WALLEYE

Project Component Termination Report for the Period
September 1, 1993 to August 31 1997

NCRAC FUNDING LEVEL: $175,000 (September 1, 1995 to August 31, 1997)

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Non-funded Collaborators:		
Iowa Department of Natural Resources (DNR)	Spirit Lake State Fish Hatchery	Iowa
Max McGraw Wildlife Foundation	Dundee	Illinois
Nebraska Game & Parks Commission	Calamus State Fish Hatchery	Nebraska
Ohio DNR	London State Fish Hatchery and Senecaville State Fish Hatchery	Ohio
Wisconsin DNR	Lake Mills State Fish Hatchery	Wisconsin
U.S. Fish & Wildlife Service	Genoa National Fish Hatchery	Wisconsin

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REASON FOR TERMINATION

The objectives for this work on Walleye were completed.

PROJECT OBJECTIVES

(1) Evaluate growth, feed efficiency, and stress responses as functions of density, loading, temperature, and feeding regimes (feeding rate and frequency) under tank and open-pond rearing conditions for raising juvenile walleye to food size.

(2) Characterize the economics and institutional aspects of the domestic market for walleye as food fish, fingerlings, and other intermediate products.

(3) Offer workshops in the North Central Region (NCR), using extension materials (fact sheets, videos, etc.) and other information that has or will be developed necessary to demonstrate the technology of culturing walleye and its hybrids.

(4) Compare the performance (survival, growth, and feed conversion) and carcass characteristics (fillet yield, proximate analysis, and organoleptic properties) of walleye × sauger hybrids produced from different parental stocks reared under intensive and tandem extensive-intensive culture systems.

PRINCIPAL ACCOMPLISHMENTS

OBJECTIVE 1

Research on this objective was conducted by investigators from Iowa State University (ISU), the Illinois Natural History Survey (ILNHS), University of Nebraska-Lincoln (UNL), and University of Wisconsin-Madison (UW-Madison). Some aspects of the project by ISU and ILNHS, and by UNL and UW-Madison were interdependent. ISU collected data on fish growth, feed efficiency, and measures of digestible energy of walleye reared under laboratory conditions. These experiments included a comparison of fish growth in tanks at two temperatures, and several feeding rates. ISU provided ILNHS with data on fish size, feeding rates, water temperatures, and samples of fish, fish feces, fish feeds, and an analysis of the feeds for development and testing of a bioenergetics model.

Because feed is a major variable cost in the production of fish and other animals, determination of appropriate feeding rates, expressed as percentage of the body weight fed per day (%BW/d), is essential to optimize feed efficiency and growth. A producer must decide on a feeding rate related to fish size and water temperature. Empirical methods, growth models, nutritional energetics, and bioenergetics modeling provide options for determining feeding rates. ISU evaluated methods based on prior experience, growth models, and dietary energy; and then provided ILNHS with data for bioenergetics modeling.

ISU determined digestibility of the WG-9206 walleye grower diet, compared fish growth and feed efficiency at 20 and 25C (68.0 and 77.0F), and conducted five trials to evaluate feeding rates (%BW/d). Digestibility of the WG-9206 diet (52.1% protein, 15.0% fat, 66.2% moisture, 0.7% fiber, 9.6% ash) was 86.2% for protein and 70.4% for dry matter. The digestible energy of the diet was estimated to be 3,572 kcal/kg (1,620 kcal/lb). The protein-energy ratio (digestible protein ÷ digestible energy) was 30.4 mg (0.001 oz) of protein per kJ energy, a higher value than average for finfish, which suggests that for walleye of this size, energy levels in the WG-9206 diet were insufficient, in which case fish had to catabolize some protein for energy, which may have reduced their growth rates. In the temperature trial, growth rates and feed efficiency were higher at 25C (77.0F) than 20C (68.0F). To avoid epizootics of bacterial diseases common at the higher temperature, a temperature of 23C (73.4F) is recommended. In the feeding-rate trials, higher feeding rates were required at higher temperatures, and feeding rates decreased with increasing fish size, poor health (i.e., disease), and stress. Feeding rates may have been affected by feed quality, especially energy content. Although the multiplicity of factors affecting feeding of fish make it difficult to define feeding rates for walleye across the entire spectrum of fish size and temperature ranges at which culture may be done, the ISU findings suggest that for fish habituated to formulated feeds, a 2%BW/d rate is suitable at 20C (68.0F) and 3%BW/d at 25C (77.0F) for fish of 170 mm (6.7 in) total length (TL); and 1.2 %BW/d at 20C (68.0F) and 1.5 %BW/d at 25C (77.0F) for fish of 330 mm (13.0 in) TL.

ILNHS modified and calibrated a bioenergetics model to simulate walleye growth under different temperature and dietary regimes. ILNHS used the model to make predictions on the basis of empirical data provided by ISU. The bioenergetics model predicts either growth or consumption

under specific environmental conditions. The simulations resulted in different growth rates for particular feed types and temperatures. Maximum growth occurred in simulations at 21.5C (70.7F) and with BioDry 1000 pelleted feed. Under these conditions, walleye could reach food size faster, depending upon the proportion of maximum food consumption (35 days at 50%, 24 days at 75%, and 20 days at 100%). Comparisons of these simulations to tank experiments performed by ISU show predicted growth was much higher than observed, given the experimental feeding regime. Likewise, predicted feed consumption based on observed growth was substantially lower than the amounts of pelleted feed added to the tanks. Walleye in the ISU experiments did not grow as fast as observed in previous experiments, suggesting problems with environmental conditions, health of the walleye, feeding rates, or model predictions. ILNHS will also test the model predictions using data from research by ISU and UW-Madison. After further testing, correction, and validation, the model can be applied to various aquaculture settings to make recommendations on feeding rates in relation to fish size and water temperature, to maximize growth rates of walleye to food size.

The main focus of UNL investigators in the first year of the sixth Walleye project was to raise a large number of Age-0 juvenile walleye in ponds for use in the second year production trials aimed at culturing fish to market size under practical conditions. On June 6, 1996, UNL researchers harvested about 43,200 walleye of 28.5 mm (1.1 in) mean TL and 0.7 g (0.02 oz) mean body weight from 0.4-ha (1.0-acre) production ponds at the Calamus State Fish Hatchery near Burwell, Nebraska. Equal numbers of these fish (about 2,700) were assigned to 16, 840-L (221.9-gal) cylindrical tanks, enclosed in a darkened Aquashelter® (Tuttle Industries, Friend, Nebraska).

All 16 tanks were equipped with in-tank lighting and 24-hour belt feeders (Zeigler Bros., Gardners, Pennsylvania), and supplied with Calamus Reservoir water run through packed columns for aeration. A feeding trial was conducted comparing a diet developed for juvenile walleye by Rick Barrows of the U.S. Fish and Wildlife Service (Bozeman, Montana) and Silver Cup salmon starter-series diet (Nelson and Sons, Inc., Murray, Utah). Far more walleye were habituated to the Barrow's diet than the Silver Cup diet. However, overall survival from the beginning to the end of the trial was extremely poor.

On July 12, 1996, less than 3,000 of the original 43,200 walleye remained alive, despite every effort to maximize survival. This poor survival was attributed primarily to facilities problems, though cannibalism was also a contributing factor. Significant disease problems were not observed. By October 9, 1996, only 973 walleye remained alive, though they were healthy and in excellent condition. Their mean total lengths and body weights were 161 mm (6.3 in) and 33.3 g (1.17 oz), respectively. On that date, the remaining walleye were placed in tanks supplied with 13.3C (55.9F) well water, and turned over to personnel of the Calamus State Fish Hatchery for overwintering. Between October 1996 and January 1997, over 50% of the remaining walleye succumbed for unknown reasons, and the project was terminated.

The decision to end the Nebraska component of Objective 1 of this project was based on poor performance as noted above and the 1996-1997 effort exhausted not only all of the North Central Regional Aquaculture Center (NCRAC) funds allotted for the UNL component of the walleye project, but also well over $20,000 in UNL and state funds.

The effort made in these abortive attempts at the Calamus hatchery suggests that various site-specific factors, yet to be identified, may be essential to culturing walleye on a large scale. Such factors may include differences in genetic stock, water chemistry, water-temperature patterns, and/or basic facilities design or operation.

UW-Madison researchers compared growth rates and feed efficiencies of walleye reared in ponds and in tanks of different sizes, and measured physiological indicators of stress in walleye reared using different culture techniques, to identify least-stress culture methods. UW-Madison

researchers also completed experiments that measured changes in serum concentrations of cortisol, glucose, and chloride following acute-stress challenge tests in walleye at different temperatures. The data reveals that the cortisol response of walleye to an acute stressor is faster than in many teleosts, but peak levels are comparable. Walleye held at 15C (59.0F) had reduced peak cortisol levels but increased time for return to baseline compared to walleye at 21C (69.8F). Water temperatures above optimal (25C; 77.0F) accelerated the initial rise to peak levels and delayed the return to baseline, suggesting a stronger and more prolonged stress response.

UW-Madison investigators found no difference in growth rates of walleye raised to food size in 750-L (198.1-gal) and 12,000-L (3,170.1-gal) tanks. Similarly, a holistic health-assessment index showed no differences in the overall health or condition factor of fish reared in the two tank sizes. Walleye reared in the larger tanks, however, displayed a markedly different activity level than those in the smaller tanks. Fish in the 12,000-L (3,170.1-gal) tanks remained actively swimming high in the water column, exhibited obvious schooling behavior, and an aggressive response to food. Walleye in the 750-L (198.1-gal) tanks generally remained sedentary on or near the bottom of the tanks.

At the time of this report, UW-Madison researchers have been unable to conduct the pond studies proposed under this objective due to significant delays in the construction of experimental pond facilities.

OBJECTIVE 2

The economics team, comprised of investigators from Purdue University (Purdue), Illinois State University, and North Dakota State University (NDSU), characterized the economics and institutional aspects of the domestic markets for walleye as food fish, fingerlings, and other intermediate products. Reliable market information on wild-caught supplies is essential for commercial growers to plan their production, financing, and marketing strategies. An understanding of marketing channels and institutional structures will provide aquaculturists with insights into the impact that farm-raised walleye products could have on domestic markets for this species.

Production information was collected from research/extension experts, public and private suppliers, and producers of walleye fingerlings by telephone interviews and mailed survey instruments. Phase I supermarket and restaurant surveys (different survey forms for restaurants and supermarkets) asked for general information on purchases and sales of fish/seafood and questions regarding the firm. The initial mailing was completed during the last week of August and the first week of September 1996.

The collection and analysis of published and secondary data on walleye exports from Canada to the United States is near completion by NDSU. A thesis on this work should be finished in December 1997 and is anticipated to result in other publications in 1998.

During the first year of the walleye marketing survey project (September 1, 1995-August 31, 1996), Purdue investigators focused on literature review, survey design, mailing list development, survey instrument development, and initial survey mailings. The literature review covered previously completed seafood marketing surveys as well as trade literature of the firm types to be surveyed. Survey design encompassed making determinations of precise definitions of firm types to be surveyed, scope of the survey, methodology employed to conduct the survey and analyze the results, and the time line in which to complete the survey process followed by data analysis and report writing. Survey instruments were developed for three firm types or groupings. Separate instruments were developed for restaurants and supermarkets. Two separate instruments, to be used in sequence, were generated for each of these firm types. A single survey instrument was produced for surveying the firm type grouping "wholesalers," which

included seafood wholesalers, seafood retailers, food service distributors, grocery wholesalers, and fish brokers. A random representative sample of businesses in each firm type was purchased from a private mailing list company. Purdue investigators discovered that there was a group on campus that contracted with in-house and outside groups for survey services. Assistance from this group was obtained for finalizing survey instrument development, survey design, mailing list management, and mailings. The mailings of the initial surveys of restaurants and supermarkets were completed at the end of the first year of the project.

In the second year of the project (September 1, 1996-August 31, 1997), the focus was on conducting the mail survey, completing survey instrument development, data entry, data analysis, and report writing. The survey services group at Purdue disbanded, leaving Riepe to manage the mailing list, conduct survey mailings, enter the survey data, and analyze the data largely on her own. This greatly expanded the previously anticipated time line. Follow-up survey mailings were completed by March 1997. However, data entry and analysis were well underway and completed in May 1997. The first draft of the first manuscript was completed and reviewed in July and early August. Revisions were nearing completion by the end of the second year of the project.

OBJECTIVE 3

Three workshops were held in the NCR in the spring and early summer of 1996 and 1997 to demonstrate technology for walleye aquaculture. The topics were: (1) intensive culture of walleye from fry to fingerlings on formulated feed, May 7, 1996, at the Max McGraw Wildlife Foundation, Dundee, Illinois (co-sponsored by Max McGraw Wildlife Foundation); (2) production of advanced fingerling walleye raised on minnows in ponds and then trained to formulated feed in intensive culture systems, June 18, 1996, at Spirit Lake State Fish Hatchery, Spirit Lake, Iowa (co-sponsored by the Iowa DNR); and (3) spawning walleye (collection, transportation, and stripping of brood fish and incubation of eggs), April 17-18, 1997, at Spirit Lake State Fish Hatchery, Spirit Lake, Iowa (co-sponsored by the Iowa DNR). Workshop participants were from Illinois, Iowa, Michigan, Minnesota, Nebraska, Pennsylvania, Wisconsin, and the Canadian provinces of Ontario and Manitoba.

Over four hours of video tape recordings were taken by UNL of the first workshop at the Max McGraw Wildlife Foundation for production of a video on the intensive culture of walleye fry. Given the large amount of video tape shot under marginal lighting conditions, some technical difficulties associated with editing a quality video on intensive fry culture have been identified and need to be addressed. Because of the cost and time requirements to do this, final release of the finished video is not anticipated until mid-1999.

In each workshop, participants were able to observe an on-going activity related to the workshop topic. For example, in the April 1997 workshop at Spirit Lake, participants were able to view gill netting from a boat, observe sorting fish by ripeness, preparation of extended semen, spawning, egg enumeration, and incubation. Some participants were able to strip eggs and semen from ripe fish. The value of such live demonstrations and "hands-on" activities, as made available through these workshops, cannot be overestimated.

OBJECTIVE 4

ISU and UW-Madison investigators undertook comparison of the performance of purebred and hybrid walleyes (male sauger × female walleye) produced from gametes obtained from several geographically distinct stocks of walleye and sauger from the midwest. Brood stock were obtained with the assistance of several state (Iowa, Ohio, South Dakota, and Wisconsin) resource management agencies and the U.S. Fish and Wildlife Service's Genoa National Fish Hatchery. In 1994, hybrids were produced from three stocks of female walleye and a single stock of sauger -- male sauger collected from the Mississippi River near Genoa, Wisconsin and female walleye

collected from the same site, and from Spirit Lake, Iowa, and Rock Lake, Jefferson County, Wisconsin. Growth rates of the hybrids were compared with pure stock walleye from Rock Lake, Wisconsin, which were half-siblings of the hybrids. Culture was carried out at ISU from hatch to 74-days posthatch.

In both 1994 and 1995, the length at hatching of pure stock walleye was greater than that of any of the hybrids, but as early as 28-30 days, hybrid walleye were longer than pure stock walleye. In 1995, hybrids were produced by crossing female Spirit Lake walleye with saugers collected from the Ohio River, Mississippi River, and Missouri River. When fry were 28-days old, the Missouri River hybrids were longer than any other group; by 83 days, the Mississippi River hybrids and Ohio River hybrids were similar in size, and both were longer and heavier than the Missouri River hybrids and the pure stock walleye.

In both 1994 and 1995, most, though not all, hybrid crosses grew faster than the parental stock (pure walleye) through the first 74-83 days posthatch. The source of the dam (walleye) was more important than the source of the sire (sauger). In both years, hybrids produced by crossing Spirit Lake walleye and Mississippi River sauger grew faster through the first 74-83 days posthatch than any other hybrid cross.

Some of the fish raised at ISU were transferred to UW-Madison investigators, who raised these purebred and hybrid walleye to food size. Their studies clearly showed that, compared to purebred walleye, hybrid walleye have markedly superior growth and performance characteristics when grown to food size by intensive culture systems. One hybrid cross, the Spirit Lake (Iowa) walleye female × Mississippi River sauger male, consistently outperformed all other purebreds and hybrids in terms of survival, growth, and feed conversion. A particularly important finding was that the improved growth of hybrids continued as fish approached market size.

Another important result of these studies was that sexually related dimorphic growth becomes apparent in all groups of purebreds and hybrids once the fish reach about 150 g (5.3 oz), i.e., well before market size. As the fish approached market size, hybrid females were growing nearly twice as fast as hybrid males, and more than six times faster than purebred males.

Organoleptic and carcass composition studies revealed no difference between purebreds and hybrids. Taste panels expressed a high degree of consumer preference for both, describing them as firm, flaky, and tender with an absence of any off flavors. Proximate analysis indicated that fillets were very low in fat (1.1-1.7%).

IMPACTS

OBJECTIVE 1

ISU researchers determined the protein and energy digestibility of the WG-9206 diet, which is presently the standard diet for grow out of feed-trained walleye fingerlings. Comparison of walleye growth at 20C (68.0F) and 25C (77.0F) demonstrated a higher growth rate at 25C (77.0F), but to reduce the incidence of disease a temperature of 23C (73.4F) is recommended as an optimum temperature for commercial culture. A multiplicity of factors affecting feeding of fish make it difficult to define feeding rates for walleye across the entire spectrum of fish sizes, temperatures, and energy content of feeds, but recommendations have been developed for walleye from 170 mm (6.7 in) to 330 mm (13.0 in) TL at 20C (68.0F) and 25C (77.0F).

After further testing, corrections, and validation, model simulations conducted by ILNHS may prove useful in recommending optimal energy levels in feeds, feeding rates, and temperatures for walleye growth in commercial aquaculture.

Field trials done in Nebraska over the past six years have shown that the number of walleye fingerlings produced per surface area of ponds by extensive culture methods can be increased by 160-320% (to well over 600,000 harvested fingerlings/ha; 242,820 fingerlings/acre) by appropriate pond fertilization, stocking, and harvesting techniques. However, survival of the pond-reared fingerlings under intensive culture conditions by Nebraska investigators was unsuccessful. Because of this experience, the Nebraska Game and Parks Commission has decided to discontinue further efforts in this regard for the foreseeable future.

The failure in one-year trial done in Nebraska for intensive culture of walleye fingerlings suggest that potential investors in commercial walleye aquaculture, before starting a major venture, should have a thorough knowledge of the known technologies for culturing this species, have or gain considerable practical experience in the application of these technologies, and be prepared to spend a number of years conducting pilot projects to resolve site-specific problems. Without this level of investment and know-how, the likelihood of long-term financial success appears slight, based on present knowledge, particularly with respect to the production of food-size walleye. Without far more research, commercial walleye aquaculture remains an extremely risky enterprise.

To help reduce such risk, the research done by UW-Madison investigators to characterize the performance and stress responses of walleye grown to food size under different conditions provides information needed to determine which culture techniques can be used to rear this species in a time frame and manner conducive to commercialization. Also, information generated by ILNHS and ISU researchers will help in preparation of guidelines and tables for predicting growth and determining appropriate feeding rates of juvenile to food-size walleye under different conditions.

OBJECTIVE 2

Publications from the marketing survey component of the project will benefit persons currently involved in or planning to produce walleye in aquaculture systems for the food-fish market by providing factual data on which to ascertain and evaluate marketing options and on which to base marketing plans, marketing strategies, enterprise budgets, and production decisions. These plans will be useful as business tools for individual aquaculturists and to help obtain outside capital. Survey data will also be useful to aquaculture research, extension, and marketing professionals in industry, government, and academia in terms of enhancing their understanding of food-fish markets for walleye and identifying and planning appropriate avenues for future activities and investigations. Lenders will also find the survey data useful for evaluating walleye aquaculture loan proposals.

OBJECTIVE 3

Regional workshops were held in conjunction with real-time, walleye aquaculture production activities. Such workshops provided excellent opportunities for training because participants directly observed techniques and potentially benefited from "hands-on" opportunities to learn from experienced practitioners. Workshops that involved direct observation of cultural practices proved useful for both extension educators, as well as students and fish culturists wanting to learn new techniques. Workshops also provide a unique opportunity to capture voice and video recordings of workshop speakers and fish culture activities that have been arranged for the participants. Finally, workshops provide opportunities for participants to get acquainted with experienced professionals and share experiences with other people involved in similar activities -- thereby providing beneficial contacts.

OBJECTIVE 4

One major constraint to the development of a commercial walleye food-fish industry is the relatively slow growth of walleye when reared from advanced fingerlings to food-size fish under typical aquaculture conditions. The studies under this objective identified a hybrid cross which has markedly superior growth and performance characteristics compared to purebred walleye. Organoleptic and proximate analyses found no important differences between purebred and hybrid walleyes. The commercial use of walleye hybrids and of monosex female populations should substantially reduce the time and costs required to produce food-size walleye.

RECOMMENDED FOLLOW-UP ACTIVITIES

OBJECTIVE 1

Based on studies done at the Max McGraw Wildlife Foundation and by ISU and Iowa DNR investigators, more research is needed on strategies of feeding walleye, including such considerations as feeding frequency, feeding rate, feeding for compensatory growth, automatic versus demand feeders, time of day, and light levels. Bioenergetics models, such as those examined by ILNHS researchers, should be refined and validated to gain full benefits of their potential to predict growth and food consumption rates by walleye in various aquaculture settings. Additional experimental work with different feeding rates and diets of known digestible energy are needed to further test such models. Once a model is validated for a diversity of cultural conditions, it could then be used to predict optimum thermal regimes, amounts of feeds required, and growth rates for cultured walleye.

The field trials conducted in Nebraska failed because of high mortality in habituating pond-reared walleye to formulated feed to produce food-size walleye by intensive culture practices that earlier had proven to be effective in culturing advanced walleye fingerlings by many other investigators in Ohio, New York, South Dakota, and Iowa. In Nebraska trials, early walleye fingerlings produced by extensive pond culture appeared to habituate rapidly to artificial diets and extensive culture conditions. But after habituation, these fish failed to thrive and were gradually lost, despite major investments in planning, fish, facilities, equipment, supplies, and technician time. The loss of fish in these field trials was not obviously attributable to major problems with disease, cannibalism, feed consumption, or swim-bladder inflation. A possible flaw in the design of production-tank drain structures appears to be one likely cause of fish losses.

Nebraska Game and Parks Commission personnel have noted suspected water-chemistry problems at the Calamus State Fish Hatchery, where both the reservoir water and well water are soft. No specific water-chemistry problems have been identified after extensive testing. However, experienced Commission fish culturists have had difficulties at the Calamus hatchery with the intensive production of a number of species, including walleye. Whether due to site-specific factors or differences in the level of experience or attentiveness of personnel, the failure of the Nebraska field trials to produce advanced fingerlings underscores the need to fully understand factors affecting the success of this cultural technology. However, such efforts are essential at the regional level if the intensive culture of walleye to food size is ever to be proven commercially feasible.

Researchers at UW-Madison are committed to undertake studies on the growth and stress responses of walleye reared to food size in ponds -- aspects of walleye aquaculture that have not yet been examined. Studies will be initiated upon completion of pond-construction project currently underway at the Lake Mills State Fish Hatchery. These trials will be done using funds from alternative sources, and the findings made available to the public through NCRAC.

OBJECTIVE 2

Publications will continue to be produced on walleye fingerling markets, the institutional aspects of the Canadian wild-caught walleye fishery, and purchase and sales information from firms in walleye marketing channels. A technical bulletin is planned that will contain detailed survey data on firms purchasing walleye and the specifics of their purchases. Following this, a fact sheet will be developed on the restaurant market for seafood. If time and circumstances allow, other fact sheets will be produced based on various aspects of survey data, such as the supermarket market for seafood, and wholesale firms as seafood markets.

OBJECTIVE 3

Walleye Work Group members have expertise on the status of walleye culture for presentations at state and regional meetings. Such presentations at meetings heavily attended by practicing or potential commercial walleye aquaculturists should be encouraged and actively supported by NCRAC. Significant findings and procedures developed by recent Walleye Work Group research should be summarized into fact sheets, videos, and other extension products, to provide commercial walleye culturists with up-to-date information. Future workshops should be held using extension materials and other information that has or will be developed to demonstrate the latest technology for culturing walleye and walleye hybrids.

OBJECTIVE 4

Before the benefits of selective breeding become available, the identification of a superior strain of walleye hybrid and the finding that females outgrow males offer great potential benefits for the commercial culture of walleye as a food fish. Certain stocks of walleye and hybrid walleye are obviously superior for intensive culture than others. Work along several lines is still needed, however, to facilitate the commercial use of these findings. First, a cooperative effort between NCRAC, commercial producers, and fisheries management agencies is needed to make the fast-growing fish stocks available to the private sector. Second, methods for producing monosex female walleye hybrids need to be developed. Third, unlike some interspecific hybrids, hybrids of walleye and sauger are known to be fertile, and their escape into the wild from commercial aquaculture facilities may be viewed as a threat to native walleye populations by the fisheries management agencies of some states. Accordingly, methods for producing sterile hybrids need to be developed.

PUBLICATIONS, MANUSCRIPTS, OR PAPERS PRESENTED

See the Appendix for a cumulative output for all NCRAC-funded Walleye activities.

SUPPORT[1]

YEARS	NCRAC-USDA FUNDING	OTHER SUPPORT					TOTAL SUPPORT
		UNIVERSITY	INDUSTRY	OTHER FEDERAL	OTHER	TOTAL	
1995-96	$117,897	$143,355		$50,000[a]		$193,355	$311,252
1996-97	$57,103	$89,841				$89,841	$146,944
TOTAL	$175,000	$233,196		$50,000		$283,196	$458,196

[1]This is funding for only the sixth Walleye project. It does not include the funds for Objective 2 of the fifth Walleye project which was continued and completed in the sixth project (Objective 4).
[a]Illinois-Indiana Sea Grant Program