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B. HARVESTING, LOADING AND GRADING SYSTEMS FOR CULTURED FRESHWATER FINFISHES AND CRUSTACEANS

Termination Report
For the Period
May 2, 1989 to April 30, 1993

FUNDING LEVEL:

Year 1	$125,000
Year 2	$125,000
Year 3	$125,000
Total	$375,000

PARTICIPANTS:

Louisiana State University (Lead Institution) - Robert P. Romaire, T. B. Lawson, J. L. Avery

Auburn University - J. W. Jensen, John M. Grizzle, L. L. Lovshin, R. K. Goodman

Clemson University - John A. Collier, Thomas E. Schwedler

Memphis State University - Kenneth B. Davis, James F. Payne, Bill A. Simco

Mississippi State University - M. J. Fuller, J. G. Dillard, M. W. Brunson

University of Georgia - George W. Lewis, James Shelton

University of Southwestern Louisiana - Jay V. Huner

ADMINISTRATIVE ADVISOR:

W. H. Brown, Associate Director
La. Agricultural Experiment Station
La. State University Agricultural Center
Baton Rouge, Louisiana

PROJECT OBJECTIVES:

1. To develop and evaluate new methods, or modify and improve existing methods, to more efficiently concentrate and harvest channel catfish and crawfish with passive and/or active harvesting devices such as seines, nets, pumps, traps or other appropriate techniques and equipment to improve harvesting efficiency and to increase profitability.

2. To develop and evaluate new methods, or modify and improve existing methods, of size-selective grading at harvest to more effectively handle catfish and crawfish to maintain or enhance product quality and to maintain or improve production and processing profitability.

3. To conduct comparative analyses of, and between, newly developed and conventional harvesting, loading, and grading equipment and procedures used in catfish and crawfish aquaculture. The standards for comparison should include direct and indirect costs associated with mortality, injury and physiological stress.

4. To assist aquaculturists in utilizing the research findings by appropriate extension methods, such as regional workshops, on-farm demonstrations and consultations, field days, publications and other educational materials.

ANTICIPATED BENEFITS:

CATFISH

Fish pumps increase the speed that catfish are loaded onto transport trucks, potentially reducing cost and increasing profitability, compared with traditional lift nets. Reduced damage to catfish from punctures and bruises during loading would improve flesh quality and reduce economic losses to processors. Size grading of fingerlings and food-sized catfish will reduce size variability at harvest and decrease problems faced by processors that filet catfish with machines preset to accept a given size range. Size grading will allow catfish farmers to return fish too small for processing to the pond for further growth. Farmers do not receive payment for small fish discarded by the processor.

Some catfish escape capture in ponds by swimming under seine nets. After several years, ponds accumulate large fish decreasing feed efficiency, and large catfish are harder to sell. Modification in a seine to reduce escapees would save farmers and processors money. A seine with a modified mud line or an electrified seine may have promise. Fish pumps, mechanical graders, and modified seines should minimize physiological stress and must be cost effective to be adopted by industry. Physiological stress may decrease growth and make fish more susceptible to disease.

CRAWFISH

Harvesting crawfish with baited traps is inefficient and accounts for 50% to 60% of production costs. Bait for traps is expensive, and lifting and emptying traps as much as 5 to 6 days/week is labor intensive. Improved harvesting equipment, such as improved traps, or trawls that reduce the need for traps, could increase farmers' profit by reducing trap density and trapping frequency. New harvesting equipment and

trapping strategies should minimize change in extant production practices if they are to be quickly adopted.

Development of national and international markets has necessitated that crawfish be graded to meet specific market requirements. Large crawfish are easily marketed at high prices and smaller crawfish are often rejected by processors. Most graders used by crawfish processors have been developed for other commodities, such as vegetables. In-boat size grading of crawfish in ponds allows peeler crawfish to be returned to ponds for further growth. After crawfish are caught and graded, they are placed in sacks and stored in coolers for up to several days before being processed or sold for the live sales retail market. Significant mortality often occurs in storage. Amount or level of physiological stress in crawfish associated with harvest, sacking, handling, and storage is not known and baseline information is required if stress, and subsequent mortality, is to be minimized.

PROGRESS:

CATFISH

The turbine fish pump loaded fish faster than either a vacuum pump or lift net, but it caused more injury. High pump speeds increased the severity of injury to fish. Trials should be conducted to determine the optimal speed of pumps. Injuries caused by the turbine pump did not reduce flesh quality and would not impact on fish harvested for processing. Fish harvested with pumps for restocking or for fee-fishing may have higher mortality than fish harvested with lift nets because of post-harvest disease outbreaks. A seine with a rubber-roller mud line was more effective for catching food-size channel catfish than was a seine with gathered-net mud line (commercial standard), particularly in ponds with deep mud bottoms. An electrified seine that was tested in eight ponds, 64 times with eight different voltage and electrical field configurations, did not improve catfish catch compared to conventional seines.

A mechanical grader size-graded fingerling catfish as rapidly and as accurately as commercial box graders. The mechanical grader was more effective in cold water than box graders. Catfish can be weighed as accurately by measuring displacement of water in transport tanks as by weighing with scales.

Stress in fingerling and food-size catfish, as measured by changes in serum cortisol, glucose, and electrolytes, was determined before, immediately after, and for several days after harvest. Stress response in catfish was similar among fish pumps and lift nets, and stress was less in cooler months. Stress recovery to pre-harvest levels occurred by the fifth day after harvest.

A comparative economic analysis of loading catfish from production ponds to live-haul trucks was made for an 8-inch turbine pump and a lift-net under conditions prevailing in the Mississippi Delta. The vacuum pump was not included because of low performance. Assumptions included custom harvesting with a boom and lift net capable of holding 1,800 pounds of fish, and a fish loading rate of 600-750 pounds per minute, a rate comparable to the turbine pump. There was little difference in cost of harvesting catfish by either method, with total harvesting cost estimated at $0.01905 per pound using a lift net, and $0.01955 using the turbine pump. Assuming a harvest of 25,000 pounds of fish, this cost difference amounts to only $12.50 per harvest from a typical pond.

Two major field-days were held, one in Monterrey, Louisiana, and the other in Cohutta, Georgia, to showcase harvesting, grading, sorting, and transportation of catfish and other finfishes. Over 800 producers, vendors, researchers and extension personnel from seven states attended the two exhibitions. Five fact sheets on harvesting, loading, and grading of finfish were published. A 30 minute video on harvesting, loading, and grading systems for catfish and other finfishes was developed and made available to state extension contacts in the Southern Region.

CRAWFISH

A pyramid trap increased trap catch 44% compared to a standard commercial stand-up trap. A pyramid trap density of 24 per acre produced optimum catch compared to 12, 36, and 48 per acre. Trapping frequency was evaluated to determine if the commercial practice of trapping 5 to 6 days per week could be reduced by using the pyramid trap. No reduction in yield occurred with trapping 3 days per week compared to 5 days per week. Trapping crawfish 3 days per week, every other week, reduced yield. A rotational trapping system, in which a portion of the pond (50% or 67%) was trapped for a week, followed by trapping the non-trapped portion the following week resulted in a yield comparable to 3 days per week and 5 days per week trapping. Harvested crawfish were smaller with rotational trapping.

A spiral crawfish grader was modified to fit in a harvesting boat and to separate harvested crawfish into four size grades. Roller spacings required to segregate crawfish into jumbo, large, medium and peeler size groups, size grades requested by crawfish buyers, were determined in laboratory trials. Commercial on-boat graders evaluated could not process large quantities of crawfish effectively because they easily jammed with debris and this required frequent stopping to clear the machine.

A trawl system, the USL crawfish skimmer, was developed for use on commercial crawfish harvesting boats. The skimmer, which eliminates the need for traps, was designed for use in late season when vegetation is minimal, crawfish are abundant, and prices are low. The skimmer was at least twice as effective as conventional traps when tested in late spring. For the trawl to be effective, trapping lanes with no vegetation must be made in ponds before flooding, and attractants must be placed in the lanes prior to harvest. The skimmer is most effective in late spring, and it is more selective for smaller crawfish than standard commercial traps.

Crawfish stress, as measured by changes in hemolymph concentrations of osmotic pressure, chloride, and sodium were determined at different temperatures and salinities. Stress due to salinity and temperature were the same between red swamp crawfish and white river crawfish, and stress increased above and below 75°F. Both species acclimated to salinities from 10 to 30 ppt. Stress in red crawfish during harvesting and storage in a cooler was similar among males and females, and physiological stress indicators in crawfish were stable for up to five days in a cooler.

See pages 17-19 for publications and videos from this project.

IMPACTS:

CATFISH

The turbine pump has potential in the catfish industry, especially if and when fish grading is required by farmers and processors. The fish pump is more suited to in-line size graders than lift nets. Presently, fish pumps are not accepted by the catfish industry, but pumps may be used in the future as catfish processors require, and are willing to pay for, size-graded fish. Lift nets provide more flexibility in loading transport tanks than do stationary fish pumps. Also, the fish pump does not permit determination of loaded fish weight with scales as does the lift net. Catfish loaded with a pump must be weighed by water displacement in the transport tank, a method not presently accepted by most catfish farmers.

The mechanical catfish fingerling grader is not used by fingerling producers because growers are not yet willing to pay a higher price for well-graded fingerlings compared to pond-graded fingerlings. Grading fingerlings with mechanical graders will become integrated into the industry when growers and processors demand a more uniform-sized fish. No mechanical grader tested was able to grade food-size fish with the speed required by industry. Grading food-size fish can be done, but it will increase the cost of

producing catfish. Presently, processors will not pay more for uniform-sized catfish.

Some catfish farmers are using modified seines with the rubber-roller mud line, but acceptance is not yet widespread among farmers. More farm trials are needed to determine if rubber-roller mud line seines will replace the more commonly used gathered-net mud line seine. An electrified seine appears to have little potential.

Harvesting in cooler months should be done when possible because stress is reduced. If fish are to be handled a second time, a recovery period of at least five days is required. Examination of diseased fish during this project led to a better understanding of the tissue injury caused by traumatic injury and by pathogenic bacteria. The choice of harvesting equipment can be made on cost or facilities because all techniques evaluated resulted in similar degrees of stress to catfish.

Mechanical grading equipment and a new method of seine construction have potential to improve the industry. However, information gathered will not have much impact on the catfish farming industry until farmers are convinced that new technology is better than that presently used. Information is available to farmers about new harvesting, loading and grading equipment. Comparisons have determined that presently employed loading equipment is as good as or better than new technology. Research findings on harvesting, loading, and grading systems for channel catfish and other cultivated warmwater finfishes have been extended to 800 commercial farmers, vendors, and extension and research personnel in the Southern Region through two regional workshops, on-farm demonstrations and consultations, field days, publications and other educational materials. Educational materials developed have been distributed throughout the Southern Region as fact sheets and videos. These materials will be used in the development of Best Management Practices and Quality Assurance Program training.

Information from this research was used to develop an educational program for a major catfish processor, saving him over $100,000 in a 4-month period by training his personnel to reduce fish death from handling stress. Producers of minor aquaculture species such as red drum, hybrid striped bass and gamefish benefited from information in this study. Funding for this project assisted in the training of three graduate students and numerous undergraduate student workers.

CRAWFISH

The crawfish harvesting research has had a significant positive economic impact on the crawfish industry. Aquaculture advisory agents with state cooperative extension services are recommending that producers use the pyramid trap design. If the pyramid trap is used, extension agents are also recommending that crawfish producers reduce their trapping effort from 5 or 6 days/week to 3 days/week, unless circumstances dictate otherwise. Although cost analyzes by economists are not yet complete, preliminary analyses indicate harvesting cost is reduced as much as 30% with pyramid traps and 3 days/week trapping. These findings have been communicated to crawfish producers at 12 crawfish production advisory meetings, and through extension newsletters. Contact with producers and extension agents indicate that 3 days/week trapping is being readily adopted. Producers are reporting that their catch has not been significantly reduced from previous years when trapping effort was higher, and they are realizing significant savings in bait and labor costs. If 20% of crawfish producers have adopted 3 days/week trapping with pyramid traps, a conservative estimate according to extension agents is that $2 million is being saved annually from reduced bait and labor costs. Rotational trapping needs further field evaluation.

The crawfish skimmer is a new concept and has been presented to a very conservative industry. Its adoption will be slow. The crawfish skimmer system has not yet had any direct effect on the crawfish aquaculture industry; however, it

offers a new technology that eventually may complement conventional trapping. The outgrowth of this project was the organization of an *ad hoc* automated harvesting work group, which brought together four of the seven known groups developing propelled trawl-type systems for harvesting crawfish. The potential cost effectiveness of the trawling system has been simulated with a crawfish pond computer model, and the information has been disseminated at several public forums.

Although no new commercial in-boat graders have been developed as a result of this research, mechanical limitations in existing commercial graders have been identified and brought to the attention of fabricators so that the graders can be improved. Presently used methods of harvesting crawfish with traps, and storage in a cooler for up to 5 days, do not appear to place undue stress on crawfish. Salinity tolerance studies indicate that it may be possible to extend the culture of red swamp and white river crawfish into waters with moderate salinity.

Funds from SRAC for crawfish harvesting research have assisted the University of Southwestern Louisiana's (USL) Crawfish Center and Louisiana Agricultural Experiment Station in securing funding for gear development work and harvesting research from the following agencies: Gulf and South Atlantic Fisheries Development Foundation, U.S. Department of Agriculture, Crawfish Promotions and Research Board, and the Louisiana Board of Regents 8-G competitive grants program. Four graduate students and six undergraduate student workers have been trained in this crawfish harvesting, loading, and grading project.

PUBLICATIONS:

PUBLICATIONS IN PRINT

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Davis, K. B., J. Newsom and B. Simco. Physiological stress in channel catfish, *Ictalurus punctatus,* harvested by lift net, vacuum pump, or turbine pump. Journal of Applied Aquaculture. In press.

de la Bretonne, L. W., Jr. and R. P. Romaire. 1990. Crawfish production: Harvesting, marketing, and economics. Southern Regional Aquaculture Center Publication No. 242, 4 pages.

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Huner, J. and G. Faulkner. 1992. A brief description of the University of Southwestern Louisiana's crawfish trawl. Crawfish Center Brochure, University of Southwestern Louisiana, Lafayette, Louisiana. Mimeographed, 8 pages.

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Jensen, Gary. 1991. Sorting and grading warmwater fish. Southern Regional Aquaculture Center Publication No. 391, 7 pages.

Jensen, Gary. 1991. Transportation of warmwater fish: Procedures and loading rates. Southern Regional Aquaculture Center Publication No. 392, 2 pages.

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Lawson, T. B. and R. P. Romaire. 1991. Evaluation of two new trap types and aerator-induced water currents for harvesting procambarid crawfish in ponds. Journal of Shellfish Research 10:349-354.

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Rode, R. A., L. L. Lovshin and R. K. Goodman. 1991. Comparison of three fish-loading systems to harvest food-size channel catfish, *Ictalurus punctatus*. Aquacultural Engineering 10: 291-304.

Romaire, R. P. 1989. Overview of harvest technology used in commercial crawfish aquaculture. Journal of Shellfish Research 8(1):281-286.

Steeby, J. A. and L. L. Lovshin. 1993. A comparison of seines equipped with rubber roller or gathered-netting mud lines for harvesting channel catfish in earthen ponds. The Progressive Fish-Culturist 55:133-136.

SUBMITTED MANUSCRIPTS

Grizzle, J. M., and L. L. Lovshin. In press. Effect of pump speed on injuries to channel catfish *(Ictalurus punctatus)* during harvest with a turbine pump. Aquacultural Engineering.

Lovshin, L. L. and R. P. Phelps. In press. Evaluation of a mechanical grader to separate fingerling channel catfish *(Ictalurus punctatus)* into length groups. J. Applied Aquaculture.

Newson, James E., and Kenneth B. Davis. Osmotic responses of white river crayfish *(Procambarus zonangulus)* and red swamp crayfish *(P. clarkii)* to changes in temperature and salinity. Submitted to Aquaculture.

Newsom, J. E., S. B. Noblitt, and K. B. Davis. Osmotic responses of red swamp crayfish *(Procambarus clarkii)* to trapping, sorting and storage in a cooler. Submitted to Journal of Aquatic Animal Health.

MANUSCRIPTS IN PREPARATION

Clark, D. W, Jr. and J. Dillard. Economics of Loading Techniques for Farm-Raised Catfish.

Faulkner, G. and J. Huner. A polyethylene trawl system for harvesting crawfish, *Procambarus* spp., in culture ponds.

Lawson, T., A. de los Reyes, and G. Vidrine. Mechanical size-grading of post-harvest crawfish: Evaluation of a roller-type grader.

Romaire, R. and J. Martinez. Relationship between trap density and crawfish harvest in ponds.

Romaire, R. and J. Martinez. Evaluation of trapping frequency on crawfish harvest in ponds.

PAPERS PRESENTED

Davis, K. B., J. Newsom and B. Simco. Physiological stress in channel catfish, *Ictalurus punctatus,* harvested by lift net, vacuum pump, or turbine pump. Presented to Annual Meeting of the Catfish Farmers of America, February 1992, Orange Beach, AL.

Faulkner, G. and J. Huner. 1993. The University of Southwestern Louisiana's pond crawfish skimmer net. Ann. Meeting, Louisiana Chapter, American Fisheries Society, Metairie, Louisiana, February, 1993.

Lovshin, L. L. 1990. Comparison of three fish-loading systems to harvest food-size channel catfish. Catfish Farmers of America, Little Rock, Arkansas.

Lovshin, L. L. 1992. Evaluation of a mechanical grader to separate fingerling channel catfish *(Ictalurus punctatus)* into length groups. Catfish Farmers of America, New Orleans, Louisiana.

Newsom, J. E., and K. B. Davis. Ionic responses of white-river crawfish *(Procambarus zonangulus)* and red swamp crawfish *(P. clarkii)* to changes in temperature and salinity. Presented at the Annual Meeting of the American Society of Zoologists. December, 1991. Atlanta. Georgia. 31:230. Abstract.

Steeby, J. 1991. A comparison of seines equipped with rubber roller or gathered-netting mud lines for harvesting channel catfish in earthen ponds. Alabama Fish Farmers Conference, Montgomery, Alabama.

THESES

Chen, J. 1991. Skin injuries and serum enzyme levels of channel catfish harvested by different loading equipment. M.S. Thesis. Auburn University, Auburn, Alabama, 101 pages.

Kiryu, Y. 1992. Bacterial diseases after harvesting channel catfish: Comparison of fish pumps to traditional methods and histopathology of fish infected with *Aeromonas hydrophila* complex. M.S. Thesis. Auburn University, Auburn, Alabama, 108 pages.

Newsom, James E. 1991. Osmotic responses of white river crayfish *(Procambarus zonangulus)* and red swamp crayfish *(P. clarkii)* to changes in temperature and salinity. M.S. Thesis. Memphis State University, Memphis, Tennessee.

Rode, R. A. 1991. Comparison of three fish-loading systems for harvesting food-sized channel catfish. M.S. Thesis. Auburn University, Auburn, Alabama, 67 pages.

VIDEOS:

Warmwater finfish: Harvesting, handling and transportation. Southern Regional Aquaculture Center Video, 1992, 30 minutes.

C. PREPARATION OF EXTENSION PUBLICATIONS ON AVIAN PREDATOR CONTROL IN AQUACULTURE FACILITIES

Termination Report
For the Period
April 1, 1990 to December 31, 1992

FUNDING LEVEL:

$15,000 for duration

PARTICIPANTS:

Texas Agricultural Extension Service (Lead Institution) - J. T. Davis

Mississippi Cooperative Extension Service - M. W. Brunson

Georgia Cooperative Extension Service - G. W. Lewis

Alabama APHIS/ADC/USDA - Frank Boyd

Arkansas APHIS/ADC/USDA - Michael Hoy

Louisiana APHIS/ADC/USDA - W. F. Stevens

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United States Fish and Wildlife Service