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2003 Dinosaur Reservoir Littoral Fish Population and Habitat Enhancement Assessments

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ABSTRACT

Dinosaur Reservoir was formed in 1979 with the completion of the Peace Canyon Dam which backs water up into a bedrock canyon for 23 km to the tailrace of W.A.C. Bennett Dam. A number of enhancement projects aimed at addressing fish habitat limitations and entrainment problems are planned for the reservoir. A night time boat electrofishing program was started in 2001 to monitor fish populations in the littoral area. In 2003 and 2002, 28 sites were sampled twice in July and once in October by boat electrofisher. The total number of fish captured was 821 in 2003 and 1072 in 2002. In 2002 the total number of fish captured was 1.26 times greater than in 2003. Comparisons of 2003 and 2002 captures had evidence of site and time effects on total fish, rainbow trout and mountain whitefish. Changing water levels, fish migration, sampling variance or entrainment may contribute to these effects. There may have been a problem with the first sample session in 2003 as the average number of fish and mountain whitefish captured per site was significantly lower ($p<0.05$ students T test) than during the other sample sessions. Rainbow trout numbers captured were also low but not statistically lower than other sessions. Woody debris was added to 2 sites in June 2002 and 5 sites in July, 2003 to enhance habitat for juvenile fish. The October 2003 survey did not document any statistically significant increase in fish numbers at the enhanced sites. Rainbow trout numbers increased from 22 to 35 at the enhanced sites and the total capture also increased from 158 to 188. Effective sampling of the enhanced areas was difficult because the debris prevented the shocking boat from reaching shore and made it more difficult to net the fish. Alternate methods of sampling sites with woody debris will be investigated for future surveys.

Acknowledgements

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INTRODUCTION

Dinosaur Reservoir was formed in 1979 after the completion of the Peace Canyon Dam. This run of the river reservoir is 23 km long and backs water up to the tailrace of W.A.C. Bennett Dam. A number of studies have been conducted on this reservoir to evaluate fish stocking programs (Hammond 1984, 1986a, 1986b, 1986c, 1987a, 1987b, 1988, Joslin 2001 a & b) and to look at habitat limitations and potential enhancements (Pattenden and Ash 1993, Ash and McLeod 1994, Aim Ecological Consultants 2000). As a result of these studies a number of enhancement projects aimed at addressing fish habitat limitations, entrainment problems and stocking assessments are planned for the reservoir. In order to evaluate the effectiveness of these activities, baseline fish data will be needed. Preliminary boat electrofishing was effective at capturing a variety of species along the shoreline of the reservoir in October 2001 (Murphy and Blackman 2003). In 2001 and 2002 the propensity for rainbow trout to concentrate near woody debris was noted (pers. obs.). In 2002 a program was initiated to add woody debris to selected embayment areas throughout the reservoir.

The objectives of the 2003 Dinosaur Reservoir littoral fish population assessment study were to:

1. compare capture numbers from the 2002 survey of the same sites,
2. evaluate the effectiveness of adding woody debris to embayment areas as a fish habitat enhancement by sampling fish populations prior to and after the addition of woody debris.
3. obtain a catch per unit effort value (CPUE) to determine if the numbers of fish increased at locations where habitat has been enhanced by the addition of woody debris along the shoreline,
4. continue a program of fish marking to collect general information about fish movement and habitat use patterns, and
5. tag trout and char captured to gain more data from future creel and/or fish sampling surveys.

STUDY AREA

This steep sided reservoir is approximately 23 km long and covers an area of 805 ha (Figure 1), of which 400 ha is a bedrock river channel (Hammond 1984). Water retention time is about three days and daily water fluctuations are normally less than two metres (Figure 2). Low water usually occurs at night, but levels are determined by the operation of the dams. The reservoir is isothermal throughout the year (Pattenden and Ash 1993) and intake water temperatures (from W.A.C. Bennett Dam) are 2 to 5 ^{o}C from November to June and seldom exceed 10 ^{o}C. Johnson and Gething Creeks are the only significant spawning and rearing tributaries for wild sport fish populations in Dinosaur Reservoir (Pattenden and Ash 1993). The length of tributary streams accessible to fish from the reservoir is limited to 500 m of Johnson Creek, which has extreme silt load problems (pers. obs.), and 600 m of Gething Creek. Fish barriers and intermittent flows at several other smaller tributaries negate their use as spawning streams.

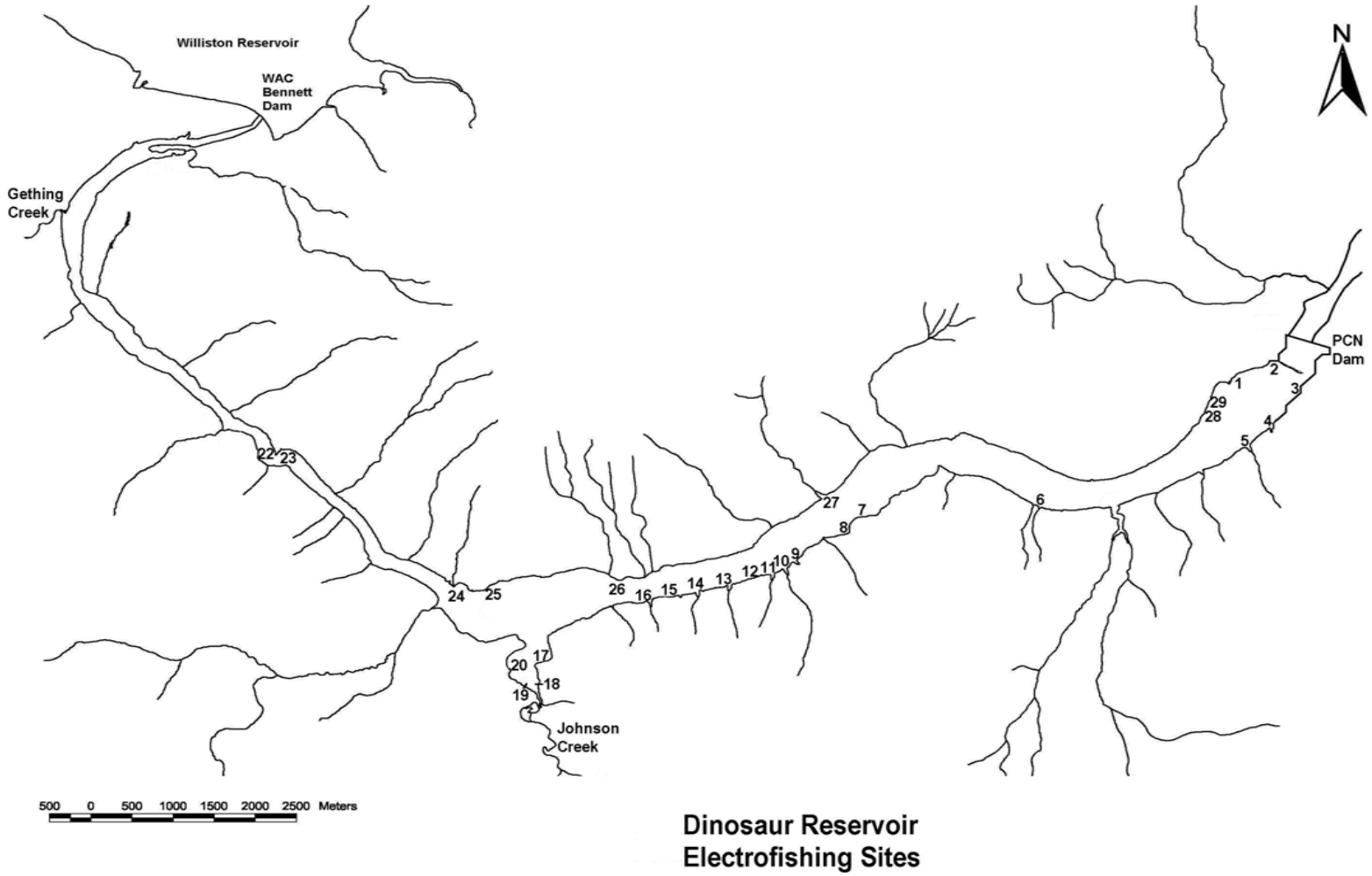

Figure 1. Dinosaur Reservoir electrofishing index sites 1-29.

METHODS

The electrofishing boat used was an 18 ft Smith-Root powered by an outboard jet, which enabled the operation in shallow water. A Smith-Root GPP 5.0 electrofisher powered by a 5,000 W generator on DC current was used. The settings were 60 Hz and between 500 and 700 volts.

The 28 sample sites were distributed throughout the reservoir, covering shoreline and bay habitat types (Figure 1). Shoreline sites were 200 m in length. Bay sites were frequently less than 200 m in length as they covered the shoreline of small bays. The sites were sampled twice in July and once in October. Start and end points of the index sites were located by GPS coordinates and landmarks.

In 2003, electrofishing started on July 7th and continued for 4 evenings between the hours of 10 pm and 5 am. Approximately half of the sites can be sampled in one evening, so the second sampling was initiated two days after the first, and the sites were sampled in the same order. The electrofishing boat sampled a 5-7 m wide area along the shoreline. Where woody debris or shallow water (<20 cm) was encountered the boat moved out from shore. Areas with woody debris required more electrofishing time per unit area and the number of fish captured tended to be higher so CPUE was calculated by length of shoreline sampled and unit time. Two technicians netted the stunned fish and placed them in holding tanks on the electrofishing boat. After the site was completed the electrofishing time was recorded and the fish collected were handed over to a second boat for processing. The fish were identified, measured and weighed. In July all fish over 250 mm were spaghetti tagged. Scale samples were taken from all wild rainbow trout (*Oncorhynchus mykiss)* and adipose clips (hatchery) were noted. Scale samples were also taken from bull trout *(Salvelinus confluentus),* and lake trout (*Salvelinus namaycush)* < 150 mm. Pelvic fin rays were taken from all bull trout and lake trout with fork lengths $\geq$ 150 mm. Once processed and marked, the fish were returned to the middle of the site from which they had been captured.

On June 17th 2003 there were 5,030 adipose clipped hatchery rainbow trout (mean weight 174 g) released at the upstream end of the reservoir. This is a yearly stocking program so all adipose clipped fish captured are not necessarily from the 2003 release.

There is also an ongoing program in this reservoir to improve rearing habitat through the addition of woody debris to selected areas. The woody debris (logs, root wads etc.) was placed along a 50-80m section of shoreline of each site and held in place by log boom sticks anchored to the shore. These sites are located in small bays and are 200 to 250 m in length, depending on the size of the bay. Only a portion of one shoreline is used so that boat access (refuge from storms) to these sheltered bays is not restricted. Woody debris was added (sites 10 and 16) in July and August 2002 after the first electrofishing session. In 2003, the wood was added (sites 11,13,14,and 17) in June prior to electrofishing. Before and after comparisons of the number of fish at the sites used only data collected in October.

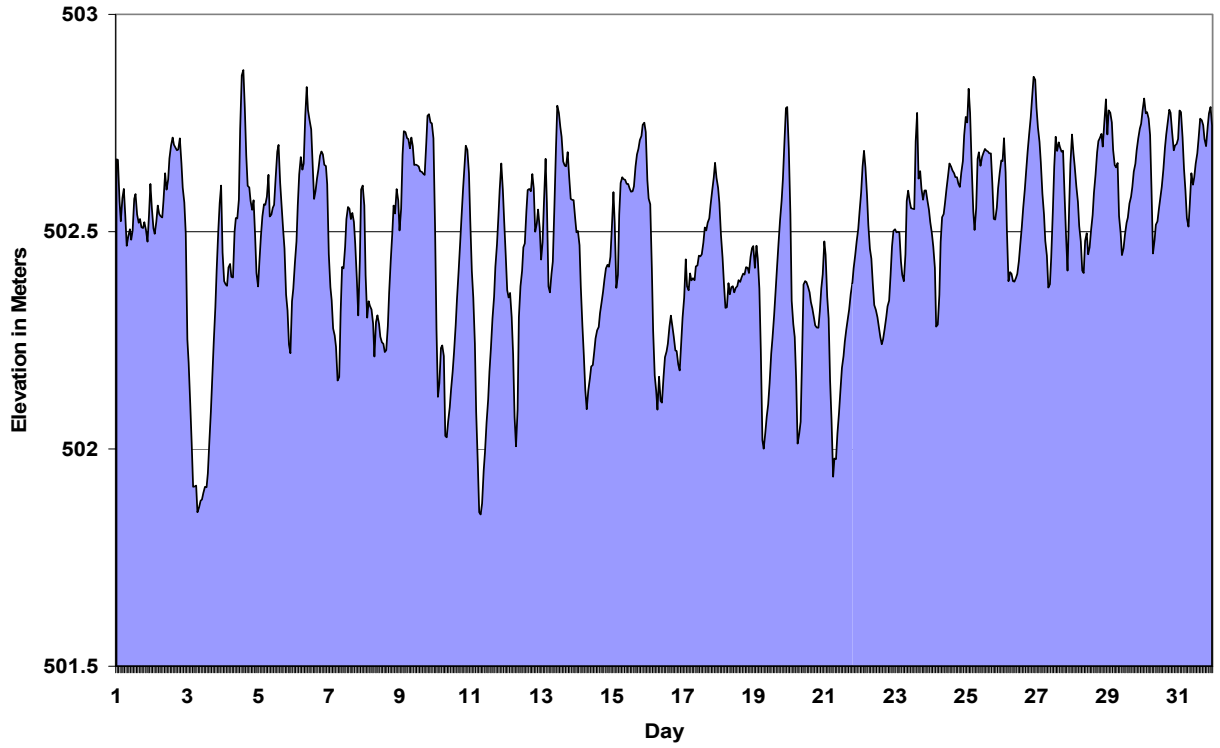

Figure 2. Dinosaur Reservoir water levels for the month of July 2003, taken at one hour intervals. Elevation normally fluctuates up to two metres and up to a rate of 40cm/hr, depending on operating regime.

RESULTS

Rainbow trout and mountain whitefish (*Prosopium williamsoni*) were the most abundant species captured in this and previous studies. Other species captured include Bull trout, kokanee (*Oncorhynchus nerka),* lake trout, lake whitefish (*Coregonus clupeaformis),* longnose sucker (*Catostomus catostomus),* peamouth chub (*Mylocheilus caurinus),* prickly sculpin (*Cottus asper),* redside shiner (*Richardsonius balteatus*), Northern Pike Minnow (*Ptychocheilus oregonensis*) and *w*hite sucker (*Catostomus commersoni).*

On pass 1, July 7th and 8th, 184 fish were captured, with 1.02 fish captured per minute or 2.81 fish per 100 m of shoreline. Total fish captured increased to 298 on the second pass July 9th and 10th and 332 on October 8th and 9th (Table 1).

Table 1. Fish captured at 28 index sites on July 7 and 8, July 9 and 10, and October 8 and 9 in Dinosaur Reservoir.

				CPUE per minute		CPUE per 100 m	
2003	Total	Mean per site	SD	Mean	SD	Mean	SD
July 7-8	191	6.8	6.3	1.2	1.4	3.2	2.7
July 9-10	298	10.6	9.1	2.1	3.0	5.0	4.2
Oct 8-9	332	11.9	6.4	2.0	1.0	5.6	3.5

Table 2. The number of each species captured in all sampling sessions.

	July 7-8 Pass # 1			July 9-10 Pass # 2			October 8-9		
Species	Sum	Mean	SD	Sum	Mean	SD	Sum	Mean	SD
Rainbow Trout	79	2.8	2.0	102	3.6	3.0	188	6.7	4.5
Mountain Whitefish	22	0.8	1.5	73	2.6	3.8	34	1.2	1.6
Lake Trout	5	0.2	0.4	2	0.1	0.4	13	0.5	0.9
Bull Trout	16	0.6	0.7	27	1.0	1.3	16	0.6	1.0
Kokanee	1	0.0	0.2	1	0.0	0.2	16	0.6	1.5
Lake Whitefish	7	0.3	0.8	4	0.1	0.4	9	0.3	0.9
Redside Shinner	0	0.0	0.0	6	0.2	0.5	0	0.0	0.0
Peamouth Chub	37	1.3	2.8	70	2.5	5.5	52	1.9	2.1
Longnose Sucker	17	0.6	2.0	13	0.5	1.4	3	0.1	0.3
Coarsescale Sucker	6	0.2	0.4	0	0.0	0.0	1	0.0	0.2
Northern Pike Minnow	1	0.0	0.2	0	0.0	0.0	0	0.0	0.0
Total	191	6.8	6.3	298	10.6	9.1	332	11.9	6.4

Total length sampled 6030 m. Electrofishing time was 10418, 11471, and 9160 seconds respectively

Table 3. Species composition as percent of fish captured during each sampling session.

Species	July 7-8	July 9-10	October 8-9
	%	%	%
Rainbow Trout	41	34	56
Mountain Whitefish	11	25	10
Lake Trout	3	1	4
Bull Trout	8	9	5
Kokanee	1	0	5
Lake Whitefish	4	1	3
Redside Shinner	0	2	0
Peamouth Chub	19	24	16
Longnose Sucker	9	4	1
Coarsescale Sucker	3	0	0
Northern Pike Minnow	1	0	0

Table 4. Average fork length (mm), size range, standard deviation (SD) and number (n), of species captured on July 7and 8 (pass 1) from the electrofishing sites in Dinosaur Reservoir.

Species	Rainbow Trout	Mountain Whitefish	Bull Trout	Lake Whitefish	Kokanee	Lake Trout	Peamouth Chub	Longnose and White Sucker
Mean	208	168	216	230	263	213	193	335
Min	69	89	178	85	261	91	147	150
Max	350	324	246	326	265	317	230	430
SD	47	79	21	79	3	96	19	78
n	79	22	16	7	2	5	37	17

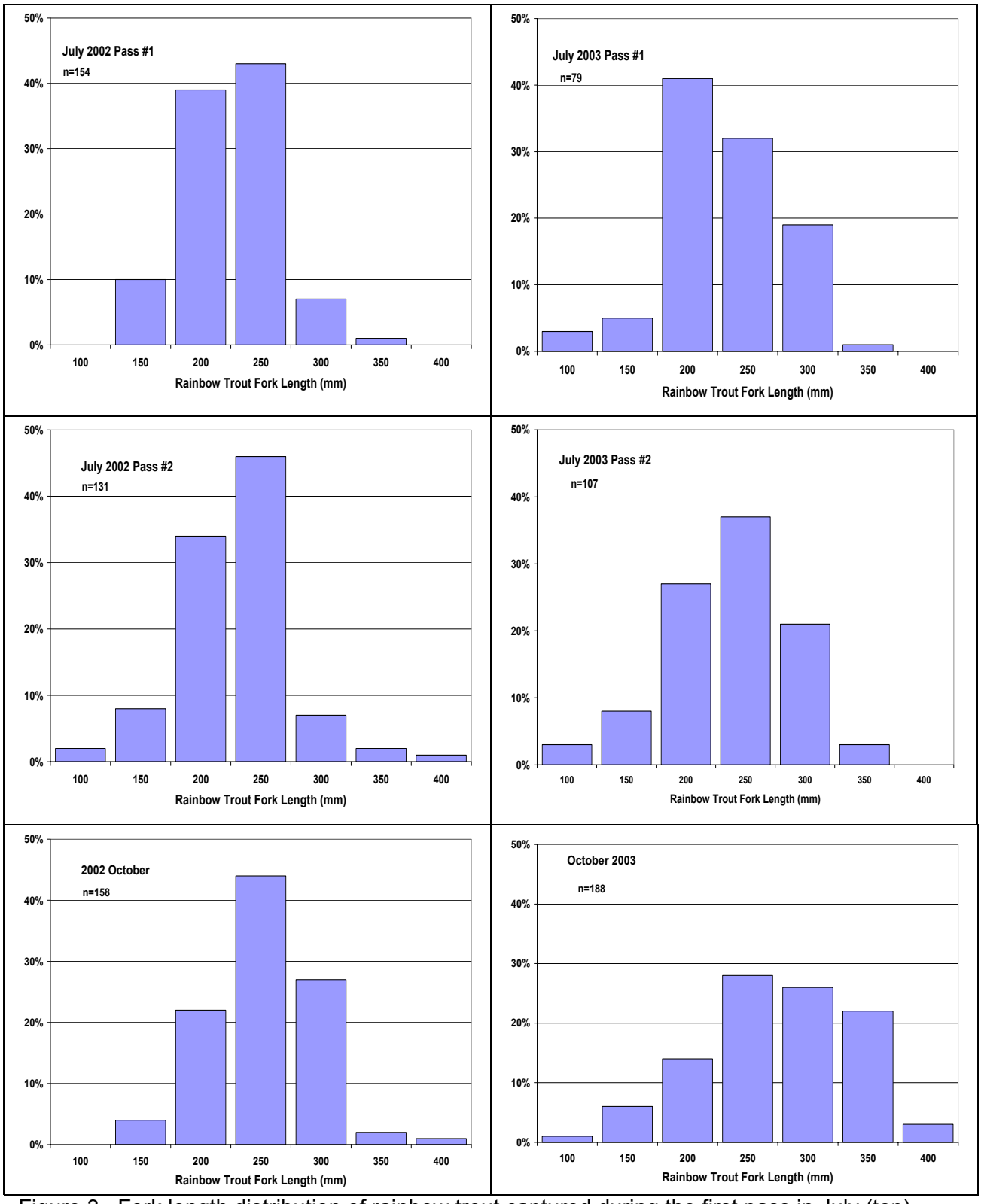

Figure 3. Fork length distribution of rainbow trout captured during the first pass in July (top), second July pass (middle) and October (bottom) in 2002 (left) and 2003 (right).

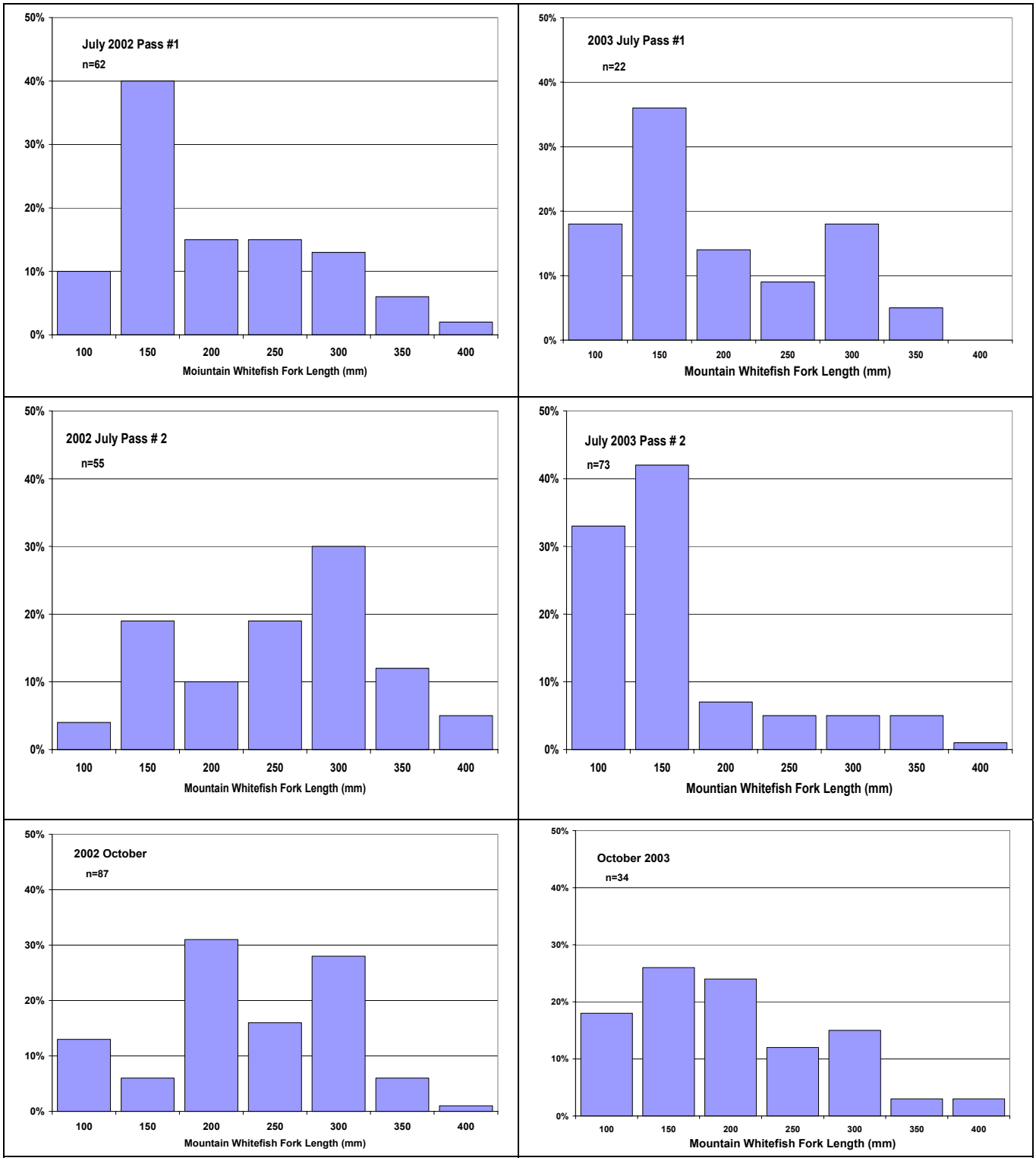

Figure 4. Fork length distribution of mountain whitefish captured during the first pass in July (top), second July pass (middle) and October (bottom) in 2002 (left) and 2003 (right).

Table 5. Average fork length (mm), size range, standard deviation (SD) and number (n), of species captured on July 9 and 10 (pass 2), from electrofishing sites in Dinosaur Reservoir.

Species	Rainbow Trout	Mountain Whitefish	Bull Trout	Lake Whitefish	Kokanee	Lake Trout	Peamouth Chub	Longnose and White Sucker
Mean	212	141	223	287	74	89	180	295
Min	68	75	185	264	74	87	100	22
Max	335	362	310	321	74	91	224	430
SD	53	71	27	28	0	3	27	136
n	107	73	27	4	1	2	70	13

Table 6. Average fork length (mm), size range, standard deviation (SD) and number (n), of species captured on October 8 and 9, from the electrofishing sites in Dinosaur Reservoir.

Species	Rainbow Trout	Mountain Whitefish	Bull Trout	Lake Whitefish	Kokanee	Lake Trout	Peamouth Chub	Longnose and White Sucker
Mean	250	182	285	280	231	236	188	163
Min	80	73	214	220	154	137	97	128
Max	379	390	500	380	398	392	315	187
SD	61	77	97	60	49	77	33	25
n	188	34	16	9	16	13	52	4

Rainbow trout, mountain whitefish, and peamouth chub were the most numerous species captured in all sampling sessions (Table 2 and 3). Mean fork length of captured rainbow increased from 208 mm on July 7th and 8th to 250 mm on October 8th and 9th (Table 4, 5 and 6).

The most abundant size class of rainbow trout captured in 2003 was between 200 and 250 mm fork length for most sample sessions (Figure 3). In July the 150-200 mm size group was the second most abundant group but in October the 250-300 mm group was second in 2002 and 300-350 mm was second in 2003. Very few rainbow trout smaller than 150 mm were captured. This is probably because few of that size are present in the reservoir. The most abundant size group of mountain whitefish was between 100 and 150 mm fork length on most surveys but the second most abundant group was highly variable, although in 2003 smaller size classes were more abundant than in 2002 (Figure 4). For both 2003 and 2002, the most abundant size groups of fish captured was between 200 and 250 mm, and the second most abundant size was 150 and 200 mm fork length (Figure 5).

In July, 8 hatchery (adipose clipped) rainbow trout were captured on pass 1 and 18 on pass 2. Six hatchery fish were captured in October. Only 1 of the 58 fish which were spaghetti tagged in July was recaptured in October. This rainbow trout had grown 33 mm from when it was tagged on July 10th at site 6 and until it was recaptured at the same site on October 9th 2003

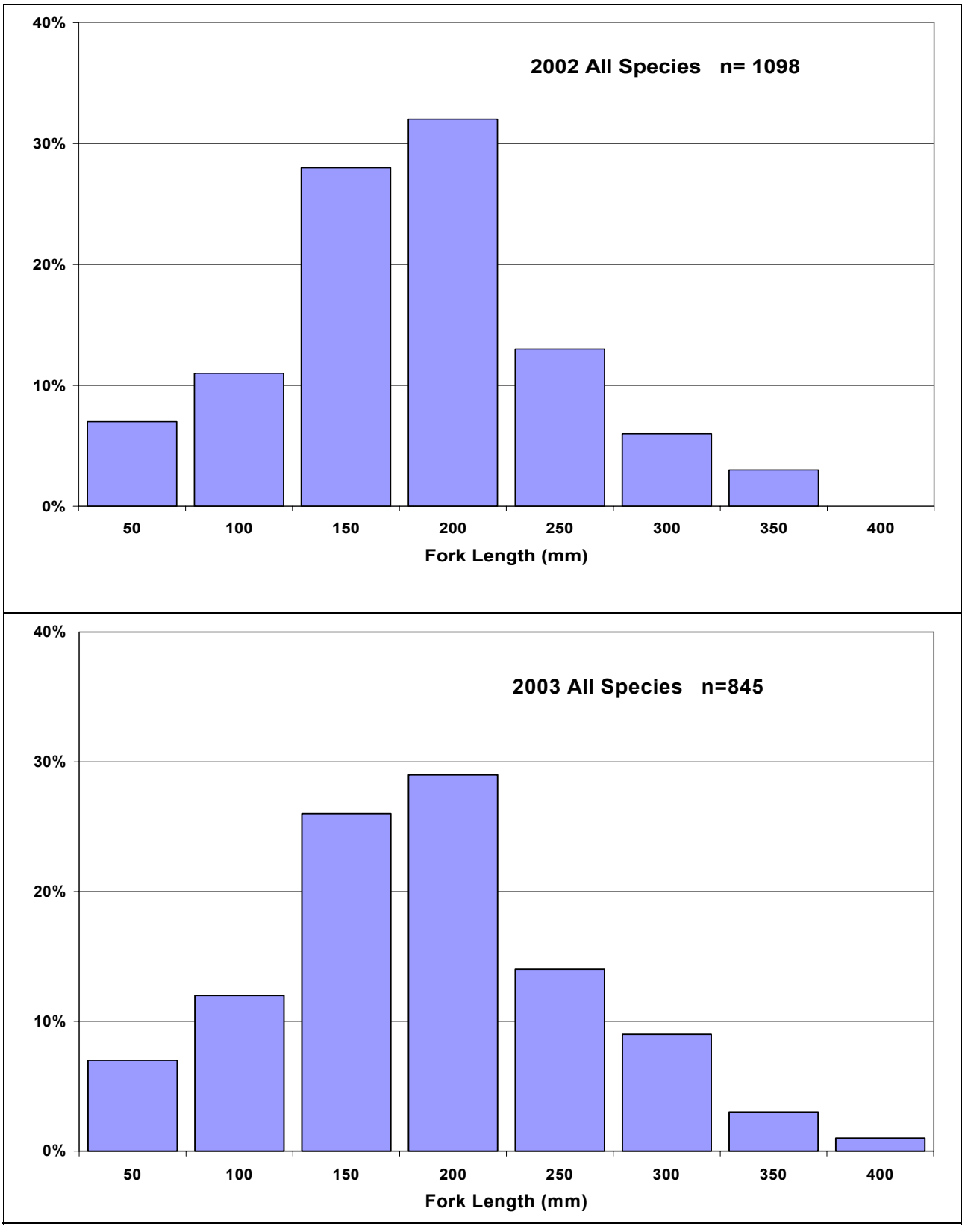

Figure 5. Fork Length distribution of all fish captured in July and October 2003 and 2002 .

DISCUSSION

In 2003, the average number of fish captured per site was 1.26 times lower than the number captured in 2002 (p=0.05) (Table 7). Rainbow trout (p= 0.022) and mountain whitefish (p=0.001) counts in 2003 were also significantly lower than in 2002. A GENMOD procedure, designed for statistical analysis of generalized linear models, indicates that the counts of fish in 2002 and 2003 vary because of site and time effects (C. Schwarz 2004). Water level changes, entrainment, and fish migration may also contribute to these effects. The variability between sample years appears high but may be a sampling anomaly. The low number of fish captured (Table 7) on the first sample session in 2003 (Pass 1) is disproportionately contributing to variability between sample years.

Reservoir water level fluctuations, entrainment, and the ongoing habitat improvement projects, as well as normal population fluctuations and sampling variability, reduce the sensitivity of the methods employed to detect population changes. Water level fluctuations of up to 2m/day or 40 cm/hr (BC Hydro water elevation records) make consistent sampling of the index sites difficult. Lower water levels reduce the amount of cover available at many sites because much of the woody debris becomes stranded on the beach, and overhanging vegetation may be several meters away from the waters edge. In small shallow bays, lower water may reduce the length of shoreline for electrofishing. Changes in water level can not be predicted and it is not logistically possible to adjust the schedules to sample under the same conditions each time.

Table 7. Capture summaries for sites sampled in 2002 and 2003.

		2002*			2003		
		Pass 1	Pass 2	October	Pass 1	Pass 2	October
Total Capture		368	339	395	191	298	332
All Fish	Mean	13.1	12.1	14.1	6.8	10.6	11.9
	SD	11.9	7.7	11.9	6.3	9.1	6.4
Rainbow Trout	Mean	5.5	4.9	5.6	2.8	3.6	6.7
	SD	7.4	6.0	6.7	2.0	3.0	4.5
Mountain Whitefish	Mean	2.2	2.0	3.1	0.8	2.6	1.2
	SD	2.9	2.6	2.9	1.5	3.8	1.6
CPUE / 100 m							
All Fish	Mean	6.4	5.8	6.8	3.2	5.0	5.6
	SD	10.1	8.8	9.7	2.7	4.2	3.5
Rainbow Trout	Mean	2.7	2.3	2.7	1.4	1.7	3.2
	SD	3.8	3.0	3.3	1.1	1.5	2.1
Mountain Whitefish	Mean	1.1	0.9	1.6	0.4	1.2	0.6
	SD	1.5	1.4	1.8	0.7	1.9	1.0
CPUE / minute							
All Fish	Mean	2.0	2.3	2.6	1.2	2.1	2.0
	SD	2.7	3.2	1.4	1.4	3.0	1.0
Rainbow Trout	Mean	0.9	0.9	1.0	0.5	0.6	1.1
	SD	0.9	0.9	0.8	0.3	0.5	0.7
Mountain Whitefish	Mean	0.3	0.4	0.6	0.1	0.5	0.2
	SD	0.4	0.6	0.6	0.2	0.6	0.3

**Some of the times in the 2002 sampling were omitted, so for some sites the time required in 2003 was substituted. CPUE for all species captured in Appendix A.*

Entrainment is also a factor that impacts reservoir fish populations. No quantifiable data exists on fish entering from Williston Reservoir or leaving Dinosaur Reservoir. Rates probably vary with operating regime, season, species, size and condition of fish. While entrainment of wild fish is only speculative, the entrainment of marked rainbow trout released into the reservoir appears to be substantial.

Earlier creel surveys (Hammond 1986 [a&b], Pattenden and Ash [b] 1993) suggest that nearly 40 % of the rainbow trout harvested from the Peace River below the Peace Canyon Dam were hatchery fish, which had been released into Dinosaur Reservoir, and that 35-59% of the rainbow trout harvested from Dinosaur Reservoir were of hatchery origin. The fishery downstream from the reservoir was substantial, with an estimated 8,629 anglers fishing 16,898 hrs and capturing 4,469 rainbow trout (Hammond 1986b). During the same period, anger effort in Dinosaur Reservoir ranged from 1,237 to 2,044 angers (Pattenden and Ash 1993[b]) and catch ranged from 597-2,380 fish (primarily rainbow trout).

Pattenden and Ash (1993[a]) suggested that improved rearing habitat for juvenile fish should reduce entrainment and so a program of adding woody debris was initiated in 2002. Woody debris was placed in small sheltered bays at sites 10 and 16 (Fig 1) in July and August, 2002, and sites 11, 13, 14, 17 in June, 2003.

The first year of study did not show any clear statistical evidence that fish numbers or size had increased at the woody debris sites. The total number of fish captured decreased from October 2002 to October 2003, but the number of fish captured from the woody debris sites (10, 11, 13, 14, 16, and 17) increased slightly from 62 to 63 (Table 8, Figure. 6 & 7). The number of rainbow trout increased from 25 to 35 and the average fork length (mm) of the rainbow trout captured also increased from 206 mm ($\pm$19) to 230 mm ($\pm$26) in the sites where debris was added. However, the average size of all fish and rainbow trout increase from 2002 to 2003 (Table 8).

Proving statistically that fish numbers have increased at the enhanced sites may be difficult in the short term. Only 20-40% of the shoreline in each site is enhanced, the number of fish captured per site is low (6.28 -14.11/site - Table 7) and variability between sites is high (SD 6.34 -11.88). The capture efficiency by boat electrofishing is also reduced at the enhanced sites because the woody debris prevents access to the shoreline and makes it more difficult to net fish stunned by the electrofisher. Further study of the effectiveness of adding woody debris to the reservoir may necessitate different sampling techniques such as the use of trap nets or modification of the structures to allow for more efficient sampling with the boat electrofisher. We anticipate that the number of fish in the woody debris sites may take several years to reach full potential as it may take time for these sites to be fully colonized by aquatic invertebrates.

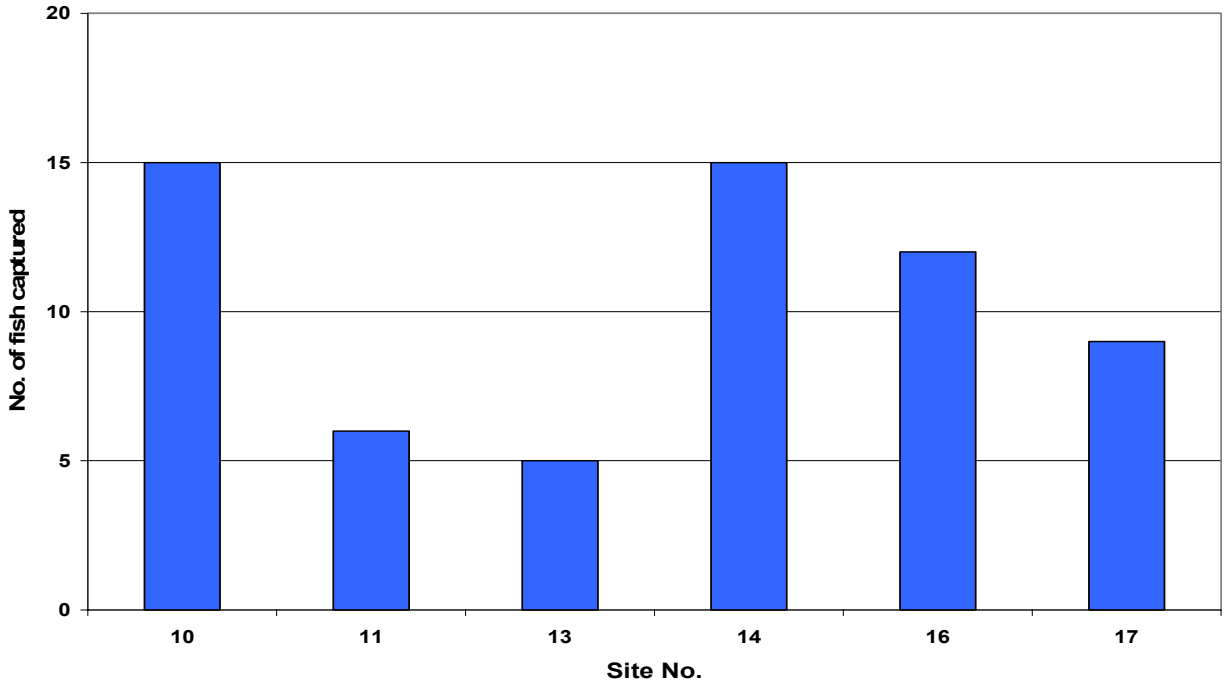

Figure 6. Number of fish captured in October 2002 from the sites prior to the addition of woody debris. Some wood was added to sites 10 and 16 in July and August 2002 and in June 2003 more wood was added to those sites as well as sites 11, 13, 14, and 17. At total of 395 fish were captured from the October 2002 sample session

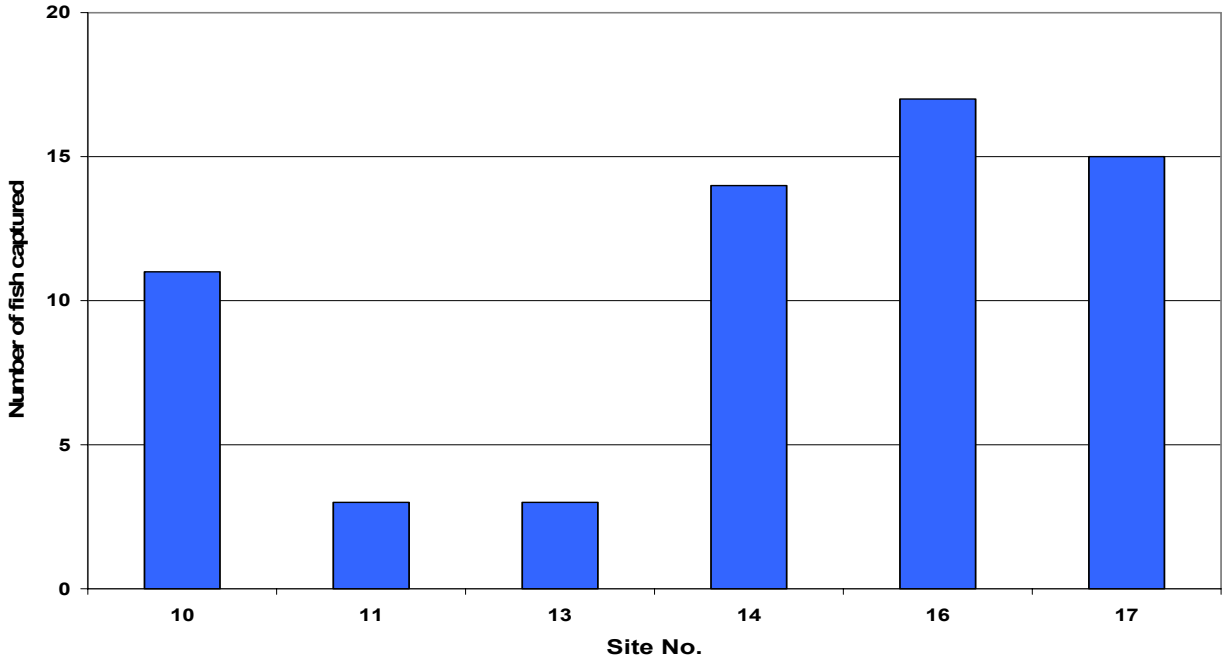

Figure 7. Number of fish captured in October 2003, at sites after woody debris had been added. Sites 10 and 16 were enhanced in 2002 and 11, 13, 14, and 17 had wood added in June 2003. At total of 332 fish were captured from the October 2003 sample session.

Table 8. Comparison of fish captured from the index sites pre and post the addition of woody debris.

Dinosaur Reservoir Fish Captured - Pre and Post Woody Debris Additions October 2002 and 2003 sampling				
			Pre 2002	Post 2003
Number Captured				
All Species				
	All Sites		395	332
	Debris Sites		62	63
	% captured - debris sites		15.7%	19.0%
Rainbow trout				
	All Sites		158	188
	Debris Sites		25	35
	% captured - debris sites		15.8%	18.6%
Size(fork length mm) of Fish Captured				
All species				
	All Sites	Mean	222	233
		SD	69	69
		n	395	332
	Debris Sites	Mean	182	216
		SD	55	72
		n	62	63
Rainbow trout				
	All Sites	Mean	228	250
		SD	44	61
		n	158	188
	Debris Sites	Mean	206	230
		SD	49	79
		n	25	35

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Appendix A

Table A. Mean catch per 100 m of shoreline sampled in all 28 sites, July pass 1, 2002 and 2003.

Pass 1	CPUE 2002		CPUE 2003	
Species	Mean	SD	Mean	SD
Rainbow Trout	2.7	3.8	1.4	1.1
Mountain Whitefish	1.1	1.5	0.4	0.7
Lake Trout	0.3	0.6	0.1	0.2
Bull Trout	0.1	0.3	0.3	0.4
Kokanee	0.3	0.7	0.0	0.1
Lake Whitefish	0.3	0.4	0.1	0.4
Redside Shiner	0.0	0.2	0.0	0.0
Peamouth Chub	0.5	1.2	0.6	1.2
Longnose Sucker	0.9	1.3	0.3	0.8
White Sucker	0.1	0.3	0.1	0.2
Northern Pike Minnow	0.0	0.0	0.0	0.1
All Species	6.4	10.1	3.2	2.7

Table B. Mean catch per 100 m of shoreline sampled in all 28 sites, July pass 2, 2002 and 2003.

Pass 2	CPUE 2002		CPUE 2003	
Species	Mean	SD	Mean	SD
Rainbow Trout	2.3	3.0	1.7	1.5
Mountain Whitefish	0.9	1.4	1.2	1.9
Lake Trout	0.1	0.1	0.1	0.3
Bull Trout	0.4	0.4	0.4	0.6
Kokanee	0.2	0.4	0.0	0.1
Lake Whitefish	0.3	0.6	0.1	0.2
Redside Shiner	0.1	0.3	0.1	0.3
Peamouth Chub	0.5	0.6	1.1	2.4
Longnose Sucker	0.8	1.5	0.2	0.7
White Sucker	0.2	0.5	0.0	0.0
Northern Pike Minnow	0.0	0.0	0.0	0.0
All Species	5.8	8.8	5.0	4.2

Table C. Mean catch per 100 m of shoreline sampled in all 28 sites, October, 2002 and 2003.

October	CPUE 2002		CPUE 2003	
Species	Mean	SD	Mean	SD
Rainbow Trout	2.7	3.3	3.2	2.1
Mountain Whitefish	1.6	1.8	0.6	1.0
Lake Trout	0.0	0.1	0.2	0.4
Bull Trout	0.6	0.7	0.2	0.4
Kokanee	0.4	1.0	0.3	0.7
Lake Whitefish	0.3	0.6	0.1	0.4
Redside Shiner	0.1	0.2	0.0	0.0
Peamouth Chub	1.1	1.8	0.9	1.1
Longnose Sucker	0.0	0.1	0.1	0.1
White Sucker	0.1	0.2	0.0	0.1
Northern Pike Minnow	0.0	0.0	0.0	0.0
All Species	6.8	9.7	5.6	3.5