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2000 Warmwater Fisheries Survey of Rock Island Ponds Douglas County, Washington

Warmwater Fish Enhancement

by Randall S. Osborne and Marc R. Petersen

Washington Department of FISH AND WILDLIFE
Fish Program
Science Division

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Abstract

Rock Island Ponds (Blue Heron, Big Bow, Hideaway, Pit, Putters, and Hammond ponds), Douglas County, Washington, were surveyed between October 23-November 6, 2000, using a boat electrofisher, gill nets, and fyke nets. Although sample sizes were low, a total of four fish species were observed in Blue Heron Pond: largemouth bass *Micropterus salmoides*, black crappie *Pomoxis nigromaculatus*, yellow perch *Perca flavescens*, and common carp *Cyprinus carpio*. All species were observed in low abundance although carp were likely more abundant than what these data indicated. Washington Department of Fish and Wildlife (WDFW) has not actively managed Blue Heron Pond in recent years and rehabilitation may be required in order to establish suitable warmwater fisheries in the future. A total of six fish species were observed in Big Bow Pond: bluegill *Lepomis macrochirus*, channel catfish *Ictalurus punctatus*, largemouth bass, largescale sucker *Catastomus macrocheilus*, pumpkinseed *L. gibbosus*, and yellow perch. Growth and condition of most species were poor which may have been due to water chemistry problems or excessive quantities of aquatic vegetation. Four fish species were observed in Hideaway Pond: brown bullhead *I. nebulosus*, bluegill, largemouth bass, and pumpkinseed. Hideaway Pond contains a high density of brown bullhead which likely contributed to limited spawning success and recruitment of largemouth bass, and poor condition of the panfish. Hideaway Pond may require rehabilitation to reduce the high abundance of brown bullhead. Although Pit Pond was designated as a juvenile trout fishing pond, three warmwater species were observed: largemouth bass, pumpkinseed, and yellow perch. Due to limited littoral habitat, warmwater species will not likely achieve densities that would warrant rehabilitation. A total of seven fish species were observed in Putters Pond: bluegill, brown bullhead, largemouth bass, pumpkinseed, rainbow trout *Oncorhynchus mykiss*, tench *Tinca tinca*, and yellow perch. Putters Pond appears to be overpopulated with bluegill and pumpkinseed and is a candidate for vegetation removal efforts and possibly rehabilitation. Five fish species were observed in Hammond Pond: bluegill, largemouth bass, pumpkinseed, rainbow trout, and yellow perch. Hammond Pond appears to be overpopulated with yellow perch and pumpkinseed and is a candidate for aquatic vegetation removal and possibly rehabilitation. High pumpkinseed and yellow perch densities likely contributed to the poor condition of panfish and smaller size largemouth bass. Similar to Putters Pond, dense aquatic vegetation in Hammond Pond most likely inhibited largemouth bass feeding efficiency and contributed to the overpopulation of pumpkinseed and yellow perch.

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Introduction and Background

Rock Island Ponds are located near the City of Rock Island in Douglas County, Washington (Figure 1). Although commonly referred to by number, each of the six ponds have specific names (Table 1). Pit, Putters, and Hammond Ponds are located inside the city limits of Rock Island; whereas, Hideaway, Big Bow, and Blue Heron Ponds are outside of the city limits.

The Rock Island Ponds were originally depressions, or potholes, containing various quantities of water (Whitey Evenhus, Mayor of Rock Island, Washington, personal communication) and primarily non-game fish species such as brown bullhead *Ictalurus nebulosus*. Upon completion of the second powerhouse at Rock Island Dam on August 31, 1979 (Chelan County Public Utilities District (PUD) 2001), water level of the Rock Island pool was raised approximately six feet and raised the ponds to present day levels. Culverts laid under State Highway 28 independently connect Hammond and Putters ponds to smaller, unnamed, ponds which are also connected, by culverts, to the Columbia River. Presently, water levels of all of the ponds are governed by the level of the Rock Island pool. However, there are no apparent surface water connections between any of the ponds and water transfer between the ponds most likely occurs through underground seepage.

Access sites on Pit, Putters, and Hammond Ponds are maintained by the City of Rock Island and include parking, toilet facilities, and unimproved boat ramps. At the request of the Rock Island Lake Enhancement Board, and in cooperation with the, Chelan County PUD has agreed to enhance access sites at Big Bow and Hideaway Ponds. Additional pond-specific information, such as fisheries management and physical characteristics, are included in the individual lake sections later in this report.

With the exception of Pit Pond (refer to Pit Pond section), anglers are allowed to fish all of the Rock Island Ponds year-round. All species fall under the 2005/2006 Washington State Sportfishing Rules. Although there is no minimum size, a total of five largemouth bass *Micropterus salmoides* less than 12 inches or greater than 17 inches may be harvested daily of which no more than one may exceed 17 inches in length. Five trout of any size may be harvested daily. A total of five channel catfish *Ictalurus punctatus* of any size may be harvested daily. In addition, there is no minimum size or daily limit on the remaining species inhabiting the ponds, including bluegill *Lepomis macrochirus*, pumpkinseed *L. gibbosus*, and yellow perch *Perca flavescens*.

Little information was known about the fish communities in Rock Island Ponds. Proper management of the ponds at Rock Island required up-to-date information which prompted Washington Department of Fish and Wildlife's (WDFW) Region 2 Warmwater Enhancement Team to conduct a warmwater survey of the ponds in the fall of 2000.

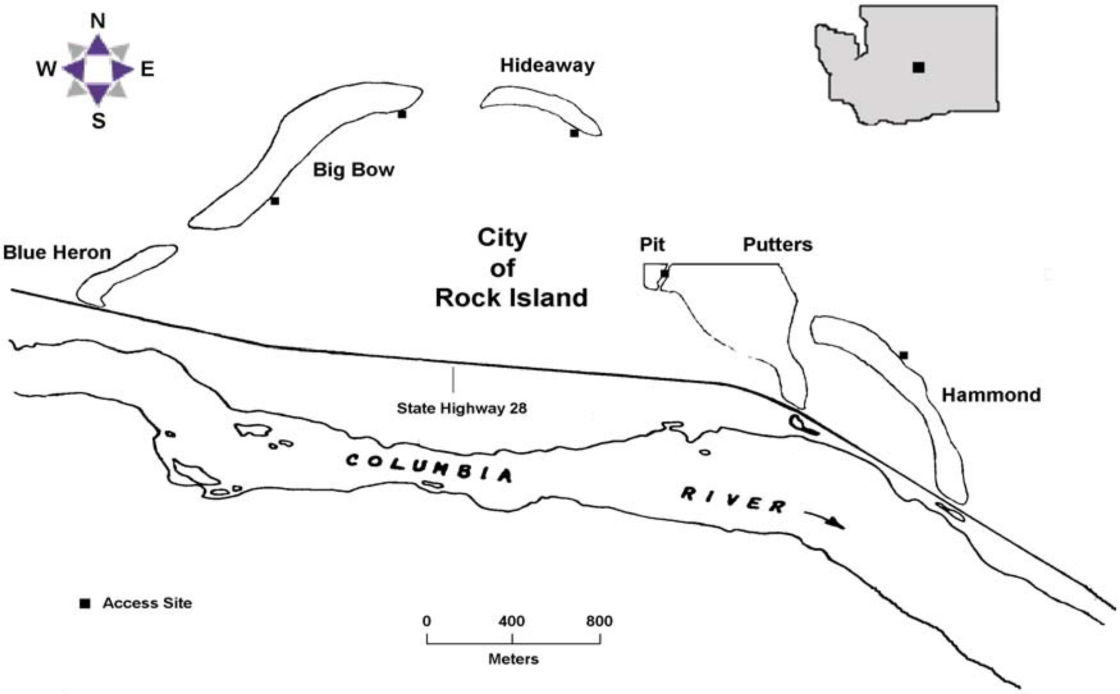

Figure 1. Map depicting locations of the ponds within the Rock Island Ponds area.

Table 1. Proper names of the Rock Island Ponds, Douglas County, Washington, and references to other known names.

Proper Name	Other Known Name(s)
Blue Heron Pond	Rock Island Pond # 1
Big Bow Pond	Rock Island Pond # 2
Hideaway Pond	Rock Island Pond # 3
Pit Pond	Pumphouse Pond, Gravel Pit
Putters Pond	Rock Island Pond # 4, Golf Course Pond
Hammond Pond	Rock Island Pond # 5, Scale House Pond

Methods and Materials

Rock Island Ponds were surveyed by a 3-person team October 23-November 6, 2000. All fish were collected using a boat electrofisher, gill nets, and/or fyke nets. The electrofisher unit consisted of a 5.5 m (18 ft.) Smith-Root GPP electrofishing boat, supplying a DC current at a setting of 120 cycles/sec at 3 to 4 amps power (Bonar et al. In Press). Experimental gill nets (45.7 m x 2.4 m) consisted of variable size (13, 19, 25, and 51 mm stretched) monofilament mesh. Fyke nets were constructed of a main trap (4.7 m long and 1.2 m in diameter with five aluminum hoops), a single 30.3 m lead, and two 15.2 m wings. All netting material was constructed of 6.35 mm nylon mesh.

Sampling locations were selected by dividing the shoreline into 400 m sections determined from a map. Blue Heron and Pit Ponds could only be sampled by gill netting since the unimproved boat launches at those locations only accommodate small watercraft. The number of randomly selected sections surveyed depended on surface acreage and were as follows: Blue Heron Pond: gill netting - 2; Big Bow Pond: electrofishing - 4, gill netting - 2, and fyke netting - 2; Hideaway Pond: electrofishing - 3, gill netting - 2, and fyke netting - 2; Pit Pond: gill netting - 2; Putters Pond: electrofishing - 7, gill netting - 4, and fyke netting - 4; Hammond Pond: electrofishing - 4, gill netting - 2, and fyke netting - 2. Electrofishing occurred in shallow water (depth range: 0.2 - 1.5 m), adjacent to the shoreline at a rate of approximately 18.3 m/minute for 600 second intervals (Bonar et al. In Press). Gill nets were set perpendicular to the shoreline with the small-mesh end attached on or near the shore and the large-mesh end anchored offshore. Fyke nets were set perpendicular to the shoreline with the wings extended at 70^o angles from the lead. Gill nets and fyke nets were set overnight prior to electrofishing and were pulled the following morning (1 net night each). All sampling was conducted during night-time hours when fish are most numerous along the shoreline thus maximizing the efficiency of each gear type.

All fish were identified to species, measured in millimeters to total length (TL), and weighed to the nearest gram (g). Total length data was used to construct length-frequency histograms and to evaluate the size structure of the warmwater gamefish in the ponds. Scales were collected from warmwater gamefish species to analyze age and growth. Warmwater gamefish were assigned to a 10 mm size group based on total length, and scale samples were collected from five fish in each size group (Bonar et al. 2000). Scale samples were mounted on adhesive data cards and pressed onto acetate slides using a Carver® laboratory press, and aged according to Jerald (1983) and Fletcher et al. (1993).

Typically, water chemistry data, such as dissolved oxygen, temperature, pH, conductivity, and turbidity, are collected on waters from the area of greatest depth. However, water chemistry measurements were not taken on the Rock Island Ponds due to equipment failure.

Species composition, by weight in kilograms (kg) and number, was determined from fish captured. Fish less than one year old, i.e., young of-the-year (YOY), were excluded from all analyses. Including young-of-the-year fish in the calculation of species composition can give a false impression of year class strength due to the abundance of small fish, which can suffer extensive mortality during the first winter (Chew 1974). In addition, eliminating young-of-the-year fish prevents distortions in analyses that may occur due to sampling location, method, and specific timing of hatches (Fletcher et al. 1993).

Catch per unit effort (CPUE) of each sampling gear was determined for each warmwater gamefish species collected. The CPUE of electrofishing was determined by dividing the number of fish captured by the total amount of time electrofished. Similarly, CPUE of gill netting and fyke netting was determined by dividing the number of fish captured by the total time that the nets were deployed. Standardized CPUE allows for comparisons of catch rates between different lakes or sampling dates on the same water.

A relative weight (W_r) index was used to evaluate the condition of fish in Rock Island Ponds. As presented by Anderson and Neumann (1996), a W_r of 100 generally indicates that the fish is in a condition similar to the national average for that species and length (1996). The index was defined as $W_r = W/W_s \times 100$, where W was the weight (g) of an individual fish and W_s was the standard weight of a fish of the same total length (mm). Standard weight (W_s) was derived from a standard weight-length ($\log_{10}$) relationship which was defined for each species of interest (Anderson and Neumann 1996; Bister et al. 2000; Hyatt and Hubert 2000). Minimum lengths were used for each species as the variability can be significant for young-of-the-year fish. Relative weights less than 50 were also excluded from our analyses as we suspected unreliable weight measurements.

Age and growth of warmwater gamefish in Rock Island Ponds were evaluated using procedures described by Fletcher et al. (1993). All samples were evaluated using both, the direct proportion method (Fletcher et al. 1993) and Lee's modification of the direct proportion method (Carlander 1982). Mean back-calculated lengths-at-age for all warmwater gamefish were then compared to those of eastern Washington or statewide averages (Fletcher et al. 1993).

The proportional stock density (PSD) of each warmwater gamefish species was determined following procedures outlined in Anderson and Neumann (1996). Proportional stock density uses two measurements, stock length and quality length, to provide useful information about the proportion of various size fish in a population. Stock length is defined as the minimum size of a fish which provides recreational value or approximate length when fish reach maturity (Table 2). Quality length is defined as the minimum size of a fish that most anglers like to catch or begin keeping (Table 2). Proportional stock density is calculated using the number of quality sized fish, divided by the number of stock sized fish, multiplied by 100. Stock and quality lengths, which vary by species, are based on percentages of world-record lengths. Stock length is 20-26 percent of the world record length; whereas, quality length is 36-41 percent of the world record length.

Relative stock density (RSD) of each warmwater gamefish species was examined using the five-cell model proposed by Gabelhouse (1984). In addition to stock and quality lengths, the Gabelhouse model adds preferred, memorable, and trophy categories (Table 2). Preferred length (RSD-P) is defined as the minimum size of fish anglers would preferred to catch. Memorable (RSD-M) length refers to the minimum size fish anglers remember catching, and trophy length (RSD-T) refers to the minimum size fish worthy of acknowledgment. Preferred, memorable, and trophy length fish are also based on percentages of world record lengths. Preferred length is 45-55 percent of world record length, memorable length is 59-64 percent of world record length, and trophy length is 74-80 percent of world record length. Relative stock density differs from PSD in that it is more sensitive to changes in year class strength. Relative stock density is calculated as the number of fish within the specified length category, divided by the total number of stock length fish, multiplied by 100. Eighty percent confidence intervals for PSD and RSD are provided as an estimate of statistical precision and were calculated using normal approximation (Conover 1980; Gustafson 1988).

Table 2. Minimum total length (mm) categories of warmwater fish used to calculate PSD and RSD values (Willis et al. 1993).

	Length Category				
Species	**Stock**	**Quality**	**Preferred**	**Memorable**	**Trophy**
Black crappie	130	200	250	300	380
White crappie	130	200	250	300	380
Bluegill	80	150	200	250	300
Yellow perch	130	200	250	300	380
Largemouth bass	200	300	380	510	630
Smallmouth bass	180	280	350	430	510
Walleye	250	380	510	630	760
Channel catfish	280	410	610	710	910
Brown bullhead	150	230	300	390	460
Yellow bullhead	150	230	300	390	460

Blue Heron Pond

Background

Blue Heron Pond is a small pond of less than 8 hectares (ha)(20 acres) and is located outside the Rock Island city limits (Figure 1). Most land surrounding Blue Heron Pond is privately owned and consists primarily of fruit orchards. A portion of the southeast bank parallels Washington State Highway 28 and may lie within right-of-way boundaries. Blue Heron Pond has no maintained access sites or boat launches. However, a turn-out off of State Highway 28 may accommodate small watercraft launched by hand. No evidence was found in the Douglas County Code (Brad Kilby, Douglas County Planning, personal communication) that restricts the use of combustible engines on this pond.

Washington Department of Fish and Wildlife has not managed Blue Heron Pond in the past, including fish stocking or rehabilitations. However, information collected in fall 2000 may be used for public inquiries or for future management.

Results and Discussion

Although in low number, a total of four fish species were observed in Blue Heron Pond in fall 2000 (Table 3). One black crappie *Pomoxis nigromaculatus* was observed which was 120 mm in length, weighed 21 g, had a relative weight of 97, and was two years of age. The only largemouth bass observed was 311 mm in length, weighed 401 g, had a relative weight of 92, and was three years of age. Both yellow perch were two years of age and had relative weights of 73 and 75. Although only one carp *Cyprinus carpio* was observed in Blue Heron Pond, others were observed prior to sampling and densities are likely much higher than what these data indicate. It should be noted that sample sizes were too low for accurate analyses, and these data should be used for informational purposes only.

Table 3. Species composition by weight, number, and size range of fish captured at Blue Heron Pond, Douglas County, Washington during October-November 2000.

	Species Composition					
	Weight		Number		Total Length (mm)	
Type of Fish	**kg**	**%**	**No.**	**%**	**Min.**	**Max.**
black crappie	0.02	1.14	1	20.00	120	120
carp	1.24	67.63	1	20.00	466	466
largemouth bass	0.40	21.82	1	20.00	311	311
yellow perch	0.17	9.41	2	40.00	194	211

Conclusions and Management Options

Since WDFW has not managed Blue Heron Pond in recent years, no management changes are recommended at this time. Although densities of some species, such as carp, were higher than what the data indicated, most warmwater gamefish species were in low abundance. If WDFW should elect to manage Blue Heron Pond in the future, further fish surveys would be required. Although their true abundance was unknown, carp are a prolific species and may soon overpopulate the pond. Rehabilitation may be a prerequisite to the establishment of suitable warmwater fisheries in Blue Heron Pond.

Big Bow Pond

Background

Big Bow Pond is located outside the Rock Island city limits, less than one kilometer northeast of Blue Heron Pond (Figure 1). Several smaller ponds existed where Big Bow Pond sits now. When water level of the Rock Island pool was raised in 1979, those ponds converged to create Big Bow Pond. Most of the land surrounding this 27 ha (67 acre) pond is privately owned and consists of fruit orchards and private residences. A portion of the land is undeveloped. Big Bow Pond has two access sites; one at the southwest end and another at the northeast end. Both access sites consist of unimproved boat launches, parking areas, and toilet facilities. No evidence was found in the Douglas County Code (Brad Kilby, Douglas County Planning, personal communication) that restricts the use of combustible engines on this pond.

Washington Department of Fish and Wildlife last rehabilitated Big Bow Pond in March 1990 (WDFW 1990a). Species of fish found during the 1990 rehabilitation in order of abundance were: yellow perch, pumpkinseed, bluegill, largemouth bass, goldfish *Carassius auratus*, and northern pikeminnow *Ptychocheilus oregonensis*. In May and June, following the 1990 rehabilitation, WDFW stocked the lake with rainbow trout *Oncorhynchus mykiss*, largemouth bass, and bluegill (Table 4). Rainbow trout have been stocked annually since 1990 and were the only species stocked between 1991 and 1998. WDFW introduced channel catfish to Big Bow Pond in 1999.

Table 4. Fish stocked in Big Bow Pond, Douglas County, Washington since the 1990 rehabilitation.

Year	Species	Number	Size
2000	channel catfish	1,000	fingerlings
	rainbow trout	3,053	catchables
1999	channel catfish	1,150	fingerlings
	rainbow trout	4,500	catchables
1998	rainbow trout	3,798	catchables
	rainbow trout	3,045	fingerlings
1997	rainbow trout	3,960	catchables
	rainbow trout	3,006	fingerlings
1996	rainbow trout	4,122	catchables
	rainbow trout	3,003	fingerlings
1995	rainbow trout	5,711	catchables
	rainbow trout	3,003	fingerlings
1994	rainbow trout	3,697	catchables
	rainbow trout	3,004	fingerlings
1993	rainbow trout	1,517	catchables
	rainbow trout	3,007	fingerlings
1992	rainbow trout	1,496	catchables
	rainbow trout	4,998	fingerlings
1991	rainbow trout	1,500	catchables
1990	rainbow trout	2,070	catchables
	largemouth bass	18	adults
	largemouth bass	73	sub-adults
	bluegill	32	adults

Results and Discussion

Species Composition

A total of six fish species were observed in Big Bow Pond in fall 2000 (Table 5). Warmwater gamefish comprised over 99 percent of the total fish captured. Bluegill were the most abundant species (94%) sampled and accounted for most of the biomass (62%). Only two channel catfish were observed in Big Bow Pond in 2000. This was fewer than expected since 1,000 channel catfish fingerlings were stocked prior to the survey 2000 and 1,150 were stocked in 1999 (Table 4). Although a total of 1,023 rainbow trout were stocked in April 2000, none were not observed during October-November 2000. This was expected since Big Bow Pond is relatively shallow and rainbow trout survival is likely low due to high summer water temperatures and/or water chemistry conditions.

Table 5. Species composition by weight, number, and size range of fish captured at Big Bow Pond, Douglas County, Washington during October-November 2000.

	Species Composition					
	Weight		Number		Total Length (mm)	
Type of Fish	**kg**	**%**	**No.**	**%**	**Min.**	**Max.**
bluegill	7.26	62.04	246	94.62	95	169
channel catfish	0.69	5.90	2	0.77	216	407
largemouth bass	1.62	13.87	8	3.08	120	414
largescale sucker	2.02	17.22	1	0.38	565	565
pumpkinseed	0.04	0.36	2	0.77	105	107
yellow perch	0.07	0.61	1	0.38	188	188

Catch Per Unit Effort (CPUE)

Whether using active (electrofishing) or passive (gill netting or fyke netting) techniques to sample a lake or reservoir, CPUE can be a useful index to monitor size structure and relative abundance (Hubert 1996). Past data collection efforts on Big Bow Pond have been sporadic. This information will be used as a baseline which will allow fishery managers to monitor the effectiveness of future management techniques used on the pond.

Overall, electrofishing captured more fish in Big Bow Pond than did gill nets or fyke nets. Electrofishing catch rates of warmwater gamefish were highest on bluegill (348.9 fish/hr) and largemouth bass (10.4 fish/hr)(Table 6). Although few fish were captured, gill netting and fyke netting catch rates were highest on bluegill.

With few exceptions, electrofishing captured the same size fish than did gill nets and fyke nets (refer to length-frequency histograms under species sections). With the exception of bluegill, most species were sampled in low numbers. If the sample size were larger, differences in the sizes of fish sampled by electrofishing, gill netting, and fyke netting may have been shown more clearly.

Table 6. Mean catch per unit effort by sampling method, including 80 percent confidence intervals, for fish collected from Big Bow Pond in October-November 2000.

	Gear Type								
	Electrofishing			Gill Netting			Fyke Netting		
Species	No. Hour	CI (+/-)	No. Sites	No. Night	CI (+/-)	Net Nights	No. Night	CI (+/-)	Net Nights
bluegill	348.9	55.8	4	4.0	1.3	2	0.5	0.6	2
channel catfish	1.5	1.9	4	0.0	–	2	0.0	--	2
largemouth bass	10.4	8.4	4	0.5	0.6	2	0.0	--	2
largescale sucker	0.0	–	4	0.5	0.6	2	0.0	--	2
pumpkinseed	3.0	3.8	4	0.0	–	2	0.0	--	2
yellow perch	0.0	–	4	0.5	0.6	2	0.0	--	2

Stock Density Indices

With the exception of bluegill, the sample size of stock length fish in our samples were below the minimum required (n = 55) for a sound PSD estimate (Bonar et al. In Press). Due to the low sample sizes, the PSD estimates calculated for largemouth bass and pumpkinseed were suspect and should be viewed accordingly. The PSD of bluegill sampled by electrofishing was less than one indicating that few fish were reaching quality size (Table 7). Of the stock length bluegill (n = 237), only two were of quality size and none were preferred size or larger. It is uncertain as to why few bluegill reached quality size although water chemistry may have played a role (refer to Water Chemistry section).

Table 7. Stock density indices, including 80 percent confidence interval, for warmwater fishes collected by electrofishing and gill netting in Big Bow Pond (Douglas County) during October-November 2000. PSD = proportional stock density, RSD = relative stock density, RSD-P = relative stock density of preferred fish, RSD-M = relative stock density of memorable fish, and RSD-T = relative stock density of trophy fish.

Species	#Stock Length	PSD	RSD-P	RSD-M	RSD-T
		Electrofishing			
bluegill	237	0.84 ± 0.76	0	0	0
largemouth bass	2	50 ± 45	50 ± 45	0	0
pumpkinseed	2	0	0	0	0
		Gill Netting			
bluegill	8	0	0	0	0

Water Chemistry

Due to equipment failure, water chemistry measurements were not taken on Big Bow Pond. However, historical information may provide insight into the current fishery dynamics of the pond. In the 1980s, several of the Rock Island Ponds experienced both summer and winter fish kills (WDFW Region 2 Files) due to low dissolved oxygen (DO) levels. In summer, decomposition of aquatic vegetation and filamentous algae may deplete unstratified waters of dissolved oxygen and can result in fish kills. Similarly, winter fish kills may occur in shallow ice-covered lakes when abundant aquatic vegetation dies and consumes oxygen during decomposition (Goldman and Horne 1983). Conditions in Big Bow Pond in recent years may not have been this extreme. However, decomposition of aquatic vegetation in the pond may be limiting available fish habitat and although they appear low, fish densities may be at sustainable levels. Water chemistry measurements should be recorded at least monthly to determine if fish production in Big Bow Pond is limited due to low dissolved oxygen levels.

Largemouth Bass

Largemouth bass were sampled in numbers too low for accurate analyses and results reported for this species should be used only for informational purposes. Largemouth bass ranged in age from 1 to 5 years with Age 3 being most abundant of those fish analyzed for age and growth (Table 8). Growth of Ages 1, 4, and 5 largemouth bass was above the statewide average whereas growth of Ages 2 and 3 largemouth bass was below the statewide average. One YOY largemouth bass was observed which indicates that at least low levels of natural reproduction had occurred.

Total lengths of largemouth bass (n = 8) sampled at Big Bow Pond ranged from 120 to 414 mm (Table 5, Figure 2) although only one fish greater than 205 mm was observed. Largemouth bass less than 205 mm were in poor condition; none had relative weights exceeding 100 (Figure 3). The only larger size largemouth bass (414 mm) that was observed had a relative weight of 111.

Overall, largemouth bass in Big Bow Pond appear to be in low density. Fish in low densities typically exhibit relative weights of, or above, 100. However, relative weights of most Big Bow Pond largemouth bass were below 100 and growth of most fish less than Age 4 was poor. Poor water chemistry may be limiting suitable habitat for largemouth bass in the pond. If low summer and/or winter dissolved oxygen levels (refer to Water Chemistry section) had forced largemouth bass and other fish species to certain areas of the pond, competition for food and space may be high. Largemouth bass less than 205 mm are likely competing with bluegill for available resources which may have limited recruitment of largemouth bass to larger sizes. Although larger size largemouth bass may be limited for space, they are likely able to utilize the larger prey items such as bluegill. Largemouth bass prefer substrate consisting of sand, gravel, or small cobble for spawning (Wydoski and Whitney 1979). Due to the dense aquatic vegetation in Big Bow Pond, largemouth spawning habitat may be limited which may also explain their low numbers.

Table 8. Age and growth of largemouth bass captured at Big Bow Pond during October-November 2000. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993), and unshaded values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length (mm) at age				
Year Class	**# Fish**	**1**	**2**	**3**	**4**	**5**
1999	2	87.7				
		94.5				
1998	1	74.9	138.1			
		85.9	141.6			
1997	4	66.0	123.8	151.6		
		79.0	130.6	155.5		
1996	0	--	--	--	--	
		--	--	--	--	
1995	1	58.7	161.1	255.9	347.8	389.9
		75.9	173.3	263.6	351.0	391.1
Overall Mean		71.6	132.4	172.5	347.8	389.9
Weighted Mean		83.3	139.5	177.1	351.0	391.1
E. WA average		68.8	135.6	189.2	248.9	299.9

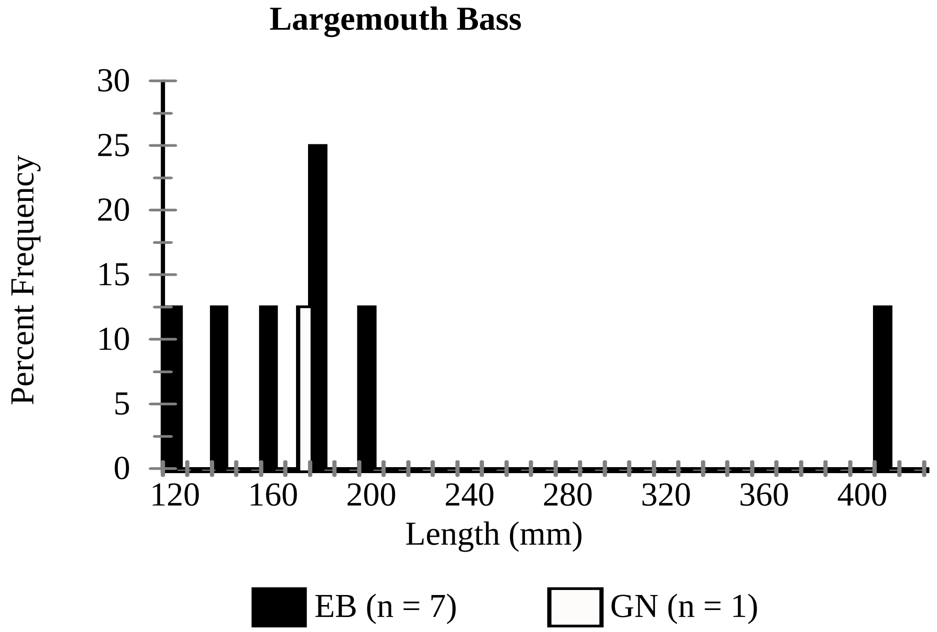

Figure 2. Length frequency distribution of largemouth bass sampled by electrofisher (EB) and gill nets (GN) in Big Bow Pond during October-November 2000.

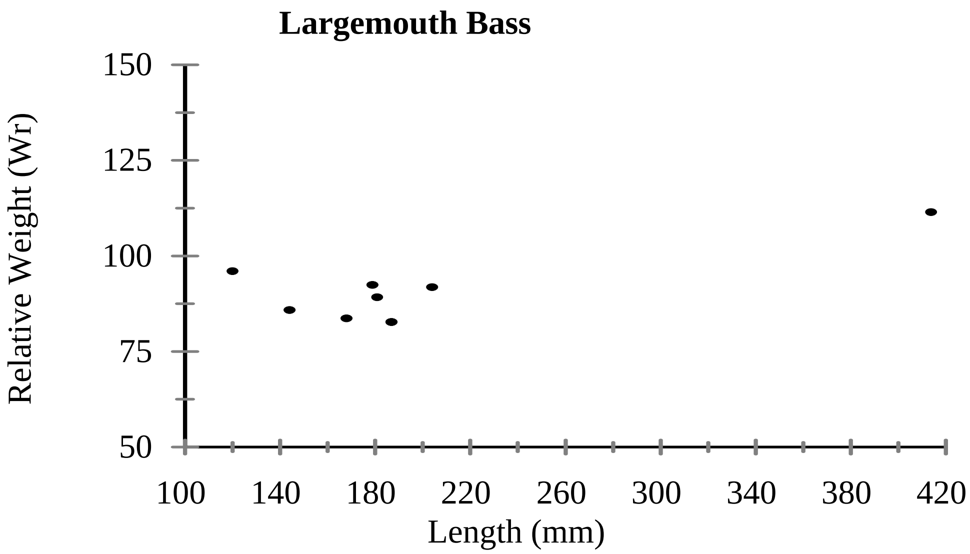

Figure 3. Relative weights of largemouth bass (n = 8) sampled at Big Bow Pond during October-November 2000, as compared to the national average, W_r = 100 (Anderson and Neumann 1996).

Bluegill

A total of 246 bluegill were sampled at Big Bow Pond in 2000 (Table 5), all but eight using electrofishing. Bluegill ranged in age from 2 to 4 years with Age 4 fish being most abundant of those analyzed for age and growth (Table 9). No YOY or Age 1 bluegill were observed. Growth of Big Bow Pond bluegill was below the statewide average at all ages.

Total lengths of bluegill sampled at Big Bow Pond ranged from 95 to 169 mm (Table 5, Figure 4). Bluegill sampled from Big Bow Pond were in poor condition; few fish had relative weights greater than 100 (Figure 5).

Although bluegill were the most abundant species sampled (~95%), their overall abundance was less than expected. In addition, growth rates and condition of bluegill in the pond were poor indicating that food or space may be limited. Similar to largemouth bass, bluegill may be limited by food and space due to low summer and/or winter dissolved oxygen levels. All fish species in Big Bow Pond may, at times, be restricted to certain areas of the pond. Although bluegill may be better suited than other species for feeding in dense vegetation, overall food abundance may be limited during periods of low dissolved oxygen.

Table 9. Age and growth of bluegill captured at Big Bow Pond during October-November 2000. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993), and unshaded values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length (mm) at age			
Year Class	**# Fish**	**1**	**2**	**3**	**4**
1999	0	–			
		–			
1998	8	23.1	68.9		
		38.9	76.5		
1997	6	24.8	65.9	97.4	
		40.6	74.8	100.9	
1996	13	16.5	57.5	100.9	119.0
		34.0	68.9	105.9	121.3
Overall Mean		20.3	62.8	99.8	119.0
Weighted Mean		36.9	72.5	104.3	121.3
WA State average		37.3	96.8	132.1	148.3

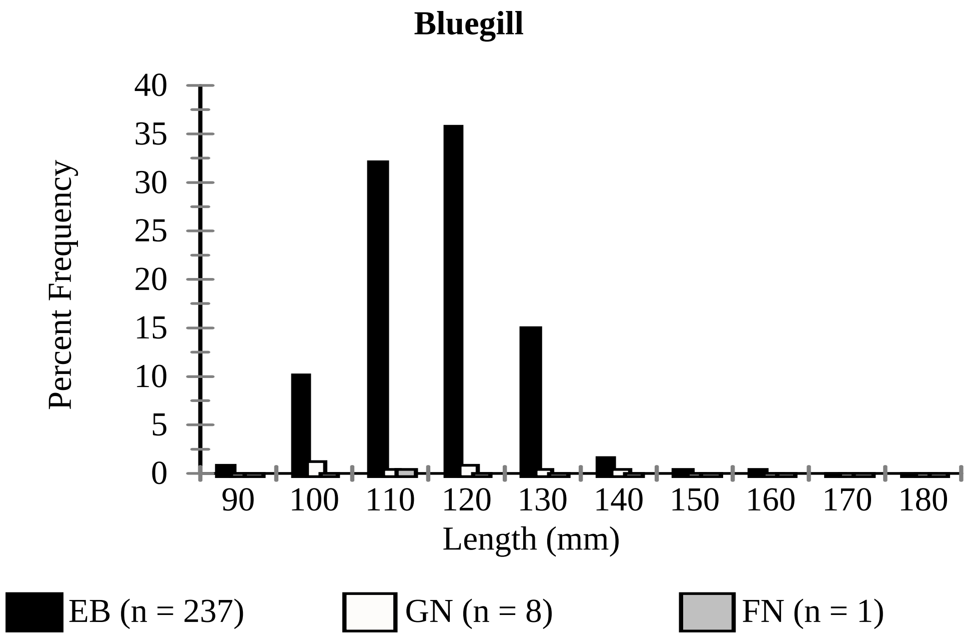

Figure 4. Length frequency distribution of bluegill sampled by electrofisher (EB), gill nets (GN), and fyke nets (FN) in Big Bow Pond during October-November 2000.

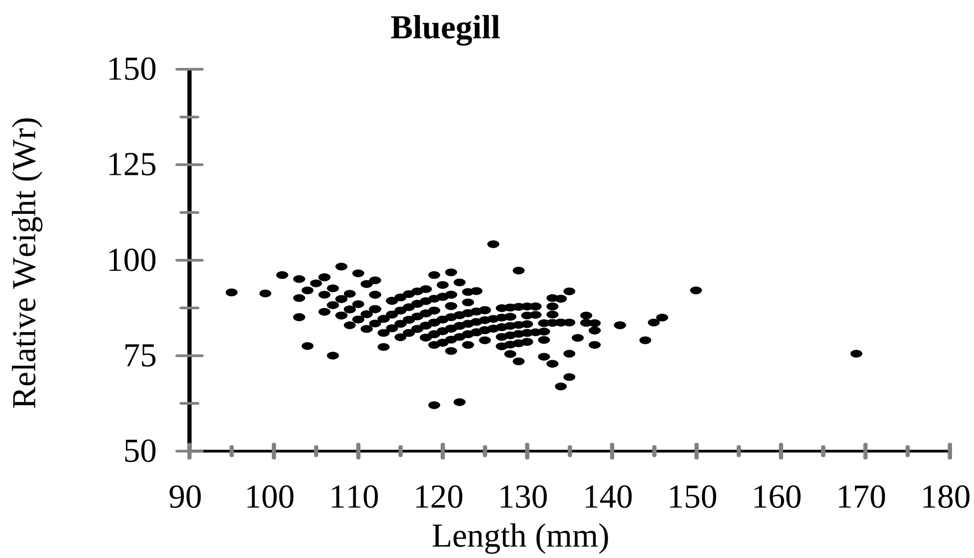

Figure 5. Relative weights of bluegill (n = 245) sampled at Big Bow Pond during October-November 2000, as compared to the national average, W_r = 100 (Anderson and Neumann 1996).

Pumpkinseed and Yellow Perch

Only two pumpkinseed and one yellow perch were sampled at Big Bow Pond in 2000 (Table 5). Pumpkinseed ranged in total length from 105 to 107 mm. Scale samples were not collected from pumpkinseed thus age and growth were not investigated. The yellow perch that was observed was 188 mm in length and was two years of age. All pumpkinseed and yellow perch were in poor condition having relative weights less than 90 indicating these species are likely limited by food and/or space. As reported for largemouth bass and bluegill, pumpkinseed and yellow perch may be negatively affected by poor water chemistry. If habitat was limited, bluegill may have out-competed pumpkinseed and yellow perch for available resources in the pond.

Channel Catfish

Only two channel catfish were sampled at Big Bow Pond in 2000 (Table 5). One of the channel catfish was 216 mm in length and was likely one of those stocked as fingerlings prior to the survey in 2000 (Table 4). The other fish was 407 mm in length and was likely stocked as a fingerling in 1999. Both channel catfish had relative weights less than 100.

Although channel catfish can survive in turbid water, they are seldom found in waters containing dense aquatic vegetation (Wydoski and Whitney 1979). Moreover, adults tend to move into shallow water areas at night to feed and return to deep holes during the day. Since most of Big Bow Pond is shallow and heavily vegetated, habitat conditions in Big Bow Pond are likely less than optimal for this species and survival may be low.

Conclusions and Management Options

With the exception of bluegill, all fish species in Big Bow Pond were observed in low density. Although density of bluegill was higher than any other species, their abundance was lower than expected. Growth and condition of most largemouth bass, bluegill, yellow perch, and pumpkinseed were poor indicating these species may be limited by food and/or space. In the 1980s, some of the Rock Island Ponds experienced both summer and winter fish kills which was contributed to low dissolved oxygen concentrations. The majority of Big Bow Pond is shallow and heavily vegetated. Waters with these characteristics are conducive to water chemistry problems due to the decomposition of aquatic vegetation and filamentous algae. During summer or winter, low dissolved oxygen may restrict fish to certain areas of the pond, drastically reduce available habitat, or result in fish kills. If fish become restricted due to low dissolved oxygen, competition may be high for smaller individuals, food may become sparse, and overall survival may be low. However, large individuals of certain species, such as largemouth bass, may subsist due their ability to utilize the larger prey. Catchable size and/or fingerling rainbow trout have been stocked in the pond annually since the 1990 rehabilitation, although none were observed during the 2000 survey. Overall survival is likely low since the pond is shallow and water temperature likely exceeds tolerable levels in summer. Channel catfish were stocked in Big Bow Pond in 1999 and 2000. Although two channel catfish were observed during the survey in 2000, habitat conditions in the pond are likely less than optimal and their overall survival is questionable.

Water Chemistry Monitoring

Due to equipment failure, water chemistry measurements were not taken on Big Bow Pond during the 2000 survey. Measurements should be taken at least once each month for a year to more fully understand the water chemistry dynamics of the pond and to determine whether water chemistry contributed to the low abundance of fish. Water chemistry data should be collected at 1 m increments at several locations including the area of greatest depth. A Hydrolab® should be used to collect information on dissolved oxygen, temperature, pH, conductivity, and turbidity. Water chemistry data may be useful not only to interpret previous conditions, but to also assist fishery biologists in determining future management and/or stocking options.

Aquatic Vegetation Control

If water chemistry monitoring reveals that dissolved oxygen during summer and/or winter are at levels that could greatly reduce available habitat for fish inhabitants, vegetation control measures should be considered. Aquatic vegetation can be reduced by mechanical, chemical, and biological methods (Wiley et al. 1984). Mechanical vegetation removal is expensive, labor intensive, and often yields only short-term benefits. Grass carp *Ctenopharyngodon idella* can be used as a biological means for removing aquatic vegetation and have been used in Washington State with variable success (Bonar et al. 1996). Prior to introducing grass carp, an application must be submitted and approved. Under appropriate conditions, chemical treatments can be effective in controlling aquatic vegetation. Investigations would be required to determine what the water in Big Bow Pond is used for and whether chemical treatments would potentially harm humans, terrestrial wildlife, and surrounding crops.

Stocking

Warm summer water temperature probably limits survival of trout throughout July and August, and it is recommended that catchable size trout be stocked in spring to provide public fishing opportunity. As with other size trout, those stocked as fingerlings may not survive through the summer and may not achieve sizes which would benefit anglers. Although rainbow trout have been stocked annually since the 1990 rehabilitation, brown trout *Salmo trutta* may provide anglers with fishing opportunity for a longer period each year. Brown trout can tolerate warmer water temperatures, more turbid water, and lower dissolved oxygen levels than rainbow trout (Wydoski and Whitney 1979) although catch rates may not be as high. Stocking a minimum of 3,000 trout each spring is recommended. Stocking should occur on two separate occasions; once in March, and again in late April or early May. This would likely provide anglers with fishing opportunity throughout spring and early summer.

Habitat conditions in Big Bow Pond are likely not optimal for channel catfish and survival of fish stocked as fingerlings is questionable. However, stocking larger size channel catfish (minimum of ~16 inches) may provide anglers with immediate angling opportunity, regardless of whether those fish survived for prolonged periods. Current angler survey information on Big Bow Pond is lacking and the benefit of the channel catfish fishery is unknown. At least a short-term creel survey would be beneficial in determining effort expended on channel catfish so that stocking rates could be adjusted accordingly.

Largemouth bass and bluegill have not been stocked in Big Bow Lake since 1990 and plans for stocking these species in recent years have not been considered. However, water chemistry investigations are required prior to stocking largemouth bass and/or bluegill for warmwater gamefish management in Big Bow Pond.

Warmwater Gamefish Monitoring

No regulation changes are recommended at this time. However, periodic warmwater fish surveys, including water chemistry monitoring, should be conducted to monitor fish population dynamics in Big Bow Pond. Future monitoring would likely forecast whether additional warmwater gamefish stocking was needed and/or adjustments in regulations should be made.

Hideaway Pond

Background

Hideaway Pond is a 7 ha (19 acre) pond located outside the Rock Island city limits in Douglas County, Washington (Figure 1). Land surrounding Hideaway Pond is either privately owned or controlled by Chelan County PUD and consists primarily of fruit orchards. Hideaway Pond has one maintained access site on the southeast end which consists of a parking area, toilet facilities, and an unimproved boat launch. No evidence was found in the Douglas County Code (Brad Kilby, Douglas County Planning, personal communication) that restricts the use of combustible engines on this pond.

Hideaway Pond was rehabilitated in 1979 and was stocked with 2,000 rainbow trout fingerlings shortly thereafter. Hideaway Pond was stocked only one other time, in 1987, when it received 6,750 eastern brook trout *Salvelinus fontinalis* fingerlings. Similar to other ponds in the area, Hideaway Pond is shallow and occasionally experiences high temperatures and low dissolved oxygen levels during summer (WDFW Region 2 Files) which likely limits trout survival. Although WDFW has not actively managed Blue Heron Pond in recent years, information collected in fall 2000 may be used for public inquiries or for future management.

Results and Discussion

A total of four fish species were observed in Hideaway Pond in fall 2000 (Table 10). Since only trout were stocked following the 1979 rehabilitation, all species presently inhabiting the pond either survived the rehabilitation, or were a result of unauthorized introductions. Brown bullhead was the most abundant species sampled comprising over 97 percent of the total number and over 90 percent of the total biomass. Of the brown bullhead sampled (n = 2,868), approximately 98 percent were captured in fyke nets whereas 2 percent were captured electrofishing. Brown bullhead ranged in total length from 101 to 132 mm (Table 10, Figure 6) and were in overall poor condition; none had relative weights greater than 100 (Figure 7). Bluegill ranged in age from 3 to 4 years and growth was below the statewide average at all ages (Table 11). No Age 1 or Age 2 bluegill were observed. Bluegill ranged in total length from 109 to 167 mm (Table 10, Figure 8) and were in poor condition. Few bluegill had relative weights greater than 100 (Figure 9). Although few in number, largemouth bass ranged in age from 3 to 5 years (Table 12) and growth was well above the statewide average at all ages. No Age 1 or Age 2 largemouth bass were observed. Total lengths of largemouth bass (n = 4) ranged from 325 to 426 mm (Table 10,

Figure 10). Largemouth bass sampled at Hideaway Pond were in exceptional condition; relative weights ranged from 103 to 131 (Figure 11). No YOY fish from any species were observed. Data indicate that Hideaway Pond is overpopulated with brown bullhead. With the exception of largemouth bass, condition of all species was poor indicating that they are limited by food and space. Largemouth bass appeared in low abundance and were in exceptional condition indicating that they are not limited by food or space. Bluegill, pumpkinseed, and brown bullhead are probably competing for the same limited resources. All largemouth bass sampled were greater than 300 mm and are likely able to utilize larger prey items such as bluegill, pumpkinseed, and abundant brown bullhead. Spawning success of largemouth bass and bluegill may have been limited due to the high density of brown bullhead in the pond. The 1999 (Age 1) and 1998 (Age 2) year classes of both largemouth bass and bluegill were absent.

Table 10. Species composition by weight, number, and size range of fish captured at Hideaway Pond, Douglas County, Washington during October-November 2000.

	Species Composition					
	Weight		**Number**		**Total Length (mm)**	
Type of Fish	**kg**	**%**	**No.**	**%**	**Min.**	**Max.**
brown bullhead	57.68	90.49	2,868	97.85	101	132
bluegill	2.02	3.17	47	1.60	109	167
largemouth bass	3.64	5.71	4	0.14	325	426
pumpkinseed	0.40	0.63	12	0.41	99	149

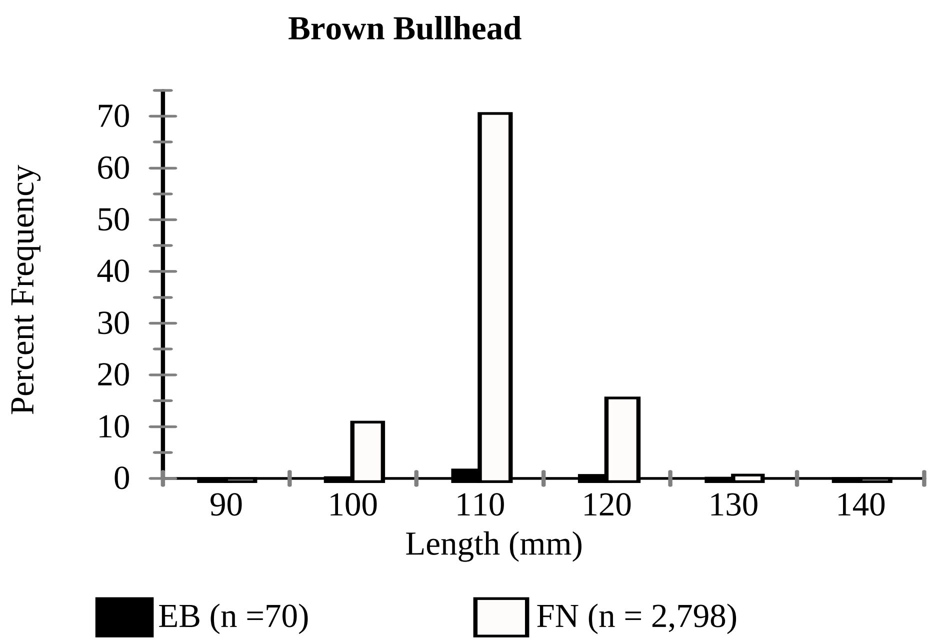

Figure 6. Length frequency distribution of brown bullhead sampled by electrofisher (EB) and fyke nets (FN) in Hideaway Pond during October-November 2000.

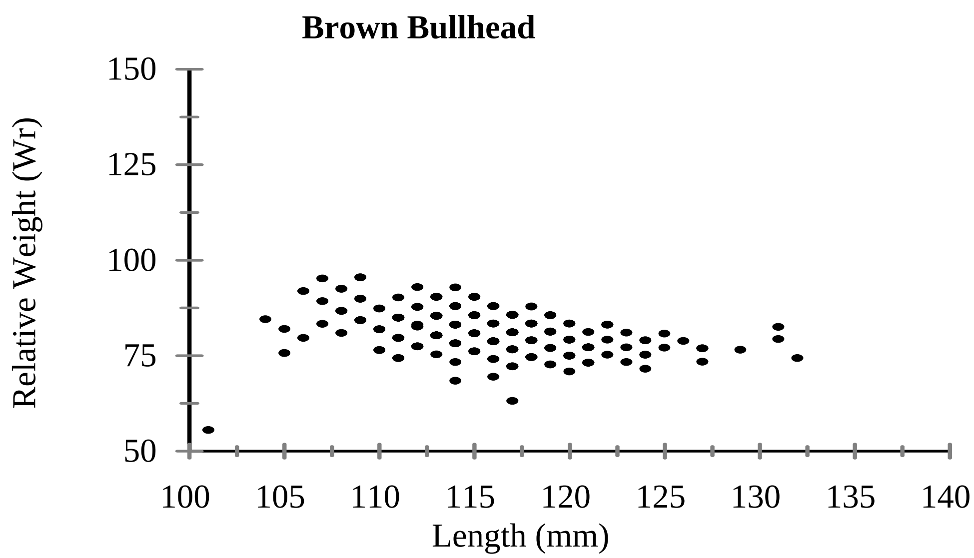

Figure 7. Relative weights of brown bullhead (n = 138) sampled at Hideaway Pond during October-November 2000, as compared to the national average, W_r = 100 (Anderson and Neumann 1996).

Table 11. Age and growth of bluegill captured at Hideaway Pond during October-November 2000. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993), and unshaded values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length (mm) at age			
Year Class	**# Fish**	**1**	**2**	**3**	**4**
1999	0	–			
		–			
1998	0	–	–		
		–	–		
1997	13	25.1	71.9	115.5	
		41.4	81.1	118.1	
1996	10	28.5	77.4	116.2	128.2
		44.4	86.0	119.1	129.3
Overall Mean		26.6	74.3	115.8	128.2
Weighted Mean		42.7	83.2	118.5	129.3
WA State average		37.3	96.8	132.1	148.3

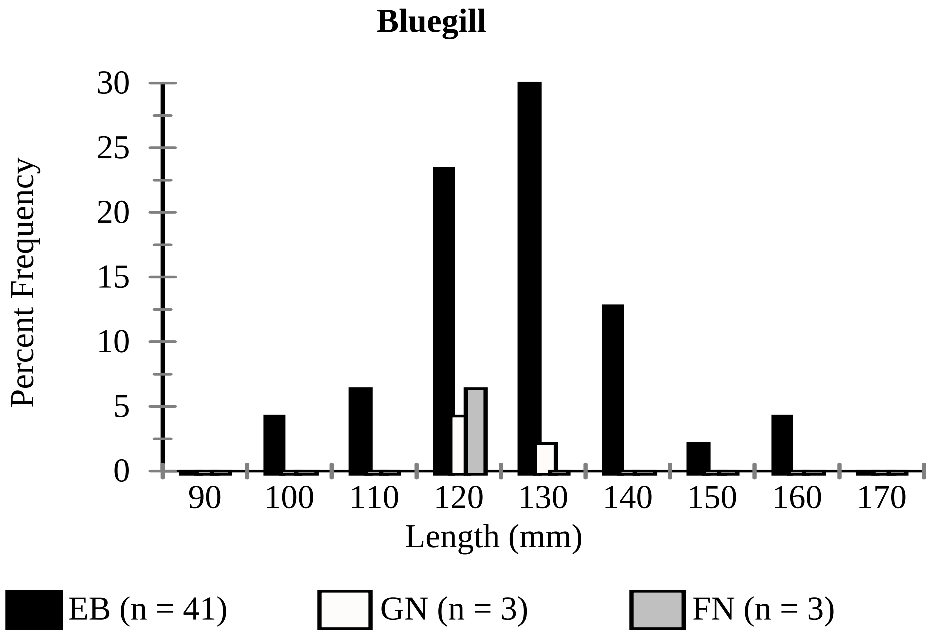

Figure 8. Length frequency distribution of bluegill sampled by electrofisher (EB), gill nets (GN), and fyke nets (FN) in Hideaway Pond during October-November 2000.

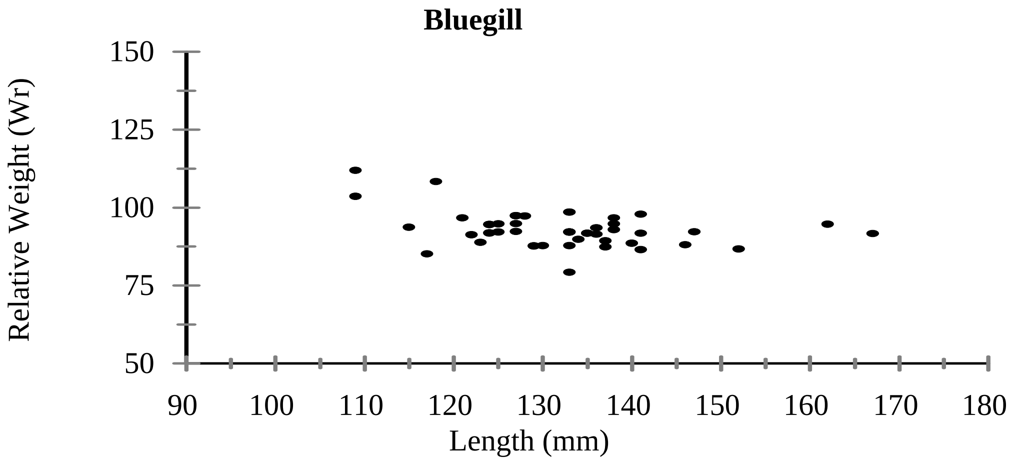

Figure 9. Relative weights of bluegill (n = 47) sampled at Hideaway Pond during October-November 2000, as compared to the national average, W_r = 100 (Anderson and Neumann 1996).

Table 12. Age and growth of largemouth bass captured at Hideaway Pond during October-November 2000. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993), and unshaded values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length (mm) at age				
Year Class	**# Fish**	**1**	**2**	**3**	**4**	**5**
1999	0	–				
		–				
1998	0	–	–			
		–	–			
1997	2	154.4	230.3	301.4		
		165.1	236.5	303.3		
1996	1	88.0	164.4	283.4	348.1	
		103.3	175.6	288.3	349.5	
1995	1	120.5	298.2	355.4	391.9	411.4
		134.8	304.2	358.7	393.5	412.1
Overall Mean		129.3	230.8	310.4	370.0	411.4
Weighted Mean		142.1	238.2	313.4	371.5	412.1
E. WA average		68.8	135.6	189.2	248.9	299.9

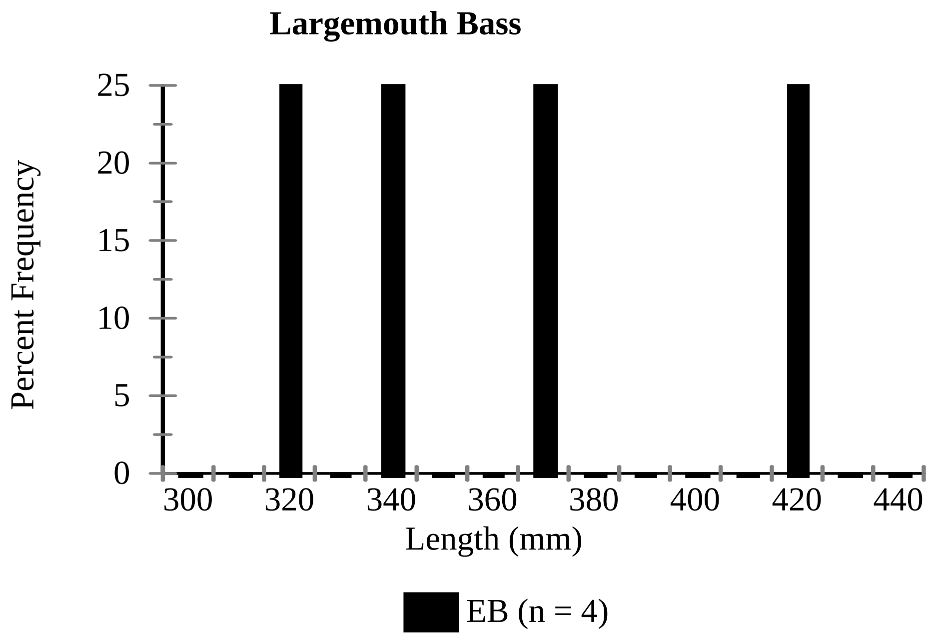

Figure 10. Length frequency distribution of largemouth bass sampled by electrofisher (EB) in Hideaway Pond during October-November 2000.

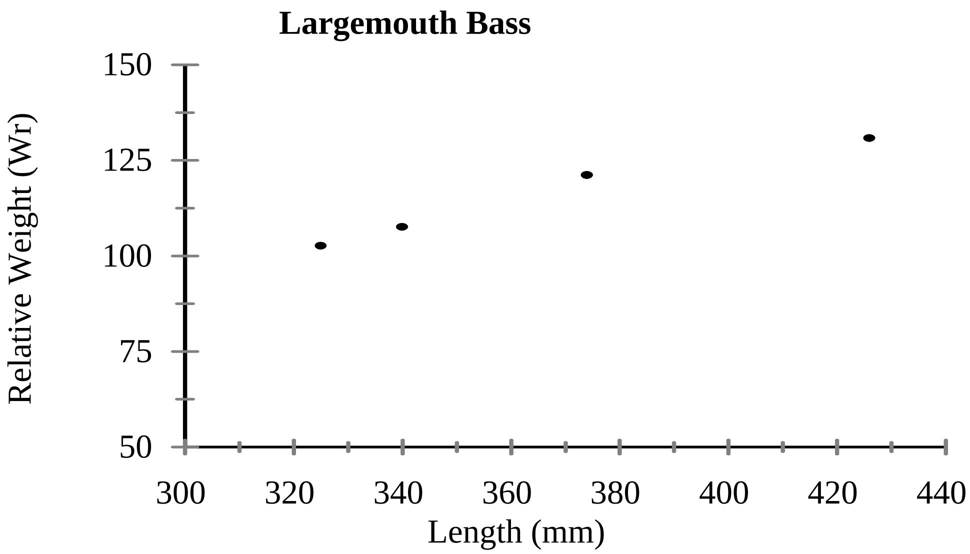

Figure 11. Relative weights of largemouth bass (n = 4) sampled at Hideaway Pond during October-November 2000, as compared to the national average, W_r = 100 (Anderson and Neumann 1996).

Conclusions and Management Options

Hideaway Pond contains a high density of brown bullhead which may have limited spawning success and recruitment of bluegill and largemouth bass. Due to their high density, brown bullhead likely compete with bluegill and pumpkinseed for food and space which may explain the poor condition of those species. Due to the high density of brown bullhead, Hideaway Pond is a candidate for rehabilitation. However, total eradication of this species will be difficult since brown bullhead can tolerate extremely low dissolved oxygen levels (0.2 mg/l) and may seek refuge in dense aquatic vegetation or bottom sediments during treatment. Other measures to reduce brown bullhead, such as physical removal, would be extremely difficult and expensive. If Hideaway Pond was rehabilitated, adult largemouth bass and bluegill should be salvaged during the treatment and transplanted in one of the other ponds in the area. Following rehabilitation, we recommend stocking Hideaway Pond with a minimum of 100 adult or sub-adult largemouth bass (5-6/acre) and 300 adult bluegill (15/acre). Periodic warmwater fish surveys would be required to monitor fish population dynamics in Hideaway Pond. Future monitoring would likely forecast whether additional warmwater gamefish stocking was needed and/or adjustments in regulations should be made.

Although current creel survey information doesn't exist, Hideaway Pond has limited access and likely receives little angler effort. Unless it is rehabilitated, stocking efforts, regardless of species, is not recommended due to the presumed low cost to benefit ratio.

Pit Pond

Background

At 1.5 ha (4 acres), Pit Pond is the smallest of all the Rock Island Ponds. Pit Pond is located inside of the Rock Island city limits in Douglas County, Washington (Figure 1). Land surrounding Pit Pond is owned by the City of Rock Island. A dike, including parking and toilet facilities, comprises the east shoreline of Pit Pond which provides access to anglers. The City of Rock Island City limits Pit Pond to juvenile, persons 15 years of age or younger, anglers only (Whitey Evenhus, Mayor of Rock Island, Washington, personal communication). Although statewide fishing limits apply, the juvenile-only regulation will likely be included in the Washington State Sport Fishing Rules Pamphlet following the 2002 regulation cycle (Art Viola, WDFW, personal communication). In addition, Rock Island City Resolution #01032 prohibits the use of flotation devices on Pit Pond.

Unlike most of the Rock Island Ponds, Pit Pond has been managed exclusively for trout. Pit Pond was rehabilitated in 1990 in an attempt to eradicate largemouth bass and bluegill (WDFW 1990b). With the exception of 1991, Pit Pond was stocked with fingerling and/or catchable size rainbow trout annually since the 1990 rehabilitation (Table 13). Although the mean and maximum depth is unknown, Pit Pond is deeper than most of the Rock Island Ponds and can likely provide juvenile anglers with trout fishing opportunities throughout most of the year due to lower summer water temperature and higher dissolved oxygen concentration.

Table 13. Fish stocked in Pit Pond, Douglas County, Washington since the 1990 rehabilitation.

Year	Species	Number	Size
2000	rainbow trout	803	catchables
1999	rainbow trout	1,500	catchables
1998	rainbow trout	1,002	catchables
	rainbow trout	1,008	fingerlings
1997	rainbow trout	1,000	catchables
	rainbow trout	1,002	fingerlings
1996	rainbow trout	1,065	catchables
	rainbow trout	1,019	fingerlings
1995	rainbow trout	1,679	catchables
	rainbow trout	1,001	fingerlings
1994	rainbow trout	1,224	catchables
	rainbow trout	996	fingerlings
1993	rainbow trout	1,002	fingerlings
1992	rainbow trout	986	fingerlings
1991	–	–	–
1990	rainbow trout	253	catchables

Results and Discussion

A total of three fish species were observed in Pit Pond in fall 2000 (Table 14). Largemouth bass, pumpkinseed, and yellow perch in Pit Pond were likely a result of unauthorized introduction. One largemouth bass was observed which was 122 mm in length, weighed 16 g, had a relative weight of 73, and was one year of age. Scales were not collected from pumpkinseed (n = 3) sampled in Pit Pond, thus, age and growth were not investigated. Two yellow perch were sampled at Pit Pond. One yellow perch was 165 mm in length, was 4 years of age, and had a relative weight of 79. The other yellow perch was 171 mm in length, was 3 years of age, and had a relative weight of 75. Growth of the largemouth bass and yellow perch sampled was slightly below the statewide average. Sample sizes were too low for accurate analyses and these data should be used for informational purposes only.

Largemouth bass, pumpkinseed, and yellow perch were observed in low numbers. Some species, such as largemouth bass and pumpkinseed are sampled more effectively by electrofishing than by gill netting. Due to limited access, gill netting was the only sampling gear used and although numbers of largemouth bass and pumpkinseed would likely have been higher if the pond were sampled by electrofishing, their densities would probably still have been considered low. Pit Pond is relatively deep, exhibits steep shorelines, and littoral habitat used by these species is limited. Although no rainbow trout were observed, at least low numbers were expected since over 800 were stocked in spring 2000.

Table 14. Species composition by weight, number, and size range of fish captured at Pit Pond, Douglas County, Washington during October-November 2000.

	Species Composition					
	Weight		Number		Total Length (mm)	
Type of Fish	**kg**	**%**	**No.**	**%**	**Min.**	**Max.**
largemouth bass	0.02	9.09	1	16.67	122	122
pumpkinseed	0.06	35.81	3	50.00	102	109
yellow perch	0.10	55.10	2	33.33	165	171

Conclusions and Management Options

Pit Pond is currently recognized by the City of Rock Island as a juvenile-only water and will likely be included as such in the 2002 Washington State Sportfishing Rules. It is recommended that Pit Pond continue to be managed as a trout water due to the pond's characteristics. Although largemouth bass, pumpkinseed, and yellow perch are present, they are in low abundance and measures to eliminate these species are not necessary at this time. To provide juvenile anglers with trout fishing opportunity, we recommend stocking Pit Pond with 400 catchable size rainbow trout in, both, mid-March and late April. In addition, stocking 1,000 rainbow trout fingerlings in the fall may provide a fishery in the spring prior to the stocking of catchable size fish. Periodic sampling should be conducted to monitor fish species composition in Pit Pond.

Putters Pond

Background

Putters Pond is a 18 ha (44 acre) pond located inside the Rock Island city limits immediately east of Pit Pond (Figure 1). Putters Pond is indirectly connected to the Columbia River via two culverts; one connecting Putters Pond to an un-named pond and the other connecting the un-named pond to the river. Several smaller ponds existed where Putters Pond sits now. When water level of the Rock Island pool was raised in 1979, those ponds converged to create Putters Pond. Most land surrounding Putters Pond is privately owned although portions are owned by the City of Rock Island and Chelan County PUD. Rock Island Municipal Golf Course, which is owned by the City of Rock Island and leased to a private party, lies on the southeast shoreline of Putters Pond. Putters Pond has intermittently been divided into a large section and a small section by a narrow levee which, at times, has created an impassable barrier (WDFW 1990c). The small section has often been dredged by Central Washington Concrete to remove material used in the production of concrete and to improve fish habitat (Whitey Evenhus, Mayor of Rock Island, Washington, personal communication). Putters Pond has two access sites; one which is shared with Pit Pond on the northwest shoreline and another on the north shoreline. Both access sites consist of unimproved boat launches, parking areas, and toilet facilities. Both access sites are maintained by the City of Rock Island.

Washington Department of Fish and Wildlife attempted to rehabilitate Putters Pond in its entirety in March 1990. Shoreline owner opposition forced WDFW to postpone the rehabilitation of the small section. Under guard of WDFW agents and the Douglas County Sheriff officers, the small section was rehabilitated in mid-April 1990. Species of fish found during the 1990 rehabilitation in order of abundance were: yellow perch, pumpkinseed, bluegill, black crappie, brown bullhead, and largemouth bass. In May and June, following the 1990 rehabilitation, WDFW stocked the pond with rainbow trout, largemouth bass, and bluegill (Table 15). Rainbow trout have been stocked annually since 1990 and were the only species stocked between 1991 and 1998. WDFW introduced channel catfish to Putters Pond in 1999. Although statewide fishing limits apply, Rock Island City Ordinance #98-022 prohibits the use of combustible boat motors on Putters Pond.

Table 15. Fish stocked in Putters Pond, Douglas County, Washington since the 1990 rehabilitation.

Year	Species	Number	Size
2000	channel catfish	1,000	fingerlings
	rainbow trout	3,038	catchables
1999	channel catfish	1,215	fingerlings
	rainbow trout	4,000	catchables
1998	rainbow trout	3,806	catchables
	rainbow trout	500	triploid (1.5 lb/#)
	rainbow trout	5,044	fingerlings
1997	rainbow trout	4,209	catchables
	rainbow trout	5,160	fingerlings
1996	rainbow trout	4,050	catchables
	rainbow trout	5,041	fingerlings
1995	rainbow trout	5,711	catchables
	rainbow trout	5,005	fingerlings
1994	rainbow trout	3,697	catchables
	rainbow trout	4,996	fingerlings
1993	rainbow trout	5,260	catchables
	rainbow trout	4,994	fingerlings
1992	rainbow trout	6,200	catchables
	rainbow trout	4,998	fingerlings
1991	rainbow trout	2,030	catchables
1990	rainbow trout	1,955	catchables
	largemouth bass	130	sub-adults
	bluegill	21	adults

Results and Discussion

Species Composition

A total of seven fish species were observed in Putters Pond in fall 2000 (Table 16). Warmwater gamefish comprised approximately 90 percent of the total fish captured. Bluegill (34%) and pumpkinseed (29%) were the most, and second-most, abundant species sampled, respectively. However, those species combined accounted for only 27 percent of the total biomass which indicate that the bluegill and pumpkinseed populations in Putters Pond may be stunted. Although less abundant (15%), largemouth bass comprised the most biomass (39%). No channel catfish were observed in Putters Pond in 2000. At least low numbers were expected since 1,000 channel catfish fingerlings were stocked prior to the survey 2000 and 1,215 were stocked in 1999 (Table 15). Although a total of 3,038 rainbow trout were stocked in spring 2000, only one was observed during October-November 2000. This was expected since Putters Pond is relatively shallow and rainbow trout survival is likely low due to high summer water temperatures and/or water chemistry conditions. Tench *Tinca tinca* were not observed during the 1990 rehabilitation but were present in the 2000 samples.

Table 16. Species composition by weight, number, and size range of fish captured at Putters Pond, Douglas County, Washington during October-November 2000.

	Species Composition				Total Length (mm)	
	Weight		Number			
Type of Fish	**kg**	**%**	**No.**	**%**	**Min.**	**Max.**
bluegill	7.29	18.11	196	34.69	79	167
brown bullhead	1.15	2.84	12	2.12	42	297
largemouth bass	15.77	39.17	87	15.40	107	398
pumpkinseed	3.79	9.42	165	29.20	84	154
rainbow trout	0.18	0.45	1	0.18	282	282
tench	9.70	24.08	45	7.96	57	452
yellow perch	2.38	5.92	59	10.44	120	208

Catch Per Unit Effort (CPUE)

Catch per unit effort can be a useful index to monitor size structure and relative abundance of fish populations in lakes and reservoirs (Hubert 1996). Data have not been collected on Putters Pond since the 1990 rehabilitation and CPUE information collected in 2000 can be used as a baseline that will allow fishery managers to monitor the effectiveness of future management techniques used on the pond.

Overall, electrofishing captured more fish in Putters Pond than did gill nets or fyke nets. Electrofishing catch rates of warmwater gamefish were highest on bluegill (160.7 fish/hr) and pumpkinseed (121.8 fish/hr)(Table 17). Although few fish were captured, gill netting catch rates were highest on yellow perch whereas fyke netting catch rates were highest on pumpkinseed.

Electrofishing captured the same size fish than did gill nets and fyke nets (refer to length-frequency histograms under species sections). Some pelagic species, such as yellow perch, tend to inhabit open water as adults and are typically sampled more effectively by gill nets. However, higher numbers of yellow perch were sampled by electrofishing than with gill nets which was probably due to the lack of deep water habitat in the pond. With the exception of bluegill and pumpkinseed, most species were sampled in moderately low numbers. If the sample size were larger, differences in the sizes of fish sampled by electrofishing, gill netting, and fyke netting may have been more clearly demonstrated.

Table 17. Mean catch per unit effort by sampling method, including 80 percent confidence intervals, for fish collected from Putters Pond in October-November 2000.

	Gear Type								
	Electrofishing			Gill Netting			Fyke Netting		
Species	No. Hour	CI (+/-)	No. Sites	No. Night	CI (+/-)	Net Nights	No. Night	CI (+/-)	Net Nights
bluegill	160.7	32.4	7	0.3	0.3	4	1.5	1.2	4
brown bullhead	3.4	2.3	7	0.3	0.3	4	1.3	0.8	4
largemouth bass	72.2	31.8	7	0.0	–	4	0.5	0.4	4
pumpkinseed	121.8	74.3	7	1.8	1.1	4	3.8	1.4	4
rainbow trout	0.9	1.1	7	0.0	–	4	0.0	–	4
tench	34.1	10.7	7	0.8	0.6	4	0.5	0.4	4
yellow perch	39.0	34.9	7	3.6	3.8	4	0.0	–	4

Stock Density Indices

A total of 189 stock size bluegill, 143 stock size pumpkinseed, and 56 stock size largemouth bass were sampled by electrofishing (Table 18). With the exception of largemouth bass, no preferred size fish were observed. Of the stock length largemouth bass that was sampled, approximately 3 percent were of preferred size.

Analyses from the stock density indices and species composition indicate that Putters Pond contains stunted populations of bluegill and pumpkinseed. Few quality size largemouth bass, bluegill, pumpkinseed, and yellow perch were present and only a small proportion of largemouth bass achieved preferred size. This confirms what was found in the species composition; relatively large numbers of bluegill and pumpkinseed which comprised a low proportion of the total biomass. It is uncertain as to why few bluegill, yellow perch, pumpkinseed, or largemouth bass reached quality size although water chemistry may have played a role (refer to Water Chemistry section).

Table 18. Stock density indices, including 80 percent confidence interval, for warmwater fishes collected by electrofishing in Putters Pond (Douglas County) during October-November 2000. PSD = proportional stock density, RSD = relative stock density, RSD-P = relative stock density of preferred fish, RSD-M = relative stock density of memorable fish, and RSD-T = relative stock density of trophy fish.

Species	#Stock Length	PSD	RSD-P	RSD-M	RSD-T
		Electrofishing			
bluegill	189	6 ± 2	0	0	0
largemouth bass	56	7 ± 4	4 ± 3	0	0
pumpkinseed	143	1 ± 1	0	0	0
yellow perch	45	2 ± 2	0	0	0

Water Chemistry

Due to equipment failure, water chemistry measurements were not taken on Putters Pond. Similar to Big Bow Pond, historical information may provide insight into the current fishery dynamics of the pond. In the 1980s, several of the Rock Island Ponds experienced both summer and winter fish kills (WDFW Region 2 Files) due to low dissolved oxygen levels. Putters Pond contains a high density of aquatic vegetation and during summer, decomposition of vegetation and filamentous algae may deplete parts of the pond of dissolved oxygen which could result in fish kills. Similarly, winter fish kills may occur in shallow ice-covered lakes when abundant aquatic vegetation dies and consumes oxygen during decomposition (Goldman and Horne 1983). Conditions in Putters Pond in recent years may not have been this extreme. However, low summer and winter dissolved oxygen levels are not uncommon in Rock Island Ponds and water chemistry measurements should be recorded at least monthly to determine if corrective measures should be considered.

Largemouth Bass

Largemouth bass ranged in age from 1 to 6 years with Age 2 being most abundant of those fish analyzed for age and growth (Table 19). The sample sizes of age 4-6 fish were too low for accurate analyses. Growth of Age 6 largemouth bass was above the statewide average whereas growth of Ages 1-5 was below the statewide average. Although largemouth bass have not been stocked in Putters Pond since 1990, age data indicate that at least low levels of natural reproduction had occurred since 1994. However, no YOY largemouth bass were observed in 2000.

Total lengths of largemouth bass (n = 87) sampled at Putters Pond ranged from 107 to 398 mm (Table 16, Figure 12) although most were less than 275 mm. Largemouth bass less than 225 mm were in poor condition; few had relative weights exceeding 100 (Figure 13).

Overall, largemouth bass in Putters Pond appear to be in moderate density. However, smaller largemouth bass are in poor condition which indicates that they may be limited by food. Food utilized by smaller largemouth bass may be limited in the pond due to the high abundance of bluegill and pumpkinseed, and may have resulted in high competition. Largemouth bass larger than 225 mm are likely able to forage on the abundant bluegill and pumpkinseed in the pond. Forage may be abundant, but feeding efficiency of the larger largemouth bass may not be optimal due to the dense aquatic vegetation present in the pond. Dense aquatic vegetation can limit foraging efficiency of largemouth bass and can contribute to the overpopulation of panfish (Bettoli et al. 1992). Removal of aquatic vegetation, whether by mechanical, chemical, or biological means, may improve feeding efficiency and growth of largemouth bass in Putters Pond.

Table 19. Age and growth of largemouth bass captured at Putters Pond during October-November 2000. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993), and unshaded values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length (mm) at age					
Year Class	**# Fish**	**1**	**2**	**3**	**4**	**5**	**6**
1999	12	85.9					
		95.3					
1998	26	46.7	94.2				
		61.3	102.6				
1997	16	69.8	115.8	163.4			
		84.0	126.0	168.7			
1996	4	55.4	101.8	145.7	190.4		
		70.8	113.5	153.8	195.1		
1995	3	45.4	105.2	168.7	222.1	266.3	
		62.7	118.8	178.6	228.9	270.3	
1994	1	66.3	100.9	121.6	153.4	241.8	366.2
		83.0	115.8	135.5	165.7	249.7	367.8
Overall Mean		61.1	102.5	159.4	197.7	260.2	366.2
Weighted Mean		74.8	112.2	166.1	204.1	265.1	367.8
E. WA average		68.8	135.6	189.2	248.9	299.9	351.5

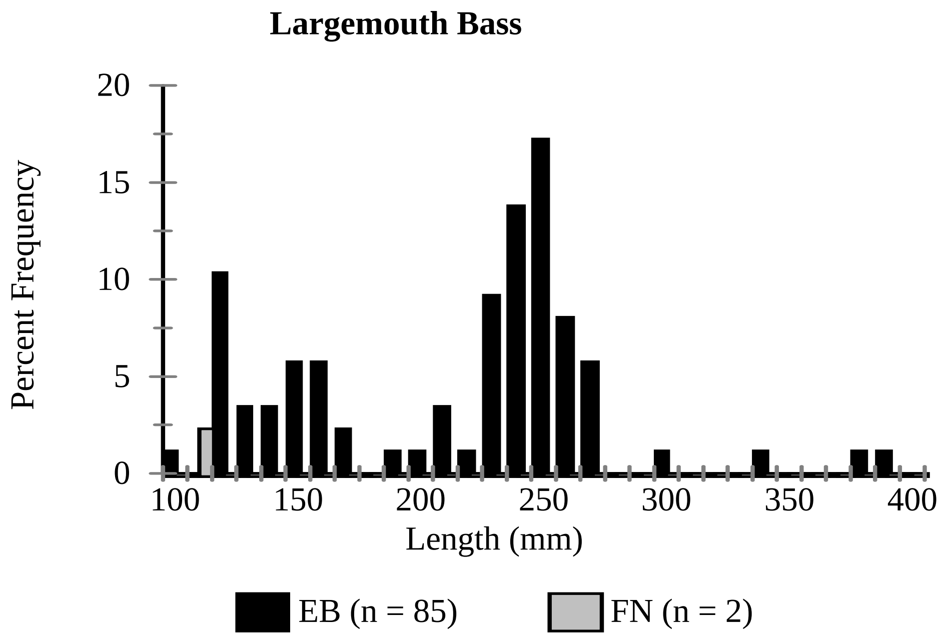

Figure 12. Length frequency distribution of largemouth bass sampled by electrofisher (EB) and fyke nets (FN) in Putters Pond during October-November 2000.

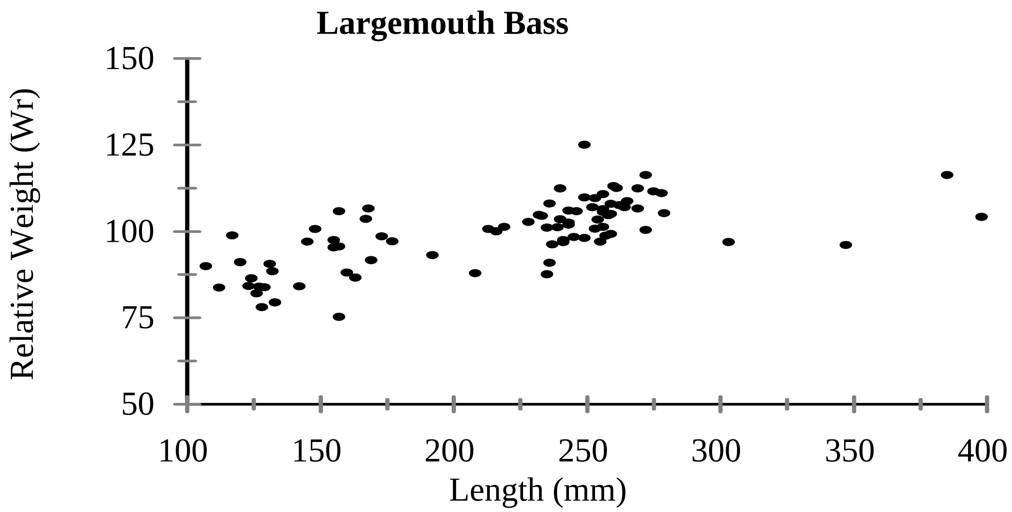

Figure 13. Relative weights of largemouth bass (n = 86) sampled at Putters Pond during October-November 2000, as compared to the national average, W_r = 100 (Anderson and Neumann 1996).

Bluegill

Bluegill ranged in age from 2 to 6 years with Age 2 fish being most abundant of those analyzed for age and growth (Table 20). Growth of Putters Pond bluegill was below the statewide average at all ages. Although bluegill have not been stocked in Putters Pond since 1990, age data indicate that at least low levels of natural reproduction had occurred since 1994. However, no YOY or Age 1 bluegill were observed in 2000.

Total lengths of bluegill (n = 196) sampled at Putters Pond ranged from 79 to 167 mm (Table 16, Figure 14). Bluegill sampled from Putters Pond were in poor condition; few fish had relative weights greater than 100 (Figure 15).

Bluegill in Putters Pond appear to be overpopulated and stunted. Although they were the most abundant (35%) species sampled in 2000, bluegill only contributed 18 percent of the total biomass. This is likely due to the dense vegetation in the pond which may have limited largemouth bass feeding efficiency. Poor growth rates and condition of bluegill in the pond are also indicative of overpopulation. Crowder and Cooper (1982) suggest that dense vegetation can inhibit foraging of bluegill and can likely contribute to less than desirable predator growth rates. Removal of aquatic vegetation may improve feeding efficiency of both bluegill and largemouth bass and result in increased growth rates of those species.

Table 20. Age and growth of bluegill captured at Putters Pond during October-November 2000. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993), and unshaded values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length (mm) at age					
Year Class	**# Fish**	**1**	**2**	**3**	**4**	**5**	**6**
1999	0	–					
		–					
1998	42	24.1	65.0				
		39.8	73.2				
1997	6	21.3	61.4	102.3			
		38.2	72.5	107.5			
1996	6	19.8	64.1	103.7	125.0		
		37.0	74.9	109.0	127.2		
1995	15	23.5	57.2	94.2	120.7	136.9	
		40.3	69.4	101.4	124.3	138.3	
1994	4	22.1	65.7	103.3	123.7	136.4	146.5
		39.2	77.1	109.8	127.6	138.6	147.4
Overall Mean		23.3	63.1	99.8	122.2	136.8	146.5
Weighted Mean		39.5	72.7	105.1	125.5	138.3	147.4
WA State average		37.3	96.8	132.1	148.3	169.9	200.9

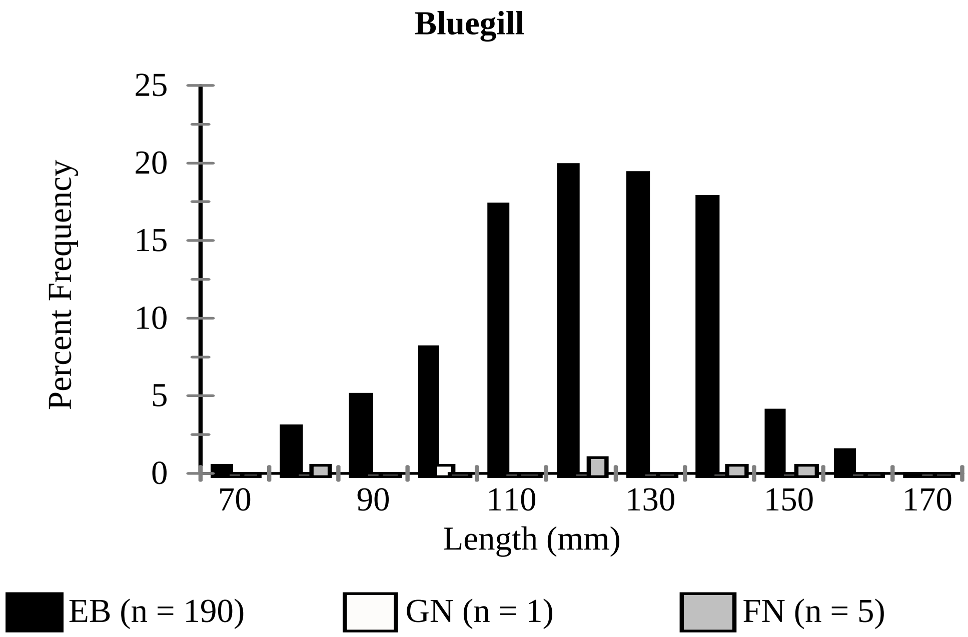

Figure 14. Length frequency distribution of bluegill sampled by electrofisher (EB), gill nets (GN), and fyke nets (FN) in Putters Pond during October-November 2000.

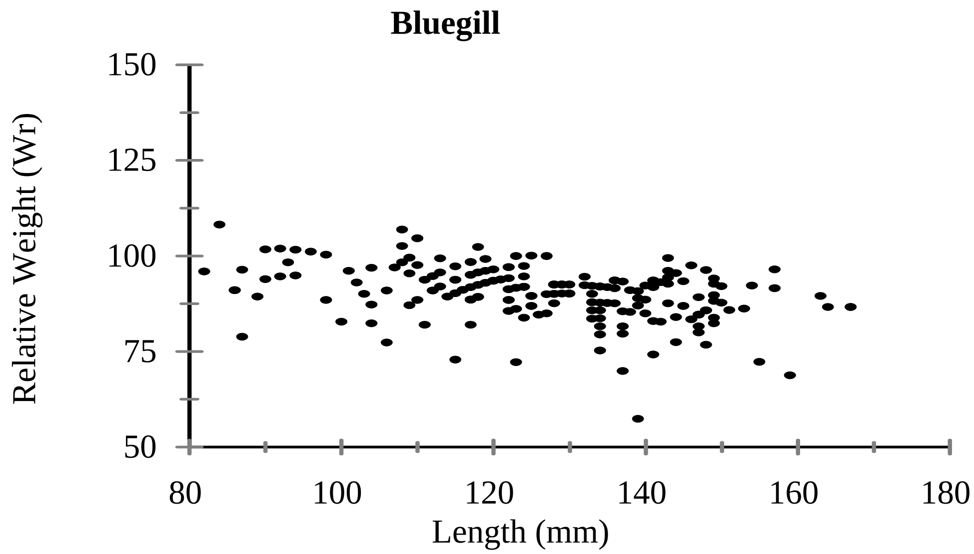

Figure 15. Relative weights of bluegill (n = 196) sampled at Putters Pond during October-November 2000, as compared to the national average, W_r = 100 (Anderson and Neumann 1996).

Yellow Perch

Yellow perch ranged in age from 2 to 4 years with Age 2 fish being most abundant of those analyzed for age and growth (Table 21). Growth of Putters Pond yellow perch was below the statewide average at all ages. No YOY or Age 1 yellow perch were observed in 2000.

Total lengths of yellow perch sampled at Putters Pond ranged from 120 to 208 mm (Table 16, Figure 16). Bluegill sampled from Putters Pond were in poor condition; few fish had relative weights greater than 90 (Figure 17).

Yellow perch were the most abundant species observed during the 1990 rehabilitation and it is uncertain when this species became reestablished in the pond. Although yellow perch were observed in moderated density, their growth rates and condition were poor, indicating that food may have been limited. Due to the high density of bluegill and pumpkinseed in Putters Pond, competition for food is likely high. In addition, feeding efficiency of the yellow perch may have been inhibited due to the dense aquatic vegetation in the pond. Although yellow perch are a gamefish and can provide anglers with sportfishing opportunity, they were not intended to be a component of the fishery in Putters Pond. Aquatic vegetation removal may allow largemouth bass to more effectively forage on the yellow perch in the pond. Yellow perch are a prolific species and predation by largemouth bass may be the only way, other than rehabilitation, to keep yellow perch at manageable levels since they don't achieve sizes that are attractive to most anglers.

Table 21. Age and growth of bluegill captured at Putters Pond during October-November 2000. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993), and unshaded values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length (mm) at age			
Year Class	**# Fish**	**1**	**2**	**3**	**4**
1999	0	–			
		–			
1998	11	55.3	100.6		
		74.4	110.5		
1997	5	63.9	102.1	131.6	
		82.1	113.1	137.1	
1996	3	57.5	108.3	153.3	173.3
		78.3	121.0	158.7	175.6
Overall Mean		57.9	102.2	139.7	173.3
Weighted Mean		77.0	112.9	145.2	175.6
WA State average		59.7	119.9	152.1	192.5

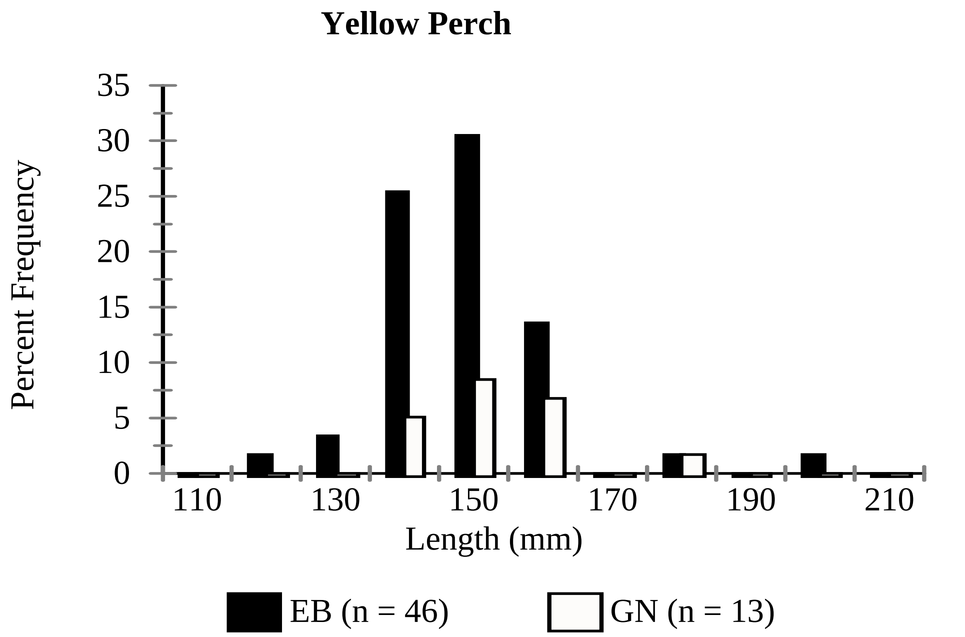

Figure 16. Length frequency distribution of yellow perch sampled by electrofisher (EB) and gill nets (GN) in Putters Pond during October-November 2000.

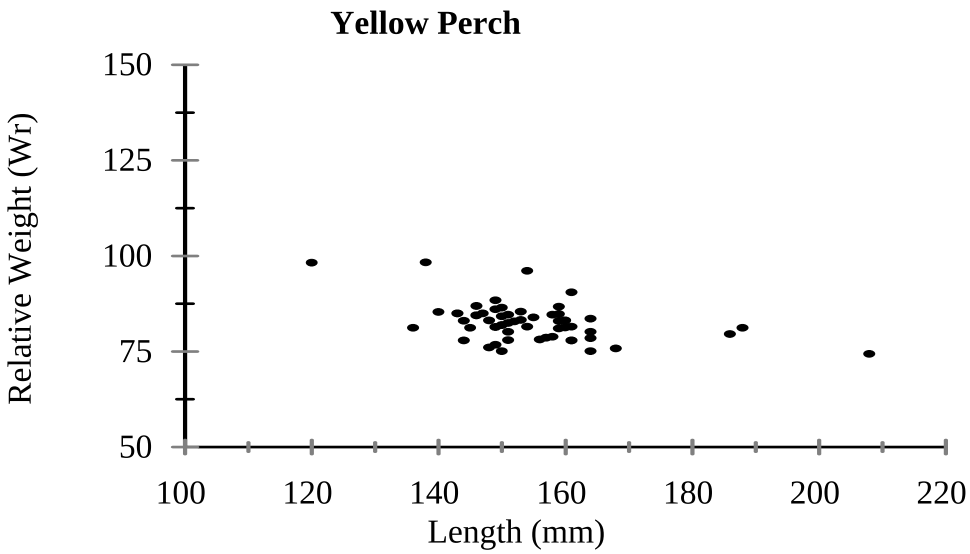

Figure 17. Relative weights of yellow perch (n = 59) sampled at Putters Pond during October-November 2000, as compared to the national average, W_r = 100 (Anderson and Neumann 1996).

Pumpkinseed

Total lengths of pumpkinseed (n = 165) sampled at Putters Pond ranged from 84 to 154 mm (Table 16, Figure 18). Although some pumpkinseed had relative weights as high as 125, most were in poor condition (Figure 19). Scales were not taken on pumpkinseed, thus age and growth were not investigated.

Similar to bluegill, pumpkinseed in Putters Pond appear to be overpopulated and stunted. Although they were the second-most abundant (29%) species sampled in 2000, pumpkinseed only contributed 9 percent of the total biomass. This is likely due to the dense vegetation in the pond which may have limited largemouth bass feeding efficiency. Poor growth rates and condition of pumpkinseed in the pond are likely due to high levels of competition with bluegill, yellow perch, and smaller size largemouth bass. Crowder and Cooper (1982) suggest that dense vegetation can inhibit foraging of bluegill (and thus likely pumpkinseed) and may contribute to less than desirable predator growth rates. Removal of aquatic vegetation may improve feeding efficiency of pumpkinseed and largemouth bass and result in increased growth rates of those species.

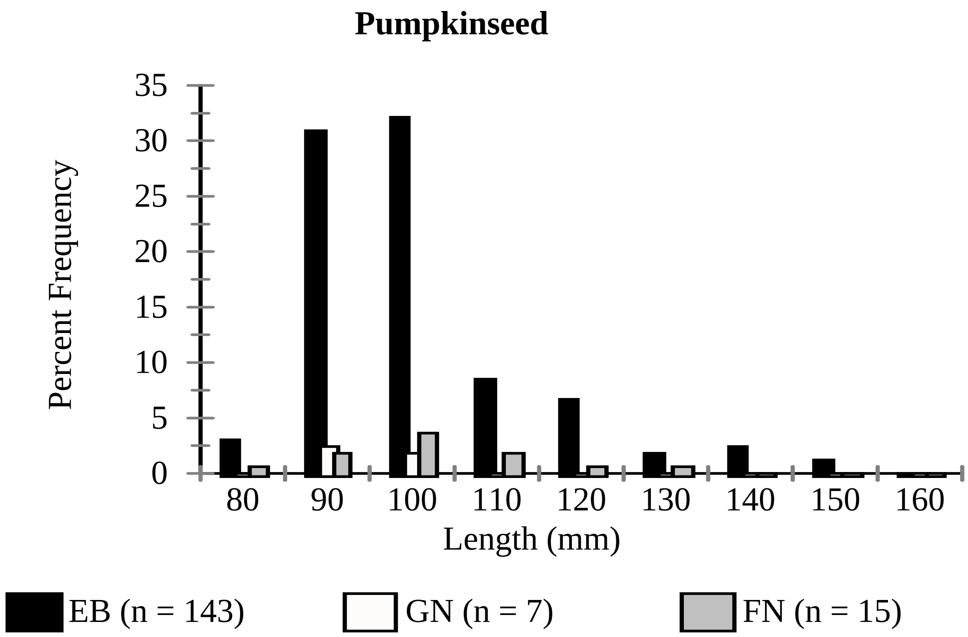

Figure 18. Length frequency distribution of pumpkinseed sampled by electrofisher (EB), gill nets (GN), and fyke nets (FN) in Putters Pond during October-November 2000.

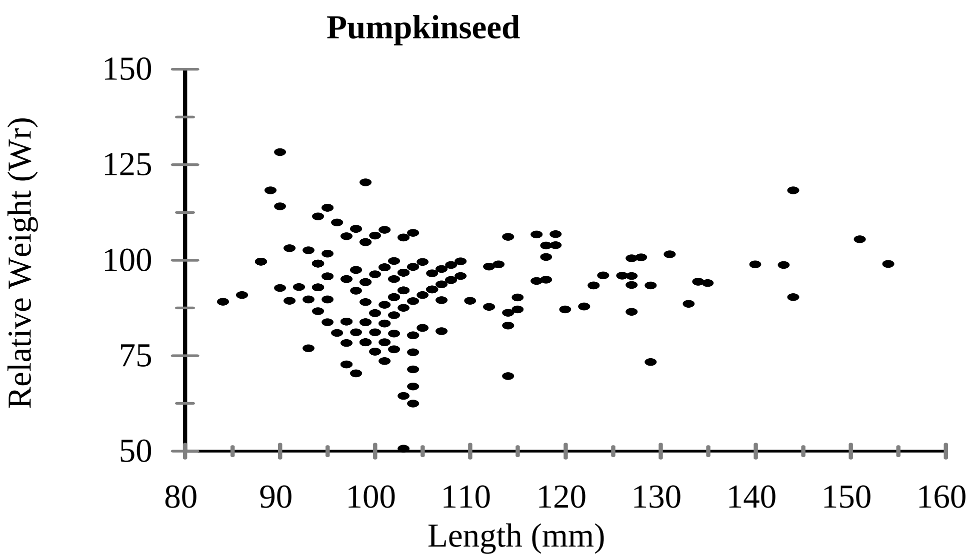

Figure 19. Relative weights of pumpkinseed (n = 164) sampled at Putters Pond during October-November 2000, as compared to the national average, W_r = 100 (Anderson and Neumann 1996).

Rainbow Trout

Only one rainbow trout was sampled at Putters Pond in 2000 (Table 16). The rainbow trout was 282 mm in length, weighed 181 g, and was in poor condition. This fish was likely one of catchable size trout that were stocked in spring 2000 (Table 15). Few trout were expected since Putters Pond is relatively shallow and summer water temperatures likely limit trout survival. The poor condition of this fish was also expected since trout primarily forage on aquatic macroinvertebrates and have to compete with the abundant bluegill and pumpkinseed for forage.

Conclusions and Management Options

Putters Pond appears to be overpopulated with bluegill and pumpkinseed and is a candidate for vegetation removal efforts and possibly rehabilitation. Levels of both interspecific and intraspecific competition are likely high which may explain the poor condition of the panfish and smaller size largemouth bass. Although the larger size largemouth bass may be able to forage on the bluegill and pumpkinseed, largemouth bass feeding efficiency is probably inhibited due to the dense aquatic vegetation in the pond. Although catchable size and/or fingerling rainbow trout have been stocked in the pond annually since the 1990 rehabilitation, only one was observed during the 2000 survey. Overall survival is likely low since the pond is shallow and water temperature likely exceeds tolerable levels in summer. Channel catfish were stocked in Putters Pond in 1999 and 2000, although none were observed during the 2000 survey. Habitat conditions in the pond are likely less than optimal for channel catfish and their overall survival is questionable.

Aquatic Vegetation Control

Since aquatic vegetation may have inhibited the feeding efficiency of largemouth bass and resulted in stunted panfish populations, vegetation control measures should be considered prior to other measures such as rehabilitation. Aquatic vegetation can be reduced by mechanical, chemical, and biological methods (Wiley et al. 1984). Mechanical vegetation removal is expensive, labor intensive, and often yields only short-term benefits. Grass carp can be used as a biological means for removing aquatic vegetation and have been used in Washington State with variable success (Bonar et al. 1996). Prior to introducing grass carp to Putters Pond, experimental introductions of those fish should occur on Big Bow Pond. Big Bow Pond has no known inlets or outlets whereas Putters Pond is indirectly linked to the Columbia River via culverts. If the experimental introduction on Big Bow Pond shows promise, characteristics of the outlet structure (culvert) of Putters Pond would need to be investigated. Some form of barrier would be required to alleviate escapement of the grass carp. Prior to introduction, an application must be submitted and approved. Under appropriate conditions, chemical treatments can be effective in controlling aquatic vegetation. Investigations would be required to determine what the water in Putters Pond is used for and whether chemical treatments would potentially harm humans, terrestrial wildlife, and surrounding crops.

Rehabilitation

Putters Pond was rehabilitated in 1990 and was stocked with bluegill and largemouth bass shortly thereafter. During the 1990 rehabilitation, yellow perch and pumpkinseed were the most and second-most abundant species observed. Since then, the pond has become re-infested with pumpkinseed, yellow perch, and tench. Rehabilitation may be required to eradicate or reduce the high abundance of pumpkinseed and yellow perch in Putters Pond. However, vegetation removal should be attempted prior to the consideration of rehabilitation. If Putters Pond were rehabilitated without first attempting to remove vegetation, feeding efficiency would still likely be hindered and keeping panfish densities at manageable levels would be difficult. If Putters Pond is rehabilitated, efforts should be expended to salvage the largemouth bass in the pond. Those largemouth bass could be stocked in other ponds in the area and possibly re-introduced following the treatments.

Water Chemistry Monitoring

Due to equipment failure, water chemistry measurements were not taken on Putters Pond during the 2000 survey. Since Rock Island Ponds have a history of low summer and winter dissolved oxygen levels, measurements should be taken at least once each month for a year to more fully understand the water chemistry dynamics of the pond. Water chemistry data should be collected at 1 m increments at several locations including the area of greatest depth. A Hydrolab® should be used to collect information on dissolved oxygen, temperature, pH, conductivity, and turbidity. Water chemistry data may be useful not only to interpret previous conditions, but to also assist fishery biologists in determining future management and/or stocking options.

Stocking

Warm summer water temperature probably limits survival of trout throughout July and August, and it is recommended that catchable size trout be stocked in spring to provide public fishing opportunity. As with other size trout, those stocked as fingerlings may not survive through the summer and may not achieve sizes which would benefit anglers. Although rainbow trout have been stocked annually since the 1990 rehabilitation, brown trout may provide anglers with fishing opportunity for a longer period each year. Brown trout can tolerate warmer water temperatures, more turbid water, and lower dissolved oxygen levels than rainbow trout (Wydoski and Whitney 1979) although catch rates may not be as high. Stocking a minimum of 8,000 trout each spring is recommended. Stocking should occur on two separate occasions; once in March (~5,000 fish) and again in late April or early May (~3,000 fish). This would likely provide anglers with fishing opportunity throughout spring and early summer.

Similar to Big Bow Pond, habitat conditions in Putters Pond are likely not optimal for channel catfish and survival of fish stocked as fingerlings is questionable. However, stocking larger size channel catfish (minimum of ~16 inches) may provide anglers with immediate angling opportunity, regardless of whether those fish survived for prolonged periods. Current angler survey information on Putters Pond is lacking and the benefit of a channel catfish fishery is unknown. At least a short-term creel survey would be beneficial in determining effort expended on channel catfish so that stocking rates could be adjusted accordingly.

Largemouth bass and bluegill have not been stocked in Putters Pond since 1990 and plans for stocking these species in recent years have not been considered. Prior to stocking these species in the future, vegetation removal or rehabilitation should be considered to help reduce bluegill and pumpkinseed abundance. If vegetation removal efforts are expended, a minimum of 90 adult largemouth bass (10-12 inches) should be stocked which may facilitate bluegill and pumpkinseed reduction. If the vegetation removal/largemouth bass stocking efforts failed to reduce panfish abundance and the pond were rehabilitated, various age classes of largemouth bass should be stocked including juveniles, sub-adults, and adults. A minimum of 200 adult, 200 sub-adult (~5 fish/acre of each size), and 600 juvenile (~15 fish/acre) largemouth bass would be recommended. In addition, a minimum of 1,300 (~30 fish/acre) bluegill should be stocked following the rehabilitation. Various size, but mostly adult, bluegill could be collected from lakes, such as Whitestone Lake in Okanogan County, Washington (Osborne and Petersen In Press), that contain a high abundance of bluegill.

Warmwater Gamefish Monitoring

No regulation changes are recommended at this time. However, periodic warmwater fish surveys, including water chemistry monitoring, should be conducted to monitor fish population dynamics in Putters Pond. If the pond were rehabilitated and/or vegetation were removed, future monitoring could be used to assess the effectiveness of those efforts and determine if additional warmwater gamefish stocking and/or adjustments in regulations were needed.

Hammond Pond

Background

Hammond Pond is located inside the Rock Island city limits, and at 23 ha (57 acre), is the second largest of all of the Rock Island Ponds (Figure 1). Like Putters Pond, Hammond Pond is indirectly connected to the Columbia River via two culverts; one connecting Hammond Pond to an unnamed pond and the other connecting the unnamed pond to the river. Several smaller ponds existed where Hammond Pond sits now. When water level of the Rock Island pool was raised in 1979, those ponds converged to create Hammond Pond. Most land surrounding Hammond Pond is privately owned although portions are owned by the City of Rock Island and Chelan County PUD. Rock Island Municipal Golf Course, which is owned by the City of Rock Island and leased to a private party, lies on the southwest shoreline of Hammond Pond. Hammond Pond has one access sites on the northwest shoreline which consists of an unimproved boat launch, parking area, and toilet facilities. The access site is maintained by the City of Rock Island.

Washington Department of Fish and Wildlife rehabilitated Hammond Pond in 1978, 1985, and 1990 (WDFW 1990d). Species of fish found during the 1990 rehabilitation in order of abundance were: bluegill, pumpkinseed, yellow perch, brown bullhead, largemouth bass, and rainbow trout. In May and June, following the 1990 rehabilitation, WDFW stocked the pond with rainbow trout, largemouth bass, and bluegill (Table 22). Rainbow trout have been stocked annually since 1990 and were the only species stocked between 1991 and 1998. Although statewide fishing limits apply, Rock Island City Ordinance #98-022 prohibits the use of combustible boat motors on Hammond Pond.

Table 22. Fish stocked in Hammond Pond, Douglas County, Washington since the 1990 rehabilitation.

Year	Species	Number	Size
2000	rainbow trout	3,198	catchables
1999	rainbow trout	3,000	catchables
1998	rainbow trout	3,802	catchables
	rainbow trout	4,947	fingerlings
1997	rainbow trout	3,992	catchables
	rainbow trout	5,160	fingerlings
1996	rainbow trout	4,097	catchables
	rainbow trout	4,987	fingerlings
1995	rainbow trout	3,501	catchables
	rainbow trout	5,006	fingerlings
1994	rainbow trout	1,537	catchables
	rainbow trout	4,996	fingerlings
1993	rainbow trout	4,557	catchables
	rainbow trout	4,994	fingerlings
1992	rainbow trout	1,496	catchables
	rainbow trout	4,998	fingerlings
1991	rainbow trout	1,588	catchables
1990	rainbow trout	2,400	catchables
	largemouth bass	17	adults
	largemouth bass	74	sub-adults
	bluegill	25	adults

Results and Discussion

Species Composition

A total of five fish species were observed in Hammond Pond in fall 2000 (Table 23). Warmwater gamefish comprised over 99 percent of the total fish captured. Pumpkinseed (39%) and yellow perch (39%) were the most abundant species sampled and accounted for the highest (33%) and second-highest (32%) proportions of biomass, respectively. Although less abundant (20%), largemouth bass comprised a proportion of biomass (30%) similar to pumpkinseed and yellow perch. Although a total of 3,198 rainbow trout were stocked in spring 2000 (Table 22), only one was observed during October-November 2000. This was expected since Hammond Pond is relatively shallow and rainbow trout survival is likely low due to high summer water temperatures.

Table 23. Species composition by weight, number, and size range of fish captured at Hammond Pond, Douglas County, Washington during October-November 2000.

	Species Composition					
	Weight		Number		Total Length (mm)	
Type of Fish	**kg**	**%**	**No.**	**%**	**Min.**	**Max.**
bluegill	1.79	3.65	23	2.40	92	216
largemouth bass	14.99	30.68	195	20.33	118	478
pumpkinseed	16.28	33.31	370	38.58	94	154
rainbow trout	0.12	0.25	1	0.10	246	246
yellow perch	15.69	32.11	370	38.58	129	189

Catch Per Unit Effort (CPUE)

Although catch per unit effort can be a useful index to monitor size structure and relative abundance of fish populations in lakes and reservoirs (Hubert 1996), data have not been collected on Hammond Pond since the 1990 rehabilitation. CPUE information collected in 2000 can be used as a baseline that will allow fishery managers to monitor the effectiveness of future management techniques used on the pond.

Overall, electrofishing captured more fish in Hammond Pond than did gill nets or fyke nets. Electrofishing catch rates of warmwater gamefish were highest on pumpkinseed (471 fish/hr)(Table 24). Yellow perch were captured at higher rates than other species using both gill nets (41.5 fish/net night) and fyke nets (31 fish/net night). Some species, such as yellow perch, tend to inhabit open water as adults and are typically sampled more effectively by gill nets. However, higher numbers of yellow perch were sampled by electrofishing than with gill nets which is likely due to the overall shallow depth of the pond. Electrofishing captured the same size fish than gill nets and fyke nets (refer to length-frequency histograms under species sections).

Table 24. Mean catch per unit effort by sampling method, including 80 percent confidence intervals, for fish collected from Hammond Pond in October-November 2000.

	Gear Type								
	Electrofishing			Gill Netting			Fyke Netting		
Species	**No. Hour**	**CI (+/-)**	**No. Sites**	**No. Night**	**CI (+/-)**	**Net Nights**	**No. Night**	**CI (+/-)**	**Net Nights**
bluegill	32.6	19.4	4	0.0	–	2	0.5	0.6	2
largemouth bass	287.9	21.9	4	0.5	0.6	2	0.0	–	2
pumpkinseed	471.0	35.9	4	9.5	5.8	2	17.0	1.3	2
rainbow trout	1.4	1.9	4	0.0	–	2	0.0	–	2

yellow perch	335.9	94.6	4	41.5	14.7	2	31.0	8.9	2

Stock Density Indices

Of the 6 stock size largemouth bass observed in Hammond Pond, 2 were of quality size and 1 was of preferred size (Table 25). All but 1 of the 23 bluegill that were sampled was of stock size or larger. Of the 22 stock size bluegill that were observed, 16 were of quality size and 1 was of preferred size. The PSD of pumpkinseed sampled by electrofishing was less than 1, and no yellow perch sampled by any gear type were larger than stock size.

Analyses from the stock density indices and species composition indicate that Hammond Pond contains stunted populations of pumpkinseed and yellow perch. These species each contributed approximately 30 percent of the total biomass but pumpkinseed only attained a maximum length of 154 mm and yellow perch grew no longer than 189 mm. Although only a small proportion (3%) of the largemouth bass sampled (n = 195) were of at least stock size, their population may not necessarily have been dominated by smaller individuals to the extent indicated by these data. Largemouth bass are typically sampled more effectively by electrofishing. Since Hammond Pond is relatively shallow and was only electrofished along the shoreline, an unrepresented proportion of largemouth bass may have inhabited offshore areas. Moreover, the low number of large size largemouth bass observed in 2000 may have been due to angler exploitation. The bluegill population in Hammond Pond is dominated by a few larger individuals. Bluegill may have been out-competed by the yellow perch and pumpkinseed which would explain their low numbers. Those larger size bluegill may have been able to forage on food items slightly larger than what could be utilized by the majority of pumpkinseed and yellow perch.

Table 25. Stock density indices, including 80 percent confidence interval, for warmwater fishes collected by electrofishing in Hammond Pond (Douglas County) during October-November 2000. PSD = proportional stock density, RSD = relative stock density, RSD-P = relative stock density of preferred fish, RSD-M = relative stock density of memorable fish, and RSD-T = relative stock density of trophy fish.

Species	#Stock Length	PSD	RSD-P	RSD-M	RSD-T
		Electrofishing			
bluegill	22	77 ± 11	4 ± 5	0	0
largemouth bass	6	50 ± 26	16 ± 19	0	0
pumpkinseed	317	1 ± 1	0	0	0
yellow perch	225	0	0	0	0
		Gill Netting			
pumpkinseed	19	0	0	0	0
yellow perch	83	0	0	0	0
		Fyke Netting			
pumpkinseed	34	0	0	0	0
yellow perch	62	0	0	0	0

Water Chemistry

Due to equipment failure, water chemistry measurements were not taken on Hammond Pond. Similar to Big Bow and Putters ponds, historical information may provide insight into the current fishery dynamics of the pond. In the 1980s, several of the Rock Island Ponds experienced both summer and winter fish kills (WDFW Region 2 Files) due to low dissolved oxygen levels. Since Hammond Pond contains a high density of aquatic vegetation, decomposition of vegetation and filamentous algae may deplete parts of the pond of dissolved oxygen during summer which could result in fish kills. Similarly, winter fish kills may occur in shallow ice-covered lakes when abundant aquatic vegetation dies and consumes oxygen during decomposition (Goldman and Horne 1983). Conditions in Hammond Pond in recent years may not have been this extreme. However, low summer and winter dissolved oxygen levels are not uncommon in Rock Island Ponds and water chemistry measurements should be recorded at least monthly to determine if corrective measures should be considered.

Largemouth Bass

Largemouth bass ranged in age from 1 to 3 years with Age 2 being most abundant of those fish analyzed for age and growth (Table 26). The sample sizes of all ages were low and analyses may not be accurate. Growth of largemouth bass was above the statewide average at all ages.

Although largemouth bass have not been stocked in Putters Pond since 1990, age data indicate that at least low levels of natural reproduction had occurred since 1997. In addition, two YOY largemouth bass were observed in 2000.

Total lengths of largemouth bass (n = 195) sampled at Hammond Pond ranged from 118 to 478 mm (Table 23, Figure 20) although only three were greater than 210 mm. The majority of largemouth bass, those less than 210 mm, were in poor condition; only one had a relative weight exceeding 100 (Figure 21). Largemouth bass greater than 210 mm (n = 3) were in good condition; all had relative weights greater than 110.

Overall, largemouth bass in Hammond Pond exhibit characteristics similar to those observed in Putters Pond. Hammond Pond largemouth bass appear to be in moderate density. However, smaller largemouth bass are in poor condition which indicates that they may be limited by food. Food utilized by smaller largemouth bass may be limited in the pond due to the high abundance of pumpkinseed and yellow perch, and may have resulted in high competition. Larger size largemouth bass are likely able to forage on the abundant pumpkinseed and yellow perch in the pond. Although forage may be abundant, feeding efficiency of the larger largemouth bass may not be optimal due to the dense aquatic vegetation present in the pond. Dense aquatic vegetation can limit foraging efficiency of largemouth bass and can contribute to the overpopulation of panfish (Bettoli et al. 1992). Removal of aquatic vegetation, whether by mechanical, chemical, or biological means, may improve feeding efficiency and growth of largemouth bass in Hammond Pond.

Table 26. Age and growth of largemouth bass captured at Hammond Pond during October-November 2000. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993), and unshaded values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length (mm) at age		
Year Class	**# Fish**	**1**	**2**	**3**
1999	9	76.5		
		86.1		
1998	18	82.5	146.7	
		93.3	150.3	
1997	5	84.2	152.6	222.5
		97.6	160.8	225.4
Overall Mean		81.1	148.0	222.5
Weighted Mean		91.9	152.6	225.4
E. WA average		68.8	135.6	189.2

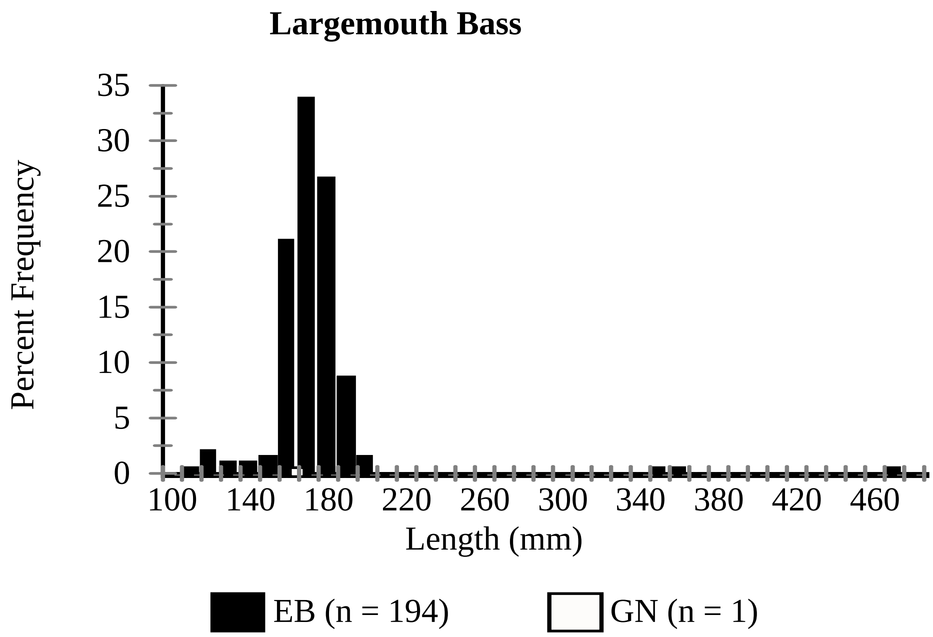

Figure 20. Length frequency distribution of largemouth bass sampled by electrofisher (EB) and gill nets (GN) in Hammond Pond during October-November 2000.

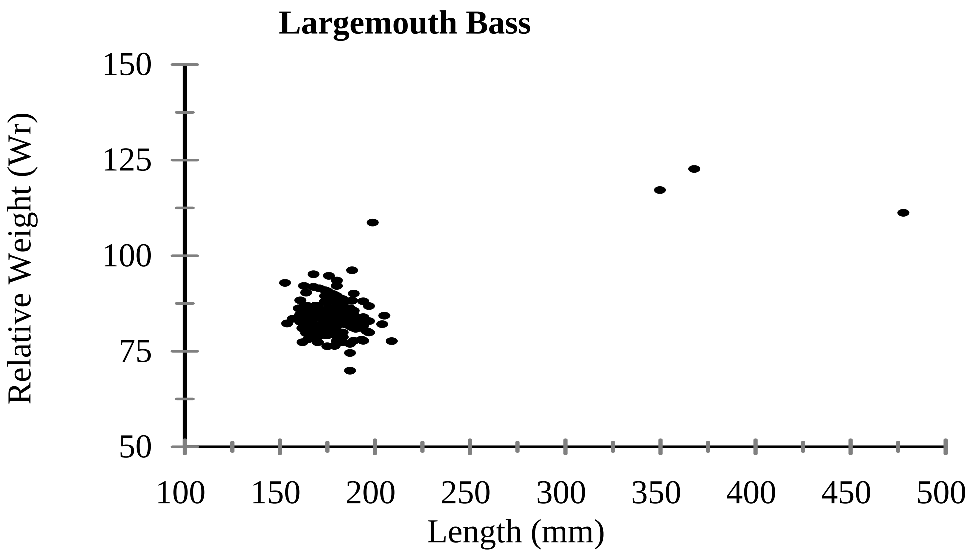

Figure 21. Relative weights of largemouth bass (n = 186) sampled at Hammond Pond during October-November 2000, as compared to the national average, W_r = 100 (Anderson and Neumann 1996).

Bluegill

Bluegill ranged in age from 1 to 5 years with Age 3 fish being most abundant of those analyzed for age and growth (Table 27). Growth of Hammond Pond bluegill was below the statewide average at Age 1 but was at or above the statewide average for all other ages. Although age data indicate that at least low levels of natural reproduction had occurred since 1995, no YOY bluegill were observed in 2000. Moreover, Age 2 bluegill were absent in the 2000 samples.

Total lengths of bluegill (n = 23) sampled at Hammond Pond ranged from 92 to 216 mm (Table 23, Figure 22) indicating that the population is comprised of few larger individuals. Bluegill sampled from Hammond Pond were in average condition with approximately equal numbers having relative weights greater than and less than 100 (Figure 23).

Bluegill in Hammond Pond appear to be present in low density. Smaller bluegill were likely out-competed for food and space by the abundant pumpkinseed and yellow perch. The average relative weights and above average growth rates indicate that the larger bluegill in the pond may have been able to utilize slightly larger forage items. Spawning success is likely limited due to the overabundant pumpkinseed and yellow perch in the pond. Pumpkinseed and yellow perch probably don't achieve sizes capable of foraging on small bluegill. However, they may invade bluegill nests and consume eggs during spawning.

Table 27. Age and growth of bluegill captured at Hammond Pond during October-November 2000. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993), and unshaded values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length (mm) at age				
Year Class	**# Fish**	**1**	**2**	**3**	**4**	**5**
1999	2	19.5				
		35.5				
1998	0	–	–			
		–	–			
1997	11	29.2	98.5	128.0		
		45.4	105.7	131.3		
1996	2	14.8	76.6	125.8	143.8	
		32.9	86.9	129.9	145.6	
1995	1	41.5	128.3	167.1	200.3	209.5
		57.7	136.4	171.6	201.8	210.1
Overall Mean		26.9	97.5	130.4	162.6	209.5
Weighted Mean		43.4	105.2	134.0	164.4	210.1
WA State average		37.3	96.8	132.1	148.3	169.9

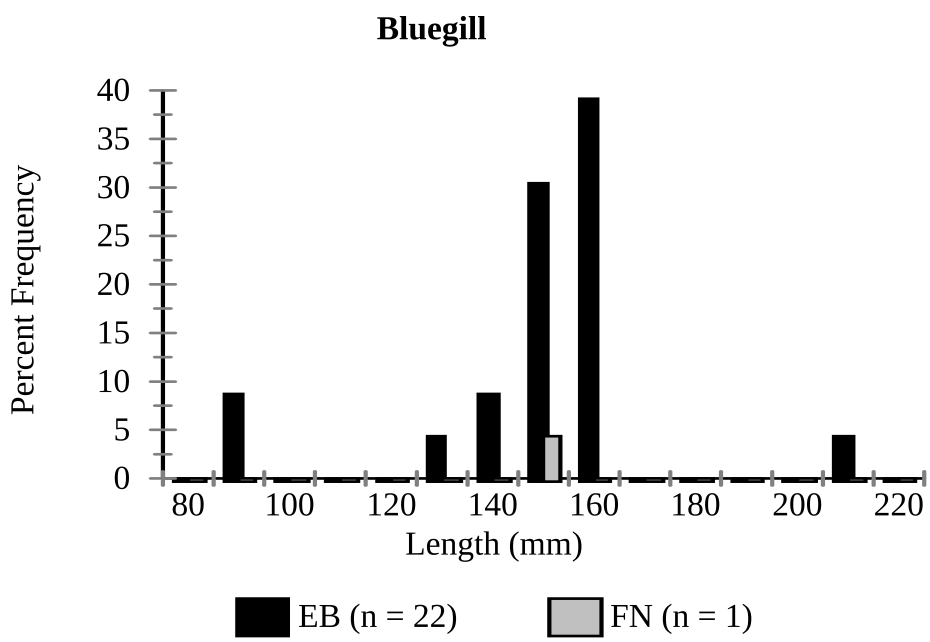

Figure 22. Length frequency distribution of bluegill sampled by electrofisher (EB) and fyke nets (FN) in Hammond Pond during October-November 2000.

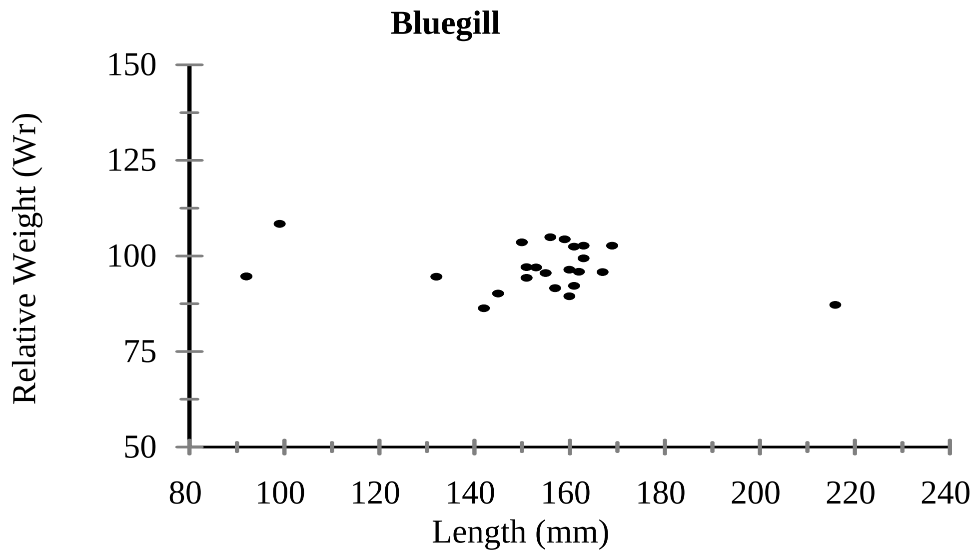

Figure 23. Relative weights of bluegill (n = 23) sampled at Hammond Pond during October-November 2000, as compared to the national average, W_r = 100 (Anderson and Neumann 1996).

Yellow Perch

Yellow perch ranged in age from 2 to 4 years with Age 4 fish being most abundant of those analyzed for age and growth (Table 28). Growth of Hammond Pond yellow perch was similar to the statewide average at Age 1 but was below the statewide average at Ages 2-4. No YOY or Age 1 yellow perch were observed in 2000.

Total lengths of yellow perch sampled at Hammond Pond ranged from 129 to 189 mm (Table 23, Figure 24). Bluegill sampled from Hammond Pond were in poor condition; most fish had relative weights less than 100 (Figure 25).

Yellow perch were observed during the 1990 rehabilitation and it is uncertain when this species became reestablished in the pond. Data collected in 2000 suggest that yellow perch are overpopulated. Yellow perch exhibited poor growth rates and relative weights which indicate that they may be limited by food and/or space. Due to the high density of yellow perch and pumpkinseed in Hammond Pond, competition for food is likely high. Due to the dense aquatic vegetation present in the pond, feeding efficiency of largemouth bass was likely hindered which may have contributed to the high density of yellow perch. Although yellow perch are a gamefish and can provide anglers with sportfishing opportunity, they were not intended to be a component of the fishery in Hammond Pond. Aquatic vegetation removal perhaps would allow largemouth bass to more effectively forage on the yellow perch in the pond and increase overall size of yellow perch. Yellow perch in Hammond Pond don't achieve sizes that are attractive to most anglers. Yellow perch are a prolific species and predation by largemouth bass may be the only way, other than rehabilitation, to reduce the abundance of yellow perch to manageable levels.

Table 28. Age and growth of bluegill captured at Hammond Pond during October-November 2000. Shaded values are mean back-calculated lengths using the direct proportion method (Fletcher et al. 1993), and unshaded values are mean back-calculated lengths using Lee's modification of the direct proportion method (Carlander 1982).

		Mean length (mm) at age			
Year Class	**# Fish**	**1**	**2**	**3**	**4**
1999	0	–			
		–			
1998	11	99.4	173.6		
		113.5	175.8		
1997	5	64.4	125.0	149.6	
		82.9	132.8	153.0	
1996	3	57.0	102.0	127.0	141.8
		75.8	112.1	132.2	144.2
Overall Mean		60.8	111.8	134.5	141.8
Weighted Mean		79.3	120.8	139.2	144.2
WA State average		59.7	119.9	152.1	192.5

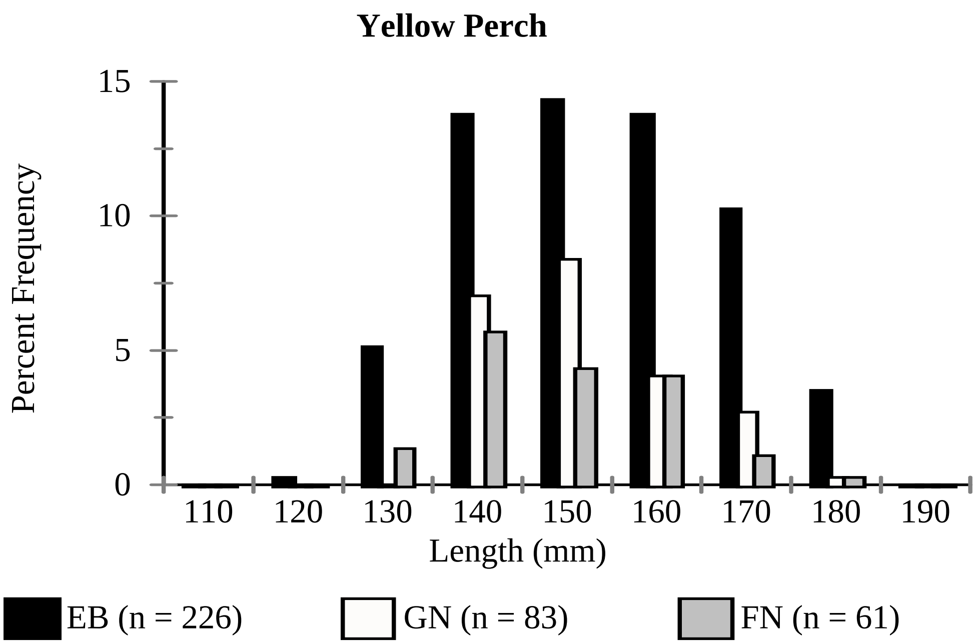

Figure 24. Length frequency distribution of yellow perch sampled by electrofisher (EB), gill nets (GN), and fyke nets (FN) in Hammond Pond during October-November 2000.

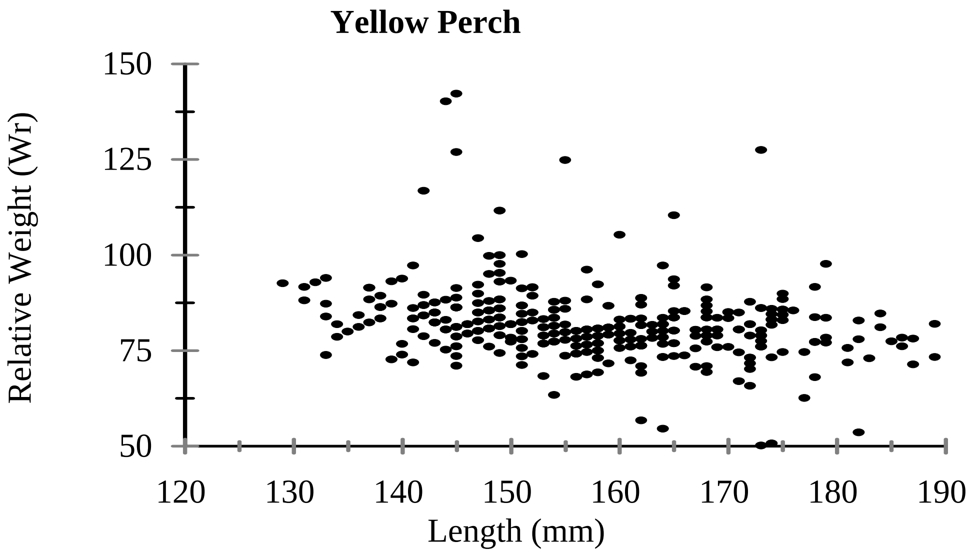

Figure 25. Relative weights of yellow perch (n = 370) sampled at Hammond Pond during October-November 2000, as compared to the national average, W_r = 100 (Anderson and Neumann 1996).

Pumpkinseed

Along with yellow perch, pumpkinseed were the most abundant species sampled in Hammond Pond (Table 23). Total lengths of pumpkinseed (n = 370) sampled at Hammond Pond ranged from 94 to 154 mm (Table 23, Figure 26). Overall, pumpkinseed were in average condition with approximately equal numbers having relative weights greater than and less than 100 (Figure 27). Scales were not taken on pumpkinseed, thus age and growth were not investigated.

Similar to yellow perch, pumpkinseed in Hammond Pond appear to be overpopulated. Although pumpkinseed contributed 33 percent of the total biomass, they achieved sizes no larger than 154 mm. Relative weights of pumpkinseed were higher than those of yellow perch and the smaller largemouth bass indicating that pumpkinseed may have been able to more effectively utilize the limited resources available in the pond. Like yellow perch, the overabundance of pumpkinseed is likely due to the dense vegetation in the pond which may have limited largemouth bass feeding efficiency. Overpopulation of panfish can result from inhibited predator feeding efficiency (Bettoli et al.1992). Removal of aquatic vegetation may improve feeding efficiency of the largemouth bass, reduce the density of pumpkinseed, and result in increased growth rates of those species.

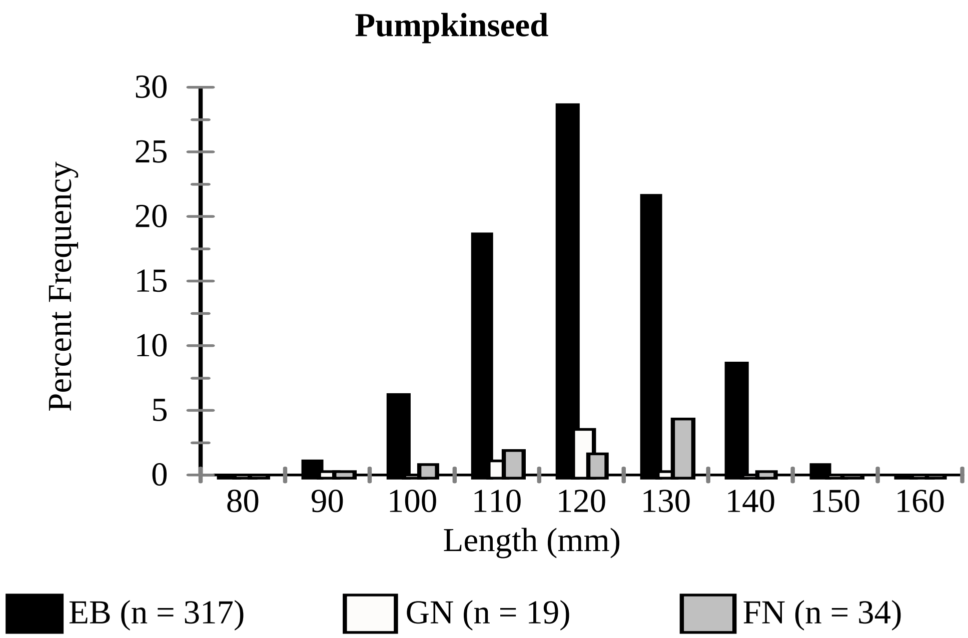

Figure 26. Length frequency distribution of pumpkinseed sampled by electrofisher (EB), gill nets (GN), and fyke nets (FN) in Hammond Pond during October-November 2000.

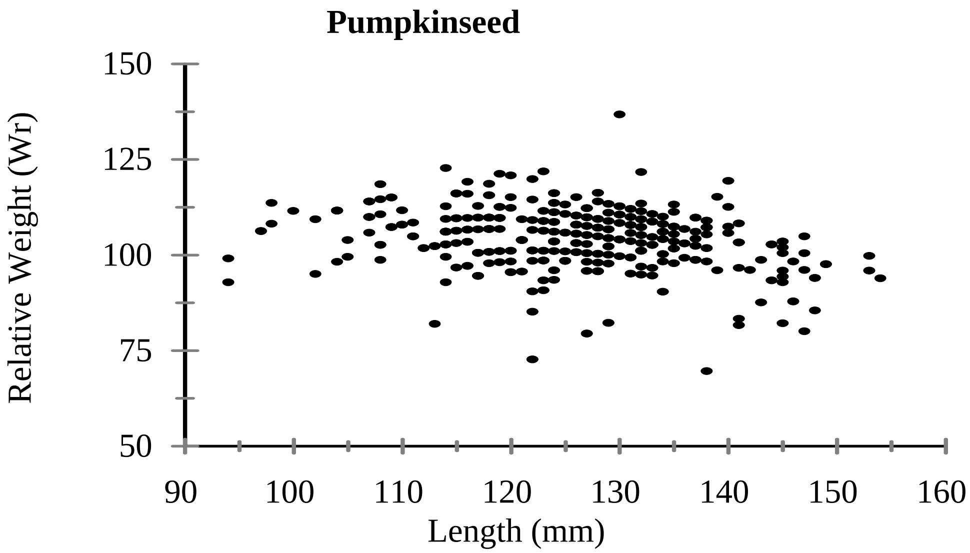

Figure 27. Relative weights of pumpkinseed (n = 368) sampled at Hammond Pond during October-November 2000, as compared to the national average, W_r = 100 (Anderson and Neumann 1996).

Rainbow Trout

Only one rainbow trout was sampled at Hammond Pond in 2000 (Table 23). The rainbow trout was 246 mm in length, weighed 122 g, and was in poor condition. This fish was likely one of catchable size trout that were stocked in spring 2000 (Table 22). Few trout were expected since like most ponds in the area, Hammond Pond is relatively shallow and summer water temperatures likely limit trout survival. The poor condition of this fish was also expected since trout primarily forage on aquatic macroinvertebrates and compete with the abundant pumpkinseed and yellow perch for forage.

Conclusions and Management Options

Hammond Pond appears to be overpopulated with pumpkinseed and yellow perch and is a candidate for vegetation removal efforts and possibly rehabilitation. The condition of most panfish and smaller size largemouth bass in the pond is poor which is likely due to high levels of both interspecific and intraspecific competition. Although the larger size largemouth bass may be able to forage on the pumpkinseed and yellow perch, largemouth bass feeding efficiency is probably inhibited due to the dense aquatic vegetation in the pond. The bluegill population in Hammond Pond is characterized by relatively few, but larger individuals. Although catchable size and/or fingerling rainbow trout have been stocked in the pond annually since the 1990 rehabilitation, only one was observed during the 2000 survey. Overall survival is likely low since the pond is shallow and water temperature likely exceeds tolerable levels in summer. Conditions in Hammond Pond were similar to those observed in Putters Pond and fishery managers may consider the recommendations listed below, or a combination thereof, relevant to both ponds or each specific pond.

Aquatic Vegetation Control

Since aquatic vegetation may have inhibited the feeding efficiency of largemouth bass and resulted in the overabundance of pumpkinseed and yellow perch, vegetation control measures should be considered prior to other measures such as rehabilitation. Aquatic vegetation can be reduced by mechanical, chemical, and biological methods (Wiley et al. 1984). Mechanical vegetation removal is expensive, labor intensive, and often yields only short-term benefits. Grass carp can be used as a biological means for removing aquatic vegetation and have been used in Washington State with variable success (Bonar et al. 1996). Similar to Putters Pond, experimental introductions of those fish should occur on Big Bow Pond prior to being introduced to Hammond Pond. Big Bow Pond has no known inlets or outlets whereas both Putters and Hammond ponds are indirectly linked to the Columbia River via culverts. If the experimental introduction on Big Bow Pond shows promise, characteristics of the outlet structure (culvert) of Hammond Pond would need to be investigated. Some form of barrier would be required to alleviate escapement of the grass carp. Prior to introduction, an application must be submitted and approved. Also, chemical treatments can be effective in controlling aquatic vegetation under certain conditions. Investigations would be required to determine what the water in Hammond Pond is used for and whether chemical treatments would potentially harm humans, terrestrial wildlife, and surrounding crops.

Rehabilitation

Hammond Pond was rehabilitated in 1990 and was stocked with bluegill and largemouth bass several months later. Pumpkinseed and yellow perch were observed during the 1990 rehabilitation and, although the 1990 rehabilitation was successful, the pond has become re-infested with those species. Rehabilitation may be required to eradicate or reduce the high abundance of pumpkinseed and yellow perch in Hammond Pond. However, vegetation removal should be attempted prior to the consideration of rehabilitation. If Hammond Pond were rehabilitated without first attempting to remove vegetation, feeding efficiency would still likely be hindered and keeping panfish densities at manageable levels would be difficult. If Hammond Pond were rehabilitated, efforts should be expended to salvage the largemouth bass and bluegill in the pond. Those fish could be stocked in other ponds in the area and possibly re-introduced following the treatments.

Water Chemistry Monitoring

Due to equipment failure, water chemistry measurements were not taken on Hammond Pond during the 2000 survey. Since Rock Island Ponds have a history of low summer and winter dissolved oxygen levels, measurements should be taken at least once each month for a year to more fully understand the water chemistry dynamics of the pond. Water chemistry data should be collected at 1 m increments at several locations including the area of greatest depth. A Hydrolab® should be used to collect information on dissolved oxygen, temperature, pH, conductivity, and turbidity. Water chemistry data may be useful not only to interpret previous conditions, but to also assist fishery biologists in determining future management and/or stocking options.

Stocking

Warm summer water temperature in Hammond Pond probably limits survival of trout throughout July and August and it is recommended that catchable size trout be stocked in spring to provide public fishing opportunity. As with other size trout, those stocked as fingerlings may not survive through the summer and may not achieve sizes which would benefit anglers. Although rainbow trout have been stocked annually since the 1990 rehabilitation, brown trout may provide anglers with fishing opportunity for a longer period each year. Brown trout can tolerate warmer water temperatures, more turbid water, and lower dissolved oxygen levels than rainbow trout (Wydoski and Whitney 1979) although catch rates may not be as high. Stocking a minimum of 6,000 trout each spring is recommended. Stocking should occur on two separate occasions; once in March (~4,000 fish) and again in late April or early May (~2,000 fish). This would likely provide anglers with fishing opportunity throughout spring and early summer.

Similar to Big Bow and Putters ponds, habitat conditions in Hammond Pond are likely not optimal for channel catfish. Although channel catfish have not been stocked in Hammond Pond, they may provide anglers with fishing opportunity if stocked at the right size. Survival of channel catfish stocked as fingerlings in Big Bow and Putters ponds is questionable. However, stocking larger size channel catfish (minimum of ~16 inches) may provide anglers with immediate angling opportunity, regardless of whether those fish survived for prolonged periods. Current angler survey information on Hammond Pond is lacking and the benefit of a channel catfish fishery is unknown. At least a short-term creel survey would help to determining effort that would be expended on channel catfish and whether stocking this species would be beneficial.

Largemouth bass and bluegill have not been stocked in Hammond Pond since 1990 and plans for stocking these species in recent years have not been considered. Prior to stocking these species in the future, vegetation removal or rehabilitation should be considered to help reduce pumpkinseed and yellow perch abundance. If vegetation removal efforts are expended, a minimum of 120 adult largemouth bass (10-12 inches)should be stocked which may facilitate pumpkinseed and yellow perch reduction. If the vegetation removal/largemouth bass stocking efforts failed to reduce panfish abundance and the pond were rehabilitated, various age classes of largemouth bass should be stocked including juveniles, sub-adults, and adults. A minimum of 300 adult, 300 sub-adult (~5 fish/acre of each size), and 900 juvenile (~15 fish/acre) largemouth bass would be recommended. In addition, a minimum of 1,700 (~30 fish/acre) bluegill should be stocked following the rehabilitation. Various size, but mostly adult, bluegill could be collected from lakes, such as Whitestone Lake in Okanogan County, Washington (Osborne and Petersen In Press), that contain a high abundance of bluegill.

Warmwater Gamefish Monitoring

No regulation changes are recommended at this time. However, periodic warmwater fish surveys, including water chemistry monitoring, should be conducted to monitor fish population dynamics in Hammond Pond. If the pond were rehabilitated and/or vegetation were removed, future monitoring could be used to assess the effectiveness of those efforts and determine if additional warmwater gamefish stocking and/or adjustments in regulations were needed.

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Glossary

Catch Per Unit Effort (CPUE): Is defined as the number of fish captured by a sampling method (ie. electrofishing, gill netting, or fyke netting) divided by the amount of time sampled.

Confidence Interval (CI): Is defined as an estimated range of values which is likely to include an unknown population parameter with a percentage or degree of confidence.

Memorable Size: Is defined as fish anglers remember catching, and also identified as 59-64 percent of the world record length. Memorable length varies by species.

Preferred Size: Is defined as the size fish anglers preferred to catch when given a choice, and also identified as 45-55 percent of world record length. Preferred length varies by species.

Proportional Stock Density (PSD): Is defined as the number of quality length fish and larger, divided by the number of stock sized fish and larger, multiplied by 100.

Quality Length: Is defined as the length at which anglers begin keeping fish. Also identified as 36-41 percent of world record length. Quality length varies by species.

Relative Stock Density (RSD): Is defined as the number of fish of a specified length category (quality, preferred, memorable, or trophy) and larger, divided by the number of stock length fish and larger, multiplied by 100.

Relative Stock Density of Preferred Fish (RSD-P): Is defined as the number of fish in the preferred size category and larger, divided by the number of stock length fish and larger, multiplied by 100.

Relative Stock Density of Memorable Fish (RSD-M): Is defined as the number of fish in the memorable size category and larger, divided by the number of stock length fish and larger, multiplied by 100.

Relative Stock Density of Trophy Fish (RSD-T): Is defined as the number of fish in the trophy size category and larger, divided by the number of stock length fish and larger, multiplied by 100.

Relative Weight (W_r): The comparison of the weight of a fish at a given size to the national average weight (W_r = 100) of fish of the same species and size.

Standard Weight (W_s): Is defined as a standard or average weight of a fish species at a given length determined by a national length-weight regression.

Stock Length: Is defined by the following: 1) approximate length of fish species at maturity; 2) the minimum length effectively sampled by traditional sampling gears; 3) minimum length of fish that provide recreational value; and 4) 20-26 percent of world record length. Stock length varies by species.

Total Length (TL): Is defined as the length measurement from the anterior most part of the fish to the tip of the longest caudal (tail) fin ray (compressed).

Trophy Size: Considered a trophy, and also identified as 74-80 percent of world record length. Trophy length varies by species.

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