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a growing understanding

Summary of Key Findings to date from a Multi-Year Study to Determine the Effects of Human-Use Activities on Fish and Fish Habitat

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1 Introduction

The purpose of this document is to concisely convey the key findings from the numerous individual investigations that comprised this study. Although many of these investigations were somewhat disparate, most are tied to the watershed and stream classification system. This common tie was intended to facilitate both the integration of the individual investigations and the extrapolation of the findings to other portions of the landscape.

The key findings and considerations are presented in four categories including:

1. Relationships between fish populations and human-use activities,
2. Relationships between fish habitat and human-use activities,
3. Forestry applications, and,
4. Recommendations for future Foothills Model Forest monitoring efforts.

In order to allow the reader to follow up with additional reading, the key findings and considerations from each parent report are presented individually.

2 Key Findings and Considerations

2.1 Relationships Between Fish Populations and Human-use Activities

Report 2.1 – A Summary of the Alberta Fishing Regulations from 1952 – 2002 in Selected Watersheds of the Foothills Model Forest

Finding 1	This report documented the evolution of sport fishing regulations in a number of small watersheds within the Foothills Model Forest. Regulations within each watershed were summarized over a 50-year period from 1952 – 2002. Regulations were grouped by five general types of restrictions including gear restrictions, seasonal restrictions, limited harvest restrictions, catch and release restrictions, and full closure of a stream. Historically, fishing regulations were not consistent with our current understanding of the limited capacity of study area streams to support angler harvest. For example, in 1952, regulations permitted anglers to harvest up to 15 trout or 20 pounds of trout per day. In order to achieve sustainability of the stream sport fishery, regulations became more restrictive over the decades. A significant increase in angling restrictions occurred in the late 1990's as fishery managers implemented catch and release regulations, with very limited harvest permitted only in certain streams. In 2000, a full closure to angling was implemented in one stream in order to protect spawning Bull Trout.
Consideration 1	These findings indicate that historic legal angler harvest may have contributed to decreases in sport fish populations within study area watersheds. Therefore, angler harvest should be considered in any attempts to explain historic or current fish abundance.

Report 1.2.1 – Changes Between Historic and Current Fish Relative Abundance and Size within Selected Foothills Model Forest Watersheds

Finding 1	Changes in catch rates between historic and current surveys were detected in two of the four watersheds where catch rate comparisons were completed. In Lambert Creek watershed, an increase in catch rate corresponded to implementation of catch and release angling regulations. Harvest and road development levels were low during both historic and current surveys. In MacKenzie Creek watershed, a decrease in catch rate of Rainbow Trout corresponded to the implementation of zero catch limit of Bull Trout in 1995 and full angling closure in 2000. Harvest and road development levels remained low throughout the study. In Moon Creek watershed, no changes in catch rate were detected despite an implementation of more restrictive angling regulations. There was little change in harvest levels and there was a decrease in road density from high to medium. In the Pinto Creek watershed, no change in catch rate was detected despite an increase in angling restrictions, harvest extent and road development.
Finding 2	Changes in proportion of catchable size fish were detected in two of the four watersheds where those comparisons were completed. In Lambert Creek watershed, an increase in proportion of catchable size fish corresponded to the implementation of catch and release angling regulations. Harvest and road development levels remained low through both survey dates. In MacKenzie Creek watershed, an increase in proportion of catchable size Rainbow Trout corresponded to very low juvenile recruitment and therefore should be considered an indicator of concern for the health of that population. This change corresponded to the implementation of more restrictive angling regulations including the zero catch limit on Bull Trout in 1995 and full angling closure in 2000. In Solomon Creek watershed, no significant changes in the proportion of catchable size Brook Trout were detected despite the more restrictive angling regulations and lack of increase in land-use. In the Upper Erith River watershed, no change in proportion of catchable size Rainbow Trout was detected despite the increase in angling restrictions and high increase in road development.

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

Finding 1	Although an impact associated with experimental riparian harvest was detected at one of the Tri-Creeks sites, this habitat change did not correspond to a decrease in fish abundance.
Consideration 1	In future decades the amount of instream cover for fish at the experimental riparian harvest site will likely continue to decrease as the existing large woody debris degrades over time without recruitment of new material from the adjacent forest. However, at present, habitat features including undercut banks may not be a limiting factor for fish abundance at the study site.

2.2 Relationships Between Fish Habitat and Human-use Activities

Report 2.2 – Overview Assessment of Historic and Current Land-use Activities in Selected Foothills Model Forest Watersheds

Finding 1	Our literature review of potential forestry related impacts to fish habitat revealed that the strong connection between forest harvest, increased peak flows and subsequent stream channel changes, which has been documented in other areas of North America, can not be assumed to exist within the study area. This is due to the occurrence of summer storms rather than snowmelt runoff as the major channel forming runoff events. Therefore, this project has the potential to provide some information that may be useful to substantiate such a relationship.
Finding 2	Unlike many areas managed for forest harvest in western North America, the Weldwood FMA ground rules, in place since harvest was initiated in the 1950's, have required maintenance of stream-side buffer strips.
Finding 3	Since the creation of the Weldwood FMA, significant resources were invested to ensure that the timber supply was managed at a sustainable level. As a result, a detailed harvest history was available and was provided by Weldwood for the watersheds in digital format. The historical information was found to be 100% accurate when compared to current orthophotos. Accurate permanent road information was derived from a variety of sources. Because of the quality of information available, neither a sampling procedure nor statistics were required to provide an overview of land use.
Finding 4	Timber harvest was very unevenly distributed through time and space in the study watersheds. Levels of harvest ranged between 0 and 56% on the inventoried forest landbase. Density of permanent roads ranged form 0 to 0.8 km/km^2.

Report 2.4.1a – Level I Classification: Basin Characteristics

Finding 1 Watershed physiography for each basin was described using six descriptors including watershed size, steepness of terrain, mean basin elevation, wetland extent, lake extent and dominant natural subregion. Based on the six watershed characteristics, the degree of similarity between the 15 basins ranged widely. Only two watersheds shared identical values for all six characteristics (Lambert and Emerson). Five pairs of watersheds had identical values for five characteristics and 13 pairs of watersheds had identical values for four characteristics. The remaining 86 watershed combinations shared less than four identical characteristics.

Each physiographic characteristic will influence both the response of the stream channels to human activities, as well as the types and productivity of aquatic organisms that inhabit the watershed. This has implications for both land-use planning and measuring changes in aquatic resources.

Based on these characteristics, watersheds may have a different sensitivities to changes in peak flow, water yield or sediment transport rates. Potentially, thresholds could be identified for the individual basin, based on its physiographic characteristics.

The basin classification system described in this report is also an important component of the larger multi-year study that is attempting to determine the effects of human-use activities on fish and fish habitat. The findings from this classification exercise have confirmed that a large amount of variation exists in physiographic characteristics between the 15 monitoring watersheds. These physiographic characteristics will influence both the fish community assemblages and the biological productivity and as a result, we would expect a high natural variability in these parameters between the watersheds. Levels of land-use were also variable among watersheds. Therefore, a multiple variable analysis that includes physical watershed characteristics and levels of land-use could be utilized to attempt to explain fish distribution and abundance patterns among the various watersheds.

Report 2.4.1b – Level I Classification: GIS-based Stream Reach Characteristics

Finding 1	The extent of mapped headwater streams was variable with the largest proportion of streams less than 2 km² occurring in the basins with the greatest relief. Many of these relief origin channels may be ephemeral or intermittent streams that occur within small draws reflected in the mapped topography. In the lower relief basins, many of the streams originate in wetland areas and discerning the starting point of a small permanent stream in a wetland area often presents difficulty for the forestry technician.
Finding 2	Although headwater streams typically have gradients greater than 4 percent in many areas of western North America, the basins occurring in the Lower Foothills natural subregion often have numerous headwater streams with gradients less than 4 percent. This suggests that sediment transport capacities and rates are variable in headwater streams among the basins selected for this study.
Finding 3	Pine riparian types were the most common overall and also the dominant riparian vegetation type in many of the Upper Foothills watersheds. In addition, black spruce / larch and non-forest dominated riparian areas were abundant in lower relief watersheds. These findings illustrated a very patchy nature of riparian areas, especially in low relief basins. The structure of the stream channels in non-forested reaches must be maintained either by large woody debris from upstream sources or other elements such as deep-rooted shrubby vegetation. With reduced sediment transport rates and decreased potential large woody debris inputs, the importance of large woody debris in headwater streams of lower gradient watersheds seems worth investigating.
Finding 4	In this classification exercise, we documented the variability of three stream reach characteristics within all stream channels in fifteen watersheds. Our findings suggest that fish habitat characteristics are highly variable both within and between watersheds. This classification could be used to develop a stratified sampling system for both operational inventory and monitoring purposes.

Finding 5	The sensitivity of a stream channel to increases in discharge or sediment load or alterations of the riparian vegetation is dependent upon a number of factors including stream size, slope, and riparian vegetation type. Land-use managers may benefit from knowing the sensitivity to disturbance of all streams in their area of interest. This classification system should serve to extrapolate field classification findings regarding channel sensitivity to other reaches and watersheds.

Report 2.4.4 – Level IV Channel Classification

Finding 1	Riparian harvest at Lower Deerlick creek corresponded to a compromise in the long-term protection of the overhanging stream banks, which are an important fish habitat feature. This change was not detectible in 1984-1985 and likely evolved over several decades as the root systems from the harvested stream-side coniferous trees slowly rotted. Similar changes would occur in a natural disturbance scenario, however, the loss of cover from eroding streambanks would likely correspond to an influx of large woody debris and instream cover and habitat complexity. These findings illustrate that large trees rooted along the streambanks of medium-sized streams, such as Deerlick Creek, provide an important bank stability function that is not duplicated by lesser vegetation once the trees are removed.

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

Finding 1	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. 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.
Finding 2	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.
Finding 3	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.
Finding 4	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. 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. 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. 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. 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. 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.

Report 2.3 – Overview Assessment of Fish Passage at Stream Crossings within Selected Watersheds

Finding 1	Prior to the initiation of this project, Weldwood of Canada Ltd. – Hinton Division had recognized the need for a stream crossing remediation program to address fish migration and habitat concerns at their existing crossings. Therefore, we developed a methodology to assist Weldwood in the identification priorities in their ongoing stream crossing remediation program.
Finding 2	To move forward with the remediation process, we selected a combined preliminary assessment of fish migration barrier status and fish habitat status. Using this approach, we identified a need for one of three more detailed assessments at a number of crossings. These included a remediation design assessment, a detailed fish passage assessment or an upstream fish habitat assessment.
Finding 3	Including a measure of the benefit in terms of length of known fish-bearing stream located upstream of a crossing of concern was useful for establishing priorities in the remediation process.
Finding 4	Based on a watershed approach, we evaluated all crossings including highways, railways, and all other roads. Our next step is to communicate our findings to the variety of agencies responsible for stream crossings within study area watersheds.

2.3 Forestry Applications

Report 2.4.2 – Level II Stream Classification Project, 1999-2002

Finding 1 This level II classification system may have applications for resource management planning at the basin and reach scales. At the basin scale, the dominant stream type varied between each watershed. Solomon Creek, the highest relief watershed, was characterized by stream type indicative of unstable channels. In contrast, a low relief basin such as Lambert Creek was characterized by stable stream type with low sediment loads where vegetation exerted a strong controlling influence. With the different stream channel disturbance sensitivities among the watersheds, it may be useful to identify those watersheds with higher sensitivities to peak flow increases.

At the site scale, the classification system may have two applications for resource managers:

First, the system can be used by forestry technicians to consistently define the land adjacent to a stream that experiences regular inundation. Planning activities in order to minimize floodplain impacts, such as soil compaction and vegetation removal, should conserve many of the riparian functions associated with these areas.

Second, a stream identified as "F" or "G" stream type, is not in a stable state and any structures, roads or crossings in the immediate vicinity may be at risk. Therefore, crossings over "F" or "G" channels should either be temporary in nature or other crossing location options should be identified.

Regardless of gradient, a vast majority of streams within the study area were "E" type streams. These types of streams have the most well developed floodplains over all other stream types. Type "E" streams are characterized by a low sediment supply and steep stream banks that are maintained by deep-rooted vegetation. Riparian vegetation exerts a very high controlling influence for maintaining width/depth ratios of these streams. Therefore, management activities that promote the vigor of deep-rooted vegetation along watercourses

	are important within the study area. Activities such as cattle grazing would have to be carefully managed in order to maintain channel and floodplain structure and function. Disturbances that promote the vigor of riparian vegetation may be of particular importance for maintaining the function in these systems.

Report 2.4.4 – Level IV Channel Classification

Finding 1	Plans to harvest trees growing along the banks of medium-sized streams should be carefully reviewed. In addition, we observed a two decade delay in the measurable response of the stream ecosystem to riparian harvest. This response time is beyond the time frame suitable for an adaptive forest management scenario. These findings illustrate the importance of protective measures during forest harvest for those trees growing adjacent to major streams.

Comparison Between Field Surveyed and GIS-Derived Descriptors of Small Streams within the west-central Foothills of Alberta

Finding 1	Small streams within the west-central foothills are characterized by a well-developed meander pattern, regardless of gradient. These well-developed floodplains along the small streams within the study area may deserve special management consideration. These areas contain recently deposited alluvial soils and support highly productive forest sites. These areas may be particularly vulnerable to soil compaction and erosion during timber harvest.
Finding 2	This occurrence has implications for accurately interpreting two GIS based stream descriptors – slope and sinuosity. Calibration factors can be introduced if accurate values of these descriptors are important in the application of GIS derived stream descriptors.

2.4 Recommendations for Future Foothills Model Forest Monitoring Efforts

Report 1.2.1 – Changes Between Historic and Current Fish Relative Abundance and Size within Selected Foothills Model Forest Watersheds

Finding 1	In order to practice adaptive forest management, any negative change in an aquatic resource would have to be linked to a particular forest management activity. For any changes other than those related to angling or angler access, some measure of habitat impact would be required. Most of the historic surveys did not contain habitat data that could have been replicated. In addition, specific hypotheses and methods related to habitat features should be formulated prior to initiation of future monitoring programs.
Finding 2	Electrofishing effort was calculated based on area and time, however, power was not considered. Power is influenced by a number of factors including pulse width, pulse frequency, output voltage, water conductance, and anode size. Standardization of electrofisher power is a key component of maintaining consistent or comparable sampling effort. Standardization was not possible given the lack of information from most historical studies. In addition, recording water conductance has not been a standard requirement during Foothills Model Forest (FMF) electrofishing surveys. Therefore, changes should be made to FMF protocols to ensure that standardization of electrofishing power on any subsequent surveys can be achieved.
Finding 3	During the historic surveys in Lambert Creek watershed, Pearl Dace were captured and no Finescale Dace was captured, while the reverse was true during the current surveys. These results indicate the possibility of a fish identification error. The current program could be expanded to include a more frequent use of voucher specimens or more rigorous testing of fish identification abilities.
Finding 4	The use of catch rates as an indicator of fish population status presented several limitations including the very low sample size (n = 2 or 3) and high variability between sites in a watershed. As a result, the possibility of both Type 1 and

	Type 2 error remained high. These problems were not associated with the use of proportion of catchable size fish.
Finding 5	Damage to eggs within redds may occur as a result of electrofishing. Consequently, several jurisdictions require that electrofishing in known Bull Trout streams occurs prior to their spawning season. The FMF should consider adopting this practice.

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

Finding 1	If there is a future desire to track the relationships between fish abundance and channel features at the Upper Deerlick Creek site, the fish site could be relocated to correspond to the Level IV site.
Finding 2	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.
Finding 3	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. 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 the 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.

Report 2.4.4 – Level IV Channel Classification

Finding 1	Three parameters were selected for this habitat evaluation including residual pool depth, mean pool spacing, and length of undercut banks. Of these three parameters, the only one that captured a change in fish habitat associated with riparian harvest was length of undercut banks. Therefore, of the three variables, length of undercut banks is recommended for incorporation into future habitat assessments.