

Automated Production of Soft-Crawfish, Malone, R. F. and Chen, S., pp. 27-31 In Proceedings of the Louisiana Aquaculture Conference 1991, Baton Rouge, Louisiana, February 7-8, 1991.

AUTOMATED PRODUCTION OF SOFT-CRAWFISH

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As a new industry in aquaculture, soft-crawfish production has great growth potential in Louisiana because of a well established hard-crawfish industry and the delicacy of the products. However, further growth of this industry depends upon reduction of the production cost and development of a coordinated marketing strategy.

Technology has played a very important role in the development of the soft-crawfish industry and will continue to do so in the future. The industry got started after researchers established the procedures for soft-shell crawfish production in the mid 1980's (Culley et al., 1985a, 1985b). Complemented by later works dealing with production techniques (Culley and Duobinis-Gray, 1987, 1988a, 1988b, 1988c, 1990) and system design (Malone and Burden 1988), this technology stimulated the development of Louisiana's soft-crawfish industry. Despite the rapid development in technology the lack of a coordinated marketing strategy resulted in a decline in soft-crawfish producers' prices from a base of \$8.00-\$8.50/lb in 1985 to a current low of \$6.00-\$6.50/lb, so a reduction in production costs is needed to facilitate market expansion.

Realizing that a seasonal industry based upon manual labor would be plagued by low productivity and high costs of production, researchers initiated efforts in 1986 to develop automated technologies (Malone and Culley, 1988) which would dramatically improve the production potential of a facility while significantly reducing the cost of production. Supported by state and federal funds, the newly developed technology promises to stimulate continuous development of the soft-crawfish industry in the southeastern states of the U.S., if it is coupled with an aggressive marketing strategy.

This paper presents the principle and basic components of the automated separation system, summarizes the status of the research development and indicates its future direction.

Process Principle and Operation

The new technologies are based upon the fact that a freshly molted crawfish lacks the ability to crawl against a water current. When placed in a water current with a certain velocity, the molted crawfish are swept away while the intermolt crawfish are unaffected. To utilize this information, a special 8' x 4' x 4" fiberglass tray was designed (Figure 1). Each tray consists of four internal raceways and a trap (a combination of the primary and secondary electrical shocking gate and a crawlout port). Ten to twenty trays are stacked directly upon one another to form a "stacked tray separator" (or stack) capable of holding large numbers of crawfish in a relatively small area. The stacks are complemented by secondary devices (Figure 2) which recycle prematurely escaped intermolts, remove dead crawfish and place soft-crawfish in an ice bath.

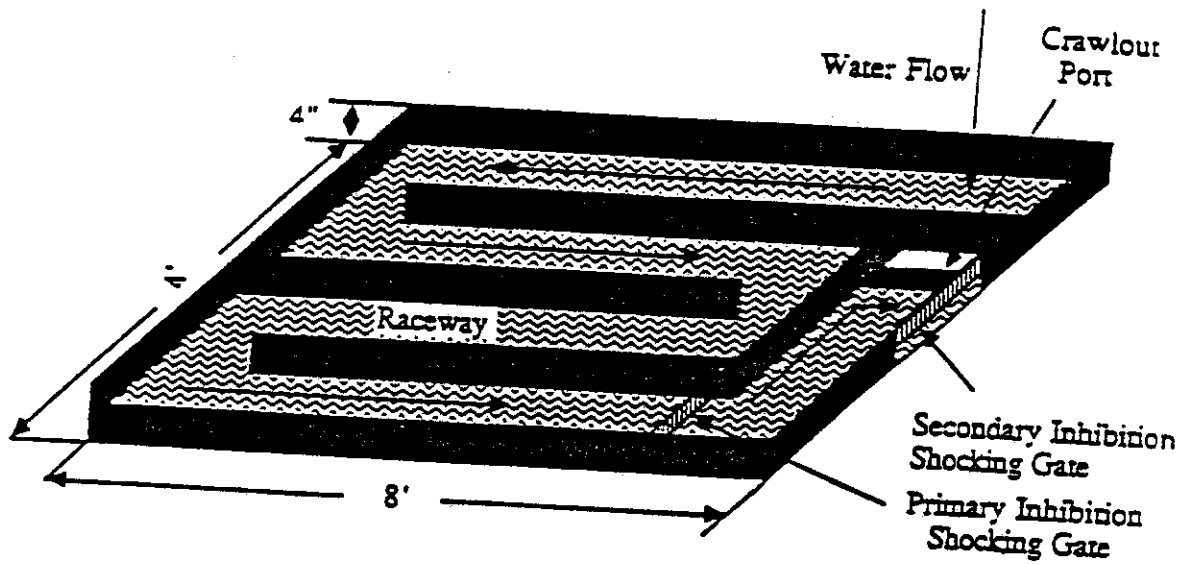


Figure 1. The basic separation tray

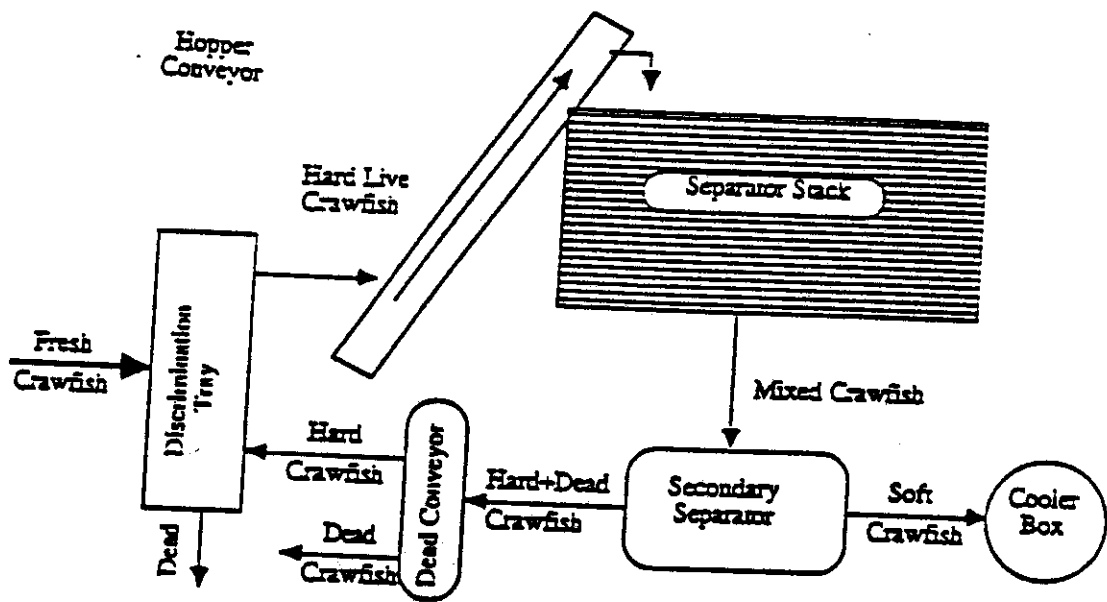


Figure 2. Major components of a separation stack

The live immature crawfish are loaded in the top tray of the stack through a conveyor. Water is delivered to the tray at the upper right corner (Figure 1), runs through the raceways, and then is discharged to the tray below. The shocking gates hold the hard-crawfish in each tray, but the crawlout port allows crawfish to distribute vertically in the stack. Coming out of each tray of the stack is a mixture of soft, dead and escaped, hard-crawfish. These animals are fed directly into a secondary separator where soft-crawfish are further separated and sent to the cooler (or refrigerated) box where they are harvested. At the same time, dead and live hard-crawfish are transferred to a tertiary separation conveyor where dead crawfish are removed. The live, hard-crawfish are then sent back to the stack through the conveyor. As a result, the soft-crawfish can be continuously harvested automatically. Table 1 describes the main components supporting the separation stack.

Table 1. Principal Elements of an Automated Soft-Crawfish Production System.

Element	Function
Separator Tray	Holds crawfish and flushes softs
Rerouting Tray	Merges rear crawfish flow line with front crawfish flow line
Inhibition Gates	Slows movements of intermolts from separator stack
Traps	Controls vertical distribution of crawfish in stack
Cascades	Gently moves molted escaping intermolts, harvested softs, and mortalities down to the secondary separator without damage
Secondary Separator	Separates soft-crawfish from the intermolt crawfish
Tertiary Separation Conveyor	Separates dead crawfish from intermolts
Hopper Conveyor	Lifts the live intermolts from floor level to the top tray of the stack
Distribution Trough	Controls horizontal distribution to top trays in multiple stack facilities
Biofilter	Purifies recirculating waters through solids capture, BOD reduction and nitrification.

Research Progress

Basic scientific studies defining the behavioral response of intermolt, premolt and soft-crawfish placed in prototype raceway trays have been finished. Acceptable flow ranges have been defined and the main design parameters have been identified. Various configurations of raceway and shocking gates have been tested and refinement of design criteria for critical processes associated with separation units have been completed. Technological problems faced when attempting to link individual units into unified production facilities have been addressed, which include: (1) methodologies for automatic distribution and collection of crawfish within a facility (2) water quality control and (3) software and hardware development required for centralized control and monitoring of a large number of stacks. Methods for crawfish distribution and collection in a multi-stack facility have been developed. The major elements (Table 1) required for an integrated multiple stack facility were envisioned by the CEASL

research group. Critical design parameters (spacing, speeds, slopes) were determined through laboratory experiments.

Active industrial collaboration for this research has been provided by Vacherie Machine Works, Inc. of Vacherie, Louisiana. During the 1990 season, an eleven tray stack, fully supported by the recycling apparatus (Table 1), was installed in Vacherie. The 2800 square foot building has been constructed specifically for the project. The facility includes a complete processing room, a production area and a second floor computer control room. The 1990 commercial testing program in Vacherie focused on refinement of the stack and examination of the effectiveness of the vertical configuration that was proven effective in laboratory evaluations. The stack functioned satisfactorily in all regards.

This spring, 1991, the Vacherie facility is being equipped with three linked stacks. The multi-stack configuration will allow the research team to conduct preliminary evaluations of horizontal, as well as, vertical distribution strategies. The stacks are currently in the final stages of assembly. They should be completed in time for a 90 - day production run during March, April and May.

This research project has significant economic ramifications. The automated production technologies can increase the production per unit area of a facility by a factor of about five to ten over the traditional hand-picked design. The labor requirements for production of a pound of soft-crawfish are more than halved. The projected result of implementation of the automated technologies is an anticipated drop in the production costs of a pound of soft-crawfish from the current range of \$4.50-\$5.50, to nearly half that at \$2.50-\$3.00.

Problems and Future Research Direction

The automatic soft-crawfish separation project is approaching the end of the technology development stage as researchers have mastered the fundamental process controlling system operation. The transfer of the systems hardware is virtually complete, but the research group now faces the need to transfer the infrastructure necessary for the technology to operate economically, from the laboratory to a full scale commercial facility.

Despite the progress that has been made in the development of the automated technologies, the research group believes that commercial applications will require additional technical support. Although every effort has been made to keep the system simple, the technology that has resulted is complicated by the mandatory linkages between devices and the more subtle cumulative impact of inefficiencies in the multiple (10-20) stack facility that is anticipated for construction in the near future. Assuring an even distribution (horizontally between stacks and vertically through trays) of crawfish in a 20 stack facility will be extremely difficult until a statistically sound monitoring and management program is implemented.

Therefore, to assure full-scale implementation of this technology, research activity in the near future will focus on the development of a computer assisted monitoring system of crawfish movements throughout a multiple stack facility and the development of management guidelines (or rules of operation). This will be to assure uniform crawfish distribution and optimum production from a multiple stack facility.

Acknowledgments

This project was funded by the National Coastal Resources Research and Development Institute, Newport, Oregon under Contract Number 2-5618-17(A). Complementary funding was provided by the Board of Regents, through the Louisiana Educational Quality Support Fund, Contract Number LEQSF (87-90)-RD-B-5. Filtration work was conducted under grants from the Louisiana Sea Grant College Program, a part of the National Sea Grant College Program under the auspices of the National Oceanic and Atmospheric Administration, U. S. Department of Commerce. The research could not be accomplished without the support of Max, Vernon, and Tommy Rodrigue who have provided the University with prototypes and fabrication expertise over the last four years. Additionally, Vacherie Machine Works, Inc. has constructed and is equipping the Vacherie Demonstration Facility which is used for evaluating commercial feasibility of the technology.

References

- Culley, D. D., M. Z. Said, and E. Rejmankova. 1981a. Producing Soft-Shell Crawfish: A State Report, Louisiana Sea Grant College Program, Baton Rouge, Louisiana, 16 pp.
- Culley, D.D., and L. Duobinis-Gray. 1987. Molting, Mortality and the Effects of Density in a Soft-shell Crawfish Culture system, Journal of the World Aquaculture Society, No. 16, pp. 183-192.
- Culley, D. D., and L. Duobinis-Gray. 1988a. Effects of Temperature on Molting and Mortality Rates of Red Swamp Crawfish (Procambarus clarkii) in a Soft-Shell Culture System, in review.
- Culley, D. D., and L. Duobinis-Gray. 1988b. Effects of Dissolved Oxygen on Molting and Mortality Rates of Red Swamp Crawfish (Procambarus clarkii) in a Soft-Shell Culture System, in review.
- Culley, D. D., and L. Duobinis-Gray. 1988c. Molting, Mortality, and the Effects of Density in a Commercial Soft-shell Crawfish Operation, Journal of the World Aquaculture Society, in press.
- Culley, D. D., and L. Duobinis-Gray. 1990. A Production Manual, Culture of the Louisiana Soft Crawfish, Louisiana Sea Grant College Program, 40 pp.
- Malone, R. F. and Culley, D. D. 1988. Method and Apparatus for Farming Softshell Aquatic Crustaceans, U. S. Patent No. 4,726,321.
- Malone, R. F. and D. G. Burden. 1988. Design of Recirculating Soft Crawfish Shedding Systems, Louisiana Sea Grant Program, Louisiana State University, Baton Rouge, Louisiana.