

**SAFETY OF 17-METHYLTESTOSTERONE FOR
INDUCTION OF SEX INVERSION IN WALLEYE⁽¹²⁾**

Project Termination Report for the Period

July 1, 1996 to August 31, 1998

NCRAC FUNDING LEVEL: \$27,000 (July 1, 1996 to December 31, 1997)

PARTICIPANTS:

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Jeffrey A. Malison	University of Wisconsin-Madison	Wisconsin
Industry Advisory Council Liaison:		
Rosalie A. Schnick		Wisconsin
Extension Liaison:		
Joseph E. Morris	Iowa State University	Iowa

REASON FOR TERMINATION

The objectives were completed and funding was terminated.

PROJECT OBJECTIVES

(1) To conduct a Target Animal Safety Study under Good Laboratory Practice (GLP) compliance for walleye fingerlings fed 17-methyltestosterone for induction of sex inversion to produce genotypic females that produce viable sperm.

(2) To evaluate selected dosages of 17-methyltestosterone for efficacy at inducing sex inversion in walleye.

PRINCIPAL ACCOMPLISHMENTS

OBJECTIVE 1

The safety of 17-methyltestosterone (MT) fed to fingerling walleye (*Percidae: Stizostedion vitreum*) was assessed at Southern Illinois University (SIUC) in compliance with GLP regulations (21 CFR Part 58) for non-clinical laboratory studies. The investigation was based on the safety study protocol for Investigational New Animal Drug (INAD) #9647. Only minor deviations from the protocol occurred which were described in a 602-page report that was submitted to the INAD Sponsor. Two studies were conducted in a single room of the Vivarium at SIUC in 208.2-L (55-gal) glass aquaria. For the first study, groups of walleye fingerlings initially 45-55 mm (1.8-2.2 in) total length (TL) were fed diets containing MT at 0 (control), 15, 30, and 75 mg/kg (ppm) of feed whereas in the second study, groups of walleye fingerlings of initially the same size as the first study, were fed diets containing MT at 0 (control), 75, and 150 mg/kg of feed. In both studies, fish were fed their assigned diets for 60 days, followed by a 30-day withdrawal period in which all fish were fed the placebo, or control diet. Fish were observed twice daily for any overt clinical signs, and on day 91 were necropsied by a U.S. Food and Drug Administration's Center for Veterinary

Medicine-certified veterinarian. No abnormal organs were observed, and no deaths or clinical abnormalities attributable to MT were noted. The results of these studies indicate that MT, used as described in the protocol, is safe for walleye fingerlings.

OBJECTIVE 2

At the University of Wisconsin-Madison, studies on the use of MT to induce sex reversal in female walleye have been completed. Groups of walleye fingerlings initially 35-45 mm (1.4-1.8 in) total length (TL) were fed diets containing MT at 0 (control), 3, and 15 mg/kg (ppm) of feed for 60 consecutive days. The fish were then grown to 200-250 mm (7.9-9.8 in) TL, sacrificed, and examined morphologically and histologically for reproductive status. One hundred percent of the fish fed MT at 3 and 15 mg/kg had identifiable testicular tissue. In the 3 mg/kg treatment group, 92% of the fish examined had apparently normal testes, and 8% had ovotestes. In the 15 mg/kg group, 95% of the fish examined had apparently normal testes, and 5% had ovotestes. Normal female development was observed only in the control group. Forty percent of the control fish were normal females and 60% were normal males. The presence of ovotestes coupled with the absence of normal female development in fish treated with MT indicates that MT at dosages as low as 3 mg/kg induces sex reversal in walleye.

IMPACTS

The successful and safe production of sex-reversed walleye brood stock provides information required for the use of MT in the production of monosex walleye, which may ultimately result in New Animal Drug Approval (NADA) for the use of MT in percids. The propagation of all-female populations of percids will result in improved production efficiency for the commercial aquaculture of these species, and a new management tool for resource enhancement programs.

RECOMMENDED FOLLOW-UP ACTIVITIES

The identification of a method to masculinize female walleye, and use of their gametes to produce broods of all-female offspring, offer great potential benefits for the commercial culture of walleye as a food fish as well as for resource enhancement. Work along several lines is still needed, however, to facilitate the commercial use of these findings. First, NADA approval of the method is needed. Second, a cooperative effort between the North Central Regional Aquaculture Center, commercial producers, and fisheries management agencies is needed to make the technology for monosex culture available to the public and private sectors. Third, research is needed to incorporate this monosex technology into the development of fast-growing strains of hybrid walleye (*Stizostedion vitreum* × *S. canadense*) that will further increase the productivity and profitability of commercial walleye culture.

PUBLICATIONS, MANUSCRIPTS, OR PAPERS PRESENTED

See the Appendix under Aquaculture Drugs.

SUPPORT

YEARS	NCRAC-USDA FUNDING	OTHER SUPPORT					TOTAL SUPPORT
		UNIVERSITY	INDUSTRY	OTHER FEDERAL	OTHER	TOTAL	
1996-97	\$27,000	\$21,375				\$21,375	\$48,375
TOTAL	\$27,000	\$21,375				\$21,375	\$48,375

APPENDIX

EXTENSION

NCRAC Extension Fact Sheet Series

Garling, D.L. 1992. Making plans for commercial aquaculture in the North Central Region. NCRAC Fact Sheet Series #101, NCRAC Publications Office, Iowa State University, Ames.

Harding, L.M., C.P. Clouse, R.C. Summerfelt, and J.E. Morris. 1992. Pond culture of walleye fingerlings. NCRAC Fact Sheet Series #102, NCRAC Publications Office, Iowa State University, Ames.

Kohler, S.T., and D.A. Selock. 1992. Choosing an organizational structure for your aquaculture business. NCRAC Fact Sheet Series #103, NCRAC Publications Office, Iowa State University, Ames.

Swann, L. 1992. Transportation of fish in bags. NCRAC Fact Sheet Series #104, NCRAC Publications Office, Iowa State University, Ames.

Swann, L. 1992. Use and application of salt in aquaculture. NCRAC Fact Sheet Series #105, NCRAC Publications Office, Iowa State University, Ames.

Morris, J.E. 1993. Pond culture of channel catfish in the North Central Region. NCRAC Fact Sheet Series #106, NCRAC Publications Office, Iowa State University, Ames.

Morris, J.E., and C.C. Kohler. In review. Pond culture of hybrid striped bass fingerlings in the Midwest. NCRAC Fact Sheet Series #107, NCRAC Publications Office, Iowa State University, Ames.

Cain, K., and D. Garling. 1993. Trout culture in the North Central Region. NCRAC Fact Sheet Series #108, NCRAC Publications Office, Iowa State University, Ames.

Mittelmark, J. In review. Fish health management. NCRAC Fact Sheet Series #109, NCRAC Publications Office, Iowa State University, Ames.

Riepe, J.R. In review. Managing feed costs: limiting delivered price paid. NCRAC Fact Sheet Series #110, NCRAC Publications Office, Iowa State University, Ames.

Riepe, J.R. 1997. Costs for pond production of yellow perch in the North Central Region, 1994-95. NCRAC Fact Sheet Series #111, NCRAC Publications Office, Iowa State University, Ames.

Morris, J.E. In review. Plankton management for fish culture ponds. NCRAC Fact Sheet Series #114, NCRAC Publications Office, Iowa State University, Ames.

NCRAC Technical Bulletin Series

Thomas, S.K., R.M. Sullivan, R.L. Vertrees, and D.W. Floyd. 1992. Aquaculture law in the north central states: a digest of state statutes pertaining to the production and marketing of aquacultural products. NCRAC Technical Bulletin Series #101, NCRAC Publications Office, Iowa State University, Ames.

Swann, L. 1992. A basic overview of aquaculture: history, water quality, types of aquaculture, production methods. NCRAC Technical Bulletin Series #102, NCRAC Publications Office, Iowa State University, Ames.

Kinnunen, R.E. 1992. North Central Region 1990 salmonid egg and fingerling purchases, production, and sales. NCRAC Technical Bulletin Series #103, NCRAC Publications Office, Iowa State University, Ames.

Hushak, L.J., C.F. Cole, and D.P. Gleckler. 1993. Survey of wholesale and retail buyers in the six southern states of the North Central Region. NCRAC Technical Bulletin Series #104, NCRAC Publications Office, Iowa State University, Ames.

Meronek, T., F. Copes, and D. Coble. 1998. The bait industry in Illinois, Michigan, Minnesota, Ohio, South Dakota, and Wisconsin. NCRAC Technical Bulletin Series #105, NCRAC Publications Office, Iowa State University, Ames.

Lichtkoppler, F.P. 1993. Factors to consider in establishing a successful aquaculture business in the North Central Region. NCRAC Technical Bulletin Series #106, NCRAC Publications Office, Iowa State University, Ames.

Swann, L., and J. R. Riepe. 1994. Niche marketing your aquaculture products. NCRAC Technical Bulletin Series #107, NCRAC Publications Office, Iowa State University, Ames.

Swann, L., J. Morris, and D. Selock. 1995. Cage culture of fish in the North Central Region. NCRAC Technical Bulletin Series #110, NCRAC Publications Office, Iowa State University, Ames.

Riepe, J.R. 1997. Enterprise budgets for yellow perch production in cages and ponds in the North Central Region, 1994/95. NCRAC Technical Bulletin Series #111, NCRAC Publications Office, Iowa State University, Ames.

Brown, P., and J. Gunderson, editors. 1997. Culture potential of selected crayfishes in the North Central Region. NCRAC Technical Bulletin Series #112, NCRAC Publications Office, Iowa State University, Ames.

Riepe, J.R. 1998. Walleye markets in the North Central Region: results of a 1996/97 survey. NCRAC Technical Bulletin Series #113, NCRAC Publications Office, Iowa State University, Ames.

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NCRAC Video Series

Swann, L. 1992. Something fishy: hybrid striped bass in cages. VHS format, 12 min. NCRAC Video Series #101, NCRAC Publications Office, Iowa State University, Ames.

Pierce, R., R. Henderson, and K. Neils. Aquacultural marketing: a practical guide for fish producers. 1995. VHS format, 19 min. NCRAC Video Series #102, NCRAC Publications Office, Iowa State University, Ames.

Swann, L., editor. 1993. Investing in freshwater aquaculture. VHS format, 120 min. NCRAC Video Series #103, NCRAC Publications Office, Iowa State University, Ames.

Morris, J.E., and C.C. Mischke. 1998. Sunfish culture. NCRAC Video Series #104, NCRAC Publications Office, Iowa State University, Ames.

Kayes, T.B. In production. Spawning and propagating yellow perch. VHS format, 45 min. NCRAC Video Series, NCRAC Publications Office, Iowa State University, Ames.

NCRAC Culture Series

Summerfelt, R., editor. 1996. Walleye culture manual. NCRAC Culture Series #101, NCRAC Publications Office, Iowa State University, Ames.

Morris, J.E., editor. In review. Sunfish culture guide. NCRAC Culture Series #102, NCRAC Publications Office, Iowa State University, Ames.

Other Videos

Kayes, T.B., and K. Mathiesen, editors. 1994. Investing in freshwater aquaculture: a reprise (part I). VHS format, 38 min. Cooperative Extension, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln.

Kayes, T.B., and K. Mathiesen, editors. 1994. Investing in freshwater aquaculture: a reprise (part II). VHS format, 41 min. Cooperative Extension, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln.

CD-ROMs

Swann, L. 1998. Getting started in freshwater aquaculture. NCRAC CD-ROM Series #101, NCRAC Publications Office, Iowa State University, Ames.

Situation and Outlook Report

Hushak, L.J. 1993. North Central Regional aquaculture industry situation and outlook report, volume 1 (revised October 1993). NCRAC Publications Office, Iowa State University, Ames.

Workshops and Conferences

Salmonid Culture, East Lansing, Michigan, March 23-24, 1990. (Donald L. Garling)

Midwest Regional Cage Fish Culture Workshop, Jasper, Indiana, August 24-25, 1990. (LaDon Swann)

Aquaculture Leader Training for Great Lakes Sea Grant Extension Agents, Manitowoc, Wisconsin, October 23, 1990. (David J. Landkamer and LaDon Swann)

Regional Workshop of Commercial Fish Culture Using Water Reuse Systems, Normal, Illinois, November 2-3, 1990. (LaDon Swann)

First North Central Regional Aquaculture Conference, Kalamazoo, Michigan, March 18-21, 1991. (Donald L. Garling, Lead; David J. Landkamer, Joseph E. Morris and Ronald Kinnunen, Steering Committee)

Crayfish Symposium, Carbondale, Illinois, March 23-24, 1991. (Daniel A. Selock and Christopher C. Kohler)

Fish Transportation Workshops, Marion, Illinois, April 6, 1991 and West Lafayette, Indiana, April 20, 1991. (LaDon Swann and Daniel A. Selock)

Regional Workshop on Commercial Fish Culture Using Water Recirculating Systems, Normal, Illinois, November 15-16, 1991. (LaDon Swann)

National Aquaculture Extension Workshop, Ferndale, Arkansas, March 3-7, 1992. (Joseph E. Morris, Steering Committee)

Regional Workshop on Commercial Fish Culture Using Water Recirculating Systems, Normal, Illinois, November 19-20, 1992. (LaDon Swann)

In-Service Training for CES and Sea Grant Personnel, Gretna, Nebraska, February 9, 1993. (Terrence B. Kayes and Joseph E. Morris)

Aquaculture Leader Training, Alexandria, Minnesota, March 6, 1993. (Jeffrey L. Gunderson and Joseph E. Morris)

Investing in Freshwater Aquaculture, Satellite Videoconference, Purdue University, April 10, 1993. (LaDon Swann)

National Extension Wildlife and Fisheries Workshop, Kansas City, Missouri, April 29-May 2, 1993. (Joseph E. Morris)

Commercial Aquaculture Recirculation Systems, Piketon, Ohio, July 10, 1993. (James E. Ebeling)

Yellow Perch and Hybrid Striped Bass Aquaculture Workshop, Piketon, Ohio, July 9, 1994. (James E. Ebeling and Christopher C. Kohler)

Workshop on Getting Started in Commercial Aquaculture Raising Crayfish and Yellow Perch, Jasper, Indiana, October 14-15, 1994. (LaDon Swann)

Aquaculture in the Age of the Information Highway. Special session, World Aquaculture Society, San Diego, California, February 7, 1995. (LaDon Swann)

Second North Central Regional Aquaculture Conference, Minneapolis, Minnesota, February 17-18, 1995. (Jeffrey L. Gunderson, Lead; Fred P. Binkowski, Donald L. Garling, Terrence B. Kayes, Ronald E. Kinnunen, Joseph E. Morris, and LaDon Swann, Steering Committee)

Walleye Culture Workshop, Minneapolis, Minnesota, February 17-18, 1995. (Jeffrey L. Gunderson)

Aquaculture in the Age of the Information Highway. Multimedia session, 18 month meeting of the Sea Grant Great Lakes Network, Niagra Falls, Ontario, May 6, 1995. (LaDon Swann)

AquaNIC. Annual Meeting of the Aquaculture Association of Canada, Nanaimo, British Columbia, June 5, 1995. (LaDon Swann)

Yellow Perch Aquaculture Workshop, Spring Lake, Michigan, June 15-16, 1995. (Donald L. Garling)

Rainbow Trout Production: Indoors/Outdoors, Piketon, Ohio, July 8, 1995. (James E. Ebeling)

North Central Regional Aquaculture Center Hybrid Striped Bass Workshop, Champaign, Illinois, November 2-4, 1995. (Christopher C. Kohler, LaDon Swann, and Joseph E. Morris)

Third North Central Regional Aquaculture Conference, Indianapolis, Indiana, February 6-7, 1997. (LaDon Swann)

Morris, J.E. Overview of Sunfish Culture. Missouri Joint Aquaculture Conference, Springfield, Missouri, March 4-6, 1998.

Proceedings

Garling, D.L., editor. 1991. Proceedings of the North Central Regional Aquaculture Conference. First North Central Regional Aquaculture Conference, Kalamazoo, Michigan, March 18-21, 1991.

Gunderson, J., editor. 1995. Proceedings of the Combined North Central and Ninth Annual Minnesota Aquaculture Conference and Tradeshow. Second North Central Regional Aquaculture Conference, Minneapolis, Minnesota, February 17-18, 1995.

Swann, L., editor. 1997. Proceedings of the 1997 North Central Regional Aquaculture Conference. Third North Central Regional Aquaculture Conference, Indianapolis, Indiana, February 6-7, 1997. Illinois-Indiana Sea Grant Program, Publication CES-305. (Also available electronically at: <http://ag.ansc.purdue.edu/aquanic/publicat/state/il-in/ces-305.htm>)

ECONOMICS AND MARKETING

Publications in Print

Aubineau, C.M. 1996. Characterization of the supply of walleye fingerlings in the north central region of the U.S. Master's thesis. Illinois State University, Normal.

- Brown, G.J. 1994. Cost analysis of trout production in the North Central states. Master's thesis. Ohio State University, Columbus.
- Edon, A.M.T. 1994. Economic analysis of an intensive recirculating system for the production of advanced walleye fingerlings in the North Central Region. Master's thesis. Illinois State University, Normal.
- Floyd, D.W., and R.M. Sullivan. 1990. Natural resources and aquaculture: the policy environment in the North Central states. Proceedings of the Third Symposium on Social Science and Resource Management, Texas A&M University, College Station, Texas.
- Floyd, D.W., R.M. Sullivan, R.L. Vertrees, and C.F. Cole. 1991. Natural resources and aquaculture: emerging policy issues in the North Central states. *Society and Natural Resources* 4:123-131.
- Gleckler, D.P. 1991. Distribution channels for wild-caught and farm-raised fish and seafood: a survey of wholesale and retail buyers in six states of the North Central Region. Master's thesis. Ohio State University, Columbus.
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- Hushak, L., C. Cole, and D. Gleckler. 1993. Survey of wholesale and retail buyers in the six southern states of the North Central Region. NCRAC Technical Bulletin Series #104, NCRAC Publications Office, Iowa State University, Ames.
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- Makowiecki, E.M.M. 1995. Economic analysis of an intensive recirculating system for the production of walleye from fingerling to food size. Master's thesis. Illinois State University, Normal.
- O'Rourke, P.D. 1996. Economic analysis for walleye aquaculture enterprises. Pages 135-145 *in* R.C. Summerfelt, editor. The walleye culture manual. NCRAC Culture Series #101, NCRAC Publications Office, Iowa State University, Ames.
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- Riepe, J.R. 1997. Costs for pond production of yellow perch in the North Central Region, 1994-95. NCRAC Fact Sheet Series #111, NCRAC Publications Office, Iowa State University, Ames.
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- Riepe, J.R. 1997. Yellow perch markets in the North Central Region: results of a 1996/97 survey. Office of Agricultural Research Programs, Department of Agricultural Economics, Purdue University, West Lafayette, Indiana.

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Tudor, K.W., R.R. Rosati, P.D. O'Rourke, Y.V. Wu, D. Sessa, and P. Brown. 1996. Technical and economical feasibility of on-farm fish feed production using fishmeal analogs. *Journal of Aquacultural Engineering* 15(1):53-65.

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Riepe, J.R. In review. Managing feed costs: limiting delivered price paid. NCRAC Fact Sheet Series #110, NCRAC Publications Office, Iowa State University, Ames.

Papers Presented

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Foley, P., R. Rosati, P.D. O'Rourke, and K. Tudor. 1994. Combining equipment components into an efficient, reliable, and economical commercial recirculating aquaculture system. 25th Annual Meeting of the World Aquaculture Society, New Orleans, Louisiana, January 12-18, 1994.

Gleckler, D.P., L.J. Hushak, and M.E. Gerlow. 1991. Distribution channels for wild-caught and farm-raised fish and seafood. First North Central Regional Aquaculture Conference, Kalamazoo, Michigan, March 18-21, 1991.

Kohler, S.T. 1995. Hybrid striped bass cost of production. North Central Regional Aquaculture Center Hybrid Striped Bass Workshop, Champaign, Illinois, November 2-4, 1995.

O'Rourke, P.D. 1995. Profitability and volume-cost business analysis tools for the aquaculture enterprise. Presented at Illinois-Indiana Aquaculture Conference and North Central Regional Aquaculture Center Hybrid Striped Bass Workshop, Champaign, Illinois, November 2-4, 1995.

O'Rourke, P.D. 1996. The economics of recirculating aquaculture systems. Conference on Successes and Failures in Commercial Recirculating Aquaculture, Roanoke, Virginia, July 19-21, 1996.

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Riepe, J.R. 1997. Revisiting retail and wholesale markets (walleye and yellow perch). Third North Central Regional Aquaculture Conference, Indianapolis, Indiana, February 6-7, 1997.

Riepe, J.R., J. Ferris, and D. Garling. 1995. Economic considerations in yellow perch aquaculture. Yellow Perch Aquaculture Workshop, Spring Lake, Michigan, June 15-16, 1995.

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YELLOW PERCH

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Brown, P.B., K. Dabrowski, and D. Garling. 1995. Nutritional requirements and commercial diets for yellow perch. Workshop on Aquaculture of Percids, Vaasa, Finland, August 21-25, 1995.

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Reports

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SOME COMMONLY USED ABBREVIATIONS AND ACRONYMS

BOD	Board of Directors
BRD	Biological Resources Division (of the U.S. Geological Survey)
C	degrees Celsius
CES	Cooperative Extension Service
CG	compensatory growth
cm	centimeter(s)
CVM	Center for Veterinary Medicine
CP	crude protein
E:P	energy to protein ratio
F	degrees Fahrenheit
FCR	food conversion ratio
FDA	Food and Drug Administration
ft, ft ² , ft ³	foot, square foot, cubic foot
g	gram(s)
gal	gallon(s)
h	hour(s)
ha	hectare(s)
HACCP	Hazard Analysis Critical Control Point
IAC	Industry Advisory Council
IAFWA	International Association of Fish and Wildlife Agencies
in	inch(es)
INAD	Investigational New Animal Drug
ISU	Iowa State University
kg	kilogram(s)
L	liter(s)
lb	pound(s)
m, m ² , m ³	meter(s), square meter(s), cubic meter(s)
mg/L	milligrams per liter = ppm (parts per million)
meq	milliequivalent(s)
mg	milligram(s)
min	minute(s)
mL	milliliter(s)
mm	millimeter(s)
MSU	Michigan State University
N	nitrogen
<i>N</i>	number
NADA	New Animal Drug Application
NCC	National Coordinating Council
NCR	North Central Region

NCRAC	North Central Regional Aquaculture Center
ng	nanogram
OSU	Ohio State University
oz	ounce(s)
P	phosphorus
<i>P</i>	probability
ppm	parts per million
PPM	plant-protein mixture
PSU	Pittsburg State University
Purdue	Purdue University
RAC	Regional Aquaculture Center
sec	second(s)
SDSU	South Dakota State University
SIUC	Southern Illinois University-Carbondale
TC	Technical Committee (TC/E = Technical Committee-Extension; TC/R = Technical Committee-Research)
TL	total length
UM	University of Minnesota University of Missouri
UNL	University of Nebraska-Lincoln
USD	University of South Dakota
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
UW-Madison	University of Wisconsin-Madison
UW-Milwaukee	University of Wisconsin-Milwaukee
YOY	young-of-the-year

1. NCRAC has funded six Extension projects. This termination report is for one of the objectives of the fifth Extension project. A progress report for all other projects and objectives is contained elsewhere in this Annual Progress Report.

2. NCRAC has funded six Extension projects, the first three of which were chaired by Donald L. Garling. The fourth project was chaired by Fred P. Binkowski. The fifth and sixth projects are chaired by Joseph E. Morris. A Project Component Termination Report for one of the objectives of the fifth Extension project is contained elsewhere in this Annual Progress Report. The sixth project is a 2-year project that began September 1, 1997.

3. NCRAC has funded six Yellow Perch projects. Termination reports for the first three projects are contained in the 1989-1996 Compendium Report. This termination report is for the fourth and fifth Yellow Perch projects, both of which were chaired by Jeffrey A. Malison. The fifth project continued and expanded upon work undertaken in the fourth project. It was a 2-year study that began September 1, 1995.

4. NCRAC has funded six Yellow Perch projects. Termination reports for the first three projects are contained in the 1989-1996 Compendium Report; a termination report for the fourth and fifth

projects is contained elsewhere in this Annual Progress Report. This progress report is for the sixth Yellow Perch project, which is chaired by Jeffrey A. Malison. It is a 2-year study that began September 1, 1997.

5. NCRAC has funded five Hybrid Striped Bass projects. Termination reports for the first four projects are contained in the 1989-1996 Compendium Report. This project component termination report is for two objectives of the fifth project, which is chaired by Christopher C. Kohler. A progress report for the remainder of this project is contained elsewhere in this Annual Report. The fifth project continued and expanded upon the first four projects. It was a 2-year study that began September 1, 1995.

6. NCRAC has funded five Hybrid Striped Bass projects. Termination reports for the first four projects are contained in the 1989-1996 Compendium Report; a project component termination report for two objectives of the fifth project is contained elsewhere in this Annual Progress Report. This progress report is for the remainder of the fifth project, which is chaired by Christopher C. Kohler. It was originally a 2-year study that began September 1, 1995.

7. NCRAC has funded four Sunfish projects. Termination reports for the first project and all but the diet work of the second project are contained in the 1989-1996 Compendium Report. This progress report is for the third and fourth projects, which are chaired by Donald L. Garling and Robert J. Sheehan, respectively. These projects continued and built upon the first two projects. The third project was originally a 2-year study that began September 1, 1994; whereas the fourth project was originally a 2-year study that began September 1, 1996.

8. NCRAC has funded four Salmonids projects. Project component termination reports for objectives of the first two projects are contained in the 1989-1996 Compendium Report; termination reports for the remainder of the first two projects and all of the third are contained in the 1996-1997 Annual Progress Report. This progress report is for the fourth project, which is chaired by Paul B. Brown. The fourth project built upon the first three projects. It is a 2-year study that began September 1, 1997.

9. NCRAC has funded two Wastes/Effluents Projects. The termination report for the first project is contained in the 1989-1996 Compendium Report. This progress report is for the second project, which is chaired by Fred P. Binkowski. It was originally a 2-year study that began September 1, 1996.

10. Ted R. Batterson serves as the facilitator for this multi-year project interacting with a steering committee in overseeing the Coordinator's activities.

11. NCRAC has funded only one Tilapia project to date, which is chaired by Donald L. Garling. This was originally a 2-year study that began September 1, 1996.

12. NCRAC has funded two Aquaculture Drugs projects. A termination report for the other project is contained in the 1996-1997 Annual Progress Report.

