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# STATUS OF COMMERCIAL AQUACULTURE AND RESEARCH IN THE NORTH CENTRAL REGION — 1986

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## **INTRODUCTION**

Aquaculture is the farming of fish, shellfish, and aquatic plants in fresh, brackish, or salt water. In the last decade, its importance as a form of agriculture has grown dramatically in the U.S. and in the world. Global production, for example, doubled from approximately 6 million to 12.4 million metric tons between 1975 and 1985; FAO analysts predict continued dramatic growth through the year 2000. In the U.S., aquaculture production more than doubled between 1975 and 1985 at which time live weight production was estimated at 500 million pounds with a pond bank value of \$500 million.

Although aquaculture is considered an emerging agri-industry in the North Central Region, the level of activity has not been documented on a regional basis. This report represents a first attempt to assess the status of commercial aquaculture production, research and extension in the North Central Region, including the twelve states of Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.

This information was collected in a brief survey conducted for a proposal to Congress regarding creation of a North Central Regional

Aquaculture Center (NCRAC) as part of the National Aquaculture Regional Development Program of USDA. The Center was established in 1988 and is administered by Michigan State University in association with Iowa State University. Future information on aquaculture production and marketing in the region will be compiled by a project of the Center.

## **SUMMARY**

North Central Regional activities in commercial aquaculture, related industries, and aquacultural research are characterized by tremendous diversity and breadth of expertise. A survey of aquacultural activities was conducted between December 1986 and January 1987, under the direction of the Steering Committee of the NCA-23 Subcommittee on Aquaculture. Unless specified otherwise, the results, reported in Tables 1-11 and Figure 1, are 1985 estimates of the importance of aquaculture to the entire region. Many reported values are underestimates because it was difficult for most states to collect complete data during the brief duration of the survey. Major findings are as follows:

1. There are approximately 800 producers

of food fish, bait fish, fee fishing, and fish for stocking in the North Central Region (Table 1).

2. Approximately 6.7 million pounds live weight of food fish are produced per year with a gross production value of \$7.8 million and a total economic value to the region of \$15.6 million (Table 2 and Figure 1).
3. Approximately 137.6 million fish per year are sold for stocking with a gross production value of \$26.6 million (Table 3 and Figure 1).
4. The production of trout and other fish species for fee fishing occurs in about 569 ponds and raceways throughout the region and is valued at about \$6 million of gross sales (Table 4 and Figure 1).
5. About 94,000 gallons/year plus 330,000 pounds/year of bait species are produced. Total wholesale value is \$2.4 million and economic value \$4.8 million to the region (Table 5 and Figure 1).
6. Over 45 different aquatic species are commercially produced in the North Central Region (Table 6). Some privately produced fish are sold to state agencies (Table 6a).
7. There are at least 23 major manufacturers of fish culture supplies and equipment located in eight states of the North Central Region (Table 7).
8. Commercial producers have formed twelve major trade organizations in the region (Table 8).
9. Approximately 50 universities, state and federal agencies, and private institutions are involved in aquaculture research and extension. It is estimated that 101

researchers and 24 extension/public education professionals are engaged in aquaculture activities fifty percent or more of their time (Table 9).

10. The expertise of research, extension and education professionals working in aquaculture in the region covers ten major disciplines (Table 10).
11. There are active aquacultural research programs at universities in every North Central Regional state (Table 11). Major funding sources between 1975 and 1986 included AES Hatch, USDA, Sea Grant, U.S. Fish and Wildlife Service, U.S. AID, Federal Aid (Dingel Johnson), and state DNRs (or similar state agencies).

In conclusion, the data on commercial aquaculture revealed that the production of fish for stocking is of greatest economic importance to the North Central Region (Figure 1). In descending order of importance of other forms of production are food fish, fee fishing and bait fish. The following statistics, however, suggest that there is tremendous potential for expansion of food fish production and marketing in the region. In 1985, 56.707 million people living in the North Central Region consumed an estimated 822.252 million pounds of fish and shellfish. This figure excludes sportfish consumption and is derived from the Department of Commerce figure of 14.5 lbs./capita as a national average for 1985. In contrast, the North Central Region's 1985 production of food fish was 6.743 million pounds or 0.8% of the total pounds of fish and shellfish consumed (Figure 2).

The estimated, gross value of all forms of commercial aquaculture in the North Central Region in 1985 was \$42.8 million. This figure probably underestimates the economic importance of aquaculture to the region because of the brief nature of the survey.

**Table 1. The number of licensed/non-licensed aquaculture producers in the North Central Region. Producers of food fish, bait fish, fee fishing, and fish for stocking are included.**

State	Number
Illinois	22
Indiana	133 <sup>1</sup>
Iowa	23
Kansas	45 <sup>1</sup>
Michigan	103
Minnesota	83
Missouri	170 <sup>1</sup>
Nebraska	35
North Dakota	na <sup>2</sup>
Ohio	74
South Dakota	25
Wisconsin	86
<b>TOTAL</b>	<b>799</b>

<sup>1</sup> Licenses not required of producers in these states. Missouri figure is based on 1980 and 1984 surveys of aquaculturists.

<sup>2</sup> na = not available

**Table 2. Production of food fish in the North Central Region.**

State:	IL	IN	IA	KS	MI	MN	MO	NE	ND	OH	SD	WI	TOTAL
<i>No. Operators:</i>	10	2	4	14	59	10	30	6	1	20	12	33	201
<i>Facilities:</i>													
Acres of ponds	500	12	5	304	na <sup>5</sup>	115	1500	160	na	na	40	20	2656
Hundreds of ln. ft. raceway	10	5.4	1.0	na	750 <sup>2</sup>	10	140	2.0	na	na	na	13	934
<i>Production:</i>													
Thousands of lb. live wt./yr.	50	500	15	271	300	45.5	4650 <sup>4</sup>	91.3	na	na	20	800	6743
<i>Economic Value:</i>													
Average price/lb. live wt.	0.55	0.90	2.50	1.10	1.80	1.58 <sup>3</sup>	1.05	1.98	na	na	1.50	1.60	—
Economic value to state (\$U.S. x 1000) <sup>1</sup>	53	900	75	596.2	1080	143.9	9765	361.6	na	na	60	2560	1594.7

<sup>1</sup> Calculated from: average price/lb. live wt. x lb. live wt/yr. x 2.

<sup>2</sup> Used for both stocking and foodfish

<sup>3</sup> Based on average for North Central Region.

<sup>4</sup> This represents 4,200 lb. catfish, 300,000 lb. trout & 150,000 lb. chinese carp.

<sup>5</sup> na = not available

**Table 3. Production of fish for stocking in the North Central Region.**

State:	IL	IN	IA	KS	MI	MN	MO	NE	ND	OH	SD	WI	TOTAL
No. Operators:	12	5	22	26	51	16	85	26	na <sup>4</sup>	74	4	48	369
<i>Facilities:</i>													
Acres of ponds	300	350	150	1204	150	540	1450	375	na	370	40	100	5029
Hundreds of In. ft. raceway	na	15	na	na	750 <sup>2</sup>	20.5	50	5.4	na	40	na	12	892.9
<i>Production:</i>													
Millions of fish sold/yr.	na	3.75	1.5	8.77	1.3	15.63	72 <sup>3</sup>	1.48	na	na	3.20	30	137.63
Gross production value <sup>1</sup> (\$U.S. x 100,000)	0.5	12.3	1.5	8.93	6.38	49.4	129.6	6.4	na	na	6.4	45	266.41

<sup>1</sup> Calculated from: average price/fish x number fish sold/yr

<sup>2</sup> Used for both stocking and foodfish

<sup>3</sup> Includes major producer of goldfish, although goldfish are not stocked in natural waters. Fingerling catfish are major stocked species.

<sup>4</sup> na = not available

**Table 4. Production of fish for fee fishing in the North Central Region.**

State:	IL	IN	IA	KS	MI	MN	MO	NE	ND	OH	SD	WI	TOTAL
No. Operators:	4	125	5	22	51	7	60	2	na <sup>2</sup>	na	3	44	323
<i>Facilities:</i>													
Trout - no. ponds or raceways	3	8	1	na	63	22	20	na	na	na	5	na	122
Other - no. ponds	10	155	4	46	10	na	220 <sup>1</sup>	2	na	na	na	na	447
<i>Economic value:</i>													
Total gross sales (\$U.S. x 1000)	50	3125	40	331.1	765	217.7	1160	70	na	na	200	na	5958.8

<sup>1</sup> Estimated from: 650 total pond acres/ ave. pond size of 3 acres.

<sup>2</sup> na = not available.

**Table 5. Production of bait (fish, crayfish, leeches, etc.) in the North Central Region.**

State:	IL	IN	IA	KS	MI	MN	MO	NE	ND	OH	SD	WI	TOTAL
No. Operators: <sup>1</sup>	na <sup>2</sup>	1	2	15	15	50	35	1	na	57	3	7	186
<i>Facilities:</i>													
Acres of ponds	na	5	10	395	250	16800	340	9.5	na	100	15	na	17924.5
<i>Production:</i>													
Hundreds of gal/yr	na	na	na	97.4	36	790	na	0.80	na	na	12	na	936.2
or Hundreds of lbs/yr	na	100	500	na	na	na	2700	n.a.	na	na	na	na	3300
<i>Economic value:</i>													
Total wholesale value (\$U.S. x 1000)	na	40	50	285.2	80	1192	754	5.8	na	na	9.6	na	2416.6
Value to the state <sup>1</sup> (\$U.S. x 1000)	na	80	100	570.3	160	2384	1508	11.5	na	na	19.2	na	4833

<sup>1</sup> Calculated as total wholesale value x 2.

<sup>2</sup> na = not available

**Table 6. Incidence of privately produced fish that are sold to state agencies for stocking in public waters.**

Species	States	Species	States
Channel catfish	IA <sup>1</sup> , IL, KS, MN, MO	Northern pike	IN, MN
Chinook salmon	MN	Sunfish sp.	MN, MO
Crappies	MN	Suckers	MN
Fathead minnow	MO, WI	Tiger muskellunge	MO
Grass carp	IA <sup>1</sup> , MO	Trout sp.	IL, MI, MN, ND, WI
Golden shiners	MO	Walleye	IA <sup>1</sup> , MN, WI
Largemouth bass	IA <sup>1</sup> , MN	White bass	IN
Muskellunge	WI		

<sup>1</sup> Sold to city and county government agencies but not to state agency.



**Table 6a. Aquacultural species and their uses in the North Central Region.**

Species	Food fish	Fee Fishing	Bait	Species	Food fish	Fee Fishing	Bait
	Stocking				Stocking		
<i>Bass:</i>				<i>Minnows:</i>			
Hybrid Striped		X		All species		X	X
Kentucky		X		Fathead		X	X
Largemouth		X	X	<i>Muskellunge</i>		X	
Smallmouth		X	X	<i>Northern Pike</i>		X	
Striped		X		<i>Paddlefish</i>	X	X	
White	X	X		<i>Shiners:</i>			
<i>Buffalo fish</i>	X			Emerald			X
<i>Bullheads</i>		X		Golden	X		X
<i>Carp:</i>				Grey			X
Bighead	X			<i>Sunfish:</i>			
Common	X	X	X	Bluegill		X	X
Goldfish		X	X	Hybrid		X	
Grass	X	X		Hybrid bluegill		X	
Silver	X			Redear		X	
<i>Cattfish:</i>				Other		X	X
Blue	X	X	X	<i>Trout/Salmon:</i>			
Channel	X	X	X	Brook	X	X	X
Flathead		X		Brown	X	X	X
<i>Crappie:</i>				Chinook		X	
Black		X		Cutthroat		X	
White		X		Lake			
<i>Crayfish</i>	X	X	X	Rainbow	X	X	X
<i>Glass shrimp</i>		X		<i>Walleye</i>		X	X
<i>Lake Sturgeon</i>	X	X		<i>White sucker</i>		X	X
<i>Mosquitofish</i> (Gambusia)		X		<i>Whitefish</i>	X	X	
				<i>Yellow Perch</i>		X	X

**Table 7. Examples of some major manufacturers of fish culture supplies or equipment in the North Central Region.**

State	Company Name	Product
IL	Continental Grain Co.	feed
IA	Berkeley Fort Dodge Laboratories Stoller Fisheries	miscellaneous anaesthetics carp pituitaries, eggs
KS	Key Milling Hubburt Milling, Inman, KS Co-op	fish feed fish feed fish feed
MI	Frigid Units (manufacturing plant)	chillers, etc.
MN	Aeration Industries Internet, Inc. World Container Int'l Inc.  Destratifying Concepts Big Redd Inc. Glencoe Mills, Inc.	aerators netting seafood shipping containers aerators incubators fish feed
MO	Air-O-Lator Corp Ralston-Purina Stewart Fish Supply	aerators fish feed miscellaneous
OH	Frigid Units (sales office)	chillers, etc.
WI	Duraframe netting Fresh-Flow Corporation Forelle Fish Netting Corp Bodin Net Company Midland Plastics, Inc. Peterson Fiberglass	netting pond aerators netting netting tanks, etc. tanks

**Table 8. Aquaculture trade organizations in the North Central Region.**

Central Minnesota Fish Farmers Association  
 Kansas Commercial Fish Growers Association  
 Michigan Bait Dealers Association  
 Michigan Fish Growers' Association  
 Michigan Fish Producers' Association  
 Midwest Aquaculture Resources  
 Missouri Aquaculture Advisory Council  
 Missouri Fish Farmers Association  
 Nebraska Fish Farmers Association  
 South Dakota Wholesale Bait Producers  
 Wisconsin Trout Growers Association  
 Wisconsin Musky Clubs Alliance

**Table 9. Institutional involvement in aquaculture research and extension in the North Central Region.**

State	Institutions <sup>1</sup>	Number of Professionals <sup>2</sup>	
		Research	Extension/ Public Ed.
IL	6	10	1
IN	3	14	4
IA	2	4	0
KS	3	6	1
MI	7	11	2
MN	3	5	2
MO	5	6	6
NE	0	0	0
ND	1	1	0
OH	10 <sup>3</sup>	25 <sup>3</sup>	2 <sup>3</sup>
SD	4	6	2
WI	6	13	4
TOTALS	50	101	24

<sup>1</sup> Includes universities, state and federal agencies, and private sector.

<sup>2</sup> Only includes individuals engaged in aquaculture activities 50% or more of their time.

<sup>3</sup> Ohio figures are all estimates.

Table 10. Discipline strengths of professionals working in the North Central Region in 1986.

State:	IL	IN	IA	KS	MI	MN	MO	NE	ND	OH	SD	WI
<i>Discipline:</i>												
Aquaculture Economics	X								X			X
Aquaculture Engineering		X			X	X	X			X		
Aquaculture Techniques	X	X	X	X	X	X	X			X	X	X
Behavior			X					X				X
Fish Health	X	X	X		X	X	X					X
Genetics	X	X	X			X	X					X
Nutrition	X		X	X	X							X
Physiology	X	X	X		X	X	X					
Toxicology		X										
Water Quality	X	X	X	X	X	X	X			X		

Table 11. Aquaculture related research projects funded at North Central Regional universities between 1975 and 1986.

Project	No. of Years	Total Funds	Funding Agency	Project	No. of Years	Total Funds	Funding Agency
<b>Illinois:</b>	na <sup>1</sup>	na	na	Host Parasite Relationship between Channel Catfish and the Protozoan <i>Ichthyophthirus multifiliis</i>	3	13,963	U.S.D.A.
<b>Indiana:</b>				Nutritional Requirements of Channel Catfish	3	21,000	Kansas Agr. Exp. Sta.
Cytogenetics of Animal Performance	3	na	AES Hatch	The Effect of Protein Type & Energy Level on Raceway Culture of Channel Catfish	2	\$14,000	Kansas Agr. Exp. Sta.
Fisheries Biology - Aquaculture	3	na	AES Hatch	Utilization of Wheat & Wheat Co-products in Crustacean & Shellfish Diets	2	6,000	Kansas Wheat Comm.
Hybr. & Polyploid of Catfish	2	\$56,238	USDA S&E Aquacult.	<b>Michigan:</b>			
Transgenic Catfish	3	314,576	USDA S&E Comp. Grants	Bioenergetics of Male vs. Female <i>O. nilotica</i> Growth	na	na	US AID
<b>Iowa:</b>				Culture of Lake Whitefish	5	na	State of Michigan
Cryopreservation of Catfish Embryos	3	30,000	IDNR	Development of Low Phosphorus Fish Feeds to Minimize Phosphorus Effluents	2	18,000	Mi. Agr. Exp. Sta.
Fungicides for Use in Aquaculture	3	60,000	U.S.F.W.S.	Development of Methods to Evaluate Nutrient Value of Live Fish Feeds	4	77,500	Mi. Agr. Exp. Sta.
Intensive Culture of Walleye	5	50,000	NY Sea Grant	Development of Michigan Fish Farms as Tourist Attractions	2	33,000	na
Walleye Nutrition	7	140,000	IDNR	Production of Sterile Triploid Fishes	3	175,000	Michigan Sea Grant Mi. Agr. Exp. Sta.
<b>Kansas:</b>				Dynamics of Pond Aquaculture	3	780,000	US AID
Crayfish Culture in Kansas	2	38,918	Kansas Agr. Exp. Sta.	Effects of Ammonia on Growth of <i>T. Nilotica</i>	1	5,500	AMID EAST
Development of Optimum Sustained Yield of Fishes in Farm Ponds	2	38,792	Kansas Agr. Exp. Sta.	Effects of Daily Temperature Cycles on Growth of Culture Bait Minnows	6	105,000	MAES
Fathead Minnow Production in Sewage Lagoons	2	500	Pittsburg State Univ.	Effects of Improved Water Quality on Larval Culture of Walking Catfish	na	15,000	US AID
Food Conversion Efficiency in Grass Carp Utilizing Duckweed	2	9,500	Pittsburg State Univ.				

<sup>1</sup> na : not available at the time of this report

Table 11. (continued)

Project	No. of Years	Total Funds	Funding Agency	Project	No. of Years	Total Funds	Funding Agency
Effects of Incubation Temperature on Survival of Chinook Salmon Eggs	2	40,000	na	Development Project: Comparative Culture Strategies for the Bait Leech, <i>Nepheleopsis obscura</i>	1	4,500	Minnesota Sea Grant
Effects of Oxygen Supersaturation on the Culture of Rainbow Trout	na	na	Michigan Sea Grant	Estimation of Genetic Parameters for Fitness Related Traits of Lake Trout, <i>Salvelinus namaycush</i>	2	47,522	Minnesota Sea Grant
Gas Super-saturation Effects on Larval Rainbow Trout	6	28,500	Michigan Sea Grant	Estimation of Genetic Parameters of Lake Trout	3	77,638	Minnesota Sea Grant
Management of Walleye Nursery Ponds	2	\$15,000	Mi. Agr. Exp. Sta.	Gene Transfer for Growth Hormone Gene for Growth Promotion in Oviparous Teleostean Fish	2	51,843	Minnesota Sea Grant
Market Potential for Cultured Yellow Perch	2	10,000	Mi. Agr. Exp. Sta.	Influence of Dietary Thiaminase on Lake Trout Reproduction	1	\$26,320	Minnesota Sea Grant
Nutritional Requirements of Commercially Important Tilapia Indigenous to Egypt	na	16,500	AMID EAST / US AID	Preservation of Gametes of Fresh Water Fish	4	63,496	Minnesota Sea Grant
Production of Sterile Triploid Fishes	3	175,000	AFTMA, MAES	Studies on the Storage & Preservation of Fish Gametes and Embryos for the Advancement of Aquaculture	2	57,497	Minnesota Sea Grant
Use of Steroids in Rainbow Trout Culture	7	90,000	Michigan Sea Grant	The Relationship of Growth Rate Changes to Smoltification of Chinook Salmon	3	40,311	Minnesota Sea Grant
<b>Minnesota:</b>				Thermal Requirements of White Bass X Striped Bass Hybrids	3	23,900	U.F.W.S. Northern States Power
Analysis of Genetic & Non-genetic Sources of Phenotypic Variation in Cultured White Suckers	3	21,830	Minnesota Sea Grant	Utilization of Waste Heat for Aquaculture	5	171,102	Northern States Power
Application of Gamete Preservation Techniques to Enhance Minnesota Aquaculture	3	80,580	Minnesota Sea Grant	<b>Missouri:</b>			
Bait Leech, <i>Nepheleopsis obscura</i> , Culture & Management	3	38,932	Minnesota Sea Grant	Cage Culture of Channel Catfish in a Heated Effluent from a Power Plant, Thomas Hill Reservoir	3	12,500	U.S. Office of Water Resources Research
Broodstock Management Guidelines for Great Lakes Fisheries Resources	3	3,800	Great Lakes Fishery Commission Minnesota Sea Grant	Density-dependent Regulation of Gizzard Shad Populations in Experimental Ponds	2	18,600	MO. Ag. Exp. St. MO. Dept. Cons.
Development Project: A Genetic Fitness Model and Broodstock Management Guidelines for Lake Trout Restoration	1	15,358	Minnesota Sea Grant				

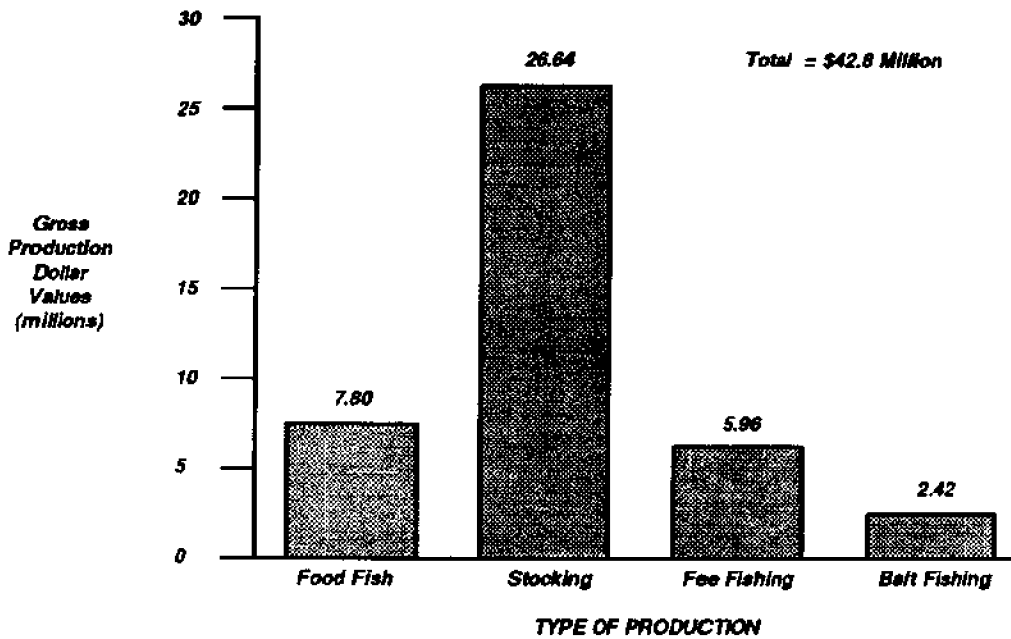
Table 11. (continued)

Project	No. of Years	Total Funds	Funding Agency	Project	No. of Years	Total Funds	Funding Agency
Limnological & Ecological Effects of Grass Carp in Ponds	2	11,500	U.S.F.W.S.	Fish Production in South Dakota Waters	2	20,000	S. Dakota Ag. Exp. St.
Management of Hatchery Pond Productivity	3	18,000	MO. Dept. Cons. Aeration Ind., Inc.	Fishery Development of South Dakota Ponds	3	65,000	S. Dakota Ag. Exp. St.
Paddlefish-Zooplankton Interactions in Hatchery Ponds	2	11,000	MO. Dept. Cons.	Fungal Control Methods, Diets & Water Temperatures Used to Culture Paddlefish	2	20,000	Federal Aid
Pond Production of White Crappie	2	10,500	MO. Coop. Fishery Research Unit	Holding Paddlefish Broodstock in a Power Plant Reservoir	2	20,000	Federal Aid
The Incidence of Lymphocystis in Orangespotted Sunfish Subjected to a Thermal Effluent	2	9,500	MO. Ag. Exp. St.	Methods for Intensively Rearing Walleye Muskellunge, & Yellow Perch	5	51,000	Federal Aid
<b>North Dakota:</b>				South Dakota Farm & Ranch Fisheries	4	40,000	S. Dakota Ag. Exp. St.
Cage Culture of Black Bullheads, <i>Ictalurus melas</i> , in North Dakota	2	na	NDGFD, Comm. Fish. Dev. Act. P.L. 88-309	<b>Wisconsin:</b>			
Feasibility of Waste-heat Aquaculture in North Dakota	na	na	na	An Economic Simulation & Evaluation of Open Pond Rearing of Perch	2	33,663	WI Sea Grant
The Biological & Economic Aspects of Cage Rearing Rainbow Trout, <i>Salmo gairdneri</i> , in North Dakota	2	na	NDGFD, Comm. Fish. Dev. Act, P.L. 88-309	Aquaculture Development & Subprogram Coordination	3	163,163	WI Sea Grant
<b>Ohio:</b>				Aquaculture Facilities on UW-Madison Campus	1	\$350,000	St. of Wisconsin
Aquaculture in Ohio: Culturing Fathead Minnows for Bait	3	\$80,000	Sea Grant Ohio State Univ.	Assessment of Dietary Amino Acid Requirements of a Representative Great Lakes Fish	4	432,246	Hatch
<b>South Dakota:</b>				Assessment of the Feasibility of Combined Pond & Cage Culture of Yellow Perch	4	na	Sea Grant/UIR/ Cooperative Res.
Catfish Cage in Heated Power Plant Waters	2	20,000	National Marine Culture Fisheries Serv.	Basic Husbandry of Great Lakes Fishes	4	530,105	WI Sea Grant
Development of Polyploid Fishes for South Dakota Waters	4	110,298	S. Dakota Ag. Exp. St.	Comparative Studies on the Requirements of Selected Great Lakes Fishes for Protein & Key Amino Acids	3	348,116	na
Evaluation of Power Plant Heated Waters for Walleye & Muskellunge Culture	na	244,000	Federal Aid	Control of Sexual Differentiation in Yellow Perch	3	95,954	WI Sea Grant

Table 11. (continued)

Project	No. of Years	Total Funds	Funding Agency	Project	No. of Years	Total Funds	Funding Agency
Development of Aquaculture Systems for Coolwater Fish Species	2	48,508	WI Sea Grant	Identification & Production of Trout Stocks Genetically Resistant to Disease	1	77,503	na
Development of a Fermentation Process for Mass Culturing Live Food Organisms for Feeding Larval Fishes	2	53,203	WI Sea Grant	Lake Mills Aquaculture Facility	4	250,000	Sea Grant/DNR/UW
Effects of Environmental & Nutritional Stress on Resistance to Disease in Cool-water Fishes	1	51,977	na	Miscellaneous Facility & Equipment Grants from Agencies & Private Industry	4	87,670	Multiple donors
Effects of Nutritional & Environmental Stress on Resistance to Disease in Fish	2	100,943	WI Sea Grant	Propagation of Perch & Walleye	2	58,558	WI Sea Grant
Genetic Manipulation of Growth & Production of Selected Great Lakes Cool-water Fishes	2	269,997	WI Sea Grant	Raising Yellow Perch for Human Food	1	79,868	WI Sea Grant

Figure 1. Gross production values for the North Central Region, in millions of dollars, for the four types of fish production. Values were taken from Tables 2–5. The value for food fish (77.97) is one-half of the total economic value given in Table 2.





**Figure 2. A comparison between 1985 food fish production (dark portion) and total fish and shellfish consumption (whole pie) in the North Central Region, based on the national average per capita fish consumption of 14.5 pounds. The shaded portion (the difference between regional production and consumption) represents the potential market for regionally produced fish and shellfish.**

