BROWN TROUT (*Salmo trutta*) STATUS, TRENDS AND CURRENT DISTRIBUTION IN THE CLEARWATER RIVER, 2005

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ACKNOWLEDGEMENTS

I would like to thank several individuals who contributed to the completion of this report. From the Alberta Conservation Association (ACA), Cal McLeod acted as the project supervisor providing his vision, advice, and support. Mike Rodtka of the ACA also provided advice and edited this document. Robert Anderson (ACA) also edited this report. Also from the ACA, Dr. Gary Scrimgeour provided several published brown trout articles; this was greatly appreciated. Steve Herman of Alberta Sustainable Resource Development helped with the acquisition of historic data and allowed me to interview him on several occasions. Robert Holmburg from Athabasca University provided advice and had enough confidence in my abilities to allow me to take on this project, and for this I am indebted.

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EXECUTIVE SUMMARY

The Clearwater River drainage has been stocked with over 1.35 million brown trout (*Salmo trutta*) since 1927. However, formal analysis of brown trout populations or stocking evaluations within the drainage are limited. A review of the historic fishing regulations for this drainage suggested that the Clearwater River has been managed historically and is still being managed as a bull trout (*Salvelinus confluentus*) fishery. Bull trout are listed as a species of special concern (Berry 1994) in Alberta and competition from exotic species such as brown trout has been suggested as a deterrent to their recovery (Berry 1994). Therefore, an assessment of brown trout status, trends and current distribution within the Clearwater River drainage may prove invaluable to fisheries managers from Alberta Sustainable Resource Development (ASRD). The specific objectives for this project were: 1) Compare the results of brown trout population estimates from historic surveys to those conducted during the Clearwater River Bull Trout Study in 2004/05, 2) Compare brown trout fork length data collected in 2004 to that collected in past studies and 3) Use current catch-per-unit-effort data to demonstrate current brown trout distribution in the Clearwater River drainage and code tributary streams of the Clearwater River as having high, moderate or low populations of brown trout.

The study area for this project included the Clearwater River and all tributaries (except for Alford Creek) located downstream of the Banff National Park boundary and upstream of the intersection of the Clearwater River and Highway 54. For population analysis purposes and in keeping consistent with historic surveys, the Clearwater River was broken to into three sections; 1)Ricinus, 2) Corkscrew and 3) Elk Creek reaches. The primary data source for this project came from the report named, "Upper Clearwater River Bull Trout Status Assessment – 2004" (Rodtka and Gardiner, in prep.). In addition, all historic brown trout population data available that have been collected on the mainstem Clearwater River and all electrofishing catch-per-unit-effort (CUE) data collected within the past eight years on tributary streams to the Clearwater River were also used.

Population estimates from 2004, 1987 and 1977 and from 2004 and 1977 were compared for the Ricinus and Corkscrew reaches, respectively. The population estimate prepared for the Elk Creek reach in 2004 is the first formal population estimate ever been established in that section of the Clearwater River. Therefore,

comparisons to other years were not possible. Fork length frequency bar charts were compared between the years of 2004, 1995, 1987 and 1977 in the Ricinus reach, 2004, 1993 and 1977 in the Corkscrew reach and 2004 and 1993 in the Elk Creek reach. The statistical program Jump-In™ (SAS) was used to group the list of all brown trout CUE's from the entire province into three groups. Brown trout populations were considered to represent a high-density population if their CUE's were within the upper 75th percentiles (≥ .8.32 brown trout per 100 m), moderate- density if within the 26th to 74th percentiles (8.31 to .98 brown trout per 100 m) and a low-density when in the 25th and lower percentiles (≤.97 brown trout per 100 m). These codes were then used to code tributary streams to the Clearwater River, where CUE data were available.

Brown trout population densities in 2004 were very similar to 1977 and higher than those from 1987 in the Ricinus reach and similar to 1977 in the Corkscrew reach; though seasonal population variations from brown trout migrations limit the strength of the 2004 data. Brown trout population densities derived on the Ricinus Reach in 2004 were 144.3 brown trout per kilometre. This is lower than that documented on the Bow River (ASRD unpublished data) but higher than what has been documented on the Little Red Deer River (Wieliczko and McLeod, 2001) and the Red Deer River (Buchwald 1992). In 2004, individual brown trout sizes ranged from 76 – 610 mm and a relatively even size distribution was observed. In 1977 and 1987 the most dominant size classes were near 200 mm and in 2004 fork lengths near 400 mm were dominant. The dominant coding for tributary streams was, "no brown trout collected". Cutoff Creek and the lower portions of Elk Creek were both coded as high-density brown trout streams, despite the fact that Cutoff Creek has never been stocked with brown trout. The middle reaches of Elk Creek and the greater length of Idlewilde Creek were coded as having a moderate density of brown trout. The lower section of the Tay River was coded as having a low density of brown trout. Specifically, within the Tay River drainage in the past eight years, only one brown trout has been collected.

The author believes that catch-and-release regulations in place on Elk Creek and size restrictions and the seasonal closures that are in place for brown trout in the rest of the Clearwater River drainage are maintaining healthy brown trout population levels and that stocking is no longer required. Despite extensive stocking historically and the current reduced (10,000/5-years) level of stocking in the Tay River drainage only one brown trout has been documented in that

drainage from the 28 surveys that have been completed there in the past eight years. Stocking may in fact only be augmenting brown trout populations in other streams that are important for bull trout such as Cutoff Creek and Elk Creek. Both of these streams have been documented as bull trout spawning streams (Rodtka and Gardiner, in prep.).

Two recommendations resulted from this project. Recommendation number one is to discontinue brown trout stocking within the Clearwater River drainage. Recommendation number two is that future research should be conducted in competition between brown trout and bull trout. This research should provide insight into whether or not established exotic brown trout population are acting as a detriment to bull trout recovery in the Clearwater River drainage.

1.0 INTRODUCTION

1.1 Study Rationale

Beginning in the 1920's and continuing to present day, brown trout (*Salmo trutta*) have been stocked within the Clearwater River drainage (Figure 1) by Alberta Sustainable Resource Development (ASRD). The intent of these stocking programs was to increase angling opportunities for Alberta's anglers. Despite the priority of stocking brown trout in the Clearwater River drainage, formal analyses of brown trout status, trends and distribution within the system are limited.

A review of pertinent literature revealed that historical population estimates of brown trout on the Clearwater River drainage are limited as most historical surveys were focussed on bull trout (*Salvelinus confluentus*). In respect to the mainstem Clearwater River, Cole (1977) completed the first formal fisheries investigation in 1977. Cole electrofished two reaches of the Clearwater River, providing a historic baseline perspective of brown trout population levels. In 1987, Rhude (1988) repeated one of the reaches established by Cole. In 1992 and 1993, Rhude and Rhem (1995) attempted bull trout population estimates in the two reaches previously established by Cole and an additional reach located upstream. Unfortunately from a brown trout management perspective, since low numbers of bull trout were encountered in the electrofishing efforts conducted by Rhude and Rhem, they limited their efforts to single pass electrofishing. In 2004, Rodtka and Gardiner (In prep.) completed brown trout population estimates on three reaches. These reaches were the Ricinus and Corkscrew reaches (Figure 2), originally established by Cole (1977) and the Elk Creek reach, originally established by Rhude and Rhem (1995).

In addition to mainstem population estimate surveys, several other surveys were conducted on both the mainstem and tributary streams. Allan *et al.* (1995) conducted a brown trout telemetry project on the Clearwater River in 1994. In regards to tributaries to the Clearwater River, most data were limited to single pass inventories. However, from studies such as McLeod and Gardiner (1999), Gardiner and McLeod (2000) Gardiner *et al.* (2002) and Rodtka and Gardiner (In prep) recent data are moderately abundant. Biological data including capture locations, survey dates, fish capture effort and fish lengths were collected within all the studies listed above and were available for analysis.

Recently, in Alberta and generally throughout mid-western North America, fisheries management has placed a high emphasis on the preservation of native stocks, including indigenous bull trout populations. In response, recent fisheries research conducted in these regions has focused largely on bull trout. From this research has come the suggestion that the stocking of non-native fish species such as brown trout and brook trout (*Salvelinus fontinalis*) may be hampering bull trout recovery efforts. Specifically, competition from exotics has been hypothesized as a cause for decline in bull trout populations (Donald and Alger 1992 and Gunckel *et al.* 2002). In support, Alberta's Bull Trout and Management Plan (Berry 1994) stated, "The introduction of exotic species such as brown trout and brook trout are suspected to have caused reduced production of bull trout in some areas, and possibly the complete displacement of some bull trout populations."

Although competition from exotic species such as brown trout is considered a detriment to bull trout populations, this hypothesis is largely untested. Waters (1983) observed a near replacement of brook trout by brown trout over a 15-year period in a Minnesota stream. In addition, Dewald and Wilzbach (1992) found evidence to support the theory of brown trout out-competing brook trout and Wang and White (1994) have suggested that brown trout will out compete cutthroat trout (*Oncorhynchus clarki*). However, recent research conducted in the Rocky Mountain House area by Rodtka (2005) suggested that juvenile brook trout may only out compete juvenile bull trout under certain environmental conditions. Rodtka (2005) also suggested that in extremely cool water, bull trout may actually out-compete brook trout.

Fisheries managers have little information to assess what effect brown trout stocking in the Clearwater River drainage is doing to bull trout populations. Therefore, an assessment of the current brown trout population status in the Clearwater River drainage and comparisons to historic levels may provide fisheries managers with some quality information. In addition, this information may provide insight to whether or not the establishment of brown trout might be limiting bull trout recovery in the drainage.

1.3 Study Objectives

The objectives for this project were:

1. Compare the results of brown trout population estimates from historic surveys to those conducted during the Clearwater River Bull Trout Study in 2004/05.
2. Compare brown trout fork length data collected in 2004 to that collected in past studies.
3. Use current catch-per-unit-effort data to demonstrate current brown trout distribution in the Clearwater River drainage and code tributary streams of the Clearwater River as having high, moderate or low populations of brown trout.

2.0 STUDY AREA

2.1 Description

The study area for this project is the same as the study area for the Clearwater River Bull Trout Study (Rodtka and Gardiner, In prep.), completed by the ACA in 2004/05. This project makes use of much of the data that were collected in that study and, therefore, the study area for this project remains the same. From Rocky Mountain House the upper and lower-ends of the study area are approximately 92 km southwest and 32 km southeast of Rocky Mountain House, respectively. The upper-end of the study area was the Banff National Park boundary and the lower-end was the intersection of the Clearwater River and Highway 54 (Figure 1). Waterbodies within the study area included the Clearwater River mainstem and all tributaries within the area excluding Alford Creek. Rodtka and Gardiner (In prep.) excluded Alford Creek due to the fact that it mostly flows through private land limiting access to the creek. This subsection of the entire Clearwater River drainage was chosen as a study area by Rodtka and Gardiner (In prep.) based on logistical and budgetary constraints and to include the majority of drainage area covered by previous assessments.

The western portion of the study area included a 613.7 km^2 area known as the Upper Clearwater Forest Land Use Zone (FLUZ) (Figure 1). Within the Upper Clearwater FLUZ, the use of motorized boats and on-highway vehicles were not permitted and the use of off highway vehicles (OHVs) was limited to winter months. Also, petroleum, natural gas and mineral exploration was not permitted in this area (Alberta Sustainable Resource Development 2002).

The headwaters of the Clearwater River are located directly inside the Banff National Park border. Within the Upper Clearwater FLUZ portion of the study area, major tributaries to the Clearwater River include: Peters Creek, Timber Creek, Forbidden Creek, Skeleton Creek and Lost Guide Creek. Tributaries located downstream of the FLUZ include Cutoff Creek, Elk Creek, Seven Mile Creek, Idlewilde Creek, Pineneedle Creek, Moose Creek, Rocky Creek and the Tay River. Approximately 214 km long the Clearwater River watershed encompasses an area of 2880 km^2.

Important roadways found within the study area include secondary highways number 734 (Forestry Trunk Road), 752 and 591. Primary highway number 54 intersects the Clearwater River in its lower reaches and is considered the lower

limit of the study area. These roadways and their tributary trails and roadways have provided the majority of the access for the fish surveys that have been completed within the study area.

Industrial activities within the study area are restricted to those areas located downstream of the Upper Clearwater River Forest Land Use Zone. These include oil/gas exploration and development, gravel extraction, timber harvesting and cattle farming. Within the study area, there is great potential for future commercial and industrial expansion. Elk Creek, Idlewilde Creek, Seven Mile Creek and the Tay River flow within areas that the Alberta government allocated for use by cattle ranchers for the summer grazing of their cattle. Often, these creeks provide the drinking water for cattle, therefore, bank erosion and vegetation damage within riparian areas is common. Currently, the study area is popular for such recreational pursuits as kayaking, white water rafting, off-highway-vehicle use, horseback riding, hiking, site seeing, hunting and fishing.

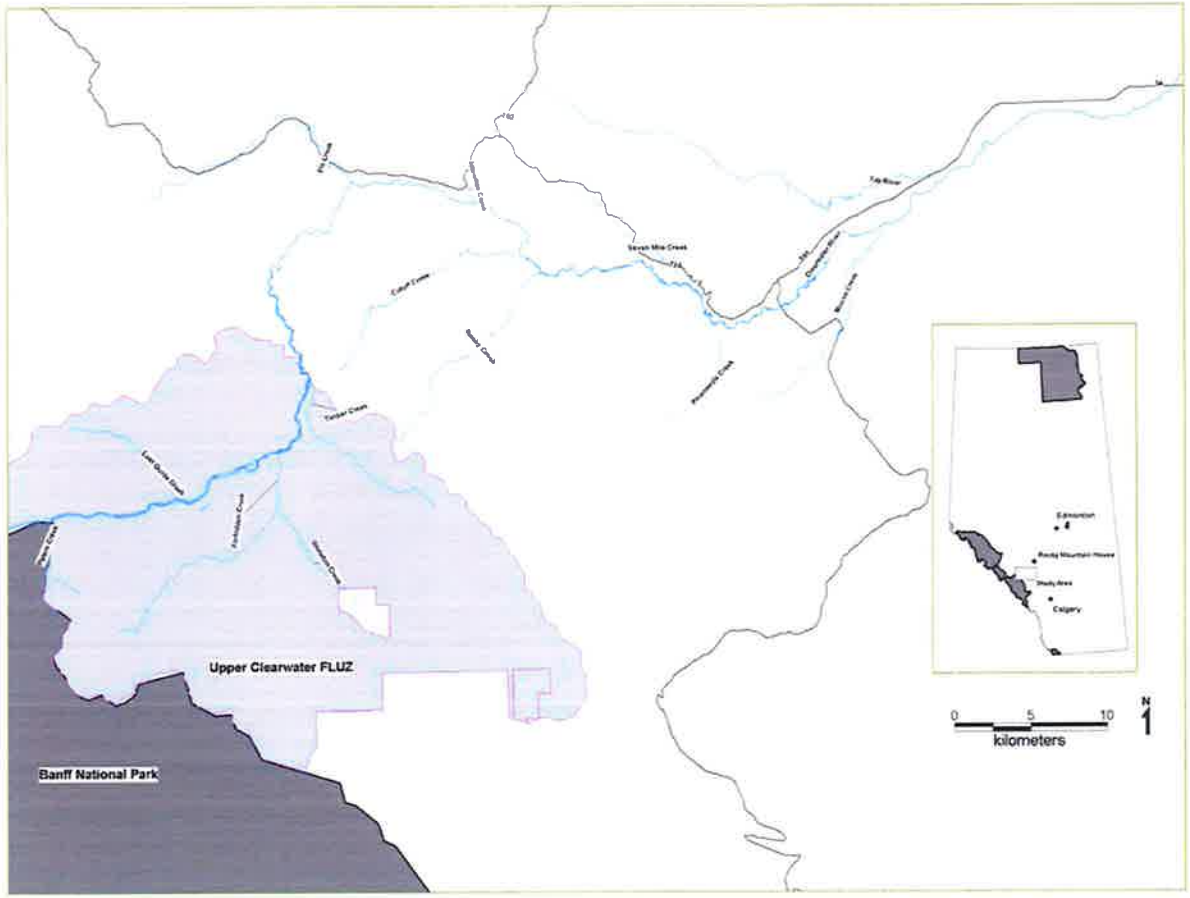

Figure 1. The Clearwater River mainstem and major tributaries located downstream of the Banff National Park boundary and upstream of Primary Highway No. 54; this represents the study area for this project.

2.2 Ecoregion, Forest Cover and Soils

The study area is represented by four ecoregions, according to the classification scheme used by Strong and Leggat (1992), and these are the Subalpine, Alpine, Upper-Boreal Cordilleran and Lower-Boreal Cordilleran. The Subalpine Ecoregion's reference vegetation is Lodgepole Pine (*Pinus contorta*) with succession to Engelman Spruce (*Picea engelmannii*) and Sub Alpine Fir (*Abies lasiocarpa*) and the reference soil is Eutric Brunisol. The mean summer (May through August) temperature is 9.4 °C, the mean winter temperature (November through February) is –8.9 °C and the annual total precipitation is approximately 568 mm. The summer month of maximum precipitation in the Sub Alpine Ecoregion is July (Strong and Legget, 1992). In the Alpine Ecoregion the reference vegetation and soil type are heather (*Hudsonia tomentosa*) and Brunisol, respectively. The mean summer temperature is estimated at 7.6 °C, the summer month of maximum precipitation is July and total summer precipitation is estimated at 206 mm (Strong and Legget, 1992). In the Lower Boreal-Cordilleran the reference vegetation is Aspen-Balsam Poplar (*Populas balsamifera* and *Populus tremuloides*), Lodgepole Pine with succession to White and Black Spruce (*Picea glauca* and *Picea mariana*) and Balsam Fir (*Abies balsamae*) and the reference soil is Gray Luvisol. The mean summer temperature is 12.8 °C and the mean winter temperature is –7.8 °C. The summer month of maximum precipitation is July and the total annual precipitation is 464 mm (Strong and Legget, 1992). The reference vegetation and soil in the Upper Boreal-Cordilleran are Lodgepole Pine with succession to White Spruce, Black Spruce and Balsma Fir and Gray Luvisol and Brunisol, respectively. The mean summer temperature is 11.5 °C with the summer month of maximum precipitation also being July. In the winter months, the mean temperature is –6.0 °C and the annual total precipitation is 538 mm (Strong and Legget, 1992).

2.3 Animal and Fish Communities

The Study area supports a wide diversity of wildlife such as black bear (*Ursus americanus*), coyote (*Canus latrans*), gray wolf (*Canis lupus*), grizzly bear (*Ursus arctos*), moose (*Alces alces*), mountain lion (*Felis concolor*), mule deer (*Odocoileus hemionus*), whitetail deer (*Odocoileus hemionus virginianus*) and a large number of other fur bearing species. In particular, the Clearwater River valley, especially that portion contained within the Forest Land Use Zone is renown for its large elk (*Cervus elaphus*) populations.

Fish species are limited to cool and coldwater fishes (Nelson and Paetz, 1993), with salmonids being the dominant sport fish. Generally speaking, aquatic habitats in the study area have very low biological productivity due to cool water temperatures, low nutrient levels, and a short growing season. Sport fish species indigenous to the Clearwater River drainage include bull trout (*Salvelinus confluentus*), burbot (*Lota lota*), lake trout (*Salvelinus namaycush*), mountain whitefish (*Prosopium williamsoni*), northern pike (*Esox lucius*) and walleye (*Sander vitreus*). Those that have been documented within the study area include bull trout, burbot and mountain whitefish. Exotic sport fish that have been stocked into the drainage include Arctic grayling (*Thymallus arcticus*), brook trout, brown trout, cutthroat trout and rainbow trout (*Oncorhynchus mykiss*). However, only brown trout and brook trout are known to currently have self-reproducing populations (Steve Herman pers. com.). Non-sport fish species that are common to the study area include: finescale dace (*Phoxinus neogaeus*), lake chub (*Couesius plumbeus*), longnose sucker (*Catostomus catostomus*), longnosed dace (*Rhinichthys catarctae*), mountain sucker (*Catostomus platyrhynchus*), pearl dace (*Margariscus margarita*), trout perch (*Percopsis omiscomaycus*) and white sucker (*Catostomus commersoni*).

2.4 Stocking History within the Clearwater River Drainage

Historically, brown trout have been stocked extensively into the Clearwater River drainage. A review of ASRD stocking record files and the Fisheries Management Information System (FMIS), which is the provincial fisheries database, indicates that stocking in the drainage began as early as 1927 and continues today. Since 1927, at least 1.35 million brown trout have been stocked into the Clearwater River drainage. This does not include several lakes within the drainage that have been stocked with brown trout and have the potential to augment brown trout stocks in lotic environments. Brown trout stocking events in the study area include the stocking of approximately 123,500 brown trout in the Clearwater River between 1932 and 1984. Between 1957 and 1987 approximately 44,300 brown trout were stocked into Elk Creek and between 1956 and 2001, approximately 44,138 brown trout were stocked into the Tay River. Historically, brown trout have never been stocked into Cutoff Creek. Currently, stocking within the Clearwater River drainage is only being done on Mud Creek (outside the study area) and the Tay River on a five-year rotation (Steve Herman pers. com.). Both of these streams are being stocked with approximately 10,000 brown trout per stocking event.

2.5 Brown Trout Management in the Clearwater River Drainage

With the exception of the extensive stocking of brown trout, a review of sport fishing regulations suggests that the Clearwater River drainage has been managed primarily for bull trout. Historically, the daily bag limit for trout in the drainage was five trout per day combined. Specifically, in the Clearwater drainage this would include brown trout, brook trout, bull trout, rainbow trout, cutthroat trout and Arctic grayling. In 1976, the portion of the drainage upstream and including Timber Creek was closed for angling and this restriction still remains today. Alternate year closures on tributaries to the Clearwater River downstream of Timber Creek was in place until 1987; at this time, the entire drainage (downstream of Timber Creek) was closed to angling from November 1 to June 15. In regard to bull trout, the bag limit was reduced to two per day in 1984, a 40 cm or greater size restriction was implemented in 1987 and zero harvest has remained since 1995. Although daily harvest limits were reduced for bull trout, harvest was not reduced on brown trout until 1998 when the entire drainage was closed to harvest between September 1 and October 31. In addition, the harvest limit for all trout and Arctic grayling combined was reduced from five to two between April 1 and August 31. Also in 1998, Elk Creek (Figure 1) became a catch and release fishery for brown trout. The regulation changes that were implemented in 1998 are still in effect today.

Before 1987, angling with bait was allowed in any flowing stream that was open for angling. In 1987, the use of bait was banned in all flowing waters but an exception on the Clearwater River is the use of maggots from August 16 to October 1 from the Forestry Trunk Road (No. 734) to the North Saskatchewan River (Figure 1). These same restrictions on the use of bait are still in place today.

3.0 MATERIALS AND METHODS

The primary data source for this project came from the report named, "Upper Clearwater River Bull Trout Status Assessment – 2004" (Rodtka and Gardiner, In prep.). Although the focus of that project was bull trout, biological data on other fish species were collected, including much data on brown trout. Historical data from a variety of sources were also used.

3.1 Current and Historic Population Comparisons

Mark-recapture population estimates on brown trout were prepared for three reaches of the mainstem – Clearwater River as part of the Upper Clearwater River Bull Trout Status Assessment-2004 (Rodtka and Gardiner, In prep.). These reaches are referred to as the Ricinus, Corkscrew and Elk Creek reaches (Figure 2), for the purpose of this report. They represent either approximately the same section of river that was surveyed historically or a sub-section of these originally established reaches. Specific sources for historic population estimates used in this project are the following: Ricinus Reach – Rhude (1988) and Cole (1977), Corkscrew Reach - Cole (1977) and the Elk Creek Reach - no historic information.

In 2004, Rodtka and Gardiner (In prep.) prepared mark-recapture population estimates using three capture passes on the Corkscrew and Elk Creek reaches according to the methods described in White *et al.* (1982). Where possible, the model selection feature was used to select the simplest, best-fitting model estimator from the eight candidate models. In all cases Model M_t was used which allows capture probabilities to vary by time. Mark-recapture estimates with only two capture events were calculated using Chapman's modification of the Petersen-Lincoln estimator (White *et al.* 1982) and the binomial distribution to generate approximate 95% confidence limits according to Krebs (1999). Rodtka and Gardiner (In prep.) used two electrofishing passes to calculate population estimates in the Ricinus reach using the Chapman's modification of the Petersen-Lincoln estimator. The same two pass method and methods for analysis were used in all the historic population estimates that were used for analysis in this report.

3.2 Current and historic size class comparisons

Brown trout fork length data collected within the Upper Clearwater River Bull Trout Status Assessment-2004 (Rodtka and Gardiner, In prep.) were used to represent current brown trout size distributions. These data were queried from the FMIS for analysis. Brown trout fork length data collected in past studies were not in digital formats. Therefore, historic data that were to be used for size class comparisons were found within the fisheries files located in the Rocky Mountain House Fish and Wildlife office. Specific sources were: Cole (1977), (Rhude) 1988, Rhude and Rhem (1995). These data were entered into the program Microsoft Excel™ for analysis. All fork length frequency bar charts were also prepared using Excel™. Fork length frequency bar charts were prepared using current and historic data for each the Ricinus, Corkscrew and Elk Creek reaches. Figure 2 provides an overview of what years data are available from each defined survey reach. In addition, a bar chart for all three reaches of the Clearwater River combined was prepared using data from Rodtka and Gardiner (In prep.).

Mean Fork Length Comparisons

In 2004 and 1977 population estimate data were available for both the Ricinus and Corkscrew reaches. The 27 years that separate these two data sets provided a good time series for significant differences in brown trout sizes to occur. In addition, 2004 and 1977 represent the only two-years in history where population estimates were completed in two sections within the same year. Therefore, a two-sample t test was completed on these two datasets, which compared the mean fork lengths 1977 and 2004 in both the Ricinus and Corkscrew reaches. The test was done to determine if there had been any significant changes in mean fork length between these years.

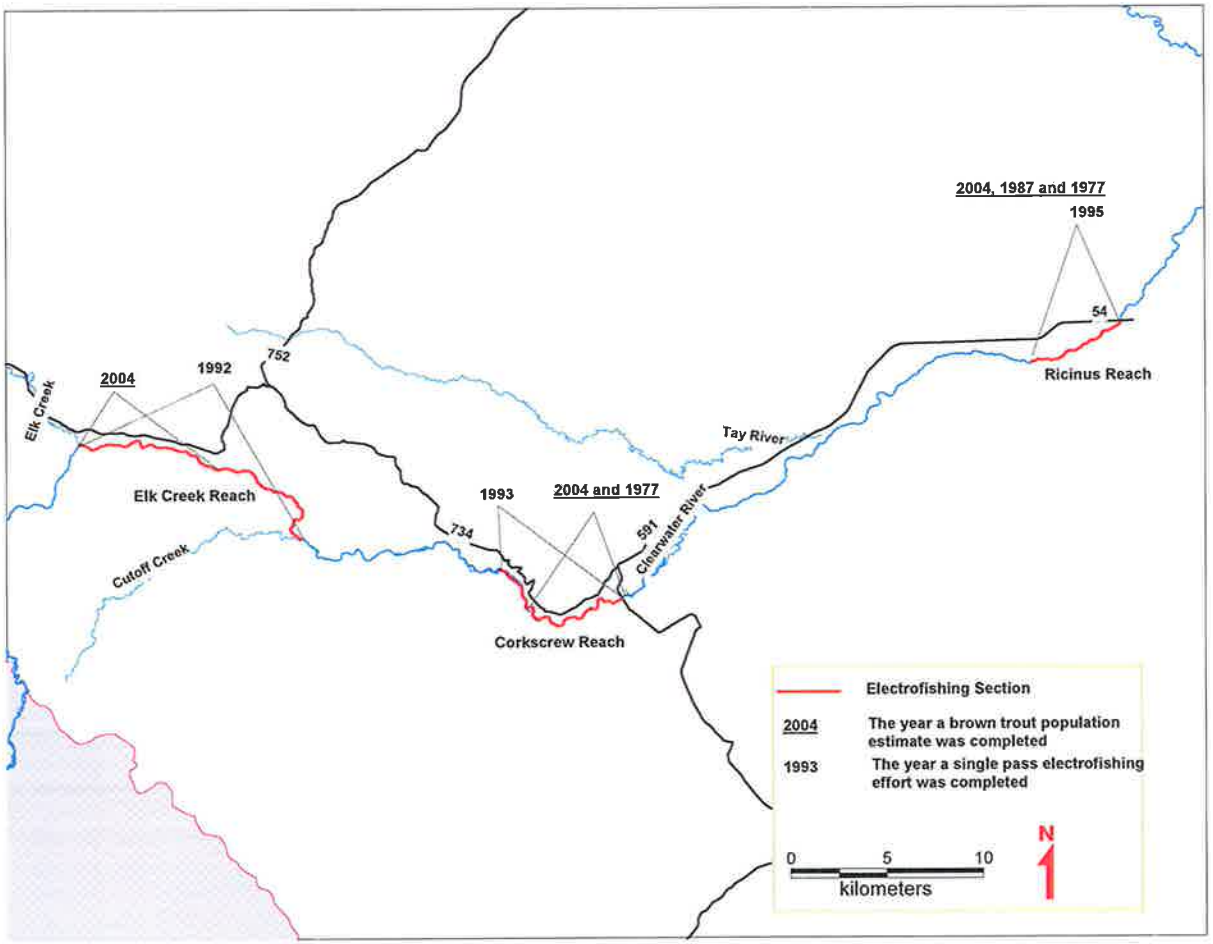

Figure 2. The year and specific reaches where brown trout float electrofishing surveys have been completed. Underlined dates refer to the years when a formal population estimate was completed.

3.3 Brown Trout Distribution and Population Densities in the Clearwater River Drainage

The primary data source for this section was the Upper Clearwater River Bull Trout Status Assessment-2004 (Rodtka and Gardiner, In prep.). Other data sources include fish inventory data collected within the Alberta Conservation Association's Co-operative Fisheries Inventory Program (CFIP). In particular, data collected in 1998, 1999 and 2001 were used. Summaries of this survey work can be found in McLeod and Gardiner (1999), Gardiner and McLeod (2000) and Gardiner *et al.* (2002). A third source of data was from backpack electrofishing efforts conducted by a University of Alberta student as part of his research towards his Master's thesis. An overview of the methods he used can be found in Rodtka (2005). These data were queried from the Fisheries Management Information System (FMIS).

All the catch-per-unit-effort (CUE) data on brown trout collected since January 1, 1998 in the entire province of Alberta were used to code Clearwater River. That is, from FMIS, all backpack electrofishing fish inventory data where brown trout were captured, distance was recorded and the number of brown trout captured were used. Data collected within the last eight years were considered current for the purpose of this project due to the fact that in 1998, the Co-operative Fisheries Inventory Program (CFIP) commenced in the East Slopes, which provided a wealth of baseline brown trout electrofishing data on smaller-tributary streams. Through this project several stream inventories were done in the Clearwater River drainage using similar capture methods as those used in the Upper Clearwater River Bull Trout Status Assessment-2004 (Rodtka and Gardiner, In prep.). Therefore, using the restriction of eight years or newer allowed me to use the large data set generated through the CFIP and to limit biases attributed to inconsistent fish capture methods.

Using these data queried from FMIS, brown trout catch-per-unit-effort results were prepared. Catch-per-unit-effort data was calculated as the number of brown trout captured divided by the distance that was electrofished and the results were presented as the number of brown trout captured per 100 meters. The statistical program Jump-In™ (SAS) was then used to group the list of all brown trout CUE's from the entire province into three groups. Groupings included the 75th and greater percentile, the 26th to 74th percentile the 25th and lower percentile. Brown trout populations were considered to represent a high-

density population if their CUE's were within the upper 75th percentile, moderate- density if within the 26th to 74th percentile and a low-density when in the 25th and lower percentiles. For the purpose of this project, from the CUE analysis done for the entire province, streams with CUE's for brown trout that were 8.32 brown trout per 100 m or greater were considered high brown trout population densities, those between 0.98 and 8.31 were considered moderate densities and those at 0.97 or less were considered low brown trout densities.

Streams were broken into reaches based upon stream order (Strahler 1957) and assigned a code according to the scheme outlined in Table 1. Reaches with multiple CUE values were coded based upon the highest CUE observed. For example, two sites were completed on stream reach A and the CUE ranking at one site is moderate-density and at the other site it is determined to be low-density. When viewing the hardcopy map, the stream would appear coded to green as the moderate-density layer lies on top of the low-density layer (yellow). The Government of Alberta's 1:20,000 base features single line network hydro layer was used (data provided by Spatial Data Warehouse Ltd.) for this stream coding exercise.

Brown trout distribution in Alberta ranges from as far north as the Athabasca River and south to the Milk River (Nelson and Paetz, 1992). Within this wide area, brown trout populations are found in varying habitats and therefore carrying capacities and long-term survivability also vary. Therefore, it is important to mention that the stream coding that was used is relative to the Clearwater River drainage. That is, if this stream coding were applied to other drainages the results would be much different. For example, a drainage that has better brown trout habitat would likely have more streams coded to high density.

Table 1. The Stream Coding scheme used on Tributary Streams to the Clearwater River based on Catch per Unit Results from surveys completed between 1998 and 2004.

Stream Code	Colour	Stream Code Order
High Density	Pink	Top
Moderate Density	Green	↓
Low Density	Yellow	
No Brown Trout Captured	Blue	
No Electrofishing Surveys Completed	Black	Bottom

4.0 RESULTS

4.1 Current and Historic Population Comparisons

Rodtka and Gardiner (In prep.) completed population estimates on brown trout in three reaches of the mainstem Clearwater River and the results are displayed in Table 2. In 2004, brown trout densities were greatest in the Ricinus reach at 144.3 brown trout per kilometre. Brown trout densities in the Corkscrew and Elk Creek reaches were 47.6 and 23. 6brown trout per kilometre, respectively.

Table 2. Mark-recapture brown trout population estimate electrofishing results from three reaches of the Clearwater River in 2004. Marking runs were performed on September 21 and 22, September 25 and 26, and October 1 and 2 and recapture runs performed on October 5, 6 and 7 on the Ricinus, Corkscrew and Elk Creek reaches, respectively.

Reach	Number Marked	Number Caught Recapture Run	Number of Recaptures	Number Captured	Estimate	95 % Confidence Interval	Fish/km
Ricinus	109	133	16	226	866	605<=N<=1816	144.3
Corkscrew	84	63	22	132	333	250<=N<=475	47.6
Elk Creek	34	18	3	49	165	85<=N<=566	23.6

Results of brown trout population estimates in the Ricinus reach of the Clearwater River mainstem were very close in 2004 and 1977 but varied greatly from the results in 1987. (Table 3 and Figure 3). In fact, the lower 95% confidence interval for 2004 remained higher than the top 95% confidence interval for 1987. Total number of brown trout captured was generally close between all three years. In the Corkscrew reach, between 1977 and 2004, there was not a large difference in population estimate numbers (Table 3 and Figure 4). Specifically, in 1977 it was estimated there were approximately 17 more brown trout per kilometer than in 2004. Work in 2004 was completed in the fall and all other estimates were completed in the spring (Table 3). Therefore, the timing of the electrofishing surveys may have affected these results, due to the fact, that the migratory patterns of brown trout may have influenced their abundance within these survey reaches.

Table 3. Population Estimate Results in 1977, 1987 and 2004 for three reaches of the Clearwater River.

Year	Date	Reach	n	Estimate	95 % Confidence Interval	Fish/km
2004	Oct. 7 - 14	Ricinus	226	866	605<=N<=1816	144.3
	Oct. 5 - 13	Corkscrew	132	333	250<=N<=475	47.6
	Oct. 12 - 15	Elk Creek	49	165	85<=N<=566	23.6
1987	Apr 22 - 28	Ricinus	219	366	281<=N<=451	65.6
	N/A	Corkscrew	N/A	N/A	N/A	N/A
	N/A	Elk Creek	N/A	N/A	N/A	N/A
1977	Mar 31 to Apr 5	Ricinus	231	702	385<=N<=1019	136.88
	Mar 29 to Apr 4	Corkscrew	N/A	394	234<=N<=554	63.13
	N/A	Elk Creek	N/A	N/A	N/A	N/A

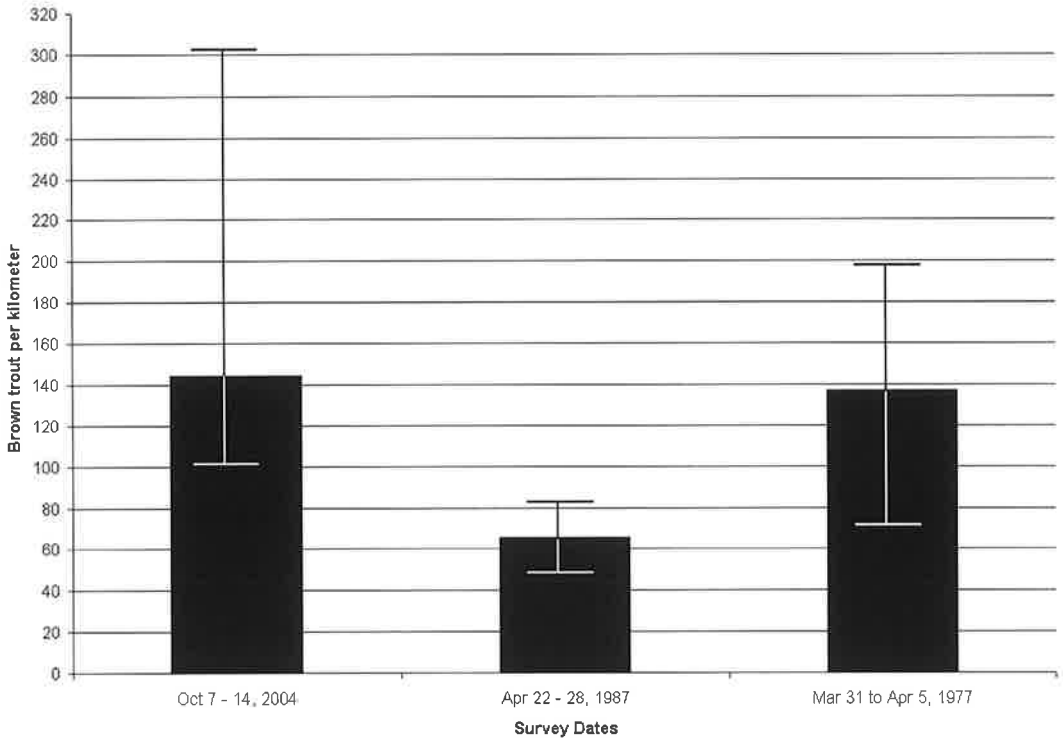

Figure 3. Population estimate comparisons between 2004, 1987 and 1977 for the Ricinus reach of the Clearwater River.

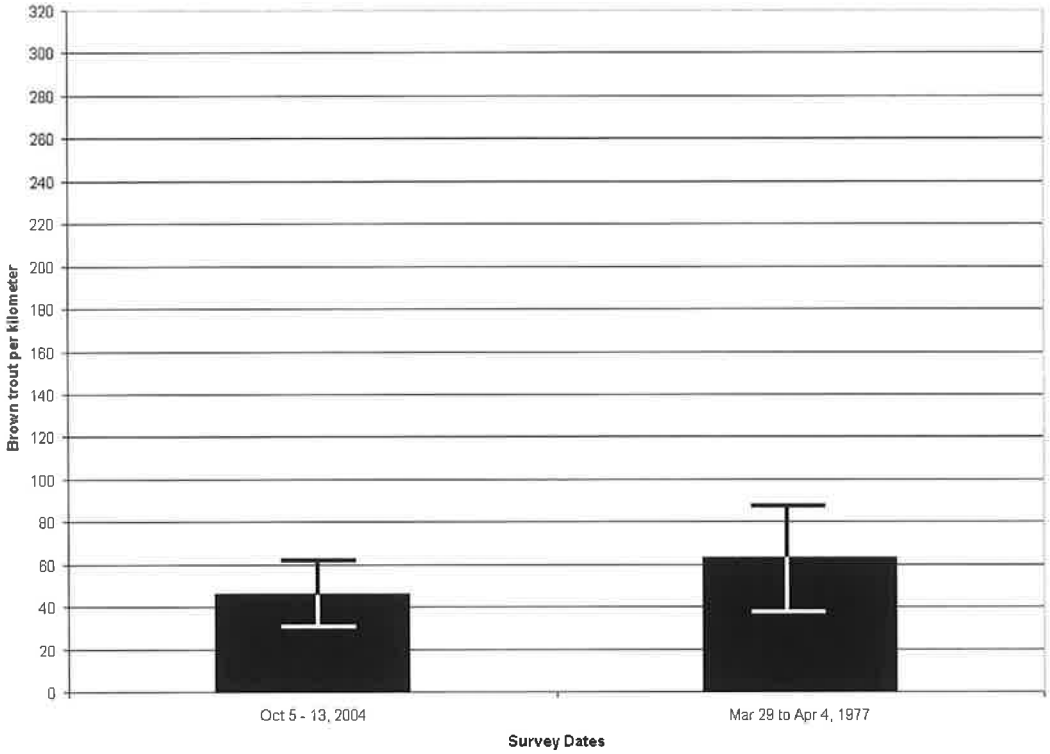

Figure 4. Population estimate comparisons between 2004 and 1977 for the Corkscrew reach of the Clearwater River.

4.2 Current and Historic Size Class Comparisons

In 2004, Rodtka and Gardiner (In prep.) sampled 466 brown trout within the population estimates they completed in the Ricinus, Corkscrew and Elk Creek reaches. Figure 5 is a fork length distribution bar chart that demonstrates the size variations in the brown trout collected. Individual brown trout sizes ranged from 76 – 610 mm and a relatively even size distribution was observed. Specifically, at 25 mm size-class delineations, no size classes were absent between the 76 mm or greater and 575 mm or smaller, size classes. The highest frequencies were between 351 – 475 mm with the most represented size class being between 401 – 425 mm. Higher frequencies of brown trout were also collected within the 176 – 275 mm size classes. Brown trout between 326 – 375 mm were notably less frequent.

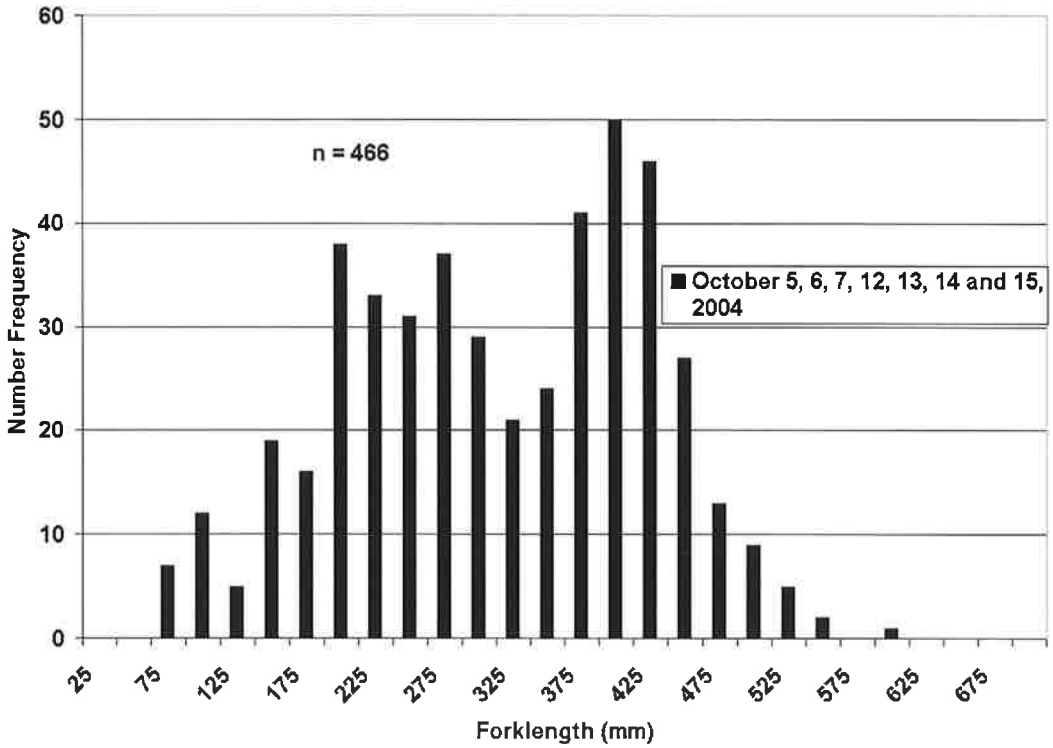

Figure 5. Fork length frequency distribution of brown trout captured while conducting population estimates at three reaches of the Clearwater River between October 5-15th, 2004.

In 2004, 1987 and 1977 the total number of brown trout captured in the Ricinus reach was comparable at 256, 194 and 231, respectively. In 1995 the total number of brown trout captured, 72, was notably reduced. However, in 2004, 1987 and 1977 two electrofishing passes were completed and only one was done in 1995. In both 1987 and 1977, brown trout captured at the 151 to 175 mm size classes were dominant in the Ricinus reach (Figure 6). Also, in those two years, brown trout less than 250 mm were more common in general. In 2004, brown trout in the 401 to 425 mm size class were most common (Figure 6). It is important to point out that in 1977, 1987 and 1995, electrofishing was done in the spring and in 2004 it was done in the fall. Therefore, the seasonal migration patterns of brown trout may have influenced electrofishing capture results.

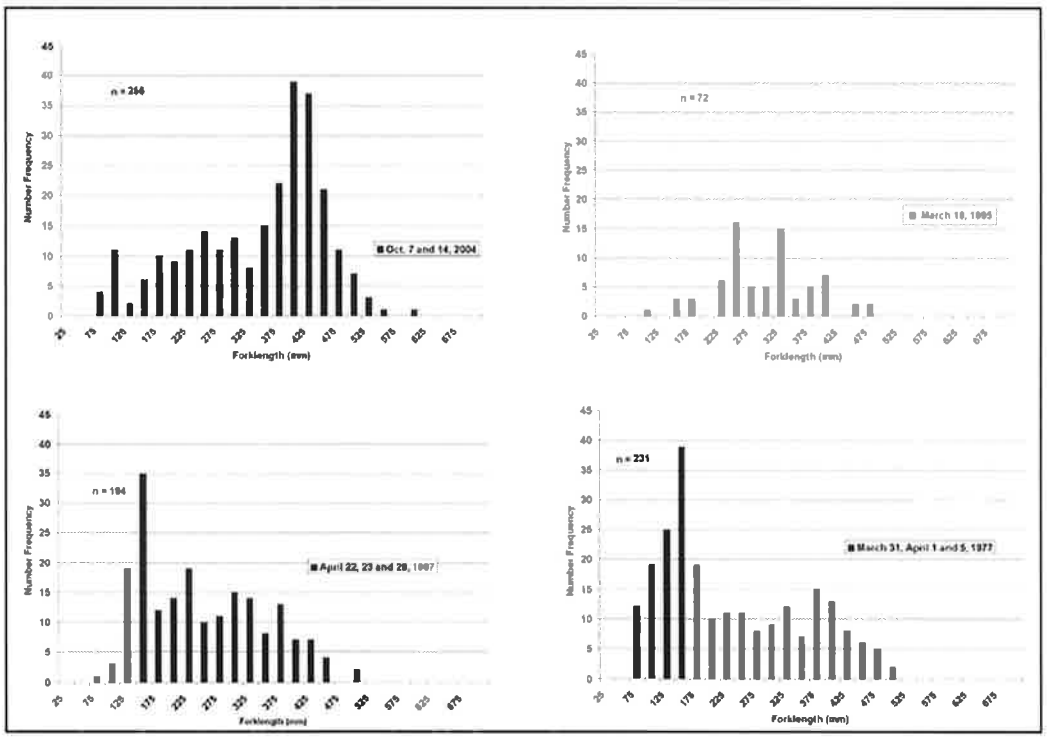

Figure 6. A comparison of fork length frequency distribution (range 25-675 mm; 25 mm size classes) of brown trout captured in the Ricinus reach of the Clearwater River in 2004, 1995, 1987 and 1977.

In the Corkscrew reach a comparable number of brown trout were captured in both 2004 and 1997 at 157 and 188, respectively. In 2004 a very even size class distribution was observed. It is notable that all size classes between the fork lengths of 76 and 526 mm were represented (Figure 7). Generally, the highest concentrations of brown trout were found within the size classes between 200 and 350 mm (Figure 7). However, the most represented individual size class was at 376 - 400 mm. There were few brown trout collected at fork lengths greater than 450 mm in 2004 (n = 6). In 1993 only 40 brown trout were captured, however, only one electrofishing pass was completed. In 1977, the dominant size classes were between 76 – 175 mm and the most dominant was 126-150 mm (Figure 7). Also in 1977, no brown trout longer than 500 mm were collected. In 1993, few brown trout were collected in total, but a relatively even distribution in brown trout sizes was observed. The most dominant size class in 1993 was the 151 to 175 mm size class and the largest brown trout captured was in the 651 – 675 mm size class (Figure 7).

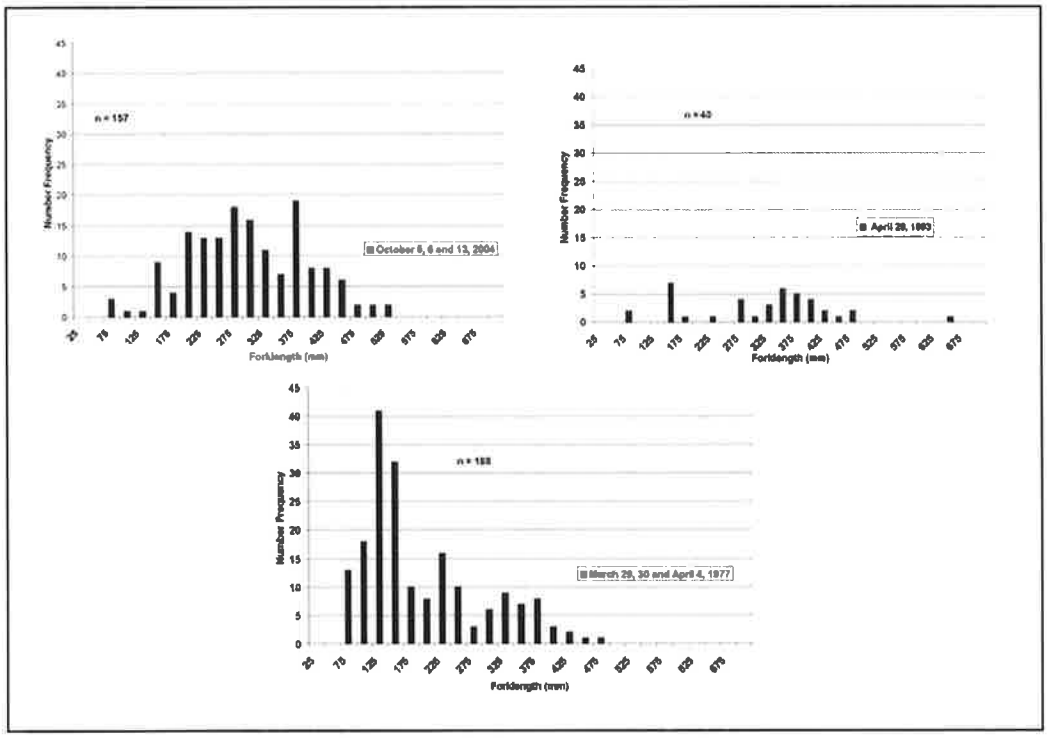

Figure 7. A comparison of fork length frequency distribution (range 25-675 mm; 25 mm size classes) of brown trout captured in the Corkscrew reach of the Clearwater River in 2004, 1993 and 1997.

Relative frequency bar charts of brown trout captured in 2004 and 1992 in the Elk Creek reach are shown in Figure 8. Few brown trout were captured in both years when compared to the Ricinus and Corkscrew reaches. In 2004, two electrofishing passes were completed on a shorter survey section than that done in 1992 when only a single electrofishing pass was completed. That is, in 2004 a section of seven kilometres was electrofished compared to 15 kilometres in 1992. Although few fish were collected, size class distributions were quite similar between years.

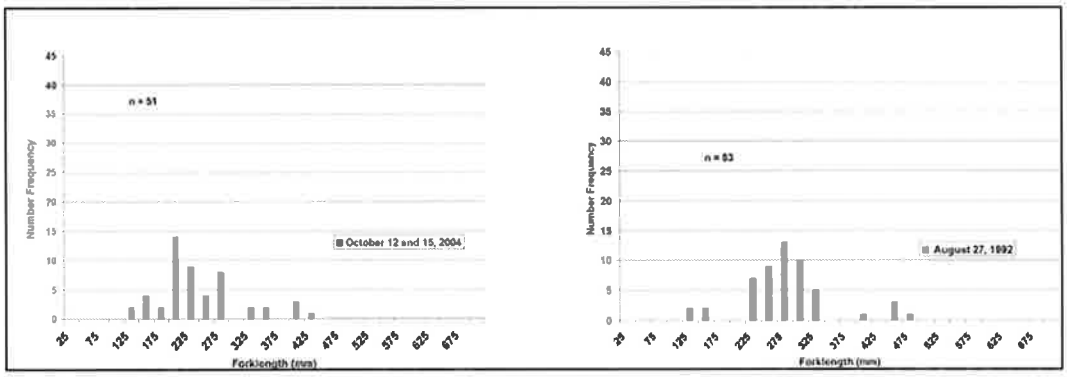

Figure 8. A comparison of fork length frequency distributions (range 25-675 mm; 25 mm size classes) of brown trout captured in the Elk Creek reach of the Clearwater River in 2004 and 1992.

Mean Fork Length Comparisons

Brown trout mean fork length in the Ricinus reach in 1977 was 221.38 mm and in 2004 it was 329.22 mm. A two-sample t test showed that this change in mean fork length represented a highly significant change between those years (P<.0001). In the Corkscrew reach the mean fork length of brown trout captured was 180.90 in 1977 and 286.20 in 2004. Again, this level of changed was determined to be highly significant (P>.0001) through a two-sample t test. These analyses show that brown trout appear to be increasing in size in the Clearwater River.

4.3 Brown Trout Distribution and Population Densities in the Clearwater River Drainage

Figure 9 provides an overview of brown trout distribution and specific densities within several sub-basins of the Clearwater River derived from surveys done within the past eight years. In a general sense, current data from within the Forest Land Use Zone are limited, however good sampling coverage of Elk Creek, Peppers Creek, Idlewilde Creek, Seven Mile Creek, Rocky Creek and the Tay River, was found. The majority of Cutoff Creek and the lower portions of Elk Creek were found to have high brown trout densities. Moderate densities of brown trout were found in the upper sections of mainstem Elk Creek, headwater tributaries to Elk Creek the greater length of Idlewilde Creek and an unnamed tributary to Cutoff Creek.

Many survey sites have been completed in the Tay River sub-basin within the past eight years. Brown trout were not found in the majority of the 28 sites that were completed in the drainage, which included 21 on the mainstem. In fact, only one brown trout has been collected and it was collected in an electrofishing survey that was completed in the lower reaches of the mainstem Tay River in 2004 by Rodtka and Gardiner (In prep.). Due to the fact that only one brown trout was collected low-density coding was assigned.

Several sub-basins within the Clearwater River drainage have been surveyed within the past eight years without the detection of brown trout. In fact, brown trout have not been documented in any tributary streams within the upper Clearwater FLUZ. Brown trout have also not been documented in Rocky Creek, Peppers Creek or Seven Mile Creek, despite extensive sampling in many of these drainages.

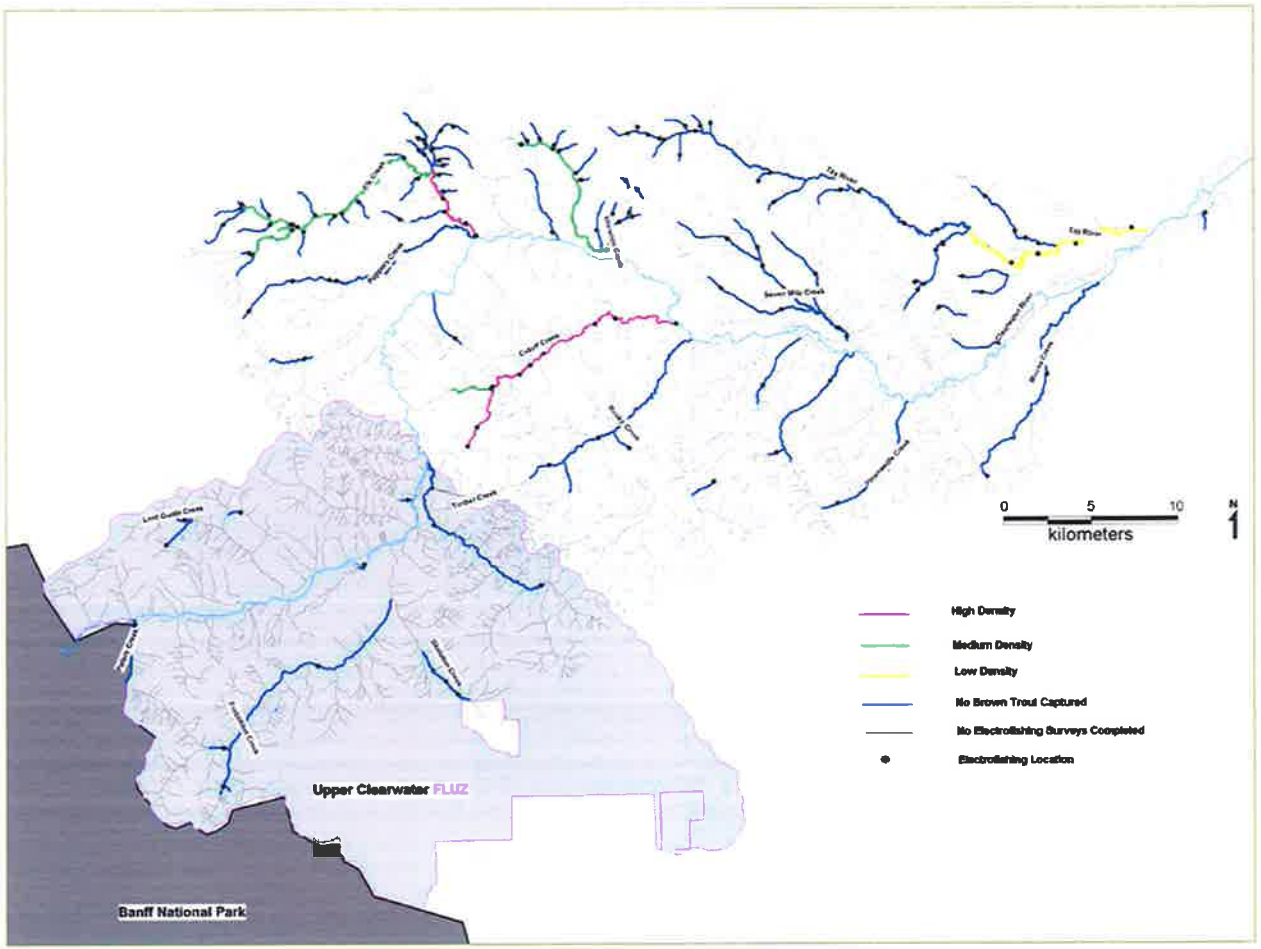

Figure 9. Stream Coding within the Clearwater River Drainage based on Catch per Unit of Effort results from data collected since January 1, 1998.

5.0 DISCUSSION

5.1 Current and Historic Population Comparisons

Analysis of the population estimates completed by Rodtka and Gardiner (In prep) shows variation in brown trout population numbers between survey reaches. A higher population density was found in the Ricinus reach (144.33 brown trout per kilometre), than either the Corkscrew (47.57 brown trout per kilometre) or the Elk Creek (23.57 brown trout per kilometre) reaches. Therefore, on the Clearwater River mainstem in general, brown trout populations appear to increase as you move downstream. This is similar to the findings of Rahel and Nibbelink (1999), who observed an increase in brown trout numbers in the middle reaches of the drainages they studied. Klemetsen *et al.* (2003) suggested that habitat variability and quality will influence fish density in a river and Elso and Giller (2001) found that brown trout numbers and biomass increases with pool size. This may explain the higher concentrations of brown trout found within the Ricinus. That is, fish cover in the form of undercut banks, woody debris, terrestrial canopy and deep pools was much more prevalent.

The time of year that this survey was completed may also contribute to larger catches of brown trout within the Ricinus reach. Allan *et al* (1995), documented abundant spawning activity within the Ricinus reach. Also, Nelson and Paetz (1992) indicate that October is typical timing for brown trout spawning and, Rodtka and Gardiner (In prep.) indicated that several large brown trout were observed spawning in the Ricinus reach during the second survey run on October 14 (Rodtka and Gardiner In prep.). Therefore, greater numbers of brown trout may have been concentrated within the Ricinus reach when the survey was completed (October 7 and 14), consequently biasing catch results. Although specific studies have not been completed to assess the spawning use of brown trout in the Corkscrew or Elk Creek reaches, there has not been any incidental data collected during previous surveys to indicate that these reaches are used heavily by brown trout for these reasons. In addition, Rodtka and Gardiner (2004) did not observe any spawning activity within these reaches in 2004, although their surveys were completed within typical brown trout spawning periods (Nelson and Paetz, 1992).

Population estimates have been completed in 2004, 1987 and 1977 on the Ricinus reach. Considerably higher densities of brown trout were found in both 2004

and 1977. In 1987 and in 1977, population estimates were completed in the spring season (Mar. 31 to Apr. 5) and in 2004 they were done in the fall (Oct. 7-14). Mentioned previously, there is evidence to suggest that in 2004 the results may have been biased due to the timing of the survey. That is, brown trout estimates may have been higher in 2004 than they would have been if they had been conducted in the spring similar to both 1987 and 1977. The lower population levels detected in 1987 in the Ricinus reach may be simply explained by natural population fluctuations (Shaw 1985). If not, the cause for reduced numbers in 1987 are unknown to the author. Personal communication with Rocklyn Konynenbelt (May, 2005), a fisheries technician of ASRD who participated in the electrofishing that was completed in both 2004 and 1987, suggested that reduced numbers in 1987 were not due to electrofishing inefficiencies.

Population estimates were only conducted in 2004 and 1977 in the Corkscrew reach. In 1977, slightly higher densities were found compared to 2004 at 63.13 and 47.57 brown trout per kilometre, respectively. Again, in 2004, results may have been biased due to the time of year that the survey was completed. Mentioned earlier, the Corkscrew reach has never been formally documented for brown trout spawning. On the contrary, Allan *et al.* (1995) documented several spawning locations downstream of the Corkscrew reach and Rhude and Rhem (1995) documented evidence of brown trout spawning upstream of the Corkscrew reach in the areas known locally as the 152 - spring complex. Therefore, it is possible that in 2004 brown trout numbers were biased low, due to the fact that many adult brown trout may have been concentrated in other areas of the drainage for spawning purposes. That said, it does not appear that there has been a great changed in brown trout population levels since 1977 in the Corkscrew reach.

Overall, it appears that brown trout densities in the Clearwater River are remaining stable and can be considered relatively healthy, although data are limited. Data were available for historical population estimate comparisons in both the Corkscrew and Ricinus reaches. These comparisons suggest that the 2004 brown trout population levels are very similar to those found in 1977 and higher than those found in 1987. Unfortunately, the population results obtained in the Elk Creek reach in 2004 represent the first occasion that a brown trout population estimate has been completed there, so time series population analysis are unavailable.

It is interesting that brown trout densities are remaining high considering that ASRD has not stocked the mainstem Clearwater River since 1984 and that stocking in general within the drainage has been reduced greatly from historic levels. This may suggest that brown trout in the Clearwater River are well established and that natural recruitment is now maintaining this population. Similar results were documented by Carline *et al.* (1991), who describe an increase in brown trout numbers seven years after the abandonment stocking and the implementation of zero harvest. Although the brown trout regulations in the Clearwater River drainage are not catch and release harvest is likely limited by the seasonal closures and bait bans that are in place.

When evaluating the current population status of brown trout in the Clearwater River, comparisons to other Alberta Rivers are necessary. The physical characteristics of the Little Red Deer River are quite similar to the Clearwater River in its length and total drainage size at 202.5 km and 2356 km^2 (Weilizcko and McLeod, 2001), respectively. Wieliczko and McLeod (2001) derived an estimate of 75.5 brown trout per kilometre on the Little Red Deer River in 1998 though those results were derived from the river section known to have the highest concentrations of brown trout, where access allowed. Therefore, the section on the Little Red Deer River would be most comparable to the Ricinus reach on the Clearwater River and the estimate there was 144.3 brown trout per kilometre. This would then indicates that in 2004 brown trout densities were much higher in the Clearwater River than those found on the Little Red Deer River in 1998. In addition, Buchwald (1992) reported 62 brown trout per kilometre on the Red Deer River in 1990, which is largely considered one of Alberta's best brown trout fisheries, and this is less than half the estimate result in the Ricinus reach (Rodtka and Gardiner, In prep.). The fact that the estimate on the Clearwater River –Ricinus reach was higher than those found on both the Little Red Deer and the Red Deer, indicates that the Clearwater River brown trout population is relatively healthy. Of interest, ASRD fisheries files in Cochrane indicate brown trout densities of as high as 505.8 brown trout per kilometre on the Bow River, much higher than those found in the Clearwater River. It is however important to note that although the Bow River, which is largely considered Alberta's best brown trout fishery, is influenced from nutrient enhancement by the City of Calgary.

5.2 Current and Historic Size Class Comparisons

When looking at the sizes of all brown trout that were captured in the Clearwater River in 2004, some interesting results were found. Overall, the fork length frequency data suggests that a relatively healthy brown trout population is present in the Clearwater River. That is, the brown trout that were collected ranged in size between 76 – 620 mm and at 25 mm size-class delineations no size classes were absent between the 76-100 mm and 551 - 575 mm size classes. Therefore, it is assumed that all life stages of brown trout were captured. This also suggests that no age classes are missing in this data set, further suggesting that the Clearwater River brown trout population can be considered healthy.

Overall, the fork length distribution of brown trout captured in the Clearwater River in 2004 was relatively uniform but there were some distinct differences in representations within individual size classes (Figure 5). The dominant size classes were between 376 – 450 mm with the most represented size class being between 376 – 450 mm. Scott and Crossman (1973) indicate that a brown trout >427 mm is likely at least 4 years old, this suggests that many brown trout in the Clearwater River are living long enough to reach sexual maturity. Higher concentrations of brown trout were also collected within the 201 – 300 mm size classes. There was a notable reduction in the number of brown trout captured between 326 – 375 mm. According to Scott and Crossman (1973), this would suggest an abundance of two-year old fish but a reduction in three year olds.

Mean Fork Length Comparisons

A highly significant increase in mean fork length was observed in 2004 when tested against 1977 data in both the Ricinus and Corkscrew reaches. Specifically, Brown trout mean fork length in the Ricinus reach in 1977 was 221.4 mm and in 2004 it was 329.2 mm. In the Corkscrew reach the mean fork length of brown trout captured was 180.9 in 1977 and 286.2 in 2004. Again, since the surveys were completed in 2004 at or near typical brown trout spawning periods, the Ricinus reach mean fork length may have been biased high and the Corkscrew mean may have been biased low. In any case when reviewing the fork length bar charts (Figures 6 and 7) it is apparent that brown trout size is increasing in both the Ricinus and Corkscrew reaches. One possible explanation is that in 1987 an angling with bait restriction was put into place on flowing waters in the Rocky Mountain House area. This has likely reduced brown trout harvest and allowed them to reach greater sizes.

5.3 Brown Trout Distribution and Population Densities in the Clearwater River Drainage

A high density of brown trout was observed in Cutoff Creek, despite the fact that it has never been stocked. A review of ASRD's historic stocking records has suggested that Cutoff Creek has never been stocked with brown trout, although, at least 1.35 million brown trout have been stocked into the Clearwater River drainage. However, within the Clearwater River drainage, with the stream-coding scheme used for this project, Cutoff Creek is one of only two creeks that were coded as high density. This suggests that Cutoff Creek must contain appropriate habitat to support a brown trout population as it was obviously colonized by fish that were stocked in other areas of the drainage. This may further suggest that brown trout stocking in other areas of the Clearwater drainage such as in the Tay River is augmenting the Cutoff Creek brown trout population. Rodtka and Gardiner (In prep.) reported that in 2004 Cutoff Creek was a major spawning area for bull trout. Although primary literature on the competition between brown trout and bull trout is not available, Waters (1983), over a fifteen-year period, documented the near total replacement of brown over brook trout. This occurred in a stream that had formerly been inhabited solely by brook trout. Brook trout themselves are considered a detriment to bull trout populations through competition (Berry, 1994). Continued stocking can only lead to increased competition between bull trout and brown trout in Cutoff Creek. Since Cutoff Creek is a major spawning area for bull trout (Rodtka and Gardiner In prep.), a species of concern in Alberta (Berry 1994), perhaps the stocking of brown trout in the Clearwater River drainage should be reviewed.

A review of historic stocking records and the population density results derived in this project for the Tay River have revealed some interesting findings. Between 1956 and 2001, approximately 44,138 brown trout were stocked into the Tay River. In addition, the Tay River is one of only two streams that are still being stocked with brown trout. Despite the priority by ASRD of continually stocking the Tay River, from the 28 sites that have been completed in the drainage, which include 21 on the mainstem, the majority of the drainage did not have the presence of brown trout formally documented. In fact, there has only been one brown trout formally documented in the drainage within the past eight years and this site was completed in the lower reaches of the mainstem Tay River. Here brown trout population levels are more likely to be influenced by brown trout migrating upstream from the Clearwater River.

In the Tay River drainage, fish inventory sites that have been completed through the CFIP were conducted where access allowed and stream flow conditions were favourable for backpack electrofishing (Gardiner and McLeod 2000). Survey sites completed within the Upper Clearwater River Bull Trout Study (Rodtka and Gardiner, In prep.) were selected completely at random. Terra Environmental Consultants Ltd., completed several sites in the drainage. These were done on the mainstem Tay River at locations where a petroleum company had proposed to cross the river with a pipeline. Between these diversified methods of selecting individual survey locations, good sampling coverage of the drainage were achieved. Although brown trout stocking efforts have been concentrated in beaver ponds (Steve Herman pers. com), the intensity and diversity of the surveys that have been completed does strongly suggest that quality brown trout populations are not present in the Tay River drainage.

Historically, brown trout densities in the Tay River sub-basin were much higher. Specifically, Rhude (1987) reported a large catch of brown trout in an electrofishing effort conducted at the highway 54 crossing in 1987. In this study, 110 brown trout were collected in 500 metres of electrofishing on the Tay River and Rhude (1987) indicated that approximately five age classes were encountered. However, Rhude (1987) also indicated that catch results were likely augmented by brown trout stocking efforts that were in place then.

This again brings into question the validity of brown trout stocking. There is abundant evidence that the Tay River may not be providing a quality brown trout fishery for anglers. Perhaps in order to maintain the type of brown trout fishery that was reported by Rhude (1987) a more intensive stocking program may need to be considered. However, this may contradict the bull trout management and recovery goals in place for the province (Berry 1994). Perhaps abandoning brown trout stocking in the drainage should be considered instead. That is, brown trout stocking in the Tay River drainage might only be serving to augment brown trout numbers in important bull trout habitats such as the spawning areas located in Cutoff Creek, rather than providing a quality fishery where intended.

When looking at the Clearwater River drainage, it appears that Elk Creek is the sub-basin with the healthiest brown trout populations. The greater length of the mainstem was coded as having either a high or medium density of brown trout.

In Gardiner *et al.* (2002) the habitat was described as favorable for sport fish in these areas due to abundant beaver activity, deep pools and cover. Brown trout are known to prefer deep pools and heavy cover (Klemetsen *et al.*, 2003, Elso and Giller, 2001), which is consistent with the habitat characteristics described in Gardiner *et al.* (2002). The very upper reaches of mainstem Elk Creek and several tributary streams in the lower and middle sections were coded as no brown trout captured. Habitat descriptions in these areas in Gardiner *et al.* (2002) were described as having a low fisheries potential rating. This was due to the fact that many of these streams drained bogs and had indiscernible flows and channels. The general increase in brown trout numbers in lower reaches is similar to the results found by Rahel and Nibbelink (1999). A possible explanation for this is that the habitat is more favorable for brown trout in the lower sections or that brown trout were more abundant in the lower section due to its close proximity to the Clearwater River mainstem.

In the middle and lower sections Gardiner *et al.* (2002) also described the habitat in tributary stream to mainstem Elk Creek as limited for use by sport fish. In these areas brown trout densities were all rated as no brown trout captured. Brown trout stocking has not occurred in Elk Creek since 1987 and in 1998 the entire Elk Creek drainage went to catch-and-release. Carline *et al.* (1991) describes an increase of 165% in the number of age one or older brown trout and an increase of 100% of the biomass of brown trout seven years after going to a catch and release fishery and the suspension of stocking in Spring Creek. Therefore, the favorable brown trout habitat and catch-and-release regulations are two possible explanations to the healthy brown trout populations found in the Elk Creek drainage.

Although Rodtka and Gardiner (In prep) did not find any evidence of bull trout spawning in Elk Creek, historically Elk Creek is a known spawning tributary (Rhude and Rhem 1995; Allan 1980). Therefore, high-density brown trout populations might impact bull trout recovery in Elk Creek. Brown trout competition with bull trout is generally considered a limitation for bull trout population growth (Berry 1994 ; Rhude and Stelfox 1997). Therefore, whether or not a healthy exotic brown trout population in Elk Creek that may out -compete native bull trout hampering their recovery in the Eastern Slopes is desirable or not is a question that fisheries managers from ASRD should consider.

The majority of the Clearwater River drainage was coded as having no electrofishing surveys completed. This speaks to a general lack of electrofishing surveys being completed within the drainage a consistent trend in Alberta. Brown trout populations were not detected in any tributaries to the Clearwater River within the upper Clearwater FLUZ. The average water temperatures found in tributaries within the FLUZ was 5.2 °C (Rodtka and Gardiner, In prep). Klemetsen *et al* (2003) listed the lower critical range for brown trout growth at between 3 – 6 °C. Therefore, cool water temperatures may explain a lack of brown trout documented in this area. Although brown trout were not documented in any backpack electrofishing surveys conducted within the last eight years within FLUZ, brown trout were documented in 1992 and 1993 (Rhude and Rhem, 1995) within the area described as 152 - spring complex. These were adult brown trout that were captured in fish migration traps in the late fall. It is possible that those fish had migrated 152 - spring complex for spawning purposes.

No brown trout were collected in Seven Mile Creek. McLeod and Gardiner (1999) describe migration barriers in the form of beaver dams and low flows and an actual lack of water as limiting factors for salmonids there. Within the CFIP, five fish inventory surveys were conducted within the Seven Mile Creek drainage. From these no fish of any species were captured. Consistent with the results found in CFIP, a review of ASRD Fisheries Files has revealed that no fish has ever been formally documented in Seven Mile Creek drainage.

Summary and Recommendations

From this project, the author has two recommendations in regards to brown trout in the Clearwater River drainage. The first recommendation is to discontinue the stocking of brown trout within the drainage. Stocking is already greatly reduced from historic levels and the brown trout population levels observed in 2004 are comparable to the levels found in 1977. Comparing the Clearwater River to the Bow River, Little Red Deer River and the Red Deer River, suggest that the Clearwater River brown trout population levels are quite healthy provincially. Currently, within the study area, stocking is only still being done on the Tay River and only on a five-year rotation (Steve Herman pers. Com.). Despite this, from 28 electrofishing surveys completed within that sub-basin in the past eight years, only one brown trout has been collected. The author suggests that stocking brown trout in the Tay River may only be serving

to augment brown trout population levels in other areas of the Clearwater River drainage and in some cases streams that bull trout use for spawning. Specifically, Cutoff Creek has been documented as a major bull trout spawning stream (Rodtka and Gardiner, In prep.) and was also documented as having high-density brown trout population, despite having never been stocked with brown trout. Sections of Elk Creek were found to have a high-density brown trout population and have historically been used by bull trout for spawning purposes. Due to the fact that a catch and release regulation is in place their, it is likely that this healthy brown trout population can be maintained in Elk Creek without stocking, if this is desired by fisheries managers from ASRD.

A second and final recommendation is that future research be directed at the analysis of competition between exotic brown trout and native bull trout. The objective of this research could be to determine if established exotic brown trout populations are inhibiting bull trout population growth. The author was unable to find any primary literature on this topic; however, literature was found that indicated that brown trout out compete other trout including brook trout, which is a char species the same as bull trout. Brook trout themselves are considered a detriment to bull trout populations, as many fish biologists believe that juvenile brook trout themselves may out compete juvenile bull trout. Rodtka and Gardiner (In prep) observed a moderate increase in bull trout numbers in the Clearwater River in 2004 from historic levels. This serves to further cloud the question of what affect a healthy brown trout populations are having on bull trout recovery in the Clearwater River drainage. If brown trout are found to be a detriment to bull trout populations than this would add weight to the suggestion of discontinuing brown trout stocking in the Clearwater River drainage and may also suggest that more liberal brown trout harvest regulations may be needed. That is, if recovery of bull trout in the Clearwater Rivet drainage is the top priority.

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