CRAYFISH[16]

Project Termination Report for the Period
September 1, 1992 to August 31, 1995

NCRAC FUNDING LEVEL: $49,677 (September 1, 1992 to June 30, 1995)

PARTICIPANTS:

Paul B. Brown	Purdue University	Indiana
Harold E. Klaassen	Kansas State University	Kansas
Robert J. Sheehan	Southern Illinois University-Carbondale	Illinois
Extension Liaison:		
Jeffrey L. Gunderson	University of Minnesota-Duluth	Minnesota
Non-Funded Collaborators:		
Carl Richards	University of Minnesota-Duluth	Minnesota
Robert Wilkinson	Southwest Missouri State University	Missouri

REASON FOR TERMINATION
The objectives for this project were completed.

PROJECT OBJECTIVES
(1) Complete a study of the status of the crayfish industry in the north central states, relative to its extent, culture operations in use, market characteristics, and problems which need to be addressed by research.

(2) Complete a report on indigenous crayfish species appropriate for culture in the North Central Region (NCR), to include species life histories, ranges of distribution, economic assessment of appropriate culture production systems, a bibliography of pertinent literature, and a summary of critical information gaps.

(3) Conduct preliminary trials evaluating the performance of several promising indigenous species in pond culture.

PRINCIPAL ACCOMPLISHMENTS
OBJECTIVE 1
Within the NCR, 73 crayfish aquaculturists were identified by state extension contacts. Those individuals were sent a survey form and asked to respond to a series of questions. Based on the responses, crayfish production in the region appears to be under 10,000 kg (22,046 lb) per year. It is felt that this may be an underestimate of total production as several of the larger producers did not respond despite numerous mailings of the survey. The majority of those who responded (71%) indicated they grew crayfish in polyculture with other fin fish. The primary market for crayfish was bait, as a hard-shell product (78% of respondents). Respondents felt there was opportunity for expansion in both the bait (hard- and soft-shell) and human food market. They also indicated that the best return on investment was as tail meat or as a hard-shell bait product. The principal problem areas identified were markets for their products and growth rates of the various species native to the region.

OBJECTIVE 2
A report on the life history and culture potential of four indigenous crayfish species (*Orconectes immunis, O. virilis, O. nais*, and *Procambarus acutus*) is nearing completion and will serve as an important source of information for new culturists interested in crayfish aquaculture in the NCR. Information is presented on the life history, biology, distribution, and an assessment of appropriate culture systems. A bibliography and summary of critical information gaps for each of the four species is also included.

OBJECTIVE 3

Research was conducted at Purdue University (Purdue), Southern Illinois University-Carbondale (SIUC) and Kansas State University (KSU) to evaluate the growth, production, and survival of several indigenous crayfish species in various pond culture systems.

Research at Purdue was designed to compare growth of several of the region's native species of crayfish in side-by-side comparisons. In the first year of the study*, O. virilis*, *O. immunis*, *O. rusticus* and *P. acutus* were evaluated. In the second year of the project, *O. virilis*, *O. propinquus*, and *O. longidigitus* were compared. *O. virilis* grew better than the other crayfish in both years and their yield was higher than the other crayfish in the first year. However, yield was similar in the second year among all crayfish species evaluated.

Research at SIUC was conducted to compare the growth and production of three species of crayfish (*P. acutus, O. virilis*, and *O. immunis*) under polyculture conditions, and compare growth and production of crayfish under two production strategies: (1) artificial destratification/aeration, use of prepared feeds, perpetually filled ponds, and seining (first year); and (2) winter cover-crop production, fall-winter draw down, and harvest via baited traps (second year).

Four ponds (0.06 ha; 0.15 acre) were aerated and four were not in Year 1. Each pond was stocked with about 8,340 young-of-the-year (YOY) crayfish. Only *O. immunis* and *O. virilis* were stocked in the first study year. All three species were examined in the second year. Heavy rains in November precluded planting in the fall prior to Year 2, so cover-crop ponds were planted with Clark Wheat at a rate of 120 kg seed/ha (107 lb/acre) in April of Year 2. The wheat reached a height of 20 cm (7.9 in) prior to flooding.

The specific findings over the two years of study by SIUC were as follows.

- Bottom mean dissolved oxygen (DO) concentrations were significantly lower in non-aerated ponds and in cover-crop ponds than in aerated ponds.
- Bottom temperatures were about 1°C higher on average in aerated versus non-aerated ponds, and the difference was significant.
- Average daily weight gain was significantly higher in aerated versus non-aerated ponds and cover-crop ponds.
- *P. acutus* grew faster than the other two species and *O. virilis* grew significantly faster than *O. immunis*. YOY crayfish began reaching harvestable size (70 mm total length [TL]; 2.76 in) in appreciable numbers by July.
- Mean weights were significantly greater in aerated (15.9 g; 0.56 oz) versus non-aerated ponds (11.8 g; 0.42 oz).
- Harvest from the cover-crop ponds was extremely low (8 kg/ha on average; 7.1 lb/acre) versus the aerated ponds (221 kg/ha on average; 197.2 lb/acre).
- *O. nais* appears to be a subpopulation of *O. virilis*, rather than a true species, based on starch-gel electrophoresis.
- The percent edible tail meat was higher for *O. immunis* (21.9%) than for *P. acutus* (19.3%), *O. virilis* (19.6%) and a sample of *P. clarkii* (16.1%) that had been obtained.

At KSU growth, survival, and harvest of the crayfish *O. nais* were evaluated in three 0.20-ha (0.5-acre) farm ponds. The water quality of these ponds varied considerably but was typical of many Kansas farm ponds.

Each pond was to be stocked in mid-summer with a low density ($3/m^2$; $0.3/ft^2$) of YOY crayfish to allow for maximum growth rate. Ponds were not fed or aerated. Growth, survival (both summer and winter), and harvest were evaluated through two growing cycles, 1993-94 and 1994-95. Prior to stocking, the ponds were to be poisoned to remove existing crayfish. Due to unusually wet weather during 1993, only one pond was poisoned and stocked at the low density. The other two ponds were intensively seined and trapped; crayfish that remained in the pond were used for the study. During 1994-95 all three ponds were poisoned and stocked as proposed.

Edible Size Crayfish
The size of crayfish considered edible or the minimum marketable size varied somewhat among the three research groups. Crayfish were judged to be edible size in the KSU study if they were larger than 38 mm (1.5 in) carapace length (CL) (approximately 76 mm TL; 3.0 in). This is somewhat larger than the 70 mm (2.8 in) TL (approximately 11-12 g or 38-41 crayfish/lb) judged as edible size in the SIUC research. Crayfish exceeding 47 mm (1.9 in) CL (approximately 94 mm TL; 3.7 in) were designated jumbo size in the Kansas State study. Crayfish weighing 15-18 g (approximately 25 to 30 crayfish/lb) were considered minimum marketable size in the Purdue study.

Crayfish did not generally reach edible size during their first growing season but attained edible and jumbo size by the following June. At the end of the growing season (both years), average CL of YOY crayfish varied significantly among ponds and ranged from 23 to 41 mm (0.9 to 1.6 in).

During June of 1994 and 1995 all three ponds were intensively trapped with minnow traps over a two week period. The catch was high at first, but fell off rapidly. Generally, after ten trap nights at least 90% of the harvested crayfish had already been captured. Ponds with larger crayfish trapped out more quickly. The weather was cool during the beginning of June 1995 and trapping success was low, but success increased rapidly as water temperatures warmed. Size of yearling crayfish harvested in June varied from pond to pond and year to year and ranged from 8% edible size (no jumbo) to 100% edible size (87% jumbo).

Crayfish survival was variable. Summer survival (stocking time to fall) ranged from 12% to 78%. Winter survival (fall to spring harvest) ranged from 3% to 55%. Winter survival was consistently lower than summer survival.

IMPACTS
- The crayfish producer survey was the first attempt at defining the status of crayfish aquaculture in the NCR, the potential for expansion, and the current crayfish culture problems/impediments.
- A manuscript is being written that succinctly summarizes the biological characteristics and examines the aquaculture potential of four native crayfish species. The document will be a valuable tool for aquaculturists and extension personnel in the region.
- Growth of several species was compared and *O. virilis* appears to be the best of those studied when reared in pond monoculture.
- Several species grew to minimum marketable size for human consumption in one growing season and many attained jumbo size by the following June.
- Aeration improves growth and production in crayfish ponds, but providing a cover crop did not.
- All three species evaluated at SIUC have their advantages: *P. acutus* reaches harvestable size early in the production season, *O. virilis* exhibited good growth and survival, and *O. immunis* had the highest percentage of edible tail meat.
- YOY crayfish can be successfully stocked.
- Most of the marketable-size crayfish can be harvested from small ponds within two weeks.
- Survival is quite variable and dependent on weather and pond conditions. Winter is a critical period. Aeration would improve survival.

RECOMMENDED FOLLOW-UP ACTIVITIES
The two primary problems identified by current aquaculturists raising crayfish in the region were market assessment and development and crayfish growth rates. Marketing studies for freshwater crustaceans are lacking and are needed for developing business plans. Numerous factors can effect growth and virtually all need to be explored with crayfish. Crayfish exhibit density-dependent growth and survival, that is, as density increases, growth and survival decrease. This happens with various species of fish as well, but is usually solved by in-depth studies. There is

also a need for a biocide registered for use on crayfish which would allow for more active management of production ponds.

PUBLICATIONS, MANUSCRIPTS, OR PAPERS PRESENTED
See Appendix.

SUPPORT

YEARS	NCRAC-USDA FUNDING	OTHER SUPPORT					TOTAL SUPPORT
		UNIVER-SITY	INDUSTRY	OTHER FEDERAL	OTHER	TOTAL	
1990-95					$61,960[a]	$61,960	$61,960
1992-95	$49,677	$58,049				$58,049	$107,726
TOTAL	$49,677	$58,049			$61,960	$120,009	$169,686

[a]State of Indiana, Business Modernization and Technology Center, through the Purdue University New Crops Center

APPENDIX

CRAYFISH

Publications in Print

Gunderson, J.L. 1995. Rusty crayfish: a nasty invader, the biology, identification, and impacts of the rusty crayfish. Minnesota Sea Grant Extension Publication, University of Minnesota, Duluth.

Richards, C., J.L. Gunderson, P. Tucker, and M. McDonald. 1995. Crayfish and baitfish culture in wild rice paddies. Technical Report No. NRRI/TR-95/39. Natural Resources Research Institute, Duluth, Minnesota.

Manuscripts

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

Fetzner, J.W., Jr., R.J. Sheehan, and L.W. Seeb. In press. High heterogeneity among populations of two crayfish *(Orconectes virilis, Procambarus acutus)* and the implications for crayfish aquaculture in the U.S. Aquaculture.

Papers Presented

Brown, P.B. 1994. Pond production of crayfish. Workshop on Getting Started in Commercial Aquaculture Raising Crayfish and Yellow Perch, Jasper, Indiana, October 14-15, 1994.

Brown, P.B. 1994. Crayfish and aquatics: raising fish for profit. Indiana Horticultural Congress, Indianapolis, Indiana.

Brown, P.B. 1995. Crayfish aquaculture in the north. Nebraska Aquaculture Conference, North Platte, Nebraska, March 25, 1995.

Gunderson, J.L. 1994. Raising crayfish commercially. Development 94, Detroit Lakes, Minnesota, February 18, 1994.

Gunderson, J.L. 1994. Softshell crayfish production. Aqua '94, Alexandria, Minnesota, March 4, 1994.

Gunderson, J.L. 1994. Outdoor culture systems and crayfish production. Minnesota Extension Service Aquaculture Seminar, Thief River Falls, Minnesota, April 25, 1994.

Gunderson, J.L. 1994. Softshell crayfish production. Workshop on Getting Started in Commercial Aquaculture Raising Crayfish and Yellow Perch, Jasper, Indiana, October 14-15, 1994.

Gunderson, J.L. 1995. Diversity in aquaculture -- crawfish. Wisconsin Aquaculture '95, Stevens Point, Wisconsin, March 17, 1995.

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[1]NCRAC has funded five Extension projects, the first three of which were chaired by Donald L. Garling. The fourth project was chaired by Fred P. Binkowski and the fifth, a two-year project that began September 1, 1995 and will continue through August 31, 1997, is chaired by Joseph E. Morris.

[2]NCRAC has funded three Economics and Marketing projects. This termination report is for the first two projects, the first of which was chaired by Donald W. Floyd and the second by Leroy J. Hushak. The second project continued and expanded upon the first project.

[3]This progress report is for the third of three Economics and Marketing projects funded by NCRAC. The project is chaired by Patrick D. O'Rourke.

[4]NCRAC has funded five Yellow Perch projects. This termination report is for the first three projects which were chaired by Terrence B. Kayes.

[5]This progress report is for the fourth and fifth Yellow Perch projects funded by NCRAC. Both projects chaired by Jeffrey A. Malison. The fifth project continues and expands upon work undertaken in the fourth project. It is a 2-year study that began September 1, 1995 and will conclude on August 31, 1997.

[6]NCRAC has funded five Hybrid Striped Bass projects. This project component termination report covers work undertaken for the first and third projects, both of which were chaired by Christopher C. Kohler. The third project continued and expanded upon the first project.

[7]NCRAC has funded five Hybrid Striped Bass projects. This project component termination report covers work undertaken for the second and fourth projects, both of which were chaired by Christopher C. Kohler. These projects continued and expanded upon earlier projects.

[8]NCRAC has funded five Hybrid Striped Bass projects. This progress report is for the fifth project which is chaired by Christopher C. Kohler. The project continues and expands upon the first four projects. It began on September 1, 1995 and will conclude on August 31, 1997.

[9]NCRAC has funded six Walleye projects. This project component termination report covers work undertaken for the first, third, and fourth projects. Robert Summerfelt chaired the first and third projects

and Jeffrey A. Malison chaired the fourth project. The third project continued the first project for an additional year whereas the fourth project expanded upon earlier projects.

[10]NCRAC has funded six Walleye projects. This progress report is for the sixth project which is chaired by Terrence B. Kayes. The project continues and builds upon the first five projects. It began on September 1, 1995 and will conclude on August 31, 1997.

[11]NCRAC has funded three Sunfish projects. This project component termination report covers work undertaken for the first and second projects. Bruce L. Tetzlaff chaired the first project and Robert J. Sheehan chaired the second project.

[12]NCRAC has funded three Sunfish projects. This project component termination report covers work undertaken for the first and second projects. Bruce L. Tetzlaff chaired the first project and Robert J. Sheehan chaired the second project.

[13]NCRAC has funded three Sunfish projects. This progress report is for the third project which is chaired by Donald L. Garling. The project continues and builds upon the first two projects. The 2-year third project began September 1, 1994.

[14]NCRAC has funded three Salmonid projects. This project component termination report covers work undertaken for the first and second projects. Both projects were chaired by Paul B. Brown.

[15]NCRAC has funded three Salmonid projects. This progress report is for third project which is a 2-year study that began on September 1, 1994. Ronald R. Rosati originally chaired the project until his departure from Illinois State University; after which Terence B. Barry became chair. The third project continues and builds upon the first two projects.

[16]This project was chaired by Paul B. Brown.

[17]This project was chaired by Daniel W. Coble.

[18]This project was chaired by Fred P. Binkowski.

[19]Ted R. Batterson serves as the facilitator for this multi-year project interacting with Henry S. Parker and a steering committee in overseeing the Coordinator=s activities.