PROJECT TITLE: Accelerating plans for the integrated control of the common carp

Project Manager: Peter W. Sorensen
Co-manager: Przemyslaw G. Bajer
Affiliation: University of Minnesota
Mailing Address: 1980 Folwell Ave.
City / State / Zip: St. Paul, MN 55108
Telephone Number: 612-624-4997
E-mail Address: soren003@umn.edu
Web Page address: http://fwcb.cfans.umn.edu/personnel/faculty/sorensen/
Funding Source: Environment and Natural Resources Trust Fund
Legal Citation: ML 2008, [Chap. 367], Sec.[2], Subd.4
Appropriation amount: $550,000

Overall Project Outcome and Results

The common carp (*Cyprinus carpio*) was introduced to Minnesota in the late 1800s and quickly came to dominate the fish communities in the south-central portion of the state where it is now responsible for poor water quality and greatly reduced duck habitat. Our previous Environment and Natural Resources Trust Fund (ENRTF) funded projects from appropriations in 2003 and 2005 had suggested that recruitment (survival of fertilized eggs to adulthood) might be a key weakness in the life history of the carp and that predatory fish, odors, or sounds might be used to control recruitment. This project investigated these possibilities in six studies '(results'):

1. For the first, we monitored the fate of carp eggs and larvae in both the field and lab to determine if predators might be eating them. We discovered that bluegill sunfish, a native game-fish, consume large numbers of carp eggs and larvae.
2. For result 2 we examined correlations between the abundance of young-of-the-year (YOY) carp and predatory game-fish across two dozen lakes using trap-net surveys. We discovered the YOY carp are rarely found in lakes that have bluegills, suggesting that bluegills control carp in lakes.
3. A third study examined the age structure of several populations of adult carp. It found that YOY carp only recruit in years and places where winter oxygen levels are low enough to kill bluegills.
4. A fourth study examined whether food odors might be used to enhance capture rates of YOY carp. While, we found evidence that certain baits are attractive in the lab, field results were variable and application appeared impractical.
5. A fifth study examined pheromones for use in YOY removal and came to a similar conclusion.
6. Lastly, we examined whether air-bubble curtains have potential to reduce the movement of YOY carps from nursery areas by producing sound. These results were promising.

In summary, this project provided compelling evidence that populations of invasive carp can be controlled by promoting the abundance of native predators and controlling movement using bubble barriers.

Project Results and Dissemination

The results of this project are presently being implemented by the Riley Purgatory Bluff Creek Watershed District and the Ramsey Washington Metro Watershed District. Both watersheds report that carp densities are reduced and under control while water quality has improved. The barrier bubble developed here is now being developed further by another ENRTF project. This work has been described in 6 peer-reviewed publications (with more in review), over a dozen scientific meetings, a dozen agency meetings and in at least 6 press and TV reports.

Environmental and Natural Resources Trust Fund 2008 Work Program Final Report

Date of Report: August 31, 2011
Final Report
Date of Work Program Approval: June 10, 2008
Project Completion Date: June 30, 2011

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E-mail Address: soren003@umn.edu
FAX Number: 612-625-5299
Web Page address: http://fwcb.cfans.umn.edu/personnel/faculty/sorensen/

Total Trust Fund Project Budget:	**Trust Fund Appropriation:**	**$550,000**
	Minus Amount Spent:	**$495,773**
	Equal Balance:	**$54,227**

Legal Citation: ML 2008, [Chap. 367], Sec.[2], Subd.4

Appropriation Language:
$550,000 is from the trust fund to the board of regents of the University of Minnesota to accelerate research on new approaches to control the invasive common carp. This appropriation is available until June 30,2011, at which time the project must be completed and final products delivered, unless an earlier date is specified in the work program.

II. and III. FINAL PROJECT SUMMARY

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IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: To determine if predation by native gamefish on carp eggs, larvae and fry can potentially be used to control carp recruitment in lake enclosures.

Introduction: The goal of this experiment was to evaluate the possibility that predatory game-fish can be managed to control the survival of carp eggs and larvae. Several experiments were conducted in both field and lab with very positive results.

Methods & Results- field: Three field experiments were conducted to test the possibility carp recruitment is controlled by native fishes. In our initial experiment (2009), we located carp spawning areas in a lake that did not winterkill and had a healthy game-fish population (Lake Keller), and another lake which winterkilled and did not (Lake Casey), and then monitored the fate of carp eggs while monitoring the

stomach contents of game-fish in this region. We discovered that carp eggs disappeared within just two days of being spawned in Lake Keller (i.e. they did not survive to hatching) but survived for at least 5 days (until hatching) in Lake Casey (Fig. 1.1). Further, many bluegill sunfish were captured and they had an average of 17.2 eggs in the stomachs. In a second field experiment (2010), eggs were collected from spawning carp and placed into the same two lakes either directly, or after being placed into coarse mesh bags (which kept fish away from the eggs), or a fine mesh bags which kept both invertebrates and fish away from the eggs. We discovered that unprotected eggs disappeared rapidly from the lake with bluegill sunfish (and other game-fish) but did not disappear from the lake that lacked predatory fish. Further, eggs survived to hatching if they were protected by mesh from fish predation (Fig. 1.2). A third field study (2011) constructed 8 enclosures in two lakes (4 per lake) and added carp eggs to all of them along with bluegills or no other fish In this still ongoing experiment, young carp are found in the enclosures that lack bluegills but not the enclosure with bluegills (data not shown).

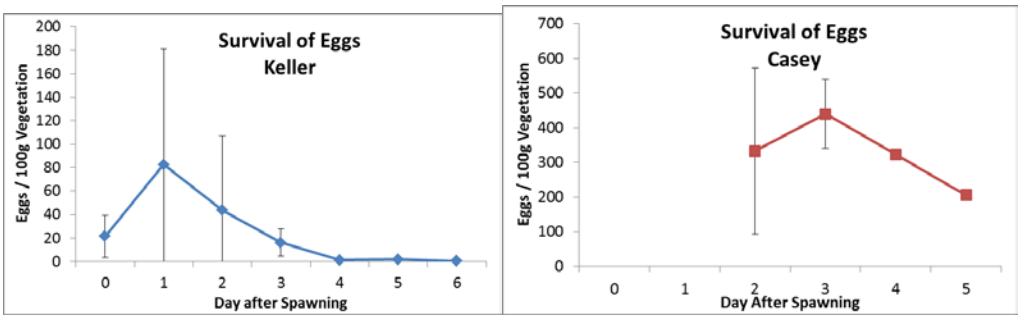

Fig. 1.1. Survival of carp eggs spawned in a 'normoxic' lake (ie. a lake that did not winterkill) and a 'hypoxic' lake (i.e. a lake that winterkilled).

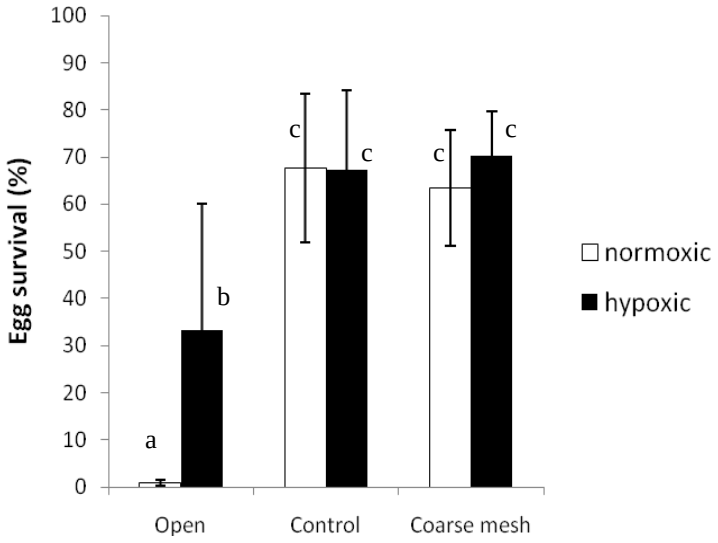

Fig. 1.2. Survival of carp eggs placed into normoxic and hypoxic lakes. Eggs were either unprotected, held in coarse mesh bags (to exclude fish), or held in fine mesh bags (to exclude invertebrates). Different letters indicate statistical differences

Methods & Results- lab: Two laboratory experiments were conducted to further test the rates at which bluegill sunfish consume carp eggs. In the first experiment, carp eggs were placed into tanks with bluegill sunfish and predation on eggs closely monitored. Eggs disappeared within a day (data not shown). In the second experiment, carp eggs were hatched and the larvae added to large tanks which either had bluegill sunfish, bullhead catfish, or no fish. Larvae did not survive more than 12 hours when present with sunfish while survival was noted in the other treatments (Fig. 1.3).

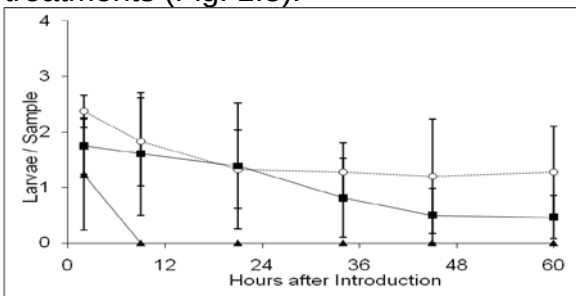

Fig. 1.3. Survivorship of carp larvae in tanks containing bluegill sunfish (triangles), catfish (squares) or no fish (circles; controls).

Summary: These experiments conclusively demonstrated that bluegill sunfish consume very large numbers of carp eggs and larvae in both the lab and field, suggesting they function as a natural control mechanism. These results are now found in a thesis manuscript and have also been submitted as a manuscript to the journal *Ecology*.

Result 2: To determine if the abundance of young-of-the-year (YOY) carp is inversely correlated with predator abundance in nursery areas following winterkills.

Introduction: This study assessed the possibility that game-fish might control carp recruitment in the field by determining whether the abundance of carp YOY recruits is naturally correlated with natural fluctuations in game-fish abundance. The alternative hypothesis that planktonic food for larval carp might explain the abundance of YOY carp in the field was examined at the same time.

Methods & Results: In the first component of this study, two dozen lakes were selected for monitoring based on whether or not they experienced winterkill, had adult carp, and could be trap-netted for sampling young fishes. A yearly sampling program then sampled each lake for oxygen to determine if it winterkilled and then the following summer sampled it for young fish by setting trap-nets. Plankton samples were taken at the same time in a subset of these lakes. This experiment showed a strong negative correlation between the presence of YOY carp and bluegill sunfish (Fig. 2.1). YOY carp were never found in the presence of bluegill

sunfish (Fig. 2.2). Analysis of plankton data showed that food supply did not always limit YOY carp survival (ex. Lake Keller had more planktonic food for YOY fishes than Lake Casey but far fewer carp). An AIC model confirmed that the presence of sunfish could be best predicted by winter oxygen levels.

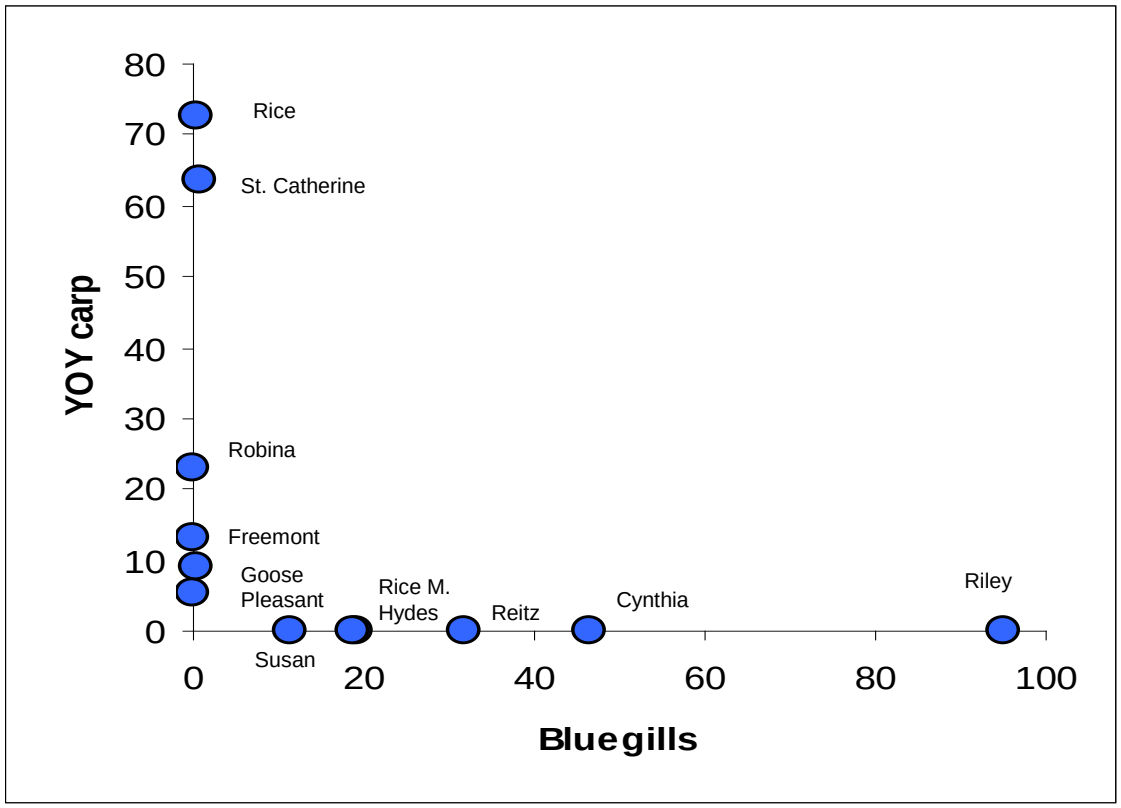

Fig. 2.1 The abundance of young-of-year (YOY) common carp versus the abundance of bluegill sunfish in our study lakes. Six lakes (Lakes Rice, St. Catherine, Robin, Freemont, Goose, and Pleasant) experienced at least a partial winterkill.

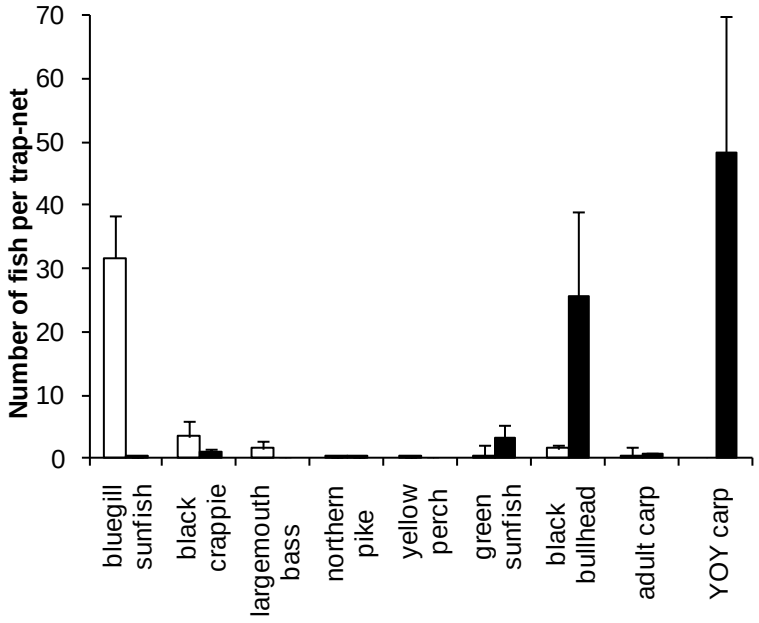

Fig. 2.2. Relative abundance of young-of-year common carp (YOY carp) and native fishes in normoxic (open bars) and hypoxic (filled bars) lakes. Error bars represent one standard error. Figures 2-1 and 2-2 share the same data.

Summary: The distribution of YOY carp across several dozen Minnesota lakes strongly supports the possibility that it is driven by the abundance of bluegill sunfish, which in turn is driven by winter oxygen. These results are described in manuscript sent to the journal *Ecology*.

Result 3: Determine whether carp age structure correlates with winterkill events.

Introduction: The goal of this experiment was to conduct a third independent test of our hypothesis that winterkill-driven declines in predatory fish trigger carp recruitment by examining the age structure of common carp populations in three lakes and correlating them with documented winterkills in those systems.

Methods and results: Three study lakes were selected in consultation with the DNR based on whether they either did (or did not) experience winterkill in the past 20 years (Lake Fremont, Lake Lucy, Upper Basin in Lake Kohlman Chain). Populations of 100 carp were sampled from each chain and their otoliths removed for aging. Lake Fremont, which has frequent and dramatic winterkills had two classes of carp that precisely coincided with winterkill events (Fig. 3.1) while the other two lakes, which do not experience winterkill, had smaller and more age classes (Fig. 3.2).

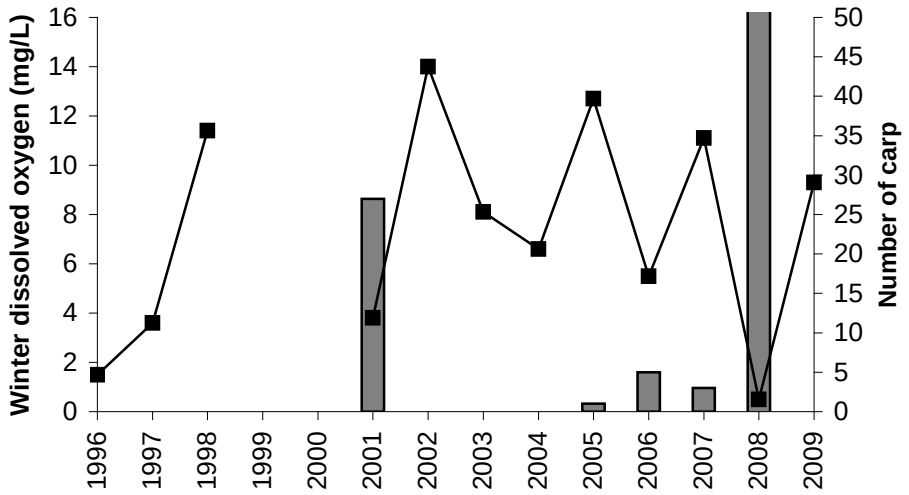

Fig. 3.1. The age structure of the population of carp in Lake Freemont and winter dissolved oxygen levels. Winter dissolved oxygen was not measured in 1999 and 2000 as these winters were relatively mild.

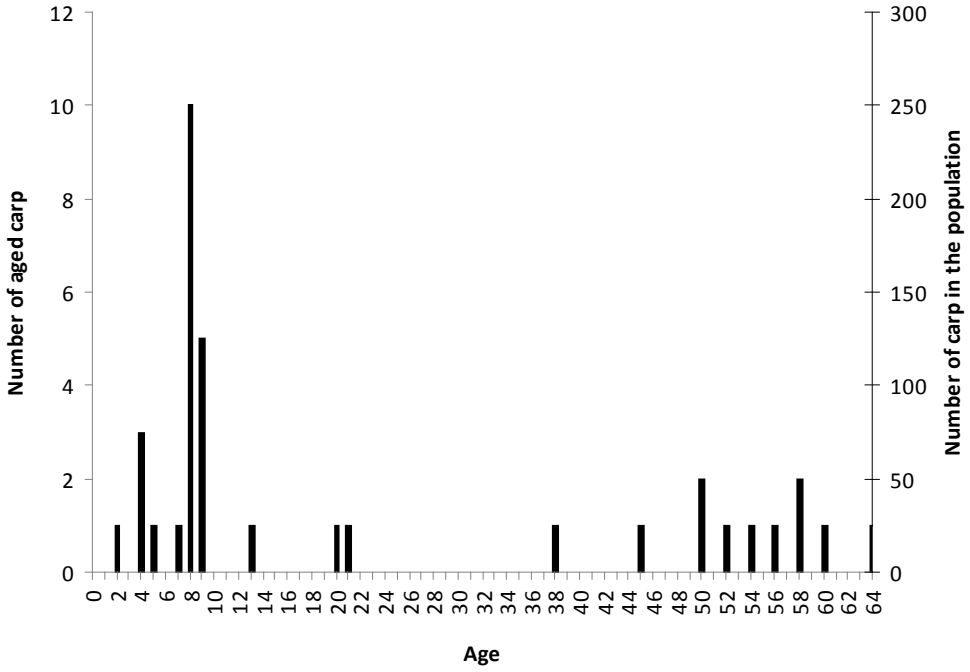

Fig. 3.2. Age structure of carp in Lake Lucy. No winterkill was noted during this period.

Summary: Winterkill, which is well known to reduce the abundance of bluegill sunfish (result 2 and Bajer and Sorensen (2010)), is highly correlated with recruitment of YOY carp. Likely winterkill acts by reducing the density of bluegill sunfish in inter-connected lakes.

Result 4: To determine if young-of-the-year (YOY) carp can be effectively trapped for census and/or removal using bait attractants.

Introduction: Integrated pest management (IPM) of carp will require excellent tools to both monitor the abundance and distribution of YOY carp and remove them when/as necessary. Odors (food and pheromones [Result 5]) and sound [Result 6] have potential given the sensitivity of young carp to these stimuli and the ease with which they can be applied. This objective sought to test whether and how food baits might be used as attractants for YOY carp. Both lab and field experiments were conducted.

Methods & Results-lab: Several sets of experiments were conducted. First, we determined what time of day carp might be most sensitive to food cues as knowing this could facilitate field trapping. YOY carp were held in 70 l aquaria into which food pellets were dropped at random while the aquaria were being observed and food-search behaviors noted. These experiments found that YOY carp are nocturnal (Fig. 4.1). Another set of laboratory experiments showed that flow appeared to enhance attraction to food (both corn and pellets, data not shown). Finally, we analyzed the amino acid composition of these food items and found them to be complex (Fig. 4.2).

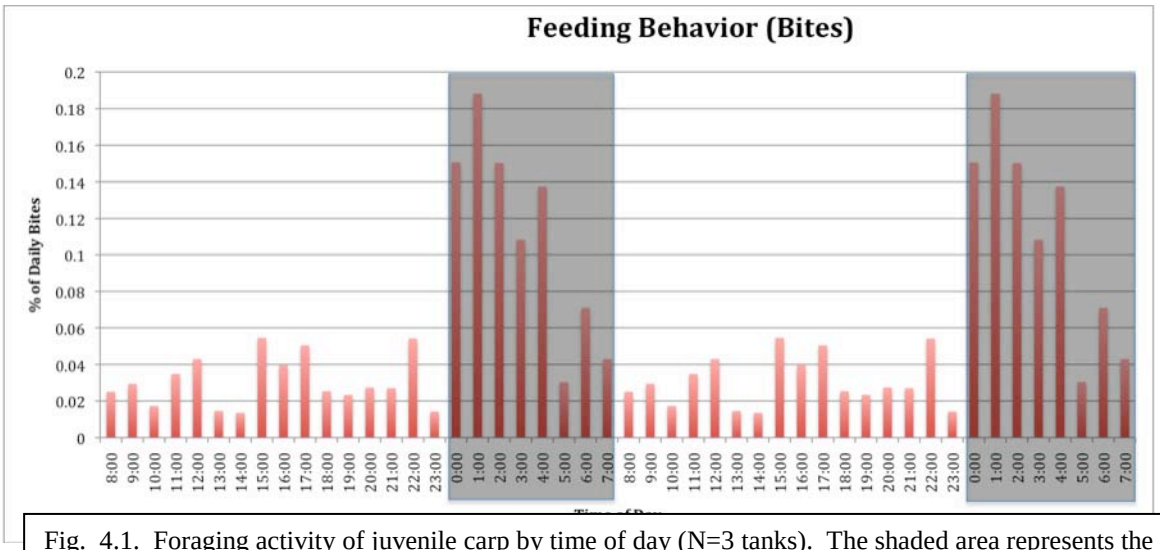

Fig. 4.1. Foraging activity of juvenile carp by time of day (N=3 tanks). The shaded area represents the scotophase (periods of darkness - lights-off; 23:30h-07:30h).

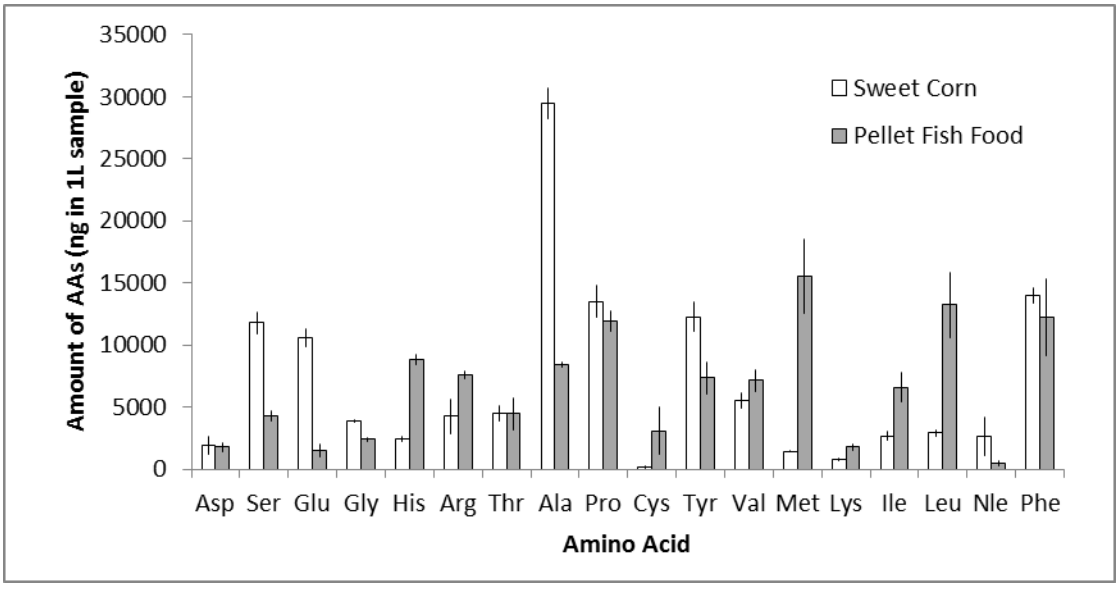

Fig. 4.2. Amino acid composition of two different carp foods.

Methods & Results- field: Having established when best to attract carp, we next conducted a field experiment in a carp nursery lake to test odor and flow. Specially designed traps were set into Lake Markham and Lake St. Catherine and battery

operated pumps used to add various food odors. While these experiments suggested that baited traps tended to catch more YOY carp than non-baited traps and that flow enhanced capture rates, the results were not significant and high by-catch of other species (bullhead catfish in particular), confounded the results (Fig. 4.2).

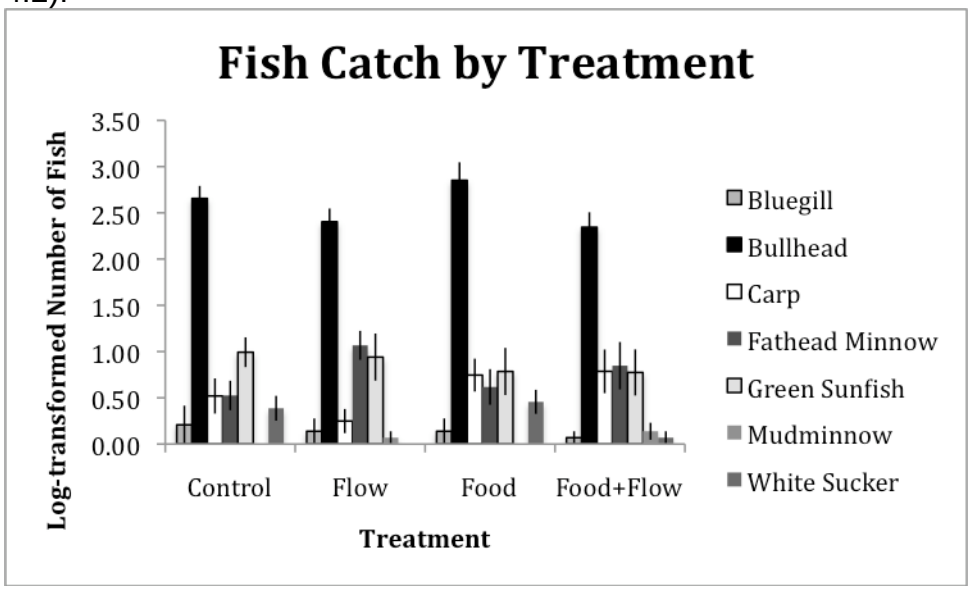

Fig. 4-2. Nightly catch rates (mean +/- standard error) of fishes in our 4 trap types in Lake St. Catherine.

Two more field experiments were conducted in two more lakes with similarly variable results. In one experiment we found that we could attract YOY carp to pelleted bait in Lake Markham without using flow (Fig 4.3) while a third experiment in Lake Casey found that YOY carp were not captured in any traps in spite of the presence of bait. Electro-fishing confirmed YOY carp were present and we surmised that adult fish were probably interfering with capture rates.

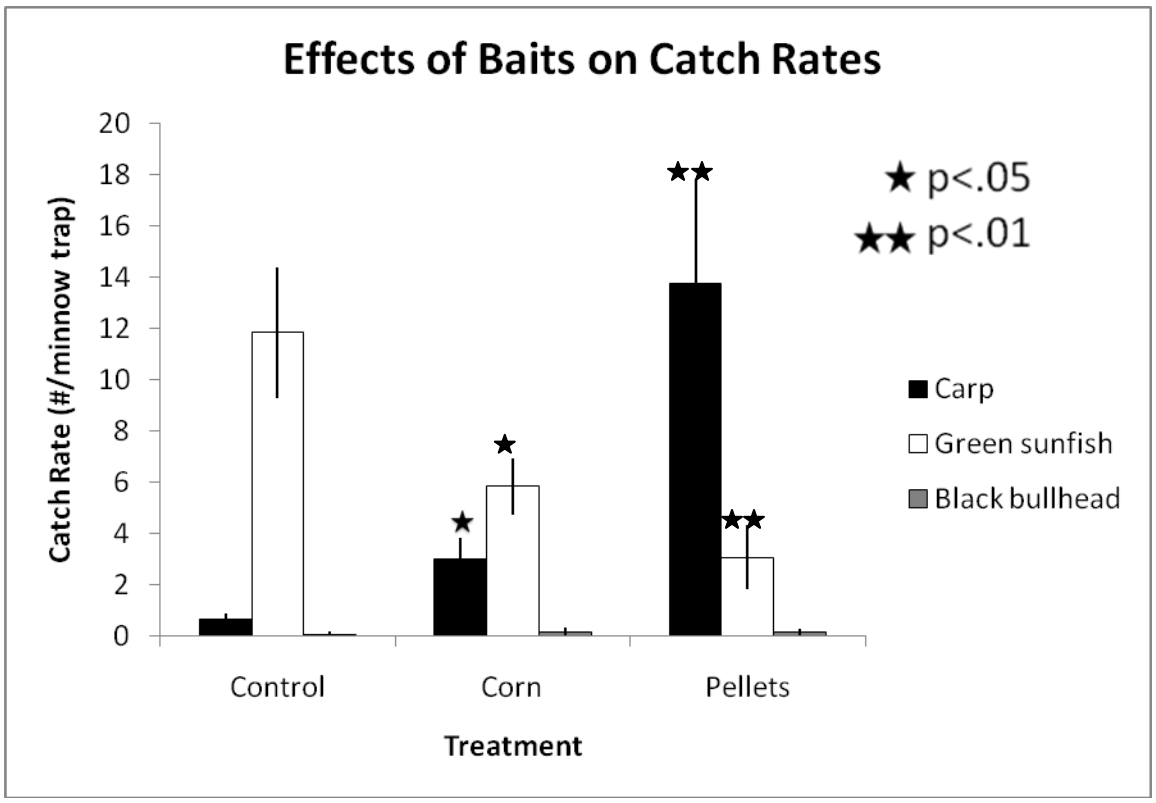

Fig. 4-3. Catch rates (mean +/- standard error) of carp and other fishes in minnow traps baited with canned sweet corn, commercial pellet fish food, and a blank control in Lake Markham.

Summary. Food odors can attract YOY carp but their utility in the field is limited and greatly complicated by local factors including the presence of other fish and hunger. Unbaited trap-nets are much easier to use and nearly as effective.

Result 5*:* To determine if young-of-the-year (YOY) carp can be effectively trapped for census and/or removal using pheromonal attractants.

Introduction: This study asked whether pheromones (chemical signals that pass between members of the same species) might have potential for use as attractants for censusing and removing carp. This class of stimuli has the potential advantage of being highly specific and thus might not be plagued by the by-catch issues seen with food. Previous studies (Levesque et al., 2011) had already shown that carp use species-specific pheromones. Here, we sought to determine their relative potency in lab tests and then if/as appropriate in field trials.

Methods & Results: An initial set of experiments used round maze tanks (Levesque et al., 2011) to confirm that the odor of juvenile carp was indeed attractive to other YOY carp and then what chemical fraction contained the activity so that chemical

analysis could be performed, if necessary. We found YOY odor was weakly (but significantly) attractive and that activity was found in both the polar and non-polar fractions (i.e. the chemistry was complex; Fig. 5.1.). Tests of flow found that it did not enhance the attractive properties of conspecific odor (data not shown) whose amino acid composition was evaluated (data not shown). Next, to determine the potency of the pheromone (and the possible need to conduct field tests), we tested the potency of food odor (pellets) versus pheromone in starved and fed YOY carp in our maze tanks. We found that food was much more potent than pheromone in hungry fish and no more attractive than pheromone in satiated carp (Figs. 5.2, 5.3).

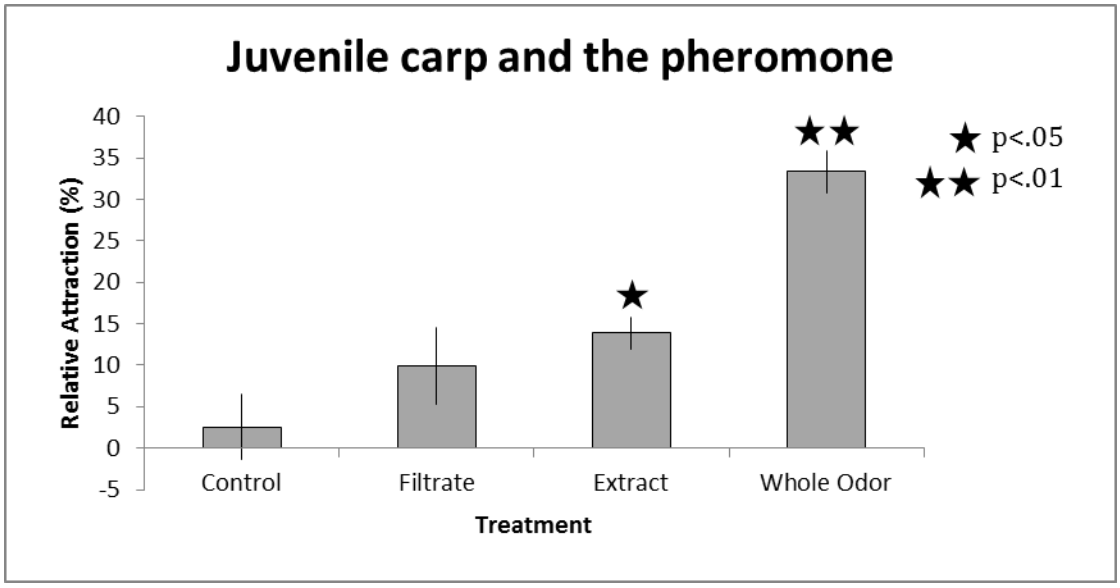

Fig. 5.1. Attractive properties of the carp pheromone and fractions thereof in lab maze tanks.

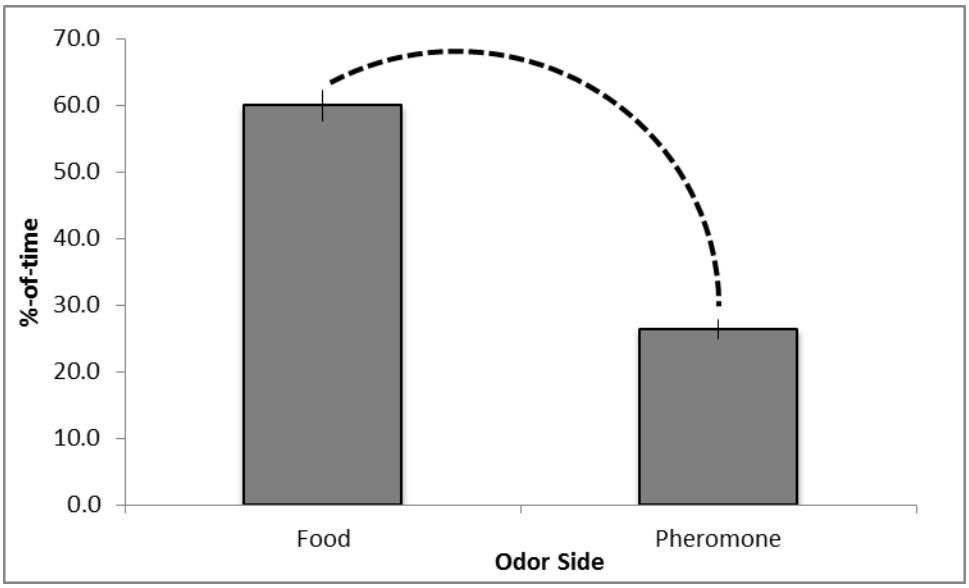

Fig. 5.2. Attractiveness of food versus pheromone odors to starved YOY carp in lab mazes

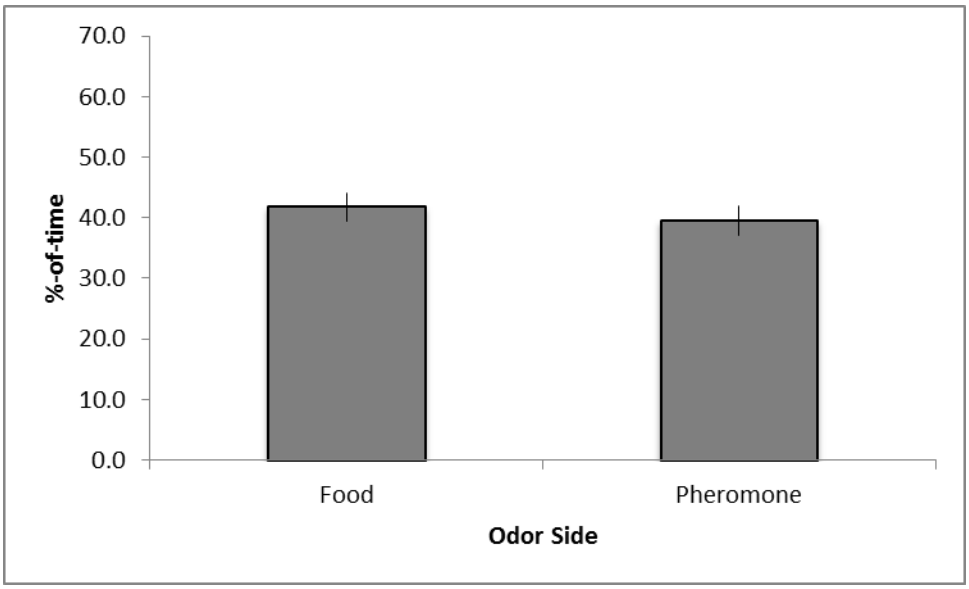

Fig. 5.3. Attractiveness of food versus pheromone odors to satiated YOY carp in lab mazes

Summary: The carp pheromone is only weakly attractive and on its own and thus appears to have little promise for field trapping. Nevertheless, because it is also used by sexually mature carp which are also highly attracted to it (Lim and Sorensen, 2011), its identity is worth pursuing for future studies.

Result 6: Developing barrier technologies to prevent spread of juvenile carp from their nurseries

Introduction: For a carp management program to be successful, tools are needed to suppress the movement of YOY carp between lakes. Trapping is of limited value (see above) and electrical barriers cannot stop upstream movement and both expensive and dangerous. This study investigated that possibility that air-bubble barriers might, through their safe and inexpensive production of sound, serve this function as carp have an unusually acute sense of hearing.

Methods & Results: Three bubble barriers were constructed and tested in rectangular troughs in the laboratory. Relatively simple bubble curtains were shown to arrest carp movement in the laboratory while causing them to jump and suppressing their feeding with 50-75% success rates (Table 6.1). Further, acoustic measurements at their dominant frequency (around 200Hz) showed that a strong acoustical pressure field is produced in front of them which both acts as a dipole source, and behaves in way that can bopth be manipulated and sensed by carp. In

particular, a field of 20 dB above background was generated up to a distance of 25 cm (10 inches) from the curtain (Fig. 6.1).

Table 6.1 Initial experimental results using acoustic fields to stop carp.

Bimodal Analysis			
Treatment	**% Pass Barrier**	**% Jump Out of Tank**	**% of Food Consumed**
Barrier Off	95%	0%	43%
Barrier On	3%	68%	3%

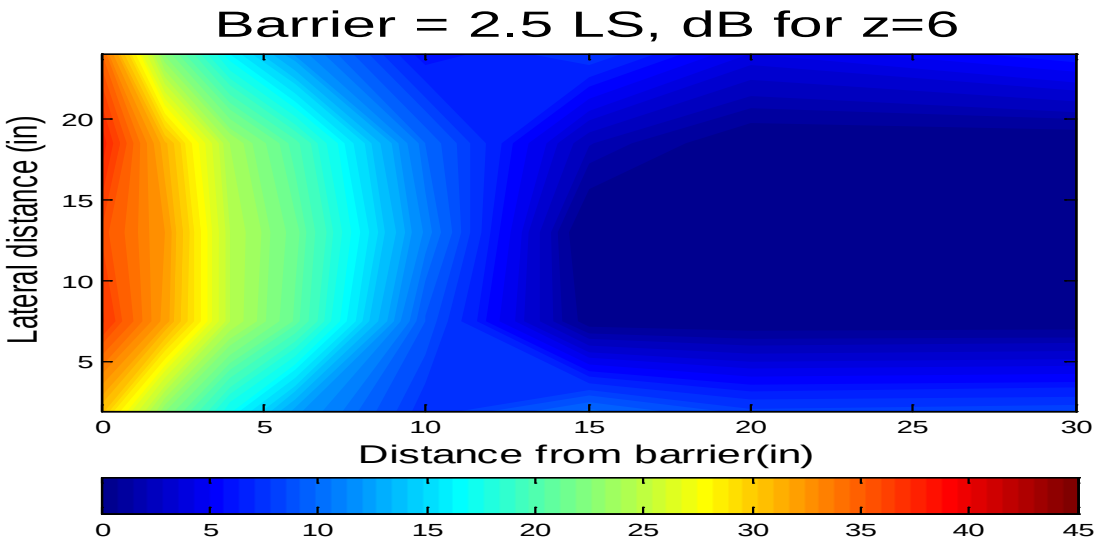

Fig. 6.1 . The spatial dB levels above background recorded six inches below the water surface for a barrier with orifices spaced 2.5 cm apart.

Summary: Bubble barriers appear to have considerable potential to deter the movement of YOY carp. Although not 100% effective, this technology is safe and inexpensive and could be applied to other species of carp. Research continues with a new LCCMR-project.

V. TOTAL TRUST FUND PROJECT BUDGET:

- *SEE ATTACHMENT A*

All results: Personnel: $417,246
All results; Equipment: $4,800
All results: Printing: $4,000
All results: Supplies: $65,954
All results: Travel:
Inside Minnesota: $25,000
Outside Minnesota: $6,000
All results: Other
Equipment repairs: $12,000
Services: $15,000
TOTAL TRUST FUND PROJECT BUDGET: $550,000

Explanation of Capital Expenditures Greater Than $3,500:
Ageing analysis (Result #3) required a low-speed diamond blade saw such as the Buehler Isomet low speed saw (http://www.buehler.com),to precisely section fish inner ear bones (otoliths) for aging. The cost estimate for the saw was furnished by a local Buehler dealer is $4,800.

VI. OTHER FUNDS & PARTNERS:

A. Project Partners:

1. Ramsey-Washington Metro Watershed District: The RWMWD paid $331,000 to cover the costs of the experimental exclosures and other materials, and one year's salary for a postdoctoral research associate to conduct Result #1. This project still continues.

2. Minnesota Department of Natural Resources, Section of Fisheries provided in-kind support for sampling lakes for Results #2 and 3.

3. Riley Purgatory Bluff Creek Watershed District (RPBCWD) provided in-kind salary support for Result #6.

4. University of Minnesota St. Anthony Falls Laboratory provided flumes for testing carp free of charge.

B. Other Funds Proposed to be spent during the Project Period:

Dr. Sorensen contributed part of his academic year salary time from the University of Minnesota to this project.

C. Past Spending:

2004-2004: Developing pheromones for use in carp control $100,000

2005-2009 Integrated and pheromonal control of carp $550,000

D. Time: July 1,2008 until June 30, 2011

We needed three years of support for this project because of its complexity and difficulty. In particular, two full field seasons (2009, 2010) were needed to investigate processes that control carp recruitment (Results 2, 3) and to allow for surveying sifficient number of lakes and account for potential year-to-year variability in recruitment. Also, because Results 4 and 5 were complex and involved both laboratory and field components that required 3 years..

VII. DISSEMINATION:

1.Publications in the peer-reviewed literature:

1. Sisler, S.P., and P.W. Sorensen. 2008. Common carp and goldfish discern conspecific identity using chemical cues. *Behaviour*. 145: 1409-1429.
2. Bajer, P.G, G.S. Sullivan, and P.W. Sorensen. 2009. Effects of a rapidly increasing population of common carp on vegetative cover and waterfowl in a recently restored Midwestern shallow lake. *Hydrobiologia* 632: 235-245.
3. Bajer, P.G, and P.W. Sorensen. 2010. The superabundance of common carp in interconnected lakes in Midwestern North America can be attributed to the propensity of adults to reproduce in outlying habitats that experience winter hypoxia. *Biological Invasions* 12: 1101-1112.
4. Bajer, P.G, H.K. .Lim, M. J. Travaline, B.D. Miller, and P.W. Sorensen. 2010 Cognitive aspects of food searching behavior in free-ranging wild common carp. *Environmental Biology of Fishes*. 88: 295-300..
5. Levesque, H., D. Scaffidi, C.A. Polkinghorne, and P.W. Sorensen 2011. A multi-component species identifying pheromone in the goldfish. *Journal of Chemical Ecology* 37(2): 219-227 (DOI 10.1007/s10886-011-9907-6)
6. Bajer, P.B., C.J. Chizinski, and P.W. Sorensen. 2011. Using the Judas technique to locate and remove wintertime aggregations of invasive common carp. *Fisheries Management and Ecology* (in press).

2. Presentations at scientific meetings (by year):

Bajer P. G., and P. W. Sorensen. 2008. Invasiveness in the common carp as a function of environmental instability and life history. Shallow Lakes Meeting, Fergus Falls, MN, USA.

Sorensen, P.W., Bajer, PB., Levesque, H., and Lim, H.K. 2008. An integrated pest management program for the common carp. Annual Midwest Fish and Wildlife Meeting, Columbus, OH.

Bajer, P. G., and P. W. Sorensen. 2009. Life history and reproductive success of common carp in Minnesota Lakes. 139th Annual Meeting of the American Fisheries Society, Nashville, TN, USA.

Sorensen .P.W. and Bajer, P.B. 2009 Integrated control of the common carp. American Fisheries society meetings, Nashville, TN

Sorensen. PW and Lim, HK 2009 lake Ecosystem and restoration, Waikato, New Zealand

Sorensen, P.W. 2009. The invasive species problem. National Caucus of Environmental Legislators, Minneapolis, MN

Sorensen, P.W. and Bajer, P.B. 2010. Integrated pest control strategies for fish. International symposium on genetic biocontrol of fish, Minneapolis, MN, June 21-24, 2010.

Sorensen, P.W. and Bajer, P.B. 2010. Sustainable removal of common carp in a model lake and its effects on water quality. Midwest Fish &Wildlife Society Meetings, Minneapolis, MN

Bajer, P. G., C. J. Chizinski, J. Silbernagel, and P. W. Sorensen. 2011. Alien versus predators: can native predators control a globally invasive fish. .Minnesota Chapter of the American Fisheries Society, Bemidji, MN, USA

Bajer, P. G., C. J. Chizinski, J. Silbernagel, J. Osborne, H. Lim, and P. W. Sorensen. 2011. Integrated Pest Management for the invasive common carp. Minnesota-Wisconsin Invasive Species Meeting, St. Paul, MN, USA

2. Meetings with the DNR and other groups

We have met with the DNR each year in December to discuss our project.
We meet with RWMWD and RPBCWD at least twice each year
We have been giving at least 5 talks each year to various environmental organizations (ex. Minnesota waters, Audubon, various lake associations)

3. Media

Minnesota Public Radio (barrier story)
Kare 11 TV (winter seining story)
Australian Broadcasting Corporation (story on carp control)
Minnesota Bound (story on carp control)

Channel 5 TV (winterkill story)
Minneapolis Star Tribune (two stories on carp control)
Milwaukee Sentinel (story on carp control)
Outdoor News (two stories on carp)
Chanhassen Villager (three stories on carp and water quality)

4. Website

http://fwcb.cfans.umn.edu/sorensen/

VIII. REPORTING REQUIREMENTS:

Periodic work program progress reports will be submitted on a biannual basis. A final work program report and associated products will be submitted between June 30 and August 1, 2011 as requested by the LCCMR

IX. RESEARCH PROJECTS:

IX RESEARCH PROJECTS

Research Addendum as Attachment B

Attachment A: Budget Detail for 2008 Projects - Summary and budget page for the University of Minnesota

Project Title: ***Accelerating plans for the integrated control of the common carp***

Project Manager Name: ***Peter W. Sorensen***

Trust Fund Appropriation: $ *550,000*

2008 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent**	**Balance** 8/24/11	**Result 2 Budget:**	**Amount Spent**	**Balance** 8/24/11	**Result 3 Budget:**	**Amount Spent**	**Balance** 8/24/11	**Result 4 Budget:**	**Amount Spent**	**Balance** 8/24/11	**Result 5 Budget:**	**Amount Spent**	**Balance** 8/24/11	**Result 6 Rebudget**	**Amount Spent**	**Balance** 8/24/11	**TOTAL BUDGET**	**TOTAL BALANCE**	
	To determine if predation by native gamefish on carp eggs, larvae and fry can potentially be used to control carp recruitment in lake enclosures.			*To determine if the abundance of young-of-the-year (YOY) carp is inversely correlated with predator abundance in nursery areas following winterkills.*			*To determine whether carp age structure correlates with winterkill events*			*To determine if young-of-the-year (YOY) carp can be effectively trapped for census and/or removal using bait attractants.*			*To determine if young-of-the-year (YOY) carp can be effectively trapped for census and/or removal using pheromonal attractants.*			*Developing barrier technologies to prevent spread of juvenile carp from their nurseries12/31/2009*					
BUDGET ITEM																					
PERSONNEL: wages and benefits (TOTAL)	100,000	100,000	0	115,200	115,200	0	89,400	89,399	1	43,100	43,100	0	43,100	43,100	0	26,446	26,446	0	417,246	1	**1**
Academic salaries and fringe : Pincipal Investigator and Project Manager (10%) Co-project manager (50% time; Objectives 2,3) Postdoctoral Associate (100% time, Objective 1)	35,000	33,648	1,352	64,100	64,156	-56	46,700	36,752	9,948	14,100	10,482	3,618	14,100	7,630	6,470	2,885	2,885	0	176,885	21,332	
Graduate students salary and fringe : PhD student (Objective 4,5, 1 year) MS student (Objective 6, 25% time, 1 year)	65,000	60,909	4,091	0	0	0	0	0	0	17,700	22,787	-5,087	17,700	32,257	-14,557	23,561	23,561	0	123,961	-15,553	
Undergraduate student salary and fringe	0	3,092	-3,092	5,300	101	5,199	6,900	808	6,092	1,300	244	1,056	1,300	877	423		0	0	14,800	9,678	
Civil service salary and fringe : Field technician (50% time)	0	2,351	-2,351	45,800	50,943	-5,143	35,800	51,839	-16,039	10,000	9,587	413	10,000	2,336	7,664		0	0	101,600	-15,456	
Equipment *(saw for Csectioning carpiotoliths; i.e.aging)*	0	0	0	0	0	0	4,800	4,951	-151		0	0		0	0		0	0	4,800	-151	
Printing (*copies, publication costs)*	0	0	0	1,000	91	909	1,000	0	1,000	1,000	432	568	1,000	354	646		0	0	4,000	3,123	
Supplies (TOTAL);	0	0	0	10,600	14,566	-3,966	10,700	7,068	3,632	22,100	10,235	11,865	22,000	16,434	5,566	554	554	0	65,954	17,097	17,097
General operating supplies	0	0	0	600	305	600	2,700	0	2,700	3,100	42	3,058	3,000	21	2,979	0	0	0	9,400	9,032	
Laboratory and field supplies	0	0	0	10,000	14,261	-4,261	8,000	7,068	932	19,000	10,193	8,807	19,000	16,413	2,587	554	554	0	56,554	8,065	
Travel expenses in Minnesota (TOTAL)	0	0	0	15,000	7,283	7,717	3,000	1,056	1,944	3,500	929	2,571	3,500	394	3,106		0	0	25,000	15,339	
Fuel for dedicated field vehicle (~15,000 miles/yr)	0	0	0	14,000	7,283	6,717	2,000	1,056	944	2,000	929	1,071	2,000	394	1,606		0	0	20,000	10,339	
Vehicle rental for peak field season	0	0	0	0	0	0	0	0	0	500	0	500	500	0	500	0	0	0	1,000	1,000	
travel to local meetings	0	0	0	1,000	0	1,000	1,000	0	1,000	1,000	0	1,000	1,000	0	1,000	100	0	0	4,100	4,100	
Travel outside Minnesota *(professional acientific meetings)*	0		0	0	0	0	0	0	0	3,000	0	3,000	3,000	0	3,000		0	0	6,000	6,000	
Other: Equipment and field vehicle maintenance and repairs	0	0	0	6,400	1,933	4,467	2,600	871	1,729	1,800	0	1,800	1,200	331	869		0	0	12,000	8,865	
Other: Lab/ medical Services *St. Anthony Fall Laboratory, Chemcial anlyses of attractants*	0	0	0	0	0	0	0	0	0	4,500	518	3,982	10,500	10,529	-29	0	0	0	15,000	3,953	
COLUMN TOTAL	**$100,000**	**$100,000**	**$0**	**$148,200**	**$139,073**	**$9,127**	**$111,500**	**$103,345**	**$8,155**	**$79,000**	**$55,214**	**$23,786**	**$84,300**	**$71,142**	**$13,158**	**$27,000**	**$27,000**	**$0**	550,000	**$54,227**	$54,227
																			550,000	**54,227**	

** The principle investigator is a professor with 9 months of regular pay from the University of MN ; the 10% time is over and above that pay level and is for summer research*

*** Supplies to include:*

General operating supplies to include: Result 1: and 2: small boat gasoline and oil for boats raingear, small sampling nets, baits; Res 4 and 5: Fish traps and baits; Res 6: nets, carp , sound projection systems

Labaoratory and field supplies to include: Result 2: plankton and other fish nets, oxygen meter, small boat; Result 3: saw blades, resins, molds, microscope slides; Results 4 and 5: carp for lab work, aquarium supplies, fish food lab solverrts, glass ware, baits and related chemicals, electrodes, pheromones; Result 6: air bubblers, video cameras, carp for tests, fish food, etc

*** Professional meeting(s): Data on carp will be presented and exchanged with national and international experts at scientific meetings which will include: Annual meetng of the American Fisheries Society, International Chemical Ecology Sooiety; Midewest Fish and Wildlife Conference*

12/31/2009 rebudegte requested for Result 6. Graduate student wrok and salary had been underestmated because of well problems while supplies were overestimated

6/29/2010. Allocation for personnel reallocated within result 1 to provide funding for student after M. McDonough granted permission

8/30/2011 Notes at closeout: results 2 and 3 often used the same field supplies which results in a slight inbalance in result 2. The intial equipment budget for result 3 was not adequate to to cover a small unanticipated price increase