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Report 1.2.2: Long-term Changes in Relative Abundance of Rainbow Trout at Selected Sites within the Foothills Model Forest

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Abstract

Relative abundance of Rainbow Trout was selected as an indicator of the status of aquatic resources within the Foothills Model Forest. This indicator was measured annually between 1996 and 2001 at seven sites. Four of these sites were located within the Tri-Creeks experimental basin, including Upper and Lower Wampus Creek and Upper and Lower Deerlick Creek.

At the Tri-Creeks sites, historic relative abundance data between 1970 and 1985 was obtained through Alberta Sustainable Resource Development. For trend analyses, data from each Tri-Creeks site was grouped into before or after 1985. Based on a comparison of mean relative abundance between the two groups, a significant decrease in relative abundance was detected at the Lower Wampus Creek site. This decline could not be explained by the habitat changes or land-use activities. Other factors that could be investigated include beaver activity, illegal angling, or additional habitat attributes.

A visual analysis of trends was completed at the remaining three sites where data was collected between 1996 and 2001. These sites included Anderson Creek, Antler Creek, and Mary-Gregg Creek. The major decline in abundance at the Anderson Creek site may be related to a number of factors including beaver activity or potential partial fish migration barriers at road-stream crossings. The rate of decline in relative abundance of Rainbow Trout at the Anderson Creek site warrants more detailed assessments of these factors.

The Foothills Model Forest is supportive of a review of the hypotheses, field methods, and analyses associated with the long-term monitoring of stream-dwelling fish species. Specific issues worth addressing include electrofishing standardization and incorporation of a habitat component.

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1 Introduction

Due to its native fish status, wide distribution, high abundance and high vulnerability to both habitat degradation and angling, Rainbow Trout (*Onchorynchus mykiss*) was selected as an indicator species for this evaluation of long-term changes in abundance. On the east side of the Rocky Mountains, Rainbow Trout were likely only native within the Peace and Athabasca drainages (Scott and Crossman 1973). Stocking efforts that have introduced various other Rainbow Trout strains in the area have made it difficult to distinguish the Athabasca strain from other strains (R.L.&L. 1996). Nonetheless, in a study of 15 Foothills Model Forest (FMF) watersheds, Rainbow Trout were present in all basins and the most abundant species in each watershed (McCleary et al. 2002). It is within these smaller basins, which have a limited capacity to assimilate impacts, that Rainbow Trout are the most sensitive to environmental degradation such as changes in flow, water quality and cover (Ford et al. 1995). In addition, Rainbow Trout are one of the top five species sought by anglers in North America (Scott and Crossman 1973), and as a result are vulnerable to over-harvest. Due to these factors, and an abundance of historic information from the Tri-Creeks study (Sterling 1973 and 1990), Rainbow Trout relative abundance was selected as an indicator of the status of the aquatic resources within the FMF.

This study on long-term changes in fish populations was linked to a larger effort to assess the sustainability of forest management activities using a framework established by the Canadian Council of Forest Ministers. This larger effort, titled Local Level Indicators for Sustainable Forest Management, was intended to guide measurement of the results of human activity in the forest (FMF 2002). The project was completed through a collaborative approach between a number of agencies including: Alberta Sustainable Resource Development, Canadian Forest Service, Foothills Model Forest, Parks Canada, Talisman Energy Inc., Weldwood of Canada Ltd. (Hinton Division), as well as private consultants.

The Canadian Council of Forest Ministers developed a number of criteria for sustainable forest management including: conservation of biological diversity and ecosystem attributes, social and economic benefits as well as components of the forest policy framework. The Foothills Model Forest developed a set of indicators for each criteria including 11 indicators to assess the conservation of biological diversity. The relative abundance of native Athabasca

Rainbow Trout at selected sites provided specific information on fish population status. Therefore, some of the results from this study were presented in the initial status report on local level indicators (FMF 2002).

2 Methods

2.1 Historic Data

Historic population estimate data for the Tri-Creeks watershed, which is comprised of Wampus, Deerlick, and Eunice Creeks, was obtained from the Edson office of Alberta Sustainable Resource Development. Although Eunice Creek was also part of the Tri-Creeks study, those sites were part of ongoing research projects by the University of Calgary and population estimate data for all years since 1996 was not provided at the time of production of this report or the development of the initial status report on local level indicators.

2.2 Field Methods

In 1996, three population estimate sites were added to the four historic sites within the Tri-Creeks watershed. The Tri-Creeks sites included Upper and Lower Wampus Creek and Upper and Lower Deerlick Creek. The three additional sites were located in Antler Creek and Mary-Gregg Creek near their confluences with the McLeod River, and in Anderson Creek at a more central location within the watershed (Figure 1).

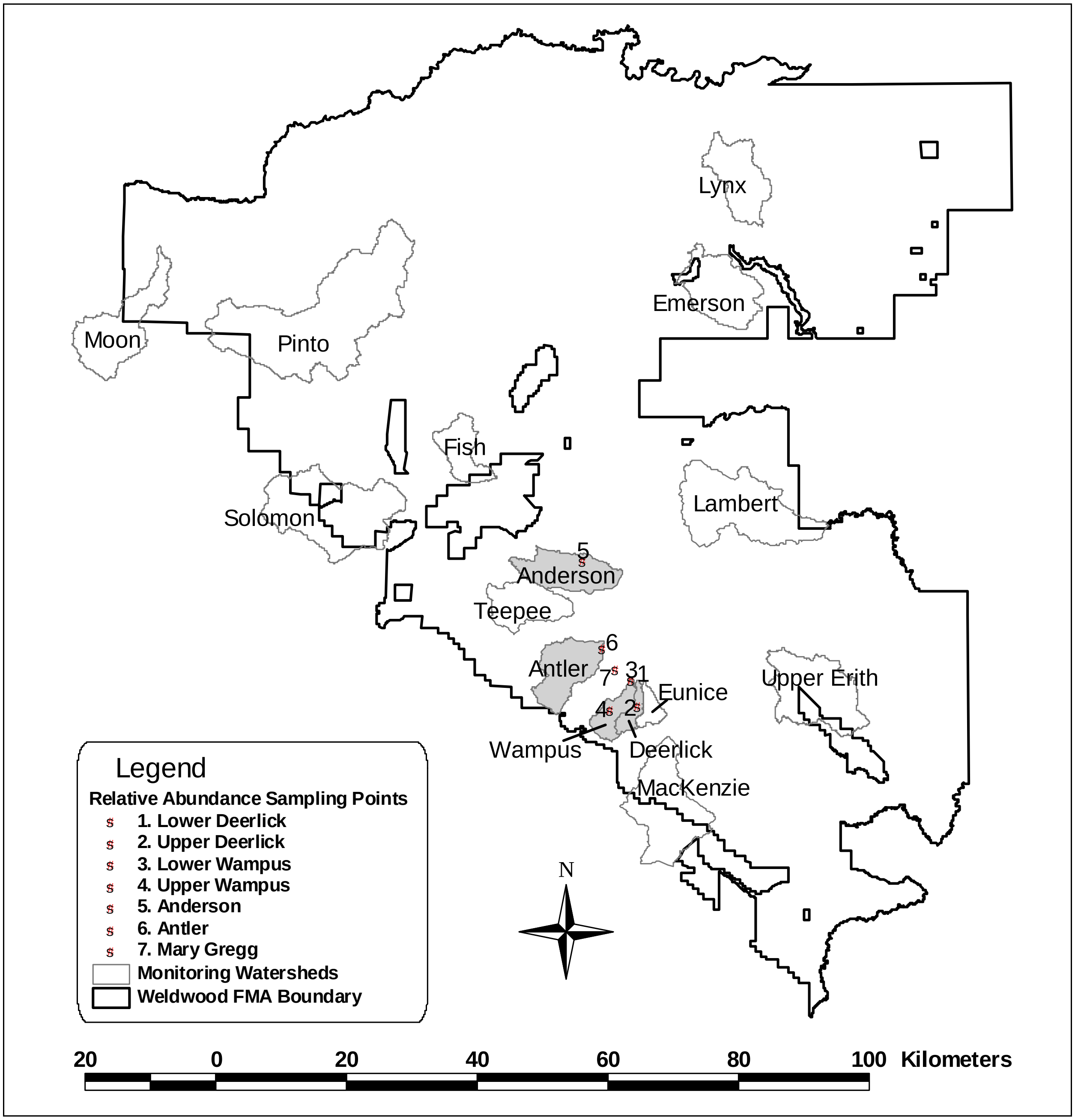

Figure 1. Monitoring watersheds and relative abundance sampling points within the Foothills Model Forest

Population estimates were completed by the FMF at each of these sites on an annual basis between 1996 and 2001. The results were previously reported (FMF 1996, FMF 1997, FMF 1998, FMF 1999, FMF 2000, and FMF 2001). The methods to complete the FMF population estimates were previously described in McCleary and Johnson 2000. The field methods to complete the historic Tri-Creeks population estimates were also previously described (Sterling

1978 and Sterling 1990). The methods used to calculate the population estimates varied between mark and recapture for historic surveys and removal-depletion for current FMF surveys.

2.3 Office Methods

All data was entered into Microsoft Access 2000 for management. To produce graphs, data were queried in Access and exported to Microsoft Excel.

2.4 Statistical Analysis of Differences Between Historic and Current Fish Abundance

The data were grouped into historic and current surveys based on the benchmark year of 1985 assigned in Report 2.1: Overview Assessment of Historic and Current Land-use Activities in Selected Foothills Model Forest Watersheds (Sherburne and McCleary 2002). All population estimates completed prior to the end of 1985 were included in Group 1 and all population estimates completed after 1985 were included in Group 2.

The null hypothesis that we tested for each watershed was that there was no difference between mean historic relative abundance (Group 1) and mean current relative abundance (Group 2) at each individual location with 90 % confidence. We completed the test for differences based on two independent samples with population variances unknown, with a preliminary test to determine if population variances were different. If equal variances were indicated, sample variances were pooled. Data analysis was completed using SPSS 10.0 for Windows (SPSS 1999).

3 Results

3.1 Relative Abundance

3.1.1 Lower Deerlick Creek

In Lower Deerlick Creek during the historic period before the end of 1985, relative abundance of Rainbow Trout varied between 47 fish/0.1 ha in 1982 and 254 fish/0.1 ha in 1984. Since 1985, relative abundance ranged between 189 fish/0.1 ha in 1993 and 82 fish/0.1 ha in 2000 (Figure 2).

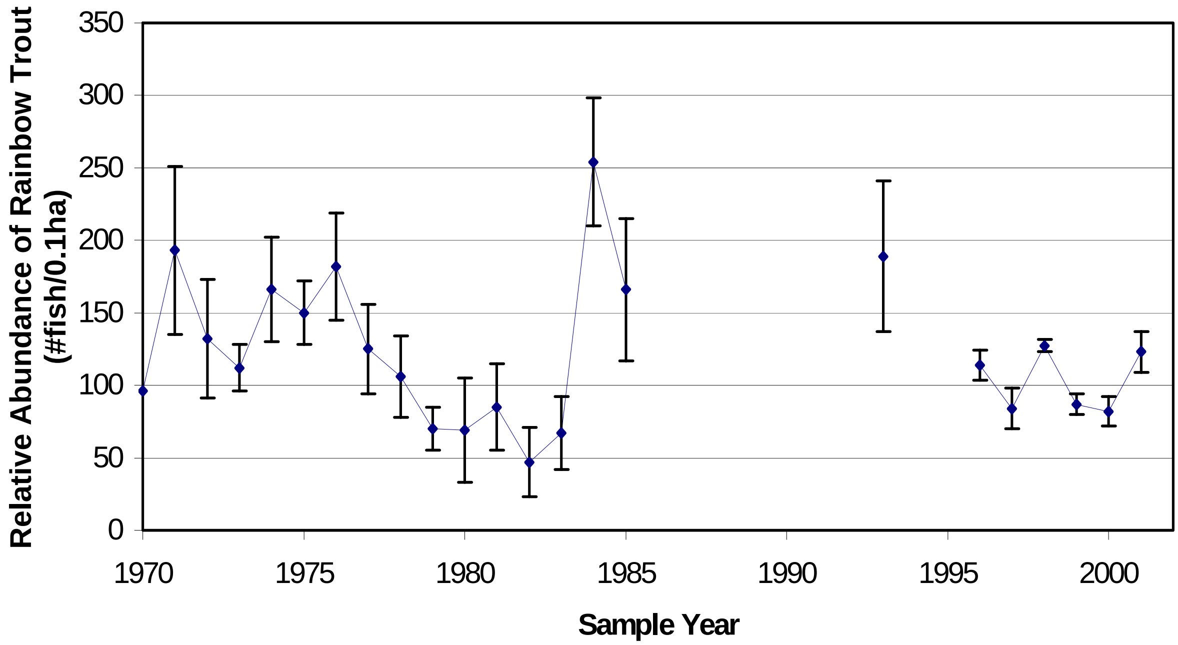

Figure 2. Relative abundance of Rainbow Trout at Location ID 418 in Lower Deerlick Creek between 1970 and 2001.

At the Lower Deerlick Creek site, the mean historic relative abundance was not different from the mean current relative abundance at the 90 % confidence interval (Table 1).

Table 1. Summary statistics for relative abundance of historic and current surveys at Lower Deerlick Creek.

Group	Mean Relative Abundance (# fish / 0.1 ha)	Standard Deviation	Variances Equal (yes/no)	t - value	P – value *
Historic	126.25	56.04	yes	.474	.641
Current	115.20	37.70			

* Indicates a significant difference in mean relative abundance between historic and current survey with 90 % confidence.

3.1.2 Upper Deerlick Creek

In Upper Deerlick Creek during the historic period before the end of 1985, relative abundance of Rainbow Trout varied between 14 fish/0.1 ha in 1981 and 204 fish/0.1 ha in 1971. Since 1985, relative abundance ranged between 234 fish/0.1 ha in 1998 and 114 fish/0.1 ha in 2000 (Figure 3).

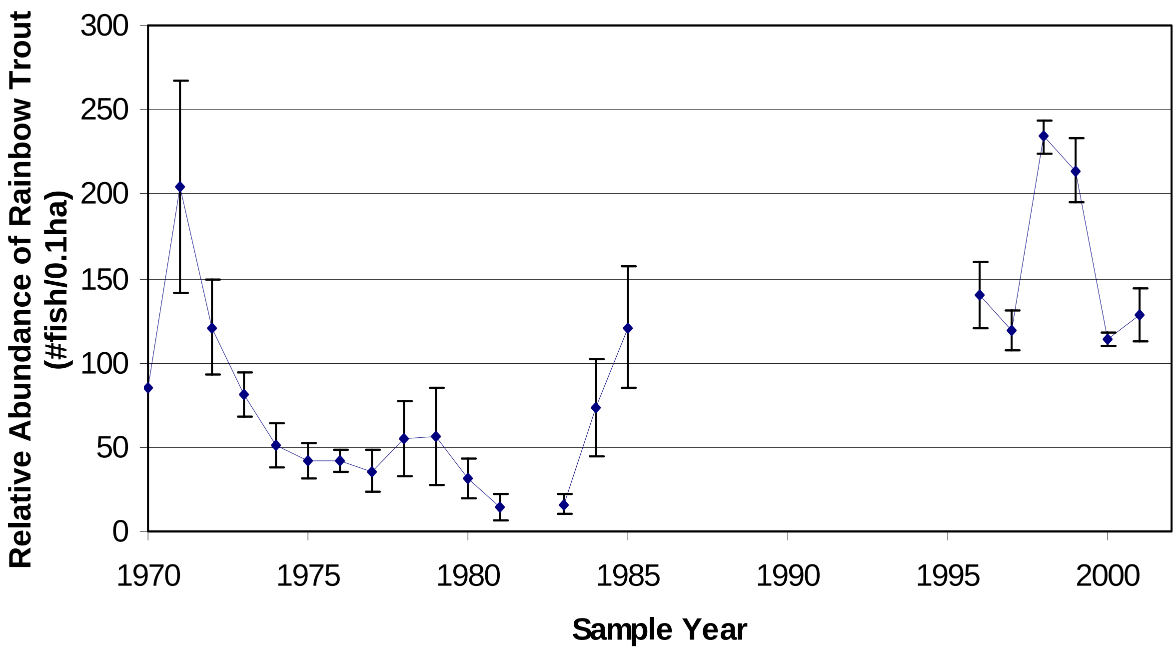

Figure 3. Relative abundance of Rainbow Trout at Location ID 413 in Upper Deerlick Creek between 1970 and 2001.

At the Upper Deerlick Creek site, the mean historic relative abundance was different from the mean current relative abundance at the 90 % confidence interval (Table 2).

Table 2. Summary statistics for relative abundance of historic and current surveys at Upper Deerlick Creek.

Group	Mean Relative Abundance (# fish / 0.1 ha)	Standard Deviation	Variances Equal (yes/no)	t - value	P – value *
Historic	68.53	49.68	yes	-3.689	.002
Current	158.20	52.08			

* Indicates a significant difference in mean relative abundance between historic and current survey with 90 % confidence.

3.1.3 Lower Wampus Creek

In Lower Wampus Creek during the historic period before the end of 1985, relative abundance of Rainbow Trout varied between 56 fish/0.1 ha in 1970 and 417 fish/0.1 ha in 1985. Since 1985, relative abundance ranged between 44 fish/0.1 ha in 1998 and 85 fish/0.1 ha in 1996 (Figure 4).

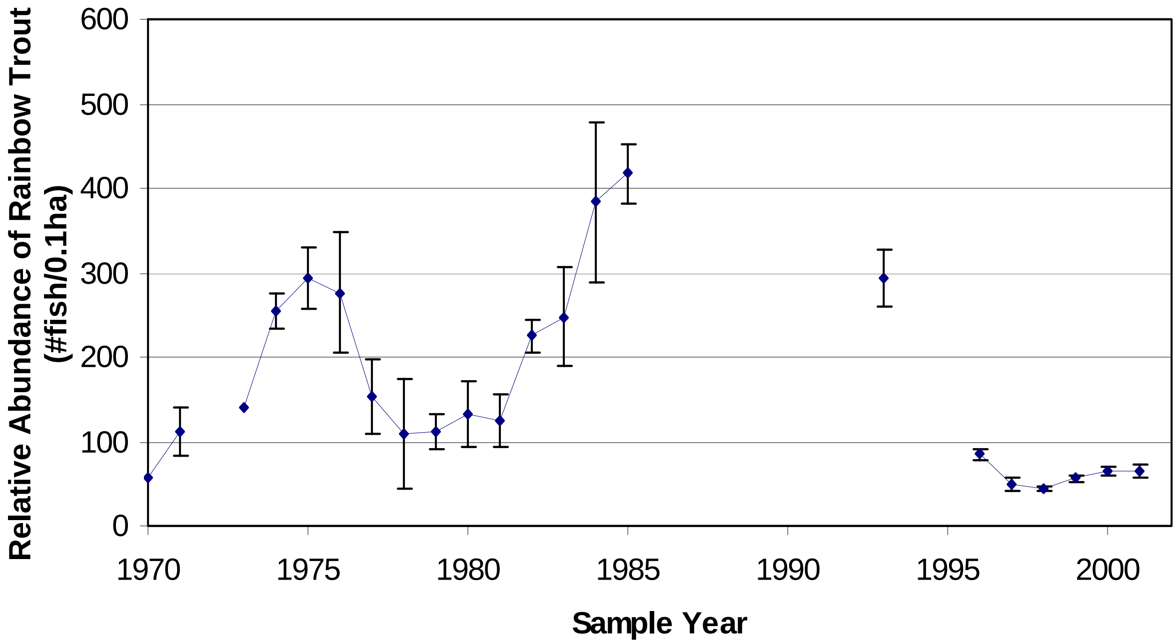

Figure 4. Relative abundance of Rainbow Trout at Location ID 401 in Lower Wampus Creek between 1970 and 2001.

At the Lower Wampus Creek site, the mean historic relative abundance was different from the mean current relative abundance at the 90 % confidence interval (Table 3).

Table 3. Summary statistics for relative abundance of historic and current surveys at Lower Wampus Creek.

Group	Mean Relative Abundance (# fish / 0.1 ha)	Standard Deviation	Variances Equal (yes/no)	t - value	P – value *
Historic	202.60	107.44	yes	2.309	.032
Current	94.61	88.65			

* Indicates a significant difference in mean relative abundance between historic and current survey with 90 % confidence.

3.1.4 Upper Wampus Creek

In Upper Wampus Creek during the historic period before the end of 1985, relative abundance of Rainbow Trout varied between 20 fish/0.1 ha in 1983 and 642 fish/0.1 ha in 1975. Since 1985, relative abundance ranged between 200 fish/0.1 ha in 1998 and 398 fish/0.1 ha in 2001 (Figure 5).

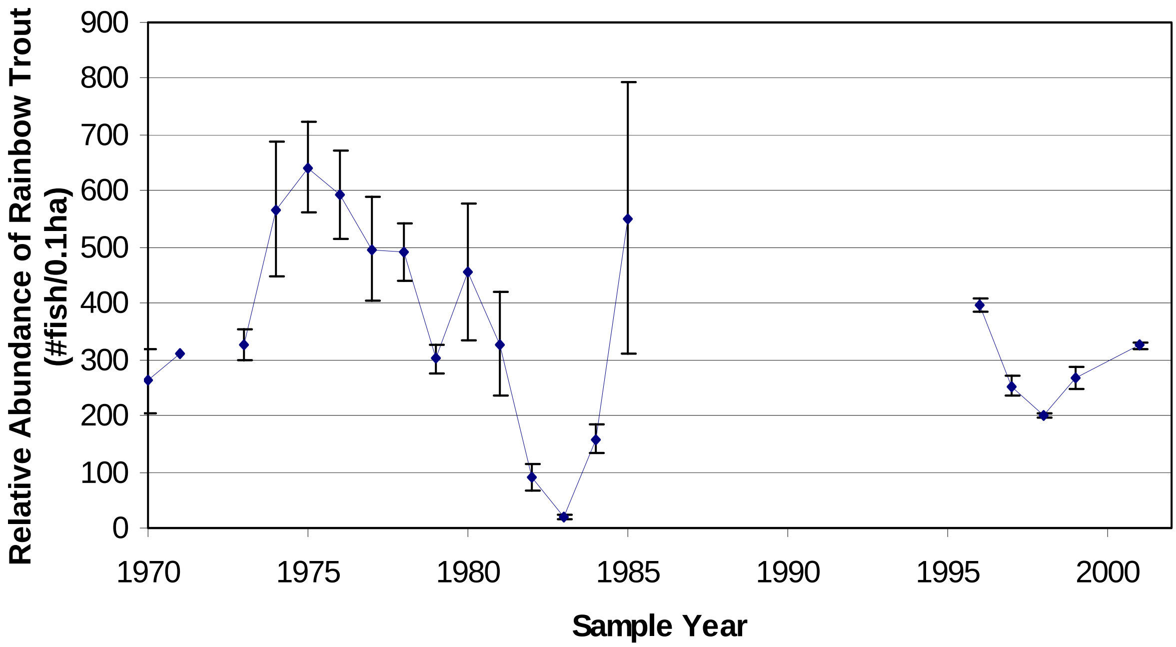

Figure 5. Relative abundance of Rainbow Trout at Location ID 350 in Upper Wampus Creek between 1970 and 2001.

At the Upper Wampus Creek site, the mean historic relative abundance was not different from the mean current relative abundance at the 90 % confidence interval (Table 4).

Table 4. Summary statistics for relative abundance of historic and current surveys at Upper Wampus Creek.

Group	Mean Relative Abundance (# fish / 0.1 ha)	Standard Deviation	Variances Equal (yes/no)	t - value	P – value *
Historic	372.87	189.51	no	1.482	.157
Current	283.11	79.82			

* Indicates a significant difference in mean relative abundance between historic and current survey with 90 % confidence.

3.1.5 Anderson Creek

In Anderson Creek, relative abundance of Rainbow Trout dropped from 142 fish/0.1 ha in 1996 to 65 fish/0.1 ha in 1997. By the end of 2000, relative abundance of Rainbow Trout was at a record low of 5 fish/0.1 ha (Figure 6). No significant recovery of the population was observed in 2001.

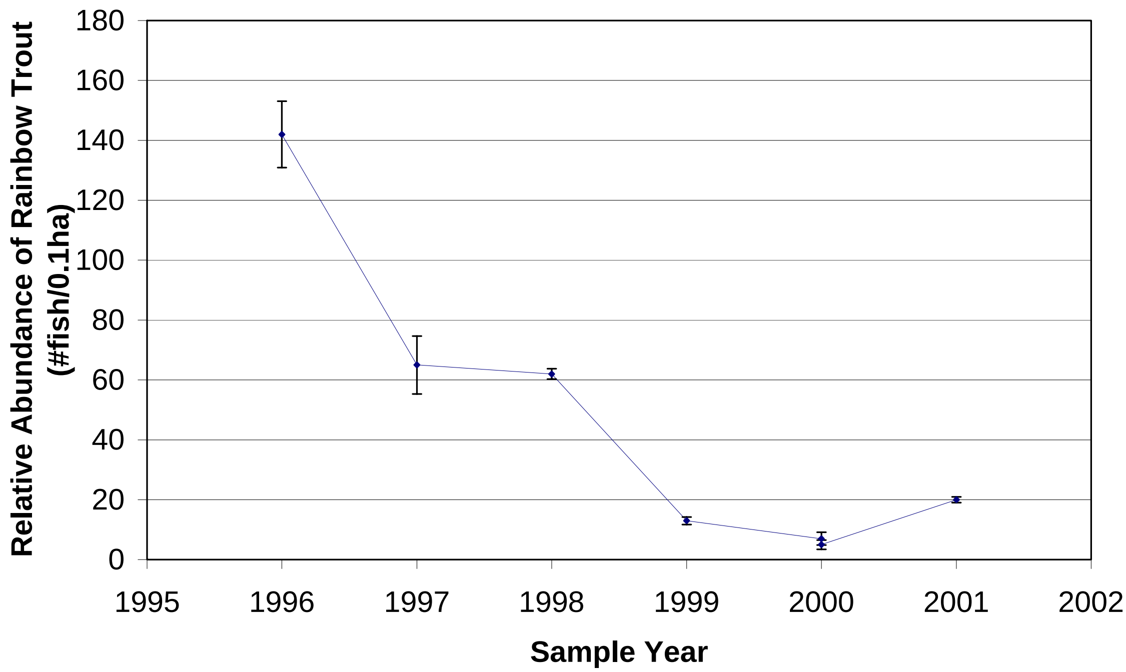

Figure 6. Relative abundance (+/- 95% Confidence interval) of Rainbow Trout at Location ID 304 in Anderson Creek between 1996 and 2001.

3.1.6 Antler Creek

At the Antler Creek site, Rainbow Trout abundance was highly variable over the six year period between 1996 and 2001. The greatest change occurred between 1996 and 1997 when relative abundance of Rainbow Trout dropped to 14 fish/0.1 ha from 45 fish/0.1 ha (Figure 7).

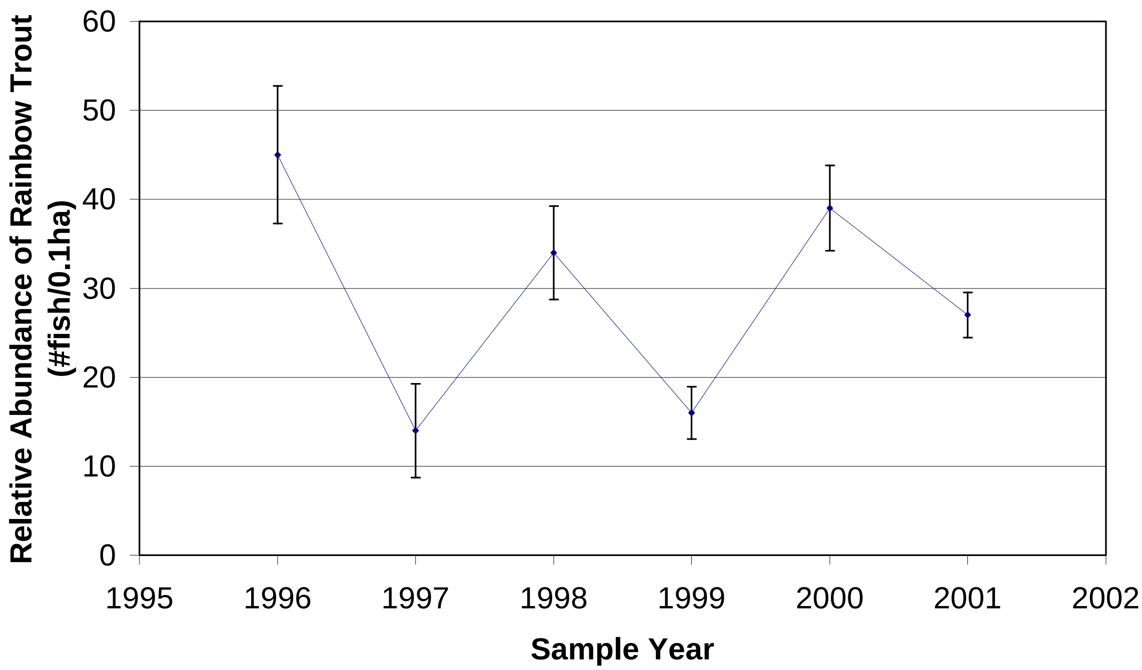

Figure 7. Relative abundance (+/- 95% Confidence interval) of Rainbow Trout at Location ID 336 in Antler Creek between 1996 and 2001.

3.1.7 Mary-Gregg Creek

At the Mary-Gregg Creek site, most annual changes remained well within the 95 % confidence interval from the previous year's estimate (Figure 8).

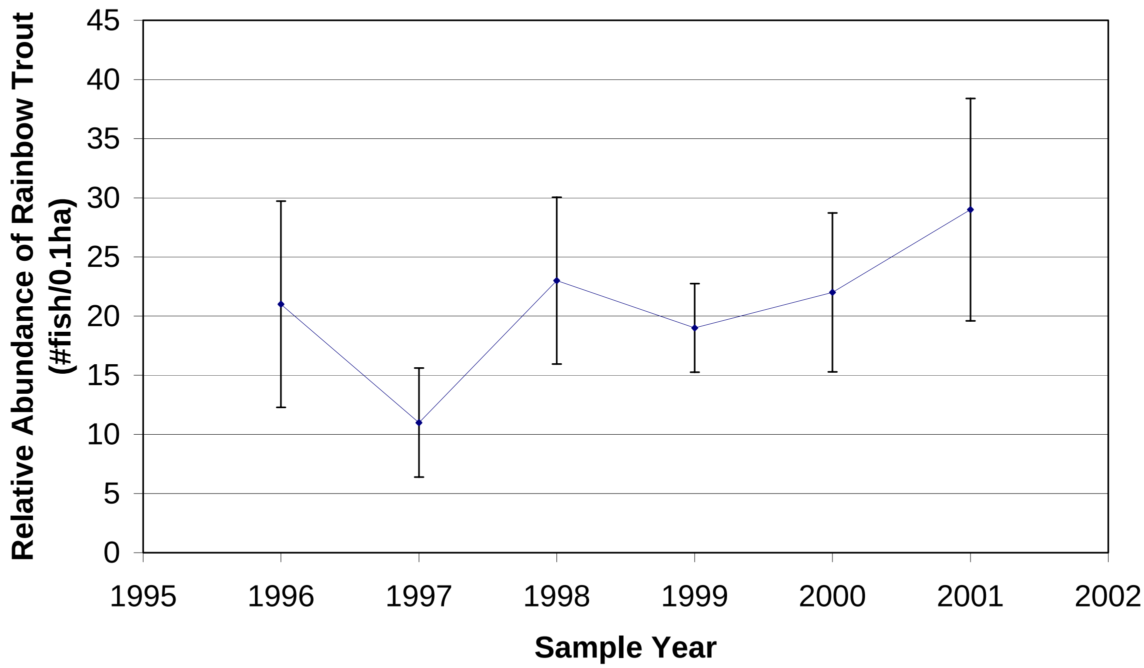

Figure 8. Relative abundance (+/- 95% Confidence interval) of Rainbow Trout at Location ID 363 in Mary-Gregg Creek between 1996 and 2001.

4 Discussion

4.1 Relationships Between Fish Abundance, Habitat Features, and Land-use at Four Sites within the Tri-Creeks Experimental Basin

In the Tri-Creeks Experimental Basin, changes in relative abundance of Rainbow Trout were apparent at two sites. At Lower Wampus Creek, the decrease in abundance could not be explained by habitat or land-use activities (Table 5). Other factors such as illegal angling, associated with a well-used random campsite adjacent to the fish sampling area, and beaver activity downstream of the site could be investigated further. Additional detailed channel morphological studies, as discussed in the Level IV Channel Classification report (McCleary 2003), could also be considered.

Table 5. Summary of changes in relative abundance, habitat information, and land-use in Wampus and Deerlick Creek watersheds.

<table>
<tr><th rowspan="2">Watershed</th><th rowspan="2">Significant change in relative abundance of RNTR [1]</th><th colspan="3">Level IV Habitat Information</th><th colspan="3">Harvest Information [2]</th><th colspan="3">Index of Road Density [3]</th></tr>
<tr><th>Significant change in mean pool spacing</th><th>Significant change in mean pool depth</th><th>Significant change in mean undercut bank</th><th>Historic % Harvested</th><th>Current % Harvested</th><th>Change</th><th>Historic</th><th>Current</th><th>Change</th></tr>
<tr><td>Upper Wampus Creek</td><td>No</td><td>No</td><td>No</td><td>No</td><td rowspan="2">high</td><td rowspan="2">high</td><td rowspan="2">low</td><td rowspan="2">high</td><td rowspan="2">low</td><td rowspan="2">med</td></tr>
<tr><td>Lower Wampus Creek</td><td>Yes (-)</td><td>No</td><td>Yes (+)</td><td>No</td></tr>
<tr><td>Upper Deerlick Creek [4]</td><td>Yes (+)</td><td>No</td><td>No</td><td>No</td><td rowspan="2">high</td><td rowspan="2">high</td><td rowspan="2">low</td><td rowspan="2">med</td><td rowspan="2">low</td><td rowspan="2">low</td></tr>
<tr><td>Lower Deerlick Creek</td><td>No</td><td>No</td><td>No</td><td>Yes (-)</td></tr>
</table>

[1] RNTR = Rainbow Trout; Significance is at 90% confidence interval
[2] Harvest Information: < 10% = low, 10-30% = medium, > 30% = high (Sherburne and McCleary 2003)
[3] Index of Road Density: ≤ 0.2 = low, 0.3-0.4 = medium, ≥ 0.5 = high (Sherburne and McCleary 2003)
[4] Population surveys and habitat surveys are in different locations

Although an increase in relative abundance of Rainbow Trout was detected at Upper Deerlick Creek, comparisons with the Level IV habitat assessment cannot be made because of different site locations. The Upper Deerlick Creek fish sampling site, located upstream from the Level IV site, was only harvested to the stream edge on one bank, while the Level IV site was harvested to the edge on both banks. If there is a future desire to track the relationships between fish abundance and channel features at this site, the fish site could be relocated to correspond to the Level IV site.

A significant decrease in the mean length of undercut banks was detected at Lower Deerlick Creek. However, this loss of cover did not correspond to a change in fish population. In future decades, at the Deerlick Creek sites, the amount of instream cover provided by large woody debris will likely decrease as a result of two factors: first, the existing debris will degrade over time and, second, because the adjacent forest has been harvested, recruitment of new material will be limited to material transported from upstream areas. Therefore, although the loss of undercut banks did not correspond to a decrease in fish numbers, habitat degradation may continue and future changes may occur. Alternatively, habitat features including undercut banks may not be a limiting factor for fish abundance at the study site.

The monitoring of long-term fish abundance at the two Eunice Creek sites was not the responsibility of the Foothills Model Forest between 1996 and 2001. As a result, this data was not readily available for presentation in this report. With the absence of extensive natural or human disturbance in that watershed, it would be interesting to compare the Eunice Creek relative abundance trends with those from Deerlick Creek and Wampus Creek.

4.2 Relationships Between Fish Abundance, Angling Regulations, and Land-use at Three Additional Sites

A decreasing trend in Rainbow Trout relative abundance was readily apparent at one of the three monitoring sites located outside of the Tri-Creeks Experimental Basin (Table 6). This change at the Anderson Creek site occurred despite the implementation of more restrictive angling regulations and a considerable time-lag since extensive harvest. There are two factors that could be related to the major decline in fish abundance at that site.

First, the site is located immediately downstream of a road crossing that has been rated as a potential partial barrier to fish migration (Wilson and McCleary 2003). However, this crossing has been in place for several decades and the decline has only occurred recently.

Second, the change could be related to the extensive recent beaver activity in the vicinity of the site. In June of 1974, three 1000 meter long sites were sampled with backpack electrofishing in Anderson Creek (Watters 1977). Although none of these sites correspond directly to the current permanent site, there is no mention of beaver activity in the results. In 2001, extensive beaver damming was observed immediately upstream of a 300 meter long site that originated at the confluence of Anderson Creek and the McLeod River (FMF 2001). This site corresponded to the lowest 1000 meter long site in the 1974 survey. In the winter of 2003, ten active beaver dams and numerous failed beaver dams were observed in the 4.2 kilometer stretch of Anderson Creek located downstream from the monitoring site (Wilson and Bambrick 2003). Similar observations have been made in other areas of the Anderson Creek watershed. Therefore, the major decline in fish abundance observed at the Anderson Creek site seems to warrant additional investigation into the interactions between beavers, fish, and road-stream crossings.

Table 6. Summary of changes in relative abundance, angling regulations, and land-use in Anderson, Antler, and Mary-Gregg Creek watersheds.

Watershed	Significant change in relative abundance of RNTR [1]	Related angling regulation changes	Harvest Information [2]		Index of Road Density [3]		
			Total Percent of Watershed Harvested	Percent of Watershed Harvested After 1990	Historic	Current	Change
Anderson	Yes (-)	Implementation of catch and release restrictions	67.2 %	4.6 %	high	high	low
Antler	No	Implementation of catch and release restrictions	41.7 %	9.3 %	low	low	low
Mary-Gregg	No	Implementation of catch and release restrictions	8.2 %	6.6 %	low	low	low

[1] RNTR = Rainbow Trout; Significance is at 90% confidence interval
[2] Harvest Information: < 10% = low, 10-30% = medium, > 30% = high (Sherburne and McCleary 2003)
[3] Index of Road Density: ≤ 0.2 = low, 0.3-0.4 = medium, ≥ 0.5 = high (Sherburne and McCleary 2003)

4.3 Future Data Analyses

The Foothills Model Forest and its project partners have made a considerable investment in collection of relative abundance information at a number of sites. Although we have made an effort to analyze this data for changes, the methods selected for this report were fairly basic in nature. The Foothills Model Forest would benefit from a thorough review of the field methods to address issues such as electrofishing standardization and site location. A review of the hypotheses and methodologies selected for monitoring are also recommended. For the 2003-2004 year, this review of methodology is considered a higher priority than the collection of additional data. The Foothills Model Forest would fully support, where possible, both Alberta Sustainable Resource Development – Fish and Wildlife Division and the Alberta Conservation Association in any efforts to develop a standard methodology for the long-term monitoring of stream-dwelling fish species.

In addition, it should be emphasized that the Foothills Model Forest supports the sustainable management of forest resources, including aquatic resources. However, should an impact to an aquatic resource be detected, it would be important to track the change to a specific forest management activity so that activity could be modified. However, without a habitat component within the monitoring program it will be difficult to make such a connection. Therefore, the monitoring of fish abundance should be supplemented with key habitat parameters that are documented as known indicators of potential effects of forest management activities.

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