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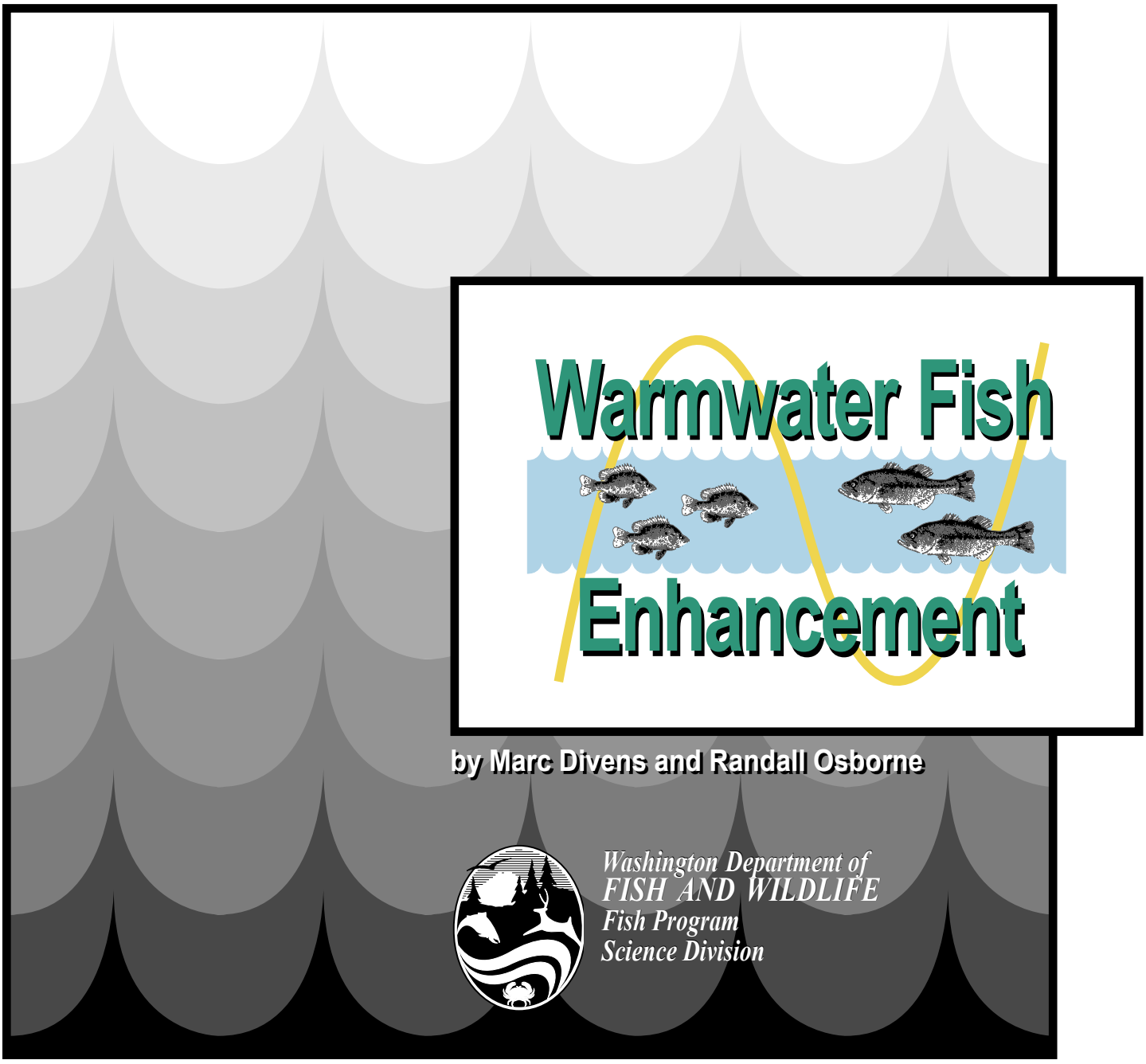
2003 Warmwater Fisheries Surveys of Upper and Lower Twin Lakes (Lincoln County)



by Marc Divens and Randall Osborne

Washington Department of
FISH AND WILDLIFE
Fish Program
Science Division

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2003 Warmwater Fisheries Surveys of Upper and Lower Twin Lakes (Lincoln County)

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Abstract

Washington Department of Fish and Wildlife biologists surveyed Upper and Lower Twin Lakes (Lincoln County) on June 8–12, 2003. Fish were captured using boat electrofishing, gill netting, and fyke netting. Each lake was populated by the same six species; however, relative abundance and indices of population structure differed between the two. The differences observed are most likely due to the cumulative effects of varying mean depth, aquatic vegetation abundance, and top predator densities.

At Upper Twin Lake, largemouth bass *Micropterus salmoides* was the most abundant species by weight (62%) and was second only to pumpkinseed sunfish *Lepomis gibossus* (53% by number) by number, comprising 36% of the sample. Rainbow trout *Oncorhynchus mykiss*, brown bullhead *Ameiurus nebulosus*, yellow perch *Perca flavescens*, and black crappie *Pomoxis nigromaculatus* were also sampled, but at much lower numbers. Largemouth bass are abundant and grow to quality size as evidenced by a high electrofishing catch rate and above average condition. Abundant pumpkinseed sunfish, while likely an important prey species for bass, offer only limited angling opportunity due to their mostly small size. The stocked rainbow trout sampled were of a size typically of interest to anglers and should coexist alongside the warmwater fish species within the lake, which has a high proportion of open water in addition to the shallow, weedy, littoral areas. Managers are encouraged to continue with the current management strategy for Upper Twin Lake.

At Lower Twin Lake, pumpkinseed sunfish was the most abundant species by weight (53%) and number (78%). Largemouth bass were second in abundance and yellow perch, brown bullhead, black crappie and rainbow trout were also sampled. Lower Twin Lake offers anglers only less-than-quality opportunities. A combination of shallower depth, extensive aquatic vegetation, and a lower density largemouth bass population are likely the key factors influencing the community. Panfish opportunities at Lower Twin Lake are best summarized as abundant, but are composed primarily of small pumpkinseed sunfish, yellow perch, and black crappie. An increase in predator abundance would likely improve the overall quality of the fishery.

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Introduction

Upper and Lower Twin lakes are located approximately 26 kilometers northeast of Odessa in Lincoln County (Figures 1 and 2). Upper and Lower Twin lakes are midsized at 17 and 20 hectares respectively (Table 1). Although similar in area, the two lakes differ in that Upper Twin is quite deep with a mean and maximum depth of 9.4 and 19.5 meters respectively, whereas Lower Twin is elongated with a mean depth of 1.8 meters and a maximum depth of 3.0 meters. The two lakes, along with several others, lie within the Lake Creek drainage. Lake Creek begins as an outlet at Wall Lake and flows southwest 26 kilometers to its confluence with Rock Creek five kilometers west of Odessa. There are 11 lakes in the drainage including from top to bottom Wall, Upper Twin, Lower Twin, Coffeepot, Deer, Browns, Tavares, Neves, Wederspahn, Pacific, and Bobs. Lake Creek flows through Upper and Lower Twin as both inlets and outlets of each lake. The lakes are somewhat isolated from Wall to the north and Coffeepot to the south by falls, which serve as natural barriers to fish passage. However, Upper and Lower Twin fish may find their way into the drainage and lakes downstream.

Upper and Lower Twin lakes lie within the 5,666-hectare Twin Lakes Recreation Area owned and managed by the U. S. Bureau of Land Management (BLM). The land was purchased by the BLM in 1995. Public access to the lakes is available at the BLM Twin Lake Recreation site, which provides parking, camping, boat launching, and a restroom.

Historically, access was limited, as were angling opportunities, to the naturally reproducing warmwater fish populations. Largemouth bass *Micropterus salmoides* and yellow perch *Perca flavescens* were stocked in 1940. Rainbow trout *Oncorhynchus mykiss* were stocked from 1951 to 1967. More recently, legal-size rainbow trout have been stocked annually since 1996. Under current statewide Washington Department of Fish and Wildlife (WDFW) angling regulations, the following rules apply on both Upper and Lower Twin: a slot-limit on largemouth bass allows anglers to retain five largemouth bass less than 305 mm (12 inches) or greater than 432 mm (17 inches), and no more than one over 432 mm; a limit of five trout, with no minimum size; and there is no minimum length or bag limit on black crappie *Pomoxis nigromaculatus*, pumpkinseed sunfish *Lepomis gibbosus*, yellow perch, or bullhead catfish *Ameiurus* spp.

Due to habitat characteristics and history as warmwater fisheries, regional fisheries biologists identified Upper and Lower Twin lakes as waters to be surveyed under the Warmwater Fish Enhancement Program. To evaluate warmwater fish populations, and to identify ways to improve the quality of fishing, personnel from the WDFW Warmwater Enhancement Program conducted fisheries surveys on both lakes in June 2003.

Table 1. Physical parameters of Upper and Lower Twin lakes (Lincoln County).

Physical Parameters	Upper Twin Lake	Lower Twin Lake
Surface Area (hectares)	17	20
Shoreline Length (kilometers)	2.6	3.7
Maximum Depth (meters)	19.5	3.0
Mean Depth (meters)	9.4	1.8
Volume (cubic meters)	1603514	382376

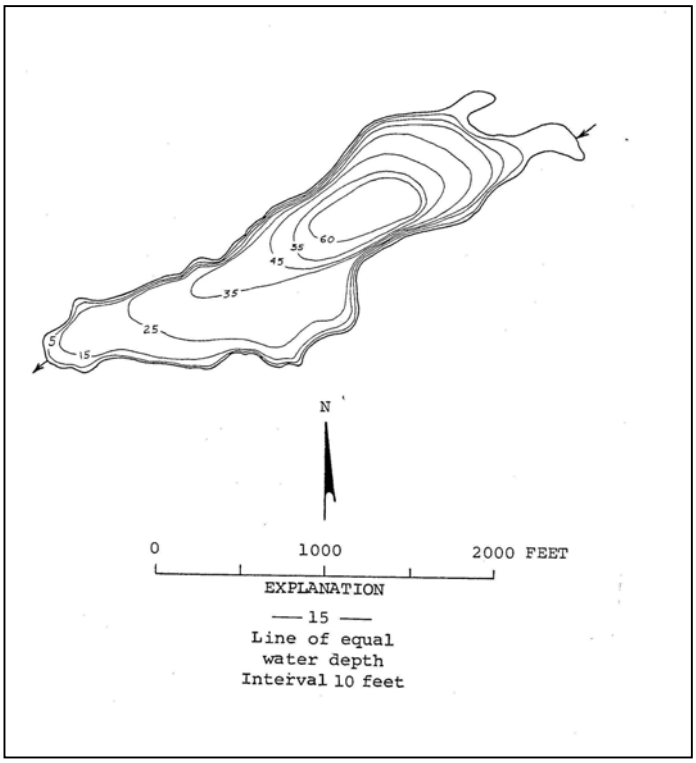

Figure 1. Bathymetric map of Upper Twin Lake (Lincoln County).

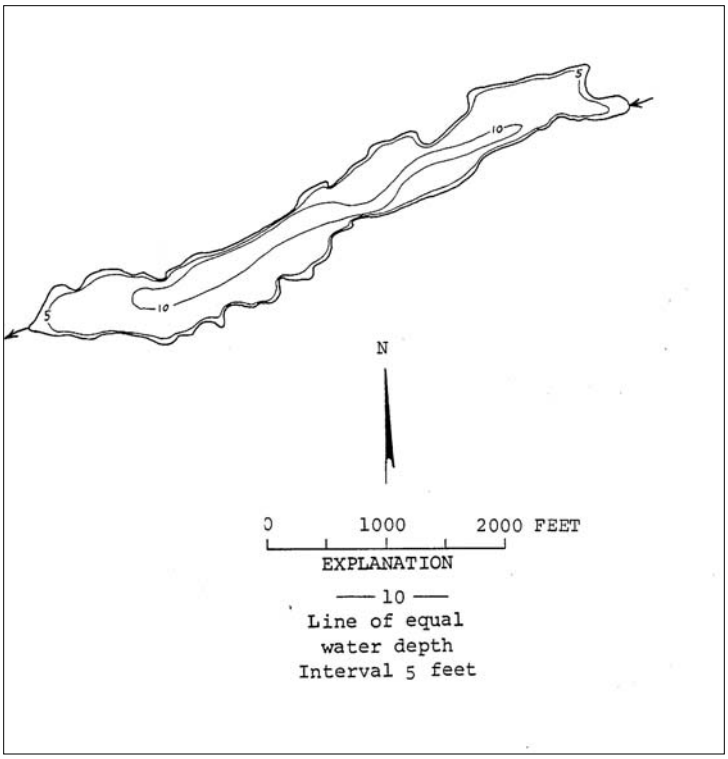

Figure 2. Bathymetric map of Lower Twin Lake (Lincoln County).

Methods

Upper and Lower Twin lakes were surveyed June 8-12, 2003. Fish were captured using boat electrofishing, gill netting, and fyke netting. The electrofishing unit consisted of a 5.5 m Smith-Root 5.0 GPP "shock boat" using a DC current of 120 cycles / sec at 5 to 6 amps power. Experimental gill nets (45.7 m long x 2.4 m deep) were constructed of four sinking panels (two each at 7.6 m and 15.2 m long) of variable size (1.3, 1.9, 2.5, and 5.1 cm stretched mesh) monofilament. Fyke nets were constructed of a main trap (4.7 m long and 1.2 m in diameter), a lead net (30.5 m long x 1.2 m), and two wings (7.6 m long x 1.2 m deep).

At Upper Twin, sampling locations were selected by dividing the shoreline into six sections of approximately 400 meters each. There, all six sections were sampled by boat electrofishing, whereas four were randomly selected for sampling by gill netting and four by fyke netting. At Lower Twin, sampling locations were selected by dividing the shoreline into eight sections of approximately 400 meters each. Six sections were randomly selected for sampling by boat electrofishing, four by gill netting, and four by fyke netting. While electrofishing, the boat was maneuvered through the shallows (depth range = 0.2 - 2 m), adjacent to the shoreline. This sampling was conducted during evening hours to maximize the size and number of fish captured. Electrofishing is more effective at night because some fish species seek shelter during the day and move freely at night (Reynolds 1996; Dumont and Dennis 1997). The total electrofishing time at each lake was 3600 seconds ("pedal-down" time). Gill nets were set perpendicular to the shoreline with the small mesh end attached onshore and the large mesh end anchored offshore. Fyke nets were set perpendicular to the shore with the lead net anchored onshore and the wing nets set at 45-degree angles to the trap. Fyke nets were set so that the trap was no deeper than three meters (Bonar et al. 2000).

Each fish captured was identified to species, measured to total length (mm TL) and weighed (g). Scales were collected for age and growth analysis from largemouth bass, black crappie, yellow perch, and pumpkinseed sunfish. Scale samples (up to five per ten mm length class for each species) were mounted, pressed, and aged according to Jearld (1983) and Fletcher et al. (1993). Rainbow trout and brown bullhead (*Ameiurus nebulosus*) were not aged.

Water quality data were collected from the deepest location in each lake. Water quality data collection was conducted on June 10, 2003, at 12:35 PM at Lower Twin and on June 12, 2003, at 12:09 PM at Upper Twin. Data were collected on dissolved oxygen, temperature, specific conductance, total dissolved solids, and pH using a Hydrolab® probe and digital recorder. Water clarity was measured using a Secchi disc.

Data Analysis

Percentages of the total biomass and number of fish collected for each species provides useful information regarding the balance and productivity of the community (Swingle 1950; Fletcher et al. 1993). Species composition by weight (kg) and number was calculated using six boat electrofishing sections, all four gill netting sections, and all four fyke netting sections for each lake. This sampling ratio maintains the WDFW standard 1:1:1 ratio of electrofishing to gill netting to fyke netting (1:1:1 -1800 seconds of boat electrofishing: 24 hours of gill netting: 24

hours of fyke netting) used to evaluate species composition for lakes. All fish were included in the calculations of species composition.

Catch per unit of effort (CPUE), by gear type, was determined for each fish species collected (number of fish/hour electrofishing, number of fish/gill net night, and number of fish/fyke net night). The CPUE for each fish species was calculated using only stock length fish and longer. Stock length fish, which varies by species, is the length of a particular fish species that offers a threshold recreational value to an angler (Anderson 1976). Randomly chosen sample sections can contribute to high variability among samples, therefore, 80% confidence intervals (CI) were calculated for each mean CPUE by species and gear type. Each CI was calculated as the mean ±t(,N-1)×SE, where *t*=Student's *t* for confidence level with N-1 degrees of freedom (two tailed) and SE=standard error of the mean. When standardized sampling is used, CPUE is a useful index to compare lakes within the state of Washington and to monitor changes in relative abundance over time.

Length frequency histograms (percent frequency captured by each gear type) were created to evaluate the size structure of populations, for which sampled size was greater than 30 individual fish. Sample size was adequate for largemouth bass, yellow perch, pumpkinseed sunfish, and rainbow trout at Upper Twin, and for largemouth bass, yellow perch, pumpkinseed sunfish and brown bullhead at Lower Twin.

Proportional stock density (PSD), calculated as the number of fish of quality length/number of fish stock length×100, was determined for each warmwater fish species collected that have established stock lengths (Anderson and Neuman 1996). PSD can provide information about the proportion of various sized fish in a population and can be a useful tool when sample size is adequate (Willis et al. 1993; Divens et al. 1998). Stock and quality lengths are based on percentages of world record catch size and vary depending on fish species. Stock length (20-26% of the world record) refers to the minimum size of fish with recreational value, and quality length (36-41% of the world record) refers to the minimum size fish anglers would like to catch. In addition to stock and quality length, Gabelhouse (1984) introduced relative stock density (RSD) which includes preferred, memorable, and trophy lengths. Preferred length (45-55% of world record length) refers to the length fish anglers would prefer to catch. Memorable length (59-64% of the world record length) refers to the minimum length fish most anglers remember catching, whereas trophy length (74-80% of world record length) refers to the minimum length fish worthy of acknowledgment. RSD, calculated as the number of species-specific length/number of stock-length fish×100, was also calculated for each game fish species. Like PSD, RSD can also provide useful information regarding population dynamics and is more sensitive to changes in year class strength. For example, relative stock density preferred (RSD-P) is the percentage of stock length fish preferred length and longer, RSD-M is the percentage of stock length fish memorable length and longer, and RSD-T is the percentage of stock length fish trophy size and longer. Eighty-percent confidence intervals for PSDs and RSDs are provided as an estimate of statistical precision and were calculated using normal approximation (Conover 1980; Gustafson 1988). Bister et al. (2000) developed and proposed additional PSD and RSD length categories for 83 additional species including brown bullhead, which was previously uncategorized.

Age and growth of warmwater fishes sampled were evaluated using the direct proportion method (Fletcher et al. 1993) and Lee's modification of the direct proportional method (Carlander 1982). Using the direct proportional method, total length at annulus formation, L_n, was back–calculated as $L_n=(A\times TL)/S$, were A is the radius of the fish scale at age n, TL is the total length of the fish captured, and S is the total radius of the scale at capture. Using Lee's modification, L_n was back–calculated as $L_n=a+A\times(TL-a)/S$, where a is the species-specific standard intercept from a scale radius-fish length regression. Mean back–calculated lengths at age n for each species were presented in tabular form for easy comparison of growth between year classes, as well as between the lake average and what has been found in other areas around the state of Washington (Fletcher et al. 1993) for the same species. Fletcher et al. (1993) calculated state averages using data collected from select warmwater fish populations throughout the state. These growth rates are referred to as the state average in the results section. Although, not a true state average, this is likely representative of fish growth for lakes sampled within the state.

The relative weight (W_r) index was calculated for all species to evaluate the relationship between the length of fish collected and their weight. W_r is calculated as the actual weight of a fish divided by the standard weight (W_s) for the same species at the same length multiplied by 100 ($W_r=W/W_s\times100$, where W is the weight (g) of an individual fish and W_s is the standard weight of a fish of the same length). W_s is calculated from the standard log 10 weight-log10 length relationship defined for the species of interest. Standard weight equations have been established for many freshwater game and non-game fish species (Anderson and Neumann 1996; Bister et al. 2000). Relative weights are useful for comparing the condition of different size groups within a single population to determine if all sizes are getting adequate nutrition (ODFW 1997). A W_r value of 100 generally indicates that a fish is in average condition when compared to the national average for that species (Anderson and Gutreuter 1983). Fish collected with relative weights below 85 are underweight and may be an indication of too many fish for their food supply (Flickinger and Bulow 1993). Anderson and Neumann (1996) list the parameters for the W_r equations of many warmwater fish species, including the minimum length recommendations for their application. W_r values from this survey were compared to the national average (W_r=100) for each species.

Results

Upper Twin Lake

Species Composition

Six fish species were collected from Upper Twin Lake in June 2003 (Table 2). Largemouth bass was the most abundant species by weight at 62% and second only to pumpkinseed sunfish by number. Yellow perch, rainbow trout, brown bullhead catfish, and black crappie were sampled at lower numbers.

Table 2. Species composition by weight (kg) and number for all fish sampled at Upper Twin Lake (Lincoln County) in June 2003.

	Species Composition					
	by Weight		by Number		Size Range (mm TL)	
Species	(kg)	(%)	(#)	(%)	Min	Max
Largemouth Bass	102.58	62.05	401	36.39	50	530
Pumpkinseed Sunfish	34.38	20.80	584	52.99	15	178
Rainbow Trout	10.21	6.18	39	3.54	247	446
Brown Bullhead	8.91	5.39	26	2.36	160	308
Yellow Perch	7.98	4.83	41	3.72	188	332
Black Crappie	1.24	0.75	11	1.00	69	275

CPUE

Largemouth bass and pumpkinseed sunfish were sampled at extraordinarily high rates by boat electrofishing, which indicates high-density populations (Table 3). Gill netting captured yellow perch and rainbow trout at the highest rate. Fyke netting captured pumpkinseed sunfish at the highest rate.

Table 3. Mean catch-per-unit-effort by sampling method, including 80% confidence intervals, for stock length fish sampled at Upper Twin Lake (Lincoln County) in June 2003.

	Gear Type					
	Electrofishing		Gill Netting		Fyke Netting	
Species	(#/hour)	Sites	#/Net Night	Net Nights	#/Net Night	Net Nights
Brown Bullhead	8.9 ± 3.2	6	0.3 ± 0.3	4	4.0 ± 2.3	4
Black Crappie	2.9 ± 3.7	6	1.0 ± 0.9	4	0.3 ± 0.3	4
Largemouth Bass	276.5 ± 52.3	6	1.8 ± 1.1	4	0.0	4
Pumpkinseed Sunfish	232.6 ± 67.5	6	3.5 ± 2.3	4	77.3 ± 54.0	4
Rainbow Trout	3.0 ± 2.6	6	8.5 ± 5.0	4	0.0	4
Yellow Perch	0.0	6	9.0 ± 7.9	4	1.3 ± 0.6	4

Stock Density Indices

Largemouth bass and pumpkinseed sunfish sample sizes from electrofishing were adequate for evaluating PSD (Table 4). Upper Twin Lake largemouth bass and panfish stock density indices most closely resemble values desired for fish populations managed for panfish. Under this management scheme, abundant largemouth bass keep panfish populations in check.

Table 4. Traditional stock density indices including 80% confidence intervals for fish sampled at Upper Twin Lake (Lincoln County) in June 2003.

Species	# Stock Length	PSD	RSD-P	RSD-M	RSD-T
		Electrofishing			
Largemouth Bass	279	14 ± 3	8 ± 2	1 ± 1	0
Pumpkinseed Sunfish	235	29 ± 4	0	0	0
		Gill Netting			
Rainbow Trout	34	3 ± 4	0	0	0
Yellow Perch	36	97 ± 4	33 ± 10	3 ± 4	0
		Fyke Netting			
Pumpkinseed Sunfish	309	15 ± 3	0	0	0

Largemouth Bass

Upper Twin Lake largemouth bass sampled ranged from 50 to 530 mm TL (Table 2; Figure 3). The age of largemouth bass ranged from one to twelve years (Table 5). Largemouth bass growth rates were generally higher than the known Washington State average (Fletcher et al. 1993). Length frequency distribution indicates stable year-class strength (Figure 3). Largemouth bass condition was generally at or above the national average and appeared to increase with length (Figure 4). This indicates plentiful forage for bass at all ages, especially for adult fish.

Table 5. Age and growth of largemouth bass sampled from Upper Twin Lake (Lincoln County) in June 2003. Unshaded values are mean back-calculated lengths at annulus using the direct proportion method (Fletcher et al. 1993). Shaded values are mean back-calculated lengths using the Lee's modification method (Carlander 1982).

		Mean total length (mm) at age											
Year class	**# of fish**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
2002	6	75											
		77											
2001	24	65	150										
		77	152										
2000	15	89	151	198									
		100	156	199									
1999	27	82	142	193	232								
		95	150	196	232								
1998	47	76	140	188	236	279							
		90	150	195	239	279							
1997	6	73	170	246	313	358	391						
		89	181	254	317	360	391						
1996	2	53	136	223	305	332	361	385					
		70	149	232	309	335	363	385					
1995	6	60	127	215	302	350	382	408	426				
		77	141	225	308	353	384	409	426				
1994	1	42	126	177	252	317	354	386	402	413			
		60	140	188	259	322	357	388	402	413			
1993	1	54	116	205	275	350	407	426	446	461	472		
		72	131	216	283	356	410	428	447	462	472		
1992	1	61	169	274	354	414	452	469	488	504	515	525	
		78	183	283	361	418	454	471	490	505	515	525	
1991	3	43	153	245	317	371	407	439	466	485	501	512	519
		61	168	256	325	377	411	442	468	486	501	512	519
Direct Proportion Mean		64	144	216	287	346	393	419	446	466	496	518	519
Lee's Weighted Mean		88	153	204	253	303	391	417	442	473	498	515	519
State Average		60	146	222	261	289	319	368	396	440	485	472	496

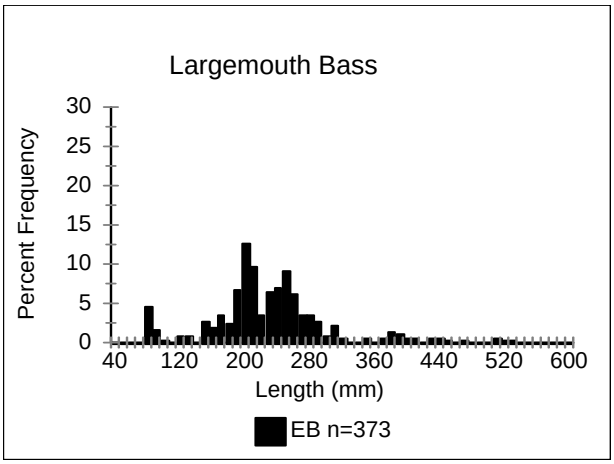

Figure 3. Length frequency distribution of largemouth bass, excluding young-of-the-year, sampled at Upper Twin Lake (Lincoln County) in June 2003 by boat electrofishing (EB).

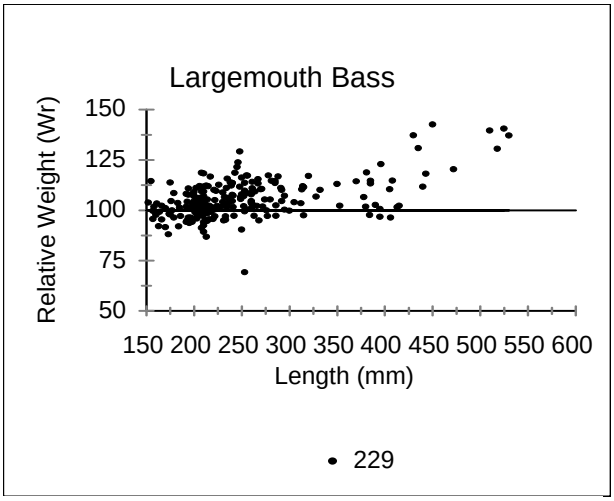

Figure 4. Relative weight (Wr) of largemouth bass, sampled at Upper Twin Lake (Lincoln County) in June 2003 compared to the national 75th percentile.

Yellow Perch

Upper Twin Lake yellow perch sampled ranged from 188 to 332 mm TL (Table 2; Figure 5). The age of yellow perch ranged from three to five years (Table 6). Yellow perch growth rates were higher than the known Washington State average (Fletcher et al. 1993). Age analysis and length frequency indicate unstable year-class strength (Table 6; Figure 5). Yellow perch condition ranged from below to above the national average, but in general was higher than typically observed for populations in Washington (Figure 6).

Table 6 Age and growth of yellow perch sampled from Upper Twin Lake (Lincoln County) in June 2003. Unshaded values are mean back-calculated lengths at annulus using the direct proportion method (Fletcher et al. 1993). Shaded values are mean back-calculated lengths using the Lee's modification method (Carlander 1982).

		Mean total length (mm) at age				
Year class	**# of fish**	**1**	**2**	**3**	**4**	**5**
2002	0	-				
2001	0	-				
2000	3	53	138	187		
		75	148	189		
1999	23	53	133	195	229	
		76	146	200	230	
1998	7	49	127	194	229	251
		73	142	201	232	251
Direct Proportion Mean		52	133	192	229	251
Lee's Weighted Mean		75	145	200	230	251
State Average		60	120	152	193	206

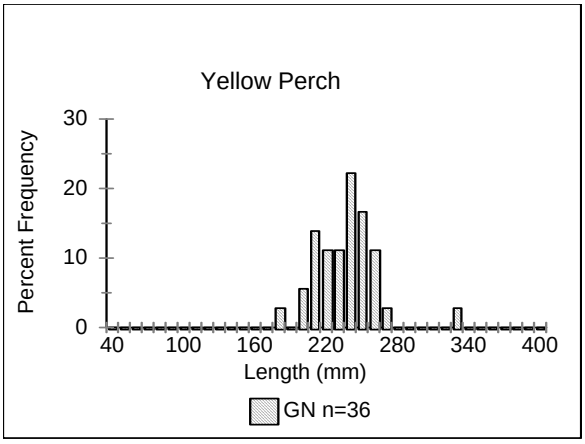

Figure 5. Length frequency distribution of yellow perch, excluding young-of-the-year, sampled at Upper Twin Lake (Lincoln County) in June 2003 by gill netting (GN).

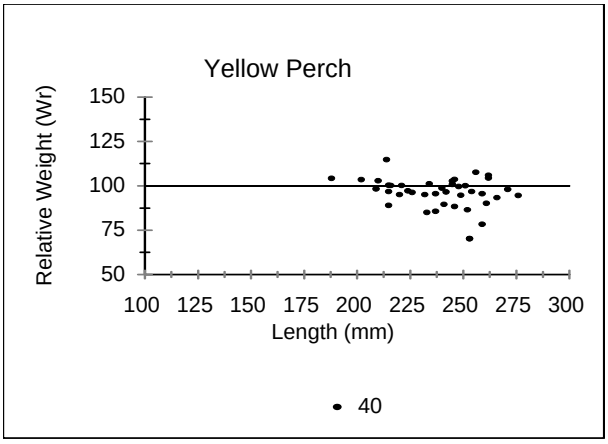

Figure 6. Relative weight (W_r) of yellow perch sampled at Upper Twin Lake (Lincoln County) in June 2003 compared to the national 75th percentile.

Pumpkinseed Sunfish

Upper Twin Lake pumpkinseed sunfish sampled ranged from 15 to 178 mm TL (Table 2; Figure 7). The age of pumpkinseed sunfish ranged from two to six years (Table 7). Pumpkinseed sunfish growth rates varied from below the known Washington average (Fletcher et al. 1993) in early years to higher in older fish. Pumpkinseed sunfish condition was generally at or above the national average (Figure 8).

Table 7. Age and growth of pumpkinseed sunfish sampled from Upper Twin Lake (Lincoln County) in June 2003. Unshaded values are mean back-calculated lengths at annulus using the direct proportion method (Fletcher et al. 1993). Shaded values are mean back-calculated lengths using the Lee's modification method (Carlander 1982).

		Mean Total Length (mm) at Age					
Year class	**# of fish**	**1**	**2**	**3**	**4**	**5**	**6**
2002	0	-					
2001	10	24	72				
		41	76				
2000	9	22	63	97			
		41	73	99			
1999	16	20	52	97	120		
		41	66	102	121		
1998	20	25	61	105	132	149	
		46	76	112	135	149	
1997	4	20	60	106	140	157	168
		42	76	116	144	158	168
Direct Proportion Mean		22	62	101	131	153	168
Lee's Weighted Mean		43	73	107	130	150	168
State Average		24	72	102	123	139	

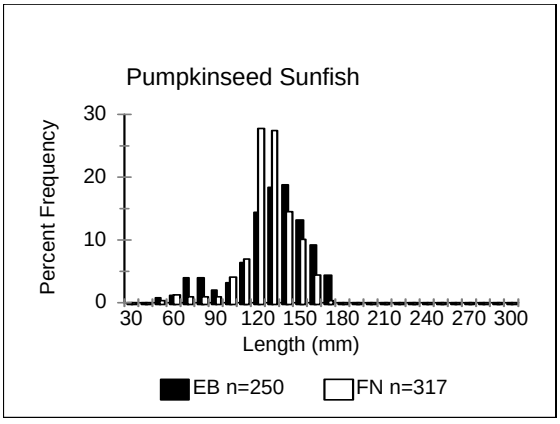

Figure 7. Length frequency distribution of pumpkinseed sunfish, excluding young-of-the-year, sampled at Upper Twin Lake (Lincoln County) in June 2003 by electrofishing (EB) and fyke netting (FN).

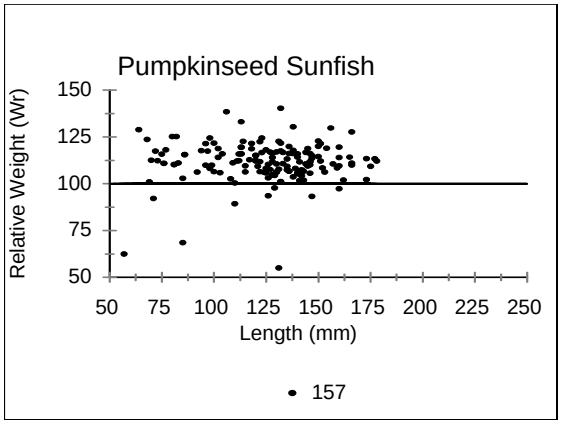

Figure 8. Relative weight (W_r) of pumpkinseed sunfish sampled at Upper Twin Lake (Lincoln County) in June 2003 compared to the national 75th percentile.

Black Crappie

Upper Twin Lake black crappie sampled ranged from 69 to 275 mm TL (Table 2). The age of black crappie ranged from one to six years (Table 8). Black crappie growth rates varied from below the known Washington average (Fletcher et al. 1993) in early years to higher in older fish. Black crappie condition was generally at or below the national average (Figure 9).

Table 8. Age and growth of black crappie sampled from Upper Twin Lake (Lincoln County) in June 2003. Unshaded values are mean back-calculated lengths at annulus using the direct proportion method (Fletcher et al. 1993). Shaded values are mean back-calculated lengths using the Lee's modification method (Carlander 1982).

		Mean Total Length (mm) at Age					
Year class	# of fish	1	2	3	4	5	6
2002	1	63					
		66					
2001	3	28	113				
		56	118				
2000	2	51	114	181			
		77	129	184			
1999	0	-	-	-	-		
1998	2	31	83	160	203	235	
		61	106	171	208	235	
1997	2	26	80	154	231	255	268
		58	104	169	235	256	268
Direct Proportion Mean		40	98	165	217	245	268
Lee's Weighted Mean		63	115	175	222	246	268
State Average		46	111	157	183	220	

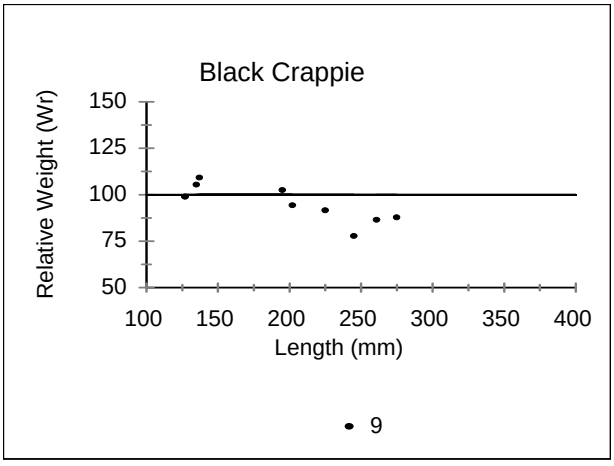

Figure 9. Relative weight (W_r) of black crappie sampled at Upper Twin Lake (Lincoln County) in June 2003 compared to the national 75th percentile.

Brown Bullhead

Upper Twin Lake brown bullhead sampled ranged from 160 to 308 mm TL (Table 2). The condition of brown bullhead was at or above the national average (Figure 10). No age analysis was done for this species.

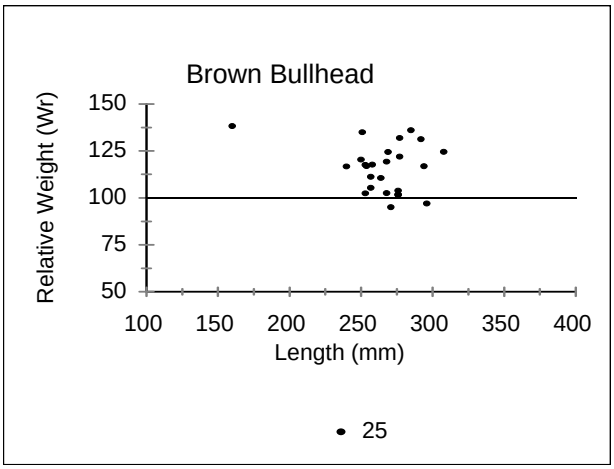

Figure 10. Relative weight (W_r) of brown bullhead sampled at Upper Twin Lake (Lincoln County) in June 2003 compared to the national 75th percentile.

Rainbow Trout

Upper Twin Lake rainbow trout sampled ranged from 247 to 446 mm TL (Table 2). The condition of rainbow trout sampled was at or below the national average (Figure 11). No age analysis was done for this species.

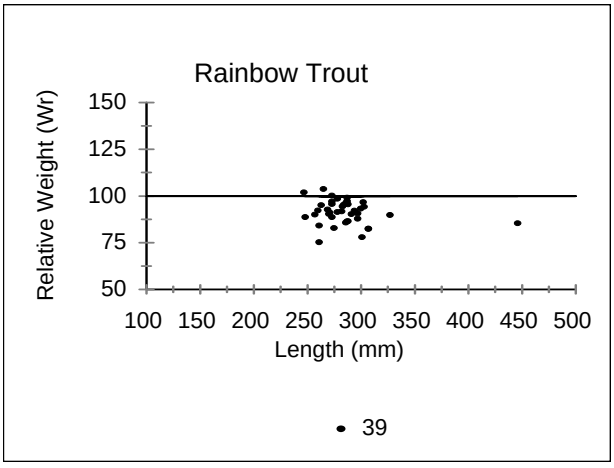

Figure 11. Relative weight (W_r) of rainbow trout sampled in Upper Twin Lake (Lincoln County) in June 2003 compared to the national 75th percentile.

Lower Twin Lake

Species Composition

Six fish species were collected from Lower Twin Lake in June 2003 (Table 9). Pumpkinseed sunfish was the most abundant species by weight (53 %) and number (78%). Largemouth bass was second in abundance at 24% by weight and 10% by number. Yellow perch, rainbow trout, brown bullhead catfish, and black crappie were sampled at lower numbers.

Table 9. Species composition by weight (kg) and number for all fish sampled at Lower Twin Lake (Lincoln County) in June 2003.

	Species Composition					
	by Weight		by Number		Size Range (mm TL)	
Species	(kg)	(%)	(#)	(%)	Min	Max
Pumpkinseed Sunfish	66.18	52.57	1303	77.74	68	189
Largemouth Bass	30.27	24.04	172	10.26	132	462
Yellow Perch	14.82	11.77	137	8.17	131	246
Brown Bullhead	12.57	9.96	43	2.57	226	301
Black Crappie	1.51	1.20	18	1.07	146	216
Rainbow Trout	0.57	0.45	3	0.18	264	276

CPUE

Pumpkinseed sunfish were sampled at high rates using all gear types (Table 10).

Table 10. Mean catch-per-unit-effort by sampling method, including 80% confidence intervals, for stock length fish sampled at Lower Twin Lake (Lincoln County) in June 2003.

	Gear Type					
	Electrofishing		Gill Netting		Fyke Netting	
Species	(#/hour)	Sites	#/Net Night	Net Nights	#/Net Night	Net Nights
Brown Bullhead	9.0 ± 8.8	6	0.5 ± 0.4	4	8.0 ± 3.8	4
Black Crappie	3.0 ± 2.6	6	2.8 ± 0.6	4	1.0 ± 0.7	4
Largemouth Bass	83.0 ± 10.8	6	2.8 ± 0.6	4	0.0	4
Pumpkinseed Sunfish	741.0 ± 97.1	6	46.5 ± 15.3	4	91.3 ± 43.9	4
Rainbow Trout	0.0	6	0.8 ± 0.6	4	0.0	4
Yellow Perch	31.0 ± 14.0	6	17.8 ± 4.2	4	8.8 ± 9.1	4

Stock Density Indices

Sample sizes of stock-length largemouth bass, pumpkinseed sunfish, and yellow perch were adequate to evaluate stock density indices (Table 11). Pumpkinseed sunfish PSD was low, which is typical of over-abundant populations. Largemouth bass proportional stock density (PSD) and relative stock density – preferred (RSD-P) were higher. This combination of predator vs. prey stock density index values is representative of a community in which the balance shift favors largemouth bass. Yellow perch PSD was higher indicating this species is more at balance with predators and available forage within the lake.

Table 11. Traditional stock density indices, including 80% confidence intervals, for fish sampled at Lower Twin Lake (Lincoln County) in June 2003.

Species	# Stock Length	PSD	RSD-P	RSD-M	RSD-T
		Electrofishing			
Largemouth Bass	83	13 ± 5	10 ± 4	0	0
Pumpkinseed Sunfish	741	7 ± 1	0	0	0
Yellow Perch	31	61 ± 11	0	0	0
		Gill Netting			
Pumpkinseed Sunfish	186	0	0	0	0
Yellow Perch	71	48 ± 8	0	0	0
		Fyke Netting			
Pumpkinseed Sunfish	364	4 ± 1	0	0	0

Largemouth Bass

Lower Twin Lake largemouth bass sampled ranged from 132 to 462 mm TL (Table 9; Figure 12). The age of largemouth bass sampled ranged from two to nine years (Table 12). Largemouth bass growth rates were generally higher than the know Washington State average. Length frequency distribution indicates unstable year-class strength (Figure 12). Few fish were sampled in the 300 to 400 mm length ranges. This may be an indication of extensive harvest of fish over 300 mm prior to the implementation of a 305 to 432 mm (12 to 17 inch) restrictive slot-limit regulation in 1999. The condition of largemouth bass less than 300 mm was generally at or below the national average (Figure 13). This may be an indication of extensive inter- and/or intra-specific competition for available food resources with young bass and abundant panfish. Largemouth bass greater than 300 mm was generally above the national average, which may indicate reduced competition, as bass become increasingly piscivorous at larger sizes.

Table 12. Age and growth of largemouth bass sampled from Lower Twin Lake (Lincoln County) in June 2003. Unshaded values are mean back-calculated lengths at annulus using the direct proportion method (Fletcher et al. 1993). Shaded values are mean back-calculated lengths using the Lee's modification method (Carlander 1982).

		Mean total length (mm) at age								
Year class	**# of fish**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2002	0	-								
2001	3	63	135							
		74	135							
2000	32	84	147	188						
		95	151	188						
1999	4	85	157	206	227					
		97	163	208	227					
1998	4	74	151	197	236	282				
		89	161	204	240	282				
1997	7	79	194	254	298	336	371			
		95	203	260	302	338	371			
1996	0	-	-	-	-	-	-	-		
1995	3	65	145	259	333	369	401	420	432	
		82	159	267	338	372	402	421	432	
1994	1	50	97	205	298	374	417	445	454	462
		68	113	216	305	378	419	446	454	462
Direct Proportion Mean		71	146	218	279	340	397	433	443	462
Lee's Weighted Mean		92	158	206	279	332	384	427	437	462
State Average		60	146	222	261	289	319	368	396	440

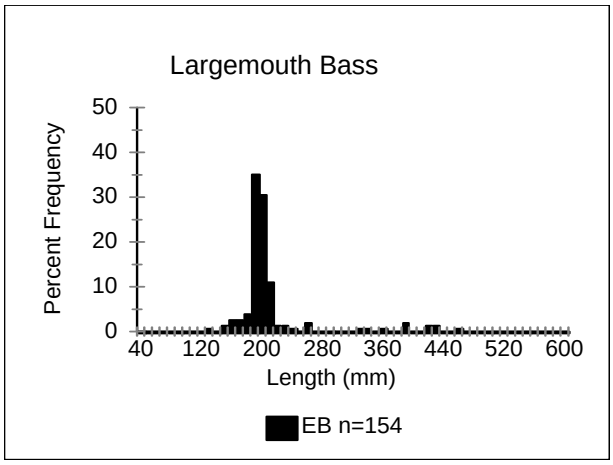

Figure 12. Length frequency distribution of largemouth bass, excluding young-of-the-year, sampled at Lower Twin Lake (Lincoln County) in June 2003 by boat electrofishing (EB).

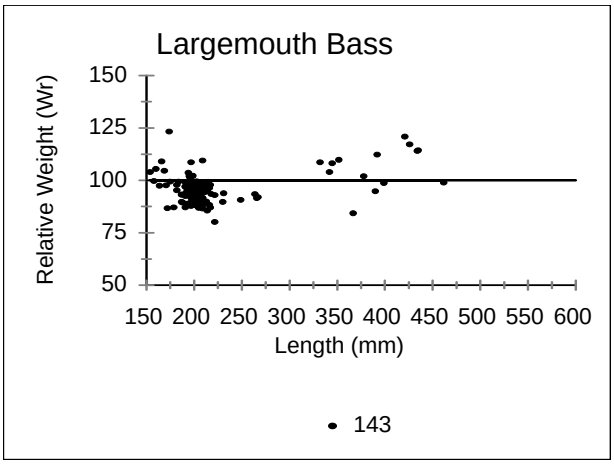

Figure 13. Relative weight (W_r) of largemouth bass, sampled at Lower Twin Lake (Lincoln County) in June 2003 compared to the national 75th percentile.

Yellow Perch

Lower Twin Lake yellow perch sampled ranged from 131 to 246 mm TL (Table 9; Figure 14). The age of yellow perch sampled ranged from two to four years (Table 13). Yellow perch growth rates were higher than the known Washington State average (Fletcher et al. 1993). Yellow perch less than 200 mm exhibited higher condition than the national average, whereas the condition of yellow perch greater than 200 mm was generally lower (Figure 15).

Table 13. Age and growth of yellow perch sampled from Lower Twin Lake (Lincoln County) in June 2003. Unshaded values are mean back-calculated lengths at annulus using the direct proportion method (Fletcher et al. 1993). Shaded values are mean back-calculated lengths using the Lee's modification method (Carlander 1982).

		Mean total length (mm) at age			
Year class	**# of fish**	**1**	**2**	**3**	**4**
2002	0	-			
2001	17	54	127		
		73	131		
2000	17	75	161	207	
		95	168	208	
1999	18	67	158	191	213
		88	166	194	213
Direct Proportion Mean		65	149	199	213
Lee's Weighted Mean		85	155	201	213
State Average		60	120	152	193

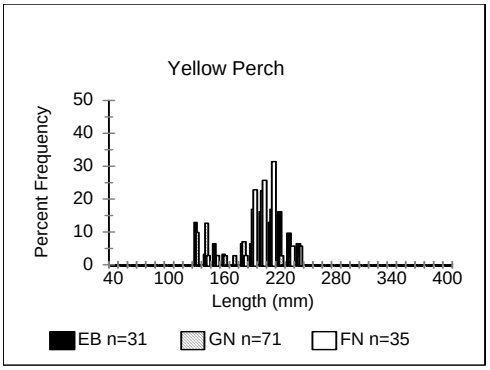

Figure 14. Length frequency distribution of yellow perch, excluding young-of-the-year, sampled at Lower Twin Lake (Lincoln County) in June 2003 by electrofishing (EB), gill netting (GN), and fyke netting (FN).

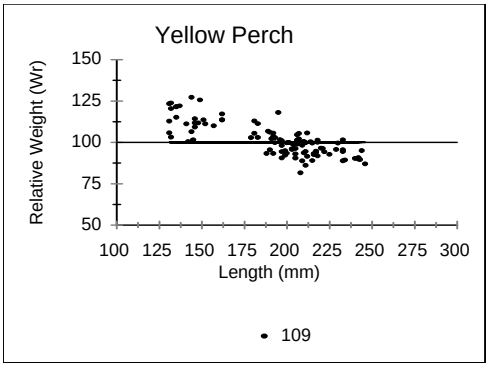

Figure 15. Relative weight (W_r) of yellow perch sampled at Lower Twin Lake (Lincoln County) in June 2003 compared to the national 75th percentile.

Pumpkinseed Sunfish

Lower Twin Lake pumpkinseed sunfish ranged from 68 to 189 mm TL (Table 9; Figure 16). The age of pumpkinseed sunfish sampled ranged from three to six years (Table 14). The growth rate of pumpkinseed sunfish was generally greater than the known Washington State average (Fletcher et al. 1993). The growth rate of young pumpkinseed sunfish as determined by back calculation was low, however, this may be attributed to the absence of age one and two year old fish in the sample. The condition of pumpkinseed sunfish was generally higher than the national average, but appeared to decrease with length and age (Figure 17).

Table 14. Age and growth of pumpkinseed sunfish sampled from Lower Twin Lake (Lincoln County) in June 2003. Unshaded values are mean back-calculated lengths at annulus using the direct proportion method (Fletcher et al. 1993). Shaded values are mean back- calculated lengths using the Lee's modification method (Carlander 1982).

		Mean Total Length (mm) at Age					
Year class	**# of fish**	**1**	**2**	**3**	**4**	**5**	**6**
2002	0	-					
2001	0	-	-				
2000	27	22	58	94			
		42	68	96			
1999	17	23	58	106	129		
		44	72	110	129		
1998	11	20	45	91	121	133	
		41	62	99	123	133	
1997	1	14	45	111	145	159	169
		37	64	120	148	160	169
Direct Proportion Mean		20	52	101	131	146	169
Lee's Weighted Mean		42	68	101	127	136	169
State Average		24	72	102	123	139	

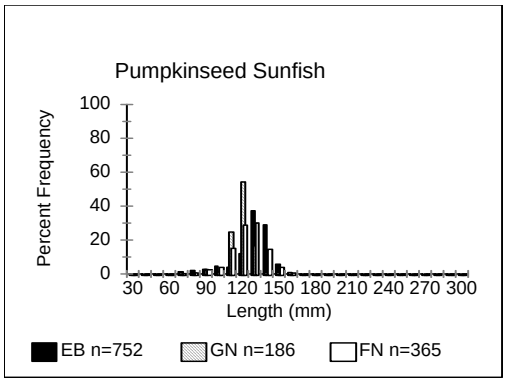

Figure 16. Length frequency distribution of pumpkinseed sunfish, excluding young-of-the-year, sampled at Lower Twin Lake (Lincoln County) in June 2003 by electrofishing (EB), gill netting (GN), and fyke netting (FN).

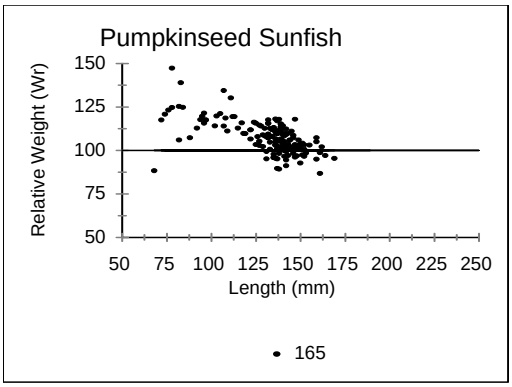

Figure 17. Relative weight (Wr) of pumpkinseed sunfish sampled at Lower Twin Lake (Lincoln County) in June 2003 compared to the national 75th percentile.

Black Crappie

Lower Twin Lake black crappie sampled ranged from 146 to 216 mm TL (Table 9). The age of black crappie sampled ranged from three to five years (Table 15). Black crappie growth rates were lower than the known Washington State average. The condition of black crappie sampled was higher than the national average for fish less than 170 mm, but decreased to below the national average for fish of greater length (Figure 18). This trend is typical for populations in Washington.

Table 15. Age and growth of black crappie sampled from Lower Twin Lake (Lincoln County) in June 2003. Unshaded values are mean back-calculated lengths at annulus using the direct proportion method (Fletcher et al. 1993). Shaded values are mean back-calculated lengths using the Lee's modification method (Carlander 1982).

		Mean Total Length (mm) at Age				
Year class	**# of fish**	**1**	**2**	**3**	**4**	**5**
2002	0	-				
2001	0	-	-			
2000	8	35	86	147		
		62	102	149		
1999	6	36	102	159	182	
		65	118	165	184	
1998	4	41	102	163	184	199
		69	119	170	187	199
Direct Proportion Mean		37	97	156	183	199
Lee's Weighted Mean		64	111	159	185	199
State Average		46	111	157	183	220

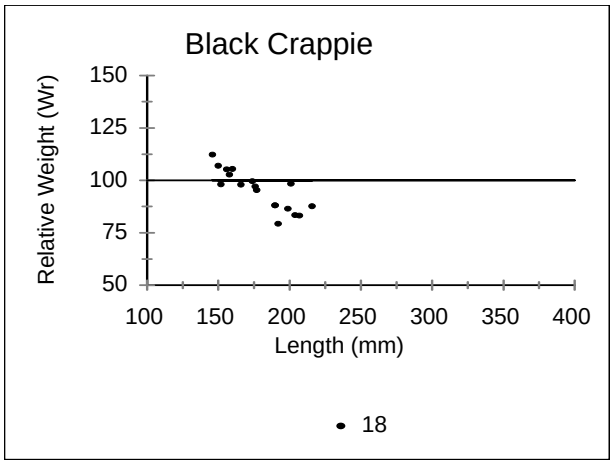

Figure 18. Relative weight (W_r) of black crappie sampled at Lower Twin Lake (Lincoln County) in June 2003 compared to the national 75th percentile.

Brown Bullhead

Lower Twin Lake brown bullhead catfish ranged in length from 226 to 301 mm TL (Table 9). The condition of brown bullhead was generally at or above the national average (Figure 19). No age analysis was done for this species.

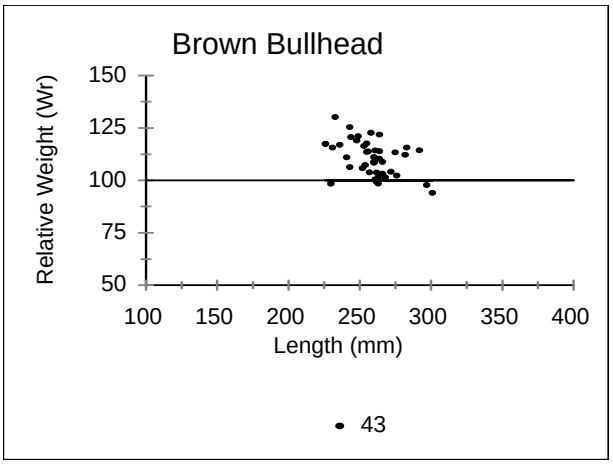

Figure 19. Relative weight (W_r) of brown bullhead sampled at Lower Twin Lake (Lincoln County) in June 2003 compared to the national 75th percentile.

Rainbow Trout

Lower Twin Lake rainbow trout ranged in length from 264 to 276 mm TL (Table 9). The condition of rainbow trout was below the national average (Figure 20). No age analysis was done for this species.

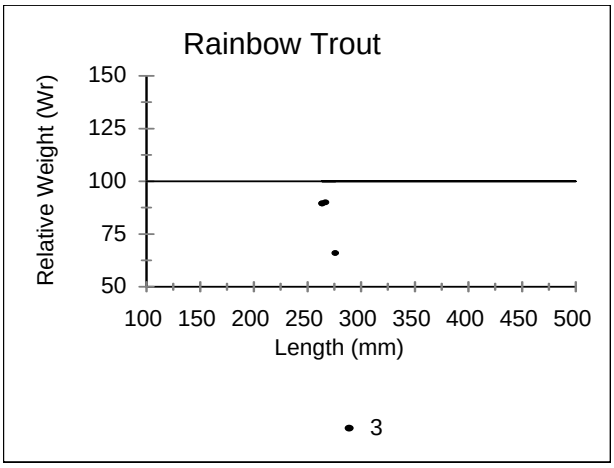

Figure 20. Relative weight (W_r) of rainbow trout sampled in Lower Twin Lake (Lincoln County) in June 2003 compared to the national 75th percentile.

Discussion

Warmwater fisheries managers commonly consider the "balance" between predator and prey species when assessing warmwater fish communities. The term balance is used loosely to describe a system in which omnivorous prey panfish species maximize food resources to produce harvestable-size fish stocks for anglers and an adequate forage base for piscivorous predator species (Bennett 1962). Fish communities may otherwise be described as being prey-crowded or predator-crowded. To provide quality warmwater fishing opportunities, predator game fish species, such as largemouth bass, must be able to reproduce and grow to control overpopulation of both predator and prey species.

At the time of this survey, Upper Twin Lake largemouth bass population indices exhibited characteristics of a predator crowded community. Densities of younger bass were high and their condition average, which is likely an indication of intra-specific competition. The condition of larger bass was above average however, indicating a reduction in competition. Adult fish become increasingly piscivorous and can better take advantage of abundant prey fish. In Upper Twin Lake, pumpkinseed sunfish likely provide that abundant forage base. Considering their higher than average abundance and good condition, Upper Twin Lakes largemouth bass provide a quality opportunity to anglers.

Upper Twin Lake panfish, are dominated by pumpkinseed sunfish. Fish within this population exhibited above average condition despite their high abundance. This is likely the result of abundant largemouth bass, which evidently keep pumpkinseed sunfish numbers at a level that does not surpass the production capabilities of the lake. Despite exhibiting above average condition, pumpkinseed sunfish offer only minimal angling opportunity due to their mostly small size and are likely more important to the fishery as prey for more desirable largemouth bass. At the time of this survey, yellow perch appeared unable to produce a successful year-class recently, possibly as a result of extensive predation by abundant bass and pumpkinseed sunfish. The fish that were present exhibited good growth and reached quality size. Similarly, although occurring at low density, black crappie, were of a size typically desirable to anglers. Considering black crappie higher than average growth rate and ability to reach quality size in the lake, Upper Twin is a good candidate for supplemental stocking consideration.

Rainbow trout and brown bullhead catfish sampled were of quality size and should be of interest to anglers. Considering the morphology of Upper Twin Lake, with a high proportion of open water in addition to the shallow, weedy, littoral areas, rainbow trout should readily coexist alongside the warm water fish species within the lake.

In contrast to Upper Twin, Lower Twin Lake offers anglers less-than-quality opportunities. The community is dominated by pumpkinseed sunfish, which are extremely abundant. A combination of shallower depth, extensive aquatic vegetation, and a lower density largemouth bass population are likely the key factors of influence. Thick aquatic vegetation is known to reduce the foraging efficiency of largemouth bass, which can affect sunfish relative abundance (Bettoli et al, 1992; Savino and Stein 1982). Panfish opportunities at Lower Twin Lake are best

summarized as abundant, but mostly small, pumpkinseed sunfish, yellow perch, and black crappie.

The Lower Twin Lake largemouth bass population likely offers only limited opportunity. The majority of bass sampled were small. At the time of this survey, few fish were sampled within the 305 to 432 mm length range (12 to 17 inch). Although largemouth bass within this size range are currently protected by a slot-limit regulation, low numbers of fish in this size range may be a result of over-harvest in the past.

Considering the findings of this survey, managers should continue with current management for Upper Twin Lake. Upper Twin Lake should continue to provide anglers good fishing opportunities for largemouth bass in addition to stocked rainbow trout. Lower Twin Lake, on the other hand, would likely benefit by reducing the overall abundance of mostly small panfish. Managers should consider action to decrease the abundance of aquatic vegetation and increase the abundance of predators in the lake.

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