ADVANCEMENT OF HYBRID WALLEYE AQUACULTURE

Chairperson: Konrad Dabrowski, Ohio State University

Industry Advisory Council Liaison: David A. Smith, Urbana, Ohio

Extension Liaison: Ronald E. Kinnunen, Michigan State University

Funding Request: $127,000

Duration: 2+ Years (September 1, 1999 - June 30, 2002)

Objectives:

1a. Carry out commercial-scale field trials for rearing hybrid walleye fingerlings to food size (25.4 cm; 10 in minimum) in tanks.

1b. Carry out commercial-scale field trials for rearing hybrid walleye fingerlings to food size (25.4 cm; 10 in minimum) in ponds (at least three ponds at each site) at sites in the upper and lower portions of the North Central Region.

2. Conduct producer training workshops on propagation of hybrid walleye.

Proposed Budgets:

Institution	Principal Investigator(s)	Objec-tive(s)	Year 1	Year 2	Year 3	Total
Ohio State University	Konrad Dabrowski	1a & 1b	$19,000	$10,000		$29,000
Freshwater Farms of Ohio	David Smith	1a	$8,750	$10,250		$19,000
Univ. of Missouri-Columbia	Robert S. Hayward	1b	$12,000	$12,000		$24,000
U. of Wisconsin-Madison	Jeffrey A. Malison	1b	$24,000	$25,000		$49,000
Michigan State University	Ronald E. Kinnunen	2		$100	$5,900	$6,000
		TOTALS	**$63,750**	**$57,350**	**$5,900**	**$127,000**

Non-funded Collaborators:

Facility	Collaborator(s)
Piketon Research & Extension Center, Ohio State University, Piketon, Ohio	Laura G. Tiu
Flowers Aquaculture, Dexter, Missouri	Kevin Flowers

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JUSTIFICATION

The walleye (*Stizostedion vitreum*) is a highly valued game and food fish in the North Central Region (NCR) of the U.S. and in central Canada. In the National Aquaculture Development Plan (Joint Subcommittee on Aquaculture 1983), the walleye was recognized as a species for which strong interest exists for development of a commercial industry producing food-size fish. The plan further indicated that this interest was driven by a strong market demand, coupled with a drop in landings by commercial fisheries.

There is little question that the walleye is a popular sport fish, and is among the most heavily exploited fish species in North America (Kendall 1978). Except for the harvests of a few tribal fisheries in Minnesota, Michigan, and Wisconsin, commercial fishing for walleye in the U.S. has been prohibited to safeguard wild populations for exclusive exploitation by sport anglers and Native American tribes. To maintain these populations, numerous fisheries management agencies in the U.S. and Canada collectively stock over one billion walleye fry and fingerlings each year (Conover 1986). In addition to this public sector production, numerous commercial aquaculturists produce walleye fingerlings that are sold to sportfishing groups, lake associations, and private pond owners.

The traditional methods used for producing walleye fingerlings include the capture of wild brood stock during the spawning season; the collection, fertilization, incubation, and hatching of eggs; and subsequent stocking of hatched fry into ponds for rearing to fingerling size (Malison and Held 1996a). Large numbers of fingerlings can be raised to a size of 25—50 mm total length (TL) by using these traditional pond culture methods (Summerfelt et al. 1996a; Kinnunen 1996). Walleye fingerlings of this size are normally harvested in late spring or early summer. The Ohio Department of Natural Resources, Division of Wildlife has used the same production methods since 1985 to annually produce in excess of 5 million hybrid walleye (female walleye × male sauger *S. canadense*) fingerlings for stocking many of Ohio's reservoirs. Pond fertilization procedures have been developed to maximize the number and quality of walleye and hybrid walleye produced in pond culture (Culver et al. 1993; Qin et al. 1995; Culver 1996).

Not surprisingly, some fisheries managers have found that large (100—200 mm TL) walleye fingerlings have much higher poststocking survival than smaller (25—50 mm TL) fingerlings. Accordingly, some public hatcheries and commercial walleye producers now raise these larger fingerlings. This has typically been done by stocking fry or small fingerlings in ponds at low densities and harvesting them in the late summer or autumn when the fish reach 100—200 mm TL. This method is expensive, however, because large quantities of expensive forage fish need to be added to the ponds during the summer (Summerfelt et al. 1996; Kinnunen 1996). Because of this expense, a significant amount of research in recent years has focused on developing and improving procedures for habituating small (25—50 mm TL) pond-reared fingerlings to formulated feed in tanks (see Nickum 1986; Malison and Held 1996b). As a result of these research efforts, methods and production parameters for rearing walleye fingerlings up to 200 mm TL in tanks are now well established.

Studies conducted over the last decade have shown that, compared to purebred walleye, the walleye female × sauger male hybrid grows significantly faster, is more tolerant of typical aquaculture conditions, and has similar processing and organoleptic properties (Malison et al. 1990; Summerfelt et al. 1996b). Results from the most recently completed NCRAC walleye project have conclusively shown that one particular strain of hybrid walleye (the "SL/MR" hybrid, produced by crossing female walleye from Spirit Lake, Iowa with male sauger from the Mississippi River) grows more than twice as fast than purebred walleye when reared intensively in tanks to a near-market size of 0.45—0.68 kg (Malison and Held 1998).

These studies have generated a high level of interest in the NCR in the commercial production of hybrid walleye as a food fish. The Industry Advisory Council (IAC) of the North Central Regional Aquaculture Center (NCRAC) recently determined that the highest priority for research on walleye is to conduct commercial-scale field trials for rearing hybrid walleye to food size in ponds and tank systems. The NCRAC IAC has determined that field trials are needed in order to establish critical production parameters and information that can be used to develop future economic models that detail the production costs of raising hybrid walleye to food size.

The NCRAC IAC has also determined that extension workshops are crucial to developing commercial aquaculture of walleye and walleye hybrids in the NCR. Past extension workshops and development of extension educational materials on the various aspects of culturing walleye have focused primarily on the purebred walleye. Studies to date clearly suggest that hybrid walleye may be better suited to commercial aquaculture than purebred walleye because of their improved growth performance and docile nature. The workshops, which will be conducted in Objective 2, will transfer to producers the commercial-scale production information developed under Objective 1.

This proposal by the NCRAC Hybrid Walleye Work Group is well suited for a cooperative regional research effort and involves investigators with appropriate expertise from four different universities and one commercial fish farm: Michigan State University (MSU), Ohio State University (OSU), University of Missouri-Columbia (UMC), University of Wisconsin-Madison (UW-Madison), and Freshwater Farms of Ohio (FFO). Specific objectives of the proposed project are to: (1) carry out commercial-scale field trials for rearing hybrid walleye fingerlings to food size in tanks and in ponds in the upper and lower portions of the NCR, and (2) conduct producer training workshops on the propagation of hybrid walleye. This project will promulgate sound information on the production parameters of raising hybrid walleye using the most promising systems available. We suggest that this information be used in a subsequent NCRAC project to develop detailed economic models documenting the production costs of hybrid walleye. In addition, this project will rigorously test, under commercial conditions, two strategies that have considerable potential to improve the production efficiency of raising hybrid walleye. The work done under this project will also be closely linked to key marketing studies that will be concurrently conducted under a separate project.

RELATED CURRENT AND PREVIOUS WORK

Over the past 40 years, a great deal of information has been published on walleye culture in the scientific literature and in government agency papers and reports (see references cited under **JUSTIFICATION**). Since 1988, various NCRAC Walleye Work Groups have made major advances in: (1) developing technology for intensively culturing walleye fry on formulated feed in tanks; (2) greatly improving procedures for producing walleye fingerlings in ponds and training these larger fish to formulated feed in tanks; (3) characterizing the annual reproductive cycle of walleye and developing techniques for inducing out-of-season spawning; (4) elaborating procedures to differentiate between different genetic stocks of walleye, and identifying stocks with positive traits for the development of domesticated brood stock; and (5) demonstrating that selected walleye × sauger hybrids grow much faster and have greater potential for commercial aquaculture than purebred walleye. More information on these advances made by the various Walleye Work Groups since 1988 are available in progress reports submitted to, and available from the NCRAC Director's Office at Michigan State University. Results can also be obtained from the chair, extension liaison, or other appropriate members of the present work group.

Commercial-Scale Field Trials (Objective 1a & 1b)

In one of the few published studies in which walleye were reared to near food size, Siegwarth and Summerfelt (1993) reported that walleye raised in relatively small tanks grew much more slowly than walleye in many wild populations (Nickum 1978). Based on a growth curve for walleye that were reared to 783 days of age in small tanks at about 21°C, Siegwarth and Summerfelt (1993) estimated that it would take 965 days in a controlled environment for walleye to reach 0.68 kg, a typical size for the food fish market. Such slow growth rates for large walleye have also been observed by other researchers (e.g., J. Malison, UW-Madison, unpublished observations). These results are particularly surprising in light of the fact that near optimal temperatures and photoperiod can be maintained in laboratory tanks, whereas such conditions exist for only about half the year in the wild.

To our knowledge, no substantive studies have been conducted to determine why walleye exhibit such poor growth and performance when reared under intensive culture conditions. In other fish species, however, some of the most important factors known to have major impacts on growth include temperature, nutrition, spatial requirements, and the general culture method employed. With regard to temperature, Huh et al. (1976) and Summerfelt (1996) have established that the optimum temperature for walleye growth is 20—25°C. Nutritionally adequate walleye diets have also been developed (Barrows and Lellis 1996).

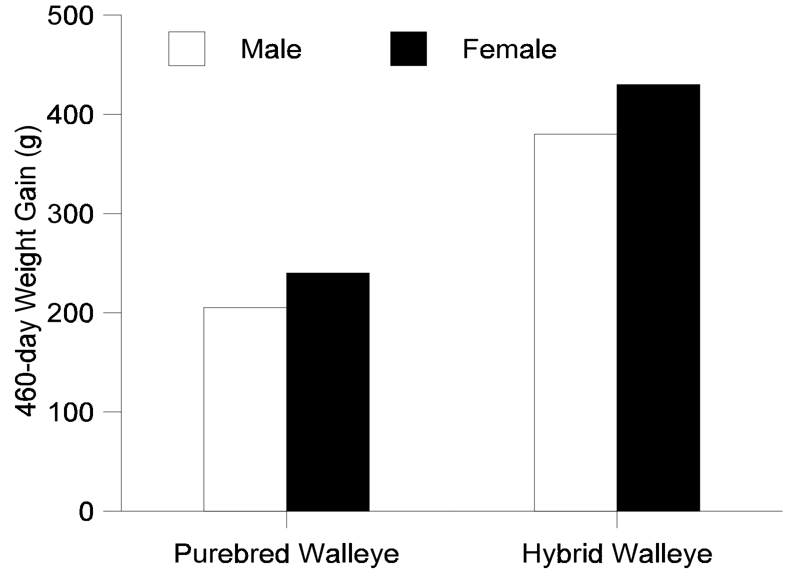
With regard to spatial constraints, Siegwarth and Summerfelt (1993) suggested that the relatively small size of tanks used in their studies might have resulted in poor growth rates. Corroborating their results are the unpublished observations of UW-Madison researchers who observed that, in one unreplicated trial, walleye reared in 750-L and 12,000-L tanks grew more than 60% faster than fish reared in 220-L tanks. We hypothesize that the growth rates of hybrid walleye raised in large tanks will be significantly faster than that of purebred walleye in small tanks. One goal of this project is to document, in a scientifically sound and replicated manner, the production parameters of rearing hybrid walleye to market size in large tanks on a commercial scale.

From a broader perspective, culture methods themselves (e.g., tanks, ponds, or net pens) can have a significant effect on the growth and performance of cultured fish (Stickney 1986). Newton (1992) has reviewed the relative merits of pond and cage culture for rainbow trout (*Oncorhynchus mykiss*) and channel catfish (*Ictalurus punctatus*), and concluded that the selection of a rearing method is highly species- and site-specific. Similarly, the recent development of food-fish production techniques for hybrid striped bass (*Morone saxatilis* × *M. chrysops*) incorporated the evaluation of performance characteristics and cost-effectiveness of earthen ponds, cages, and recirculation systems (Kerby 1986).

Several small-scale attempts have also been made at raising food-size walleye in net pens (e.g., C. Stevens, Knoxville, Iowa, personal communication). These studies have suggested that the growth of walleye reared in net pens is no faster than in small tanks. Open pond culture of food-size walleye is an alternative to tank or net pen culture that has not been investigated to date. Some advantages of open pond culture are that large numbers of fish can be produced at a comparatively low cost in labor and capital equipment. Additionally, fish growth performance and survival may be greatly improved because of lower rearing densities and reduced stress levels. Although pond culture has not yet become a common grow-out method for food fish in the northern U.S., studies on pond culture of yellow perch (*Perca flavescens*) to food size in southern Wisconsin have shown considerable promise (Malison 1997). In these studies, a high percentage of one-year-old (125 mm TL) yellow perch fingerlings stocked in spring reached a market size of 200 mm TL by autumn. Because the thermal requirements of walleye are similar to those of yellow perch, we hypothesize that food-size hybrid walleye can be produced in ponds in two growing seasons in the NCR. Accordingly, this project will document the production characteristics of rearing hybrid walleye in ponds in the northern and southern part of the region.

Regardless of culture method used, improving the growth rate of intensively cultured walleye is of paramount importance if the culture of food-size walleye is to become a commercially viable industry. It has recently been shown that hybridization between walleye and sauger and the production of monosex female populations of either the hybrids or purebred walleye are two potential methods of achieving this goal. Research from two laboratories initially showed that walleye female × sauger male fingerlings grow faster than purebred walleye (Malison et al. 1990; Siegwarth and Summerfelt 1990). In contrast, Siegwarth and Summerfelt (1993) later suggested that hybrids may not reach food size any faster than purebreds. Recently completed studies funded by NCRAC, however, have shown that the SL/MR strain of hybrid walleye was the fastest growing fish when compared to five other hybrid walleye strains and two purebred strains. These studies also demonstrated that SL/MR hybrid walleye maintain their growth advantage up to food size (Malison and Held 1998; see also Figure 1). Taken together, the studies referenced above provide the rationale used by the NCRAC IAC to focus this project on the SL/MR hybrid walleye.

Like many fish species, walleye and hybrid walleye exhibit sexually related dimorphic growth. Female walleye grow faster and reach a much larger size than males (Scott and Crossman 1973; Colby et al. 1979). In the wild, this sexually related dimorphic growth pattern begins when fish reach 1—3 years of age (Colby et al. 1979). Malison recently found that female walleye purebreds and hybrids raised under intensive culture conditions begin to outgrow males when they reach 150 g (Figure 2). Malison et al. (1998) also recently reported on a method for producing monosex female populations of purebred and hybrid walleye. The method relies on treating juveniles with an androgen to induce phenotypic sex inversion of the (genetic) females and to use the sperm from genetic females to fertilize normal eggs. A similar method has been developed for use in yellow perch, and is now being used by six commercial perch farms under the auspices of a U.S. Food and Drug Administration Investigational New Animal Drug approval. The portion of this project conducted by UW-Madison proposes to determine the extent to which monosex female hybrid walleye offer improved production traits compared to mixed-sex hybrid walleye.



Mean daily weight gain during the final growth interval of the study (days 378—460)

Purebred Male	Purebred Female	Hybrid Male	Hybrid Female
0.22 g/day	0.61 g/day	0.96 g/day	1.44 g/day

Figure 1. Weight gain of purebred versus SL/MR hybrid walleye (Spirit Lake, Iowa female walleye crossed with male sauger from the Mississippi River). Data represents the mean of more than 300 fish reared in separate tanks per species and is from Malison (unpublished).

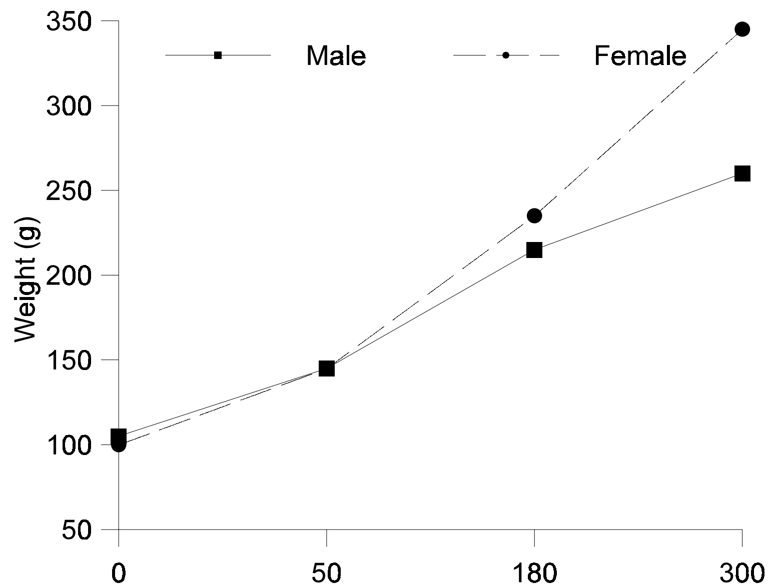


Figure 2. Weight gain of male versus female SL/MR hybrid walleye (Spirit Lake, Iowa female walleye crossed with male sauger from the Mississippi River). Data represents the mean of 89 fish raised in two tanks and is from Malison (unpublished).

Culture procedures for rearing larval and juvenile walleyes include out-of-season spawning as early as late January (Malison et al. 1998) and intensive, high density rearing of juveniles (Bristow 1996; Dabrowski et al. Submitted). Using these techniques, OSU's aquaculture program has been conducting studies on optimizing procedures for the production of out-of-season walleye fingerlings with the eventual extension of results to production of out-of-season hybrid walleye fingerlings (Czesny et al. In press; Kolkovski et al. In press). They used walleye that were kept in an earthen pond until December, moved indoors and gradually acclimated to warmer temperatures until hormonally induced to ovulate in early February. Fry were successfully hatched and reared to about 100 mg in 32 days (February-early March) in water temperatures below optimum (Figure 3; Dabrowski et al. Submitted). OSU's portion of this project will be to extend their efforts to produce out-of-season hybrid walleye fingerlings under near optimum temperatures for grow out, and, in conjunction with UMC and FFO, determine the extent to which "early season" hybrids provide production advantages compared to normal season hybrids in fish raised to market size in indoor tanks and ponds in the southern part of the region. Ponds in the northern part of the region will not be tested in this regard, however, because any advantage gained would probably be overriden by their cold spring water temperature.

Producer Training Workshops (Objective 2)

With respect to NCRAC, certain members of the Hybrid Walleye Work Group for years have routinely given talks and research updates at various local, state, and regional meetings and aquaculture conferences which mainly focused on purebred walleye. Thus far, no educational materials or programmed activities specifically centered on hybrid walleye have been produced or put into action. The recently produced NCRAC Walleye Culture Manual (Summerfelt 1996) has been an excellent resource for those interested in various techniques used in walleye culture but only several pages actually focus on hybrid walleye. Thus, more comprehensive information on the culture of hybrid walleye is needed for producers in the region.

We propose that the best way to accomplish the above is through workshops. The logical progression is to first conduct workshops on the specific production systems being used for the field trials of this project. In a subsequent project we propose that NCRAC use the field trial data generated in this project to develop economic models comparing the production costs of the different systems. After economic models are developed, additional extension activities should be conducted to transfer this information to current and potential producers.

ANTICIPATED BENEFITS

This project will address priority needs identified by the NCRAC IAC for advancing hybrid walleye aquaculture in the NCR. One major constraint limiting development of hybrid walleye aquaculture is the lack of substantive information on the commercial feasibility of culturing hybrid walleye to food size. The proposed commercial field trials described will establish critical production parameters (including but not limited to fish growth rate, survival, and feed conversion) that can be expected for commercially raising hybrid walleye to food size in tanks and in ponds in the northern and southern parts of the NCR. In order to minimize costs, the ponds and tanks used for this study are near the minimum size needed to have commercial applicability. The trials will also generate detailed information that can be used to develop economic models outlining the production costs of producing food-size hybrid walleye with these different systems. The next logical step in this line of study will be for NCRAC to employ economists to develop such models in a subsequent project.

In addition to providing field trial data, the grow-out studies at FFO, UMC and UW-Madison will each test critical scientific hypotheses with an adequate number of replications to reach valid statistical conclusions. The studies at FFO and UMC will determine the extent to which out-of-season spawning can improve the production efficiency of rearing hybrid walleye to food size in tanks and ponds in the southern part of the region. The studies at UW-Madison will determine the extent to which monosex female populations improve production efficiency.

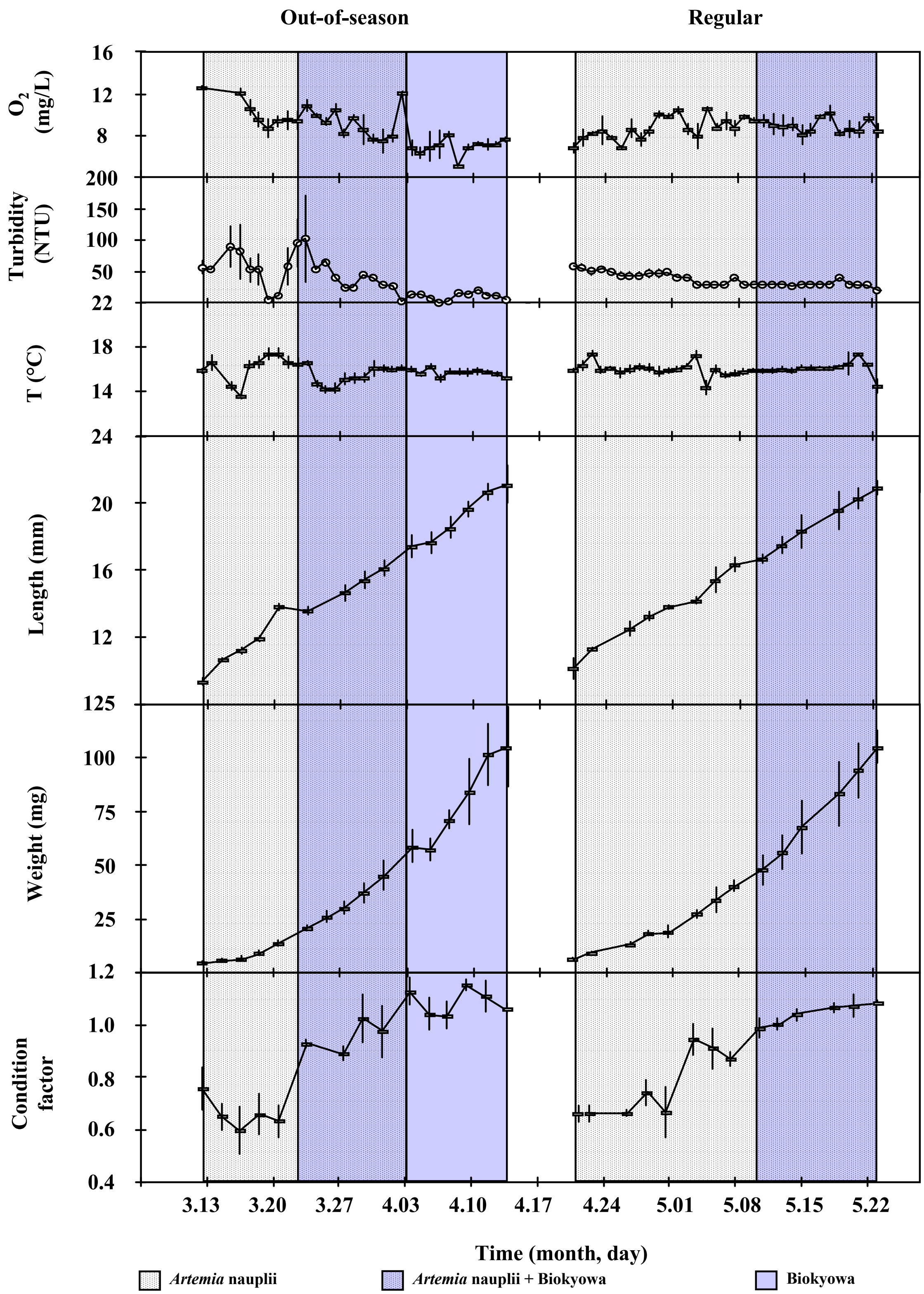


Figure 3. Environmental conditions in rearing tanks and rates of growth of walleye juveniles fed live *Artemia*, mixed, or exclusively formulated food (figure from Dabrowski et al. Submitted).

One of the greatest potential benefits of the workshops under Objective 2 will be that aquaculture producers will be made aware of a new species that can be cultured in the region that has the potential for considerable economic returns. The study will also identify real and perceived potential barriers to the commercial production of hybrid walleye. This information will be useful in designing educational materials and technical assistance. In addition, aquaculture extension professionals are expected to be among the participants in these workshops, which should result in a significant "multiplier effect" in disseminating the knowledge presented. Another benefit of very visible commercial field trials will permit and encourage persons interested in commercially raising hybrid walleye to tour and inspect the facilities, thereby helping them assess the potential of raising hybrid walleye in different systems. Additional extension information will be disseminated in conjunction with the proposed economic models to be prepared subsequent to the conduct of the field trials of the present study.

This study will also be closely linked to a related NCRAC study on the marketing of hybrid walleye. All of the collaborators for this project have agreed to provide samples of hybrid walleye at the end of the first and second year of this project that will be needed to conduct components of the marketing study. Dr. Ed Mahoney is the leader of the marketing project and will serve as the contact person for this study should the need arise.

OBJECTIVES

1a. Carry out commercial-scale field trials for rearing hybrid walleye fingerlings to food size (25.4 cm minimum) in tanks.

1b. Carry out commercial-scale field trials for rearing hybrid walleye fingerlings to food size (25.4 cm minimum) in ponds (at least three ponds at each site) at sites in the upper and lower portions of the North Central Region.

2. Conduct producer-training workshops on propagation of hybrid walleye.

PROCEDURES

Commercial-Scale Field Trials (Objectives 1a & 1b)

All of the studies to be conducted under Objective 1 will use the SL/MR strain of hybrid walleye. UW-Madison investigators have access to all of the needed brood stock for these studies. In the autumn of 1999, UW-Madison personnel will provide adult brood stock to OSU investigators who will overwinter these fish in a 0.1-ha pond (2-m deep) provided with adult minnows and juvenile carp as prey. OSU investigators will then produce all of the fingerlings needed for UMC and FFO as described below. UW-Madison researchers will produce the fingerlings needed for their study at their own facilities. To the extent possible, grow-out studies conducted by FFO, UMC, and UW-Madison researchers will utilize the same or similar diets. Because of changes and progress being made in diet availability in the NCR, the selection of specific diets will be made collaboratively by the Work Group just prior to the onset of the grow-out studies.

The objectives, as set forth by the IAC, will assess the feasibility of growing out hybrid walleye to 25 cm, which is 10 cm less than the traditional market for purebred walleye. Thus, each group will determine the amount of time required to reach 25 cm in their respective culture systems and location. It is recognized that some fish marketers feel that a significant market may exist for walleye and hybrid walleye as small as 25 cm and that this formed the rationale for using 25 cm as the minimum market size for this study. However, it is felt that valuable data and insight can be gained by having all field trials continue grow out until 35 cm, the traditional market size. This design will allow collection of data needed to assess the incremental cost of going from 25 cm to 35 cm in size in tanks and ponds, data valuable to a culturist trying to determine the best size or combination of sizes in terms of costs/benefits. Also, later development of economic models (and enterprise budgets) for potential culturists will be more complete if they include both the traditional market size and the size set forth by the IAC. Lastly, much of the published work on purebred walleye has incorporated grow out to 35 cm. Growing out the hybrids to 35 cm would allow for a more complete comparison of these results to previous studies with walleye.

Although all field trials will grow out hybrids to 25 and 35 cm, the culture systems used will be different given regional conditions. Tanks trials (FFO) will be conducted in recirculation tanks capable of being maintained at 25°C and should serve as a viable assessment of tank culture potential of hybrid walleye in the NCR. Procedures for pond grow out will differ between the southern trial (UMC) and northern trial (UW-Madison). In Missouri, fingerlings will be immediately placed in cages in each pond for continued grow out lasting four to six weeks. They will then be released to the pond for final grow out. This strategy has limited value in Wisconsin due to the shortened growing season. For the following reasons, UW-Madison will use a strategy of raising fingerlings in tanks throughout much of the first year and completing grow out in ponds in the second year. One, to reach a size of 35 cm in northern locations in two years, pond grow-out trials will need to begin with relatively large fingerlings. One known way to produce such large fingerlings is to raise them in tanks throughout the first year where favorable rearing temperatures can be maintained for a longer period. Pond grow-out trials in southern locations may not require tank culture to economically raise hybrids due to their longer growing season. Secondly, it may be difficult to raise feed-trained fingerlings to this size in ponds because previous experiences have suggested small feed-trained walleye fingerlings (<10 cm) in ponds quickly go off of formulated, pelleted diets and become increasingly piscivorous. Hybrid fingerlings may need to be held in large pens within ponds until this critical stage is passed, a possibility being examined by UMC researchers in their segment of this project.

FFO

Commercial-scale field trials for tank-rearing hybrid walleye fingerlings to food size will be conducted under the direction of Dr. David Smith (Research Director) and Timothy Nagel (Hatchery Manager). The study will generate production information and costs needed to develop a future economic model for raising hybrid walleye to food size in tanks. Ultimately, this information can be compared to the information generated by UMC and UW-Madison investigators who will generate similar information for ponds. In addition, the study will document the extent to which early season spawning of hybrid walleye affects production parameters and costs. Each treatment (early season and regular season) will utilize three tanks per treatment.

The grow-out trials will be conducted over a two-year period, starting with 18,000 fingerlings at 50 mm TL provided by OSU (see below). Half of the fingerlings will be early season fingerlings and will be stocked into three indoor 3,600-L recirculation tanks capable of being heated up to 25°C. The remaining fingerlings will be from normal season production and will be stocked later into three additional 3,600-L tanks. Dead fish will be weighed but not replaced during grow out. Water exchange will be 2—5% daily and initial fish densities will average about 0.02 kg/L. Supplemental aeration will be provided to maintain dissolved oxygen levels above 5.0 ppm. Alarm systems are in place to monitor water levels and aeration pressure. Automatic feeders will be used to provide feed each day. Water quality will be monitored using Hach Co. water test kits; pH will be measured daily while ammonia, nitrate, nitrite, and carbon dioxide will be measured weekly. Daily temperature and dissolved oxygen levels will be monitored with a YSI dissolved oxygen/temperature meter.

Samples of live walleye hybrids from each tank will be weighed and measured monthly to monitor growth and adjust feeding rates. Individual tank-group feed consumption and conversion will be recorded. At the end of the study, all of the performance parameters (e.g., comparisons of growth, final fish size, feed conversion, and total production of early season versus normal season fish) will be analyzed and published. All of the economic inputs and outputs will be provided to economists for developing an accurate production cost analysis for raising hybrid walleye in tanks in the upper NCR. Inputs to be recorded include labor (hours), feed consumed, and incidental costs (chemicals, etc.) while the primary output variable recorded will be production (kg).

OSU

Out-of-season and normal season hybrid walleye fingerlings will be produced from the brood stock described above at OSU's Piketon Research and Extension Center in Piketon, Ohio. Some of these fish will be moved indoors in mid-December, maintained in 450-L tanks, and gradually exposed to increased temperature and light regimes until late January. When female walleyes appear to have reached egg maturation in late January

(50—100 eggs will be taken with a catheter and tested for germinal vesicle migration), they will receive primary and resolving doses of hCG at a rate of 150 IU/kg and 500 IU/kg fish weight, respectively. The doses will be about 35 h apart. It is anticipated that male sauger will spermiate naturally. Female walleye will be checked for ripeness (egg release), stripped, and immediately fertilized following established Ohio Division of Wildlife procedures. Eggs will be incubated in 5-L McDonald jars (2—3 L of eggs per jar) with a continuous flow rate at a temperature of 8—9°C. Treatment with formalin (500 mg/L for 30 min) will be done daily to prevent fungal infections. Once hatching commences, temperature will be raised to 12°C to synchronize hatching. As hatching proceeds, larvae from all females will be collected in a single, large tank to maximize the likelihood each female will be equally represented in each rearing tank when larvae are stocked. For normal season hybrid walleye eggs, the brood fish remaining in the ponds will be removed in April and the same fertilization and incubation methods as described above will be employed.

Within two to four days after hatch of both early season and normal season eggs, 16,000 larvae from the common tank will be stocked into each of six, 1,000-L tanks for rearing to a total length of 15—20 mm. Water flow (4—5 L/min) in each tank will follow the design of Moore et al. (1994) and temperature will be raised to 20—21°C (from 12°C) over three days. An additional 750 mL/min of water will be introduced through two spray points to provide sufficient surface agitation to facilitate swim bladder inflation. Central standpipes will be covered with 500 μm mesh screens. Turbidity in the larvae rearing tanks will be maintained at 40—50 NTU by introducing a constant supply of clay solution using a peristaltic pump. Larvae will be provided dry diets (Biokyowa 400) for the first seven to ten days and then Biokyowa 700 until day 30 (see Dabrowski et al. Submitted). Diet particle size and amount fed will be adjusted as fish grow (Summerfelt 1996). Dry diets will be provided using automatic belt feeders. Throughout the larval growth period at 4-day intervals, samples of 30 fish will be collected from each tank, weighed, and measured to the nearest 0.01 g and 0.1 mm, respectively.

Once fry are 15—20 mm TL, they will be transferred to two, recirculating 10,000-L tanks located in a greenhouse. In these larger tanks, temperature will be maintained at 21°C and natural light conditions will be maintained. Fish will be continuously fed dry diets via automatic belt feeders during daylight hours to satiation. Throughout the fingerling growth period, samples of 30 fish will be collected weekly, weighed, and measured to the nearest millimeter. Once the fish reach 50 mm TL, they will be shipped to UMC and FFO investigators for grow out to market size.

<u>UMC</u>

The work proposed by UMC will generate production information and costs needed to develop an economic model for raising hybrid walleye to food size in ponds in the southern part of the region. Ultimately, this information can be compared to the information generated by FFO and UW-Madison investigators who will generate similar information for tanks and ponds in the northern part of the region, respectively. In addition, the study will document the extent to which early season spawning of hybrid walleye affects production parameters and costs. Each treatment (early season and regular season) will utilize three ponds per treatment.

UMC's industry cooperator is Flowers Aquaculture (Kevin Flowers, owner) located in Dexter, Missouri. The use of six, 0.20-ha ponds has been offered for two years by Flowers Aquaculture. The ponds have aeration and drainage capabilities, and well water can be added as needed to maintain water temperatures below 30°C. This latter feature will likely be particularly important in this southerly location because water temperatures reaching 34°C, considered the upper lethal temperature for juvenile walleye (Hokanson and Koenst 1986), can occur. However, up to seven months with water temperatures within the optimal range for walleye growth (22—28°C; Hokanson and Koenst 1986) are possible.

Nine thousand out-of-season hybrid walleye (mean length = 5.0 cm TL) will be received from OSU in late March 2000 and stocked into three of the ponds. Likewise in June 2000, 9,000 normal-season hybrid walleye will be received from OSU and stocked into the remaining three ponds. Fish will initially be stocked into net pens within the ponds to ensure that they continue to feed on the commercial diet provided. After one month in net pens, fish will be released into the ponds at densities of approximately 15,000 fish/ha. An effort will be made to keep feeding schedules consistent between this study and a parallel pond study to be carried out at the UW-Madison and the feeds to be used will be selected as described above.

Temperature and dissolved oxygen will be determined in all six ponds on a weekly basis, as will Secchi disk depth. Growth patterns and growth rates of hybrid walleye will be determined from monthly seine hauls when at least 50 fish from each pond will be measured for TL, batch weighed, and released. Feed allocation will be adjusted monthly on the basis of seine samples. Feed conversion rates (FCRs) will be determined monthly and overall from monthly weight data and knowledge of feed weights provided. Inter-individual size variation (CV) will be calculated monthly, on the basis of seine sampling, and finally when the ponds are drained. Mortality rates will also be determined from numbers stocked and numbers remaining when ponds are drained.

Fish stocked in Year 1 will be grown in the ponds until the 25th percentile of length reaches 25 cm TL. Removals of fish >25 cm TL may be carried out, with appropriate adjustments made in the feed quantities subsequently provided. Unless further growing of Year 1 fish is required, Year 2 fish will be stocked again in March and June of 2001 and Year 1 procedures repeated.

Growth rates, weight gain, FCR, CV, and mortality rate will be compared between the out-of-season and normal-season hybrid walleye groups within years. Results will also be compared between years with consideration of temperature, dissolved oxygen, and secchi disk depths as variables that may explain differences. Finally, results from the pond study in Missouri will be compared to those from the Wisconsin pond study.

<u>UW-Madison</u>

The work proposed by the UW-Madison will generate production information and costs needed to develop an economic model for raising hybrid walleye to food size in ponds in the northern part of the region. Ultimately, this information can be compared to the information generated by FFO and UMC investigators who will generate similar information for tanks and ponds in the southern part of the region, respectively. In addition, the study will document the extent to which the use of monosex female populations affects production parameters and costs. For the latter, each treatment (monosex females and mixed sex) will utilize three tanks or ponds per treatment.

All hybrid walleye used in the field trials conducted in Wisconsin will be the offspring of captive walleye and sauger brood stock currently held at the UW-Madison Aquaculture Program’s facilities at the Lake Mills State Fish Hatchery, Lake Mills, Wisconsin. The walleye are offspring of fish from Spirit Lake, Iowa and the sauger are offspring of fish from the Mississippi River. Hybrids of these specific populations of walleye and sauger will be used because previous studies funded by NCRAC have demonstrated that these hybrids grew significantly faster than hybrids produced using other populations of walleye and sauger as brood stock (Malison and Held 1998). The UW-Madison currently has 1996 and 1997 year-class walleye and sauger that will be sexually mature in the spring of 2000, and also has 1997 year-class sauger that were treated as juveniles with 17α-methyltestosterone according to the method of Malison and Held (1998). These fish will also be sexually mature in the spring of 2000.

In the spring of 2000, approximately 50 captive female walleye will be injected with hCG at 100 IU/kg. Within 5—7 days following injection, 80% of the females will ovulate. Eggs from the ovulated females will be collected as needed and about 50% of each group of eggs will be fertilized with normal sauger semen to produce mixed-sex hybrid walleye. The remaining eggs from each group will be fertilized with semen from sex-inverted genetic female sauger to produce monosex female hybrid walleye. A total of at least 20 females and 20 males will be used to produce each group of eggs. The eggs will be incubated at 11°C for five days, and then under a rising temperature regime (+ 0.5°C/day) for a total of 11—14 days until hatch.

Within two to four days after hatch, approximately 50,000 fry will be stocked into each of two 0.1-ha fertilized production ponds (one pond for each sex) for larval and early juvenile rearing. After six to eight weeks, fingerlings will be harvested and brought into the laboratory. The two groups of fingerlings will be habituated to formulated feeds and intensive culture conditions in six flow-through fiberglass tanks (three for each sex) provided with tempered water (21 ± 0.5°C), airstone aeration, and constant illumination. Initially, the fish will be fed continuously with automatic feeders and by hand several times daily using an appropriately sized diet. These conditions have been found to result in habituation rates of 60—70% within one month. Subsequently, the fish will be habituated to floating pellets and reared at 21°C and a photoperiod of 16 h light/8 h dark until approximately January 2001 when they reach a mean size of 200—250 mm TL and 100 g. At this time the fish will be acclimated to photoperiod and temperature conditions ambient to southern Wisconsin.

In mid-April 2001, a sample of 30 fish from each tank will be weighed and measured, and the fish from each tank will be counted and stocked into a separate 0.4-ha pond (three ponds for each sex) at 20,000 fish/ha. This stocking density is based on estimations that fish survival will be approximately 90% and the fish will gain an average of 1.25 g/day (see Figure 1) over a 200 day growing season, resulting in a total production of 4,500 kg/ha. The fish will be fed to satiation once each day shortly after dawn, at which time walleye will readily come to the surface of ponds to eat floating food (presumably because of the low light level). The amount of food fed to each pond will be recorded daily. Pond temperatures and dissolved oxygen levels will be monitored each morning, and fresh cold water will be added only as needed to keep pond temperatures <26°C. Once each month, each pond will be partially seined to capture a sub-sample of approximately 30 fish for weight and length measurements. In mid-November 2001, the ponds will be harvested and the fish will be individually weighed, measured, and necropsied to determine sex. Throughout the trial, important economic inputs into production (e.g., labor, electricity, etc.) will be recorded.

At the end of the study, all of the performance parameters (e.g., comparisons of growth, final fish size, feed conversion, and total production of mixed-sex versus monosex fish) will be analyzed and published. All of the economic inputs and outputs will be provided to economists for developing an accurate production cost analysis for raising hybrid walleye in ponds in the upper NCR.

Producer Training Workshops (Objective 2)

<u>MSU</u>

Under Objective 2, the Hybrid Walleye Work Group will conduct two funded producer training extension workshops in early 2002 on the propagation of hybrid walleye. The workshops will provide information on various aspects of intensive hybrid walleye culture, from production of early and normal season walleye hybrid fingerlings for tank and pond grow out, to production of monosex and mixed-sex hybrid walleye fingerlings, to production of hybrid walleye fingerlings to market food-size in ponds, tanks, and recirculating systems. Each of the two workshops will be held in a different state within the NCR in conjunction with a state aquaculture association annual meeting to increase attendance. Relevant printed materials will be distributed to attendees of these two workshops. The extension liaison for the Hybrid Walleye Work Group will coordinate both workshops and use the researchers within the Work Group as resource personnel.

<u>OSU</u>

Extension and research personnel associated with OSU's Piketon Research and Extension Center will conduct a series of contributed, non-funded "hands on" workshops and training for interested individuals. An initial meeting will be held early in the project period to brief potential participants on the NCRAC project, hybrid walleye potential, presentation on the hybrid's biology, and the timetable for subsequent workshops and training throughout the project period. All participants will be encouraged to attend all subsequent events as they occur. Specific topics will include out-of-season fingerling production, egg fertilization and incubation, fry and fingerling rearing and feeding requirements, tank stocking for grow out, water quality monitoring, and harvest/marketing potential. Some of these topics will be presented at OSU's Piketon Center while the remainder will be presented during workshops at FFO, location of tank grow out of the hybrids.

FACILITIES

<u>FFO</u> – Objective 1a

Freshwater Farms of Ohio is a commercial aquaculture facility started in 1983 near Urbana, Ohio. Indoor facilities consist of 4,275 m^2 of former poultry rearing buildings. Six recirculating raceways systems (60,000 L each) have been used in commercial production since 1986. Thirty-eight indoor and outdoor flow-through tanks are also in operation with sizes ranging up to 72,000 L each. Six, 3,600-L indoor recirculating tanks will be used for this study. Support facilities include laboratory equipment for water testing, compound microscopes for fish diagnosis, and a complete workshop for fabrication and repair of system components. A federally inspected fish processing plant is available for complete preparation of fish for organoleptic evaluation at the end of the grow-out period.

<u>MSU</u> – Objective 2

Two workshops will be scheduled for early 2002 and will require no specific facilities but access to annual state aquaculture conferences. It is anticipated that one of the workshops will be in the Minnesota/Wisconsin region and the other in the Michigan/Ohio region but could change as deemed necessary based on producer need. Kinnunen, who serves as the Extension Liaison, will coordinate both of these workshops. Kinnunen has extensive experience with coordinating and conducting educational extension workshops. Each of the three researchers (Dabrowski, Hayward, and Malison) in Objective 1 will present their findings at each workshop.

<u>UMC</u> – Objective 1b

UMC's industry cooperator is Flowers Aquaculture (Kevin Flowers, owner) located in Dexter, Missouri. The use of six, 0.20-ha ponds has been offered for two years by Flowers Aquaculture. The ponds have aeration and drainage capabilities, and well water can be added as needed to maintain water temperatures below 30°C. UMC has the necessary water quality monitoring equipment to assess pond conditions throughout the grow-out period.

<u>OSU</u> – Objectives 1a & 1b

Fish rearing facilities are located about one mile east of Piketon, Ohio along Rt. 32. The indoor fish rearing facility is a 333 m^2 building using treated well water for fish maintenance. Incubation jars (10) and trays (8) are available for hatching eggs with both jar and tray systems able to be operated as closed, recirculated or flow-through systems. Eighty-seven small tanks (40 L) and 30 aquaria are available for rearing larvae/fry/fingerlings; all aquaria are on recirculated, closed systems. Temperature can be adjusted on the small tank systems and aquaria. Fifty-one larger tanks (300—450 L) are used to rear larger fingerlings, juveniles, and adults; six of these tanks are located just outside the building with the remainder inside. Additionally, eight of the indoor tanks are located in isolation rooms (two per room) where light and temperature can be controlled. Another four indoor tanks are located in the building's quarantine room. A second indoor rearing greenhouse facility is currently being developed in which six large rearing tanks (10,000 L) will be housed, receiving water from a nearby 0.4 ha pond.

The main administration building contains a 46.5 m^2 laboratory equipped with a PICO-Tag HPLC amino-acid analyzer, a Alpkem RFA 300 rapid flow auto-analyzer, general lab equipment for water analysis, sample preparation and storage, as well as several meeting rooms.

<u>UW-Madison</u> – Objective 1b

Research on Objective 1 in Wisconsin (the upper portion of the NCR) will be conducted at the UW-Madison Aquaculture Program's laboratory facilities at the Lake Mills State Fish Hatchery, Lake Mills, Wisconsin, and at the Water Science and Engineering Laboratory (WSEL) on the UW-Madison campus. The Lake Mills facility has three sources of water (Rock Lake, dechlorinated municipal, and high-capacity well), a variety of fiberglass tanks (110 to 3,020 L), and eight environmental control suites each having independent water temperature, light intensity, and photoperiod control. This facility also has 36 production ponds ranging in size from 0.04—0.5 ha, many of which have aeration and water circulation systems, and the availability of cool (15°C) and cold (11°C) water for tempering as needed. For this proposal, two 0.1-ha ponds will be made available for walleye fingerling production, and six 0.04-ha ponds will be used for grow out. Some of the tank rearing of fingerlings needed for this project may be conducted in the 220—12,000-L flow-through tanks at the WSEL.

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PROJECT LEADERS

State	Name/Institution	Area of Specialization
Michigan	Ronald E. Kinnunen Michigan State University	Aquatic Resources/Fisheries and Aquaculture Extension
Missouri	Robert S. Hayward University of Missouri-Columbia	Fish Bioenergetics/Feeding Models
Ohio	David A. Smith Freshwater Farms of Ohio	Aquaculture/Marketing
	Konrad Dabrowski Ohio State University	Larval Fish Culture/Nutrition Physiology
Wisconsin	Jeffrey A. Malison University of Wisconsin-Madison	Aquaculture/Physiology/Endo-crinology

PARTICIPATING INSTITUTIONS AND PRINCIPAL INVESTIGATORS

Ohio State University (OSU)
Konrad Dabrowski

Freshwater Farms of Ohio (FFO)
David A. Smith

University of Missouri-Columbia (UMC)
Robert S. Hayward

University of Wisconsin-Madison (UW-Madison)
Jeffrey A. Malison

Michigan State University (MSU)
Ronald E. Kinnunen

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0022
Expires 5/31/98

BUDGET

ORGANIZATION AND ADDRESS School of Natural Resources Ohio State University 2021 Coffey Rd., Columbus, OH 43210				**USDA AWARD NO.** Year 1: Objectives 1a & 1b	
PRINCIPAL INVESTIGATOR(S)/PROJECT DIRECTOR(S) Konrad Dabrowski				Duration Proposed Months: 12 **FUNDS REQUESTED by PROPOSER**	Duration Awarded Months: ________ **FUNDS APPROVED BY CSREES** (If Different)
A. Salaries and Wages	**CSREES FUNDED WORK MONTHS**				$
1. No. of Senior Personnel	Calendar	Academic	Summer		
a. ___ (Co)-PI(s)/PD(s)					
b. ___ Senior Associates					
2. No. of Other Personnel (Non-Faculty) a. 1 Research Associates-Postdoctorates	4.0			$12,272	
b. ___ Other Professional					
c. ___ Graduate Students					
d. ___ Prebaccalaureate Students					
e. ___ Secretarial-Clerical					
f. ___ Technical, Shop and Other					
Total Salaries and Wages →				$12,272	
B. Fringe Benefits (If charged as Direct Costs)				$2,908	
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$15,180	
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for **each** item.)					
E. Materials and Supplies				$2,320	
F. Travel 1. Domestic (Including Canada)				$1,500	
2. Foreign (List destination and amount for each trip.)					
G. Publication Costs/Page Charges					
H. Computer (ADPE) Costs					
I. All Other Direct Costs (Attach supporting data. List items and dollar amounts. Details of Subcontracts, including work statements and budget, should be explained in full in proposal.)					
J. Total Direct Costs (C through I) →				$19,000	
K. Indirect Costs If Applicable (Specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)					
L. Total Direct and Indirect Costs (J plus K) →				$19,000	
M. Other →					
N. Total Amount of This Request →				$19,000	$
O. Cost Sharing (If Required Provide Details)	$18,425				
NOTE: Signatures required only for Revised Budget				This is Revision No. →	

NAME AND TITLE (Type or print)	**SIGNATURE**	**DATE**
Principal Investigator/Project Director		
Authorized Organizational Representative		

Form CSREES-55 (6/95)

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0022
Expires 5/31/98

BUDGET

ORGANIZATION AND ADDRESS School of Natural Resources Ohio State University 2021 Coffey Rd., Columbus, OH 43210	**USDA AWARD NO.** Year 2: Objectives 1a & 1b	
PRINCIPAL INVESTIGATOR(S)/PROJECT DIRECTOR(S) Konrad Dabrowski	Duration Proposed Months: 12 **FUNDS REQUESTED by PROPOSER**	Duration Awarded Months: ________ **FUNDS APPROVED BY CSREES** (If Different)

	CSREES FUNDED WORK MONTHS				
	Calendar	Academic	Summer	Funds Requested by Proposer	Funds Approved by CSREES
A. Salaries and Wages 1. No. of Senior Personnel					$
a. ___ (Co)-PI(s)/PD(s)					
b. ___ Senior Associates					
2. No. of Other Personnel (Non-Faculty) a. 1 Research Associates-Postdoctorates	2.0			$6,136	
b. ___ Other Professional					
c. ___ Graduate Students					
d. ___ Prebaccalaureate Students					
e. ___ Secretarial-Clerical					
f. ___ Technical, Shop and Other					
Total Salaries and Wages . . . . →				$6,136	
B. Fringe Benefits (If charged as Direct Costs)				$1,454	
C. Total Salaries, Wages, and Fringe Benefits (A plus B) . . . . →				$7,590	
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for **each** item.)					
E. Materials and Supplies				$1,410	
F. Travel 1. Domestic (Including Canada)				$1,000	
2. Foreign (List destination and amount for each trip.)					
G. Publication Costs/Page Charges					
H. Computer (ADPE) Costs					
I. All Other Direct Costs (Attach supporting data. List items and dollar amounts. Details of Subcontracts, including work statements and budget, should be explained in full in proposal.)					
J. Total Direct Costs (C through I) . . . . →				$10,000	
K. Indirect Costs If Applicable (Specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)					
L. Total Direct and Indirect Costs (J plus K) . . . . →				$10,000	
M. Other . . . . →					
N. Total Amount of This Request . . . . →				$10,000	$
O. Cost Sharing (If Required Provide Details)	$20,655				

NOTE: Signatures required only for Revised Budget — This is Revision No. →

NAME AND TITLE (Type or print)	**SIGNATURE**	**DATE**
Principal Investigator/Project Director		
Authorized Organizational Representative		

Form CSREES-55 (6/95)

BUDGET EXPLANATION FOR OHIO STATE STATE UNIVERSITY

(Dabrowski)

Objective 1a & 1b

A. Salaries and Wages. The salary of the post-doctoral researcher is needed to assist the PI with fish propagation, husbandry, data analysis, and publication of results.

B. Fringe Benefits. The OSU fringe benefit rate for post-doctoral researchers is 23.7%

E. Materials and Supplies. Year 1: wet laboratory chemicals including hCG, MS-222, water softener salt ($420); wet laboratory supplies including fish nets, airstones and aeration products, tank and drain cleaning chemicals and brushes, plastic bags ($400); fish feed ($1,200); and general office supplies including paper, pens, notebooks, folders, and toner ($300). Year 2: wet laboratory chemicals including hCG, MS-222, water softener salt ($310); wet laboratory supplies including fish nets, airstones and aeration products, tank and drain cleaning chemicals and brushes, plastic bags ($150); fish feed ($800); and general office supplies including paper, pens, notebooks, folders, and toner ($150).

F. Travel. Year 1: $750 for partial payment of registration, transportation, lodging, and meals for the PI and/or post-doctoral associate to present the results of the study at a 3-day national aquaculture conference, destination to be determined; $750 for transportation between the campus of OSU at Columbus, Ohio and the Piketon Research Center—total round-trip distance is 135 miles (30 trips @ $0.185/mile). Year 2: $750 for partial payment of registration, transportation, lodging, and meals for the PI and/or post-doctoral associate to present the results of the study at a scientific conference, destination to be determined; $250 for transportation between the campus of OSU at Columbus, Ohio and the Piketon Research Center—total round-trip distance is 135 miles (10 trips @ $0.185/mile).

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

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Expires 5/31/98

BUDGET

ORGANIZATION AND ADDRESS Freshwater Farms of Ohio, Inc. 2624 N. U.S. 68 Urbana, OH 43078				**USDA AWARD NO.** Year 1: Objective 1a	
PRINCIPAL INVESTIGATOR(S)/PROJECT DIRECTOR(S) David A. Smith				Duration Proposed Months: 12 **FUNDS REQUESTED by PROPOSER**	Duration Awarded Months: ________ **FUNDS APPROVED BY CSREES** (If Different)
A. Salaries and Wages	**CSREES FUNDED WORK MONTHS**				$
1. No. of Senior Personnel	Calendar	Academic	Summer		
a. ___ (Co)-PI(s)/PD(s)					
b. ___ Senior Associates					
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates					
b. ___ Other Professional					
c. ___ Graduate Students					
d. ___ Prebaccalaureate Students					
e. ___ Secretarial-Clerical					
f. _1_ Technical, Shop and Other				$5,000	
Total Salaries and Wages →				$5,000	
B. Fringe Benefits (If charged as Direct Costs)					
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$5,000	
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for **each** item.)					
E. Materials and Supplies				$3,500	
F. Travel 1. Domestic (Including Canada)				$250	
2. Foreign (List destination and amount for each trip.)					
G. Publication Costs/Page Charges					
H. Computer (ADPE) Costs					
I. All Other Direct Costs (Attach supporting data. List items and dollar amounts. Details of Subcontracts, including work statements and budget, should be explained in full in proposal.)					
J. Total Direct Costs (C through I) →				$8,750	
K. Indirect Costs If Applicable (Specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)					
L. Total Direct and Indirect Costs (J plus K) →				$8,750	
M. Other →					
N. Total Amount of This Request →				$8,750	$
O. Cost Sharing (If Required Provide Details)	$750				

NOTE: Signatures required only for Revised Budget — This is Revision No. →

NAME AND TITLE (Type or print)	**SIGNATURE**	**DATE**
Principal Investigator/Project Director		
Authorized Organizational Representative		

Form CSREES-55 (6/95)

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0022
Expires 5/31/98

BUDGET

ORGANIZATION AND ADDRESS Freshwater Farms of Ohio, Inc. 2624 N. U.S. 68 Urbana, OH 43078	**USDA AWARD NO.** Year 2: Objective 1a	
	Duration Proposed Months: 12	Duration Awarded Months: ________
PRINCIPAL INVESTIGATOR(S)/PROJECT DIRECTOR(S) David A. Smith	**FUNDS REQUESTED by PROPOSER**	**FUNDS APPROVED BY CSREES** (If Different)

	CSREES FUNDED WORK MONTHS			FUNDS REQUESTED by PROPOSER	FUNDS APPROVED BY CSREES (If Different)
A. Salaries and Wages 1. No. of Senior Personnel	Calendar	Academic	Summer		$
a. ___ (Co)-PI(s)/PD(s)					
b. ___ Senior Associates					
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates					
b. ___ Other Professional					
c. ___ Graduate Students					
d. ___ Prebaccalaureate Students					
e. ___ Secretarial-Clerical					
f. _1_ Technical, Shop and Other				$5,000	
Total Salaries and Wages . . . . →				$5,000	
B. Fringe Benefits (If charged as Direct Costs)					
C. Total Salaries, Wages, and Fringe Benefits (A plus B) . . . . →				$5,000	
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for **each** item.)					
E. Materials and Supplies				$5,000	
F. Travel 1. Domestic (Including Canada)				$250	
2. Foreign (List destination and amount for each trip.)					
G. Publication Costs/Page Charges					
H. Computer (ADPE) Costs					
I. All Other Direct Costs (Attach supporting data. List items and dollar amounts. Details of Subcontracts, including work statements and budget, should be explained in full in proposal.)					
J. Total Direct Costs (C through I) . . . . →				$10,250	
K. Indirect Costs If Applicable (Specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)					
L. Total Direct and Indirect Costs (J plus K) . . . . →				$10,250	
M. Other . . . . →					
N. Total Amount of This Request . . . . →				$10,250	$
O. Cost Sharing (If Required Provide Details)	$1,500				

NOTE: Signatures required only for Revised Budget — This is Revision No. →

NAME AND TITLE (Type or print)	**SIGNATURE**	**DATE**
Principal Investigator/Project Director		
Authorized Organizational Representative		

Form CSREES-55 (6/95)

BUDGET EXPLANATION FOR FRESHWATER FARMS OF OHIO

(Smith)

Objective 1a

A. **Salaries and Wages.** An aquaculture technician will assist with general fish husbandry, water quality monitoring, and fish sampling. The technician will also record and report data collected.

E. **Materials and Supplies.** Year 1: laboratory and water analysis chemicals ($500); culture supplies including fish nets, aeration supplies, tank cleaning supplies ($400); fish feed ($2,500); and data collection supplies including folders, notebooks, pens, paper ($100). Year 2: laboratory and water analysis chemicals ($500); culture supplies including fish nets, aeration supplies, tank cleaning supplies ($400); fish feed ($4,000); and data collection supplies including folders, notebooks, pens, paper ($100).

F. **Travel.** Annual costs: $250 for partial payment of registration, transportation, lodging, and meals for the PI to present the results of the study at a 3-day national aquaculture conference, destination to be determined.

NOTE: Freshwater Farms of Ohio, Inc. will only be asking for a portion of the total costs that will be incurred to conduct its portion of the project. Costs that are being requested to be covered are actual and do not include any mark-up or additional fees.

UNITED STATES DEPARTMENT OF AGRICULTURE
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OMB Approved 0524-0022
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BUDGET

ORGANIZATION AND ADDRESS School of Natural Resources University of Missouri-Columbia Columbia, MO 65211				**USDA AWARD NO.** Year 1: Objective 1b	
PRINCIPAL INVESTIGATOR(S)/PROJECT DIRECTOR(S) Robert S. Hayward				Duration Proposed Months: 12 **FUNDS REQUESTED by PROPOSER**	Duration Awarded Months: ________ **FUNDS APPROVED BY CSREES** (If Different)
A. Salaries and Wages	**CSREES FUNDED WORK MONTHS**				$
1. No. of Senior Personnel	Calendar	Academic	Summer		
a. ___ (Co)-PI(s)/PD(s)					
b. ___ Senior Associates					
2. No. of Other Personnel (Non-Faculty) a. 1 Research Associates-Postdoctorates	1.8			$3,600	
b. ___ Other Professional					
c. 1 Graduate Students				$2,500	
d. 1 Prebaccalaureate Students				$1,000	
e. ___ Secretarial-Clerical					
f. ___ Technical, Shop and Other					
Total Salaries and Wages →				$7,100	
B. Fringe Benefits (If charged as Direct Costs)				$900	
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$8,000	
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for **each** item.)					
E. Materials and Supplies				$2,500	
F. Travel 1. Domestic (Including Canada)				$1,500	
2. Foreign (List destination and amount for each trip.)					
G. Publication Costs/Page Charges					
H. Computer (ADPE) Costs					
I. All Other Direct Costs (Attach supporting data. List items and dollar amounts. Details of Subcontracts, including work statements and budget, should be explained in full in proposal.)					
J. Total Direct Costs (C through I) →				$12,000	
K. Indirect Costs If Applicable (Specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)					
L. Total Direct and Indirect Costs (J plus K) →				$12,000	
M. Other →					
N. Total Amount of This Request →				$12,000	$
O. Cost Sharing (If Required Provide Details)	$7,880				

NOTE: Signatures required only for Revised Budget — This is Revision No. →

NAME AND TITLE (Type or print)	**SIGNATURE**	**DATE**
Principal Investigator/Project Director		
Authorized Organizational Representative		

Form CSREES-55 (6/95)

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

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Expires 5/31/98

BUDGET

ORGANIZATION AND ADDRESS School of Natural Resources University of Missouri-Columbia Columbia, MO 65211				**USDA AWARD NO.** Year 2: Objective 1b	
PRINCIPAL INVESTIGATOR(S)/PROJECT DIRECTOR(S) Robert S. Hayward				Duration Proposed Months: 12 **FUNDS REQUESTED by PROPOSER**	Duration Awarded Months: ________ **FUNDS APPROVED BY CSREES** (If Different)
A. Salaries and Wages 1. No. of Senior Personnel	**CSREES FUNDED WORK MONTHS**				$
	Calendar	Academic	Summer		
a. ___ (Co)-PI(s)/PD(s)					
b. ___ Senior Associates					
2. No. of Other Personnel (Non-Faculty) a. 1 Research Associates-Postdoctorates	1.8			$3,600	
b. ___ Other Professional					
c. 1 Graduate Students				$2,500	
d. 1 Prebaccalaureate Students				$1,000	
e. ___ Secretarial-Clerical					
f. ___ Technical, Shop and Other					
Total Salaries and Wages . . . . →				$7,100	
B. Fringe Benefits (If charged as Direct Costs)				$900	
C. Total Salaries, Wages, and Fringe Benefits (A plus B) . . . . →				$8,000	
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for **each** item.)					
E. Materials and Supplies				$2,500	
F. Travel 1. Domestic (Including Canada)				$1,500	
2. Foreign (List destination and amount for each trip.)					
G. Publication Costs/Page Charges					
H. Computer (ADPE) Costs					
I. All Other Direct Costs (Attach supporting data. List items and dollar amounts. Details of Subcontracts, including work statements and budget, should be explained in full in proposal.)					
J. Total Direct Costs (C through I) . . . . →				$12,000	
K. Indirect Costs If Applicable (Specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)					
L. Total Direct and Indirect Costs (J plus K) . . . . →				$12,000	
M. Other . . . . →					
N. Total Amount of This Request . . . . →				$12,000	$
O. Cost Sharing (If Required Provide Details)	$8,030				

NOTE: Signatures required only for Revised Budget — This is Revision No. →

NAME AND TITLE (Type or print)	**SIGNATURE**	**DATE**
Principal Investigator/Project Director		
Authorized Organizational Representative		

Form CSREES-55 (6/95)

BUDGET EXPLANATION FOR THE UNIVERSITY OF MISSOURI-COLUMBIA

(Hayward)

Objective 1b

A. **Salaries and Wages.** A post-doctoral associate (0.15 FTE) will provide a portion of the supervision of this research as well as coordinate day-to-day activities. A graduate student (0.25 FTE) and an undergraduate research assistant (hourly wages) will carry out the majority of the sampling and field activites.

B. **Fringe Benefits.** Fringe benefits will be paid for the post-doctoral associate at the rate of 25%.

E. **Materials and Supplies.** Year 1: laboratory chemicals including hCG, MS-222, feed grade sodium chloride, water softener salt, and water analysis chemicals ($500); field supplies including fish nets, measuring boards, ice, plastic bags ($400); fish feed ($1,500); and general office supplies including paper, pens, notebooks, folders, and toner ($100). Year 2: laboratory chemicals including hCG, MS-222, feed grade sodium chloride, water softener salt, and water analysis chemicals ($500); field supplies including fish nets, measuring boards, ice, plastic bags ($400); fish feed ($1,500); and general office supplies including paper, pens, notebooks, folders, and toner ($100).

F. **Travel.** Annual costs: $750 for partial payment of registration, transportation, lodging, and meals for the PI and/or post-doctoral associate to present the results of the study at a 3-day national aquaculture conference, destination to be determined; $750 for partial payment of transportation between the campus of UMC at Columbia, Missouri and Flowers Aquaculture, Dexter, Missouri—total round-trip distance is 500 miles (20 trips @ $0.075/mile).

UNITED STATES DEPARTMENT OF AGRICULTURE
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OMB Approved 0524-0022
Expires 5/31/98

BUDGET

ORGANIZATION AND ADDRESS Board of Regents University of Wisconsin System 750 University Ave., Madison, WI 53706				**USDA AWARD NO.** Year 1: Objective 1b	
PRINCIPAL INVESTIGATOR(S)/PROJECT DIRECTOR(S) Jeffrey A. Malison				Duration Proposed Months: 12 **FUNDS REQUESTED by PROPOSER**	Duration Awarded Months: ________ **FUNDS APPROVED BY CSREES** (If Different)
A. Salaries and Wages	**CSREES FUNDED WORK MONTHS**				$
1. No. of Senior Personnel	Calendar	Academic	Summer		
a. ___ (Co)-PI(s)/PD(s)					
b. ___ Senior Associates					
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates					
b. 1 Other Professional	5.0			$14,000	
c. ___ Graduate Students					
d. ___ Prebaccalaureate Students					
e. ___ Secretarial-Clerical					
f. ___ Technical, Shop and Other					
Total Salaries and Wages . . . . →				$14,000	
B. Fringe Benefits (If charged as Direct Costs)				$4,550	
C. Total Salaries, Wages, and Fringe Benefits (A plus B) . . . . →				$18,550	
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for **each** item.)					
E. Materials and Supplies				$3,950	
F. Travel 1. Domestic (Including Canada)				$1,500	
2. Foreign (List destination and amount for each trip.)					
G. Publication Costs/Page Charges					
H. Computer (ADPE) Costs					
I. All Other Direct Costs (Attach supporting data. List items and dollar amounts. Details of Subcontracts, including work statements and budget, should be explained in full in proposal.)					
J. Total Direct Costs (C through I) . . . . →				$24,000	
K. Indirect Costs If Applicable (Specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)					
L. Total Direct and Indirect Costs (J plus K) . . . . →				$24,000	
M. Other . . . . →					
N. Total Amount of This Request . . . . →				$24,000	$
O. Cost Sharing (If Required Provide Details)	$18,722				

NOTE: Signatures required only for Revised Budget — This is Revision No. →

NAME AND TITLE (Type or print)	**SIGNATURE**	**DATE**
Principal Investigator/Project Director		
Authorized Organizational Representative		

Form CSREES-55 (6/95)

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0022
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BUDGET

ORGANIZATION AND ADDRESS
Board of Regents
University of Wisconsin System
750 University Ave., Madison, WI 53706

USDA AWARD NO. Year 2: Objective 1b

Duration Proposed Months: 12
Duration Awarded Months: ________

PRINCIPAL INVESTIGATOR(S)/PROJECT DIRECTOR(S)
Jeffrey A. Malison

	CSREES FUNDED WORK MONTHS: Calendar	Academic	Summer	FUNDS REQUESTED by PROPOSER	FUNDS APPROVED BY CSREES (If Different)
A. Salaries and Wages 1. No. of Senior Personnel					$
a. ___ (Co)-PI(s)/PD(s)					
b. ___ Senior Associates					
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates					
b. 1 Other Professional	5.0			$14,630	
c. ___ Graduate Students					
d. ___ Prebaccalaureate Students					
e. ___ Secretarial-Clerical					
f. ___ Technical, Shop and Other					
Total Salaries and Wages →				$14,630	
B. Fringe Benefits (If charged as Direct Costs)				$4,755	
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →				$19,385	
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for **each** item.)					
E. Materials and Supplies				$4,115	
F. Travel 1. Domestic (Including Canada)				$1,500	
2. Foreign (List destination and amount for each trip.)					
G. Publication Costs/Page Charges					
H. Computer (ADPE) Costs					
I. All Other Direct Costs (Attach supporting data. List items and dollar amounts. Details of Subcontracts, including work statements and budget, should be explained in full in proposal.)					
J. Total Direct Costs (C through I) →				$25,000	
K. Indirect Costs If Applicable (Specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)					
L. Total Direct and Indirect Costs (J plus K) →				$25,000	
M. Other →					
N. Total Amount of This Request →				$25,000	$
O. Cost Sharing (If Required Provide Details)	$19,570				

NOTE: Signatures required only for Revised Budget — This is Revision No. →

NAME AND TITLE (Type or print)	**SIGNATURE**	**DATE**
Principal Investigator/Project Director		
Authorized Organizational Representative		

Form CSREES-55 (6/95)

BUDGET EXPLANATION FOR UNIVERSITY OF WISCONSIN-MADISON

(Malison)

Objective 1b

A. Salaries. The salary of a research specialist is needed as shown to assist the PI with fish propagation and husbandry and analysis and publication of results.

B. Fringe Benefits. The UW-Madison benefits rate for technical staff is 32.5%

E. Supplies. Year 1: wet laboratory chemicals including hCG, MS-222, feed grade sodium chloride, water softener salt ($850); wet laboratory supplies including fish nets, airstones and aeration products, tank and drain cleaning chemicals and brushes, plastic bags ($1,800); fish feed ($850); and general office supplies including paper, pens, notebooks, folders, and toner ($450); Year 2: wet laboratory supplies including hCG, MS-222, feed grade sodium chloride, water softener salt ($850); wet laboratory supplies including fish nets, airstones and aeration products, tank and drain cleaning chemicals and brushes, plastic bags ($1,315); fish feed ($1,500); and general office supplies including paper, pens, notebooks, folders, and toner ($450).

F. Travel. Annual costs: $750 for partial payment of registration, transportation, lodging and meals for PI and/or research specialist to present the results of the study at a 3-day national aquaculture conference, destination to be determined; $750 for transportation for the PI and research specialist to travel from the campus at UW-Madison to Lake Mills State Fish Hatchery—total round trip distance is 60 (50 trips @ $0.25/mile).

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0022
Expires 5/31/98

BUDGET

ORGANIZATION AND ADDRESS Michigan State University - Upper Peninsula, 702 Chippewa Square, Marquette, MI 49855				**USDA AWARD NO.** Year 2: Objective 2	
PRINCIPAL INVESTIGATOR(S)/PROJECT DIRECTOR(S) Ronald E. Kinnunen				Duration Proposed Months: 12 **FUNDS REQUESTED by PROPOSER**	Duration Awarded Months: ________ **FUNDS APPROVED BY CSREES** (If Different)
A. Salaries and Wages	**CSREES FUNDED WORK MONTHS**				$
1. No. of Senior Personnel	Calendar	Academic	Summer		
a. ___ (Co)-PI(s)/PD(s)					
b. ___ Senior Associates					
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates					
b. ___ Other Professional					
c. ___ Graduate Students					
d. ___ Prebaccalaureate Students					
e. ___ Secretarial-Clerical					
f. ___ Technical, Shop and Other					
Total Salaries and Wages →					
B. Fringe Benefits (If charged as Direct Costs)					
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →					
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for **each** item.)					
E. Materials and Supplies					
F. Travel 1. Domestic (Including Canada)					
2. Foreign (List destination and amount for each trip.)					
G. Publication Costs/Page Charges					
H. Computer (ADPE) Costs					
I. All Other Direct Costs (Attach supporting data. List items and dollar amounts. Details of Subcontracts, including work statements and budget, should be explained in full in proposal.) Telephone ($20), Postage ($20), Photocopying ($35), Computer Services ($25)				$100	
J. Total Direct Costs (C through I) →				$100	
K. Indirect Costs If Applicable (Specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)					
L. Total Direct and Indirect Costs (J plus K) →				$100	
M. Other →					
N. Total Amount of This Request →				$100	$
O. Cost Sharing (If Required Provide Details)	$23,525				

NOTE: Signatures required only for Revised Budget — This is Revision No. →

NAME AND TITLE (Type or print)	**SIGNATURE**	**DATE**
Principal Investigator/Project Director		
Authorized Organizational Representative		

Form CSREES-55 (6/95)

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0022
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BUDGET

ORGANIZATION AND ADDRESS Michigan State University - Upper Peninsula 702 Chippewa Square Marquette, MI 49855	**USDA AWARD NO.** Year 3: Objective 2	
	Duration Proposed Months: 12	Duration Awarded Months: ________
PRINCIPAL INVESTIGATOR(S)/PROJECT DIRECTOR(S) Ronald E. Kinnunen	**FUNDS REQUESTED by PROPOSER**	**FUNDS APPROVED BY CSREES** (If Different)

	CSREES FUNDED WORK MONTHS				
A. Salaries and Wages	Calendar	Academic	Summer		$
1. No. of Senior Personnel					
a. ___ (Co)-PI(s)/PD(s)					
b. ___ Senior Associates					
2. No. of Other Personnel (Non-Faculty) a. ___ Research Associates-Postdoctorates					
b. ___ Other Professional					
c. ___ Graduate Students					
d. ___ Prebaccalaureate Students					
e. ___ Secretarial-Clerical					
f. ___ Technical, Shop and Other					
Total Salaries and Wages . . . . →					

B. Fringe Benefits (If charged as Direct Costs)		
C. Total Salaries, Wages, and Fringe Benefits (A plus B) . . . . →		
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for **each** item.)		
E. Materials and Supplies		
F. Travel 1. Domestic (Including Canada)	$5,600	
2. Foreign (List destination and amount for each trip.)		
G. Publication Costs/Page Charges		
H. Computer (ADPE) Costs		
I. All Other Direct Costs (Attach supporting data. List items and dollar amounts. Details of Subcontracts, including work statements and budget, should be explained in full in proposal.) Telephone ($50), Postage ($100), Photocopying ($100), Computer Services ($50)	$300	
J. Total Direct Costs (C through I) . . . . →	$5,900	
K. Indirect Costs If Applicable (Specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)		
L. Total Direct and Indirect Costs (J plus K) . . . . →	$5,900	
M. Other . . . . →		
N. Total Amount of This Request . . . . →	$5,900	$
O. Cost Sharing (If Required Provide Details) $25,475		

NOTE: Signatures required only for Revised Budget   This is Revision No. →

NAME AND TITLE (Type or print)	**SIGNATURE**	**DATE**
Principal Investigator/Project Director		
Authorized Organizational Representative		

Form CSREES-55 (6/95)

BUDGET EXPLANATION FOR MICHIGAN STATE UNIVERSITY

(Kinnunen)

Objective 2

F. Travel. Year 3: $4,200 for partial payment of transportation, lodging, and meals for the Hybrid Walleye Work Group researchers (Dabrowski, Hayward, Malison) to present their research results at two producer workshops in the region, locations to be determined ($700 each); $1,400 for partial payment of transportation, lodging, and meals for PI to coordinate and attend both workshops, locations to be determined.

I. All Other Direct Costs. Year 2: Telephone ($20), Postage ($20), Photocopying ($35), and Computer Services ($25); Year 3: Telephone ($50), Postage ($100), Photocopying ($100), and Computer Services ($50).

BUDGET SUMMARY FOR EACH PARTICIPATING INSTITUTION

Year 1

	OSU	FFO	UMC	UW-M	MSU	TOTALS
Salaries and Wages	$12,272	$5,000	$7,100	$14,000		$38,372
Fringe Benefits	$2,908	$0	$900	$4,550		$8,358
Total Salaries, Wages, and Fringe Benefits	$15,180	$5,000	$8,000	$18,550		$46,730
Nonexpendable Equipment	$0	$0	$0	$0		$0
Materials and Supplies	$2,320	$3,500	$2,500	$3,950		$12,270
Travel	$1,500	$250	$1,500	$1,500		$4,750
All Other Direct Costs	$0	$0	$0	$0		$0
TOTAL PROJECT COSTS	**$19,000**	**$8,750**	**$12,000**	**$24,000**		**$63,750**

Year 2

	OSU	FFO	UMC	UW-M	MSU	TOTALS
Salaries and Wages	$6,136	$5,000	$7,100	$14,630	$0	$32,866
Fringe Benefits	$1,454	$0	$900	$4,755	$0	$7,109
Total Salaries, Wages, and Fringe Benefits	$7,590	$5,000	$8,000	$19,385	$0	$39,975
Nonexpendable Equipment	$0	$0	$0	$0	$0	$0
Materials and Supplies	$1,410	$5,000	$2,500	$4,115	$0	$13,025
Travel	$1,000	$250	$1,500	$1,500	$0	$4,250
All Other Direct Costs	$0	$0	$0	$0	$100	$100
TOTAL PROJECT COSTS	**$10,000**	**$10,250**	**$12,000**	**$25,000**	**$100**	**$57,350**

Year 3

	OSU	FFO	UMC	UW-M	MSU	TOTALS
Salaries and Wages					$0	$0
Fringe Benefits					$0	$0
Total Salaries, Wages, and Fringe Benefits					$0	$0
Nonexpendable Equipment					$0	$0
Materials and Supplies					$0	$0
Travel					$5,600	$5,600
All Other Direct Costs					$300	$300
TOTAL PROJECT COSTS					**$5,900**	**$5,900**

RESOURCE COMMITMENT FROM INSTITUTIONS[1]

Institution	Year 1	Year 2	Year 3
Ohio State University			
Salaries and Benefits: SY @ 0.05 FTE	$6,425	$6,655	
Supplies and Waiver of Overhead	$7,500	$8,500	
Piketon Research and Extension Center Facilities and Utilities	$4,500	$5,500	
Total	$18,425	$20,655	
Freshwater Farms of Ohio, Inc.			
Supplies (Feed)	$750	$1,500	
Total	$750	$1,500	
University of Missouri-Columbia			
Salaries and Benefits: SY @ 0.20 FTE	$3,100	$3,175	
Supplies, Expenses, Equipment and Waiver of Overhead	$4,780	$4,855	
Total	$7,880	$8,030	
University of Wisconsin-Madison			
Salaries and Benefits: SY @ 0.08 FTE	$6,042	$6,344	
Salaries and Benefits: TY @ 0.04 FTE	$2,120	$2,226	
Supplies, Expenses, Equipment and Waiver of Overhead	$10,560	$11,000	
Total	$18,722	$19,570	
Michigan State University			
Salaries and Benefits: 1 SY @ 0.20 FTE each		$13,000	$13,200
Salaries and Benefits: 1 SY @ 0.10 FTE each		$10,500	$10,800
Supplies, Expenses, Equipment and Waiver of Overhead		$25	$1,475
Total		$23,525	$25,475
Total per Year	$45,777	$73,280	$25,475
GRAND TOTAL		**$144,532**	

[1]Because cost sharing is not a legal requirement, universities are not required to provide or maintain documentation of such a commitment.

SCHEDULE FOR COMPLETION OF OBJECTIVES

Objective 1a: Initiated in Year 1 and completed in Year 2.

Objective 1b: Initiated in Year 1 and completed in Year 2.

Objective 2: Initiated in Year 2 and completed in Year 3.

LIST OF PRINCIPAL INVESTIGATORS

Konrad Dabrowski, Ohio State University

Robert S. Hayward, University of Missouri-Columbia

Ronald E. Kinnunen, Michigan State University

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EDUCATION

M.S. Agriculture and Technical University, Olsztyn, Poland, 1972
Ph.D. Agriculture and Technical University, Olsztyn, Poland, 1976
D.Sc. Agricultural University, Szczecin, Poland, 1984

POSITIONS

Professor (1989-present), School of Natural Resources, Ohio State University
Visiting Professor (1987-1989), University of Innsbruck, Innsbruck, Austria
Visiting Professor (1984-1985), Tokyo University of Fisheries, Tokyo, Japan
Associate Professor (1972-1987), Agriculture and Technical University, Olsztyn, Poland

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

Editorial Board Member for Aquaculture and Aquatic Living Resources
Fisheries Society of British Isles
Japanese Fisheries Society
National Research Council, Washington, Subcommittee on Fish Nutrition (1990-1992)
World Aquaculture Society

SELECTED PUBLICATIONS

Moreau, R., and K. Dabrowski. 1998. Ascorbic acid synthesis in sea-lamprey: the evolutionary perspective into vertebrate reproduction. Proceedings of the National Academy of Science USA 95:10279-10282.

Honeyfield, D.C., J.G. Hnath, J. Copeland, K. Dabrowski, and J.H. Bloom. 1998. Thiamine ascorbic acid and environmental contaminants in Lake Michigan coho salmon displaying early mortality syndrome. American Fisheries Society Symposium 21:135-145.

Petroff, B.K., R.E. Ciereszko, K. Dabrowski, A.C. Ottobre, W.F. Pope, and J.S. Ottobre. 1998. Prostagladin F_2 depletes luteal vitamin C by inducing secretion of the vitamin from porcine corpora lutea. Journal of Reproductive Fertility 112:243-247.

Lin, F., and K. Dabrowski. 1998. Androgenesis and homozygous gynogenesis in *Esox masquinongy*: Evaluation using flow cytometry. Molecular Reproduction and Development 49:10-18.

Ciereszko, A., L. Li, and K. Dabrowski. 1998. Optimal conditions for determination of aspartate aminotransferase activity in rainbow trout and whitefish. Journal of Applied Ichthyology 14:57-63.

Kolkovski, S., and K. Dabrowski. 1998. Off-season spawning of yellow perch. Progressive Fish-Culturist 60:133-136.

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EDUCATION

B.S. Cornell University, 1977
M.S. Tennessee Technological University, 1980
Ph.D. Ohio State University, 1988

POSITIONS

Associate Professor (1995-present), and Assistant Professor (1988-1995), Fisheries and Wildlife, University of Missouri
Aquatic Ecologist (1985-1987), Battelle Memorial Institute
Research Associate (1980-1984), Aquatic Ecology Program, Ohio State University

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

American Fisheries Society (Aquaculture, Physiology, Reservoir Fisheries, Education technical committees)
American Institute of Fishery Research Biologists
Missouri Chapter of American Fisheries Society

SELECTED PUBLICATIONS

Wang, N., R.S. Hayward, and D.B. Noltie. In press. Variation in food consumption, growth, and growth efficiency among juvenile hybrid sunfish held in isolation. Aquaculture.

Wang, N., R.S. Hayward, and D.B. Noltie. In press. Effect of feeding frequency on food consumption, growth, size variation, and feeding pattern of age-0 hybrid sunfish. Aquaculture.

Zweifel, R.D., R.S. Hayward, and C.F. Rabeni. In press. A bioenergetics evaluation of black bass distributions in Ozark Border region streams. North American Journal of Fisheries Management.

Whitledge, G.W., R.S. Hayward, D.B. Noltie, and N. Wang. In press. Testing bioenergetics model predictions of fish growth and food consumption under feeding regimes that elicit compensatory growth. Transactions of the American Fisheries Society.

Hayward, R.S., and M.A. Weiland. 1998. Gastric evacuation rates and maximum daily rations of rainbow trout fed chironomid larvae at 7.8, 10 and 12.8°C. Environmental Biology of Fishes 51:321-330.

Whitledge, G.W., and R.S. Hayward. 1997. Laboratory evaluation of a bioenergetics model for largemouth bass at two temperatures and feeding levels. Transactions of the American Fisheries Society 126:1030-1035.

Weiland, M.A., and R.S. Hayward. 1997. Cause for the decline of large rainbow trout in a tailwater fishery: too much putting or too much taking? Transactions of the American Fisheries Society 126:758-773.

Hayward, R.S., D.B. Noltie, and N. Wang. 1997. Use of compensatory growth to double hybrid sunfish growth rates. Transactions of the American Fisheries Society 126:316-322.

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EDUCATION

B.S. Michigan State University, 1976
M.S. Michigan State University, 1979
Ph.D. Michigan Technological University, 1997

POSITIONS

Michigan Sea Grant Extension Agent (1981-present), Upper Peninsula, Michigan State University
Acting Alger County Extension Director (1988-1989), Michigan State University Cooperative Extension Service
Fisheries Pathologist (1981), Rangen Research Laboratory, Hagerman, Idaho
Fisheries Biologist (1979-80), U.S. Fish and Wildlife Service, Leetown, West Virginia

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

American Fisheries Society, Fish Health Section
Michigan Association of Extension Agents
National Association of Extension Agents
Sea Grant Advisory Service Association

SELECTED PUBLICATIONS

Kinnunen, R.E. 1996. Walleye fingerling culture in undrainable ponds. Pages 135-145 *in* R.C. Summerfelt, editor, Walleye culture manual. NCRAC Culture Series #101, NCRAC Publications Office, Iowa State University, Ames.

Kinnunen, R.E., and J.D. Schwartz. 1994. A comparison of the Escanaba 1988 and 1992 transient boater marketing and economics surveys. Michigan Sea Grant College Program (MICHU-SG-94-205).

Kinnunen, R.E., and J.D. Schwartz. 1994. Upper Peninsula of Michigan Lake Superior 1992 transient boater marketing and economics survey. Michigan Sea Grant College Program (MICHU-SG-94-204).

Burton, T.M., M.J. O'Malley, and R.E. Kinnunen. 1992. Shakey Lakes association strives for solution to aquatic weed problem. The Michigan Riparian November 1992:7-9, 22.

Kinnunen, R.E. 1992. North Central Region 1990 salmonid egg and fingerling purchases, production, and sales. NCRAC Technical Bulletin Series #103. North Central Regional Aquaculture Center Publications Office, Iowa State University, Ames.

Kinnunen, R.E., and E.M. Mahoney. 1989. 1987 Upper Michigan charter fishing study. Michigan Sea Grant College Program (MICHU-SG-89-501).

Kinnunen, R., J. Lempke, and T. Sundstrom. 1987. Behavior patterns of divers visiting the Alger Underwater Preserve. Michigan Sea Grant College Program (MICHU-SG-87-505).

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EDUCATION

B.S. University of Wisconsin-Stevens Point, 1976
M.S. University of Wisconsin-Madison, 1980
Ph.D. University of Wisconsin-Madison, 1985

POSITIONS

Director (1995-present), Assistant Director (1990-1995), and Associate Researcher (1987-1990), University of Wisconsin Aquaculture Program, University of Wisconsin-Madison

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

American Association for the Advancement of Sciences
American Fisheries Society
Wisconsin Aquaculture Industry Advisory Council
Wisconsin Aquaculture Association
World Aquaculture Society

SELECTED PUBLICATIONS

Malison, J.A., L.S. Procarione, T.B. Kayes, J.F. Hansen, and J.A. Held. 1998. Induction of out-of-season spawning in walleye (*Stizostedion vitreum*). Aquaculture 163:151-161.

Malison, J.A., J.A. Held, L.S. Procarione, and M.A.R. Garcia-Abiado. 1998. The production of monosex female populations of walleye (*Stizostedion vitreum*) using intersex broodstock. Progressive Fish-Culturist 60:20-24.

DiStefano, R.J., T.P. Barry, and J.A. Malison. 1997. Correlation of blood parameters with reproductive problems in walleye in a Missouri Impoundment. Journal of Aquatic Animal Health 9:223-229.

Malison, J.A., and J.A. Held. 1996. Reproduction and spawning in walleye. Journal of Applied Ichthyology 12:153-156.

Malison, J.A., and M.A.R. Garcia-Abiado. 1996. Sex control and ploidy manipulations in yellow perch (*Perca flavescens*) and walleye (*Stizostedion vitreum*). Journal of Applied Ichthyology 12:189-194.

Malison, J.A., and J.A. Held. 1996. Habituating pond-reared fingerlings to formulated feed. Pages 199-204 *in* R.C. Summerfelt, editor. Walleye culture manual. NCRAC Culture Series #101, NCRAC Publications Office, Iowa State University, Ames.

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EDUCATION

B.S. Ohio State University, 1976
M.S. Louisiana State University, 1979
Ph.D. University of Wisconsin-Madison, 1987

POSITIONS

President and Founder (1983-present), Freshwater Farms of Ohio, Inc.
Research Director (1986-present), WaterSmith Systems
Chairman (1989-1996) and Representative to Interregional Waste Management Initiative (1992), Industry Advisory Council, North Central Regional Aquaculture Center, U.S. Department of Agriculture
Aquaculture Industry Representative, Board of Directors (1989-1996), North Central Regional Aquaculture Center, U.S. Department of Agriculture
National Aquaculture Representative (1991, 1992, 1994), U. S. Department of Agriculture Regional Aquaculture Centers
By-law Committee Member (1989-1990), Ohio Aquaculture Task Force, Ohio State University
President (1990-1997) and Ohio Representative to North Central Regional Aquaculture Center (1988-present), Ohio Aquaculture Association
Aquaculture Legislative Task Force (1993-1995), Ohio Department of Agriculture
Aquaculture Commodity Representative (1997-present), Ohio Farm Bureau
Liaison Committee (1992-present), Piketon Research & Extension Center, Ohio State University
Aquaculture Program Advisory Committee (1997-present), Ohio State University
Aquatic Nuisance Species Advisory Committee (1997-present), Ohio Department of Natural Resources, Division of Wildlife

SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS

World Aquaculture Society