YELLOW PERCH[(3)]

Project Termination Report for the Period

September 1, 1993 to August 31, 1998

NCRAC FUNDING LEVEL: $350,000 (September 1, 1993 to August 31, 1998)

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Non-funded Collaborators:		
Harlan Bradt, etc.	Coolwater Farms, LLC, Cambridge	Wisconsin
William Hahle	Pleasant Valley Fish Farm, McCook	Nebraska
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Dave Smith	Freshwater Farms of Ohio, Inc., Urbana	Ohio
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REASON FOR TERMINATION

The objectives for this project were completed and funding was expended.

PROJECT OBJECTIVES

(1) Continue to improve larval rearing techniques by developing and evaluating different starter diets in relation to size at transfer to formulated feeds under selected environmental conditions.

(2) Continue to improve pond fingerling production through examination of in-pond feeding techniques using physical/chemical attractants and improved harvesting strategies for different sizes of fingerlings from various types and sizes of ponds.

(3) Continue development of extension materials and workshops emphasizing practical techniques coinciding with production events to meet the needs of established and potential

yellow perch culturists through on-site presentations at two or more locations in different parts of the region.

PRINCIPAL ACCOMPLISHMENTS

As an integral component of this project, private producers cooperated by providing facilities, fish, feed, day-to-day husbandry, and routine data collection. At its inception, this project included the participation of eight different private fish farms in various parts of the North Central Region (NCR). Participating university researchers provided project oversight on experimental design, advice or direct assistance with the technical set-up of any specialized experimental systems, supervision and assistance on critical end-point data collection, and analyses of results.

In the project, significant progress was made at certain sites at testing selected research-based production technologies. Accordingly, from an extension perspective, the project successfully built and/or expanded working relationships between North Central Regional Aquaculture Center (NCRAC) researchers and certain regional fish farmers, testing various research-based technologies under practical production conditions, transferring knowledge from academia to the private sector, and identifying private producers who are both capable and willing to sustain a collaborative technology evaluation and demonstration effort. Several of the original private-sector collaborators have either met or have worked hard to meet their project commitments.

OBJECTIVE 1

Researchers at Michigan State University (MSU) directed their efforts towards: (1) identifying mouth gapes for first feeding yellow perch larvae, (2) correlating *Artemia* cyst diameter to nauplius hatching size, and (3) estimating heritabilities. Mouth gapes for larval yellow perch less than 10 mm (0.39 in) total length (TL) were described by linear regression models. For a first feeding 6.0-mm (0.24-in) TL larvae, the mouth gape width was approximately 322 m (0.0127 in) and the mouth gape height was approximately 318 m (0.0125 in).

Newly hatched *Artemia* nauplii from the Great Salt Lake strain (GSL) were as small or smaller than nauplii from the San Francisco Bay strain (SFB). The SFB strain has been marketed as producing the smallest nauplii. The demand and price for the SFB strain was higher, reaching as much as $220/kg ($100/lb), while the GSL strain was priced at less than $77/kg ($35/lb). Large statistical variations in cyst diameters were observed for the SFB and GSL *Artemia* strains. Nauplii hatched from cysts collected in the micro-sieves MS200 (mesh size in m) and MS280 had statistically significant differences in length, width, and appendage length for both strains. These results indicate that there was a significant, positive correlation between *Artemia* cyst diameter and nauplii length, width, and appendage length.

Decapsulated *Artemia* cysts were used to culture first feeding yellow perch larvae with limited success. Hydrated, decapsulated cysts were also used with limited aeration, but dehydrated cysts would be better, because they tend to float on the surface and sink over a longer period of time. A flat bottom added to the yellow perch larval culture tanks helped to spread out the larvae when they exhibited resting behavior.

Initially, MSU researchers evaluated the effect of female spawner size on larval yellow perch characteristics. Positive linear relationships were significant between female spawner size (TL and weight) and egg ribbon weight and total fecundity. However, linear relationships were not significant between female spawner size and number of eggs per gram of eggs, chorion shell diameter, and egg yolk diameter. The inability to establish a correlation between female spawner size and these egg characteristics may be due to large environmental variation. Examples of variables that can result in environmental variation are food availability, food quality, water temperature, and predation. Linear relationships could not be established between female spawner size and larval TL and size of the mouth gape, which could have been the result of large paternal influences or environmental variation. A genetics study was designed to identify the amount of influence from both maternal and paternal sources and from the environment.

The MSU genetics study was designed to partition out the influence of the maternal and paternal sources of variation on larval TL, mouth gape width, and height. Overall, the paternal contribution to the total variation was small (0-0.13). The overall residual term, including any environmental variance, was larger (0.05-0.21), which indicates the significant environmental influence. Heritabilities (h^2), based on spawner TL and age, were estimated for larval yellow perch TL (h^2 = 0.14), mouth gape width (h^2 = 0.00), and mouth gape height (h^2 = 0.23). All values of heritability were less than 0.50, which indicates that selection for improvement of these characteristics will be unlikely. Because this study included a fixed assignment of the parental stock, a true estimation of heritability could not be calculated. However, the estimates of heritability provide a valuable insight to the possibility of starting breeding programs, which could select for other desirable characteristics. The number of brood stock used and the number of larvae sampled were large enough to estimate the genetic variance components. However, by increasing the number of brood stock used, the amount of variation in the population would be better represented. The large dominance values (0.21-1.57) indicate that the variations in larval TL and mouth gape sizes occurred by chance.

Studies at Purdue University (Purdue) were designed to quantify the dietary requirements for sulfur amino acids (methionine plus cyst(e)ine) and the dietary choline requirements, providing the framework for the legal use of betaine as a flavor additive in diets for yellow perch. To date, the dietary requirements for lysine, arginine, total sulfur amino acids, the sparing effect of cyst(e)ine for methionine, and choline have been quantified in juvenile fish fed experimental diets.

The dietary requirements for lysine and arginine were 1.5% and 1.4% of the dry diet, respectively. The dietary total sulfur amino acid requirement for juvenile yellow perch is 1.0% of the diet and cyst(e)ine, a nonessential amino acid, can spare approximately 50% of the dietary requirement for the essential amino acid methionine. When total sulfur amino acid concentrations were held at the requirement, the dietary choline requirement was 750 mg/kg (ppm) of diet.

In 1996, Ohio State University (OSU) researchers spawned yellow perch out-of season during September-October by shifting the photothermal condition (light hours and temperature) by six months. The natural spawning of yellow perch occurs in April-May at 12-14C (53.6-57.2F) and a 12 h photoperiod. The brood stock was maintained at higher temperature and longer photoperiod during September-February (18C [64.4F] and 13 h). The photothermal conditions were decreased gradually until June. The chill period (10C [50F] and 11 light h) was 60 days in duration (June-July) and was followed by gradually increased water temperature and longer day light (12C [53.6F] and 19 h). Following this period, 47% of the females were recorded as gravid and 24 were stripped or spawned naturally. The males spermiated during the entire shifted spawning period from August until September. The average relative weight of ovulated eggs as percentage of the female weight was 26.6 ± 10.7%. Embryo survival through the eyed-stage was 56 ± 24%. Larval skeleton abnormalities (45 ± 15%) and a low frequency of swim bladder inflation (44 ± 34%) were observed.

Hatching occurred seven days after spawning incubation at 14C (57.2F). Just before hatching, the eggs were transferred to 20-L (5.3-gal) aquariums with continuous water flow at 20C (68F). Three days after hatching, fresh-water rotifers *Brachionus calyciflorus* and microalgae *Dictyosphaerium chlorelloides* were added three times a day to aquariums at an average concentration of 10 rotifers/ml (296/oz). Eighty percent of the larvae were found to have 1-4 rotifers in the gut at first feeding. *Artemia* nauplii were added six days after hatching. The combination of rotifers, algae and *Artemia* was supplied until 14 days after hatching after which, only *Artemia* nauplii were offered to the larvae. Two different dry diets were tested for weaning 25 day old larvae, salmonid starter diet and experimental squid based diet. However, only 35 day old juveniles were found to accept dry diets and were not weaned completely from *Artemia* until an age of 45 days.

Nine diets were tested as weaning diets, including two commercial ("Zeigler" trout starter [Zeigler Bros., Gardiner, Pennsylvania] and "Biokyowa" [Biokyowa, Inc., Chesterfield, Missouri]), one semi-commercial (F.T. Barrows, Fish Technology Center, Bozeman, Montana), and six experimental diets. Live food (*Artemia* nauplii) was used as a control. In addition, the semi-commercial and one experimental diet ("walleye") were supplemented with 20% (initial fish biomass) *Artemia.* The "Zeigler" trout starter was coated with 5 or 10% (diet weight) krill hydrolysate as a feed attractant. One hundred fish (average wet weight 75.5 ± 5 mg; 0.0027 ± 0.00 oz) were placed in each of 44, 20-L (5.3-gal) aquariums. Fish were fed ad libitum, eight feedings per day. After 31 days, fish were sacrificed, counted, and sampled for length, wet weight, dry weight, and digestive tract enzyme activities. Percent survival to 31 days ranged from 35 ± 6.2% (French diet - based on freeze-dried liver and yeast extract with CMC was used as a binder) to over 70% on a walleye diet (based on krill meal and herring meal as protein sources, including 2% krill hydrolysate with gelatin used as a binder) or Barrows with 20% *Artemia* nauplii (manufactured by marumerization technique).

OBJECTIVE 2

Trials were completed by University of Wisconsin-Madison researchers at Coolwater Farms, LLC, to determine key parameters for producing yellow perch fingerlings habituated to formulated feed and reared in ponds for an entire growing season, and to compare the performance of two types of pond lighting and feeding systems. Their studies showed that rearing fingerlings in ponds for the entire first growing season can result in yields greater than 247,097 fish/ha (100,000 fish/acre), although variability in both pond productivity and fish size result in a wide range of production levels. Over two years of data collection, fingerling production in ponds harvested in the autumn ranged from 49,919-276,478 fish/ha (20,000- 112,000/acre, and averaged about 148,250 fish/ha (60,000 fish/acre). Autumn-harvested fingerlings ranged in size from 6.4-20.3 cm (2.5-8.0 in) TL (2-100 g; 0.1-3.5 oz total weight). On a per acre basis, gross revenues (based on a fingerling price of $0.075/in) from the various production methods studied were as follows:

- traditional tandem pond/tank -- $4,800-$8,000,
- improved tandem pond/tank -- $6,000-$12,000,
- in-pond fingerling production with July harvest -- $5,700-$9,500, and
- in-pond fingerling production with October harvest -- $12,500.

University of Nebraska-Lincoln (UNL) researchers coordinated pond culture field trials in Nebraska. In 1994 and 1995, field trials were conducted at Pleasant Valley Fish Farm in two 0.08-ha × 1.5-m-deep (0.2-acre × 4.9-ft) rectangular ponds, which were drainable, aerated with low-pressure blowers connected to subsurface diffused-air distribution systems, and supplied with groundwater as needed for temperature moderation and to provide fresh water for flushing. Both ponds were filled and fertilized in early spring prior to stocking, then stocked with about 200,000 eyed-eggs (2,500,000/ha; 1,011,750/acre). Three major changes in procedures were made in Year 2: (1) the number of feeding stations in each pond was increased from five to seven, (2) the automatic feeders used were better maintained and more frequently filled with fresh feed, and (3) in one pond, a predetermined number of advanced fry were concentrated in a 1.8-m × 1.8-m × 0.9-m- (5.9-ft × 5.9-ft × 3.0-ft) deep net-pen around one of the feeders.

Perhaps the most significant finding of the Year 1 field trail was that ponds stocked at high rearing densities produced at least three populations of perch of markedly different body sizes, a result that was almost certainly dependent on degree of acceptance of formulated feed. In the first pond, for example, about 25% of the perch harvested averaged about 34.5 g (1.22 oz), about 15% averaged about 8.2 g (0.29 oz), and the remaining 60% averaged about 1.4 g (0.05 oz) in body weight. Examination of gut contents revealed that at the time of harvest the large fish were consuming significant amounts of formulated feed, the medium-size fish were consuming "some" formulated feed, while the small fish were consuming almost no feed. By the date of harvest, the natural forage base in both ponds appeared to be depleted, which was not unexpected given the stocking rates. Conversely, post-harvest analysis in Year 2 revealed distinctly bimodal fish size distributions in both ponds. The weight distributions of the two distinct populations of perch in both ponds were found to be statistically normal. For the first pond, large fish comprised about 18% of those harvested and had a mean weight of about 30.5 g (1.08 oz), while the smaller fish had a mean weight of about 7.1 g (0.25 oz). For the second pond, the comparable figures were about 21%, 33.2 g (1.17 oz) and 7.4 g (0.26 oz), respectively. The perch confined to the net-pen supplied with formulated feed from one feeder had a near-normal (slightly positively skewed) size distribution, with a mean weight at harvest of only about 6.1 g (0.22 oz), suggesting that natural forage in ponds fed formulated feeds may still comprise a major source of food for much of the growing season. However, analysis of gut contents revealed that nearly all the fish in both ponds, as well as the net-pen, were consuming significant amounts of formulated feed by the final harvest date.

Comparison of the data generated by the Nebraska field trials revealed similarities between Year 1 and Year 2 in the estimated numbers of perch produced and estimated survival rates in the two ponds used at Pleasant Valley Fish Farm. Specifically, the estimated numbers of perch produced and survival rates in Year 1 and Year 2 in the first pond were 12,833 and 11,145 and 13% and 11%, respectively. The same production estimates for the second pond were 8,011 and 9,831 fish, and 8.3% and 9.8% survival, respectively. However, the total biomass of perch harvested from the first pond was about 70.4 kg (880 kg/ha or 785 lb/acre) for Year 1 compared to 122 kg (1,525 kg/ha or 1,360 lb/acre) for Year 2, while the total biomass of perch harvested from the second pond was about 97.3 kg (1,216 kg/ha or 1,085 lb/acre) for Year 1 compared to about 126 kg (1,575 kg/ha or 1,406 lb/acre) for Year 2. Collectively, these findings demonstrated that providing formulated feed to perch fry and fingerlings in small (0.08-ha; 0.20-acre) rearing ponds by the procedures described can increase total production two- to four-fold, depending in large part on the number of feeders used per unit of pond surface area and the level of sustained attention given to maintaining feeders and keeping them supplied with fresh feed.

UNL investigators also evaluated several strategies of harvesting various sizes of young-of-the-year yellow perch (16-mm-35-mm [0.63-in-1.38-in] TL) using light attraction from various types and sizes of ponds. The studies evaluated four different lighting system designs to optimize light attraction and the capture of young perch in three different designs of passive capture gear. The four different lighting systems were tested in combination with all three designs of capture gear. Regardless of the equipment tested, UNL researchers found the "best" size at which to light harvest young perch to minimize physical injury while maximizing the number of fish captured seems to be between about 18-mm (0.71-in) and 25-mm (0.98-in) TL. However, a large number of variables influenced the number of fish captured and the catch per unit effort, combined with the widely varying harvest results observed under what appeared to be very similar conditions. Thus, a single night's effort under seemingly similar conditions with the same equipment might yield anywhere from 50,000-500,000 fish with no obvious explanation for the differences.

Many factors appeared to have major effects on harvest success, regardless of the combinations of harvesting equipment tested. Percentage success of total pond harvest seems to be inversely related to pond surface area, depth and the steepness of slope of pond banks. Thus with 0.2-ha (0.50-acre) ponds, harvest percentages as high as 50% can sometimes be achieved, while with 0.4-ha (1.0-acre) ponds harvest percentages higher than 50-60 are rare. Preliminary trials with larger ponds suggest that percentage harvest declines progressively with increasing pond surface area. Harvesting success can be impaired by poor weather and windy conditions, and can be particularly poor in ponds with steeply sloped banks where most of the littoral zone is deeper than 1.2-m (3.9-ft). High initial stocking rates of ponds with eyed-eggs or fry, if survival is good normally increased initial capture numbers and catch per unit effort. However, the percentage success of total pond harvest is often reduced by high initial stocking rates due in part to the great numbers of harvesting efforts required, each of which seems to have a negative influence on the strength of the phototactic response of perch of similar size to recurring exposures to artificial light. Two particularly important factors that appear to significantly reduce the utility of light harvesting young perch from ponds are: (1) the very short time period during which perch are in an appropriate size range to harvest on a large scale, and (2) repeated or prolonged exposures to artificial light of perch of a size that are normally highly photopositive have a significant cumulative dampening effect on their overall phototactic response. The first of these factors is of major practical importance because of its limiting effects on the logistics of pond harvesting. Under good growing conditions, young perch may be in the desired range of 18-mm (0.71-in) to 25-mm (0.98-in) TL for only seven to ten days. Such a short time period makes the large-scale light harvesting of perch extremely sensitive to disruptions by poor weather or equipment failures, as well as the physical stamina of workers engaged in all-night harvesting efforts night after night. The obvious dampening effect of repeated or prolonged exposures to artificial light on the phototactic response patterns of young perch suggest that under practical conditions the practice of first habituating young fish to formulated feed in ponds using light as initial attractant to automatic feeders may be incompatible with any subsequent light harvesting strategies.

OBJECTIVE 3

During 1996, three yellow perch workshops were conducted. The University of Wisconsin Sea Grant Institute sponsored two workshops entitled "Intensive Aquaculture of Yellow Perch in Conjunction with Recirculating Aquaculture Systems," which included NCRAC Extension and Yellow Perch Work Group members. Alpine Farms (Sheboygan Falls, Wisconsin) personnel participated as aquaculture industry cooperators to provide their practical experience with, and knowledge of, yellow perch rearing in their recirculating aquaculture system technology. UNL conducted a workshop in Nebraska. In 1997, UW-Madison researchers sponsored an organizational meeting of producers of yellow perch who are using pond systems. The objectives of this meeting were to discuss common problems and opportunities facing these aquaculturists. The group was unanimous in their identification of fingerling size uniformity and pond production variability as being the most critical problem areas of production. The group also expressed interest in examining the potential of developing a cooperative mechanism to purchase commodities (e.g., fish food) and market products (e.g., fingerlings and processed fillets). A follow-up meeting of this group together with perch producers using other systems was held at the 1998 Wisconsin Aquaculture Conference (March 13-14, 1998, Eau Claire). These meetings have led to the formation of a yellow perch committee within the Wisconsin Aquaculture Industry Advisory Council. This committee will first meet in September 1998 and one of its first goals will be to develop a means of networking and communicating among all interested perch producers.

UNL delivered a total of eight extension programs that, in whole or in part, provided timely information on various aspects of yellow perch aquaculture. Some progress was made on the production of two videotapes on selected aspects of perch aquaculture: one on procedures for spawning perch, and the second on small-scale perch processing. A "rough-cut" edition of the perch spawning videotape has been reviewed by several aquaculture professionals, and has been shown at aquaculture conferences or workshops in several states, among them Indiana, Michigan, Minnesota, Nebraska, Ohio, Wisconsin, Maryland, and North Carolina. Both videotapes are expected to be completed by UNL by March 1, 1999.

IMPACTS

Quantifying critical nutritional requirements for targeted species reduces feed costs and allows variation in use of feed ingredients. The research completed at Purdue, MSU, and OSU, is defining a yellow perch diet and feeding strategies for use in the NCR.

Total sulfur amino acid concentrations are typically the first limiting amino acid in diets that contain high levels of plant protein feedstuffs. That is, if the requirements for methionine + cyst(e)ine are met, then other essential amino acid concentrations will be at or above the needs of perch. Once methionine is absorbed by perch, it is either used for synthesis of new protein, such as fillets, or catabolized (broken down) into cyst(e)ine, then choline. Given that methionine is limiting in most diets for perch, there will not be excess methionine for cysteine and choline synthesis. Thus, the values quantified at Purdue are vital pieces of information for dietary formulation and provide the basis of equally important work on flavor additives.

With the mouth gape of first feeding yellow perch fry identified, researchers and culturists can focus on providing suitable diets that are small enough for the larvae to consume.

The procedure of shifting the spawning season has to be accompanied with indoor larvae rearing. The larvae rearing protocol developed in this project is based on a combination of microalgae and rotifers as the larvae first feed. *Artemia* nauplii were offered from six days after initiation of feeding. Weaning period started at 35 days and the fingerlings were completely weaned from *Artemia* to dry diet at the age of 45 days. Co-feeding of dry diets and *Artemia* as well as coating starter diet with krill hydrolysate significantly increased growth of yellow perch juveniles.

Studies on pond fingerling production by UW-Madison researchers have shown that research-based production strategies can be used on a commercial scale to produce large numbers of perch fingerlings at a relatively low cost. Lights and automatic feeders can be used to improve the habituation of fingerlings to formulated feeds in tanks, and to feed-train perch directly in ponds. Improvements in feeder design has increased reliability and decreased capital and operational costs.

The Nebraska field trials conducted in ponds at Pleasant Valley Fish Farm in collaboration with the UNL clearly demonstrated that research-based production strategies can be used to culture both fingerling and food-size perch under commercial conditions in ponds, by stocking ponds at high densities and using intensive feeding methods. Field trial data collected at Pleasant Valley Fish Farm indicate that perch can be raised in ponds from eyed-eggs to fingerlings having mean weights of 11.0-12.8 g (0.39-0.45 oz) within one growing season at production levels as high as 1,216-1,525 kg/ha (1,085-1,360 lb/acre); and that age-1 fingerling perch can be raised in one growing season to food-size fish having weights averaging 135 g (4.76 oz), at production levels at least as high as 4,740 kg/ha (4,229 lb/acre). Rates of growth at Pleasant Valley Fish Farm aimed at the production of food-size perch were excellent, ranging from 0.55-0.82 g/day (0.02-0.03 oz/day). While many problems remain in perch culture, these field trials suggest that perch can be raised to food size in ponds within two years.

The extensive field trials conducted by UNL investigators have demonstrated both the utility and limitations of using light to harvest young photopositive perch. Given the highly variable success rates of harvesting such perch with light and the nature and cost of the highly specialized equipment required to light harvest perch in large numbers, it is recommended that this harvesting practice by used only by experienced fish culturists for very targeted applications, such as the early harvest of very young perch for habituation to formulated feed. Comparatively small numbers of such feed-trained fish can potentially be used later in the growing season to facilitate the habituation of large numbers of perch fingerlings to formulated feed under intensive culture conditions.

Requests for information on yellow perch aquaculture continue to increase annually. Workshops done on yellow perch aquaculture in the NCR have enabled extension specialists and researchers to provide information on this species to established fish farmers, potential fish farmers, and the general public. The workshops have also provided a mechanism for yellow perch culturists to identify problem areas. For example, producers have identified the excessive variability in fingerling size and pond productivity as the critical problems currently faced by yellow perch fingerling producers. This provides valuable insight into future directions that are needed for yellow perch aquaculture research. Addressing these areas of concern expressed by current yellow perch producers will bridge the gap between research and solutions to real-world problems.

RECOMMENDED FOLLOW-UP ACTIVITIES

While the results of these studies have provided important information regarding larval and fingerling yellow perch production, they have also served to emphasize several areas in which improvements are greatly needed.

Results of these studies are being used to continue to improve larval culture. The first objective of the NCRAC Yellow Perch Project that began in September 1, 1997 was, "With the goal of larval intensive yellow perch feeding in tanks from the onset of first feeding, continue to develop methods to produce fingerlings." With the mouth gape identified, researchers can focus on providing suitable diets that are small enough for the larvae to consume. Work completed at OSU provides a strong basis for further study. Although separating *Artemia* cysts by size would enhance their use, the process used by MSU researchers would not be efficient for small-scale aquaculture operations. After the hydration and separation processes, the *Artemia* cysts would have to be dehydrated for storage. Better cyst processing techniques should be developed to separate cysts into smaller size categories after harvesting, but prior to dehydrating the cysts. The cysts could be graded, dehydrated, and sold according to diameter to improve utilization by small larvae.

The nutritional requirements data should be used in developing feeds specifically for larval yellow perch.

The results of heritability studies indicated that, through natural selection, larval TL and the size of the mouth gape for perch may have reached a plateau and cannot be increased through selective improvement. If artificial selection for these traits operates in the same direction as natural selection (i.e., larger mouths and longer lengths), then it may be difficult to improve on natural selection. However, other traits that are important for culture, such as larval survival should be investigated. Another genetics experiment should be conducted, but only after some of the environmental variables can be controlled (i.e., a captive brood stock). A selection program, which identifies perch that grow well in intensive culture conditions, should be started to aid intensive larval culture techniques. This could be started by using perch raised entirely in intensive culture conditions as the brood stock for future cultures.

The high cost of fingerlings continues to be one of the greatest factors constraining the growth of yellow perch aquaculture. The extreme variability in the size of pond-reared fingerlings, coupled with relatively poor overall production rates (which are typically as much as an order of magnitude lower than theoretical production levels), continue to be critical problems facing yellow perch producers. Accordingly, efforts to develop improved methods of fingerling production need to be continued.

PUBLICATIONS, MANUSCRIPTS, OR PAPERS PRESENTED

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

SUPPORT

YEARS	NCRAC-USDA FUNDING	OTHER SUPPORT					TOTAL
		UNIVER-	INDUSTRY	OTHER	OTHER	TOTAL	

		SITY		FEDERAL			SUPPORT
1993-94	$75,000	$87,240	$30,000	$10,000[a]		$127,240	$202,240
1994-95	$75,000	$81,587	$30,000	$81,000[abc]		$192,587	$267,587
1995-96	$107,086	$145,814	$20,000	$134,000[ac]		$299,814	$406,900
1996-97	$92,914	$106,095	$22,000	$86,911[a]		$215,006	$307,920
TOTAL	$350,000	$420,736	$102,000	$311,911		$834,647	$1,184,647

[a]Sea Grant/USDC/NOAA

[b]USDI, Bureau of Indian Affairs

[c]EPA

YELLOW PERCH

Publications in Print

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