots to perform inspection, cleaning, and maintenance of intake pipes**

Research Category: 2.6 Integrated Control Strategy

Overview: 1) To develop a prototype remotely operated vehicle (ROV), or robot, for cleaning and inspecting water intake pipes; and 2) to promote the design, prototyping, and testing technology for underwater robots performing work in constrained environments.

Principal Investigator(s): Dr. Samuel Landsberger, Cornell University, Ithaca, NY 14853 lands@romeo.caltech.edu

Start Date: Jul-91

End Date: Jan-94

Funder: New York Sea Grant

Total Cost: $140,939 (US)

Publication/Citation: --

Geographic Area: Laboratory

Summary Submitted by: Trent R. Schneider, New York Sea Grant, 115C Nassau Hall, SUNY, Stony Brook, NY 11794-5001, ph: 516-632-9123, fax: 516-632-6917, e-mail: tschneider@ccmail.sunysb.edu

53 ***Title:*** **Application of wide-range ultraviolet radiation for zebra mussel control**

Research Category: 2.6 Integrated Control Strategy

Overview: 1) To determine the minimum UV exposure that will prevent settling of zebra mussel larvae on an exposed surface; 2) to investigate the effects of UV exposure on veliger behavior; 3) to refine specifications for a prototype instrument capable of delivering UV radiation to restricted locations subject to zebra mussel infestation; and 4) to determine the minimum chronic UV exposure needed to kill existing mussel populations.

Principal Investigator(s): Dr. Linda Chalker-Scott, SUNY College at Buffalo, Buffalo, NY 14222, chalkelk@snybufaa.cs.snybuf.edu; Dr. James D.Scott, SUNY College at Buffalo, Buffalo, NY 14222, scottjd@snybufaa.cs.snybuf.edu

Start Date: Sep-92

End Date: Oct-94

Funder: New York Sea Grant

Total Cost: $224,189 (US)

Publication/Citation: --

Geographic Area: Laboratory

Summary Submitted by: Trent R. Schneider, New York Sea Grant, 115C Nassau Hall, SUNY, Stony Brook, NY 11794-5001, ph: 516-632-9123, fax: 516-632-6917, e-mail: tschneider@ccmail.sunysb.edu

54 ***Title:*** **Control of zebra mussel veligers in water treatment plants by chemical coagulants**

Research Category: 2.6 Integrated Control Strategy

Overview: 1) To characterize the effects of coagulants on veligers in terms of their behavioral response as well as the particle stability characteristics of both veliger and non-veliger particulates; 2) to identify the effects of coagulant addition at water intakes on solid/liquid separation processes using bench scale testing procedures; 3) to measure particle aggregation/disaggregation characteristics of the veligers with different coagulant doses and turbulence levels; 4) to develop a stochastic transport model that can be used as a screening tool to evaluate the effects of coagulant addition to water intakes.

Principal Investigator(s): Dr. John VanBenschoten, SUNY at Buffalo, Buffalo, NY 14260, Dr. Joseph F. Atkinson, SUNY at Buffalo, Buffalo, NY 14260, ciejfa@ubvms.cc.buffalo.edu

Start Date: Sep-93

55 - 56 Zebra Mussel

End Date: Dec-95

Funder: New York Sea Grant

Total Cost: $131,141 (US)
Publication/Citation: --
Geographic Area: Laboratory
Summary Submitted by: Trent R. Schneider, New York Sea Grant, 115C Nassau Hall, SUNY, Stony Brook, NY 11794-5001, ph: 516-632-9123, fax: 516-632-6917, e-mail: tschneider@ccmail.sunysb.edu

55 ***Title:*** **Impact of zebra mussels on communities of unionid bivalve mollusks in lakes and rivers**

Research Category: 3.1 Community Structure
Overview: Study is focused on the interaction between zebra mussels and the unionid bivalve community in Lake St. Clair and the upper Clinton River, Oakland County, Michigan. The Lake St. Clair study focuses on mortality, starvation, and recovery of impacted unionids. The Clinton River study focuses on population growth of zebra mussels and their impact on riverine unionids, particularly endangered species.
Principal Investigator(s): R.D. Hunter, Biological Sciences, Oakland University, Rochester, MI 48309-4401, hunter@vela.acs.oakland.edu
Start Date: May-94
End Date: continuing
Funder: Michigan Department of Natural Resources, Natural Heritage Grants Program
Total Cost: $2,324 (US)
Publication/Citation: --
Geographic Area: Lake St. Clair, Clinton River
Summary Submitted by: R. Douglas Hunter, Biological Sciences, Oakland University, Rochester, MI 48309-4401, ph: 810/370-3552, fax: 810/370-4225, e-mail: hunter@vela.acs.oakland.edu

56 ***Title:*** **Invasion, impact and interactions of zebra mussels and rusty crayfish in the St. Joseph River basin, Indiana-Michigan, and in streams of northern Wisconsin-Michigan**

Research Category: 3.1 Community Structure
Overview: The overall goal of this project is to describe and understand the spread, interaction, and ecological effects of zebra mussels and rusty crayfish in midwestern stream systems. The focus is on factors controlling mussel and crayfish distribution and abundance, and on the impact of these exotic species on native stream plants, invertebrates, and fish.
Principal Investigator(s): Gary A. Lamberti, University of Notre Dame, Department of Biological Sciences, Notre Dame, IN 46556, lamberti.1@nd.edu; David M. Lodge, University of Notre Dame, Department of Biological Sciences, Notre Dame, IN 46556, lodge.1@nd.edu
Start Date: Sep-92
End Date: Sep-96
Funder: U.S. Environmental Protection Agency
Total Cost: $293,000 (US)
Publication/Citation: Can. J. of Fish. Aquat Sci., J. N. Am. Benthol. Soc. (submitted)
Geographic Area: 1) the St. Joseph River and its tributaries in southern Michigan and northern Indiana (vicinity of South Bend, IN; 2) the Ontonagon River and its tributaries in the Upper Peninsula of Michigan and the Manitowish River in northern Wisconsin (vicinity of Land ‘o Lakes)
Summary Submitted by: J. David Yount, U.S. Environmental Protection Agency, 6201 Congdon Blvd., Duluth, MN 55804, Duluth, MN 55804, ph: 218-720-5752, fax: 218-720-5539, e-mail: yount.david@epamail.epa.gov

57 ***Title*:** **The potential influence of the zebra mussel (*Dreissena polymorpha*) on the biodiversity, population structure, and physiology of native mussels (Unionidae)**

Research Category: 3.1 Community Structure

Overview: The project is aimed at examining the potential effect zebra mussels may have on the biodiversity, population structure, and physiology of native mussels. There are two major parts of this project: 1) field studies to document the influence of the zebra mussel invasion on existing population density and community structure of native unionids; and 2) laboratory studies to examine the influence of Dreissena colonization on the physiology of individual unionids.

Principal Investigator(s): Daniel J. Hornbach, Macalester College, Department of Biology, St. Paul, MN, hornbach@macalstr.edu; Shirley Baker, Macalester College, Department of Biology, St. Paul, MN, baker@macalstr.edu

Start Date: Sep-92

End Date: Aug-96

Funder: U.S. Environmental Protection Agency

Total Cost: $531,000 (US)

Publication/Citation: --

Geographic Area: St. Croix and Mississippi Rivers - MN and WI. Hudson, WI; Stillwater MN; Minneapolis/St. Paul, MN; Taylor's Falls, MN; Danbury, WI

Summary Submitted by: J. David Yount, U.S. Environmental Protection Agency, 6201 Congdon Blvd., Duluth, MN 55804, ph: 218-720-5752, fax: 218-720-5539, e-mail: yount.david@epamail.epa.gov

58 ***Title:*** **Introduction and spread of zebra mussels -- Factors influencing distribution in the Upper Mississippi River.**

Research Category: 3.1 Community Structure

Overview: The objectives of this project are to: a) evaluate the effects of spread and colonization of zebra mussels (*Dreissena polymorpha*) on density, biomass, and trophic structure of selected macroinvertebrate assemblages in the Upper Mississippi River System (UMRS); b) investigate physical and chemical characteristics of water and sediment that affect density, distribution and demography of zebra mussels; and c) assess changes in these conditions as this nonindigenous species spreads throughout the UMRS.

Principal Investigator(s): Andrew C. Miller, Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS 39180-6199, millera3@ex1.wes.army.mil; John W. Barko, U.S. Fish and Wildlife Service, Environmental Management Technical Center, 575 Lester Ave., Onalaska, WI 54650

Start Date: Jul-92

End Date: Jun-96

Funder: U.S. Environmental Protection Agency

Total Cost: $480,000 (US)

Publication/Citation: --

Geographic Area: Mississippi River, from LaCross, WI to Cairo, IL (focusing on LaCross, WI area

Summary Submitted by: J. David Yount, U.S. Environmental Protection Agency, 6201 Congdon Blvd., Duluth, MN 55804, ph: 218-720-5752, fax: 218-720-5539, e-mail: yount.david@epamail.epa.gov

59 ***Title:*** **Impact of the zebra mussel on the lower food web of Saginaw Bay**

Research Category: 3.1 Community Structure

Overview: 1) Identify and understand changes in abundance, biomass, and composition of the lower food web of Saginaw Bay that resulted from the invasion of the zebra mussel. 2) Construct a model of carbon flow in the bay to determine major changes in pathways. 3) Monitor changes in abundance and distribution of mussels in the bay.

60 - 61 Zebra Mussel

Principal Investigator(s): Thomas F. Nalepa, Great Lakes Environmental Research Lab/National Oceanic and Atmospheric Administration, nalepa@glerl.noaa.gov; Gary L. Fahnenstiel, Great Lakes Environmental Research Lab/National Oceanic and Atmospheric Administration, fahnenstiel@glerl.noaa.gov

Start Date: 1991
End Date: 1995
Funder: National Oceanic and Atmospheric Administration
Total Cost: $2,300,000 (US)
Publication/Citation: J. Great Lakes Res.
Geographic Area: Saginaw Bay
Summary Submitted by: H.A. Vanderploeg, Great Lakes Environmental Research Lab/National Oceanic and Atmospheric Administration

60 ***Title:*** **The effect of zebra mussel infestation in inlnad lakes on pelagic benthic coupling**

Research Category: 3.1 Community Structure

Overview: The continuing spread of zebra mussels (*Dreissena polymorpha*) from the Great Lakes to inland lakes raises serious questions regarding what effects these invasions will have on the overall structure of these lake ecosystems and management strategy. The major objective of this study will be to determine the potential for zebra mussel infestation to affect the transfer of energy between primary producers and higher trophic levels. The study sites, Elkhart Lake (Sheboygan Co, WI,) and Silver Lake (Kenosha Co., WI) represent the continuum of Wisconsin lakes between relatively deep oligotrophic, phytoplankton limited and shallow eutrophic lakes. The differing water quality regimes and benthic substrates of these lakes allow particular emphasis to be placed on determining the effects of lake characteristics on the potential shift from pelagic, zooplankton - fish dominated systems, to benthic, zebra mussel - fish dominated systems. The shift from pelagic to benthic processing, i.e. energy flow, may have ecological consequences at every stage of energy transfer particularly in relation to the support of fish populations in these lakes and therefore management strategies.

Principal Investigator(s): David N. Edgington, Center for Great Lakes Studies, Univ. of Wisconsin, Milwaukee; Russell Cuhel, Center for Great Lakes Studies; Jerry Kaster, Center for Great Lakes Studies

Start Date: Sep-95
End Date: Aug-99
Funder: National Oceanic and Atmospheric Administration, Wisconsin Sea Grant
Total Cost: $390,000 (US)
Publication/Citation: --
Geographic Area: Elkhart Lake (Sheboygan, Co, WI), Silver Lake (Kenosha, Co, WI)
Summary Submitted by: D.N. Edgington, Center for Great Lakes Studies, U. Wisconsin, Milwaukee, 650 E. Greenfield Ave., Milwaukee, WI 53204, ph: 414/382-1750, fax: 414/382-1705, e-mail: dnedge@csd.uwm.edu

61 ***Title:*** **Effect of zebra mussel colonization of native gastropod shells -- fecundity, feeding rates, energetics, and mortality**

Research Category: 3.1 Community Structure

Overview: 1) Document the extent of fouling by zebra mussels on native gastropod fauna among habitats, among species, and among individuals in Lake Michigan; 2) determine the population level impacts of zebra mussel fouling on native gastropod fauna -3) determine the impacts of zebra mussel fouling on individual snail metabolic and life history parameters (consumption, respiration, fecundity and growth); 4)determine species characteristics (behavior, shell characteristics, habitat, mucus) which influence differential susceptibility to fouling within and among gastropod species.

Principal Investigator(s): J.E. Marsden, D. Schneider, Illinois Natural History Survey; D. Padilla, U.W. Madison
Start Date: Sep-94

End Date: Jun-97
Funder: National Sea Grant
Total Cost: $128,183 (US)
Publication/Citation: --
Geographic Area: Lake Michigan

Summary Submitted by: J. Ellen Marsden, Illinois Natural History Survey, Lake Michigan Biological Station, 400 17th St., Zion, IL 60099, ph: 708/872-8677, fax: 708/872-8679, e-mail: JMARSDEN@UIUC.EDU

62 ***Title:*** **Biotic and abiotic factors controlling adult zebra mussel densities in coastal lagoon habitats**

Research Category: 3.1 Community Structure

Overview: The objectives of this research are 1) determine the comoctitive relationship between zebra mussels and freshwater sponges; 2) evaluate the impact of predation; 3) evaluate the physical factors controlling densities of zebra mussels and freshwater sponges in coastal lagoon habitats.

Principal Investigator(s): Thomas E. Lauer, Purdue University, 1159 Forestry Bldg., West Lafayette, IN 47907, flauer@forest1.fnr.purdue.edu

Start Date: Jan-96

End Date: Jun-96

Funder: Sea Grant

Total Cost: $3,825 (US)

Publication/Citation: --

Geographic Area: Southern Lake Michigan

Summary Submitted by: Thomas Lauer, Purdue University, 1159 Forestry Bldg., West Lafayette, IN 47907, ph: 317/494-3609, fax: e-mail: hauer@forest1.fnr.purdue.edu

63 ***Title:*** **The role of zebra mussels in promoting nuisance blooms of blue -green algae**

Research Category: 3.1 Community Structure

Overview: 1) Examine the roles of zebra mussel selective filtering and nutrient excretion on the promotion of blooms of nuisance blue-green algae (Microcystis) in Saginaw bay and Lake Erie. 2) Determine the effect of the blooms on mussel population dynamics and ecosystem and public health.

Principal Investigator(s): Henry A. Vanderploeg, Vanderploeg@glerl.noaa.gov

Start Date: 1995

End Date: 1997

Funder: National Oceanic and Atmospheric Administration

Total Cost: $200,000 (US)

Publication/Citation: --

Geographic Area: Lake Erie

Summary Submitted by: Hank Vanderploeg, National Oceanic and Atmospheric Administration/Great Lakes Environmental Research Laboratory

64 ***Title:*** **Compensatory responses of fish populations to the invasion of the zebra mussel (*Dreissena polymorpha*) -- Benthic - pelagic coupling**

Research Category: 3.1 Community Structure

Overview: 1) To assess the indirect effects of zebra mussels on benthic invertebrates. 2) To assess the indirect effects of zebra mussels on feeding by larval, juvenile, and adult yellow perch. 3)To examine compensatory responses of yellow perch based on long-term field observations in Oneida Lake. 4) To assess linkages in the benthic-pelagic food web of Oneida Lake using stable isotopes. 5) To model the effect of hypothesized and measured effects of zebra mussels on the population dynamics of walleye and yellow perch in Oneida Lake.

65 - 67 Zebra Mussel

Principal Investigator(s): Dr. Edward L. Mills, Cornell Biological Field Station, Bridgeport, NY 13030-9750, elm5@cornell.edu; Dr. Lars G. Rudstam, Cornell Biological Field Station, Bridgeport, NY 13030-9750

Start Date: Sep-95

End Date: Aug-97

Funder: National Oceanic Atmospheric Administration-Sea Grant
Total Cost: $282,824 (US)
Publication/Citation: --
Geographic Area: Lake Ontario
Summary Submitted by: Trent R. Schneider, New York Sea Grant, 115C Nassau Hall, SUNY, Stony Brook, NY 11794-5001, ph: 516-632-9123, fax: 516-632-6917, e-mail: tschneider@ccmail.sunysb.edu

65 ***Title:*** **The effects of zebra mussels on the invertebrate communities of Saginaw Bay, Michigan, wetlands**

Research Category: 3.1 Community Structure
Overview: 1) Investigate the dynamics of mussel colonization of the dominant vegetation, *Scirpus americanus*, in a coastal wetland in Saginaw Bay, Lake Huron (near Quanicassee, MI). 2) Observe how zebra mussels affect the invertebrate community of this coastal wetland. 3) Determine direct and indirect effects of mussels on wetland zooplankton.
Principal Investigator(s): Thomas M. Burton, Chair, Zoology Department, 203 Natural Science Bldg., MSU, East Lansing, MI 48824; Valerie J. Brady, Zoology Department 203 Natural Science Bldg., MSU, East Lansing, MI 48824, bradyval@pilot.msu.edu
Start Date: May-96
End Date: Aug-96
Funder: U.S. Environmental Protection Agency
Total Cost: $86,000 (US)
Publication/Citation: J. Great Lakes Res.
Geographic Area: Saginaw Bay
Summary Submitted by: Valerie Brady, Michigan State University, Zoology Department, 203 Natural Science Bldg., MSU, East Lansing, MI 48824, ph: 517/355-6474, fax: 517/432-2784, e-mail: bradyval@pilot.msu.edu

66 ***Title:*** **Zebra mussel ecology in large rivers**

Research Category: 3.1 Community Structure
Overview: --
Principal Investigator(s): J.H. Thorp, Biology Department, Univ. of Louisville, Louisville, KY 40292, jhthor01@ulkyvm.louis
Start Date: Jun-94
End Date: Oct-95
Funder: U.S. Environmental Protection Agency
Total Cost: $0 (US)
Publication/Citation: --
Geographic Area: Mississippi river near Winona, MN and Ohio River near Louisville, KY
Summary Submitted by: Michael DeLong, Winona State Univ., Large River Studies Center and Biology Department, WSU, Winona, MN 55987, ph: 507/457-5484, fax: 507/457-5681, e-mail: mdelong@vax2.winona.msus.edu

67 ***Title:*** **The effects of zebra mussels on the invertebrate community of Saginaw Bay, Michigan wetlands**

Research Category: 3.1 Community Structure
Overview: The field and laboratory studies of this project focus on the effects of zebra mussels on the invertebrate community of a *Scirpus* dominated coastal marsh in Saginaw Bay, Lake Huron. These studies attempt to identify and size species susceptibilities to mussel

filtration within the zooplankton community and characterize the dynamics of zebra mussel colonization in a Great Lakes coastal wetland.
Principal Investigator(s): Dr. Thomas M. Burton, Zoology Department, Michigan State University, East Lansing, MI 48824-1046, 19813tmb@msu.edu
Start Date: May-93
End Date: Sep-96

Funder: U.S. Environmental Protection Agency
Total Cost: $94,872 (US)
Publication/Citation: J. Great Lakes Res.
Geographic Area: Saginaw Bay, Michigan wetlands
Summary Submitted by: John Brazner, U.S. Environmental Protection Agency, 6201 Congdon Blvd., Duluth, MN, ph: 218/720-5725, fax: 218/720-5539, e-mail: BRAZNER.JOHN@U.S. Environmental Protection AgencyMAIL.U.S. Environmental Protection Agency.GOV

68 ***Title:*** **Predicting the intensity and impact of *Dreissena* infestation**
Research Category: 3.1 Community Structure
Overview: To quantify relationships between infestation intensity of *Dreissena* on unionids and *Dreissena* density, and determine whether *Dreissena* density and infestation intensity can be used to predict unionid mortality.
Principal Investigator(s): Anthony Ricciardi, Department of Biology, McGill Univ.; Fred Whoriskey, Department of Natural Resource Sciences, McGill University; Joseph Rasmussen, Department of Biology, McGill University
Start Date: --
End Date: --
Funder: --
Total Cost: --
Publication/Citation: Can. J. Fish. Aquat. Sci. 52:1449-1461
Geographic Area: --
Summary Submitted by: Anthony Ricciardi, Department of Biology, McGill University, Montreal, QC H3A 1B1, ph: 514/398-4096, fax: 514/398-5069, e-mail: tonyr@bio1.lan.mcgill.ca

69 ***Title:*** **The effects of zebra mussels on *Gammarus* populations -- A mechanistic approach**
Research Category: 3.1 Community Structure
Overview: Determine precisely to what extent *Gammarus* sp. is affected by the presence of zebra mussels. Determine if the high abundances of *Gammarus* sp. observed in areas colonized by zebra mussels is caused by an increase in habitat complexity and/or an increase in food source.
Principal Investigator(s): Maria J. Gonzalez, Wright State University, 3640 Colonel Glenn Highway, Dayton,OH 45435, mgonzalez@desire.wright.edu
Start Date: Sep-94
End Date: Feb-97
Funder: Ohio Sea Grant College Program
Total Cost: $146,003 (US)
Publication/Citation: --
Geographic Area: Field and lab work is being conducted in the western basin of Lake Erie at the F. Theodore Stone Laboratory, Put-in-Bay, OH
Summary Submitted by: Maria Gonzalez, Wright State University, 3640 Colonel Glenn Highway, Dayton, OH 45435, ph: 513-873-2301, fax: 513-873-3301, e-mail: mgonzalez@desire.wright.edu

70 ***Title:*** **Zebra mussel-mediated shifts in benthic algal communities in Saginaw Bay, Lake Huron**
Research Category: 3.1 Community Structure
Overview: Determine how increased densities of zebra mussels affect the structure and function of benthic algal communities. Determine which environmental factors are important to the

benthic algal community and how these factors have changed with the invasion of zebra mussels. Determine if primary consumers are able to utilize new benthic algal resources in Saginaw Bay. Develop a model useful for predicting the effects of zebra mussels in other systems by sampling a wider range of sites within Saginaw Bay in 1996.
Principal Investigator(s): Rex L.Lowe, Bowling Green State University, Bowling Green, Ohio, 43403, lowe@opie.bgsu.edu; Robert Pillsbury, Bowling Green State University, Bowling Green,

Ohio, 43403, rpillsb@opie.bgsu.edu

Start Date: Sep-94
End Date: Aug-96
Funder: Ohio Sea Grant
Total Cost: $211,470 (US)
Publication/Citation: --
Geographic Area: Saginaw Bay, Lake Huron
Summary Submitted by: Great Lakes Commission, 400 Fourth Street, Ann Arbor, MI 48105, ph: 313-665-9135, fax: 313-665-4370, e-mail: glc@great-lakes.net

71 ***Title:*** **Impacts of dreisenid mussels on juvenile fish of western Lake Erie**

Research Category: 3.1 Community Structure
Overview: To measure the distribution, abundance, growth and diet of a number of juvenile fish species in western Lake Erie and to determine the possible impacts of the colonizing mussels on these attributes. Bi-weekly trawling at a number of fixed sites in the western basin from mid July through September.
Principal Investigator(s): Stephen Nepszy, Ontario Ministry of Natural Resources, Lake Erie Fisheries Station, RR#2, Wheatley, ONT N0P 2P0
Start Date: 1988
End Date: ongoing
Funder: Ontario Ministry of Natural Resources
Total Cost: $30,000 (CAN)
Publication/Citation: --
Geographic Area: Lake Erie (western basin)
Summary Submitted by: Stephen J. Nepszy, Ontario Ministry of Natural Resources, Lake Erie Fisheries Station, R.R. 2, Wheatley, ONT N0P 2P0, ph: 519-825-4684, fax: 519-825-3163, e-mail: nepsyst@epo.gov.on.ca

72 ***Title:*** **Impacts of dreisenid mussels on benthic invertegrates in Western Lake Erie**

Research Category: 3.1 Community Structure
Overview: To analyze information on the distribution and relative abundance of benthic invertebrates in the vicinity of the Chicken/Hen Island Reef and Chickenolee Reef of Western Lake Erie to determine the impacts of dreissenid mussels.
Principal Investigator(s): Stephen Nepszy, Ontario Ministry of Natural Resources, Lake Erie Fisheries Station, RR#2, Wheatley, ONT N0P 2P0, nepszyst@epo.gov.on.ca; Joseph Leach (retired), Ontario Ministry of Natural Resources
Start Date: --
End Date: 1992
Funder: Ontario Ministry of Natural Resources
Total Cost: $4,000 (CAN)
Publication/Citation: --
Geographic Area: Lake Erie (western basin)
Summary Submitted by: Stephen J. Nepszy, Ontario Ministry of Natural Resources, Lake Erie Fisheries Station, R.R. 2, Wheatley, Ontario, N0P 2P0, ph: 519-825-4684, fax: 519-825-3163, e-mail: nepsyst@epo.gov.on.ca

73 ***Title:*** **Reproduction and culture of native freshwater mussels from the Ohio River**

Research Category: 3.1 Community Structure

Zebra Mussel 74 - 75

Overview: Salvage zebra-infested unionids and hold them in ponds. Evaluate spawning and reproductive success of unionids held in pocket nets and racks.

Principal Investigator(s): R. J. Neves, Department of Fish and Wildlife, Virginia Tech, Blacksburg, VA 24061; B. Parker, Biology Department, Virginia Tech, Blacksburg, VA 24061
Start Date: Apr-95

End Date: Dec-98
Funder: National Biological Service
Total Cost: $105,744 (US)
Publication/Citation: --
Geographic Area: Ohio River, WV
Summary Submitted by: Dick Neves, National Biological Service, Research Unit, Virginia Tech., Fish and Wildlife, Blackburg, VA 24061, ph: 540-231-5927

74 ***Title:*** **Responses of macrophytes and associated fish larvae to zebra mussels in Saginaw Bay**

Research Category: 3.1 Community Structure
Overview: The objectives are to describe the quantity and quality of underwater light in the littoral zone in relation to turbidity, the distribution and abundance of submersed macrophytes in relation to turbidity and light, and species composition of submersed macrophyte beds. We will document any changes in these characteristics as the influence of zebra mussels increases throughout the inner Saginaw Bay ecosystem. In addition, we will estimate critical standing crop of early life stages of yellow perch and common carp for food resources associated with different abundances of submersed macrophytes. We will measure abundance of fish larvae of these and other taxa to determine if their density and growth changes as zebra mussels influence the littoral ecosystem.
Principal Investigator(s): Thomas Coon, Michigan State University, (Department of Fisheries and Wildlife), 13 Natural Resources Building, Michigan State University, East Lansing, MI, 48824-1222
Start Date: Apr-92
End Date: Apr-93
Funder: Michigan Sea Grant
Total Cost: $30,000 (US)
Publication/Citation: --
Geographic Area: Saginaw Bay, Lake Huron.
Summary Submitted by: Jennifer Smith, Michigan Sea Grant, 2200 Bonisteel Blvd., Ann Arbor, MI 48109-2099, ph: (313) 763-1437, fax: (313) 747-0768, e-mail: jsjean@umich.edu

75 ***Title:*** **Genetic structure of unionid populations prior to and following encrustation by zebra mussels**

Research Category: 3.1 Community Structure
Overview: Determine effects of zebra mussel encrustation on genetic structure of native unionid populations. Comparison of encrusted populations (western Lake Erie) and unencrusted populations (Ohio River Basin).
Principal Investigator(s): David Berg, Miami University, Department of Zoology, Oxford, OH 45056, bergdj@muohio.edu; Sheldon I. Guttman, Miami University, Department of Zoology, Oxford, OH 45056, guttman@msmail.muohio.edu
Start Date: Dec-92
End Date: Dec-95
Funder: Mussel Mitigation Trust Fund
Total Cost: $55,000 (US)
Publication/Citation: --
Geographic Area: Western Lake Erie, Ohio River Basin
Summary Submitted by: David J. Berg, Miami University, Department of Zoology, Miami University, Oxford, OH 45056, ph: 513-529-3174, fax: 513-529-6900, e-mail: bergdj@muohio.edu

76 - 79 Zebra Mussel

76 ***Title:*** **Reduced survival and fitness in native bivalves in response to fouling by the introduced zebra mussel in western Lake Erie**

Research Category: 3.1 Community Structure
Overview: Determine the effects of zebra mussel attachment on survival and fitness of unionid bivalves. Determine whether effects differed among unionid species.
Principal Investigator(s): David Garton, Indiana University of Kokomo, Deptartment of Biological and Physical

Sciences, Kokomo, IN 46904

Start Date: Mar-90
End Date: Jun-91
Funder: Ohio Sea Grant Development Fund
Total Cost: $1,500 (US)
Publication/Citation: Can. J. Fish Aquat. Sci.
Geographic Area: Western Lake Erie
Summary Submitted by: David J. Berg, Miami University, Department of Zoology, Miami University, Oxford, OH 45056, ph: 513-529-3174, fax: 513-529-6900, e-mail: bergdj@muohio.edu

77 ***Title:*** **Effects of the zebra mussel invasion on the Hudson River ecosystem (several projects)**

Research Category: 3.1 Community Structure
Overview: Comprehensive assessment of zebra mussel effects on ecosystem of freshwater tidal Hudson River (Troy to Newburgh, NY).
Principal Investigator(s): David Strayer, Nina Caraco, Jon Cole, Michael Pace, Stuart Findlay
Start Date: 1986
End Date: 1998
Funder: Hudson River Foundation
Total Cost: --
Publication/Citation: Can. J. Fish. Aquat. Sci.; Ecology; Estuaries
Geographic Area: Hudson River
Summary Submitted by: David Strayer, Institute of Ecosystem Studies, Box AB, Millbrook, NY 12545

78 ***Title:*** **Expansion of invading mussel assemblages on soft substrates**

Research Category: 3.2 Habitat (physical/chemical)
Overview: Determine or estimate change in bottom substrate due to spread zebra mussels (*Dreissena*).
Principal Investigator(s): Dr. Paul Arthur Berkman, Byrd Polar Research Center, Ohio State University; Dr. David W. Garton; Department of Biological & Physical Sciences, Indiana University, Kokomo; Dr. John E. Gannon; Gregory W. Kennedy, Habitat and Containment Assessment Section, National Biological Service; Dr. Scudder D. Mackey Division of Geological Survey, Ohio Department of Natural Resources
Start Date: Sep-96
End Date: Aug-96
Funder: State/Federal Sea Grant
Total Cost: $125,000 (US)
Publication/Citation: Ecosystem state changes in Lake Erie: Expansion of invading mussel assemeblages on soft substrates
Geographic Area: Lake Erie, Western Basin focus, may include parts of central basin
Summary Submitted by: Scudder D. Mackey, Department of Natural Resources Geological Survey, 1634 Sycamore Line, Sandusky, OH 44870, ph: 419/626-4296, fax: 419/626-8767, e-mail: SCUDDER.MACKEY @Department of Natural Resources.OHIO.GOV

79 ***Title:*** **Impact of zebra mussel on Hatchery Bay, S. Bass Island Lake Erie**

Research Category: 3.2 Habitat (physical/chemical)
Overview: To determine the impact of the zebra mussel on the pelagic environment, i.e. water transparency, nutrient chemistry and zooplankton.

Principal Investigator(s): A.M. Beeton, Great Lakes Environmental Research Lab/National Oceanic and Atmospheric Administration

Start Date: Apr-83
End Date: Sep-95
Funder: National Oceanic and Atmospheric Administration-Great Lakes Environmental Research Lab

Total Cost: $30,000 (US)
Publication/Citation: Can. J. Fish. and Aquat. Sci., 1995
Geographic Area: Hatchery Bay, S. Bass Island, Lake Erie
Summary Submitted by: A.M. Beeton, Great Lakes Environmental Research Lab/National Oceanic and Atmospheric Administration, 2205 Commonwealth Blvd., Ann Arbor, MI 48105, ph: 313/741-2244, fax: 313/741-2003

80 ***Title:*** **Zebra mussel research program --- Effects on water quality and sediment**
Research Category: 3.2 Habitat (physical/chemical)
Overview: Dense infestations of zebra mussels in aquatic systems can significantly alter water quality. The extent to which altered water quality conditions result from changes in sediment composition and related processes at the sediment-water interface is essentially unknown. Particularly in shallow water systems, altered conditions at this interface can potentially greatly influence biological composition and activity. Resultant impacts are likely to vary among water resource projects, dependent on differences in hydrodynamic features, morphometry, water quality, and operation/use. The objectives are to analyze effects of dense infestations on physiochemical characteristics of water and sediment and determine the potential for impacts to water resource projects.
Principal Investigator(s): Steven Ashby, U.S. Army Engineer Waterways experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, ASHBYS@EX1.ARMY.MIL
Start Date: 1994
End Date: 1997
Funder: U.S. Army Corps of Engineers
Total Cost: $80,000 (US)
Publication/Citation: --
Geographic Area: --
Summary Submitted by: Larry Sanders, USAE Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199

81 ***Title:*** **The effects of zebra mussels on lake trout spawning**
Research Category: 3.2 Habitat (physical/chemical)
Overview: To determine the impact of zebra mussels on lake trout reproduction in western Lake Ontario.
Principal Investigator(s): John Fitzsimons, Fisheries and Oceans Canada, 867 Lakeshore Rd, Burlington, ONT. L7R 4A6
Start Date: Apr-90
End Date: Mar-96
Funder: Fisheries and Oceans Canada
Total Cost: $25,000 (CAN)
Publication/Citation: --
Geographic Area: Western Lake Ontario
Summary Submitted by: John Fizsimons, Fisheries and Oceans Canada, 867 Lakeshore Rd., Burlington, Ont. L7R 4A6, ph: 905/336-4865, fax: 905/336-6437, e-mail: fitzsimons@burdfo.bur.dfo.ca

82 ***Title:*** **The effects of zebra mussels on walleye spawning**
Research Category: 3.2 Habitat (physical/chemical)
Overview: To determine the impact of zebra mussels on walleye reproduction in western Lake Erie.

83 - 85 Zebra Mussel

Principal Investigator(s): John Fitzsimons, Fisheries and Oceans Canada, 867 Lakeshore Rd., Burlington, ONT L7R 4A6, fitzsimons@burdfo.dur.dfo.ca
Start Date: Apr-90
End Date: Mar-92
Funder: Fisheries and Oceans Canada
Total Cost: $28,000 (CAN)
Publication/Citation: Can. J. Fish. Aquat. Sci. 52:578-586, 1995
Geographic Area: Western Lake Erie (Sunken Chicken Reef)

Summary Submitted by: John Fitzsimons, Fisheries and Oceans Canada, 867 Lakeshore Rd., Burlington, ONT L7R 4A6, ph: 905/336-4865, fax: 905/336-6437, e-mail: fitzsimons@burdfo.bur.dfo.ca

83 ***Title:*** **Quantification and substrate controls on zebra mussels in Lakes Erie & St. Clair**

Research Category: 3.2 Habitat (physical/chemical)
Overview: Development of techniques to quantify zebra mussel infestation in Western Lake Erie and Lake St. Clair; use of side scan sonar, diver surveys and video imaging to map & quantify mussel distributions.
Principal Investigator(s): J.P. Coakley, National Water Research Institute/DOE, 867 Lakeshore Rd., Burlington, ONT L7R 4A6, John.Coakley@cciw.ca; Glenn R. Brown, Geology Department U of Toronto, browngr@ecf.utoronto.ca; Murray Charlton, NRWI/DOE, murray.charlton@cciw.ca
Start Date: Apr-94
End Date: Mar-96
Funder: Environment Canada
Total Cost: $80,000 (CAN)
Publication/Citation: --
Geographic Area: Lake Erie, Lake St. Clair (Windsor, Leamington)
Summary Submitted by: Dr. J.P. Coakley, National Water Research Institute/DOE, 867 Lakeshore Rd., Burlington, ONT L7R 4A6, ph: 905/336-4881, fax: 905/336-6430, e-mail: John. Coakley@cciwl.ca

84 ***Title:*** **Littoral zone distribution and habitat utilization of the zebra mussel (*Dreissena polymorpha*)**

Research Category: 3.2 Habitat (physical/chemical)
Overview: Examination of the distribution of the zebra mussel in Oneida Lake, New York with particular emphasis on location both on the substrate and depth gradients.
Principal Investigator(s): David L. Smith, Department of Biology, Le Moyne College, Syracuse, NY 13214, dsmith@maple.lemoyne.edu
Start Date: --
End Date: --
Funder: --
Total Cost: $0 (US)
Publication/Citation: --
Geographic Area: Oneida Lake
Summary Submitted by: David L. Smith, Department of Biology, LeMoyne College, Syracuse, NY 13214, ph: 315/445-4424, fax: 315/445-4129, e-mail: dsmith@maple.lemoyne.edu

85 ***Title:*** **Ecological impact of zebra mussel colonization in the finger lakes**

Research Category: 3.2 Habitat (physical/chemical)
Overview: To ascertain the impacts to the physical, chemical and biological characteristics of Finger Lakes colonized by zebra mussels. Estimate the significance of the impacts to fisheries management objectives. Develop strategies for mitigating unacceptable impacts.
Principal Investigator(s): Bill Abraham, Gene Lane, New York State Department of Environmental Conservation, Region 8, 6274 East Avon-Lima Road, Avon, NY 14414
Start Date: Oct-94

End Date: Sep-96
Funder: U.S. Fish and Wildlife Service
Total Cost: $25,000/yr (US)
Publication/Citation: --
Geographic Area: Finger Lakes
Summary Submitted by: Timothy J. Sinnott, NYS Department of Env. Cons., Room 576 50 Wolf Rd., Albany, NY 12233-4756, ph: 518/457-0758, fax: 518/485-8424, e-mail: TIM.SINNOTT@DEC.MAILNET.STATE.NY.US

86 ***Title:*** **Remote sensing studies of zebra mussel impacts in Saginaw Bay**

Research Category: 3.2 Habitat (physical/chemical)

Overview: The goal of this research is to determine whether changes in water quality variables caused by zebra mussels can be detected in remotely sensed images and mapped and quantified using computer-assisted image processing techniques. Geographic information systems (GIS) technology will allow us to incorporate ground truth measurements into the classified imagery. The revised research plan for academic year 1992-93 consists of two basic objectives: 1) to utilize AVHRR imagery of western Lake Erie to investigate the historical magnitude of zebra mussels on the western portion of the basin and to assess the sensitivity of AVHRR imagery to recorded changes in water quality variables; and 2) to classify AVHRR and TM imagery of Saginaw Bay for various water quality parameters, and verify the results with in situ measurements.

Principal Investigator(s): W. Charles Kerfoot, Michigan Technological University, Department of Biological Sciences, Michigan Technological University, 1400 Townsend Drive, Houghton, MI 49931-1295; Ann MacClean, Michigan Technological University, Department of Biological Sciences, Michigan Technological University, 1400 Townsend Drive, Houghton, MI 49931-1295

Start Date: Aug-93

End Date: Jul-96

Funder: Michigan Sea Grant

Total Cost: $105,761 (US)

Publication/Citation: --

Geographic Area: Saginaw Bay, Lake Huron

Summary Submitted by: Jennifer Smith, Michigan Sea Grant, 2200 Bonisteel Blvd., Ann Arbor, MI 48109-2099, ph: (313) 763-1437, fax: (313) 747-0768, e-mail: jsjean@umich.edu

87 ***Title:*** **Direct experimental assessment of the impact of *Dreissena polymorpha* on Unionid growth, mortality, and condition in Lake St.Clair**

Research Category: 3.2 Habitat (physical/chemical)

Overview: The goal of this research is to determine whether changes in water quality variables caused by zebra mussels can be detected in remotely sensed images and mapped and quantified using computer-assisted image processing techniques. Geographic information systems (GIS) technology will allow us to incorporate ground truth measurements into the classified imagery. The revised research plan for academic year 1992-93 consists of two basic objectives: 1) to utilize AVHRR imagery of western Lake Erie to investigate the historical magnitude of zebra mussels on the western portion of the basin and to assess the sensitivity of AVHRR imagery to recorded changes in water quality variables; and 2) to classify AVHRR and TM imagery of Saginaw Bay for various water quality parameters, and verify the results with in situ measurements.

Principal Investigator(s): R. Douglas Hunter, Oakland University (Department of Biological Sciences), Oakland University, Rochester, MI 48309-4401

Start Date: Sep-92

End Date: Oct-93

Funder: Michigan Sea Grant

Total Cost: $5,000 (US)

Publication/Citation: --

88 - 90 Zebra Mussel

Geographic Area: Lake St.Clair

Summary Submitted by: Jennifer Smith, Michigan Sea Grant, 2200 Bonisteel Blvd., Ann Arbor, MI 48109-2099, ph: (313) 763-1437, fax: (313) 747-0768, e-mail: jsjean@umich.edu

88 ***Title:*** **Impact of *Dreissena polymorpha* on the plankton diatoms in western Lake Erie and lower Saginaw Bay, Lake Huron**

Research Category: 3.2 Habitat (physical/chemical)

Overview: 1) To evaluate the impact of *Dreissena polymorpha* on the community structure of planktonic diatoms in western Lake Erie. 2) to evaluate the impact of *Dreissena*

polymorpha on the community structure of planktonic diatoms in lower Saginaw Bay, Lake Huron.

Principal Investigator(s): Ruth H. Beeton, University of Michigan Atmospheric, Oceanic and Space Science, 2233 Space Research Bldg, University of Michigan, Ann Arbor, MI 48109-2143
Start Date: Sep-92
End Date: Aug-95
Funder: Michigan Sea Grant
Total Cost: $55,679 (US)
Publication/Citation: J. Great Lakes Res. 19(3):617-624
Geographic Area: Western Lake Erie, lower Saginaw Bay, Lake Huron
Summary Submitted by: Jennifer Smith, Michigan Sea Grant, 2200 Bonisteel Blvd., Ann Arbor, MI 48109-2099, ph: (313) 763-1437, fax: (313) 747-0768, e-mail: jsjean@umich.edu

89 ***Title:*** **Remote sensing studies of zebra mussel impacts in Saginaw Bay**

Research Category: 3.2 Habitat (physical/chemical)
Overview: The goal of this research is to determine whether changes in water quality variables caused by zebra mussels can be detected in remotely sensed images and mapped and quantified using computer-assisted image processing techniques. Geographic information systems (GIS) technology will allow us to incorporate ground truth measurements into the classified imagery. The revised research plan for academic year 1992-93.
Principal Investigator(s): W. Charles Kerfoot, Michigan Technological University, 1400 Townsend Drive, Houghton, MI 49931-1295; Ann Maclean, Michigan Technological University, 1400 Townsend Drive, Houghton, MI 49931-1295
Start Date: Sep-92
End Date: Aug-93
Funder: Department of Natural Resources
Total Cost: $18,212 (US)
Publication/Citation: --
Geographic Area: Saginaw Bay, Lake Huron, Lake Erie
Summary Submitted by: Jennifer Smith, Michigan Sea Grant, 2200 Bonisteel Blvd., Ann Arbor, MI 48109-2099, ph: (313) 763-1437, fax: (313) 747-0768, e-mail: jsjean@umich.edu

90 ***Title:*** **Benthic pelagic coupling over a bed of zebra mussels in the western basin of Lake Erie**

Research Category: 3.2 Habitat (physical/chemical)
Overview: Field study of the effect of zebra mussel filter feeding on seston concentrations in Lake Erie, Site was near N. Harbor Island.
Principal Investigator(s): Mark Loewen, Assistant Professor, Dept. of Mechanical Engineering, University of Toronto, 5 King's College Rd., Toronto, ONT M5S 3G8, loewen@me.utoronto.ca
Start Date: May-94
End Date: May-95
Funder: Environment Canada
Total Cost: $30,000 (US)
Publication/Citation: --
Geographic Area: N. Harbour Island, Lake Erie

Summary Submitted by: Mark Loewen, University of Toronto, 5 King's College Rd., Toronto, ONT M5S 3G8, ph: 416/978-1282, fax: 416/978-7753, e-mail: loewen@me.utoronto.ca

91 ***Title:*** **Influences of zebra mussels on the distribution and fate of coplanar PCB congeners in the Green Bay estuary**

Research Category: 3.3 Nutrient/Contaminant Cycles
Overview: The goal is to examine the influence of zebra mussels on the distribution and fate of PCBs, especially coplanar congeners, and to assess resulting effects on the toxicity of PCBs in Green Bay (Lake Michigan). Specific objectives are to: 1) develop a data set of

coplanar PCBs and other congeners in Green Bay, including concentrations in veliger and adult zebra mussels, fecal matter, plankton, zooplankton, benthic invertebrates, sediments, and fish; 2) determine whether short-term temporal trends and spatial differences occur in concentrations of coplanar PCB congeners in zebra mussels and fish by sampling over a three- year period and in three or more areas; and 3) assess the influence of zebra mussels on coplanar PCBs by comparing ratios, quantities, and fluxes of coplanar and non-coplanar congeners among compartments of the foodweb.

Principal Investigator(s): David E. Armstrong, Univ. of Wisconsin-Madison, 660 N Park St, Madison, WI 53706, armstrong@engr.wisc.edu; W.C. Sonzogni, Univ. of Wisconsin-Madison, 660 N. Park St, Madison, WI 53706, sonzogni@slh.wisc.edu; Jon Manchester, Univ. of Wisconsin-Madison, 660 N. Park St, Madison, WI 53706, jonman@macc.wisc.edu

Start Date: Sep-95

End Date: Aug-95

Funder: National Oceanic and Atmospheric Administration-Sea Grant

Total Cost: $272,495 (US)

Publication/Citation: --

Geographic Area: Green Bay estuary, western Lake Michigan

Summary Submitted by: Jon Manchester, Univ. of Wisconsin-Madison, 660 N. Park Street, Madison, WI, U.S.A 53706, ph: 608-265-4182, fax: 608-262-0454, e-mail: jonman@macc.wisc.edu

92 ***Title:*** **Contaminated burdens associated with sediments colonized by *Dreissena* mussels in lower Great Lakes**

Research Category: 3.3 Nutrient/Contaminant Cycles

Overview: The goal is to examine the influence of zebra mussels on the distribution and fate of PCBs, especially coplanar congeners, and to assess resulting effects on the toxicity of PCBs in Green Bay (Lake Michigan). Specific objectives are to: 1) develop a data set of coplanar PCBs and other congeners in Green Bay, including concentrations in veliger and adult zebra mussels, fecal matter, plankton, zooplankton, benthic invertebrates, sediments, and fish; 2) determine whether short-term temporal trends and spatial differences occur in concentrations of coplanar PCB congeners in zebra mussels and fish by sampling over a three- year period and in three or more areas; and 3) assess the influence of zebra mussels on coplanar PCBs by comparing ratios, quantities, and fluxes of coplanar and non-coplanar congeners among compartments of the foodweb.

Principal Investigator(s): Dr. C.H. Marvin, Department of Chemistry McMaster University, Hamilton, ONT L8S 4M1, marvinc@mcmail.cis.mcmaster.ca; Dr. B.E. McCarry, Department of Chemistry McMaster University, Hamilton, ONT L8S 4M1, mccarry@mcmail.cis.mcmaster.ca; Dr. E.T. Howell, Surface Water Section, Environmental Monitoring and Reporting Branch Ontario Ministry of Environment, 125 Resources Rd., Etobicoke, ONT M9P 3V6, howellt@gov.on.ca

Start Date: Sep-94

End Date: Sep-96

Funder: Ontario Ministry of Environmnet and Energy

Total Cost: $80,000 (CAN)

Publication/Citation: --

Geographic Area: Hamilton Harbour, Fort Erie(Eastern Lake Erie), Port Dalhousie (Western Lake Ontario), Indian Point (Bay of Quinte)

93 - 94 Zebra Mussel

Summary Submitted by: Chris Marvin, McMaster University, Department of Chemistry, 1280 Main St. West, Hamilton, ONT L8S 4M1, ph: 416/235-6253, fax: 416/235-6235, e-mail: mrvinc@mcmail.cis.mcmaster.ca

93 ***Title:*** **Contaminant cycling and dynamics of the zebra mussel**

Research Category: 3.3 Nutrient/Contaminant Cycles

Overview: The objective of this study is to determine contaminant concentrations in the zebra mussel, partitioning relationships, and potential cycling impacts on other food chain

elements in a bioaccumulation modeling framework. The modeling construct is anticipated to be applicable and portable to any mesotrophic system experiencing the invasion of zebra mussels. Samples from field collections in progress are being provided by the U.S. Coast Guard from navigation buoys in the Great lakes, and by the U.S. Coast Guard from navigation buoys in the Great Lakes, and by the U.S. Army Corps of Engineers from locks. Samples were obtained from Lake Michigan, Green Bay, Lake Huron, Saginaw Bay, Lake Erie, Lake Ontario, and the Ohio River.

Principal Investigator(s): Russell G. Kreis Jr., U.S. Environmental Protection Agency, Large lakes Research Station, 9311 Groh Road, Grosse Ile, MI 48138, RGK@LLOYD.GRL.U.S. Environmental Protection Agency.GOV; Michael D. Mullin, U.S. Environmental Protection Agency, Large Lakes Research Station, 9311 Groh Road, Grosse Ile, MI 48138; Ronald Rossman, U.S. Environmental Protection Agency, Large Lakes Research Station, 9311 Groh Road, Grosse Ile, MI 48138; Douglas Endicott, U.S. Environmental Protection Agency

Start Date: Oct-91

End Date: Sep-95

Funder: U.S. Environmental Protection Agency

Total Cost: $295,000 (US)

Publication/Citation: --

Geographic Area: Lake Michigan, Green Bay, Lake Huron, Saginaw Bay, Lake Erie, Lake Ontario, and the Ohio River

Summary Submitted by: Russell G. Kreis Jr., U.S. Environmental Protection Agency, LLRS 9311 Groh Road, Grosse Ile, MI 48138, ph: 313/692-7615, fax: 313/692-7603, e-mail: RGK@LLOYD.GRL.U.S. Environmental Protection Agency.GOV

94 ***Title:*** **Ecosystem modeling of the impact of zebra mussels on nutrient/phytoplankton dynamics**

Research Category: 3.3 Nutrient/Contaminant Cycles

Overview: The objective of this project is to improve the understanding of processes that influence the structure and function of the lower food chain, as influenced by the invasion of zebra mussels. Existing and new data will be synthesized within a mass balance modeling framework to incorporate zebra mussels into an existing multi-class eutrophication model for Saginaw Bay. The model will be calibrated and used to simulate nutrient/plankton relationships through the past decade, without zebra mussels, and for the future with zebra mussels. The study is being conducted in cooperation with the Michigan Department of Natural Resources and the Great Lakes Environmental Research Laboratory (NOAA).

Principal Investigator(s): Victor J. Bierman, Limno-Tech, Inc., 20780 S. Gatehouse Dr., South Bend, IN 46637; Joseph V. DePinto, Great Lakes Program, State University of New York at Buffalo, Buffalo, NY 14260

Start Date: Oct-92

End Date: Sep-96

Funder: U.S. Environmental Protection Agency

Total Cost: $210,000 (US)

Publication/Citation: --

Geographic Area: Saginaw Bay

Summary Submitted by: Russell G. Kreis, Jr., U.S. Environmental Protection Agency, Large Lake Research Station, 9311 Groh Road, Grosse Ile, MI 48138, ph: 313/692-7615, fax: 313/692-7603, e-mail: RGK@LLOYD.GRL.U.S. Environmental Protection Agency.GOV

95 ***Title:*** **Accumulation and transfer of xenobiotics by zebra mussels**

Research Category: 3.3 Nutrient/Contaminant Cycles

Overview: The objective of this study is to measure accumulation of selected hydrophobic contaminants (PCBs and PAHs) in zebra mussels from water contaminated algae and sediment. Toxicokinetic measurements of accumulation as a function of organism size

and lipid level will be performed. C-14 labeled contaminants will be used to trace the routes of contaminant transfer through algae, suspended sediments, water, zebra mussels, zebra mussel feces, to gammarids.

Principal Investigator(s): Susan Fisher, Ohio State University, Department of Entomology, 1735 Neil Ave., Columbus, OH 43210, Peter F. Landrum, National Oceanic and Atmospheric Administration Great Lakes Environmental Research Lab., 2205 Commonwealth Blvd., Ann Arbor, MI 48105,

Start Date: Oct-92

End Date: Sep-94

Funder: U.S. Environmental Protection Agency

Total Cost: $117,000 (US)

Publication/Citation: J. Great Lakes Res.

Geographic Area: --

Summary Submitted by: Russell G. Kreis, Jr., U.S. Environmental Protection Agency, LLRS, 9311 Groh Road, Grosse Ile, MI 48138, ph: 313/692-7615, fax: 313/692-7603, e-mail: RGK@LLOYD.GRL.U.S. Environmental Protection Agency.GOV

96 ***Title:*** **Uptake and depuration of PCBs and hexachlorobenzene by zebra mussels**

Research Category: 3.3 Nutrient/Contaminant Cycles

Overview: *Dreissena* sampled from five Great Lakes field sites (Lake St. Clair, Detroit River, Lake Erie) had tissue Aroclor loads ranging from 120-530 ng/g for Aroclor 1254 (wet weight basis). PCB 77 was detected at 1.9 ng/g at one site. Tissue levels for both Aroclors in *Dreissena* were approximately 10 times those of *Lampsilis siliquodea*, a unionid bivalve to which they were attached. Where *Dreissena* reaches high densities, it is likely to play a significant role in contaminant dynamics.

Principal Investigator(s): Gottfried Brieger, Department of Chemistry, Oakland University, Rochester, MI 48309, gbrieger@oakland.edu; R.D. Hunter, Biological Sciences, Oakland University, Rochester, MI 48309-4401, hunter@vela.acs.oakland.edu

Start Date: Oct-90

End Date: Dec-92

Funder: Michigan Great Lakes Protection Fund

Total Cost: $105,000 (US)

Publication/Citation: Ecotoxic. Environ. Saf. 26:153-165

Geographic Area: Lake St. Clair, Detroit River, lake Erie

Summary Submitted by: R. Douglas Hunter, Biological Sciences, Oakland University, Rochester, MI 48309-4401, ph: (810) 370-3552, fax: (810)370-4225

97 ***Title:*** **ERIE -- Ecosystem response to invaders in Erie**

Research Category: 3.3 Nutrient/Contaminant Cycles

Overview: Lake Erie, whole lake water quality response to zebra mussel and GLWQA.

Principal Investigator(s): Murray N. Charlton, National Water Research Institute, Environment Canada, P.O. Box 5050, Burlington, ONT Canada L7R 4A6, muray.charlton@cciw.ca

Start Date: 1993

End Date: 1997

98 - 100 Zebra Mussel

Funder: Environment Canada

Total Cost: $20,000 (US)

Publication/Citation: J. Biol. Sys., Vol.2, No.4 (1994) 467-480

Geographic Area: Lake Erie

Summary Submitted by: Murray N. Charlton, National Water Research Institute, P.O. Box 5050, Burlington, ONT L7R 4A6 Canada, ph: 905/336-4758, fax: 905/336-6430, e-mail: murraycharlton@cciw.ca

98 ***Title:*** **Bioaccumulation of metals by zebra mussels**

Research Category: 3.3 Nutrient/Contaminant Cycles

Overview: 1) To evaluate the usefulness of zebra mussels (*Dreissena polymorpha*) as bioindicator organisms for freshwater contamination by metals. 2) To assess the role of zebra mussels in influencing metal cycling in freshwater ecosystems, with focus on the upper Hudson River.

Principal Investigator(s): Dr. Nicholas S. Fisher, Marine Sciences Research Center, SUNY, Stony Brook, NY 11794-5000

Start Date: Feb-96

End Date: Jan-98

Funder: National Oceanic Atmospheric Administration-Sea Grant

Total Cost: $94,192 (US)

Publication/Citation: --

Geographic Area: Hudson River, NY

Summary Submitted by: Trent R. Schneider, New York Sea Grant, 115C Nassau Hall, SUNY, Stony Brook, NY 11794-5001, ph: 516-632-9123, fax: 516-632-6917, e-mail: tschneider@ccmail.sunysb.edu

99 ***Title:*** **Phosphorus budget of a zebra mussel population**

Research Category: 3.3 Nutrient/Contaminant Cycles

Overview: 1) To quantify standing stocks of phosphorus (P) in zebra mussel shell and tissue. 2) To determine inputs and outputs of P from a zebra mussel population. 3) To compare this information to P load to the downstream ecosystem of the Erie Canal. 4) To measure filtration and excretion rates of zebra mussels in Lake Ontario for comparative purposes. 5) To develop a computer model of the P budget for a zebra mussel population.

Principal Investigator(s): Dr. Joseph C. Makarewicz, SUNY College at Brockport, Brockport, NY 14420, jmakarew@acspr1.acs.brockport.edu

Start Date: Sep-92

End Date: Aug-95

Funder: National Oceanic Atmospheric Administration-Sea Grant

Total Cost: $188,842 (US)

Publication/Citation: --

Geographic Area: Erie Canal, NY

Summary Submitted by: Trent R. Schneider, New York Sea Grant, 115C Nassau Hall, SUNY, Stony Brook, NY 11794-5001, ph: 516-632-9123, fax: 516-632-6917, e-mail: tschneider@ccmail.sunysb.edu

100 ***Title:*** **Biomonitors**

Research Category: 3.3 Nutrient/Contaminant Cycles

Overview: At present, Canada conducts four major contaminant surveillance programs in the Great Lakes, i.e., CWS's monitoring program for contaminants in eggs of fish-eating colonial birds, DFO's lake trout program, and MOEE's sport fish and young-of-the-year spottail shiner monitoring programs. A zebra mussel monitoring program may be a useful addition due to -- I) the widespread distribution and abundance of these exotic molluscs, ii) their occupation of a lower trophic level than other species currently monitored, and

iii) their ability to alter contaminant cycling in the Great Lakes. As there are few published data on the occurrence, distribution and concentrations of organic contaminants in zebra mussels from the Great Lakes, it is difficult to evaluate their potential as biomonitors. In this study, zebra mussels were collected from 24 sites in Lake Erie, Lake Ontario and the St. Lawrence River between November 1990 and June 1992, and analyzed for residues of organochlorine pesticides and PCBs. Most target chemicals were detected in mussels from most sites, and concentration ranges varied greatly, indicating that mussels were sensitive to different levels of contamination. Zebra mussels reflected the known spatial distributions of organic contaminants and confirmed trends indicated by other biomonitors. They also reflected the PCB congener class signatures of industrial point sources. To date, there has been no consistency in the method used for normalizing body burdens of organic contaminants in zebra mussels;

wet whole, dry whole, wet tissue, dry tissue and lipid weight basis have all been used. In this study, we compared these methods and showed that normalizing to dry soft tissue weight was the most reliable and lipid weight the least reliable method. The results of this study show that zebra mussels have excellent potential as biomonitors for organic contaminants in the Great Lakes.

Principal Investigator(s): Michael Comba, Janice Metcalfe-Smith, Klaus Kaiser
Start Date: 1991
End Date: 1995
Funder: Environment Canada
Total Cost: $20,000 (CAN)
Publication/Citation: --
Geographic Area: Lake Erie, Lake Ontario, St. Lawrence River
Summary Submitted by: Michael Comba, Environment Canada, 867 Lakeshore Rd., Burlington, ONT, ph: 905/336-4617, fax: 905/336-6430, e-mail: Michael.Comba@cciw.ca

101 ***Title:*** **Zebra mussel and sediment interactions -- is there an effect on nitrogen and phosphorus generation ratios?**

Research Category: 3.3 Nutrient/Contaminant Cycles
Overview: The goals were 1) to determine whether mussels change the N/P supply ratio; and 2) to determine if mussels affect sediment oxygen dynamics. Our data support both of these hypotheses. The work was performed in Saginaw Bay - at an inner bay site and an outer bay site.
Principal Investigator(s): James Cotner, Wayne Gardner, National Oceanic and Atmospheric Administration/Great Lakes Environmental Research Lab, 2205 Commonwealth Blvd., Ann Arbor, MI 48105, gardner@glerl.noaa.gov
Start Date: Sep-93
End Date: Aug-95
Funder: Sea Grant College Program
Total Cost: $150,000 (US)
Publication/Citation: J. Great Lakes Res.
Geographic Area: Saginaw Bay
Summary Submitted by: James Cotner, Texas A & M University, Department Wildlife & Fisheries, CS, Texas 77843-2258, ph: 409/845-0169, fax: 409/845-4096, e-mail: j-cotner@tamu.edu

102 ***Title:*** **Temporal and spatial variation of organochlorine contaminants in *Dreissena polymorpha* from Western Lake Erie**

Research Category: 3.3 Nutrient/Contaminant Cycles
Overview: Assess whether body burdens of organochlorine contaminants (PCBs, pesticides) vary seasonally with lipid levels and sexual development of zebra mussels from Western Lake Erie.
Principal Investigator(s): Susan L. Roe, Department of Biological Sciences, University of Windsor, Windsor, ONT N9A 3P4, sroe@server.uwindsor.ca; Hugh J. MacIsaac, University of Windsor, hughm@server.uwindsor.ca

103 - 105 Zebra Mussel

Start Date: --
End Date: --
Funder: Ministry of Environment and Energy
Total Cost: --
Publication/Citation: --
Geographic Area: Western Lake Erie
Summary Submitted by: Susan Roe, Department of Biological Sciences, University of Windsor, Windsor, ONT N9A 3P4, ph: 519/253-4232, ext. 2734, fax: e-mail: sroe@server.uwindsor.ca

103 ***Title:*** **Biomonitoring of trace metals in *Dreisenna polymorpha* at near-shore sites along the St. Lawrence River, New York, USA**

Overview: Zebra mussels (& quagga, where available) are sampled from up to 15 sites along the St. Lawrence River from Cape Vincent, NY to the St. Regis Mohawk Reservation, NY.

		Animals are sorted by size & analyzed for copper, cadmium, zinc and other trace elements. Objectives are to: 1) determine magnitude & spatial distribution of bioaccumulation of trace metals by these animals; and 2) monitor for long-term trends which may reflect trends in water quality in this section of the river.
	Principal Investigator(s):	Dr. Carolyn Johns, Environmental Studies Program, St. Lawrence University, Canton, NY 13617, CJOH@MUSIC.STLAWU.EDU
	Start Date:	1993
	End Date:	ongoing
	Funder:	St. Lawrence Univ.
	Total Cost:	$1,000/year (US)
	Publication/Citation:	--
	Geographic Area:	St. Lawrence River, NY
	Summary Submitted by:	Dr. Carolyn Johns, St. Lawrence University, Env. Studies Program, St. Lawrence U., Canton, NY 13617 USA, ph: 315/379-5840, fax: 315/379-5802, e-mail: CJOH@MUSIC.STLAWU.EDU
104	***Title:***	**Effects of zebra mussel on nutrient cycling and lower food web dynamics in the Great Lakes**
	Research Category:	3.3 Nutrient/Contaminant Cycles
	Overview:	To identify and quantify the effects of zebra mussel on nutrient cycling and lower food web dynamics in Saginaw Bay, Lake Huron.
	Principal Investigator(s):	Wayne S. Gardner, National Oceanic and Atmospheric Administration/Great Lakes Environmental Research Lab, 2205 Commonwealth Blvd., Ann Arbor, MI 48105, Gardner@Great Lakes Environmental Research Lab.National Oceanic and Atmospheric Administration.GOV
	Start Date:	--
	End Date:	--
	Funder:	National Oceanic and Atmospheric Administration/Great Lakes Environmental Research Lab, Sea Grant and others
	Total Cost:	$50,000/yr (US)
	Publication/Citation:	J. Great Lakes Res.
	Geographic Area:	Saginaw Bay
	Summary Submitted by:	Wayne S. Gardner, National Oceanic and Atmospheric Administration/Great Lakes Environmental Research Lab, 2205 Commonwealth Blvd, Ann Arbor, MI 48105, ph: 313/741-2269, fax: 313/741-2055, e-mail: GARDNER@Great Lakes Environmental Research Lab.National Oceanic and Atmospheric Administration.GOV
105	***Title:***	**The impact of zebra mussels on the dynamics of heavy metals**
	Research Category:	3.3 Nutrient/Contaminant Cycles
	Overview:	This research addressed the impact on the establishment of high densities of the zebra mussel (as seen in Western Lake Erie) on the cycling of copper, nickel and zinc in a lake environment. Experiments consisted of field experiments in Maumee Bay near

		Toledo (OH), semifield experiments in flow-through tanks receiving natural Lake Erie water, and laboratory experiments with radio isotopes. Among other variables, metal biodeposition and bioaccumulation were assessed.
	Principal Investigator(s):	Dr. Peter Fraleigh, University of Toledo, Biology Department, Toledo, OH; Dr. Paul L. Klerks, Department of Biology, University of SW Louisiana, Lafayette, LA 70504-2451, klerks@usl.edu
	Start Date:	Sep-92
	End Date:	Aug-94
	Funder:	National Oceanic and Atmospheric Administration/nonindigenous species
	Total Cost:	$175,420 (US)
	Publication/Citation:	--
	Geographic Area:	Maumee Bay, Toledo, OH
	Summary Submitted by:	Paul L. Klerks, Univ. of SW Lousiana, Department of Biology, Box 42451, Lafayette,

LA 70504-2451, ph: 318/482-6356, fax: 318/482-5834, e-mail: klerks@usl.edu

106 ***Title:*** **Food chain contamination of edible fish through zebra mussel directed trophic transfer**

Research Category: 3.3 Nutrient/Contaminant Cycles
Overview: Measure efficiency of transfer through various trophic levels in an aquatic food web. Food web links include algae to zebra mussels, zebra mussels to crayfish and zebra mussels to fish. A stead state model of contaminant transfer will be evaluated.
Principal Investigator(s): Dr. Susan Fisher, Department of Entomology, 1735 Neil Ave., Ohio State University, Columbus, OH; Dr. Peter Landrum, Great Lakes Environmental Research Lab, 2205 Commonwealth Blvd., Ann Arbor, MI 48105
Start Date: Oct-93
End Date: Sep-95
Funder: Ohio Sea Grant
Total Cost: $285,190 (US)
Publication/Citation: --
Geographic Area: --
Summary Submitted by: Peter Landrum, National Oceanic and Atmospheric Administration, Great Lakes Environmental Research Lab, 2205 Commonwealth Blvd., Ann Arbor, MI 48105, ph: 313/741-2276, fax: 313/741-2055, e-mail: landrum@glerl.noaa.gov

107 ***Title:*** **Effects of the zebra mussel on nutrient cycling in Saginaw Bay**

Research Category: 3.3 Nutrient/Contaminant Cycles
Overview: Determine the direct and indirect effects of the zebra mussel on nutrient regeneration and uptake by various components in the lower food web.
Principal Investigator(s): Wayne S. Gardner, gardner@glerl.noaa.gov
Start Date: 1991 *End Date:* 1995
Funder: National Oceanic and Atmospheric Administration
Total Cost: $450,000 (US)
Publication/Citation: J. Great Lakes Res.
Geographic Area: Saginaw Bay
Summary Submitted by: H. Vanderploeg, Great Lakes Environmental Research Lab/National Oceanic and Atmospheric Administration, 2205 Commonwealth Blvd., Ann Arbor, MI 48105, e-mail: vanderploeg@glerl.noaa.gov

108 ***Title:*** **Effects of zebra mussels on plankton and nutrient concentrations in the Rideau River, Ontario**

Research Category: 3.3 Nutrient/Contaminant Cycles
Overview: The Rideau River, Ottawa, ON is a navigational/recreational water body. The project studies the factors regulation phytoplankton and zooplankton biomass. In certain

sections over the last 2 years zebra mussels are potentially causing their decline and a concomitant increase in nutrients.
Principal Investigator(s): Frances Pick, Department of Biology, University of Ottawa, frpick@orea.uottawa.ca
Start Date: --
End Date: --
Funder: Natural Sciences and Engineering Research Council of Canada
Total Cost: $10,000 (CAN)
Publication/Citation: Can. J. Fish Aquat.
Geographic Area: Rideau River

Summary Submitted by: Frances Pick, Department of Biology, University of Ottawa, Ottawa, ONT, ph: 613/562-5800 ext.6364, fax: 613/562-5486, e-mail: frpick@oreo.uottawa.ca

109 ***Title:*** **Nutrients regeneration by zebra mussels and its impact on phytoplankton**

Research Category: 3.3 Nutrient/Contaminant Cycles

Overview: Quantify the amount and proportion of nitrogen and phosphorus consumed, assimilated, and released by zebra mussels and the fraction available to phytoplankton. Determine the effect of nutrient release on phytoplankton nutrition, growth, and community structure. Create a computer model that predicts the effects of zebra mussel nutrient cycling on the whole ecosystem.

Principal Investigator(s): Michael J. Vanni, Miami University, Department of Zoology, Oxford, OH 45056, mjvanni@miamiu.acs.muohio.edu

Start Date: Sep-92

End Date: Aug-95

Funder: Ohio Sea Grant

Total Cost: $145,038 (US)

Publication/Citation: --

Geographic Area: --

Summary Submitted by: Great Lakes Commission, 400 Fourth St., Ann Arbor, MI 48103, ph: 313-665-9135, fax: 313-665-4370, e-mail: glc@great-lakes.net

110 ***Title:*** **Influence of zebra mussel invasion on nutrient dynamics in plankton communities -- Field verification of mesocosm findings in Saginaw Bay**

Research Category: 3.3 Nutrient/Contaminant Cycles

Overview: Test the hypothesis that planktonic nutrient dynamics observed in the field will show the same sensitivity in the presence of zebra mussels as seen in lab and mesocosm experiments. Confirm that changes in bacterial nutrient dynamics are caused by loss of labile dissolved organic carbon.

Principal Investigator(s): Robert T. Heath, Kent State University, Cunningham Hall, Kent OH 44242-0001, rheath@kentvm.kent.edu

Start Date: Aug-92

End Date: Jul-94

Funder: Ohio Sea Grant

Total Cost: $68,937 (US)

Publication/Citation: --

Geographic Area: Saginaw Bay

Summary Submitted by: Great Lakes Commission, 400 Fourth St., Ann Arbor, MI 48103, ph: 313-665-9135, fax: 313-665-4370, e-mail: glc@great-lakes.net

111 ***Title:*** **Impact of zebra mussel filtering on pelagic food webs**

Research Category: 3.3 Nutrient/Contaminant Cycles

Overview: Determine how zebra mussel grazing affects open-water communities. Gauge how the benthic boundary layer affects the food available to zebra mussels.

Principal Investigator(s): David A. Culver, Ohio State University, Departmentof Zoology, 1735 Neil Avenue, Columbus, OH 43210, culver.3@osu.edu; Robert M. Sykes, Ohio State University, Department of Civil Engineering, 2070 Neil Ave., Columbus, OH 43210, bob-sykes+@osu.edu

Start Date: Feb-92

End Date: Jan-95

Funder: Ohio Sea Grant

Total Cost: $238,263 (US)

Publication/Citation: --

Geographic Area: --

Summary Submitted by: Great Lakes Commission, 400 Fourth St., Ann Arbor, MI 48103, ph: 313-665-9135, fax: 313-665-4370, e-mail: glc@great-lakes.net

112 ***Title:*** **Zebra mussel -- fish relations and their effects on nutrient/energy and contaminant dynamics**

Research Category: 3.3 Nutrient/Contaminant Cycles

Overview: Determine if various sizes of freshwater drum and yellow perch exhibit size-selective predation on zebra mussels. Measure prey handling times of various sizes of freshwater drum and yellow perch preying on various sizes of zebra mussels. Determine

digestibility. Determine metabolic rates of oxygen consumption and ammonia excretion as a function of swimming speed in freshwater drum and yellow perch. Determine energy and protein balance. Determine ability of drum to bioaccumulate various polychlorinated aromatic isomers by feeding on environmentally contaminated zebra mussels.

Principal Investigator(s): Konrad Dabrowski, Ohio State University, School of Natural Resources, 2021 Coffey Rd., Columbus, OH 43210, dabrowski.1@osu.edu; Paul Baumann, National Biological Service, 2021 Coffey Rd., Columbus, OH 43210

Start Date: Oct-91

End Date: Sep-94

Funder: Ohio Sea Grant

Total Cost: $242,049 (US)

Publication/Citation: --

Geographic Area: --

Summary Submitted by: Great Lakes Commission, 400 Fourth St., Ann Arbor, MI 48103, ph: 313-665-9135, fax: 313-665-4370, e-mail: glc@great-lakes.net

113 ***Title:*** **Influence of zebra mussel invasion on carbon and phosphorus dynamics in plankton communities -- a mesocosm study in Saginaw Bay**

Research Category: 3.3 Nutrient/Contaminant Cycles

Overview: Test the hypothesis that zebra mussels alter carbon and phosphorus dynamics at the base of the food web by grazing selectively on phytoplankton, but not on bacteria. Determine whether these effects are related to the trophic state of the community and zebra mussel density.

Principal Investigator(s): Robert T. Heath, Kent State University, Department of Biology, Cunningham Hall, Kent, OH 44242-0001, rheath@kentvm.kent.edu

Start Date: Sep-91

End Date: Aug-92

Funder: Ohio Sea Grant

Total Cost: $195,560 (US)

Publication/Citation: --

Geographic Area: Saginaw Bay

Summary Submitted by: Great Lakes Commission, 400 Fourth St., Ann Arbor, MI 48103, ph: 313-665-9135, fax: 313-665-4370, e-mail: glc@great-lakes.net

114 ***Title:*** **Impact of zebra mussels on distribution of contaminants in Saginaw Bay**

Research Category: 3.3 Nutrient/Contaminant Cycles

Overview: 1) Examine toxicokenetic and bioaccumulation of PAHs and PCBs by zebra mussels. 2) Define the role of zebra mussels in altering the distribution of these contaminants in Saginaw Bay.

115 - 116 Zebra Mussel

Principal Investigator(s): Patricia L. Van Hoof, National Oceanic and Atmospheric Administration-Great Lakes Environmental Research Lab, 2205 Commonwealth Blvd., Ann Arbor, MI 48105, vanhoof@glerl.noaa.gov; Peter F. Landrum, National Oceanic and Atmospheric Administration-Great Lakes Environmental Research Lab, Commonwealth Blvd., Ann Arbor, MI 48105, landrum@glerl.noaa.gov

Start Date: 1994

End Date: 1995

Funder: National Oceanic and Atmospheric Administration-Great Lakes Environmental Research Lab

Total Cost: $200,000 (US)

Publication/Citation: --

Geographic Area: Saginaw Bay, Lake Michigan

Summary Submitted by: Hank Vanderploeg, National Oceanic and Atmospheric Administration-Great Lakes Environmental Research Lab, 2205 Commonwealth Blvd., Ann Arbor, MI 48105, ph: 313-741-2235, fax: e-mail: vanderploeg@glerl.noaa.gov

115 ***Title:*** **Influence of zebra mussels on C-and P-dynamics in plankton communities -- long-term effects in the western basin of lake Erie and Saginaw Bay**

Research Category: 3.3 Nutrient/Contaminant Cycles

Overview: Test the hypothesis that the long-term effects of zebra mussels will result in a diminished efficiency of carbon-flux from algae to micro-crustaceans, decreased uptake of phosphate by bacteria, and diminished transfer of phosphorus from bacteria to microcrustaceans. Test whether the community composition will shift to less edible species of phytoplankton resistant to zebra mussel grazing.

Principal Investigator(s): Robert T. Heath, Kent State University, Cunningham Hall, Kent, OH 44242-0001, rheath@kentvm.kent.edu

Start Date: Sep-94

End Date: Aug-96

Funder: Ohio Sea Grant

Total Cost: $119,172 (US)

Publication/Citation: --

Geographic Area: Lake Erie and Saginaw Bay

Summary Submitted by: Robert T. Heath, Kent State University, Department of Biology, Cunningham Hall, Kent, OH 44242-0001, ph: 216-672-7828, fax: 216-672-3713, e-mail: rheath@kentvm.kent.edu

116 ***Title:*** **Effect of the introduction of zebra mussels on the growth of young-of-the-year fish from the western basin of Lake Erie**

Research Category: 3.4 Food Web Structure

Overview: Growth of young-of-the-year yellow perch, walleye, emerald shiner, spottail shiner, white bass, white perch, freshwater drum, alewife, gizzard shad, and trout-perch collected from the western basin of Lake Erie (1976-1993) were compared with phytoplankton and zooplankton abundances. Fish growth and plankton abundances were divided into pre (1976-88) and post (1989-93) zebra mussel establishment groups and tested for significant change.

Principal Investigator(s): Elizabeth S. Trometer, Sandra M. Keppner, Wolf-Dieter N. Busch, U.S.FWS, Lower Great Lakes Fishery Resources Office, 405 North French Road, Amherst, NY 14228, r5ffa_lglfro@mail.fws.gov

Start Date: --

End Date: --

Funder: --

Total Cost: --

Publication/Citation: --

Geographic Area: Western basin of Lake Erie near Sandusky

Summary Submitted by: Elizabeth Trometer, U.S.FWS-Lower Great Lakes FRO, 405 North French Road, Amherst, NY 14228, ph: 716-691-5456, fax: 716-691-6154, e-mail: r5ffa_lglfro@mail.fws.gov

117 ***Title:*** **Ecological relationships of zebra mussels and diatoms**

Research Category: 3.4 Food Web Structure

Overview: The objective of this study is to determine the epizoic diatom flora of zebra mussels and the diatom species composition and size range ingested by zebra mussels. Increased habitat surface area, habitat alteration, and colonization by diatom species may increase benthic invertebrate production. Ingestion studies relate to algae being removed from the water column, other environments, and the preferred feeding size range of zebra mussels for ecosystem modeling studies. Investigations were conducted in western Lake Erie near Monroe, MI.

Principal Investigator(s): Russell G. Kreis Jr., U.S. Environmental Protection Agency Large Lakes Research Station, 9311 Groh Road, Grosse Ile, MI 48138, RGK@LLOYD.GRL.U.S. Environmental Protection Agency.GOV

Start Date: Oct-91

End Date: Sep-95
Funder: U.S. Environmental Protection Agency, Med-Duluth
Total Cost: $42,200 (US)
Publication/Citation: --
Geographic Area: Western Lake Erie, Monroe, MI
Summary Submitted by: Russell G. Kreis, Jr., U.S. Environmental Protection Agency, LLRS, 9311 Groh Road, Grosse Ile, MI 48138, ph: 313/692-7615, fax: 313/692-7603

118 ***Title:*** **Prediction and assessment of changes in wetland biotic communities and aquatic food webs associated with the zebra mussel invasion of Green Bay, Lake Michigan**

Research Category: 3.4 Food Web Structure
Overview: The study will examine changes in the configuration of plankton assemblages across the productivity gradient that extends from north to south in Green Bay. The objective is to understand the food web consequences of the zebra mussel, as populations are expected to increase in Green Bay over the next few years. Stable isotope ratio patterns of carbon and nitrogen will be used to predict impacts on the aquatic food web as zebra mussels alter as the assemblage of plankton. Samples have been collected in 4 wetlands that range from south to north along the west shore of Green Bay: Peter's Marsh, Little Tail Marsh, Seagull Bar Marsh and Portage Marsh. Samples of all elements of the aquatic food web were collected, including phytoplankton, zooplankton, macroinvertebrates, forage fish, piscivores, wetland birds. Offshore samples of plankton and fish have also been collected from the southern, mid- and northern portions of Green Bay.
Principal Investigator(s): Dr. Douglas Wilcox, DOI/NBS Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI 48105, douglas_wilcox@nbs.gov; Dr. Janet Keough, DOI/NBS Northern Prairie Science Center, 8711 37th St. SE, Jamestown, ND 58401, janet_keough@nbs.gov; Dr. Glenn Guntenspergen, DOI/NBS Northern Prairie Science Center, 8711 37th St. SE, Jamestown, ND 58401, glenn_guntenspergen@nbs.gov
Start Date: 1994
End Date: 1998
Funder: U.S. Environmental Protection Agency
Total Cost: $367,500 (US)
Publication/Citation: --
Geographic Area: West shore of Green Bay
Summary Submitted by: Janet Keough, Department of the Interior, National Biological Service, Northern Prairie Science Center, 8711 37th St. S.E., Jamestown, ND 58401, ph: 701/252-5363, fax: 701/252-4217, e-mail: janet_keough@nbs.gov

119 - 121 Zebra Mussel

119 ***Title:*** **Effect of zebra mussels on growth of yellow perch and on macrozoobenthos in pond enclosures**

Research Category: 3.4 Food Web Structure
Overview: Pond enclosures adjacent to Lake St. Clair (Mt. Clemens, Macomb Co., MI) were the site of a study on how zebra mussels affect yellow perch. Yellow perch in enclosures with zebra mussels grew faster and reached greater lengths and weights than yellow perch in enclosures without zebra mussels. Changes in the macrozoobenthos and sediments were also documented.
Principal Investigator(s): Sarah Thayer, 608 Second St., Fenton, MI 48430; R.D. Hunter, Biological Sciences, Oakland Univ., Rochester, MI 48309-4401, hunter@vela.acs.oakland.edu; R.C. Haas, Michigan Department of Natural Resources, 33135 So. River Rd., Mt. Clemens, MI 48045
Start Date: Jun-91
End Date: Sep-93
Funder: Michigan Department of Natural Resources, Fisheries Division
Total Cost: $26,241 (US)
Publication/Citation: --
Geographic Area: Lake St. Clair

Summary Submitted by: R. Douglas Hunter, Biological Sciences, Oakland University, Rochester, MI 48309-4401, ph: 310/370-3552, fax: 810/370-4225, e-mail: hunter@vela.acs.oakland.edu

120 ***Title:*** **Dietary composition of common goldeneye and scoup collected from the Niagara River**

Research Category: 3.4 Food Web Structure
Overview: The primary goal is to determine the relative importance of zebra mussel in the diet of two avian molluscivores. If zebra mussels are found to be a significant component of the diet, work will be expanded to assess the role of zebra mussels on the bioavailability of contaminants to these waterfowl species.
Principal Investigator(s): David T. Mayack, New York State DEC, Hale Creek Field Station, 182 Steele Ave. Ext., Gloversville, NY 12078
Start Date: Apr-94
End Date: Mar-96
Funder: New York State DEC
Total Cost: $20,500 (US)
Publication/Citation: --
Geographic Area: Niagara River
Summary Submitted by: David T. Mayack, New York State Department of Environmental Conservation, Hale Creek Field Station, 182 Steele Ave., Ext., Gloversville, NY 12078, ph: 518/773-7318, fax: 518/773-7319

121 ***Title:*** **Project Quinte**

Research Category: 3.4 Food Web Structure
Overview: A long-term, multi-trophic level project investigating effects of P control and other remedial actions on the Bay of Quinte ecosystem--to understand the relative importance of P management U.S. food-chain interactions on phyto and zooplankton biomass. Have RAP goals for the bay been met? What are the effects & consequences of recent invasion by zebra mussels?
Principal Investigator(s): Scott Millard, Ron Dermott, Ken Minns, Ora Johannson, Fisheries and Oceans, Burlington; Fred Stride, Ken Nicholls, Ont. Ministry of Environment and Energy; Tom Stewart, ONT Ministry Natural Resources
Start Date: 1972
End Date: ongoing
Funder: Fisheries and Oceans Canada
Total Cost: $15,000 (CAN)

Publication/Citation: Canadian Special Publication of Fisheries & Aquatic Sci. No.86, 1986
Geographic Area: Bay of Quinte
Summary Submitted by: Scott Millard, Fisheries and Oceans Canada, Great Lakes Lab for Fisheries and Aquatic Science, P.O. Box 5050, 867 Lakeshore Rd., Burlington, ONT, ph: 905/336-4702, fax: 905/336-6437, e-mail: millard@burdfo.bur.dfo.ca

122 ***Title:*** **Food web changes and diet changes to smelt in eastern Lake Erie**

Research Category: 3.4 Food Web Structure
Overview: Examination of evidence linking changes to the food resources in Lake Erie since the arrival of *Dreissena*, and the diet of smelt population in the east basin of Lake Erie.
Principal Investigator(s): Larry Witzel, Lake Erie Management Ontario Min. Nat. Res., Port Dover, Ronald Dermott, Great Lakes Fisheries and Oceans, Burlington, ONT
Start Date: Mar-94
End Date: Jun-96
Funder: Fisheries and Oceans Canada Sustainable Fisheries
Total Cost: $16,000 (CAN)
Publication/Citation: --
Geographic Area: Eastern Lake Erie
Summary Submitted by: Ronald Dermott, Gt. Lakes Lab Fisheries and Oceans Canada Canada, 867 Lakeshore

Rd., Burlington, ONT, ph: 905/36-4868, fax: 905/336-6437

123 ***Title:*** **The impact of zebra mussels (*Driessena polymorpha*) on lower food web dynamics in a large freshwater ecosystem**

Research Category: 3.4 Food Web Structure

Overview: 1) To model the lower food web (nutrients to phytoplankton and zooplankton) of Oneida Lake and make modeling predictions of the whole lake response to zebra mussel (*Dreissena polymorpha*) invasion. 2) To determine the probable impact of zebra mussels on nutrient dynamics, phytoplankton, zooplankton and larval fish based on field observations and in situ experimentation. 3) To test predictions of the lower food web model after colonization of zebra mussels in Oneida Lake and compare ecological results obtained with other large lake ecosystems.

Principal Investigator(s): Dr. Donald J. Stewart, SUNY Coll. Env. Sci & Forestry, Syracuse, NY 13210, djstewar@mailbox.syr.edu; Dr. Edward L. Mills, Cornell Biological Field Station, Bridgeport, NY 13030-9750, elm5@cornell.edu; Myron J. Mitchell, SUNY Coll. Env. Sci. & Forestry, Syracuse, NY 13210, mitchell@mailbox.syr.edu; John Forney, Cornell Biological Field Station, Bridgeport NY 13030

Start Date: Sep-91

End Date: Aug-94

Funder: National Oceanic Atmospheric Administration-Sea Grant

Total Cost: $222,717 (US)

Publication/Citation: --

Geographic Area: Oneida Lake, NY

Summary Submitted by: Trent R. Schneider, New York Sea Grant, 115C Nassau Hall, SUNY, Stony Brook, NY 11794-5001, ph: 516-632-9123, fax: 516-632-6917, e-mail: tschneider@ccmail.sunysb.edu

124 ***Title:*** **Shifts in southwestern Lake Michigan benthic food web dynamics since the invasion of the zebra mussel**

Research Category: 3.4 Food Web Structure

Overview: Determine how the 1992 zebra mussel invasion of the rock reef in southwestern Lake Michigan will affect the dynamics of the benthic food web by comparing pre-1992 data on benthic algal, macroinvertebrate, and crayfish abundances and composition with post-1992 data.

125 - 126 Zebra Mussel

Principal Investigator(s): Nancy C. Tuchman, Loyola University of Chicago, 6525 North Sheridan Rd., Chicago, IL 60626, ntuchma@luc.edu

Start Date: Aug-93

End Date: Jul-95

Funder: Illinois-Indiana Sea Grant Program

Total Cost: $58,000 (US)

Publication/Citation: --

Geographic Area: Southwestern Lake Michigan

Summary Submitted by: Great Lakes Commission, 400 Fourth St., Ann Arbor MI, 48013, ph: 313-665-9135, fax: 313-665-4370, e-mail: glc@great-lakes.net

125 ***Title:*** **The influence of zebra mussels on the recruitment of Saginaw Bay fishes**

Research Category: 3.4 Food Web Structure

Overview: The objective of this study is to measure the impact of zebra mussels on larval fish recruitment. Zebra mussels in Saginaw Bay are expected to attain high levels of abundance and remove algal and detrital particles from the water column, potentially reducing or changing the diversity and abundance of zooplankton, critical food for larval fish survival. The goals of this study will be to: 1) measure the abundance and diversity of larval fish during the logarithmic growth phase of zebra mussels and compare these

data with data collected prior to the colonization of the bay with zebra mussels; 2) characterize the growth history (using otoliths) and diet of four major fish species at 12 sites; 3) compare diet with zooplankton abundances; 4) regress growth and diet variables against site-specific zebra mussel densities at each station or groups of stations to determine if growth or diet are affected at stations with maximum zebra mussel densities; 5) use larval fish and trawled fish densities from stations with high and low zebra mussel densities, to determine mortality rates for selected species.and relate them to zebra mussel abundance.

Principal Investigator(s): David Jude, University of Michigan, (Center For Great Lakes and Aquatic Sciences, 2200 Bonisteel Blvd., University of Michigan, Ann Arbor, MI 48109-2099

Start Date: Sep-92

End Date: Aug-95

Funder: Michigan Sea Grant

Total Cost: $104,258 (US)

Publication/Citation: --

Geographic Area: Saginaw Bay, Lake Huron.

Summary Submitted by: Jennifer Smith, Michigan Sea Grant, 2200 Bonisteel Blvd., Ann Arbor, MI 48109-2099, ph: (313) 763-1437, fax: (313) 747-0768, e-mail: jsjean@umich.edu

126 ***Title:*** **The impact of zebra mussels on phytoplankton dynamics in a large unstratified lake**

Research Category: 3.4 Food Web Structure

Overview: Field measurements of velocity and phytoplankton concentration were taken at 25 cm intervals above a zebra mussel bed in the western basin of Lake Erie. These distributions were then used to estimate the consumption rate of the zebra mussels using a simple turbulent mixing model. The objective of the study was to obtain realistic estimates of consumption which include the effects of turbulent mixing and transport within the water column.

Principal Investigator(s): Ellen T. McDonald, Ohio State University, 2070 Neil Ave., Columbus, OH 43210, mcdonald.136@osu.edu; David A. Culver, Ohio State University, Department of Zoology, Columbus, OH 43210

Start Date: Jun-95

End Date: Aug-96

Funder: National Science Foundation

Total Cost: $17,747 (US)

Publication/Citation: --

Geographic Area: Western basin of Lake Erie

Summary Submitted by: Susan Fisher, Ohio State University, 470 Hitchcock Hall, 2070 Neil Ave., Columbus, OH 43210, ph: 614-292-6420, fax: 614-292-3780, e-mail: mcdonald.136@osu.edu

127 ***Title:*** **Consumption of *Dreissena* veligers by invertebrates in Lake Erie**

Research Category: 3.5 Predator/Prey Interactions

Overview: Evidence in the early 1990s indicated a decline in rotifers in Lake Erie probably due to competition and predation from adult *Dreissena*. At the same time, mussel veligers increased. The question was whether the loss of rotifers as a prey source for predatory invertebrates was made up for by the appearance of similar-sized veligers. Lab and field experiments indicated that both cyclopoid copepods and *Bythotrephes* consumed veligers. At times, cyclopoids acquired much of their energy from veligers, and accounted for a moderate fraction of the mortality of planktonic veligers. *Bythotrephes* neither consumed veligers nor contributed to their mortality to any degree.

Principal Investigator(s): W. Gary Sprules, Univ. of Toronto - Erindale, Mississauga, ONT L5L 1C6, gsprules@cyclops.erin.utoronto.ca; H. MacIsaac, Biol. Sci, Univ. of Windsor, Windsor, ONT, hughm@uwindsor.ca

Start Date: Apr-92

End Date: Mar-94

Funder: Fisheries and Oceans Canada
Total Cost: $13,500 (CAN)
Publication/Citation: --
Geographic Area: Lake Erie, north east shore at Nanticoke Generating Station
Summary Submitted by: W. Gary Sprules, University of Toronto, Erindale College, Mississauga, ONT L5L 1C6, ph: 905-828-3987, fax: 905-828-3792, e-mail: gsprules@cyclops.erin.utoronto.ca

128 ***Title:*** **Field experimental analysis of factors regulating the potential distribution, abundance, and community impact of zebra mussels in large rivers.**
Research Category: 3.5 Predator/Prey Interactions
Overview: The objective is to determine the likely success and impact of zebra mussels (and to a lesser extent, quagga mussels) in large rivers. Predator-prey experiments were conducted in the Ohio River near Louisville, KY and in the Mississippi River near Winona, MN. Studies of impact on plankton have been conducted in the field and in experimental, drifting potamocorrals. Effects of acute and chronic turbidity have been conducted in the laboratory.
Principal Investigator(s): James H. Thorp, Univ. of Louisville, Biology Department, Louisville, KY 40292, jhthor01@ulkyvm.louisville.edu; P. Bukaveckas, R.J. Stevenson, J.D. Jack
Start Date: Oct-92
End Date: Sep-96
Funder: U.S. Environmental Protection Agency
Total Cost: $499,000 (US)
Publication/Citation: Can. J. Fish. Aquat. Sci. (2 articles); Proc. 4th International Zebra Mussel Conf.; others being prepared
Geographic Area: Ohio River near Louisville, KY; Mississippi River near Winona, MN
Summary Submitted by: J. David Yount, U.S. Environmental Protection Agency, 6201 Congdon Blvd., Duluth, MN 55804, ph: 218-720-5752, fax: 218-720-5539, e-mail: yount.david@epamail.epa.gov

129 ***Title:*** **Biology and ecology of non-indigenous aquatic species with emphasis on the zebra mussel**
Research Category: 3.5 Predator/Prey Interactions

130 - 131 Zebra Mussel

Overview: The objectives of this study are to conduct laboratory and field investigations on the ecological-physiological tolerances and ecological impacts of zebra mussels. Laboratory microcosms will be used to determine the physical and chemical requirements and tolerances of zebra mussels and effects of these factors on their osmotic regulation, development, growth and reproduction. Outdoor, field mesocosms will be used to determine the ecological effects of zebra mussels on bacterioplankton, phytoplankton, zooplankton, benthic macroinvertebrates, and juvenile fish. All laboratory and field studies are to be conducted within the Russian Republic.
Principal Investigator(s): Alexander Kopylov, Director, Institute for Biology of Inland Waters, Russian Academy of Science, Borok, Nekouz, Jarouslavl Region, Russian Republic 152 742, German Vinogradov, Project Leader, Paul Umorin
Start Date: Oct-91
End Date: Sep-96
Funder: U.S. Environmental Protection Agency, Med-Duluth
Total Cost: $90,000 (US)
Publication/Citation: --
Geographic Area: Russian Republic
Summary Submitted by: Russell G. Kreis Jr., U.S. Environmental Protection Agency, LLRS, 9311 Groh Road, Grosse Ile, MI 48138, ph: 313/692-7615, fax: 313/692-7603

130 ***Title:*** **Prediction and assessment of changes in wetland biotic communities and aquatic food webs associated with zebra mussel invasion of Green Bay, Lake Michigan**

Research Category: 3.5 Predator/Prey Interactions
Overview: This study uses stable isotope analyses to identify food web linkages in wetlands of Green Bay (Lake Michigan) of varying trophic status and characteristizes wetland habitats to develop predictive capabilities for potential changes in food webs associated with the filtering activities of invading zebra mussels.
Principal Investigator(s): Dr. Douglas A. Wilcox, NBS-GLSC, 1451 Green Rd., Ann Arbor, MI 48105, douglas_wilcox@nbs.gov; Dr. Janet R. Keough, Dr. Glenn R. Guntenspergen, NBS-NPSC, 8711 37th St. SE, Jamestown, ND 58401-7317
Start Date: Sep-94
End Date: Sep-94
Funder: U.S. Environmental Protection Agency Environmental Research Lab, Duluth
Total Cost: $367,000 (US)
Publication/Citation: --
Geographic Area: Green Bay, Lake Michigan
Summary Submitted by: Dr. Douglas A. Wilcox, National Biological Service, Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI 48105, ph: 313/994-3331, ext. 256, fax: 313/994-8780, e-mail: douglas_wilcox@nbs.gov

131 ***Title:*** **Impacts of zebra mussels on unionid bivalves in Great Lakes**

Research Category: 3.5 Predator/Prey Interactions
Overview: Zebra mussels are parasitic on shells of native bivalve clams. The research examines impacts on natural populations in Lake Erie and the Detroit River.
Principal Investigator(s): Don Schloesser
Start Date: 1990
End Date: 1996
Funder: National Biological Survey
Total Cost: $55,000/yr (US)
Publication/Citation: --
Geographic Area: Lake Erie, Detroit River
Summary Submitted by: Don Schlnesser, National Biological Service, 1451 Green Rd., Ann Arbor, MI 48105, ph: 313/994-3331, fax: e-mail: Dan_Schloesser@NBS.GOV

132 ***Title:*** **Monitoring for the zebra mussel *Dreissena polymorpha* in the Missouri River near Sioux City, IA**

Research Category: 4.1 Identification of Potential Invaders
Overview: Examine plankton samples for veliger larvae during June and July, 1996, from Sioux City to the Port Neal power stations (a 12 mile reach of the Missouri River). Sioux City is the end of navigation on the Missouri River.
Principal Investigator(s): Dr. Joe Claflin, Biology Department, Morningside College, Sioux City, IA 51106
Start Date: May-96
End Date: Jul-96
Funder: MidAmerica Energy
Total Cost: $3,000 (US)
Publication/Citation: --
Geographic Area: Missouri River
Summary Submitted by: Joseph Claflin, Morningside College, Biology Department, Sioux City, IA 51106, ph: 712/274-5155, fax: 712/274-5378, e-mail: wjcooi@alpha.morningside.edu

133 ***Title:*** **The efficacy of the Amiad filter fitted with absolute 40 micron in removal of all life stages of zebra mussels (*Dreissena polymorpha)***

Research Category: 4.3 Determination of Preventive Measures
Overview: Mississippi Power & Light (MP&L) Geral Andrus Plant (GAP) in Greenville, Mississippi. Water drawn from Lake Ferguson, an open oxbow lake, contiguous with the Mississippi River. Conducted for State of Michigan, Mud Creek Irrigation District

(MCID), Bad Axe, Michigan by Acres International Corporation.

Principal Investigator(s): Williams, Osminski & Associates, Consulting Engineers, 255 East Huron, Bad Axe, MI 48413; Fishbeck, Thompson, Carr & Huber Inc, Engineers, Scientists & Architects, 6090 East Fulton, Ada, MI 49301; Acres International Corporation, Engineers, Scientists & Planners, 140 John James Audubon Parkway, Amherst, NY 14228

Start Date: --

End Date: --

Funder: --

Total Cost: --

Publication/Citation: Filtration News, Waterworld, Water Waste Dig.

Geographic Area: Lake Ferguson

Summary Submitted by: Bill Stinehart, Amiad Water System Technologies, 2220 Celsius Ave., Oxnard, CA 93030, ph: 1/800/969-4055 ex. 214, fax: 1-800-776-3458

134 ***Title:*** **Facilitation of exotic species information exchange between North America and the former Soviet Union**

Research Category: 4.4 Establishment of International Protocols

Overview: To bring experts on zebra mussels from the former Soviet Union to North America for an exchange of information, ideas and collaborative research.

Principal Investigator(s): D.K. Padilla, Dept of Zoology, UW Madison, 430 Lincoln Drive, Madison, Wi 53706, padilla@macc.wisc.edu

Start Date: Sep-95

End Date: Aug-97

Funder: National Oceanic and Atmospheric Administration/Sea Grant

Total Cost: $108,184 (US)

Publication/Citation: --

Geographic Area: North America

Summary Submitted by: Dr. Dianna K. Padilla, Department of Zoology, UW Madison, 430 Lincoln Drive, Madison, WI 53706, ph: 608/262-6506, fax: 608/265-6320, e-mail: padilla@macc.wisc.edu

135 - 137 Zebra Mussel

135 ***Title:*** **Zebra mussel research program -- contaminant and toxicity related issues**

Research Category: 5.1 Human Health Aspects

Overview: Under certain conditions, chemicals will have to be used to control zebra mussels at public facilities. Information is required on their potential environmental effects, permitting requirements, and difficulty of obtaining and using these biocides. In addition, there is concern that zebra mussels removed from certain waterbodies could cause disposal problems if they bioaccumulate contaminants. The objective is to develop protocols for selecting appropriate biocides that can be used in an environmentally sound manner and for disposal of contaminated zebra mussels. Assess the contaminant status of zebra mussel populations at Great Lakes areas of concern and CE and public facilities.

Principal Investigator(s): Henry E. Tatem, U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, TATEMH@EX1.ARMY.MIL

Start Date: 1992

End Date: 1996

Funder: U.S. Army Corps of Engineers

Total Cost: $15,000 (US)

Publication/Citation: Zebra Mussel Technical Notes - U.S. Army Engineer Waterways Experiment Station

Geographic Area: --

Summary Submitted by: Larry Sanders, USAE Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199

136 ***Title:*** **The economic costs of the zebra mussel to Ohio's north coast economy**

Research Category: 5.2 Recreation/Tourism Impacts
Overview: Survey Ohio and Michigan licensed drivers about their current and future recreational activities on Lake Erie and costs incurred as a result of zebra mussels. Estimate the economic value and impact of Lake Erie tourism and recreational fishing and how they have been affected by zebra mussels.
Principal Investigator(s): Leroy J. Hushak, Ohio State University, 2120 Fyffe Rd. Columbus, OH 43210, hushak.1@osu.edu
Start Date: Aug-91
End Date: Jul-93
Funder: Ohio Sea Grant
Total Cost: $133,292 (US)
Publication/Citation: --
Geographic Area: Ohio, Michigan
Summary Submitted by: Great Lakes Commission, 400 Fourth St., Ann Arbor, MI 48103, ph: 313-665-9135, fax: 313-665-4370, e-mail: glc@great-lakes.net

137 ***Title:*** **Chemical cleaning of zebra mussels (industry)**
Research Category: 5.4 Water Use-Agricultural, Industrial, Municipal
Overview: Chemical cleaning of zebra mussels in heat exchangers and raw water piping.
Principal Investigator(s): Joy E. Harris
Start Date: Jan-93
End Date: ongoing
Funder: Dalpro, ICOA
Total Cost: $5,000 (CAN)
Publication/Citation: --
Geographic Area: Hamilton, Stelco and DoFasco
Summary Submitted by: Jay E. Harms, DALPRO, ICOA, 339 Leaside ave., Stoney Creek, ONT L8E 2N8, ph: 905/662-2550, fax: 905/662-0117

138 ***Title:*** **Zebra mussel impact study and protection plan**
Research Category: 5.6 Resource Management Issues
Overview: Lake Champlain contains the best preserved collection of 18th and 19th century shipwrecks in the United States. These resources are seriously threatened by the recent invasion of zebra mussels (*Dreissena polymorpha*), a non-native nuisance species. Zebra mussels threaten submerged cultural resources not only by obscuring them, making inventory and survey impossible, but also by physically destroying the resources, which can collapse under the zebra mussel colony's weight. Unfortunately data documenting the adverse effects of zebra mussels on underwater historic resources is not available, and the effectiveness or appropriateness of protection techniques is not well understood. This study is meant to present an overview of all known information about the impacts of zebra mussels on historic shipwrecks, detailed options for protection/treatment, and analysis of how the available information can be applied to Lake Champlain shipwrecks.
Principal Investigator(s): Arthur B. Cohn, Director, Lake Champlain Maritime Museum at Basin Harbor, Inc., RR3, Box 4092, Vergennes, VT 05491
Start Date: Feb-95
End Date: Dec-95
Funder: Lake Champlain Basin Program
Total Cost: $17,039 (US)
Publication/Citation: Lake Champlain Basin Program
Geographic Area: Lake Champlain
Summary Submitted by: Arthur B. Cohn, Lake Champlain Maritime Museum, RR3, Box 4092, Vergennes, VT 05491, ph: 802/475-2027, fax: 802/475-2953

139 ***Title:*** **Aerial exposure tolerance of zebra and quagga mussls -- implications for overland**

dispersal

Research Category: 6.2 Mechanisms of Spread

Overview: Zebra and quagga mussels collected from the St. Lawrence River were used in laboratory experiments to examine the effects of temperature, relative humidity, exposure period, and mussel size on the survivorship of dreissenids in air. This information may help predict the rate of overland spread of dreissenids, e.g. by boat trailers.

Principal Investigator(s): Anthony Ricciardi, Department of Biology, McGill Univ.; Robert Serroya, Department of Natural Resource Sciences, McGill Univ.; Fred Whoriskey, Department of Natural Resource Sciences, McGill Univ.

Start Date: --

End Date: --

Funder: Natural Sciences and Engineering Research Council of Canada

Total Cost: --

Publication/Citation: Can. J. Fish. Aquat. Sci. 52:470-477

Geographic Area: St. Lawrence River

Summary Submitted by: Anthony Ricciardi, Department of Biology, McGill University, Montreal, QC H3A 1B1, ph: 514/398-4096, fax: 514/398-5069, e-mail: tonyr@bio1.lan.mcgill

140 ***Title:*** **An assessment of the overland dispersal of zebra mussels into inland North American Lakes**

Research Category: 6.3 Rate of Spread

Overview: 1) Document the spatial and temporal pattern of the spread of zebra mussels within local systems of inland waters using standardized methods for detecting the presence of zebra mussels. 2) Compare the characteristics of invaded and non-invaded lakes to determine correlates of invasion susceptibility and infer likely mechanisms of dispersal. 3) Assess the relative importance of primary and secondary invasion events on the spread of zebra mussels within local systems of inland waters. 4) Compare patterns of local invasions in different regions to determine the generality of any observed patterns and test predictions of importance of the "exposure" of inland systems to nearby source populations. 5) Provide an initial assessment of the efficacy of educational and outreach programs.

141 - 143 Zebra Mussel

Principal Investigator(s): Clifford Kraft, University of Wisconsin Sea Grant Institute, ES-105, University of Wisconsin Green Bay, WI 54311-7001, KRAFTC@UWGB.EDU; Ladd Johnson, Universite Laval, Departement de Biologie Universite Laval Sainte Foy, QC G1K 7P4 CANADA, LADD.JOHNSON@BIO.ULAVAL.CA

Start Date: Sep-94

End Date: Aug-97

Funder: University of Wisconsin Sea Grant College Program

Total Cost: $196,508 (US)

Publication/Citation: --

Geographic Area: Approximately 100 inland lakes in Wisconsin, Michigan, Indiana and Minnesota

Summary Submitted by: Clifford Kraft, University of Wisconsin Sea Grant Institute, ES-105, UW-Green Bay, Green Bay, WI 54311-7001, ph: 414-465-2795, fax: 414-465-2376, e-mail: KRAFTC@UWGB.EDU

141 ***Title:*** **The zebra mussel invasion of the inland waters of Michigan -- Current status and trends in ANS and the continuation of a sampling program**

Research Category: 6.3 Rate of Spread

Overview: Zebra mussel dispersal project, large scale systematic inland lake monitoring program to determine the incidence and patterns of overland dispersal of zebra mussels into inland lakes in the lower Peninsula of Michigan. Also included pilot volunteer plankton sampling program.

Principal Investigator(s): Paul Marangelo, Ludel Johnson

Start Date: Apr-95

End Date: Dec-95

Funder: Michigan Department of Environmental Quality
Total Cost: $12,000 (US)
Publication/Citation: --
Geographic Area: Inland lakes, Lower Peninsula of Michigan
Summary Submitted by: Mark Coscarelli, Office of the Great Lakes, P.O. Box 30473, Lansing, MI 48909-7973, ph: 517/373-3588, fax: 517/335-4053

142 ***Title:*** **Distribution of zebra mussels on navigational buoys**
Research Category: 6.4 Range of Spread
Overview: Examine abundance and mean size of zebra and quagga mussels on navigational buoys in Canadian Waters of Lakes Huron, St. Clair, Erie and Ontario during the winter of 1993.
Principal Investigator(s): Alan Wormington, Ont. Min. Nat. Resources, Weatly, Ontario; R. Dermott, Great Lakes Lab., Fisheries and Oceans Canada, Burlington, Ont.
Start Date: Nov-93
End Date: Mar-94
Funder: Fisheries and Oceans Canada, Great Lakes Water Quality Agreement
Total Cost: $4,500 (CAN)
Publication/Citation: Can. Man. Rpt. Fish. Aquat. Sci.
Geographic Area: Lake Huron, Lake St. Clair, Lake Erie, Lake Ontario
Summary Submitted by: Ronald Dermott, Fisheries and Oceans Canada, 867 Lake Shore Rd., Burlington, ONT L7R 4A6, ph: 905/336-4868, e-mail: DERMOTT@BURFisheries and Oceans.BUR.Fisheries and Oceans.CA

143 ***Title:*** **Bioenergetics model for the zebra mussel**
Research Category: 6.6 Predictive Models
Overview: The objectives are to experimentally examine the effects of flow and suspended sediments on zebra mussel energetics, refine a bioenergetics model using experimental results, and to test model predictions against data from Illinois and Mississippi Rivers. (NOTE: Although this study was not conducted in the Great Lakes basin, the model and energetics information will be useful to Great Lakes Zebra Mussel predictive techniques.)

Principal Investigator(s): Richard Sparks, Dan Schneider, Jim Stoeckel, Forbes Biological Station, PO Box 590, Havana, IL 62644
Start Date: Oct-92
End Date: Oct-96
Funder: U.S. Environmental Protection Agency MED-DULUTH
Total Cost: $294,175 (US)
Publication/Citation: --
Geographic Area: Havana, IL; Upper Mississippi River; Illinois River
Summary Submitted by: Frank Stay, U.S. Environmental Protection Agency MED-DULUTH, 6201 Congdon Blvd., Duluth, MN 55804, ph: 218 720-5542, fax: 218 720-5539, e-mail: STAY.FRANK@U.S. Environmental Protection AgencyMAIL.U.S. Environmental Protection Agency.GOV

144 ***Title:*** **Monitoring and disseminating information on the spread of zebra mussels in the upper Great Lakes -- Northern Lake Michigan sites**
Research Category: 6.6 Predictive Models
Overview: To use literature on distribution and abundance of zebra mussels in Europe to develop predictive models of the abundance and distribution of zebra mussels in North America.
Principal Investigator(s): A. Miller, Wisconsin Sea Grant, D.K. Padilla, Department of Zoology, U-W Madison, 430 Lincoln Drive, Madison, WI 53706, padilla@macc.wisc.edu; S.I. Dodson, Department of Zoology, UW Madison, 430 Lincoln Drive, Madison, WI 53706
Start Date: Jun-90
End Date: Jun-91

Funder: National Oceanic and Atmospheric Administration/Sea Grant
Total Cost: $39,000 (US)
Publication/Citation: Can. J. Fish. Aquat. Sci.
Geographic Area: Northern Lake Michigan
Summary Submitted by: Dr. Diana K. Padilla, Department of Zoology U.W. Madison, 430 Lincoln Dr., Madison, WI 53706, ph: 608/262-6506, fax: 608/265-6320, e-mail: padilla@macc.wisc.edu

145 ***Title:*** **Exotic species invasions -- population dynamics and community consequences of the zebra mussel, *Dreissena polymorpha***
Research Category: 6.6 Predictive Models
Overview: To predict the potential spread and ecological impacts of the zebra mussel invasion in North American Great Lakes Region.
Principal Investigator(s): D.K. Padilla, Department of Zoology, U.W. Madison, 430 Lincoln Drive, Madison, WI 53706, padilla@macc.wisc.edu
Start Date: Jun-91
End Date: May-94
Funder: National Oceanic and Atmospheric Administration
Total Cost: $196,530 (US)
Publication/Citation: Can. J. Fish. Aquat. Sci., 51:1189-1196
Geographic Area: Great Lakes
Summary Submitted by: Dr. Diana K. Padilla, Department of Zoology U.W. Madison, 430 Lincoln Dr., Madison, WI 53706, ph: 608/262-6506, fax: 608/265-6320, e-mail: padilla@macc.wisc.edu

146 ***Title:*** **Exotic species invasions -- ecological consequences and spread of aquatic invaders across a landscape**
Research Category: 6.6 Predictive Models
Overview: To make predictive models of the impact and geographic spread of the zebra mussel invasion.
Principal Investigator(s): D.K. Padilla, Department of Zoology, U.W. Madison, 430 Lincoln Drive, Madison, WI 53706, padilla@macc.wisc.edu
Start Date: Jul-94

147 - 148 Zebra Mussel

End Date: Jun-95
Funder: U.W. Graduate School Research
Total Cost: $17,000 (US)
Publication/Citation: Biol. Conserv.
Geographic Area: Great Lakes
Summary Submitted by: Dr. Diana K. Padilla, Department of Zoology U.W. Madison, 430 Lincoln Dr., Madison, WI 53706, ph: 608/262-6506, fax: 608/265-6320, e-mail: padilla@macc.wisc.edu

147 ***Title:*** **Exotic species invasions -- Ecological consequences and spread of aquatic invaders across a landscape**
Research Category: 6.6 Predictive Models
Overview: Use the spread of previous invading species to predict the path of spread of the zebra mussel and future invading species.
Principal Investigator(s): D.K. Padilla, Department of Zoology, U.W. Madison, 430 Lincoln Drive, Madison WI 53706, padilla@macc.wisc.edu
Start Date: Jul-95
End Date: Jun-96
Funder: U.W. Graduate School Research
Total Cost: $17,000 (US)
Publication/Citation: J. Biogeogr. (in review)
Geographic Area: --
Summary Submitted by: Dr. Dianna K. Padilla, Department of Zoology, U.W. Madison, 430 Lincoln Dr.,

Madison, WI 53706, ph: 608/262-6506, fax: 608/265-6320, e-mail: padilla@macc.wisc.edu

148 ***Title:*** **Prediction and early detection of zebra mussel invasions of the inland waters of Michigan**

Research Category: 6.6 Predictive Models

Overview: We will determine the rate, direction, and spatial pattern of the spread of zebra mussels into the inland waters of Michigan. Specifically, we intend on verifying predictions of the hypothesis that the transfer of mussels by recreational boat traffic between the Great lakes and inland water is responsible for initial invasions. The use of a multifaceted early detection program (EDP) will permit us to evaluate the best means for detecting the early stages of a zebra mussel invasion. We will gather further data with which to predict the spatial patterns of secondary invasions. Finally, we will make pre-invasion collections of planktonic communities to serve as baseline information for future studies on the effects of zebra mussels on aquatic ecosystems.

Principal Investigator(s): Ladd Johnson, Mystic Seaport, Mystic, Connecticut 06355-0990

Start Date: Apr-93

End Date: Aug-93

Funder: Department of Natural Resources

Total Cost: $19,777 (US)

Publication/Citation: Articles in the newsletter of the Michigan Lakes and Stream Association

Geographic Area: Inland water, Lake Michigan

Summary Submitted by: Jennifer Smith, Michigan Sea Grant, 2200 Bonisteel Blvd., Ann Arbor, MI 48109-2099, ph: (313) 763-1437, fax: (313) 747-0768, e-mail: jsjean@umich.edu

Sea Lamprey

149 ***Title:*** **Studies toward a more efficient method of predicting metamorphosis in larval sea lampreys**

Research Category: 1.1 Life History
Overview: Determine condition factor of premetamorphic larvae in populations subjected to different growth conditions, 2) determine whether these criteria need to be adjusted to reflect seasonal/locality differences in weight-length relationships, 3) determine age of metamorphosing larvae and variability in how ages among populations subject to a range of growth conditions, 4) determine relationship between temperature and incidence of metamorphosis.
Principal Investigator(s): Dr. John Holmes, University of Toronto, Toronto, Ontario
Start Date: Jan-96
End Date: Dec-96
Funder: --
Total Cost: $85,042 (CAN)
Publication/Citation: --
Geographic Area: Lake Superior
Summary Submitted by: Great Lakes Fishery Commission, 2100 Commonwealth Blvd. Suite 209, Ann Arbor, MI 48105-1566, ph: 313-662-3209, fax: 313-741-2077

150 ***Title:*** **Hormonal control of metamorphosis in sea lampreys -- examination of the potential for alteration of life history type**

Research Category: 1.1 Life History
Overview: To block/alter metamorphosis in sea lampreys in such a way that adults will not be able to properly feed or will by-pass feeding all together.
Principal Investigator(s): Dr. John Youson, University of Toronto, Toronto, Ontario,
Start Date: 1995
End Date: 1997
Funder: Other
Total Cost: $256,738 (CAN)
Publication/Citation: --
Geographic Area: Michigan, Ontario
Summary Submitted by: Great Lakes Fishery Commission, Great Lakes Fishery Commission, 2100 Commonwealth Blvd. Suite 209, Ann Arbor, MI 48105-1566, ph: 313-662-3209, fax: 313-741-2077

151 ***Title:*** **Estimation of sea lamprey-induced and fishing mortality of lake trout in the main basin of Lake Huron, 1984-1993**

Research Category: 1.2 Population Dynamics
Overview: Evaluate the effects of fishing and sea lamprey-induced mortality rates on lake trout populations in the main basin of Lake Huron, 1984-1993.
Principal Investigator(s): Dr. William W. Taylor, Department of Fisheries and Wildlife, Michigan State University, 13 Natural Resources Bldg. East Lansing, MI 48824-1222, 21844wwt@msu.edu; Dr. James R. Bence, Department of Fisheries and Wildlife, Michigan State University, 13 Natural Resources Bldg. East Lansing, MI 48824-1222, jbence@perm.fw.msu.edu
Start Date: Nov-93
End Date: Mar-96
Funder: Great Lakes Fishery Commission
Total Cost: $60,000 (US)
Publication/Citation: --
Geographic Area: Main basin of Lake Huron, U.S. and Canadian waters

Summary Submitted by: Shawn P. Sitar, Department Fisheries and Wildlife, Michigan State University, 13 Natural Resources Bldg., East Lansing, MI 48824-1222, ph: 517-353-6697, fax: 517-432-1699, e-mail: sitarsha@pilot.msu.edu

152 ***Title:*** **Ecology of recruitment of sea lamprey**

Research Category: 1.3 Environmental Requirements/Tolerance

Overview: 1) To determine whether population characteristics of larval sea lamprey are subject to environmental influence. 2) To determine if recruitment of juvenile lamprey and population reproductive potential are expressions of the ecosystem quality experienced by larvae in native streams. 3) To determine if following an abrupt and precipitous reduction in larval abundance (i.e. chemical treatment), residual and recruited larval lamprey will exhibit rapid growth and, at the population level, a preponderance of females and enhanced fecundity.

Principal Investigator(s): William Beamish, University of Guelph, Guelph, Ontario

Start Date: Mar-96

End Date: 1998

Funder: Other

Total Cost: $313,137 (CAN)

Publication/Citation: --

Geographic Area: Great Lakes

Summary Submitted by: Great Lakes Fishery Commission, 2100 Commonwealth Blvd. Suite 209, Ann Arbor, MI 48105-1566, ph: 313-662-3209, fax: 313-741-2077

153 ***Title:*** **Laboratory testing of green light to attract spawning phase sea lampreys, *Petronyzon marinus***

Research Category: 1.7 Physiology and Behavior

Overview: To determine if spawning-phase sea lampreys are 1) attracted to light, 2) preferentially attracted to green light.

Principal Investigator(s): Kim T. Fredricks, National Biological Service, 11188 Ray Rd., Millersburg, MI 49759, glsc_lake_huron@nbs.gov; Roger A. Bergstedt, National Biological Service, 11188 Ray Rd., Millersburg, MI 49759, glsc_lake_huron@nbs.gov

Start Date: Apr-96 *End Date:* Jun-97

Funder: Federal

Total Cost: $75,500 (US)

Publication/Citation: --

Geographic Area: Lake Superior, Lake Huron, Lake Michigan, Lake Erie, Lake Ontario

Summary Submitted by: Kim T. Fredricks, National Biological Service, Lake Huron Biological Station, 11188 Ray Rd., Millersburg, MI 49759, ph: 517-734-4768, fax: 517-734-4494, e-mail: glsc_lake_huron@nbs.gov

154 ***Title:*** **Using strobe lighting to increase the number of sea lampreys captured for the sterile-male release program**

Research Category: 1.7 Physiology and Behavior

Overview: To determine if strobe lights will increase the percentage of migrating adult sea lampreys that will be captured in traps.

Principal Investigator(s): Kim T. Fredricks, National Biological Service, 11188 Ray Rd., Millersburg, MI 49759, glsc_lake_huron@nbs.gov; William D.Swink, National Biological Service, 11188 Ray Rd., Millersburg, MI 49759, Ron Brown, Flash Technologies

Start Date: May-96

End Date: Jun-96

Funder: Federal

Total Cost: $5,000 (US)

Publication/Citation: --

Geographic Area: Lake Superior, Lake Erie, Lake Michigan, Lake Ontario, Lake Huron
Summary Submitted by: Kim T. Fredricks, National Biological Service, Lake Huron Biological Station, 11188 Ray Rd., Millersburg, MI 49759, ph: 517-734-4768, fax: 517-734-4494, e-mail: glsc_lake_huron@nbs.gov

155 ***Title:*** **Lamprey cell cultures for in vitro production of pheromonally active bile acids**
Research Category: 1.7 Physiology and Behavior
Overview: Develop lamprey cell culture systems that can be utilized for in vitro production of pheromonal bile acids.
Principal Investigator(s): Dr. Paul Collodi, Purdue University
Start Date: Feb-96
End Date: Jan-98
Funder: Other
Total Cost: $99,636 (US)
Publication/Citation: --
Geographic Area: Not applicable
Summary Submitted by: Great Lakes Fishery Commission, Great Lakes Fishery Commission, 2100 Commonwealth Blvd. Suite 209, Ann Arbor, MI 48105-1566, ph: 313-662-3209, fax: 313-741-2077

156 ***Title:*** **Evaluating the seasonality of olfactory function of migratory adult sea lamprey and the distribution of water-borne lamprey bile acids in the Great Lakes to determine whether bile acids function as the lamprey migratory pheromone *(control no. 3400)***
Research Category: 1.7 Physiology and Behavior
Overview: To determine if reductions in reproductive success caused by release of sterile males persist through the larval stage or if they are subjected to compensatory processes.
Principal Investigator(s): Peter Sorensen, University of Minnesota
Start Date: 1994
End Date: 1996
Funder: Other
Total Cost: $120,855 (US)
Publication/Citation: --
Geographic Area: Great Lakes
Summary Submitted by: Great Lakes Fishery Commission, Great Lakes Fishery Commission, 2100 Commonwealth Blvd. Suite 209, Ann Arbor, MI 48105-1566, ph: 313-662-3209, fax: 313-741-2077

157 ***Title:*** **Long-term evaluation of sterile male release for control of sea lampreys in the Great Lakes**
Research Category: 2.2 Biological Interactions - Predator/prey, Parasites/Diseases
Overview: To determine if reductions in reproductive success caused by release of sterile males persist through the larval stage or if they are subjected to compensatory processes.
Principal Investigator(s): Roger A. Bergstedt, National Biological Service, 11188 Ray Rd., Millersburg, MI 49759, glsc_lake_huron@nbs.gov; John Heinrich, Fish and Wildlife Service, Robert Young, Fisheries and Oceans Canada
Start Date: May-96
End Date: Mar-99
Funder: Federal
Total Cost: $55,500 (US)
Publication/Citation: --
Geographic Area: Lake Superior tributaries, Lake Superior, Ontario, Michigan
Summary Submitted by: Roger Bergstedt, National Biological Service, Lake Huron Biological station, 11188 Bay Rd., Millersburg, MI 49759, ph: 517-734-4768, fax: 517-734-4494, e-mail: glsc_lake_huron@nbs.gov

158 ***Title:*** **Evaluate the behavior of Atlantic Ocean male sea lampreys as potential sterile males in the Great Lakes Program**

Research Category: 2.2 Biological Interactions - Predator/prey, Parasites/Diseases
Overview: To determine 1) if larger Atlantic-origin male sea lampreys will spawn with the smaller Great Lakes female sea lampreys, 2) if a dosage of 100 mg/kg of bisazir completely sterilized Atlantic-origin males.
Principal Investigator(s): Kim T. Fredricks, National Biological Service, 11188 Ray Rd., Millersburg, MI 49759, glsc_lake_huron@nbs.gov
Start Date: May-96
End Date: Sep-96
Funder: Federal
Total Cost: $88,100 (US)
Publication/Citation: --
Geographic Area: Lake Superior, Great Lakes
Summary Submitted by: Kim T. Fredricks, National Biological Service, Lake Huron Biological Station, 11188 Ray Rd., Millersburg, MI 49759, ph: 517-734-4768, fax: 517-734-4494, e-mail: glsc_lake_huron@nbs.gov

159 ***Title:*** **Survey for lamprey pathogens and parasites, and determination of the size and timing of Atlantic runs of sea lamprey**

Research Category: 2.2 Biological Interactions - Predator/prey, Parasites/Diseases
Overview: Search for unknown, selective pathogen or parasite of lampreys that might provide biological control for sea lampreys in the Great Lakes, and determine a suitable alternative source of adult male sea lampreys for use with the sterile-male-release techniques of control in the Great Lakes.
Principal Investigator(s): Willliam D. Swink, National Biological Service, 11188 Ray Rd., Millersburg, MI 49759, glsc_lake_huron@nbs.gov; Kim T. Fredricks, National Biological Service, 11188 Ray Rd., Millersburg, MI 49759, glsc_lake_huron@nbs.gov
Start Date: May-96
End Date: Feb-97
Funder: Federal
Total Cost: $55,300 (US)
Publication/Citation: --
Geographic Area: Out of basin
Summary Submitted by: William D. Swink, National Biological Service, Lake Huron Biological Station, 11188 Ray Rd., Millersburg, MI 49759, ph: 517-734-4768, fax: 517-734-4494, e-mail: glsc_lake_huron@nbs.gov

160 ***Title:*** **Conduct sea lamprey studies to determine the survival of burbot attacked by sea lampreys**

Research Category: 2.2 Biological Interactions - Predator/prey, Parasites/Diseases
Overview: Determine the effect of sea lamprey attack on survival of burbot.
Principal Investigator(s): Willliam D. Swink, National Biological Service, 11188 Ray Rd., Millersburg, MI 49759, glsc_lake_huron@nbs.gov
Start Date: Apr-96
End Date: Jun-96
Funder: Federal
Total Cost: $56,600 (US)
Publication/Citation: --
Geographic Area: Lake Ontario, Lake Erie, Lake Huron, Lake Superior, Lake Michigan
Summary Submitted by: William D. Swink, National Biological Service, Lake Huron Biological Station, 11188 Ray Rd., Millersburg, MI 49759, ph: 517-734-4768, fax: 517-734-4494, e-mail: glsc_lake_huron@nbs.gov

161 ***Title:*** **Develop a reliable method for the analysis of bisazir in sea lamprey tissue**

Research Category: 2.2 Biological Interactions - Predator/prey, Parasites/Diseases

Overview: 1) Develop an analytical method to quantify bisazir in sea lampreys; 2) verify that 48 hours after injection, bisazir does not exist in sea lampreys; 3) verify that immediately after injection, sea lampreys have retained a full 100 mg/kg dose of bisazir.

Principal Investigator(s): Ronald J. Scholefield, National Biological Service, 11188 Ray Rd., Millersburg, MI 49759, glsc_lake_huron@nbs.gov

Start Date: 1995

End Date: Dec-96

Funder: Federal

Total Cost: $81,000 (US)

Publication/Citation: --

Geographic Area: Lake Ontario, Lake Erie, Lake Huron, Lake Superior, Lake Michigan

Summary Submitted by: Ronald J.Scholefield, National Biological Service, Lake Huron Biological Station, 11188 Ray Rd., Millersburg, MI 49759, ph: 517-734-4768, fax: 517-734-4494, e-mail: glsc_lake_huron@nbs.gov

162 ***Title:*** **Collaborative design of a raised electrical weir for the Ocqueoc River**

Research Category: 2.3 Physical Measures

Overview: Design a raised, electrical sea lamprey weir that will completely block spawning migrations without creating large impoundments and allow normal passage of other jumping fish species.

Principal Investigator(s): Willliam D. Swink, National Biological Service, 11188 Ray Rd., Millersburg, MI 49759, glsc_lake_huron@nbs.gov; David Smith, Smith-Root, Inc.

Start Date: May-96

End Date: Jan-97

Funder: Federal

Total Cost: $44,100 (US)

Publication/Citation: --

Geographic Area: Lake Superior, Lake Erie, Lake Michigan, Lake Ontario, Lake Huron

Summary Submitted by: William D. Swink, National Biological Service, Lake Huron Biological Station, 11188 Ray Rd., Millersburg, MI 49759, ph: 517-734-4768, fax: 517-734-4494, e-mail: glsc_lake_huron@nbs.gov

163 ***Title:*** **Transport of lampricides in the St. Marys River**

Research Category: 2.4 Chemical Measures

Overview: A computer model for simulating lampricide dispersal patterns in the St. Marys River is being developed. The model will provide a good understanding on the transport and dispersal pattern of lampricide in the river, so that an effective application program can be developed by targeting the lampricide to areas of high larvae populations.

Principal Investigator(s): H.T. Shen, P.D. Yapa, Department of Civil and Env. Engineering, Clarkson University, Potsdam, NY 13699-5710, htshen@sun.soe.clarkson.edu

Start Date: Sep-96

End Date: Aug-96

Funder: Great Lakes Fishery Commission

Total Cost: $21,750 (US)

Publication/Citation: --

Geographic Area: St. Marys River

Summary Submitted by: Hung Tao Shen, Clarkson University, Department of Civil & Envir. Engineering, Potsdam, NY 13599-5710, ph: 315/268-6606, fax: 315/268-7985, e-mail: htshen@sun.soe.clarkson.edu

164 ***Title*:** **Determining the olfactory sensitivity of sea lamprey, a first step in evaluating whether natural odors can be used for biocontrol**

Research Category: 2.4 Chemical Measures

Overview: To determine the olfactory sensitivity of mature male and female sea lamprey to hormonal metabolites which have been postulated to function as sex pheromones in fish. Special emphasis was placed on testosterone and its metabolites because they have been suggested to be pheromonally active in lamprey. To determine the olfactory sensitivity of parasitic-phase lamprey to putative prey odors.

Principal Investigator(s): Peter W. Sorenson, University of Minnesota

Start Date: Jan-91 *End Date:* Dec-91

Funder: Minnesota Sea Grant (R/F-24)

Total Cost: $18,200 (US)

Publication/Citation: J. Gen. Physiol. 105:569-587; Thesis citation: Li, W. 1994. The olfactory biology of adult sea lamprey. Ph.D. Thesis. Univ. Minn. 184 pp.

Geographic Area: --

Summary Submitted by: Douglas A. Jensen, Minnesota Sea Grant Program, 2305 East Fifth Street, Duluth, MN 55812-1445, ph: 218/726-8712, fax: 218/726-6556, e-mail: djensen@mes.umn.ed

165 ***Title:*** **Determining the olfactory sensitivity of sea lamprey -- An essential first step in evaluating whether natural odors can be used for biocontrol**

Research Category: 2.4 Chemical Measures

Overview: To determine the olfactory sensitivity of mature male and 1) the olfactory sensitivity of parasitic and adult sea lamprey to chemical compounds which may serve important roles as feeding stimulants, migrational cues, sexual stimulants (pheromones, and repellents; 2) the biological relevance of identified synthetic olfactory stimulants to determine if they might be useful in biocontrol; 3) verify the biological and olfactory activity of crude odors suggested to have pheromonal actions, and then to chemically characterize them so that they can eventually be identified; and 4) develop an understanding of the structure of lamprey olfactory tissue to learn more about how it functions. Pilot studies demonstrate that olfactory sense is unique among fish suggesting that specific natural attractants with the potential to serve as biocontrol agents may exist.

Principal Investigator(s): Peter W. Sorenson, University of Minnesota

Start Date: Feb-91

End Date: Jan-94

Funder: Minnesota Sea Grant (R/F-24)

Total Cost: $74,930 (US)

Publication/Citation: J. Gen. Physiol. 105:569-587; Thesis citation: Li, W. 1994. The olfactory biology of adult sea lamprey. Ph.D. Thesis. Univ. Minn. 184 pp.

Geographic Area: --

Summary Submitted by: Douglas A. Jensen, Minnesota Sea Grant Program, 2305 East Fifth Street, Duluth, MN 55812-1445, ph: 218/726-8712, fax: 218/726-6556, e-mail: djensen@mes.umn.ed

166 ***Title:*** **Characterizing the biochemical origins and behavioral actions of water-borne acids on sea lamprey and other fish -- the secondary step in evaluating whether natural odors can be used in lamprey population control *(control no. 3125)***

Research Category: 2.4 Chemical Measures

Overview: Determine 1) if production and release of the sea lamprey bile acid cue is related to life-stage and/or feeding activity, 2) whether water-borne bile acids are also detected by larval and parasitic sea lamprey, 3) if production of the sea lamprey bile acid cue is species-specific: do other species of lamprey and teleost fish produce and release the same bile acids as sea lamprey? 4) if biological actions of sea lamprey bile acids are species-specific: do the olfactory systems of three species of lamprey and teleost fish also detect these compounds? Characterization of the olfactory sensitivity of sea lamprey led

to the discovery that this system is acutely and specifically sensitive to two novel bile acids produced and released by larval sea lamprey. This cue may be the lamprey migratory pheromone.

Principal Investigator(s): Peter W. Sorenson, University of Minnesota, Daniel D. Gallaher, University of Minnesota
Start Date: Feb-94
End Date: Jan-96
Funder: Minnesota Sea Grant (R/F-25)
Total Cost: $120,419 (US)
Publication/Citation: J. Gen. Physiol. 105:569-587. Thesis citation: Li, W. 1994. The olfactory biology of adult sea lamprey. Ph.D. Thesis Univ. Minn. 184 pp
Geographic Area: --
Summary Submitted by: Douglas A. Jensen, Minnesota Sea Grant Program, 2305 East Fifth Street, Duluth, MN 55812-1445, ph: 218/726-8712, fax: 218/726-6556, e-mail: djensen@mes.umn.ed

167 ***Title:*** **Evaluate the toxicity of new Bayer granules to larval lampreys under different water velocities in laboratory studies *(control no. 3335)***

Research Category: 2.4 Chemical Measures
Overview: To determine the effect of current velocity on the effectiveness of a new bottom-release formulation of the lampricide Bayer-73 (niclosamide) against burrowed sea lamprey larvae.
Principal Investigator(s): Roger A. Bergstedt, National Biological Service, 11188 Ray Rd., Millersburg, MI 49759, glsc_lake_huron@nbs.gov; Ronald J.Scholefield, National Biological Service, 11188 Ray Rd., Millersburg, MI 49759
Start Date: Oct-94 *End Date:* Oct-96
Funder: Federal
Total Cost: $94,400 (US)
Publication/Citation: --
Geographic Area: Michigan, Lake Huron
Summary Submitted by: Roger Bergstedt, National Biological Service, Lake Huron Biological station, 11188 Bay Rd., Millersburg, MI 49759, ph: 517-734-4768, fax: 517-734-4494, e-mail: glsc_lake_huron@nbs.gov

168 ***Title:*** **Prepare lampricide analytical field standards for control units**

Research Category: 2.4 Chemical Measures
Overview: Provide sea lamprey control agents with lampricide (TFM and Bayer 73) standards for use during stream treatment.
Principal Investigator(s): Ronald J. Scholefield, National Biological Service, 11188 Ray Rd., Millersburg, MI 49759, glsc_lake_huron@nbs.gov
Start Date: many years
End Date: ongoing
Funder: Federal
Total Cost: $3,100/per year (US)
Publication/Citation: --
Geographic Area: Lake Ontario, Lake Erie, Lake Huron, Lake Superior, Lake Michigan
Summary Submitted by: Ronald J.Scholefield, National Biological Service, Lake Huron Biological Station, 11188 Ray Rd., Millersburg, MI 49759, ph: 517-734-4768, fax: 517-734-4494, e-mail: glsc_lake_huron@nbs.gov

169 ***Title:*** **Evaluate TFM samples for physical, chemical, and toxicological properties**

Research Category: 2.4 Chemical Measures
Overview: Determine if treatment-grade TFM meets the GLFC specifications for physical and chemical characteristics, percent active ingredient, toxicity and selectivity.

Principal Investigator(s): Ronald J. Scholefield, National Biological Service, 11188 Ray Rd., Millersburg, MI 49759, glsc_lake_huron@nbs.gov
Start Date: 1990
End Date: ongoing
Funder: Federal
Total Cost: $110,500 (US)
Publication/Citation: --
Geographic Area: Lake Ontario, Lake Erie, Lake Huron, Lake Superior, Lake Michigan
Summary Submitted by: Ronald J.Scholefield, National Biological Service, Lake Huron Biological Station, 11188 Ray Rd., Millersburg, MI 49759, ph: 517-734-4768, fax: 517-734-4494, e-mail: glsc_lake_huron@nbs.gov

170 ***Title:*** **Analyze water samples from sterilization process for bisazir *(control no. 3390)***
Research Category: 2.4 Chemical Measures
Overview: In accordance with our NPDES permit, the discharge water from the sea lamprey sterilization facility at LHBS is monitored for bisazir.
Principal Investigator(s): Ronald J. Scholefield, National Biological Service, 11188 Ray Rd., Millersburg, MI 49759, glsc_lake_huron@nbs.gov
Start Date: 1990
End Date: ongoing
Funder: Federal
Total Cost: $250,000 (US)
Publication/Citation: --
Geographic Area: Lake Huron, Michigan
Summary Submitted by: Ronald J.Scholefield, National Biological Service, Lake Huron Biological Station, 11188 Ray Rd., Millersburg, MI 49759, ph: 517-734-4768, fax: 517-734-4494, e-mail: glsc_lake_huron@nbs.gov

171 ***Title:*** **Restoration of salmonids to Lake Champlain *(control no. 1530)***
Research Category: 2.5 Consequences of Control
Overview: To reduce the sea lamprey population sufficiently to increase survival of salmon and trout to explore alternatives of chemical control of sea lamprey.
Principal Investigator(s): Jon Anderson, Vt. Fish & Wildlife, 111 West St. Essex, VT 05452, JAnderson@anressex.anr.state.vt.us; Brian Chipman, Vt. Fish & Wildlife, 111 West St., Essex, VT 05452, BChipman@anressex.anr.state.vt.us
Start Date: 1990
End Date: 1998
Funder: Fed. Aid.
Total Cost: $300,000 (US)
Publication/Citation: --
Geographic Area: Lake Champlain
Summary Submitted by: Jon Anderson, Vt. Fish & Wildlife, 111 West St., Essex Sct., VT 95452, ph: 802/878-1564, e-mail: JAnderson@anressex.anr.state.vt.us

172 ***Title:*** **Biomonitors *(control no. 2030)***
Research Category: 3.4 Food Web Structure
Overview: Comparison between lamprey ammocoets and bivalve molluscs as biomonitors of organochlorine contaminants.
Principal Investigator(s): Claude Renaud, CMN, 1770 Pink Rd., Alymer, Quebec; Michael Comba, Environment Canada, Burlington, ONT, Klaus Kaiser, Environment Canada
Start Date: Apr-91
End Date: ongoing
Funder: Environment Canada
Total Cost: $35,000 (CAN)

Publication/Citation:	Can. J. Fish. Aquat. Sci.
Geographic Area:	seven rivers of the St. Lawrence Basin
Summary Submitted by:	Michael Comba, Lakes Research Branch, National Water Research Institute, P.O. Box 5050, 867 Lakeshore Rd., Burlington, ONT L7R 4A6, ph: 905/336-4617, fax: 905/336-6430, e-mail: Michael.Comba@cciw.ca

172 ***Title:*** **Survey and geographical distribution of sea lamprey larvae in the St. Marys River**

Research Category:	6.4 Range of Spread
Overview:	To provide geographically referenced data on larval abundance in the St. Marys River. Those data will be combined with data from models of lampricide transport to predict treatment effectiveness.
Principal Investigator(s):	Roger A. Bergstedt, Lake Huron Biological station, 11188 Bay Rd., Millersburg, MI 49759, glsc_lake_huron@nbs.gov
Start Date:	Jun-93
End Date:	ongoing
Funder:	Federal
Total Cost:	$84,900 (US)
Publication/Citation:	--
Geographic Area:	St. Marys River, Lake Huron, Michigan, Ontario
Summary Submitted by:	Roger Bergstedt, National Biological Service, Lake Huron Biological station, 11188 Bay Rd., Millersburg, MI 49759, ph: 517-734-4768, fax: 517-734-4494, e-mail: glsc_lake_huron@nbs.gov

Ruffe; for additional research projects addressing the Ruffe, see listing 203.

173 ***Title:*** **Early life history of ruffe in the St. Louis River estuary**

Research Category: 1.1 Life History

Overview: 1. To locate pre-spawning aggregations of ruffe. 2. To determine time of spawning 3. To determine time and location of hatching and 4. To describe possible vertical and horizontal movements of larval ruffe.

Principal Investigator(s): William P. Brown, James Selgeby, Hollie Collins, Univ. of Minnesota, 10 University Dr., Duluth, MN 55801

Start Date: Apr-92

End Date: Mar-95

Funder: U.S. Environmental Protection Agency

Total Cost: $70,000 (US)

Publication/Citation: --

Geographic Area: St. Louis River near Duluth, MN

Summary Submitted by: William P. Brown, National Biological Service, 2800 Lake Shore Drive East, Ashland, WI 54806-2427, ph: 715/682-6163, fax: 715/682-6163

174 ***Title:*** **An assessment of the feasibility of controlling the spread of ruffe *(Gymnocephalus cernuus*) in the Great Lakes by application of chemical toxicants to tributary streams**

Research Category: 1.1 Life History

Overview: Despite exceptional reproduction and increasing numbers of yellow perch in the St. Louis River, concerns remain regarding the ecological impacts of ruffe. The Ruffe Control Committee proposed a strategy to stop or slow the spread of ruffe by eliminating them from river mouths at the periphery of their range. This strategy is feasible assuming that all ruffe enter river mouths at a predictable time. To evaluate this assumption, ruffe abundance and reproductive conditions were monitored in the mouths of the Iron and Sand Rivers during the summer of 1995 and ruffe were collected from Lake Superior near each river mouth during June 19-22. Mid June had been proposed as the most likely time for ruffe aggregations. Patterns of ruffe abundance in two rivers were dissimilar, with peak abundance occurring in May in the Sand River and in late June in the Iron River. Large numbers of ruffe remained in the lake. Ruffe were found at densities of approximately 21 per hectare in the 1-10m depth range in Lake Superior near the Iron River. Lake Superior warms to temperatures suitable for ruffe spawning throughout June. These results do not support the assumption of the range reduction strategy.

Principal Investigator(s): William H. Horns, Dennis M. Pratt and Scott R Hulse

Start Date: --

End Date: --

Funder: --

Total Cost: --

Publication/Citation: --

Geographic Area: Lake Superior

Summary Submitted by: William H. Horns, Wisconsin Department of Natural Resources, 101 S. Webster, Madison, WI 53707, ph: 608/266-8782, fax: 608/267-7857, e-mail: HRONSW@Department of Natural Resources.STATE.WI.U.S.

175 ***Title:*** **Geographic variation and colonization patterns of ruffe (*Gymnocephalus cernuus*) in the Great Lakes -- Otolith signatures and DNA sequence divergence**

Research Category: 1.1 Life History

Overview: Determine the European origins of ruffe, *Gymnocephalus cernuus*, within the Great Lakes and its colonization patterns with the streams and estuaries of Lake Superior.

Principal Investigator(s): George R. Spangler, University of Minnesota, Duluth, MN; Carol Stepien, Case Western Reserve University

Start Date: Jun-95
End Date: May-98
Funder: Minnesota Sea Grant (R/F-30)
Total Cost: $177,150 (US)
Publication/Citation: --
Geographic Area: Lake Superior
Summary Submitted by: Douglas A. Jensen, Minnesota Sea Grant Program, 2305 East Fifth Street, Duluth, MN 55812-1445, ph: 218/726-8712, fax: 218/726-6556, e-mail: djensen@mes.umn.ed

176 ***Title:*** **Evaluation of abundance and dynamics of ruffe populations, Thunder Bay, Lake Huron**

Research Category: 1.2 Population Dynamics
Overview: With the discovery of ruffe in Lake Huron's Thunder Bay, a need was created for monitoring population strength and dynamics, and to begin collecting baseline information on the nearshore fish community to measure changes resulting from potential population increases. The study was initiated in August 1995 in Thunder Bay adjacent to the mouth of the Thunder Bay River near Alpena, Michigan.
Principal Investigator(s): Jerry R. McClain, U.S. Fish and Wildlife Service, 145 Water Street, Alpena, MI 49707, Jerry_McClain@mail.fws.gov
Start Date: Sep-95
End Date: ongoing
Funder: U.S. Fish and Wildlife Service
Total Cost: $25,000 (US)
Publication/Citation: --
Geographic Area: Thunder Bay, Alpena, MI
Summary Submitted by: Jerry R. McClain, U.S. Fish and Wildlife Service, Federal Bldg., #203, 145 Water Street, Alpena, MI 49707, ph: 517/356-5102, fax: 517/36-4651, e-mail: Jerry_McClaine@ mail.fws.gov

177 ***Title:*** **Preliminary evaluation of ruffe reproductive capabilities in Lake Superior by histological examination of ovaries**

Research Category: 1.2 Population Dynamics
Overview: To assess the dynamics of oogenesis of different ages.
Principal Investigator(s): Richard Leino, University of Minnesota, Duluth, MN
Start Date: Feb-96
End Date: Jan-98
Funder: Minnesota Sea Grant
Total Cost: $5,000 (US)
Publication/Citation: Am. Fish. Soc. (submitted)
Geographic Area: St. Louis River Estuary, Lake Superior
Summary Submitted by: Douglas A. Jensen, Minnesota Sea Grant Program, 2305 East Fifth Street, Duluth, MN 55812-1445, ph: 218/726-8712, fax: 218/726-6556, e-mail: djensen@mes.umn.ed

178 ***Title:*** **Bioenergetics modeling to evaluate top-down control of ruffe *(Gynmocephalus cernuus*)**

Research Category: 2.2 Biological Interactions - Predator/prey, Parasites/Diseases
Overview: 1) To obtain a caloric energy density value for ruffe; 2) to evaluate the effectiveness of a top-down predator control strategy on ruffe; 3) and to examine the increased predator impact on the native prey fish community.
Principal Investigator(s): Kathleen Mayo, National Biological Service, 2800 Lake Shore Drive East, Ashland, WI 54806-2427

Start Date: Sep-94
End Date: May-96
Funder: Minnesota Sea Grant
Total Cost: $30,000 (US)
Publication/Citation: --
Geographic Area: St. Louis River Harbor between Duluth, MN and Superior, WI
Summary Submitted by: Kathleen R. Mayo, National Biological Service, 2800 Lake Shore Drive East, Ashland, MI 54806-2427, ph: 715/682-6163

179 ***Title:*** **Control of harmful fish through natural spawning pheromone attractants**

Research Category: 2.2 Biological Interactions - Predator/prey, Parasites/Diseases
Overview: Introduction of exotic species have resulted in significant impacts to Great Lakes aquatic resources. This habitat protection and restoration project to control the Eurasian ruffe and the common carp, will be conducted in the St. Louis River estuary, Lake Superior by the Fond du Lac Natural Resources Program and Ceded Territory Biologist, the National Biological Service, and the College of Fisheries and Wildlife-University of Minnesota/St. Paul. The project goal is to determine and implement an effective control method for ruffe and carp through the use of reproductive pheromones to supplement other control measures to prevent or significantly slow the further expansion of these harmful exotic species. Methodologies developed could be applied basin-wide.
Principal Investigator(s): Larry Schwartskopf, Fond du Lac Natural Resources Program, 105 University Road, Cloquet, MN 55720; Dr. Peter Sorenson, Department of Fish and Wildlife, Univ. of Minnesota, 200 Hodson Hall, 1980 Folwell Ave., St. Paul, MN; James Selgeby, National Biological Service, Ashland, WI
Start Date: Sep-94
End Date: Sep-96
Funder: U.S. Environmental Protection Agency, Great Lakes National Program Office
Total Cost: $70,000 (US)
Publication/Citation: --
Geographic Area: St. Louis River Estuary
Summary Submitted by: Richard Greenwood, U.S. Fish and Wildlife Service/U.S. Environmental Protection Agency, Great Lakes National Program Office, 77 West Jackson Blvd. (G-9J), Chicago, IL 60604, ph: 312/886-3853, fax: 312/353-2018, e-mail: rich_greenwood@mail.fws.gov

180 ***Title:*** **Evaluation of avoidance behavior of ruffe exposed to selected formulations of the piscicides TFM, Bayluscide, Rotenone, Antimycin**

Research Category: 2.4 Chemical Measures
Overview: 1) To develop classical avoidance data for ruffe during exposure to various concentrations of the piscicides TFM, Bayluscide, Rotenone, and Antimycin. 2) To evaluate the potential for the normally bottom-dwelling ruffe, to move vertically in the water column to avoid piscicides dissolving from the new timed-release formulations of Bayluscide and Antimycin.
Principal Investigator(s): Verdel K. Dawson, Upper Mississippi Science Center, National Biological Service, P.O. Box 818, LaCrosse, WI 54602
Start Date: Sep-95
End Date: Sep-96
Funder: U.S. Fish and Wildlife Service
Total Cost: $52,000 (US)
Publication/Citation: --
Geographic Area: --
Summary Submitted by: Thomas Busiahn, U.S. Fish and Wildlife Service, 2800 Lake Shore Drive East, Ashland, WI 54806, ph: 715/682-6185, fax: 715/682-8899, e-mail: Tom_Busiahn@mail.fws.gov

181 ***Title:*** **Identification of the ruffe oocyte maturation--Inducing substance and characterization of its receptor**

Research Category: 2.4 Chemical Measures
Overview: 1) Determine the hormonal basis of ruffe oocyte maturation. 2) Determine hormonal genesis of ruffe sex pheromones. 3) Characterize the response of ruffe to pheromonal signals. 3) Identify the molecules involved with sperm-egg binding during fertilization. 4) Test the agents designed to block or interfere with hormonal development, pheromonal signaling at the organismal or cellular level, or gamete binding for their ability to reduce or eliminate ruffe reproduction.
Principal Investigator(s): Patrick K. Schoff, University of Minnesota, Duluth; MN, Peter Sorenson, University of Minnesota, Duluth, MN; John Holy, University of Minnesota, Duluth, MN; Peter Thomas, University of Texas, Austin
Start Date: Jun-95
End Date: May-98
Funder: Minnesota Sea Grant (R/F-29)
Total Cost: $311,138 (US)
Publication/Citation: No
Geographic Area: Lake Superior
Summary Submitted by: Douglas A. Jensen, Minnesota Sea Grant Program, 2305 East Fifth Street, Duluth, MN 55812-1445, ph: 218/726-8712, fax: 218/726-6556, e-mail: djensen@mes.umn.ed

182 ***Title:*** **Evaluation of avoidance behavior of ruffe exposed to selected formulations of piscicides**

Research Category: 2.4 Chemical Measures
Overview: To determine the avoidance behavior of ruffe exposed to various concentrations and formulations of piscicides.
Principal Investigator(s): Verdel Dawson, Upper Mississipi Science Center, P.O. Box 818, LaCrosse, WI 54602; Terry Bills, Upper Mississipi Science Center, P.O. Box 818, LaCrosse, WI 54602; Michael Boogaard, Upper Mississipi Science Center, P.O. Box 818, LaCrosse, WI 54602
Start Date: Sep-95
End Date: Sep-96
Funder: Federal government
Total Cost: $20,000 (US)
Publication/Citation: --
Geographic Area: Lake Superior, Wisconsin
Summary Submitted by: Verdel Dawson, National Biological Service, P.O. Box 818, La Crosse, WI 54602, ph: 608-783-6451, fax: 608-783-6066, e-mail: verdel_dawson@nbs.gov

183 ***Title:*** **Spatial changes in the distribution and abundance of ruffe and native fishes in the St. Louis River Estuary, 1989-94**

Research Category: 3.1 Community Structure
Overview: A GIS was used to examine and map changes in density and habitat distributions of ruffe and selected native species in the St. Louis estuary, Duluth, MN from 1989-94. Density and distribution data was provided by National Biological Service trawling surveys. Project collaborators included University of Minnesota, Duluth, EPA, NBS. A master of science thesis was produced in July 1995 with project results.
Principal Investigator(s): Andrew Edwards, National Biological Service, Ashland, WI; Jim Selgeby, National Biological Service, Ashland, WI; Dr. Hollie Collins, University of MN, Duluth, 10 University Drive, Duluth, MN 55810
Start Date: Apr-92
End Date: Mar-95
Funder: U.S. Environmental Protection Agency
Total Cost: $70,000 (US)
]

Publication/Citation: --
Geographic Area: St. Louis estuary, Duluth, MN
Summary Submitted by: Andrew J. Edwards, National Biological Service, 2800 Lake Shore Drive East, Ashland, WI 54806-2427, ph: 715/682-6163, fax: 715/682-6163, e-mail: Andy-Edwards@nbs.gov

184 ***Title:*** **Potential impacts of invading ruffe (*Gymnocephalus cernuus*)**
Research Category: 3.1 Community Structure
Overview: The purpose is to 1) identify the relationship between ruffe feeding and benthic communities; 2) delineate the extent and nature of interactions between ruffe and native Great Lakes fishes; 3) understand the effects of ruffe on nutrient cycling in lentic systems; and 4) predict the magnitude of impact that ruffe may have on ecosystems with differing physical and trophic conditions within the Great Lakes.
Principal Investigator(s): Carl Richards, Richard P. Axler, and Anne E. Hershey, University of Minnesota, Duluth, MN; Edward S. Rutherford, University of Michigan, Gary A. Lamberti and David M. Lodge, University of Notre Dame; Martin B. Berg, University of Loyola; Michael C. Miller, University of Cincinnati
Start Date: Jun-95
End Date: May-98
Funder: Minnesota Sea Grant (R/F-28)
Total Cost: $1,061,712 (US)
Publication/Citation: --
Geographic Area: Lake Superior
Summary Submitted by: Douglas A. Jensen, Minnesota Sea Grant Program, 2305 East Fifth Street, Duluth, MN 55812-1445, ph: 218/726-8712, fax: 218/726-6556, e-mail: djensen@mes.umn.ed

185 ***Title:*** **Comparisons of biodiversity in harbors with and without ruffe (*Gymnocephalus cernuus*)**
Research Category: 3.1 Community Structure
Overview: 1) To determine whether fish communities in dredged channels of Lake Erie harbors are vulnerable to the introduction of the ruffe. 2) To gain a better understanding of the effects that the introduction of ruffe has had on the fish communities of the dredged channel areas of the St. Louis River and what effects an introduction may have on the fish communities of dredged channel areas in Lake Erie. A)Examine changes in fish communities in dredged channels of St. Louis River (1989-1995), species abundance and diversity. B)Examine fish communities in dredged channels of 7 Lake Erie harbors. C) Apply Shannon-Weiner Diversity and Percent Similarity indices as measures of comparison.
Principal Investigator(s): Sandra M. Keppner, Thomas Czapla, U.S. Fish & Wildlife Service, 405 North French Road, Amherst, NY 14228, R5FFA_LGLFRO@mail.fws.gov
Start Date: Oct-95
End Date: Sep-95
Funder: U.S. Fish and Wildlife Service (Nonindigenous Aquatic Nuisance Species Prevention and Control funding)
Total Cost: $12,500 (US)
Publication/Citation: --
Geographic Area: St. Louis River, Lake Superior (Duluth, MN); Lake Erie sites include Maumee River, Sandusky Harbor, Cuyahoga River, Ashtabula Harbor, Conneaut Harbor, Erie Harbor and Buffalo Harbor
Summary Submitted by: Sandra M. Keppner, U.S. Fish and Wildlife Service, 405 North French Road, Amherst, NY 14228, ph: (716)691-5456, fax: (716)691-6154, e-mail: R5FFA_LGLFRO@mail.fws.gov

186 ***Title:*** **Invertebrate macrobenthos of the St. Louis River -- food available for benthophagus fishes**

Research Category: 3.4 Food Web Structure
Overview: Characterize the benthos community of the St. Louis River Estuary and compare benthos available for forage and those eaten by ruffe.
Principal Investigator(s): Michael E. McDonald, University of Minnesota, Duluth, MN
Start Date: Oct-94
End Date: May-95
Funder: Minnesota Sea Grant
Total Cost: $7,827 (US)
Publication/Citation: --
Geographic Area: St. Louis River Estuary, Lake Superior
Summary Submitted by: Douglas A. Jensen, Minnesota Sea Grant Program, 2305 East Fifth Street, Duluth, MN 55812-1445, ph: 218/726-8712, fax: 218/726-6556, e-mail: djensen@mes.umn.ed

187 ***Title:*** **Trophic relations of the exotic ruffe (*Gymnocephalus*)**

Research Category: 3.5 Predator/Prey Interactions
Overview: To investigate the feeding ecology and potential control of ruffe based on the --- 1) food habits of ruffe, and 2) predation of ruffe and other forage fish by indigenous piscivores, in the St. Louis River estuary near Duluth, MN.
Principal Investigator(s): Raymond M. Newman, University of Minnesota; Mary G. Henry, University of Minnesota.
Start Date: Jan-90
End Date: Dec-91
Funder: Minnesota Sea Grant
Total Cost: $66,294 (US)
Publication/Citation: Trans. Amer. Fish. Soc. 124:356-369
Geographic Area: St. Louis River estuary near Duluth, MN
Summary Submitted by: Douglas A. Jensen, Minnesota Sea Grant Program, 2305 East Fifth Street, Duluth, MN 55812-1445, ph: 218/726-8712, fax: 218/726-6556, e-mail: djensen@mes.umn.ed

188 ***Title:*** **A test in experimental management -- Applications of top-down predator control for pest management**

Research Category: 3.5 Predator/Prey Interactions
Overview: To assess manipulation of piscivore levels to reduce ruffe biomass in the St. Louis River Estuary, Lake Superior.
Principal Investigator(s): Gerald L. Hill, University of Minnesota, Duluth, MN
Start Date: Sep-94
End Date: Jan-96
Funder: American Indians in Marine Science, University of Minnesota Sea Grant College Program, National Sea Grant College Program
Total Cost: $21,490 (US)
Publication/Citation: --
Geographic Area: St. Louis River Estuary, Lake Superior
Summary Submitted by: Douglas A. Jensen, Minnesota Sea Grant Program, 2305 East Fifth Street, Duluth, MN 55812-1445, ph: 218/726-8712, fax: 218/726-6556, e-mail: djensen@mes.umn.ed

189 ***Title:*** **Great Lakes ballast water study**

Research Category: 4.2 Definition of Vectors of Introduction - Shipping, Bait, Aquaria, Canals, Biological Vectors

Overview: Concerns over the potential spread of ruffe (*Gymnocephalus cernuus*) via inter- or intra-lake ballast water prompted MN Sea Grant and the Seaway Port Authority of Duluth to cooperatively initiate a study to identify which Great Lakes ports experience the greatest relative risk for ruffe infestation based on 1993 shipping patterns and amount of deballasted water taken from the Duluth-Superior Harbor.
Principal Investigator(s): Jeffrey L. Gunderson, University of Minnesota, Duluth, MN; Graham Tobin, University of Minnesota
Start Date: May-93
End Date: Dec-93
Funder: Minnesota Sea Grant
Total Cost: $13,600 (US)
Publication/Citation: --
Geographic Area: Lake Superior, Great Lakes ports
Summary Submitted by: Douglas A. Jensen, Minnesota Sea Grant Program, 2305 East Fifth Street, Duluth, MN 55812-1445, ph: 218/726-8712, fax: 218/726-6556, e-mail: djensen@mes.umn.ed

190 Title: **Great Lakes voluntary ballast water management plan**
Research Category: 4.3 Determination of Preventive Measures
Overview: Owners and operators of vessels in the domestic and international trade on the Great Lakes recognize their role in assisting the governments of the United States and Canada in controlling the introduction and spread of non-indigenous fish species. We recognize that control must be on many fronts, including ballast water management, chemical control, predatory fish control, and other mechanisms. Vessels must use ballast water for safety purposes to provide adequate stability, trim, propulsion, maneuverability, and hull stress control. Recognizing these constraints, the marine industry will do everything within its power, consistent with safety and stability, to decrease the spread of known unwanted non-indigenous species. The introduction of new species from outside the system is under the control of the U.S. and Canadian Coast Guards through ballast water exchange regulations prior to entry into the system. This plan deals with the control of the spread of the European Ruffe from Western Lake Superior ports, in particular, Duluth/Superior or other harbors where Ruffe colonies are documented.
Principal Investigator(s): Seaway Port Authority of Duluth, 1200 Port Terminal Dr., Duluth, MN 55802; The Thunder Bay Harbour Commission, 100 Main St., Thunder Bay, ONT P7B 6R9; Lake Carriers' Association, 915 Rockefeller Bldg., 614 Superior Ave. W., Cleveland, OH 44113-1383; U.S. Great Lakes Shipping Association, 3434 E. 95th St., Chicago, IL 60617; Canadian Shipowners Association, 350 Sparks St., Ste. 705, Ottawa, ONT K1S 7S8; Shipping Federation of Canada, 300 St. Sacrement St., Ste.326, Montreal, Quebec H2Y 1X4
Start Date: --
End Date: --
Funder: --
Total Cost: --
Publication/Citation: Great Lakes Maritime Industry Voluntary Ballast Water Management Plan for the Control of Ruffe in Lake Superior Ports
Geographic Area: Great Lakes
Summary Submitted by: Lisa Marciniak for Ray Skelton, Seaway Port Authority of Duluth, 1200 Port Terminal Drive, Duluth, MN 55802, ph: 218/727-8525, fax: 218/727-6888.

191 Title: **Growth temperature relation for young of the year ruffe**
Research Category: 6.4 Range of Spread
Overview: Determine the fundamental thermal niche of the ruffe to provide the basis for determining the habitat it is likely to colonize in the Great Lakes and elsewhere in North America--if it spreads from its population center in western Lake Superior.

Principal Investigator(s): Thomas A. Edsall, National Biological Service, Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI 48105, Thomas_Edsall@NBS.gov
Start Date: Aug-92
End Date: Aug-93
Funder: National Biological Service
Total Cost: $30,000 (US)
Publication/Citation: J. Great Lakes Res. 19(3), 630-633
Geographic Area: Western Lake Superior
Summary Submitted by: Thomas A. Edsall, National Biological Service, Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI 48105, ph: 313/994-3331, ext.235, fax: 313/994-8780, e-mail: Thomas_Edsall@NBS.gov

192 ***Title:*** **Surveillance for ruffe, 1995**

Research Category: 6.4 Range of Spread
Overview: 1) Locate new populations of ruffe and/or size composition. 2) Describe the fish community of each location surveyed, and to monitor locations where ruffe had been previously sighted.
Principal Investigator(s): Ashland Fishery Resources Office, U.S. Fish and Wildlife Service, 2800 Lake Shore Drive Suite 8, Ashland, WI 34806
Start Date: 1995
End Date: 1995
Funder: U.S. Fish and Wildlife Service
Total Cost: $14,000 (US)
Publication/Citation: --
Geographic Area: Lake Superior, Northern Lake Michigan and Lake Huron
Summary Submitted by: Kerry Kindt, Ashland Fishery Resources Office, U.S. Fish and Wildlife Service, 2800 Lakeshore Dr. East, Suite B, Ashland, WI 54806

Round Goby; for additional research projects addressing the Round Goby, see listing 42.

193 ***Title:*** **The round goby (*Neogobius melanostomus*) --- an exotic fish invader in the Great Lakes**

Research Category: 1.1 Life History
Overview: Objectives --- 1) Predation on zebra mussels by round gobies (ms submitted) 2) behavioral interactions between the exotic round goby and the native, mottled sculpin (*Cottus bairdi*) (ms in preparation) 3) feeding habits (day vs night) on different sizes of gobies throughout the open water season in the Detroit River (work in progress) 4) age, growth, survivorship and reproduction of round gobies in the St. Clair/Detroit River 5) habitat preference and dispersal of round gobies in Detroit River and Western basin of Lake Erie.
Principal Investigator(s): Dr. Lynda D. Corkum, Univ. of Windsor, Department of Biological Sciences, Windsor, ONT N9B 3P4, corkum@server.uwindsor.ca
Start Date: Jun-94
End Date: Aug-94
Funder: Ministry of the Environment and Energy
Total Cost: $17,000 (CAN)
Publication/Citation: in review process for J. Great Lakes Res.
Geographic Area: Detroit River, St. Clair River, Western basin of Lake Erie
Summary Submitted by: Dr. Lynda D. Corkum, Univ. of Windsor, Department of Biological Sciences, ph: 519/253-4232 ext.2717, fax: 519/971-3609, e-mail: corkum@server.uwindsor.ca

194 ***Title:*** **Diet of round goby in the St. Clair River and Lake St. Clair**

Research Category: 1.1 Life History
Overview: Document the diet of round gobies in the St. Clair River and Lake St. Clair during 1993.
Principal Investigator(s): Mike Thomas, Michigan Department of Natural Resources, 33135 S. River Rd, Mt. Clemens, MI 48045
Start Date: May-93 *End Date:* Oct-93
Funder: MI Department of Natural Resources
Total Cost: --
Publication/Citation: --
Geographic Area: St. Clair River, Lake St. Clair
Summary Submitted by: Mike Thomas, Michigan Department of Natural Resources, 33135 S. River Rd., Mt.Clemens, MI 48045, ph: 810-465-4771, fax: 810-465-7504

195 ***Title:*** **Round and tubenose gobies in Lake St. Clair**

Research Category: 1.1 Life History
Overview: 1) To monitor the colonization of Lake St. Clair by both goby species. 2) Document the life history characteristics of both goby species for Lake St. Clair. 3) Monitor the fish community impact of both goby species for Lake St. Clair.
Principal Investigator(s): Mike Thomas, Michigan Department of Natural Resources, 33135 S. River Rd., Mt. Clemens, MI 48045; Robert C. Haas, Michigan Department of Natural Resources, 33135 S. River Rd., Mt. Clemens, MI 48045
Start Date: Apr-96
End Date: --
Funder: MI Department of Natural Resources, DJ project study 488 of F-35-R
Total Cost: $265,000 (US)
Publication/Citation: --
Geographic Area: Lake St. Clair
Summary Submitted by: Mike Thomas, Michigan Department of Natural Resources, 33135 S. River Rd., Mt.Clemens, MI 48045, ph: 810-465-4771, fax: 810-465-7504

196 ***Title:*** **Preliminary assessment of the potential effects of introduced gobies on aquatic ecosystems in Illinois**

Research Category: 1.2 Population Dynamics
Overview: Monitor the spread and population growth of round gobies in Lake Michigan, the Calumet/Illinois River system, and tributaries of southern Lake Michigan.
Principal Investigator(s): D. Soluk, W. Resetarits, J.E. Marsden, Illinois Natural History Survey; J. Janssen, Loyola University
Start Date: Sep-95
End Date: Aug-97
Funder: Environmental Protection Trust Fund Commission (Illinois Department of Natural Resources)
Total Cost: $149,515 (US)
Publication/Citation: --
Geographic Area: Calumet/Illinois River system, Lake Michigan
Summary Submitted by: J. Ellen Marsden, Illinois Natural History Survey, Lake Michigan Biological Station, 400 17th St., Zion, IL 60099, ph: 708/872-8677, fax: 708/872-8679, e-mail: JMARSDEN@UIUC.EDU

197 ***Title:*** **Range expansion, diet and ecology of round goby in Central Basin Lake Erie**

Research Category: 1.2 Population Dynamics
Overview: To examine increasing abundance, distribution and food habits of round goby in Ohio waters of Lake Erie.
Principal Investigator(s): Carey Knight, Fairport Fisheries Research Station, 421 High Street, Fairport Harbor, OH 44077
Start Date: Jul-95
End Date: Jul-97
Funder: Ohio Department of Natural Resources, Division of Wildlife
Total Cost: $39,828 (US)
Publication/Citation: Ohio's Lake Erie Fisheries 1995, Lake Erie Fisheries Units 1995 January Report
Geographic Area: Central Basin Lake Erie
Summary Submitted by: Gene Lane, NYSDEC Region 8 Fisheries, 6274 E. Avon-Lima Rd., Avon, NY 14414, ph: 716/226-2466, fax: 716/226-2466

198 ***Title:*** **Feeding preferences of an exotic mollusk predator, the round goby (*Neogobius melanostomus*), in the Great Lakes**

Research Category: 1.2 Population Dynamics
Overview: The round goby (*Neogobius melanostomus*), a native of the Black and Caspian seas, recently became established in the St. Clair River region of the Great Lakes basin. Sampling indicates a rapid spread from the vicinity of the Belle River Power Plant to the St. Clair delta, where it is apparently replacing native species. As a molluscan predator the round goby's effects on both native molluscs and the introduced zebra mussel *(Dreissena polymorpha*) are of considerable interest. Preliminary tests showed that an individual goby could consume an average of 47 and a maximum of 78 zebra mussels in 24 hours. Gobies 6-8 cm in standard length consumed mussels in the range of 4.5 mm-12.5 mm in length. In laboratory experiments, gobies were exposed to equal numbers and sizes of zebra mussels and native molluscs on substrates of sand and rubble.
Principal Investigator(s): David Jude, Center for Great Lakes & Aquatic Sciences, Gerald R. Smith, Museum of Zoology, University of Michigan, Ann Arbor, MI
Start Date: Jul-93
End Date: Jul-96
Funder: U.S. Environmental Protection Agency
Total Cost: $143,000 (US)
Publication/Citation: J. Great Lakes Res., Can. J. Fish. Aquat. Sci.
Geographic Area: St. Claire River Delta

Summary Submitted by: David Jude, Center for Great Lakes & Aquatic Science, 2200 Bonisteel Blvd., Ann Arbor, MI 48109

199 ***Title:*** **Parasites of gobies in Lake St. Clair**

Research Category: 1.4 Parasites and Diseases
Overview: To identify the parasites present in round and tubenose gobies in Lake St. Clair.
Principal Investigator(s): Mike Thomas, Michigan Department of Natural Resources, 33135 S. River Rd, Mt. Clemens, MI 48045
Start Date: Jun-94
End Date: Oct-94
Funder: MI Department of Natural Resources
Total Cost: --
Publication/Citation: J. Helminthol.
Geographic Area: Lake St. Clair
Summary Submitted by: Mike Thomas, Michigan Department of Natural Resources, 33135 S. River Rd., Mt.Clemens, MI 48045, ph: 810-465-4771, fax: 810-465-7504

200 ***Title:*** **Benthic invertebrate community responses to goby predation in Calumet Harbor, IL**

Research Category: 3.1 Community Structure
Overview: 1) Determine if zebra mussel density influences nearshore benthic invertebrate assemblages. 2) Determine if round gobies influence nearshore benthic invertebrate communities. 3)Determine if round gobies modify the response of benthic invertebrates to zebra mussel colonies.
Principal Investigator(s): Linda A. Benning, Loyola University Chicago, 6525N Sheridan Rd, Chicago, IL 60626, lbennin@orion.it.luc.edu; Martin B. Berg, Loyola University Chicago, 6525N Sheridan Rd, Chicago, IL 60626, mberg@orion.it.luc.edu
Start Date: --
End Date: --
Funder: --
Total Cost: --
Publication/Citation: --
Geographic Area: Calumet Harbor, Lake Michigan at the Illinois/Indiana border
Summary Submitted by: Linda A. Benning -Graduate Student, Loyola University Chicago, 6525N Sheridan Rd, Chicago IL 60626, ph: (312)508-8853, fax: (312)508-3646, e-mail: lbennin@orion.it.luc.edu

Purple Loosestrife

201 ***Title:*** **Biological Control of Purple Loosestrife**

Research Category: 2.2 Biological Interactions - Predator/prey, Parasites/Diseases

Overview: Test five European insect species as potential controls for purple loosestrife, *Lythrum salicaria*, in Minnesota. These species are a root-mining weevil, *Hylobius transversovittatus*, two leaf-feeding beetles, *Galerucella calmariensis* and *G. pusilla*, and two flower-feeding weevils, *Nanophyes marmoratus* and *N. brevis*. All five species were thoroughly tested and determined to be host specific and were cleared for release in the United States by the Animal and Plant Health Inspection Service of the United States Department of Agriculture. Insects were released at a variety of locations statewide in Minnesota. Insect releases will be monitored for establishment and control success.

Principal Investigator(s): Dr. David Ragsdale, University of Minnesota, 219 Hodson Hall, St. Paul, MN 55108, ragsd001@maroon.tc.umn.edu; Dr. David Andow, University of Minnesota, 219 Hodson Hall, St. Paul, MN 55108, dandow@maroon.tc.umn.edu; Dr. Roger Becker, University of Minnesota, Agronomy, 411 Bolaug Hall, St Paul, MN, becke003@maroon.tc.umn.edu; Dr. Robert Nyvall, University of Minnesota, North Central Experiment Station, 1861 Highway 169 E., Grand Rapids, MN 55744

Start Date: Jul-93

End Date: Jul-95

Funder: State of Minnesota

Total Cost: $150,000 (US)

Publication/Citation: --

Geographic Area: Purple loosestrife infested wetlands statewide

Summary Submitted by: Luke Skinner, Minnesota Department of Natural Resources, Box 25, 500 Lafayette Road, St. Paul, MN 55155-4025, ph: 612-297-3763, fax: 612-296-1811, e-mail: luke.skinner@dnr.state.mn.us

202 ***Title:*** **Development of evaluation criteria to assess the biological and ecological integrity of Great Lakes wetlands**

Research Category: 3.1 Community Structure

Overview: This study assesses the use of indicator organisms to identify early stages of degradation in Great Lakes wetlands. Indicators include non-indigenous and aquatic nuisance species. Study sites include wetlands around the Bayfield Peninsula of L. Superior, Saginaw Bay of L. Huron, and river-mouth wetlands in the mid-portion of the east shore of Lake Michigan.

Principal Investigator(s): Dr. Douglas A. Wilcox, NBS-GLSC, 1481 Green Road, Ann Arbor, MI 48105, douglas_wilcox@nbs.gov; Dr. Janet R. Keough, NBS-NPSC, 8311 37th St. SE

Start Date: Jul-93

End Date: Sep-97

Funder: U.S. Environmental Protection Agency-Environmental Research Laboratory, Duluth

Total Cost: $627,000 (US)

Publication/Citation: --

Geographic Area: L. Superior, L. Huron, L. Michigan

Summary Submitted by: Dr. Douglas A. Wilcox, National Biological Service, Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI 48105, ph: 313/994-3331, ext 256, fax: 313/994-8780, e-mail: douglas_wilcox@nbs.gov

203 ***Title:*** **Stable isotope patterns in a Lake Superior estuary as indicators of food web linkages**

Research Category: 3.4 Food Web Structure

Overview: The objective of the study was to investigate the linkages between elements of the food web of a Lake Superior coastal wetland and associated nearshore lake habitats using the patterns of ratios of stable isotopes of carbon and nitrogen. The study was initiated in

1992. Samples of all forms of primary producers, invertebrate consumers, invertivorous fish, ominivorous fish, and piscivorous fish were collected from the Allouez Bay wetland and from offshore Lake Superior. The study site is located in the western arm of Lake Superior, on the eastern end of the Duluth-Superior Harbor in a natural lagoon. As well as a full range of native food web elements, the study included samples of the following nuisance or exotic species: purple loosestrife (*Lythrum salicaria*), common carp (*Cyprinus carpio*), white perch (*Morone americana*) and ruffe (*Gymnocephalus cernuus*). Results showed that the wetlandgrazing food web obtains its carbon from phytoplankton; carbon signatures were outside the range for vascular plants and epiphytes. Purple loosestrife had a carbon and nitrogen signature similar to that of native vascular plants, indicating similarities in its role in the detritus cycle of this wetland. The nitrogen signature for carp placed it among the lower order vertebrate consumers, with white sucker and many young of the year planktivores. The carp we sampled likely consume invertebrate biomass. Both young of the year and adult ruffe had nitrogen signatures that indicated feeding on benthic invertebrates, while the other exotic species, white perch, apparently resembles yellow perch, feeding on plankton as young and switching to a diet of fish as an adult.

Principal Investigator(s): Janet Keough, DOI/NBS Northern Prairie Science Center, 8711 37th St. SE, Jamestown, ND 58401, janet_keough@nbs.gov; Michael Sierszen, U.S. Environmental Protection Agency, 6201 Congdon Blvd., Duluth, MN 55804

Start Date: Aug-92

End Date: Aug-95

Funder: U.S. Environmental Protection Agency

Total Cost: $50,000 (US)

Publication/Citation: Limnol. Oceanogr., J. Great Lakes Res.

Geographic Area: Lake Superior

Summary Submitted by: Janet R. Keough, Department of Interior, National Biological Service, Northern Prairie Science Center, 8711 37th St. SE, Jamestown, ND 58401, ph: 701/252-5363, fax: 701/252-4217, e-mail: janet_keough@nbs.gov

204 ***Title:*** **Remote sensing applied to detection of purple loosestrife**

Research Category: 6.1 Improvement of Initial Detection

Overview: Development of remote sensing technique to locate purple loosestrife in Great Lakes Basin. Study sites at Apostle Islands National Lakeshore--Lake Superior and Indiana Dunes--Lake Michigan (Gary, Ind.)

Principal Investigator(s): Lucy Bachanan, University of Wisconsin

Start Date: 1993

End Date: 1996

Funder: National Park Service

Total Cost: $15,000 (US)

Publication/Citation: --

Geographic Area: Lake Superior and Indiana Dunes, Lake Michigan, Gary, IN

Summary Submitted by: Rich Klukas, National Park Service, 1709 Jackson, Omaha, NE 68102

205 ***Title:*** **Invasive plants of Canada (IPCAN)**

Research Category: 6.4 Range of Spread

Overview: Development of databases and compilation of information for monitoring spread, computer mapping control and development of information documents promoting a better understanding of the impact of invasive alien plants on natural ecosystems. Area - Canada, including terrestrial and aquatic ecosystems. Species of special concern in the Great Lakes Basin -- European frog-bit, purple loosestrife, Eurasian watermilfoil, flowering rush.

Principal Investigator(s): Eric Haber, Ph.D., National Botanical Services, 604 Wavell Ave., Ottawa, ONT K2A 3A8, ehaber@magi.com

Start Date:	Jan-96
End Date:	Mar-97
Funder:	Environment Canada
Total Cost:	$89,000 (CAN)
Publication/Citation:	Invasive Plants of Natural Habitats in Canada (book)
Geographic Area:	Canada, Great Lakes Basin
Summary Submitted by:	Erich Haber (Ph.D.), National Botanical Services, 604 Wavell Ave., Ottawa, ONT K2A 3A8, ph: 613/722-5523, fax: 613/722-6291, e-mail: ehaber@magi.com

Eurasian Watermilfoil; for additional research projects addressing Eurasian Watermilfoil, see listing 205.

206 ***Title:*** **Experimental analog and sensitivity modeling studies predicting influences of global climate change on introduced species**

Research Category: 1.3 Environmental Requirements/Tolerance

Overview: Effects of predicted changes in temperature due to climate change were examined on several exotic nuisance species (*Dreissena* spp., *Daphnia lumholtzi, Hydrilla* sp., *Myriophyllum* sp.). Species were exposed to elevated temperatures (ambient; amb. + 2 deg C; amb. + 4 deg C) and turbidities (ambient; ambient x 2) in outdoor tanks with Ohio River water in summer and winter.

Principal Investigator(s): James H. Thorp, Univ. of Louisville, Department of Biology, Louisville, KY 40292, jhthor01@ulkyvm.louisville.edu; A.R. Black, University of Louisville, Biology Department, Louisville, KY 40292, J.E. Alexander, Univ. of Louisville, Biology Department, Louisville, KY 40292, K.H. Haag, D. Howarth, R.W. Bosserman

Start Date: Oct-93

End Date: Sep-96

Funder: U.S. Environmental Protection Agency

Total Cost: $200,000 (US)

Publication/Citation: Oecologia

Geographic Area: Ohio River, near Louisville, KY

Summary Submitted by: J. David Yount, U.S. Environmental Protection Agency, 6210 Congdon Blvd., Duluth, MN 55804, ph: 218-720-5752, fax: 218-720-5539, e-mail: yount.david@epamail.epa.gov

207 ***Title:*** **The secondary metabolites of eurasian watermilfoil and their relation to potential control agents**

Research Category: 2.4 Chemical Measures

Overview: To determine whether: 1) biologically active secondary metabolites of Eurasian watermilfoil affect native plant competitors and potential biocontrol agents by testing aquatic animals and plants; 2) the active metabolite can be isolated (using a systematic extraction and bioassay process) and chemically characterized; 3) biological and olfactory activity of crude odors are suggested to have pheromonal actions, and then to chemically characterize them so that they can eventually be identified; and 4) develop an understanding of the structure of lamprey olfactory tissue to learn more about how it functions. Pilot studies demonstrate that olfactory sense is unique among fish suggesting that specific natural attractants with the potential to serve as biocontrol agents may exist.

Principal Investigator(s): Florence K. Gleason, University of Minnesota, Raymond M. Newman, University of Minnesota

Start Date: Feb-91

End Date: Jan-94

Funder: Minnesota Sea Grant (R/F-24)

Total Cost: $84,889 (US)

Publication/Citation: Oecologia (submitted)

Geographic Area: --

Summary Submitted by: Douglas A. Jensen, Minnesota Sea Grant Program, 2305 East Fifth Street, Duluth, MN 55812-1445, ph: 218/726-8712, fax: 218/726-6556, e-mail: djensen@mes.umn.ed

208 ***Title:*** **Aquatic plant management in Lake St. Clair, MI, 1995**

Research Category: 2.6 Integrated Control Strategy

Overview: Survey submersed aquatic plants present at 126 stations in August and September 1995 throughout Lake St. Clair found *Myriophyllum spicatum* increased in percent frequency of occurrence from 21% in 1978 to 44% in 1995 and *Nitellopsis obtusa* occurred at about

the same frequency (19%) in both 1978 and 1995. Both these plants are nonindigenous; *M. spicatum* is recognized as a nuisance species.

Principal Investigator(s): Thomas A. Edsall, Donald W. Schloesser, Great Lakes Science Center, National Biological Service, 1451 Green Road., Ann Arbor, MI 48105, Donald W. Schloesser
Start Date: Jul-95
End Date: Sep-96
Funder: U.S. Army Corps of Engineers
Total Cost: $60,000 (US)
Publication/Citation: --
Geographic Area: Lake St. Clair
Summary Submitted by: Bruce A. Manny, National Biological Service, 1451 Green Rd., Ann Arbor, MI 48105, ph: 313/994-3331, fax: 313/994-8780

209 ***Title:*** **Littoral vegetation in the Old Woman Creek community dynamics and energy flow**

Research Category: 3.1 Community Structure
Overview: Macrophyte patch dynamics, floristics, community productivity, competition versus abiotic forcing functions as determinants of macrophyte dynamics. Population dynamics/spread of first pioneer populations of *Myriophyllum spicatum* in the Old Woman Creek estuary, with attempt to determine factors influencing invasion.
Principal Investigator(s): David A. Francko, Department of Botany, Miami Univ., Oxford, OH 45056
Start Date: Aug-93 *End Date:* Dec-94
Funder: Ohio Department of Natural Resources
Total Cost: $48,000 (US)
Publication/Citation: Abstracts in IAGLR proceedings; N. Amer. Lake Management Society proceedings paper in preparation to J. Great Lakes Res.
Geographic Area: Old Woman Creek NERR, Huron, OH (L. Erie) & adjacent coastal wetland
Summary Submitted by: David A. Francko, Prof./Chair, Department Botany, Miami Univ., Oxford, OH 45056, ph: 513/529-4200, fax: 513/529-4243, e-mail: franckDA@cus.mail.muohio.edu

210 ***Title:*** **Effects of macrophyte loss on invertebrate community stucture following application of an herbicide to control Eurasian watermilfoil**

Research Category: 3.1 Community Structure
Overview: Auburn and Zumbra Lakes, Carver Co, MN
Principal Investigator(s): M. Delong, Biology Department, Winona State Uni., Winona, MN 55987, mdelong@vax2.winona.msus.edu; N. Mundahl, Biology Department, Winona State Univ., Winona, MN 55987, nmundahl@vax2.winona.msus.edu
Start Date: Jun-93
End Date: May-96
Funder: Minnesota Department of Natural Resources
Total Cost: --
Publication/Citation: --
Geographic Area: Auburn and Zumbra Lakes, Carver Co., MN
Summary Submitted by: Michael DeLong, Winona State Univ., Large River Studies Center and Biology Department, Winona State University, Winona, MN 55987, ph: 507/457-5484, fax: 507/457-5681, e-mail: mdelong@vax2.winona.msus.edu

Other Species

Alewife; for additional research projects addressing the Alewife, see listing 116.

211 ***Title:*** **Effect of *Bythotrephes* PCB biomagnification on salmonids**

Research Category: 3.3 Nutrient/Contaminant Cycles

Overview: Investigate whether predation of *Bythotrephes* (BC) by alewife is increasing the contaminant burden of alewife, which in turn is responsible for the constant and/or increase of PCBs in coho salmon and lake trout in Lake Michigan. Specific objectives include: 1) determine PCB congener concentrations in all components of the alewife foodweb, 2) verify the trophic levels of the foodweb samples using stable isotope analyses, 3) estimate alewife PCB concentrations from foodweb models and our measured input data, and compare them to our measured alewife concentrations, and 4) estimate lake trout and coho salmon PCB concentrations and compare to measured concentrations, and to published trend data. This research will determine whether BC is responsible for these trends.

Principal Investigator(s): Deborah L. Swackhammer, University of Minnesota

Start Date: Feb-96

End Date: Jan-98

Funder: Minnesota Sea Grant (R/CL-48)

Total Cost: $103,783 (US)

Publication/Citation: --

Geographic Area: Lake Michigan

Summary Submitted by: Douglas A. Jensen, Minnesota Sea Grant Program, 2305 East Fifth Street, Duluth, MN 55812-1445, ph: 218/726-8712, fax: 218/726-6556, e-mail: djensen@mes.umn.ed

Carp; for additional research projects addressing the Carp, see listings 179 and 202.

212 ***Title*:** **Response of carp population in Hamilton Harbor to a carp barrier excluding adults from a wetland spawning**

Research Category: 2.1 Habitat Manipulation

Overview: 1) To predict the long-term effects of carp exclusion on the dynamics of a carp population-- Hamilton Harbor Cootes Paradise AOC; 2) simulation modeling & field population studies.

Principal Investigator(s): Dr. C.K. Minns, Geoff Burchill, McMasters University

Start Date: Apr-95

End Date: Dec-97

Funder: Fisheries and Oceans Canada Canada

Total Cost: unknown (CAN)

Publication/Citation: --

Geographic Area: Hamilton Harbor, Cootes Paradise

Summary Submitted by: Dr. C.K. Minns, Great Lakes Laboratory for Fisheries & Aquatic Science, Fisheries and Oceans Canada, 867 Lakeshore R., Burlington, Ont. L7R 4A6, ph: 906/336-4874, fax: 906/336-6437

213 ***Title:*** **Carp exclusion to rehabilitate the Cootes Paradise Marsh**

Research Category: 3.1 Community Structure

Overview: This project will determine the impact of carp control on wetland restoration of the Cootes Paradise marsh. Cootes Marsh is a 250 ha marsh located at the west end of Lake Ontario. Cootes is connected to Hamilton Harbor by a narrow man-made channel. We have constructed a carp barrier and fish way across the channel. Two years of research have been done to document the status of the fish community, pre-barrier. The barrier will be in place in the spring of 1996. Research will continue to measure the effects of carp exclusion on water quality, plant growth, and the fish community.
Principal Investigator(s): V. Cairns, K. Minns, B. Randall, Fisheries and Oceans Canada; Tys Theismeijer, Patricia Chow-Fraser, Brad White, McMaster University; Ken Simser, Royal Botanical Gardens
Start Date: 1990
End Date: 2010
Funder: Government of Canada
Total Cost: $2.5 million (CAN)
Publication/Citation: --
Geographic Area: Cootes Paradise marsh
Summary Submitted by: Vic Cairns, Fisheries and Oceans, 867 Lakeshore Rd., Burlington, Ontario L7R 4A6, ph: 905/336-4862, fax: 905/336-6437

Corbicula fluminea; for additional research projects addressing *Corbicula fluminea*, see listing 7.

214 ***Title:*** ***Corbicula fluminea* in a Michigan river -- implications for low temperature tolerance and range extension**
Research Category: 1.3 Environmental Requirements/Tolerance
Overview: A population of *Corbicula fluminea* (Asiatic clam) is known to have existed in the upper Clinton River in Oakland Co., MI since before July 1990. Since these waters are not thermally buffered, this population has tolerated normal winter temperatures for at least five years. The widespread belief that this is a warm-water species unable to tolerate 0-2 degrees Celsius needs to be re-examined. This cold tolerance, if widespread in northern populations, may enable the species to extend its range further north.
Principal Investigator(s): R.D. Hunter, Biological Sciences, Oakland University, Rochester, MI 48309-4401, hunter@vela.acs.oakland.edu
Start Date: May-94
End Date: Dec-94
Funder: Michigan Department of Natural Resources, Natural Heritage Grants Program
Total Cost: $1,523 (US)
Publication/Citation: Malacol. Rev. 28:125-130
Geographic Area: upper Clinton River, Oakland county, Michigan
Summary Submitted by: R. Douglas Hunter, Biological Sciences, Oakland University, Rochester, MI 48309-4401, ph: 310/370-3552, fax: 310/370-4225

Daphnia lumholtzi; for additional research projects addressing the *Daphnia lumholtzi*, see listing 206.

215 ***Title:*** **Plankton monitoring program for nonindigenous species**
Research Category: 6.4 Range of Spread
Overview: Because of its geographic position, the Illinois River serves as a major invasion route for exotic species spreading from the Great Lakes Basin to the Mississippi Drainage Basin, or vice versa. In 1994 we initiated a plankton monitoring program at Illinois River Mile

121.1 (Havana, IL) and have accrued a collection of biweekly plankton samples from April 1994 through the December 1995. We have also conducted sampling trips up and down the length of the Illinois River. This program allows us to monitor production rates, drifting patterns, and growth rates of zebra mussel veligers, and has enabled us to document seasonal abundance and range extension of an exotic zooplankton, *Daphnia lumholtzi*, as population sites expand northward towards the Great Lakes. We are currently looking for funding to allow us to extend this program into 1996.

Principal Investigator(s): Doug Blodgett, Illinois Natural History Survey, LTRMP LaGrange Field Station, 704 N. Schrader Ave., Havana, IL 62644, k_douglas_blodgett@nbs.gov; Jim Stoeckel, Illinois Natural History Survey, Forbes Biological Station, 17500 East CR 1950 North, P.O. Box 590, Havana, IL 62644, rsparks@ux1.cso.uiuc.edu

Start Date: --

End Date: --

Funder: --

Total Cost: --

Publication/Citation: J. Freshwat. Ecol.

Geographic Area: Illinois River, Mile 121.1

Summary Submitted by: Jim Stoeckel, Illinois Natural History Survey, Forbes Biological Station, 17500 East CR 1950 North, P.O. Box 590, Havana, IL 62644-0590, ph: 309/543-3950, fax: 309/543-4999, e-mail: stoeckel@ux1.cso.uiuc.edu

Flowering Rush

216 ***Title:*** ***Butomus umbellatus* in Cecker County Minnesota --- an investigation into the control of an exotic species *(control no. 3245)***

Research Category: 2.3 Physical Measures

Overview: Populations of *Butomus umbellatus* (emergent form) in Becker County, MN were cut repetitively by hand during 1995 and observed for density of regrowth in order to determine the effectiveness of hand cutting as a control method.

Principal Investigator(s): Kirk Johnson/Steve Spigarelli, Bemidji State University--Center for Environmental Studies, 1500 Birchmont Drive N.E., Bemidji, MN 56601-2699, saspigarelli@vax1.bemidji.msus.edu

Start Date: May-95

End Date: Dec-95

Funder: Minnesota Department of Natural Resources

Total Cost: $5,000 (US)

Publication/Citation: --

Geographic Area: Becker County, MN

Summary Submitted by: Donna J. Perleberg, Minnesota Department of Natural Resources, Section of Ecological Services, 1601 Minnesota Drive, ph: 218/828-6132, fax: 218/828-2439

Quagga Mussel; for additional research projects addressing the Quagga Mussel, see listings 4, 14, 20, 28, 30, 103, 128, 139 and 142.

217 ***Title:*** --

Research Category: 1.1 Life History

Overview: Examine morphological differences of newly settled zebra mussels and quagga mussels. Examine size of Prodissoconch shell at settling in the zebra and quagga mussels at different locations and water depths in Lake Erie.

Principal Investigator(s): Ander Martel, Museum of Nature, Ottawa, Ontario, Trevor Claxton, Department of Zoology, Univ. of Guelph, Ont., Ronald Dermott, Gt. Lakes Lab, Fisheries and Oceans Canada
Start Date: --
End Date: --
Funder: --
Total Cost: --
Publication/Citation: --
Geographic Area: Lake Erie
Summary Submitted by: Ronald Dermott, Fisheries and Oceans Canada Canada, Gt. Lakes Lab 867 Lakeshore Rd., Burlington, ONt. L7R 4A6, ph: 905/336-6437, fax: e-mail: Dermott@BURFisheries and Oceans.BUR.Fisheries and Oceans.CA

218 ***Title:*** **Swimming and settlement behavior in the quagga mussel**
Research Category: 1.1 Life History
Overview: Rear larvae and study factors influencing settlement
Principal Investigator(s): V. Kennedy, University of Maryland, Horn Point Environmental Lab, Box 775, Cambridge, MD 21613, kennedy@hpel.cees.edu
Start Date: Sep-93
End Date: Aug-95
Funder: Maryland Sea Grant Program
Total Cost: $85,123 (US)
Publication/Citation: --
Geographic Area: --
Summary Submitted by: V. Kennedy, University of Maryland, Horn Point Environmental Lab, Box 775, Cambridge, MD 21613, ph: 410/221-8286, fax: 410/221-8490, e-mail: kennedy@hpel.cees.edu

219 ***Title:*** **Genetic variability and environmental tolerances of the quagga mussel --- A new dreissenid invader of the Great Lakes**
Research Category: 1.5 Genetics
Overview: 1) Measure levels of genetic variability of the quagga mussel and its degree of natural hybridization with *Dreissena polymorpha*; 2) Determine salinity and thermal tolerances of the quagga by assessing their individual and combined effects on quagga mortality.
Principal Investigator(s): Dr. Edward L. Mills, Cornell Biological Field Station, Bridgeport, NY 13030, elm5@cornell.edu
Start Date: Aug-92
End Date: May-93
Funder: New York Sea Grant
Total Cost: $22,671 (US)
Publication/Citation: Can J. Fish. Aquat. Sci., Can J. Zool., Am. Sci. 33
Geographic Area: Lake Ontario
Summary Submitted by: Trent R. Schneider, New York Sea Grant, 115C Nassau Hall, SUNY, Stony Brook, NY 11794-5001, ph: 516-632-9123, fax: 516-632-6917, e-mail: tschneider@ccmail.sunysb.edu

220 ***Title:*** **Submersible examination of deep water quagga mussels**
Research Category: 1.7 Physiology and Behavior
Overview: Examine and photograph the bottom coverage and orientation of shells on mud surface of the deep water quagga mussel population in eastern Lake Erie using the Canadian navy's submersible SDL-1 estimate population density from cores collected.
Principal Investigator(s): R. Dermott, Great Lakes Lab, Fisheries and Oceans Canada, Burlington, Ont.
Start Date: Jul-94
End Date: Sept. 1995

Funder: Fisheries and Oceans Canada, Great Lakes 2000
Total Cost: $1,670 (CAN)
Publication/Citation: 1996 Verh. Intern. Verein. Limnol.
Geographic Area: Eastern Lake Erie
Summary Submitted by: Ronald Dermott, Fisheries and Oceans Canada, Great Lakes Lab, 867 Lakeshore Rd., Burlington, Ont. L7R 4A6, ph: 905/336-4868, fax: 905/336-4868

221 ***Title:*** **Impact of quagga mussels on benthic invertebrates of lower Great Lakes**
Research Category: 3.1 Community Structure
Overview: Examine historical changes to the benthic community in the deep water zone of eastern Lake Erie, and Bay of Quinte before and after the arrival of the quagga mussels. Examine distribution and biomass of amphipod *diporeia* in eastern Lake Erie and lower Bay of Quinte, Lake Ontario.
Principal Investigator(s): R. Dermott, Great Lakes Lab, Fisheries and Oceans Canada, Burlington, ONT, M. Munawar, GLLFAS, Fisheries and Oceans Canada
Start Date: Jul-93
End Date: Mar-96
Funder: Fisheries and Oceans Canada Canada, Great Lakes 2000
Total Cost: $9,300 (CAN)
Publication/Citation: --
Geographic Area: Lake Ontario, Bay of Quinte
Summary Submitted by: Ronald Dermott, Fisheries and Oceans Canada Canada, Great Lakes Lab, 867 Lakeshore Rd., Burlington, ONT L7R 4A6, ph: 905/336-4868, fax: 905/336-6437

Red Shiner

222 ***Title:*** **Potential establishment of red shiner minnows and consequences to native fish faunas in upland streams of eastern North America as related to climate change**
Research Category: 6.4 Range of Spread
Overview: Quantitative information on behavioral interactions and predator-prey interactions among red shiners and native minnows of the interior highlands.
Principal Investigator(s): Dr. Frances P. Gelwick, Texas A & M University, email: fgelwick@tamu.edu; Dr. William J. Matthews, University of Oklahoma, Biological Station, Kineston, OK 73439
Start Date: 1993
End Date: 1996
Funder: U.S. Environmental Protection Agency
Total Cost: $343,154 (US)
Publication/Citation: --
Geographic Area: eastern North America
Summary Submitted by: Roger Hermanutz, U.S. Environmental Protection Agency, 6201 Congdon Blvd., Duluth, MN 55804-2595

Rusty Crayfish; for additional research projects addressing the Rusty Crayfish, see listing 56.

223 ***Title:*** **Status and distribution of *Oreonectes rustiens* in Illinois**
Research Category: 6.3 Rate of Spread
Overview: 1) Determine the current range of *O. rustiens* in Illinois. 2) Estimate population sizes of selected locations. 3) Determine if displacement of native crayfish species has occurred.
Principal Investigator(s): Chris A. Taylor, Illinois Natural History Survey, 607 E. Peabody Dr., Champaign, IL 61820, ctaylor@mail.inhs.uiuc.edu; Larry M. Page, Illinois Nat. History Survey, 607 E. Peabody Dr., Champaign, IL 61820, darters@mail.inhs.uiuc.edu

Start Date: Jul-94
End Date: Jul-95
Funder: Illinios Department of Conservation, Wildlife Preservation Fund
Total Cost: $1,000 (US)
Publication/Citation: J. Crust. Biol.
Geographic Area: all of Illinois
Summary Submitted by: Chris A. Taylor, Illinois Natural History Survey, ph: 217/244-2153, fax: 217/333-4949, e-mail: ctaylor@mail.inhc.uiuc.edu

Smelt; for additional research projects addressing smelt, see listing 122.

224 ***Title:*** **Lake and stream survey, smelt travel survey**
Research Category: 3.1 Community Structure
Overview: Green Bay and L. Bay de Noc and Tributaries surveys; Lake Michigan, Two Rivers, WI area and Green Bay catch comparison.
Principal Investigator(s): Fred Copes, Bio. Department UW-SP, Stevens Point, WI
Start Date: 1994
End Date: 1995
Funder: Travelers Assoc.
Total Cost: $15,000 (US)
Publication/Citation: --
Geographic Area: Green Bay, L. Bay de Noc, Lake Michigan, Two Rivers
Summary Submitted by: Fred Copes, Univ. Wis-SP, Bio. Department UWSP, Stevens Point, WI 54481, ph: 715/346-3078, fax: 715/346-3624

225 ***Title:*** **The role of rainbow smelt and alewives in a thiamine deficiency in Great Lakes Trout**
Research Category: 3.3 Nutrient/Contaminant Cycles
Overview: To determine the effect of a diet consisting of either rainbow smelt or alewives on thiamine levels in Great Lakes lake trout and their progeny. The effect of these diets will be evaluated on the basis of thiamine and thiaminase content and the relative availability of thiamine at lower levels in the food chain.
Principal Investigator(s): John Fitzsimons, Fisheries and Oceans Canada, 867 Lakeshore Rd., Burlington, ONT L7R 4A6; Scott Brown, Fisheries and Oceans Canada, Freshwater Institute, 501 University Cres., Winnipeg, Manitoba
Start Date: Apr-94 *End Date:* Mar-96
Funder: Fisheries and Oceans Canada
Total Cost: $20,000 (US)
Publication/Citation: --
Geographic Area: Great lakes and selected inland lakes
Summary Submitted by: John Fitzsimons, Fisheries and Oceans Canada, 867 Lakeshore Rd., Burlington, ONT L7R 4A6, ph: 905/336-4865, fax: 905/336-6437, e-mail: fitzsimons@burdfo.bur.dfo.ca

Spiny Water Flea; for additional research projects addressing the spiny water flea, see listing 211.

226 ***Title:*** **Ph.D. Candidate Research**
Research Category: 1.7 Physiology and Behavior
Overview: Research is designed to acquire basic understanding of the biology/physiology of *Bythotrephes cederstroemi* in Lake Michigan.

Principal Investigator(s): --
Start Date: --
End Date: --
Funder: --
Total Cost: --
Publication/Citation: Limnol. Oceanogr., Can. J. Fish. Aquat. Sci.
Geographic Area: Lake Michigan
Summary Submitted by: Peder M. Yurista, University of Michigan, Department of Biology, Ann Arbor, MI 48109, ph: 313/747-0898, fax: e-mail: pmy@umich.edu

227 ***Title:*** **Food web impacts of *Bythotrephes* in inland lakes**

Research Category: 3.4 Food Web Structure

Overview: *Bythotrephes* has recently invaded some inland lakes in central Ontario. Since some evidence of potential food web impacts existed for the Great Lakes, there was concern about problems in the inland lakes, particularly on sports fish. We are engaged in a project along with scientists from the Ontario Ministry of Natural Resources and the Ministry of Environment and Energy to assess any impacts. Our approach consists of comparing plankton communities in a long-term monitoring lake before and after invasion, comparing plankton communities in lakes with and without *Bythotrephes*, determining feeding rates and prey preferences of *Bythotrephes*, computing *Bythotrephes* production, computing production of their preferred prey, and analyzing growth and diet of lake herring in lakes with and without Bythotrephes. Early evidence is that plankton communities have been changed by Bythotrephes, but that the fraction of prey production removed by this predator in any given season is modest.

Principal Investigator(s): W. Gary Sprules, Univ. of Toronto - Erindale, Mississauga, ONT L5L 1C6, gsprules@cyclops.erin.utoronto.ca; H. MacIsaac, Biol. Sci, Univ. of Windsor, Windsor, ONT, hughm@uwindsor.ca
Start Date: Jul-94
End Date: Jun-96
Funder: Ont. Ministry of Environment & Energy
Total Cost: $40,000 (CAN)
Publication/Citation: --
Geographic Area: Muskoka Lakes district, central Ontario (Harp Lake, Lake Muskoka and others nearby)
Summary Submitted by: W. Gary Sprules, University of Toronto, Erindale College, Mississauga, ONT L5L 1C6, ph: 905-828-3987, fax: 905-828-3792, e-mail: gsprules@cyclops.erin.utoronto.ca

Aquatic Nuisance Species General

228 ***Title:*** **Ecosystem framework policy exercise**

Research Category: 1.1 Life History

Overview: The International Joint Commission had adopted and promoted the ecosystem framework approach as a desirable management tool for the Great Lakes. The goal of the Ecosystem Framework Policy Exercise was to establish research priorities for the Great Lakes using an ecosystem framework approach. The policy exercise consists of two group activities: the SEIDL Game and the Issue Seminar. The topic of the first official run of the policy exercise in January 1995 was prioritizing zebra mussel research for the Great Lakes region.

Principal Investigator(s): Dr. Steven E. Underwood, EECS Intelligent Transportation Lab, University of Michigan, 208 EPB, 2609 Draper Dr., Ann Arbor, 48109-2140; Dr. Richard D. Duke, College of Architecture & Urban Planning, University of Michigan, 2208 F. Art & Arch., Ann Arbor, MI 48109-2069, dickduke@umich.edu

Start Date: May-96

End Date: Jul-95

Funder: U.S. Environmental Protection Agency

Total Cost: $247,179 (US)

Publication/Citation: --

Geographic Area: Great Lakes region

Summary Submitted by: Lisa A. Leutheuser, ITS Research Laboratory, 200 Engineering Programs Bld., 2609 Draper Dr., Ann Arbor, MI 48109-2140, ph: 313/936-0543, fax: 313/763-1674

229 ***Title:*** **Return and increase in abundance of aquatic flowering plants in Put-in-Bay Harbor, Lake Erie, OH**

Research Category: 1.2 Population Dynamics

Overview: Following changes in community composition of macrophytes in Put-in-Bay Harbor as related to improved water quality and transmittance. Introduced weedy species are decreasing as native clear-water species are increasing.

Principal Investigator(s): Dr. Ronald L. Stuckey, The Ohio State University Herbarium, Museum of Biological Diversity, Columbus, OH 43212-1192; Dr. David L. Moore, Utica College of Syracuse University, Department of Biology, 1600 Burrstone Rd., Utica, NY 13502-4892

Start Date: --

End Date: --

Funder: --

Total Cost: $0 (US)

Publication/Citation: Ohio J. Sci. 95(3):261-266, 1995

Geographic Area: Put-in-Bay Harbor, Lake Erie, OH

Summary Submitted by: Dr. David L. Moore, Utica College of Syracuse University, Department of Biology, Utica, NY 13502-4892, ph: 315/792-3137, fax: 315/792-3292

230 ***Title:*** **Survival and reproduction of pathogenic bacteria in a Great Lakes estuary**

Research Category: 1.3 Environmental Requirements/Tolerance

Overview: Year One--1. quantify the survival of the *Salmonella typhimuruim* and y-protobacteria in water and sediments under simulated natural conditions, 2. calculate the partitioning of *S. typhimuruim* between water and sediments, and 3. design and synthesize PCR primers to detect the presence of salmonella and y-protobacteria in water and sediments from a freshwater estuary. Year Two--1. test whether resuspending sediments increases the relative abundance of salmonella, total coliform, and fecal coliform in overlying water, 2. identify the distributions of salmonella, coliform and y-protobacteria from sewage effluent discharged in a freshwater estuary, and 3. compare zones of influence based on PCR amplifications and culture methods to test if pathogens are surviving undetected in a freshwater estuary.

Principal Investigator(s): Randall E. Hicks, Department of Biology, 10 University Drive, University of Minnesota Duluth, 55812, rhicks@d.umn.edu
Start Date: Feb-96
End Date: Jan-96
Funder: Minnesota Sea Grant College Program
Total Cost: $101,042 (US)
Publication/Citation: --
Geographic Area: Western Lake Superior
Summary Submitted by: Randall E. Hicks, Department of Biology, University of Minnesota, 10 University Drive, Duluth, MN 55812, ph: 218/726-8134, fax: 218/726-8142, email: rhicks@d.umn.edu

231 ***Title:*** **Restoration of Great Lakes coastal shore habitats -- control of alien plants on Nature Conservancy Preserves in Michigan**
Research Category: 2.1 Habitat Manipulation
Overview: The Michigan Chapter of the Nature Conservancy will use this assistance from GLNPO to protect and maintain ecologically significant open dune, interdunal wetlands and alvar grassland communities and the threatened and endangered plants and animals that reside in four Michigan nature preserves. This grant will accomplish the protection goals by reclaiming habitat from alien plant species distributions, developing and field-testing new biological management techniques and establishing local volunteer preserve committees.
Principal Investigator(s): Maureen Martin, The Nature Conservancy, Michigan Chapter, 2840 East Grand River Avenue, #5, East Lansing, MI 48823; Jack McGowan Stinski, The Nature Conservancy, Michigan Chapter, 2840 East Grand River Ave. #5, East Lansing, MI 48823
Start Date: Oct-95
End Date: Mar-98
Funder: U.S. Environmental Protection Agency, Great Lakes National Program Office
Total Cost: $40,000 (US)
Publication/Citation: --
Geographic Area: Great Lakes
Summary Submitted by: Callie Bolattino, U.S. Environmental Protection Agency, Great Lakes National Program Office, G-9J 77 West Jackson Boulevard, Chicago, IL 60604, ph: 312/353-3490, fax: 312/353-2018, email: bolattino.callie@epamail.epa.gov

232 ***Title:*** **Lake Ontario barrier beach/wetlands habitat restoration project**
Research Category: 2.3 Physical Measures
Overview: Objectives -- Project provides for construction of dune protection and user management structures, dune restoration, native vegetation re-establishment, control and removal of invader species, and public education in a dune wetland lagoon system of national and global significance. Helps protect unique habitat of globally endangered buckmoth species.
Principal Investigator(s): Donald Slingerland, New York State DEC, 50 Wolf Road, Albany, NY 12233-4480
Start Date: Oct-94
End Date: Sep-96
Funder: U.S. Environmental Protection Agency, Great Lakes National Program Office
Total Cost: $50,000 (US)
Publication/Citation: --
Geographic Area: Eastern shore of Lake Ontario 4 miles west-northwest of the Village of Pulaski, NY, incorporating lower Deer Creek, Deer Creek Marsh and the sand spit-barrier beach separating the marsh lagoon complex from Lake Ontario
Summary Submitted by: Robert Beltran, U.S. Environmental Protection Agency, 77 West Jackson Boulevard, Chicago, IL 60604, ph: 312/353-0826, fax: 312/353-2018, email: beltran.robert@epamail.epa.gov

233 ***Title:*** **New York Power Authority -- monitoring and treatment data**

Research Category: 2.4 Chemical Measures
Overview: No research was conducted. However, we have been monitoring and treating with sodium hypochlorite since 1991. These data would be available if someone wished to use them.
Principal Investigator(s): --
Start Date: --
End Date: --
Funder: New York Power Authority
Total Cost: $0 (US)
Publication/Citation: --
Geographic Area: --
Summary Submitted by: Daniel Parker, NY Power Authority, P.O. Box 700, Massena, NY 13662, ph: 315/764-0226, fax: 365/764-1730

234 ***Title:*** **Effect of exotic fish on native fish populations**

Research Category: 3.1 Community Structure
Overview: 1) Determine composition of original native fish community; 2) study effects of introduced fish species on native fish community and individual species.
Principal Investigator(s): Dr. Larry Kallemeyn, Voyageurs National Park, International Falls, MN
Start Date: May-95
End Date: May-98
Funder: National Park Service
Total Cost: $450,000 (US)
Publication/Citation: --
Geographic Area: Rainy Lake, International Falls, MN
Summary Submitted by: Rich Klukas, National Park Service, 1709 Jackson, Omaha, NE, ph: 402/221-3603, fax: 402/221-3480, email: Richard_Klukas@NPS.Gov

235 ***Title:*** **Commercial fisheries monitoring and stream surveys**

Research Category: 3.1 Community Structure
Overview: Lake Michigan, Wisconsin waters and Green Bay monitoring commercial fisheries and lake and stream surveys by students.
Principal Investigator(s): Fred Copes, University of Wisconsin, 404 CNR Bldg., UW Stevens Point, WI 54481
Start Date: --
End Date: --
Funder: Wisconsin Department of Natural Resources, Sea Grant, commercial fisheries
Total Cost: $0 (US)
Publication/Citation: --
Geographic Area: Lake Michigan, Wisconsin waters; Green Bay
Summary Submitted by: Fred Copes, UW-SP, 404 CNR Bldg., UW Stevens Point, Stevens Point, WI 54481, ph: 715/346-3078, fax: 715/346-3426

236 ***Title:*** **Larval fishes--ecology and taxonomy**

Research Category: 3.1 Community Structure
Overview: Determine community structures of young of year fishes in streams, canals, bays and other littoral areas. Describe habitat types for spawning taxa and nursery areas for larvae.
Principal Investigator(s): J.K. Leslie; C.A. Timmins
Start Date: 1994
End Date: 1999
Funder: Sustainable Fisheries *(Govt. Canada)*
Total Cost: $48,000 (CAN)
Publication/Citation: --

Geographic Area: Western End Lake Erie; Eastern St. Clair Area; Western St. Lawrence; Bay of Quinte; E. Lake Huron
Summary Submitted by: John K. Leslie, Bayfield Laboratory, 867 Lakeshore Rd., Burlington, ONT L7R 4A6, ph: 905/336-6288

237 ***Title:*** **Determination of algal metrics for Lake Erie estimates**
Research Category: 3.1 Community Structure
Overview: Primary objective is to develop and recommend measurements of metrics for evaluating the composition and structure of algal periphyton communities with regard to water quality. These metrics will be developed for freshwater estuaries along the southern shore of Lake Erie.
Principal Investigator(s): Jeff Johansen, John Carroll University
Start Date: Feb-95
End Date: Jan-98
Funder: Lake Erie Protection fund
Total Cost: $72,512 (US)
Publication/Citation: --
Geographic Area: Southern shore of Lake Erie
Summary Submitted by: Gerald Saro, John Carroll University, University Hts., OH 44118, ph: 397-3077, email: j.saro@jcvaxa.jcu.edu

238 ***Title:*** **Nonindigenous macro-invertebrates in the rivers Rhine and Meuse *(the Netherlands)***
Research Category: 3.1 Community Structure
Overview: Current project based on monitoring activities in the rivers Rhine and Meuse.
Principal Investigator(s): Abraham bij de Vaate, Institute for Inland Water Management and Waste Water Treatment, P.O. Box 17, NL-8200 AA LELYSTAD, The Netherlands, email: b.bdvaate@riza.rws.minvenw.nl
Start Date: --
End Date: --
Funder: --
Total Cost: $0 (US)
Publication/Citation: --
Geographic Area: Rhine and Meuse Rivers, the Netherlands
Summary Submitted by: Abraham bij de Vaate, Institute for Inland Water Management and Waste Water Treatment, P.O. Box 17, NL-8200 AA LELYSTAD, The Netherlands, ph: 31 032 2900 701, fax: 31 032 249 2100, email: b.bdvaate@riza.rws.minvenw.nl

239 ***Title:*** **Great Lakes fish contaminants surveillance *(1977-95)***
Research Category: 3.3 Nutrient/Contaminant Cycles
Overview: This program provides a long-term database to assess both the temporal and spatial trends of contaminant burdens in the Great Lakes fish community and principle components of the forage base. Information from the database is utilized to determine the effectiveness of toxic chemical remedial activities within the basin and the impact of changes in the fish community. Participation in this binational activity represents DFOs contribution to a basin wide contaminant monitoring program as defined by the requirements of Annex 11 of the Canada/U.S. Great Lakes Water Quality Agreement.
Principal Investigator(s): D.M. Whittle, Fisheries and Oceans Canada *(Canada)*, 867 Lakeshore Rd., Burlington, ONT L7R 4A6, email: whittle@burdfo.bur.dfo.ca
Start Date: 1994/95
End Date: 1996/97
Funder: Fisheries and Oceans Canada
Total Cost: $150,000 (CAN)
Publication/Citation: J. Great Lakes Research, Can. J. Fish. Aquat. Sci.

Geographic Area: Great Lakes
Summary Submitted by: D.M. Whittle, Fisheries and Oceans Canada (CA), 867 Lakeshore Rd., Burlington, ONT L7R 4A6, ph: 905/336-4565, fax: 905/336-6437, email: whittle@burdfo.bur.dfo.ca

240 ***Title:*** **The Role of shipping in the introduction of nonindigenous aquatic organisms to the coastal waters of the United States and an analysis of control options**

Research Category: 4.2 Definition of Vectors of Introduction - Shipping, Bait, Aquaria, Canals, Biological Vectors

Overview: This study examines the role of shipping in the introduction of nonindigenous species to U.S. waters, and potential control options for preventing such introductions. This study suggests that the speed and global nature of the modern shipping industry make the likelihood of ballast water mediated invasions even higher than in previous times. Several control options are identified, including both vessel equipment and management practices that could be combined into "integrated ballast management" strategies for reducing the risk of future invasions.

Principal Investigator(s): James T. Carlton, Maritime Studies Program, Williams College, 75 Greenmanville Ave., Mystic, CT 06355

Start Date: Apr-91
End Date: Apr-95
Funder: U.S. Coast Guard
Total Cost: $200,000 (US)
Publication/Citation: National Technical Information Service, accession number is AD-A 294809
Geographic Area: --
Summary Submitted by: LTJG Lauren V. Kabler, U.S. Coast Guard, 2100 2nd Street S.W., Washington, D.C. 20593-0001, ph: 202/267-0423, fax: 202/267-4085, email: L.Kabler/G-M03@cgsmtp.uscg.mil

241 ***Title:*** **Great Lakes ballast water control guidelines -- compliance & effectiveness study, 1991**

Research Category: 4.3 Determination of Preventive Measures

Overview: Determine the compliance with ballast water exchange guidelines during the period of March 30, 1991 and May 30, 1991 for all vessels entering the Upper St. Lawrence and Great Lakes. Determine the effectiveness of these guidelines in preventing live organisms from entering the Great Lakes. Identify organisms found in ballast water entering the Lakes.

Principal Investigator(s): A. Locke, D.M. Reid, W.G. Sprules, H.C. van Leeuwen, Erindale College, Mississauga, Ontario; J.T. Carlton, Williams College - Mystic Seaport, Mystic, Connecticut

Start Date: May-90
End Date: Aug-92
Funder: U.S. Environmental Protection Agency
Total Cost: $180,000 (CAN)
Publication/Citation: --
Geographic Area: Great Lakes Basin, St. Lawrence Seaway
Summary Submitted by: Phil Strobel, U.S. Environmental Protection Agency-Great Lakes National Program Office, 77 W. Jackson Blvd. (G-9J), Chicago, IL 60604, ph: 312-353-7996, fax: 312-353-2018, email: strobel.philip@epamail.epa.gov

242 ***Title:*** **Disinfection of ballast water -- a review of potential options**

Research Category: 4.3 Determination of Preventive Measures

Overview: Project comprised -Desk based review of ballast water treatment options -Laboratory trials to evaluate two treatment methods (electrolytically generated Cu/Ag ions and UV radiation) for disinfection of ballast water -Feasibility analysis of suitability of above techniques for use on-board ship.

Principal Investigator(s): Dr. G. Reynolds, Lloyds Register, 29 Wellesley Road, Croydon CRO 2AJ, United Kingdom; K Muller, Lloyds Register,
Start Date: Nov-94
End Date: Jan-96
Funder: U.K. Marine Safety Agency
Total Cost: $90,000 (US)
Publication/Citation: --
Geographic Area: United Kingdom
Summary Submitted by: Dr. G. Reynolds, Lloyds Register, 29 Wellesley Road, Croydon Cro 2AJ, United Kingdom, ph: +44 181 681 4849, fax: +44 181 681-4864

243 ***Title:*** **Ballast technology demonstration project**

Research Category: 4.3 Determination of Preventive Measures

Overview: The Northeast-Midwest Institute and the Lake Carriers' Association are cooperating with a cadre of public and private sector players, including the Great Lakes Commission, to test technologies to prevent ballast-transfers of nonindigenous species into and within the Great Lakes by commercial vessels. While the Great Lakes is the laboratory for the experiment, the results of the project will be of critical concern to policy-makers nationally and abroad. The demonstrations will take place aboard operating ships under normal conditions which are representative of both the sea-going and lake trades. The 12-18 month project will build upon an engineering analysis funded by federal agencies. Great Lakes Protection fund monies would be devoted to the full-scale demonstration of at least three technologies, a detailed evaluation of their performance with recommendations, and associated costs of project implementation.

Principal Investigator(s): Allegra Cangelosi, Northeast-Midwest Institute, 218 D. St. S.E., Washington, D.C. 20003, email: acangelo.nemw.org; Rick Harkins, Lake Carriers' Association, Cleveland, OH

Start Date: Feb-96
End Date: Jun-96
Funder: U.S. Environmental Protection Agency
Total Cost: $1,000,000 (US)
Publication/Citation: --
Geographic Area: Great lakes
Summary Submitted by: Allegra Cangelosi, Northeast-Midwest Institute, 218 D. St. SE, Washington, D.C. 20003, ph: 202/544-5200, fax: 202/544-0043, email: acangelo@nemw.org

244 ***Title:*** **Ballast water exchange study**

Research Category: 5.3 Shipping and Navigation

Overview: Large ships destined for ports on the St. Lawrence River indicate a high non-compliance rate with the Canadian Great Lakes Ballast Water Control Guidelines. The non-compliance is due to safety concerns over excessive hull stresses and loss of stability when exchanging ballast water at sea. A still water analysis of 2 bulk carriers indicated that bending moment limitations and shear force limitations would restrict their ability to comply with the guidelines.

Principal Investigator(s): Andrew Prior, Melville Shipping Ltd., Suite 1007, 35 Sparks St., Ottawa, ONT K1R 7S8; Marius Koniecki, Transport Canada, AMBBC, Marine Regulatory Directorate, 344 Slater St., Ottawa, ONT K1A 0N7

Start Date: Jan. 1995
End Date: Mar-95
Funder: Transport Canada
Total Cost: $15,000 (CAN)
Publication/Citation: Contact Principal Investigator
Geographic Area: Lower St. Lawrence River

Summary Submitted by: Tom Morris, Transport Canada, AMBBA, 344 Slater St., Ottawa, Ont. K1A 0N7, ph: 613-991-3170, fax: 613-954-4916

245 ***Title:*** **A policy framework for nonindigenous species in the Great Lakes**

Research Category: 5.5 Policy and Law Determinants

Overview: Develop policy approaches that are appropriate for accidental introductions, purposeful private introductions, and purposeful public introductions of exotic species. Develop a method to identify the costs and benefits of both accidental and planned introductions of exotics. Complete a cost-benefit analysis of an introduction that has already occurred in the Great Lakes.

Principal Investigator(s): Alan J. Randall, Ohio State University, Department of Agricultural Economics and Rural Sociology, 2120 Fyffe Rd. Columbus, OH 43210, email: arandall+@osu.edu

Start Date: Sep-92 *End Date:* Aug-94

Funder: Ohio Sea Grant

Total Cost: $227,220 (US)

Publication/Citation: --

Geographic Area: Great Lakes Region

Summary Submitted by: Great Lakes Commission, 400 Fourth St., Ann Arbor, MI 48103, ph: 313-665-9135, fax: 313-665-4370, email: glc@great-lakes.net

246 ***Title:*** **Potential effects of climate change on thermal complexity and biotic integrity of streams -- seasonal intrusion of Non-Native fishes**

Research Category: 6.2 Mechanisms of Spread

Overview: This research will continue to examine the effects of climate warming on the interactions between native and introduced fishes in the Pacific Northwest streams. Specific components will investigate direct effect of warming on stream habitat, the influence of habitat changes on native/non-native interactions, the influence of thermal refugia to native fishes and interactions with non-natives, and the role of human land use activities on reducing or exacerbating the effects of climate change on fish assemblages.

Principal Investigator(s): Dr. William J. Liss, Department of Fisheries and Wildlife, Nash Hall, Room #104, Oregon State University, Corvallis, OR 97331-3803

Start Date: Sep-93

End Date: Mar-96

Funder: U.S. Environmental Protection Agency

Total Cost: $389,474 (US)

Publication/Citation: --

Geographic Area: Pacific Northwest streams

Summary Submitted by: John Eaton, U.S. Environmental Protection Agency, 6201 Cougdon Blvd., Duluth, MN 55804, ph: 218/720-5557, fax: 218/720-5539, email: Eaton.john@U.S. Environmental Protection Agencymail.U.S. Environmental Protection Agency.gov

247 ***Title:*** **PCBs at the air-water interface of Lake Winnipeg*)***

Research Category: 6.2 Mechanisms of Spread

Overview: The major objective of our project was to determine the behavior of PCBs at the air-water interface of Lake Winnipeg. Lake Winnipeg is located near the city of Winnipeg in Manitoba, CA.

Principal Investigator(s): Ken Friesen, Department of Chemistry, The University of Winnipeg, 515 Portage Ave., Winnipeg, MB R3B 2E9, kfriesen@uwinnipeg.ca

Start Date: May-94

End Date: Aug-96

Funder: Manitoba Hydro

Total Cost: $35,000 (CAN)

Publication/Citation: --

Geographic Area: Lake Winnipeg, Canada

Summary Submitted by: Ken Friesen, The University of Winnipeg, 515 Portage Ave., Winnipeg, MB R3B 2E9, ph: 204/786-9043, fax: 204/786-1824, email: kfriesen@uwinnipeg.ca

248 ***Title:*** **Utility of the physical habitat template as a predictor of lotic ecosystem invasibility by alien aquatic species**

Research Category: 6.5 Natural Barriers

Overview: The objectives of this project are to describe physical habitat stability in lotic ecosystems at multiple spatial scales in different landscape settings, to relate this to functional measures of benthic invertebrate community structure in these different settings, and to generalize the results into a framework for characterizing stream invasibility by alien aquatic species.

Principal Investigator(s): N. LeRoy Poff, University of Maryland, Department of Zoology, College Park, MD 20742, email: np21@umail.umd.edu; Karen L. Prestegaard, University of Maryland, Department of Geology, College Park, MD 20742

Start Date: Oct-92

End Date: Oct-96

Funder: U.S. Environmental Protection Agency

Total Cost: $349,000 (US)

Publication/Citation: --

Geographic Area: Streams in Lake Superior drainage of extreme NW Wisconsin (vicinity of Brule, WI)

Summary Submitted by: J. David Yount, U.S. Environmental Protection Agency, 6201 Congdon Blvd., Duluth, MN 55804, ph: 218-720-5752, fax: 218-720-5539, email: yount.david@epamail.epa.gov

249 ***Title:*** **Determinants of invasion success**

Research Category: 6.6 Predictive Models

Overview: 1) Assess models of species invasion to determine whether invader features or features of invaded systems can predict invasion success. Alternatively, must one simply consider invasion opportunities when assessing invasions?

Principal Investigator(s): W. Gary Sprules, Univ. of Toronto

Start Date: 1995

End Date: 1999

Funder: NSERC

Total Cost: $70,000 (CAN)

Publication/Citation: --

Geographic Area: Great Lakes, central Ontario

Summary Submitted by: Hugh MacIsaac, Univ. of Windsor, Biology Department, Windsor, ONT N9B 3P4, ph: 519-252-4232 ext. 2734, fax: 519-971-3609, email: hughm@uwindsor.ca

250 ***Title:*** **Predictive models**

Research Category: 6.6 Predictive Models

Overview: Recently we published a book that contains a chapter on the flow of radionuclides 90Sr, 137Cs and 239/240Pu through the chain of the Great Lakes. The other book is on the transfer of pesticides.

Principal Investigator(s): Dr. B.S. Shukla, 140 Golden Orchard Drive., Hamilton, ONT Canada L9C 6J6

Start Date: 1993

End Date: 1998

Funder: Environmental & Res. Publications Inc.

Total Cost: $0 (US)

Publication/Citation: Soil Science Soc. Am. 58 *(3)* May-June 1994

Geographic Area: Great Lakes

Summary Submitted by: Dr. B.S. Shulka, Environmental Research & Publications, Inc., 140 Golden Orchard Drive, Hamilton, ONT L9C 6J6, ph: 905/385-8111, fax: 905/385-8263.

VI. Appendices

Index of Projects Cross Referenced by Research Category

Biology and Life History

Control and Mitigation

Ecosystem Effects

Prevention of Introduction

Socio-economic Considerations and Analysis

Spread of Established ANS Populations

Index of Projects Cross Referenced by Geographic Region

Appendix 2

Appendix 3

Appendix 4