Department of Agriculture, Trade and Consumer Protection
Division of Agricultural Development
Agricultural Development & Diversification Program (ADD)
Grant Project Final Report

Contract Number: 18013

Grant Project Title: Using Floating Raceways to Raise Yellow Perch as a Complimentary Crop for Cranberry Growers

Amount of Funding Awarded: $12,500

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Primary Contact: Chris Hartleb, Ph.D., Associate Professor of Fisheries Biology & Aquaculture

What did you want to accomplish with the grant?

The objectives of this project were to construct, monitor and quantify a mobile, floating raceway system placed within a cranberry reservoir for production of yellow perch fingerlings. While cranberry production in Wisconsin has been increasing over the past few years, the value of sales has declined from a high of $149 million in 1997 to $50 million in 2001. This has resulted in the closing of many cranberry farms and prompted other cranberry producers to explore alternative crops. While aquaculture in Wisconsin continues to be the fastest growing segment of agriculture, with annual increases in production averaging 17% (value of sale), frequently market demand exceeds production. Since both cranberry and fish farming are water resource dependent crops, there appears to be a complimentary production interest by both industries that could assist one struggle agricultural market while supplying fish to an agricultural segment that currently has a high demand.

The specific objectives of this project were to examine the cost of constructing a mobile, floating raceway at an existing cranberry farm, determine the use of the agricultural water resources and asses the production of yellow perch in a floating raceway system.

What steps did you take to reach your goal?

A three-channel, mobile, floating raceway system supplied by Superior Aquaculture LLC (www.superiorraceways.com; Bancroft, WI) was placed in a 0.5 acre (0.21 ha) reservoir, at Engelnook Cranberry® Farm LLC (Wisconsin Rapids, WI), that was primarily used in the fall to flood the fields during cranberry harvest. On July 15, 2003, approximately, 31,000 feed-trained yellow perch fingerlings were stocked directly into one raceway channel and approximately 50,000 fingerlings were stocked into a second raceway channel three days later. Yellow perch were fed an average of 10 times daily, at an average rate of 4% body weight with Ziegler #1, #2, and 1.5 mm feed. Cleaning each raceway required approximately 30 min each day. A sample of 50 fish per raceway was collected each week and measured for total length and wet weight. In addition, water quality was monitored weekly in the raceways and reservoir. This included measurements of dissolved oxygen and temperature (YSI Model 95 meter), pH (YSI Model 63 meter), hardness (titrimetric), alkalinity (titrimetric), turbidity (LaMotte Model 2020 turbidimeter), secchi depth, TSS (gravimetric), ammonia, nitrate, nitrite, and reactive phosphorus (colorimetric). Phytoplankton and zooplankton samples were collected weekly and used for chlorophyll analysis and supplemental diet comparison for the fingerling yellow perch. The study was terminated on October 27, 2003 when yellow perch were graded and placed into raceway channels based on size groups.

- **What worked?**

We were successfully able to collect all the water, plankton, and fish samples during each weekly visit to Engelnook Cranberry. Water samples were analyzed for nitrogen and phosphorus and were compared between the floating raceway system and the reservoir to better understand the relationship that developed between the two synergistic units. Preserved samples of phytoplankton and

zooplankton were identified, enumerated, and weekly composition was tabulated for analysis. Growth and diet selection by fingerling yellow perch were determined and growth was modeled based on length and weight until grading in late October. Yellow perch fingerlings in both raceways exhibited high survival rates of 83.5% and 87.1% over the 14 week experiment.

- **What did not work?**

In late October the cranberry grower decided to keep the advanced-stage, fingerling yellow perch in the floating raceway system through the winter and continue rearing them in 2004. The final objective of this project was to assess the value of sale of the yellow perch at the time of harvest and compare the cost/profit of this system with the PAS. Since the yellow perch will not be harvested until Fall 2004, this final objective will have to be accomplished at that time.

Water temperature within the reservoir increased in mid-August to 75°F, which is at the stressful limit of yellow perch. An increase in mortality of yellow perch within the floating raceway system was observed at this time and was attributed to the water temperature. The floating raceway is designed to allow the farmer to alter the depth of the intake pipes to provide deeper, cooler water to the raceway units. Unfortunately, the reservoir became isothermal in mid-August and even though the farmer lowered the intake pipes, the water temperature remained high until the air temperature cooled in late-August. In addition, when the farmer attempted to lower the intake pipes we discovered that the deeper water of the reservoir had become anoxic and, while the intake pipes remained at the deeper location, the anoxic conditions may have contributed to the higher mortality rates observed during this time. Eventually, the water temperature cooled in late-August and the mortality rates of the yellow perch declined and growth rates improved.

- **What would you do differently?**

When designing the experiment to evaluate the performance of the floating raceway system I would have modified two steps:

1) I would have monitored the reservoir at the cranberry farm for water temperature, dissolved oxygen, pH, alkalinity, hardness, TSS, and turbidity one year prior to constructing the floating raceway system. This would have provided us with advanced knowledge of how the reservoir changes during the fish growing season and would have prepared us for periods of higher than expected water temperatures and periods of anoxic conditions within the reservoir.
2) I would have raised other types of fish in the raceway units at the same time as the yellow perch, so I could compare growth and performance of 2-3 types of fish and observe their survival during periods of less than optimal water conditions. Depending on the reservoir conditions, yellow perch may or may not be suited for each individual floating raceway system. The farmer should have a better understanding of the water body that they plan to construct the floating raceway system in, prior to construction, and stocking with fish. This would enable to grower to plan ahead for periods of less than ideal conditions and make a more informed decision about the type of fish they will culture.

What were you able to accomplish?

Raceway #1, which was stocked with approximately 31,000 fingerlings, had an average weekly mortality of 1.28%, which was slightly higher than raceway #2, stocked with approximately 50,000 fingerlings, which had an average weekly mortality of 0.91%. Average yellow perch growth in both raceways showed a linear increase in length (R^2 = 0.96), with fingerlings nearly doubling in length (1.9-3.7 in; 4.9-

9.5 cm) and a linear increase in wet weight (R^2 = 0.97), with a seven-fold increase in weight (0.05–0.34 oz; 1.4-9.7 g) over the 14 weeks. Distinct size differences developed in each raceway during the experiment, suggesting that size grading during grow-out may be necessary and could decrease cannibalism and feeding hierarchies that appeared to arise later in the growing season. Growth was also affected by water temperature, with minimal growth observed from August 6–19 (< 0.01 oz; < 0.27 g weight gain), a period when temperatures ranged from 74-77°F (23.4–25.2^{o}C). These stressful temperatures for yellow perch strongly influenced growth and, approximately one-week later, the greatest weekly mortality rate in raceway #1 was observed (5.29%). Since the shallow reservoir at the cranberry farm maintained isothermal conditions, it was not possible to lower the intake pipes into deeper, cooler water during this period, which may have decreased the water temperature and stress on the perch.

Water quality parameters showed little variation within the raceway and between the raceway and reservoir. Total suspended solids, pH, hardness and alkalinity showed no significant difference ($P > 0.05$) among the inflow, mid-raceway, outflow and reservoir. TSS averaged 0.0048 mg/L in the reservoir and 0.0053 mg/L in the raceway; pH ranged from 6.8–7.3 at all sites during the study; hardness and alkalinity averaged 171 mg/L and 67 mg/L at all sites throughout the study, respectively. Secchi depth was not significantly different ($P > 0.05$) among the four sampling locations, but was consistently lower at the mid-raceway site (1.1 m), when compared to the average of the other three locations (1.3 m). The automatic feeder and belt feeder for each raceway was located close to the mid-raceway sampling location; the release of feed and yellow perch activity at this location most likely contributed to the decreased visibility. Likewise, the turbidity showed no significant difference ($P > 0.05$) among the four sampling locations, but was consistently higher at the mid-raceway sampling location (mid-raceway 5.1 NTU, with an average of 4.4 NTU for the other three sampling locations). The feeder location and fish activity most likely contributed to this slight difference as well. Temperature in the reservoir showed isothermal conditions with respect to depth (max. depth 23 ft (7 m)) throughout the study and averaged 72°F (22.4°C) in July, 75°F (24°C) in August, 63°F (17.4^{o}C) in September, and 55°F (12.9^{o}C) in October.

Dissolved oxygen showed no significant difference ($P > 0.05$) between inflow and mid-raceway and between outflow and reservoir, but DO was significantly different ($P < 0.05$) between those two groups of locations. The outflow and reservoir DO averaged 9.5 ppm for most of the summer, but the inflow and mid-raceway averaged 8 ppm, with DO decreasing to 5-6 ppm in late July to mid-August. This coincided with the warmest water temperatures and, during this period, the yellow perch often were seen crowding the front of the raceway near the intake pipes where higher DO and slightly lower temperatures occurred. Crowding increased the oxygen demand per volume of water and decreased the DO in the front half of the raceway. Airstones lined the raceway and reoxygenated the water near the outflow, yet slightly warmer temperatures deterred most of the perch from occupying the discharge end of the raceways.

Nitrogen and phosphorus were monitored during the study to model the exchange of nutrients between the raceway and reservoir. There was no significant difference in the concentration of ammonia-nitrogen (NH_3-N), nitrite-nitrogen (NO_2-N) and nitrate-nitrogen (NO_3-N) between the reservoir and three raceway locations for most of the growing season. Significantly higher ($P < 0.05$) levels of ammonia-nitrogen and nitrite-nitrogen were found in the reservoir the week of September 4. Significantly higher levels ($P < 0.05$) of nitrate-nitrogen were found in the reservoir the week of July 24 and in the inflow water the week of August 8. At no time did the ammonia, nitrite and nitrate concentrations exceed the tolerance limit for yellow perch. Though the levels of these compounds were slightly higher at these dates and locations, there was no clear explanation for the increase and it did not appear to affect the growth and survival of the yellow perch.

Reactive (ortho-) phosphorus was often significantly lower ($P < 0.05$) in the reservoir and the outflow from the raceway. Two factors may explain this pattern: 1) Phosphorus levels may have been higher at the intake and mid-raceway locations due to the quantity and periodicity of the fish feed supplied to the

yellow perch by the automatic feeders. Uneaten fish feed and slowly sinking fish feed often releases phosphorus into the water. Based on the density of yellow perch in each raceway, the amount of feed supplied to the raceway each day and the confines of the raceway channel may have trapped any released phosphorus in the raceway and kept the phosphorus at an elevated level when compared to the reservoir. 2) The outflow may have had a lower phosphorus level than the intake and mid-raceway because the outflow water immediately mixed with the reservoir and this may have diluted the phosphorus levels. Water analysis results support this theory since the phosphorus concentration of the outflow was not significantly different ($P > 0.05$) than the reservoir phosphorus concentration.

Zooplankton composition and abundance showed slight differences between the reservoir and the raceway. Generally, the raceway had the same zooplankton composition but lower abundance. Both systems were dominated by calanoid copepods throughout the growing season, with rotifer eggs, *Bosmina* and various rotifers increasing in abundance throughout the season. Further analyses of the zooplankton data were not performed, since the fingerling yellow perch consumed plankton for only two weeks after stocking in the raceways.

Algal diversity increased during the study, with only one type of algae present early and 5-6 types of algae present starting in early August. Algal diversity and abundance did not differ significantly ($P > 0.05$) between the reservoir and raceway. Two types of dinoflagellates and one type of chrysomonad were the most common phytoplankton in both systems. Warmer water temperatures and increased nutrients in the reservoir most likely supported the increase in algal composition and abundance.

Analysis of the fingerling yellow perch diets showed that yellow perch initially fed on supplied pellet feed, copepods and Daphnia present within the reservoir system and pumped into the raceway via the intake pipes. The yellow perch quickly adapted their diet to only supplied pellet feed, which helped the cranberry grower regulate fish growth, since fish growth was strongly influenced by the quantity of feed supplied daily.

Water flow within the raceway system showed a gradual flow that descended from the intake to the outflow. Additional aeration added to the raceway during stressful periods often disrupted the flow and caused a recirculation of water within the raceway. This appeared to have little effect on the yellow perch, but did increase how often the grower had to clean the system due to the decrease in water flow and waste removal.

What challenges did you face?

As noted earlier, mortality rates of the yellow perch increased in mid-August as a result of increasing water temperatures that exceeded stressful levels for yellow perch. Isothermal and anoxic conditions in the reservoir hampered the cranberry grower's attempts at adjusting the intake pipes to compensate for the elevated water temperatures. Increasing aeration and removing the dead yellow perch were the only options during this period and waiting for the air temperature to decrease and cool the water. Also, in mid to late August we observed the yellow perch having difficulty breathing. We collected water samples and had them analyzed at the UW-Stevens Point water testing laboratory. High levels of methane gas were detected in the water during this period. Further analysis of local geologic maps indicated that a nearby Tamarack swamp drains in the direction of the reservoir and may have been releasing methane gas into the water. I worked with the cranberry grower to develop short-term solutions to the methane gas problem that included increasing aeration to the raceway units and incorporating a packed column into the intake of the raceway to further decrease the amount of methane entering the raceways.

What do you plan to do in the future as a result of this project?

The results of this project are being shared with aquaculturists, cranberry growers and fish biologists. The results have already been presented at the World Aquaculture Conference (February 2004) and some of the project results were published in Aquaculture Magazine (Jan/Feb 2004). In addition, complete results of the project are being presented at the American Fisheries Society annual meeting in Madison, WI (August 2004); the Aquaculture Magazine article was distributed at the March meeting of the Wisconsin Aquaculture Industry Advisor Council; and will be presented at the 2005 Cranberry School hosted by the WI Cranberry Growers Association.

The results of this project were also used in a grant proposal submitted to the University of Wisconsin System – Applied Research Grant Program. That grant proposal has been funded for the Summer 2004 and will allow me to continue the project for another year. I will continue to work with the cranberry and fish farmer using the floating raceway system and we will monitor the growth and production of yellow perch, bluegill sunfish, and hybrid bluegill sunfish in floating raceways located at both farms.

How should the agricultural industry or the State of Wisconsin use the results from your grant project?

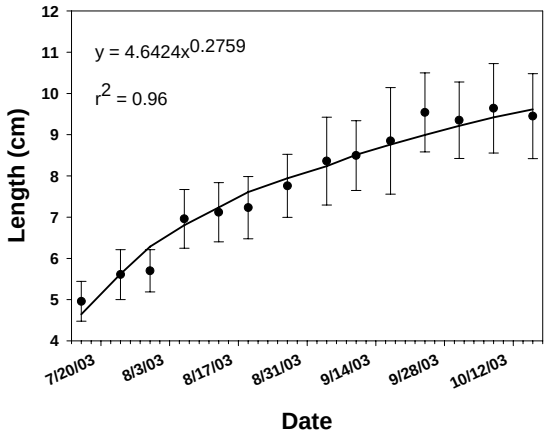
The floating raceways permitted the simultaneous rearing of multiple stocks of yellow perch fingerlings in a single reservoir and allowed the daily assessment of culture conditions, which assisted the cranberry grower in making necessary changes to the system. The close monitoring proved beneficial during early August when warm water temperatures resulted in decreased growth and stress of the yellow perch and allowed the farmer to add additional oxygen to minimize potential losses. The compact, manageable design also aided the farmer in making daily adjustments to feed delivery to increase growth and survival and maintain high levels of production. Water and nutrient exchange between the raceways and reservoir showed that the reservoir assisted in effluent management and that nitrogen more than phosphorus recirculated between the raceways and reservoir, but did not greatly impact the survival and production of the yellow perch. The goal of the project was to monitor the synergistic culture environment of the cranberry reservoir and raceway by quantifying exchanges, monitoring yellow perch growth and assessing the feasibility of the combined system. Where smaller bodies of water are present, such as at cranberry farms, floating raceways provide an alternative culturing techniques for a complimentary crop that can benefit cranberry growers and others by diversifying their crop production through an alternative market and an efficient use of agricultural resources.

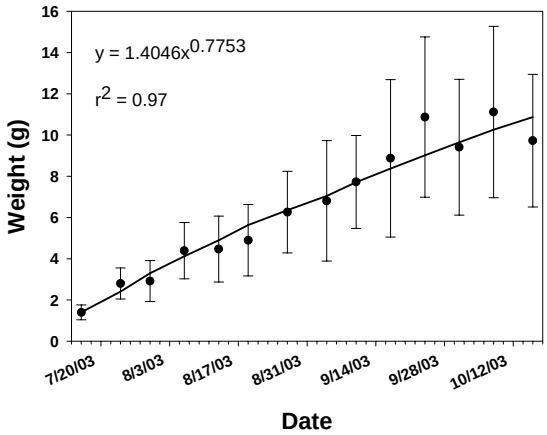
Continued investigation and development of new technologies that not only utilize Wisconsin's natural water bodies in an efficient and ecological way but assist agricultural sectors such as cranberry and fish farming benefit both industries and the state's natural resources. The floating raceway system proved to be a viable option for a cranberry farm interested in diversifying its crops during difficult economic times. The system proved to be easy to construct, manage, and resulted in the production of advanced, feed-trained, fingerling yellow perch. Further investigation in 2004 into the use of floating raceways to raise bluegill and hybrid bluegill sunfish may further show the useful of this system to raise a variety of alternative crops for both cranberry and fish farmers.

Three-channel, mobile, floating raceway system constructed within a cranberry reservoir.

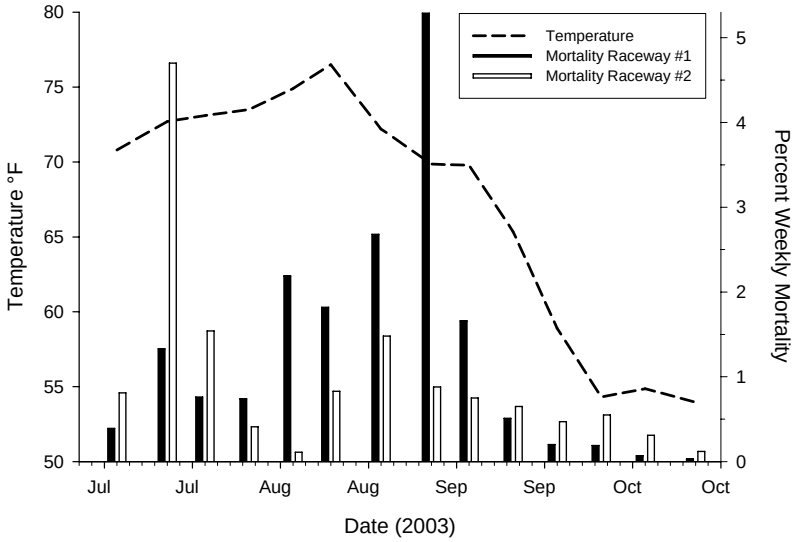
Fixed and operating cost of mobile, floating raceway system.

Three-channel, mobile floating raceway system	$10,000
81,000 yellow perch fingerlings	$10,000
Electricity to run air blowers & cleaning equipment (one growing season)	$4,000
Fish feed (one growing season)	$875
Labor cost (one individual time spent cleaning, feeding, repairs, grading, & general maintenance of system for one growing season)	$2,250
Total:	$27,125

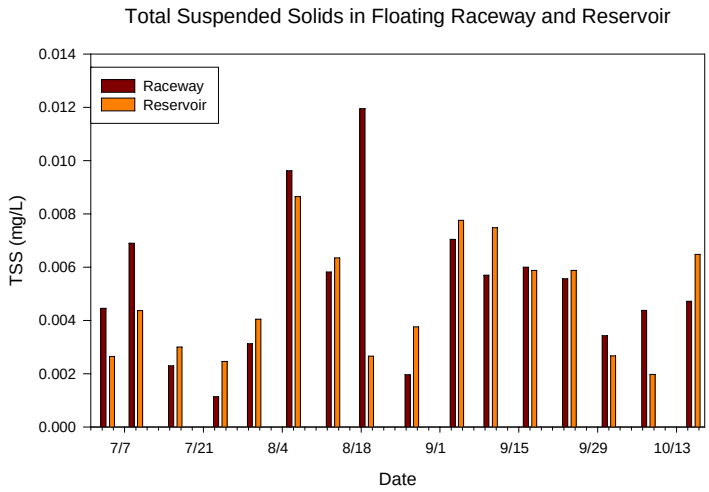


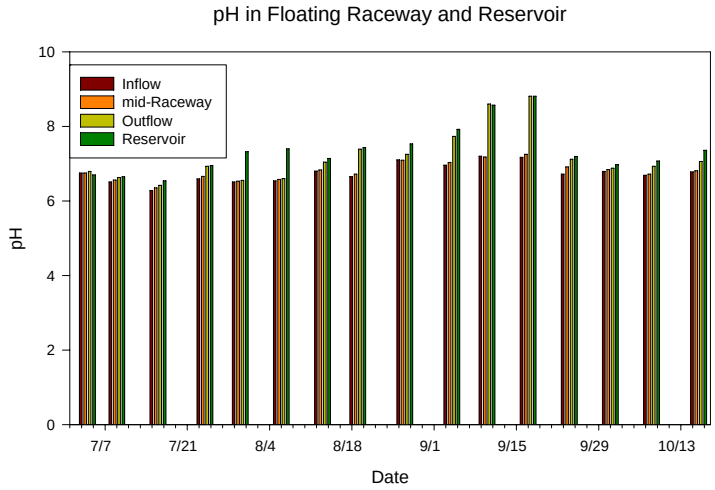


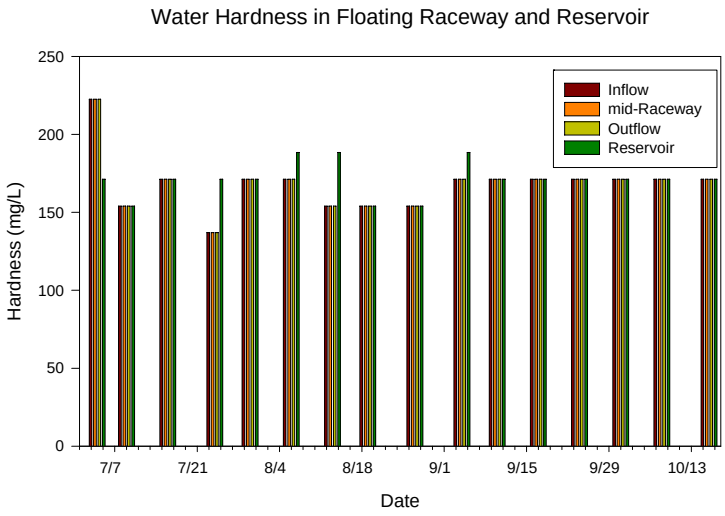
Growth of fingerling yellow perch.

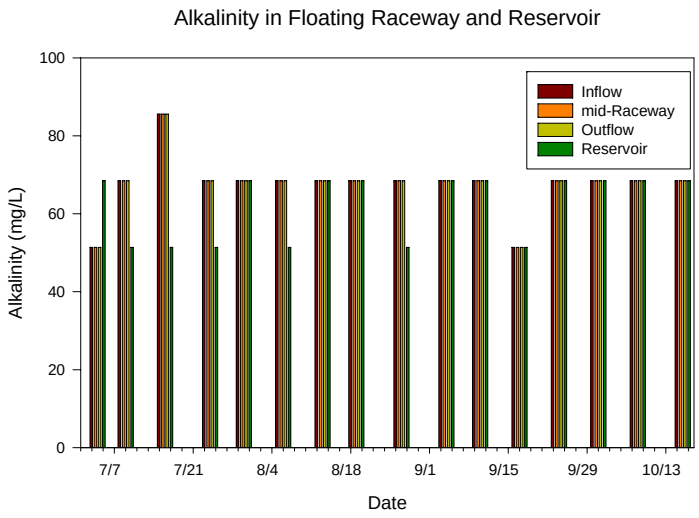


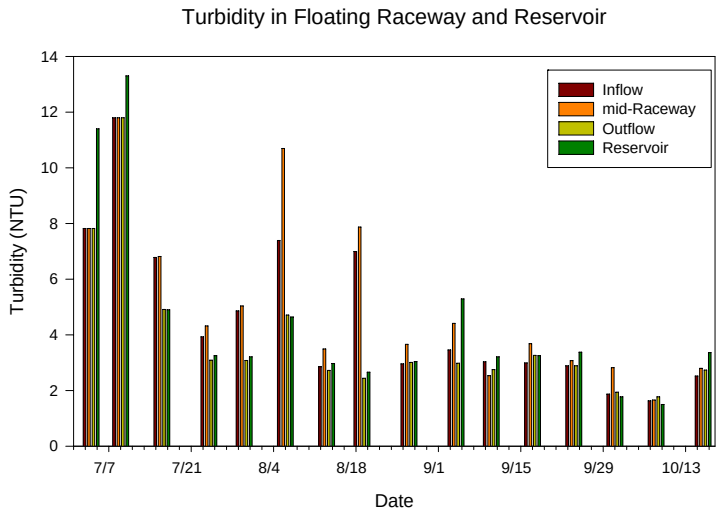
Water temperature and weekly mortality rates for yellow perch in two raceway channels.

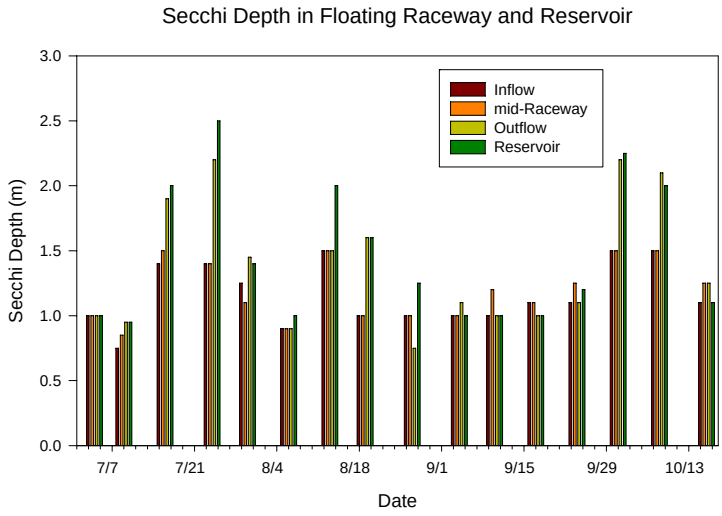

Total Suspended Solids in Floating Raceway and Reservoir
Raceway
Reservoir
TSS (mg/L)
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
7/7
7/21
8/4
8/18
9/1
9/15
9/29
10/13
Date

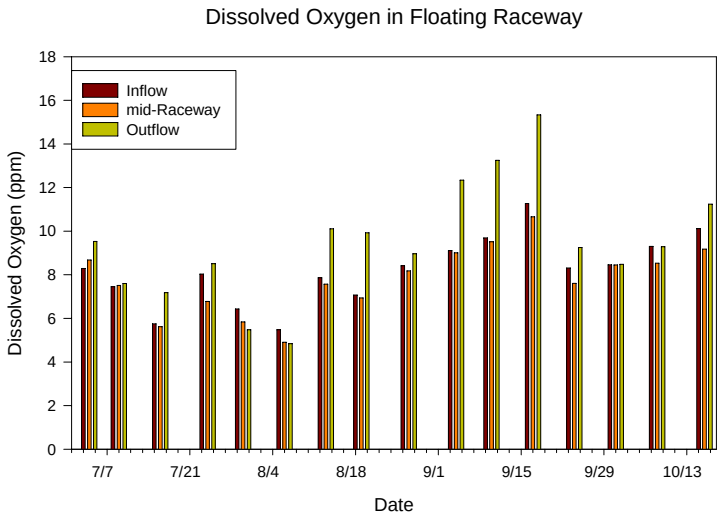

pH in Floating Raceway and Reservoir
Inflow
mid-Raceway
Outflow
Reservoir
pH
10
8
6
4
2
0
7/7
7/21
8/4
8/18
9/1
9/15
9/29
10/13
Date

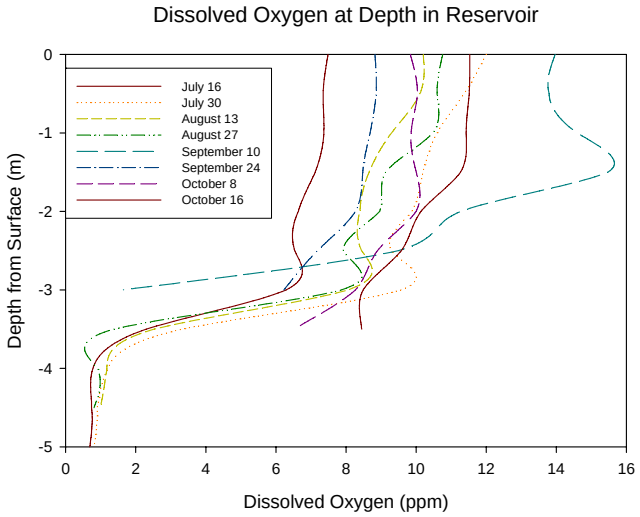

Water Hardness in Floating Raceway and Reservoir
Hardness (mg/L)
250
200
150
100
50
0
7/7
7/21
8/4
8/18
9/1
9/15
9/29
10/13
Date
Inflow
mid-Raceway
Outflow
Reservoir


Alkalinity in Floating Raceway and Reservoir
Alkalinity (mg/L)
100
80
60
40
20
0
7/7
7/21
8/4
8/18
9/1
9/15
9/29
10/13
Date
Inflow
mid-Raceway
Outflow
Reservoir

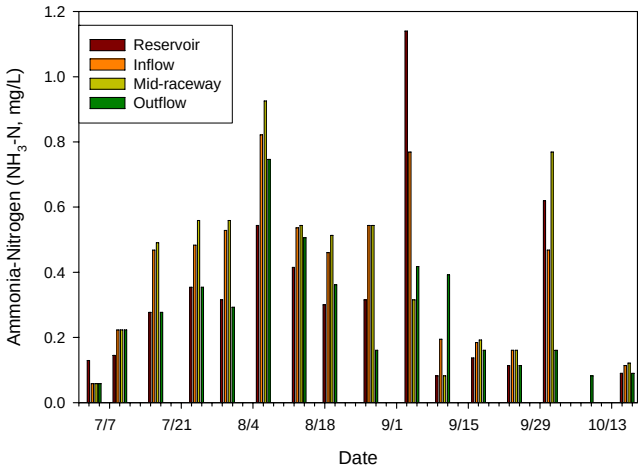

Turbidity in Floating Raceway and Reservoir
Turbidity (NTU)
0
2
4
6
8
10
12
14
7/7
7/21
8/4
8/18
9/1
9/15
9/29
10/13
Date
Inflow
mid-Raceway
Outflow
Reservoir


Secchi Depth in Floating Raceway and Reservoir
Secchi Depth (m)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
7/7
7/21
8/4
8/18
9/1
9/15
9/29
10/13
Date
Inflow
mid-Raceway
Outflow
Reservoir

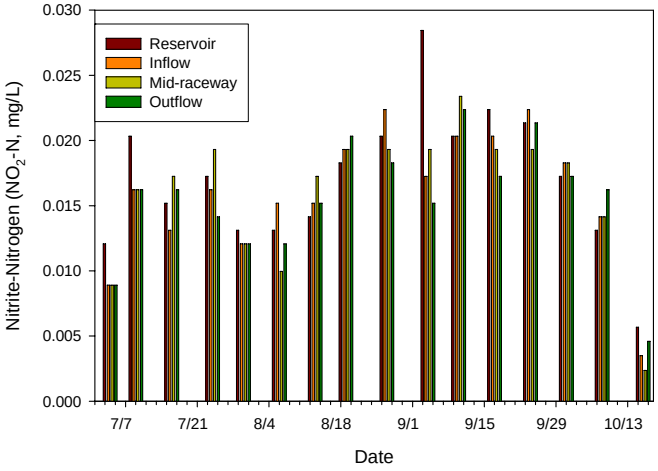

Dissolved Oxygen in Floating Raceway
Inflow
mid-Raceway
Outflow
Dissolved Oxygen (ppm)
0
2
4
6
8
10
12
14
16
18
7/7
7/21
8/4
8/18
9/1
9/15
9/29
10/13
Date


Dissolved Oxygen at Depth in Reservoir
July 16
July 30
August 13
August 27
September 10
September 24
October 8
October 16
Depth from Surface (m)
0
-1
-2
-3
-4
-5
0
2
4
6
8
10
12
14
16
Dissolved Oxygen (ppm)

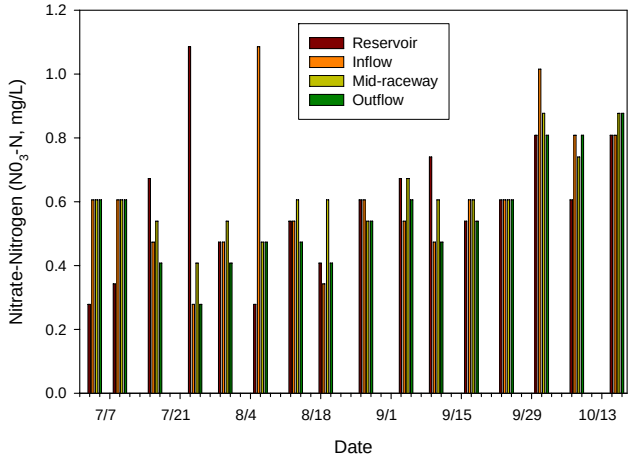
Ammonia-Nitrogen (NH_3-N) Levels in Floating Raceway and Reservoir



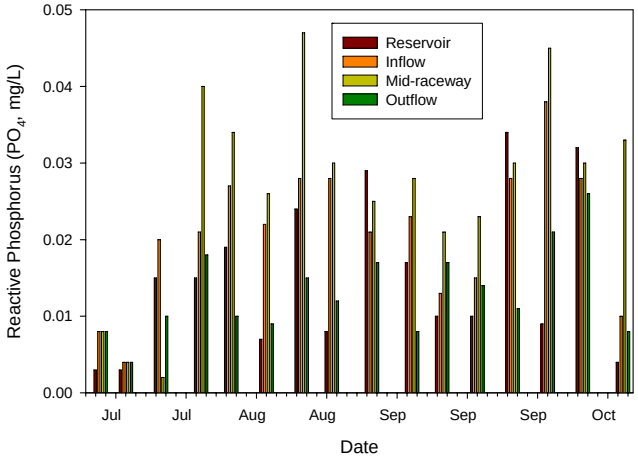
Nitrite-Nitrogen (NO_2-N) Levels in Floating Raceway and Reservoir



Nitrate-Nitrogen (NO_3-N) in Floating Raceway and Reservoir



Reactive (Ortho-)Phosphorus (PO_4) in Floating Raceway and Reservoir



Zooplankton Composition and Abundance in Reservoir (Organisms per liter of lake water).

Net Plankton	**7/4**	**7/9**	**7/16**	**7/24**	**7/30**	**8/6**	**8/13**	**8/19**	**8/27**	**9/4**	**9/10**	**9/17**	**9/24**	**10/1**	**10/8**	**10/16**
Calanoida copepod	17.97	26.7	12.24	5.68	4.12	0.38	7.49	8.09	3.48	5.17	0.49	7.83	9.08	1.24	1.57	0.45
Chironomid	0.08												0.32			
Daphnia longiremis	0.08	1.35	27.25	8.01	1.33	0.76		2.36		0.4			0.32			
Brachionous rubens	0.08															
Rotifer eggs		4.76								8.61		9.54	4.54	1.12	0.79	
Skistodiaptomus oregonesis			0.39													
Chaborous			0.13													
Ceriodaphnia				6.72	0.73		2.84	1.35				0.14				
Nauplius							1.55	2.92					0.32			
Kellicotia longispina								0.11			0.82	0.14				
Immature copepods								1.35				0.14				
Asplancha herreki									8	2.38		1.28	2.76		0.67	
Ostracoda										0.13	0.16	0.14				
Bosmina longirostris										0.26		4.55	0.32	0.34	0.11	

Nannoplankton	**7/4**	**7/9**	**7/16**	**7/24**	**7/30**	**8/6**	**8/13**	**8/19**	**8/27**	**9/4**	**9/10**	**9/17**	**9/24**	**10/1**	**10/8**	**10/16**
Calanoida copepod	60.19	38.43	28.26	17.52	2.44	0.63	8.18	48.24	2.86	14.71	24.77	89.33	12.23	4.59	6.5	
Keratella cochlearis	70.83		105.49		4.14									34.01		
Brachionous havanaensis	63.13															
Felinia terminalis	9.5							0.77								
Rotifer eggs		22.36	137.34				65.09	92.09							27.52	
Keratella quadrata		36.33	88.77	3.58	3.17						7.08	44.67				
Lecane		1.4														
Bosmina longirostris		0.23			6.09	0.63			0.41		3.54		0.38	2.29	9.55	6.88
Daphnia longiremis			42.6	18.71	1.22	0.63	4.29	11.09								
Nauplius			0.4		5.84		4.68	8.51			38.92	11.17		16.05	2.68	0.76
Ceriodaphnia				2.79			7.02	1.55								
Kellicottia longispina				5.18	3.17				330.92	835.95	8627.03	8657.68	685.99		6.88	2.29
Ostracoda					0.24											
Diaphanosoma abingei					0.24											
Immature copepod								8.51								4.59
Asplancha herreki									11.43	9.29			9.17	9.94	2.68	3.06

Zooplankton Composition and Abundance in Floating Raceway (Organisms per liter of lake water).

Net Plankton	**7/4**	**7/9**	**7/16**	**7/24**	**7/30**	**8/6**	**8/13**	**8/19**	**8/27**	**9/4**	**9/10**	**9/17**	**9/24**	**10/1**	**10/8**	**10/16**
Calanoida copepod	38.36	47.52	0.9	0.1	0.7	7.08	2.21		4	0.93	2	0.13	0.14	1	3.27	0.14
Chironomid																0.14
Daphnia longiremis		0.15	0.3	0.21	0.9	3.18			0.76			0.13				
Rotifer eggs		5.25													10.81	
Ceriodaphnia					1.1		15.49	2.35				0.13	0.14			
Nauplius							0.35							0.14		
Kellicotia longispina								2.77	16.21	24.19	60.19	12.33	17.77			
Immature copepods			0.6													
Asplancha herreki								1.66	13.73	5.74	0.52	1.06	5.4	5.55	1.71	
Bosmina longirostris		0.6				0.18				0.16	0.43	0.53	0.14	0.28		0.14
Keratella quadrata			0.1									0.13				
Keratella cochlearis										3.57	0.17				0.28	

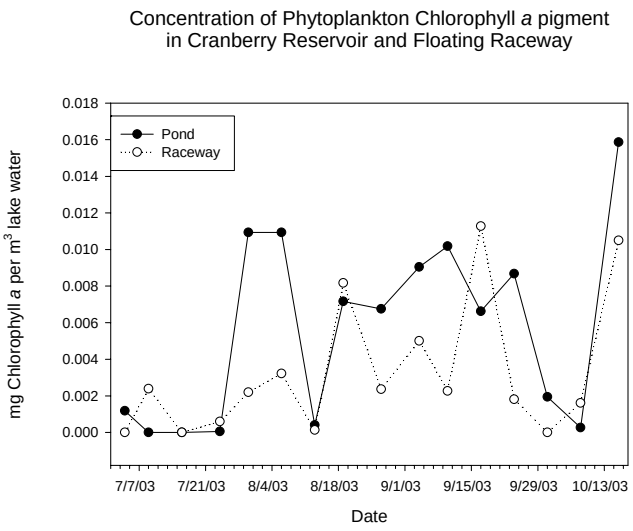
Nannoplankton	**7/4**	**7/9**	**7/16**	**7/24**	**7/30**	**8/6**	**8/13**	**8/19**	**8/27**	**9/4**	**9/10**	**9/17**	**9/24**	**10/1**	**10/8**	**10/16**
Calanoida copepod	61.82	62.5	7.74	0.26	0.41	35.67	0.67		3.47	4.16	3.27			1.27	1.69	0.85
Keratella cochlearis		3.41	10.89	5.44						12.23				49.46		4.44
Felinia terminalis	5.12									6.12						
Rotifer eggs									7.26							
Keratella quadrata		6.82	3.73	8.55	0.41				5.68	15.17						4.02
Bosmina longirostris		0.45				0.81			0.32				6.41	4.65		
Daphnia longiremis		0.23		9.59	1.23	6.89	24.52	3.31					0.71			
Nauplius		3.41			6.99		1.01	9.94	0.63		2.12			8.03	9.93	0.63
Ceriodaphnia	1.33				0.41		20.82	0.83					0.36			
Kellicottia longispina							31.91	346.11	654.5	146.79	427.03	676.28	351.48			14.16
Immature copepod					1.23											
Asplancha herreki			0.29	0.78			7.39	4.97	13.25	0.73			9.61	9.93	5.71	0.42
Harpacticoida copepod			6.02													
Ostracoda						0.81		0.41								
Brachionous rubens						0.81								1.48		

Phytoplankton Composition in Reservoir (values are ranked abundance).

Phytoplankton	7/4	7/9	7/16	7/24	7/30	8/6	8/13	8/19	8/27	9/4	9/10	9/17	9/24	10/1	10/8	10/16
Anabaena	1								7			5				
Arthrospira									4	4			5			
Ceratium					4	2	2	2	2	2	1	1	1	1	4	2
Dinobryon							3	3	5	3		4	4		2	1
Eudorina					3											
Gomphosphaeria					2											
Gymnodinium				1										3	3	
Oscillatoria									6		2	2	3			
Peridinium					1	1	1	1	3							
Ultothrix					5		4			1						
Unknown Green Algae									1		3	3	2	2	1	
Uroglena											4					
Volvox		1						4						4		

Phytoplankton Composition in Floating Raceway (values are ranked abundance).

Phytoplankton	7/4	7/9	7/16	7/24	7/30	8/6	8/13	8/19	8/27	9/4	9/10	9/17	9/24	10/1	10/8	10/16
Arthrospira										4	5					
Certium	1		1				2	2	2	2	1	1	1	2	3	
Cladophora				3												
Ctenophora				1												
Dinobryon							3	3	4		4			3	2	1
Gymnodinium				2										4	4	
Oscillatoria					3			4			3	2	2	5	5	
Peridinium						1	1	1	3	3						
Rhizoclonium						2										
Staurastrum														7		
Stigeoclonium					2											
Ulothrix		1			1								5			
Unknown Green Algae									1	1	2	3	3	1	1	
Volvox	2											4	4	6		



Fingerling Yellow Perch Diet Composition (%).

Date	Pellet Food	Daphnia	Copepods
7/24/2003	37	26	37
7/30/2003	58	25	17
8/6/2003	100		
8/19/2003	100		
8/27/2003	100		
9/4/2003	100		
9/10/2003	100		
9/17/2003	100		
9/24/2003	100		
10/1/2003	100		
10/8/2003	100		
10/16/2003	100		