Monitoring Bull Trout in Select Tributaries to the Kakwa River Watershed

John Tchir and Tyler Johns
Alberta Conservation Association
Bag 900-26 9621 96 Avenue
Peace River, Alberta, Canada
T8S 1T4

EXECUTIVE SUMMARY

The bull trout (Salvelinus confluentus) is native to the Eastern slopes of Alberta. As a result of over exploitation and habitat loss, the bull trout has suffered significant decline and currently exists within only a fraction of its range. The Kakwa River watershed supports populations of bull trout that rely on tributaries for spawning and rearing. Among others, Lynx and Grizzly Creeks provide spawning and rearing habitat for Kakwa River fluvial bull trout. The adult spawning run on Lynx Creek has been monitored since 1995, while abundance of juvenile bull trout (based on an index site) has been monitored since 1996. The objectives of this study conducted in 2004 were to enumerate the bull trout spawning run in Lynx Creek and estimate juvenile abundance in Lynx and Grizzly Creeks.

Juvenile abundance estimation

A stratified random sampling design was employed to estimate juvenile bull trout densities in Lynx and Grizzly Creek. Streams were stratified by natural breaks in elevation, resulting in five strata in Lynx Creek and eight strata in Grizzly Creek. Sampling units that comprised each stratum were defined as 35 times the bank full width and samples were selected at random with a minimum of 200 m between sites. Sample size was allocated proportionately to stratum size. Within each stratum, a site was randomly selected to assess sampling efficiency (i.e., *q*). Mark-recapture techniques were used to determine *q* for each stratum. Sampling efficiency and catch of fish per unit of effort were then used to estimate abundance of fish in each stratum using simulation (i.e., bootstrapping) techniques. Estimates for each stratum were then added together to produce an estimate of juvenile bull trout abundance for all strata sampled. Estimated density of bull trout in Lynx Creek in the fall of 2004 was 5.8 fish /100 m^2 (95% CI 3.2-8.2). While estimated density of bull trout in Grizzly Creek was less at 3.2 fish/100 m^2 (95% CI = 2.1-4.1).

Enumeration of post spawn adult bull trout in Lynx Creek

A fence was constructed across Lynx Creek approximately 600 m upstream of its confluence with the Kakwa River to enumerate the bull trout spawning run, from 12-29 September 2004. However, as a result of high flow conditions and leaf litter accumulations, the fence failed to stop the downstream movement of fish during most of the out migration of adult fish. Over the period, a total of 12 adult bull trout were captured upstream of the fence.

Monitoring the adult spawning run and juvenile abundance will provide insight into changes that may occur as a result of industrial development. Future industrial developments in the Kakwa River watershed pose a risk to the health and abundance of bull trout and other natural populations within this watershed. Critical and valuable information on the natural variation and perturbations resulting from industrial and recreational activities can reduce uncertainty and aid in development of integrated resource management plans.

ACKNOWLEDGEMENTS

We thank Greg Fortier, Leanne Osokin, Dave Jackson, James Aiken and John Hallett for their assistance in the field. We also thank Paul Hvenegaard, for reviews and comments on earlier drafts. We thank Weyerhaeuser Canada and Talisman Energy Inc. for providing funding in support of bull trout monitoring in Lynx Creek.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

The bull trout (Salvelinus confluentus) is native to the Eastern slopes of Alberta (Nelson and Paetz 1992). As a result of over exploitation and habitat loss, bull trout populations have suffered significant decline and currently exist within only a fraction of the species historic range (Post and Johnston 2002). Decreased abundance and distribution of bull trout (Carl 1985; Berry 1994) prompted fisheries managers to react by imposing zero harvest regulations in 1995. This regulation was implemented to promote the recovery of this sensitive species throughout Alberta. Bull trout have been ranked as 'sensitive' in Alberta, and 'threatened' under the Endangered Species Act in the United States (Post and Johnston 2002). The perpetuation of this species is dependent on the quality and connectivity of habitats that support all of its life processes.

The Kakwa River watershed supports populations of bull trout that rely on tributaries for spawning and rearing. Among others, Lynx and Grizzly Creeks provide spawning and rearing habitat for Kakwa River fluvial bull trout. Road crossings and logging in the Lynx and Grizzly Creek sub-basins are proposed to occur within the next three to five years. The potential effects of these landscape disturbances on bull trout in these sub-basins are largely unknown. Monitoring of the adult spawning run and juvenile abundance will provide insight into changes that may occur as a result of these impending impacts. The Alberta Conservation Association has monitored the Lynx Creek bull trout spawning run annually since 1995. While Juvenile abundance has been estimated annually using various methods since 1996.

The objectives of this study were to enumerate the spawning run of bull trout in Lynx Creek and estimate the abundance of juvenile bull trout in Lynx Creek and Grizzly Creeks in 2004.

2.0 STUDY AREA

2.1 Description

The Kakwa River watershed is located approximately 100 km south of Grande Prairie in west central Alberta. The study focused on Lynx Creek and Grizzly Creek, bull trout spawning and rearing tributaries of the Kakwa River. Lynx Creek is a fifth order (Strahler 1957) stream which drains an area of 130 km^2; while, Grizzly Creek is a fifth order stream, which drains an area of 33 km^2 (Figure 1).

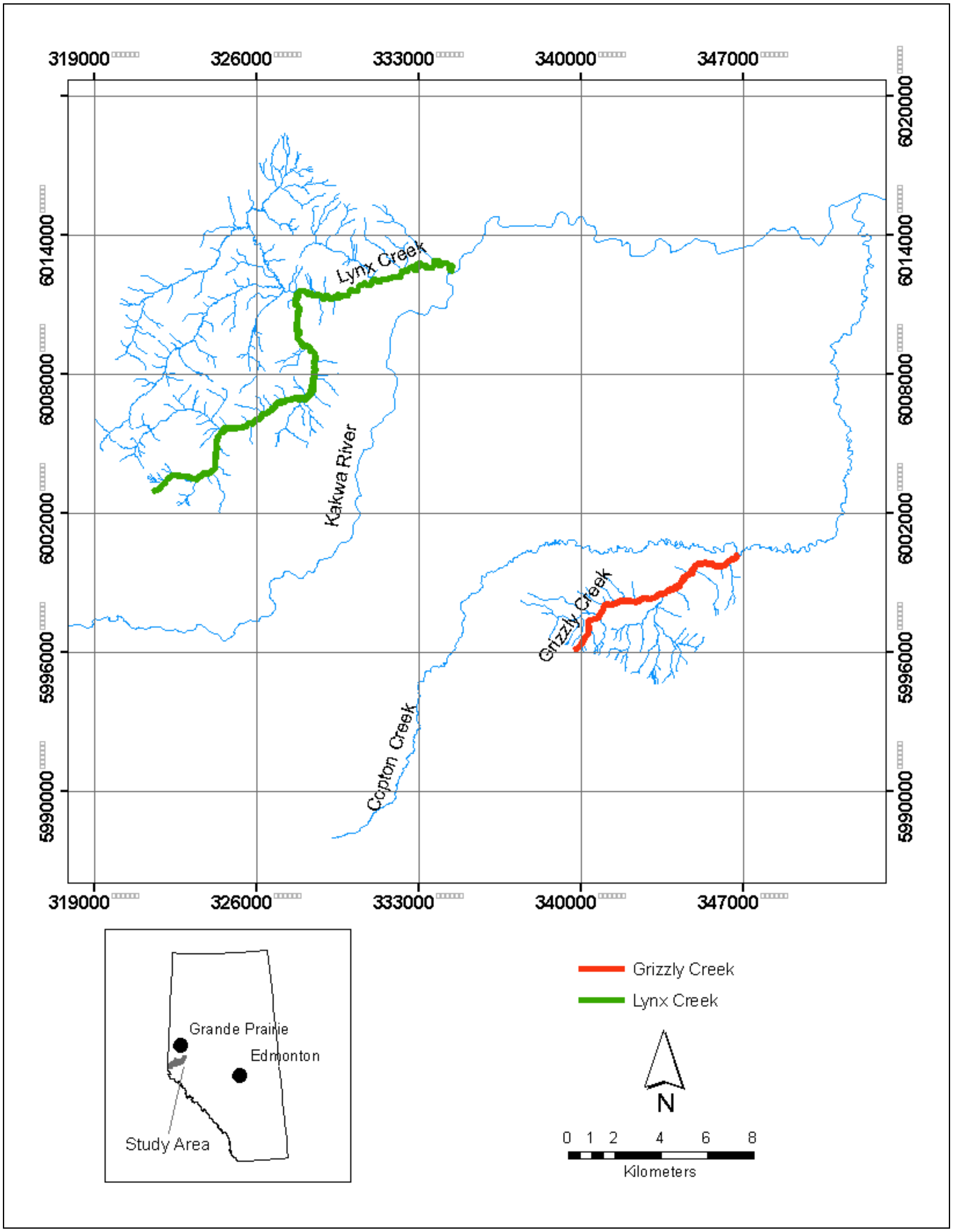

Figure 1. Map showing Lynx and Grizzly Creeks, tributaries to the Kakwa River, Alberta.

2.2 *Fish Communities*

Salmonids are the dominant family found in Lynx Creek and Grizzly Creek. These include bull trout, introduced rainbow trout (Oncorhynchus mykiss), mountain whitefish (Prosopium williamsoni), and Arctic grayling (Thymallus arcticus). Other common species present in the watershed are slimy sculpin (Cottus cognatus), longnose sucker (Catostomus catostomus) and white sucker (Catostomus commersoni).

2.3 *Ecoregion, forest cover and soils*

Lynx and Grizzly Creek drainage basins are primarily located in the Upper Boreal-Cordilleran ecoregion, and to a lesser extent the Subalpine and Alpine ecoregions. Average winter temperatures range from -6 °C in the Upper Boreal Cordilleran to –8.9 °C in the Subalpine. Summer temperatures range from 11.5 in the Upper Boreal Cordilleran to 10 °C in the Alpine ecoregion. Coniferous trees dominate forest stands in the Upper Boreal-Cordilleran and Subalpine. White spruce (Picea glauca) and lodgepole pine (Pinus contorta) are found in the lower elevations and Engelmann spruce (Picea engelmannii) and subalpine fir (Abies lasiocarpa) located at higher elevations. Vegetation in the Alpine ecoregion is dominant by low growing heather communities. Brunisolic and Luvisolic soils are common in the Upper Boreal-Cordilleran and Subalpine (Strong and Leggat 1992).

3.0 MATERIALS AND METHODS

3.1 *Enumeration of Spawning Run*

The number of adult bull trout spawning in Lynx Creek were enumerated by erecting and maintaining a fence (Hvenegaard and Thera 2001) about 600 m upstream of the confluence of Lynx Creek and the Kakwa River. The fence provides a barrier to stop the out migration of post-spawned fish and allows enumeration of the spawning run.

Fish were measured and examined for tags, any tag numbers present were recorded, fish were considered adults if they had a fork length (FL) greater than 400 mm (Hvenegaard and Thera 2001). All biological data collected were submitted for incorporation into the Fisheries Management Information System (FMIS[1]).

3.2 Juvenile Bull Trout Population Estimates

3.2.1 Sampling design and locations

A stratified random sampling design was employed and streams were stratified by natural breaks in elevation, resulting in five strata in Lynx Creek and five strata in Grizzly Creek (Figures 2 and 3). Sampling units (i.e., reaches) that comprised each stratum were defined as 35 times the mean wetted width (Lyons 1992) and reaches were selected at random with a minimum of 200 m between sites. Locations of sample reaches are presented in Figures 2 and 3 for Lynx and Grizzly Creeks, respectively. Sample size was allocated proportionately to stratum size.

---

[1] FMIS is a provincial database containing comprehensive information on fish and fish habitat data. It was developed by Alberta Sustainable Resource Development (ASRD) to meet the data storage and data requirements of fisheries managers. As a requirement of a fisheries research licence fish information collected must be sent to ASRD for inclusion in the database. ASRD and the Alberta Conservation Association use the data to develop fish management and land use planning strategies.

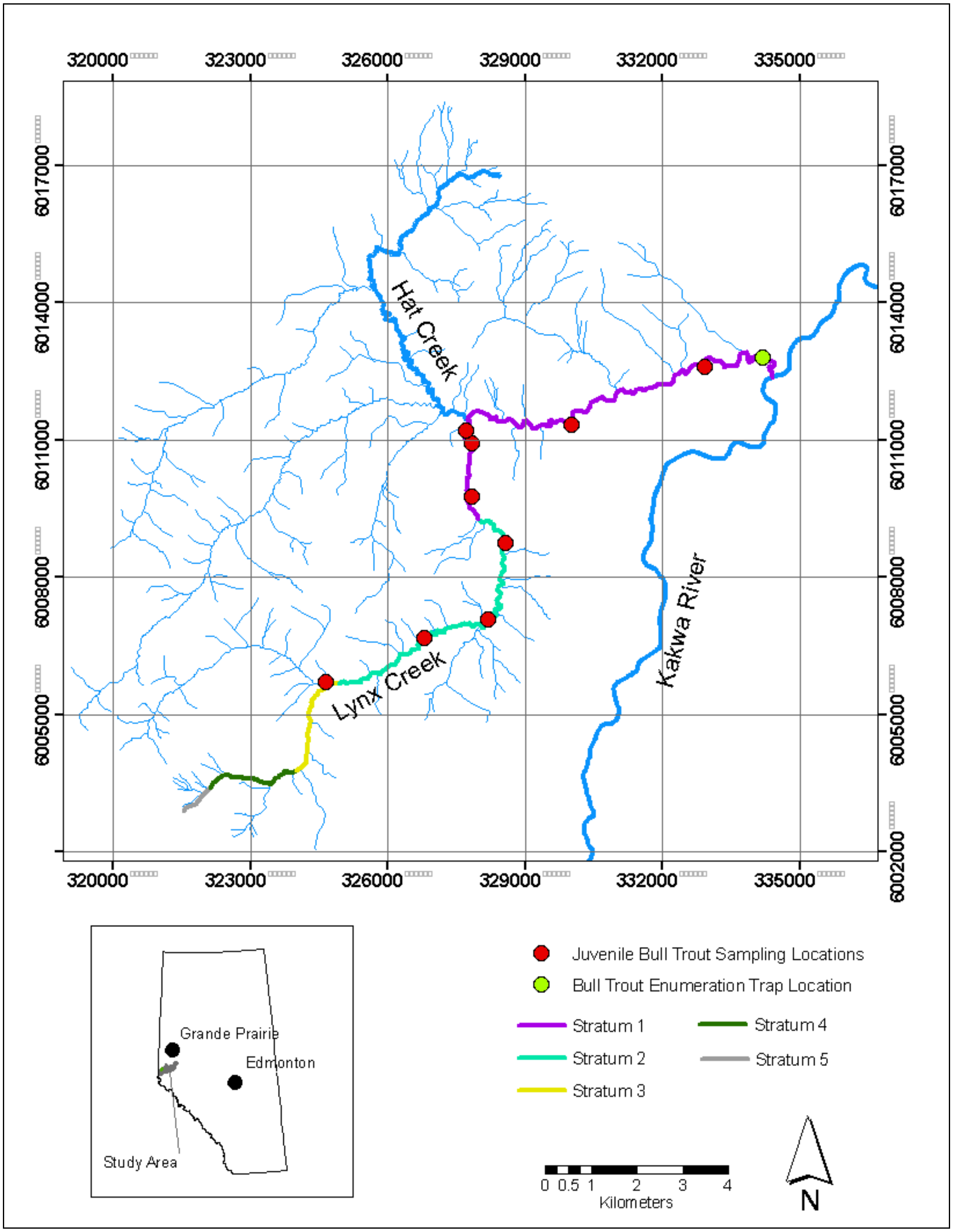

Figure 2. Stratification of Lynx Creek based on natural breaks in elevation, colors depict five separate strata. Juvenile bull trout sampling locations are depicted as red dots on the map. Fish were sampled using a backpack electrofisher from 21-23 September 2004.

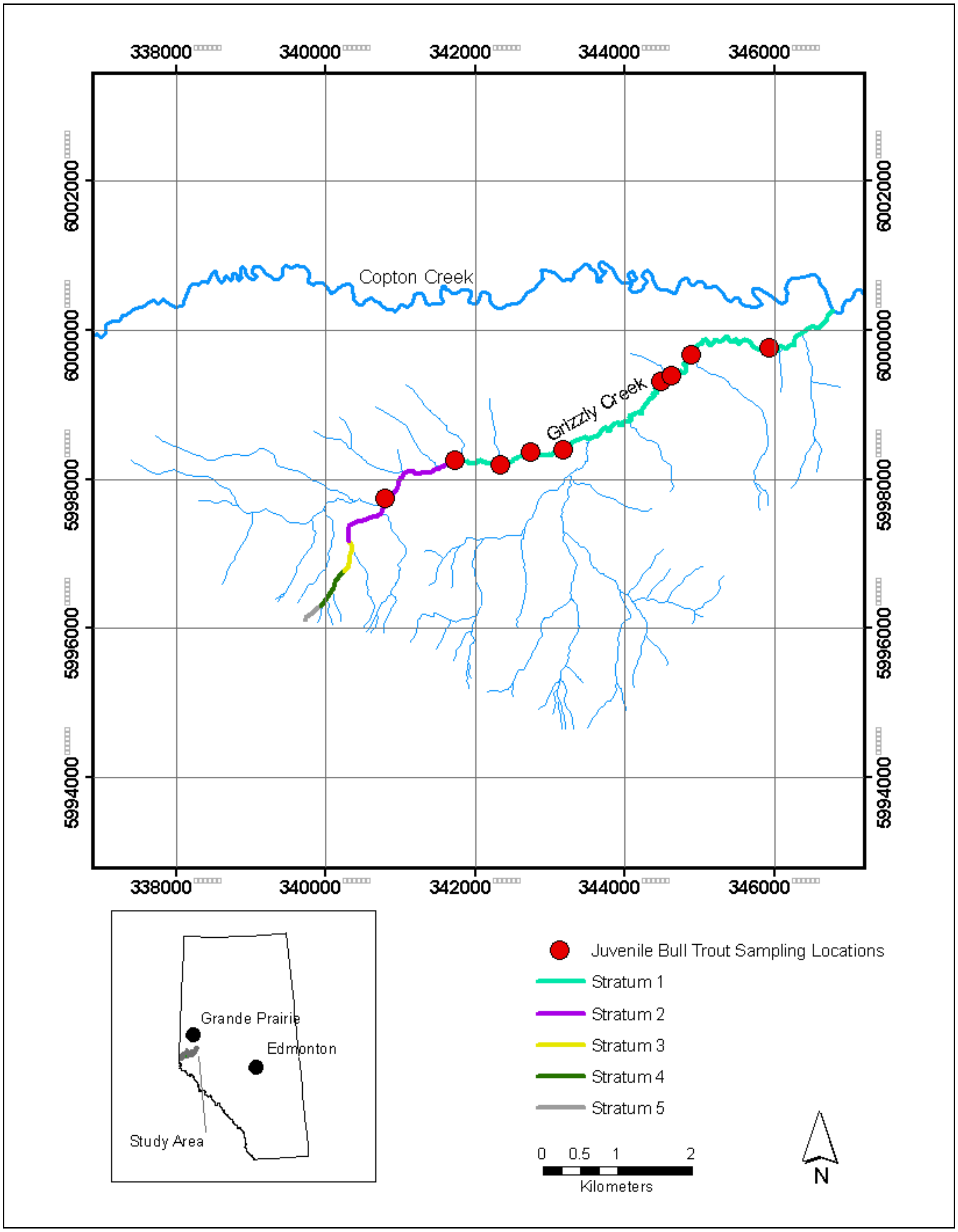

Figure 3. Stratification of Grizzly Creek based on natural breaks in elevation, colors depict five separate strata. Juvenile bull trout sampling location are depicted as red dots on the map. Fish were sampled using a backpack electrofisher from 21-23 September 2004.

3.2.2 Estimation of Abundance and Density

Within each stratum, a site was randomly selected to assess catchability (q). Mark-recapture techniques were used to determine q for one second of electrofishing in each stratum, q was calculated as q=(R_f/ M_f)/E_s). Where R_f is the number of marked fish that were recaptured, M_f is the number of fish marked and E_s is the effort electrofished in seconds. Catch of fish per unit of effort in seconds and q were then used to estimate abundance (N) of fish in each sampled reach (i.e., N=(catch/effort)/ q). Abundance estimates for reach within each stratum were bootstrapped 10,000 times to estimate abundance and precision for each stratum. The bootstrapped means from each stratum were combined to estimate the total number of fish across all strata. Abundance was converted to density (i.e., fish/100m^2) by dividing the estimate of total abundance by the total area (i.e., (mean wetted width)(total length)).

The use of this mark-recapture technique in the calculation of q required the following assumptions to be made:

1) The population is closed.

To reduce the likelihood of immigration, emigration, natality and mortality, recapture events occurred within 24 hours.

2) Capture efficiency remained constant within stratum.

Consistency in electrofishing sampling was maintained throughout the sampling period by: maintaining crew members responsible for electrofishing and dip-netting and ensuring voltage, pulse width and frequency remained constant. Attempts were also made to sample under consistent flow conditions.

3) No marks are lost before the second sample is taken and all marked individuals are recognized as such (Seber 1982).

To ensure no marks were lost and marks were recognizable, fish were marked by removing a recognizable portion of their adipose fin. Experienced crews examined all fish for marks.

3.2.3 *Sample Size*

A prospective power analysis was used to estimate the required sample size to detect a 25% change in CPUE. Quinn and Deriso (1999) state that Catch per Unit Effort (CPUE) is proportional to average abundance and can be used as an index of abundance over time. Using JMP™ available catch / unit effort (CPUE) data previously collected from Lynx and Grizzly Creeks, were analyzed resulting in approximately 10 reaches that would be needed to achieve a detectable difference of 25% change in CPUE ($\beta = 0.8$, $\alpha=0.05$).

3.2.4 *Data Collection*

Sample reaches sampled in both Grizzly and Lynx Creek were accessed by helicopter. To optimize the use of manpower and helicopter time two sampling crews operated in a 'leap frog' pattern in an up-stream direction until all accessible reaches were sampled. Several alternate sites were chosen prior to sampling in the event that primary sites were inaccessible. Using a Smith Root Model 12A backpack electrofisher fish were sampled in an upstream direction, ensuring all habitats were sampled. At the end of each reach, fish were measured to nearest fork length (mm), and a section of all bull trout adipose fins were clipped for later identification in the recapture run. All fish were released back to the habitat that they were sampled from. Electrofisher units operated consistently at pulse DC, producing 60 pulses per second at 400 volts.

3.2.5 Statistical Analysis

Using one-way Analysis Of Variance (ANOVA) we tested for differences in mean fork length between strata. Where no significant differences were found fork length samples were pooled to construct size class distributions. In the event that a significant difference was found length samples were not pooled and separate distributions were constructed.

4.0 RESULTS

4.1 Enumeration Of The Spawning Run

In 2004, 12 bull trout were captured at the barrier fence. As a result of two fence failures, we suspected that a large portion of the spawning run was not enumerated. Fish ranged in size from 313 to 645 mm FL (Table 1).

Table 1. Summary of bull trout enumerated at the Lynx Creek trap during the fall of 2004.

Date	Fork Length (mm)	Total Length (mm)	Initial Capture
13-Sep-04	NA	NA	No
15-Sep-04	540.00	550.00	No
21-Sep-04	NA	NA	No
22-Sep-04	645.00	670.00	No
24-Sep-04	592.00	615.00	No
24-Sep-04	520.00	545.00	Yes
24-Sep-04	371.00	393.00	Yes
24-Sep-04	495.00	512.00	Yes
25-Sep-04	562.00	584.00	No
25-Sep-04	358.00	380.00	Yes
25-Sep-04	386.00	411.00	Yes
26-Sep-04	313.00	334.00	Yes

4.2 Juvenile Bull Trout Size Composition

A total of 39 juvenile bull trout were sampled in Lynx Creek. Fish ranged in size from 42 to 234 mm fork length (FL). There were no significant differences in mean fork length of juvenile bull trout between strata (ANOVA F=0.84; $P>0.05$; df=2). Therefore, fork length data were pooled to produce a size class distribution (Figure 4). A total of 54 juvenile bull trout were sampled from Grizzly Creek. Bull trout sampled from Grizzly Creek ranged in size from 71 to 346 mm FL. The size class distribution for Grizzly Creek is presented in Figure 5.

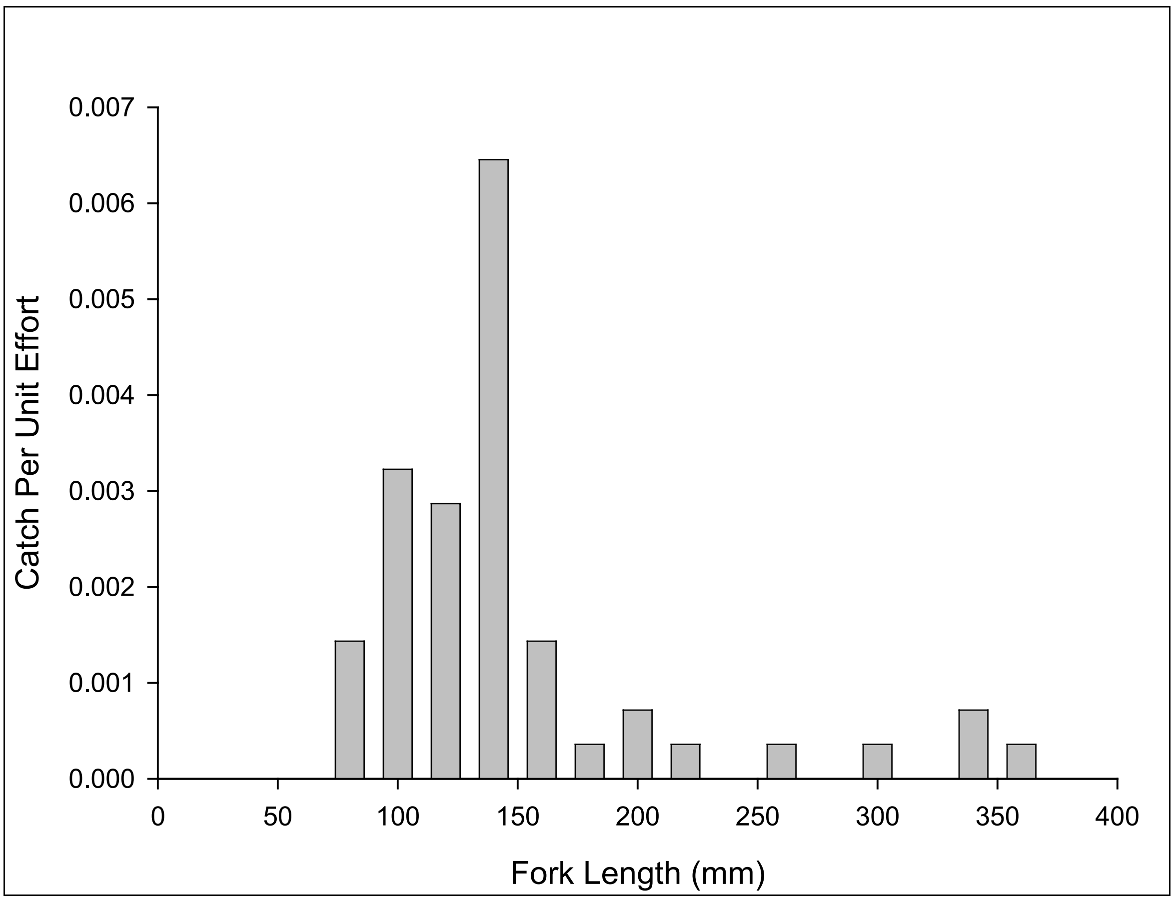

Figure 4. Size class distribution of juvenile bull trout sampled in Lynx Creek, 2004. Y axis is catch of bull trout per 1 second of electrofishing.

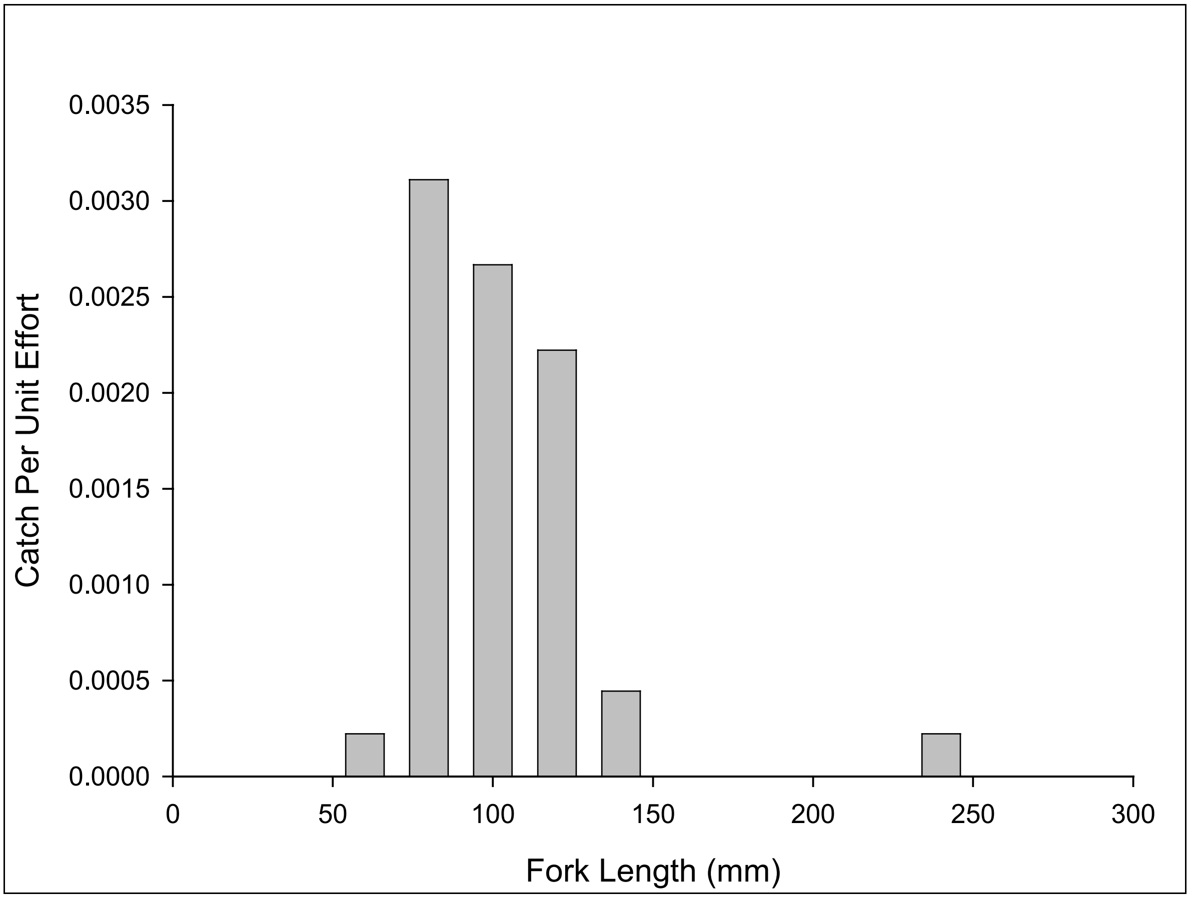

Figure 5. Size class distribution of juvenile bull trout sampled in Grizzly Creek, 2004. Y-axis is catch of bull trout per second of electrofishing.

4.3 Juvenile Bull Trout Population Estimates

Nine reaches were sampled in Lynx Creek from 21-23 September 2004. Catchability coefficients (q) were quantified for two strata in Lynx Creek. As a result of dense forest cover and steep terrain, we were unable to sample the upper most two strata. We conducted two successful mark-recapture experiments to quantify q in strata two and three (Table 2). The catchability coefficient quantified for stratum 2 was also applied to stratum 1. We assumed there was no difference in q between stratum 1 and 2. Abundance and density estimates for each of the sampled stratum are shown in Table 3.

Abundance of fish in each stratum was combined to produce an estimate of 3400 fish (95% CI 1700-5000) or an average density of 5.8 fish /100 m^2 (95% CI 3.2-8.2) in Lynx Creek (Figure 6).

As a result of steep terrain, the three upper most strata in Grizzly Creek were not sampled. Consequently, seven reaches were sampled in stratum one and one reach was sampled in stratum 2 in Grizzly Creek from 21 to 23 September 2004. Given the low sample size in stratum 2 we pooled the samples to estimate density of bull trout within stratum 1 and 2 combined. We conducted one successful mark-recapture experiment to quantify *q* (Table 2) and seven single pass samples in Grizzly Creek. It was assumed that this *q* was representative and it was used to estimate abundance of fish for all sampled strata (strata one and two) in Grizzly Creek. Average density of juvenile bull trout for both stratum was estimated to 3.2 fish/100 m^2 (95% CI = 2.1-4.1). Abundance and density estimates for sampled stratum are shown in Table 3.

Table 2. Electrofishing catchability coefficients (*q*) of juvenile bull trout sampled in Grizzly Creek and Lynx Creek, tributaries in the Kakwa River watershed. Catchability coefficients (*q*) were calculated as $q=(R_f/ M_f)/E_s)$. Where R_f is the number of marked fish that were recaptured, M_f is the number of fish marked and E_s is the effort electrofished in seconds.

Stream	Stratum	Catchability Coefficient (*q*)
Grizzly Creek		0.000378
Lynx Creek	1	0.00035
Lynx Creek	2	0.00035
Lynx Creek	3	0.000315

Table 3. Estimates of juvenile bull trout abundance and density by stratum, for Lynx Creek and Grizzly Creek with 95% confidence limits from 2004.

Stream	Stratum	Estimated Density (fish/100 m^2)	Lower 95% CI	Upper 95% CI	Estimated Abundance	Lower 95% CI	Upper 95% CI
Grizzly Creek	1 and 2	3.2	2.1	4.1	1100	700	1300
Lynx Creek	1	1.2	0.2	2.2	1170	170	1870
	2	1.6	1.0	2.0	1000	500	1100
	3	9.2	5.8	12.2	1500	900	2000

5.0 Summary

The Alberta Conservation Association has monitored the Lynx Creek bull trout spawning run annually since 1995. It is unfortunate that we were unable to enumerate the spawning run in 2004. Although attempts were made to mitigate the effects of high water, and higher than average leaf and debris loads, the fence failed to contain the downstream migration of bull trout.

Monitoring of the bull trout spawning run in Lynx Creek is limited to describing annual changes in the number of bull trout using this particular stream. It does not account for changes in the spawning population of bull trout in the Kakwa River nor does it account for fish moving into other tributaries to spawn. For example, a rise in the number of bull trout spawning in Lynx Creek does not necessarily mean that the adult population has increased, as fish may have moved from spawning in a more disturbed stream to selecting one that is more favorable. To monitor the differential use of spawning tributaries by the Kakwa River bull trout adults could be enumerated in several tributaries and compared at less frequent intervals (e.g., every 3-5 years versus every year).

Estimation of juvenile abundance in Lynx Creek has occurred since 1996. Although, the last two years we have switched from relying on a single index site (permanent sample site) and estimating abundance in a small section of the stream, to stratifying the stream by elevation and using random site selection to determine abundance of fish in a much larger area of the stream. This method enables the monitoring of changes in abundance at a larger, more biologically meaningful scale. This year we further expanded sampling to include Grizzly Creek. Although, we attempted to incorporate a large enough sample to detect a 25% change in population, variability in density was unexpectedly high in stratum 1 of Lynx Creek. This resulted in the ability to detect an approximate 50% percent change in population abundance overall in Lynx Creek. Using power analysis (β = 0.8, α=0.05), we estimated that an additional 11 sites at Lynx Creek and an additional 2 sites in Grizzly Creek to improve precision to detect a 25% change in density if sample standard deviation remains consistent with data collected in 2004.

Juvenile abundance monitoring in these streams will allow us to examine changes in production of bull trout in association with disturbance levels in their sub-basins. In the near future, it may be important to expand monitoring so that it occurs at the population scale, which would encompass much of the Kakwa River watershed. This scale would provide insight into broader changes in the population of bull trout rather than focusing on site-specific changes in juvenile production.

Increasing the precision of estimating bull trout abundance and quantifying the environmental factors (i.e., water quality, habitat alteration) will enable the detection of trends and relationships that impact both bull trout and the health of this watershed. This information should be used in integrated landscape management to mitigate potential effects of land use disturbances.

6.0 LITERATURE CITED

Berry, D.K. 1994. Alberta's bull trout management and recovery plan. Alberta Environmental Protection, Fish and Wildlife Services, Fisheries Management Division, Edmonton, Alberta. 22pp.

Carl, L. M. 1985. Management plan for bull trout in Alberta. Pp. 71-80 *In* D. D. MacDonald(ed.) Flathead River Basin bull trout biology and population dynamics modeling information exchange.Fisheries Branch, British Columbia Ministry of Environment, Cranbrook, British Columbia.

Hvenegaard, P.J. and T.M. Thera. 2001. Monitoring the bull trout (*Salvelinus confluentus*) spawning run in Lynx Creek, a tributary to the Kakwa River, West central Alberta. Pages 147-151 in Brewin, M.K., A.J. Paul, and M. Monita, editors, Bull trout II conference proceedings. Trout Unlimited Canada, Calgary, Alberta.

Lyons, J. 1992. The length of stream to sample with a towed electrofishing unit when species richness is estimated. North American Journal of Fisheries Management 12:198-203.

Nelson, J.S. and M. J. Paetz. 1992. The fishes of Alberta. University Alberta Press. Edmonton Alberta. 437pp.

Post, J.R. and F.D. Johnston. 2002. Status of the bull trout (Salvelinus confluentus) in Alberta. Alberta Wildlife Status Report No. 39. Alberta Sustainable Resource Development and Alberta Conservation Association, Edmonton, Alberta. 40 pp.

Quinn, T. J., II and R. B. Deriso. 1999. Quantitative Fish Dynamics. Oxford University Press, New York. 542pp.

Seber, G. A. F. 1982. The estimation of animal abundance and related parameters, 2nd edition. Charles Griffin & Co. Ltd., London.

Strahler, A.N. 1957. Quantitative analysis of watershed geomorphology. Transactions of the Geophysical Union 38:913-920.

Strong, W.L., Leggat, K.R. 1992. Ecoregions of Alberta. Land Information Services Division, Alberta Forestry, Lands and Wildlife, Edmonton, Alberta, Canada.