1.0 EXECUTIVE SUMMARY

Details of the development, implementation, and results of the Cooperative Fisheries Inventory Program (CFIP) are presented in this manuscript. The CFIP is a comprehensive and cooperative venture sponsored by the Department of Fisheries and Oceans, the timber harvest industry, and Alberta anglers through the Alberta Conservation Association (formerly the Buck For Wildlife: Fisheries Habitat Development Program) trust fund. This program was designed to augment the informational database pertaining to fish and fish habitat from prescribed areas within the Northwest Boreal Region of Alberta. The CFIP was initiated in the spring of 1993 and is proposed to continue until at least the fall of 1997.

Information collected from this program will be presented in electronic and GIS compatible formats and will be accessible to all participating partners. The database developed during the CFIP represents an appreciable increase in knowledge of regional fisheries and will be integrated into current and future timber harvest planning and review processes.

2.0 INTRODUCTION

The absence of current, reliable, and accessible baseline data on fish populations and aquatic habitats is recognized as the foremost restriction in the regional development and application of sound fisheries management strategies on timber harvest operations (D.A. Westworth and Assoc.1992). To date, typical forest harvest planning and operation involves the application of standard ground rules (Alberta Forest Service 1990). Considerations with respect to the protection of fish and fish habitat in these areas are based on general watershed data particularly stream permanency and width. In addition, staffing reductions and budgetary constraints within Alberta Environmental Protection (AEP), specifically Natural Resources Service (NRS) and the Land and Forest Service (LFS), limits time available to review timber harvest plans and provide input. Recommended in "*An Overview of Potential Forest Harvesting Impacts on Fish and Fish Habitat in the Northern Boreal Forests of Canada's Prairie Provinces*" (D.A. Westworth and Assoc.1992) to address these informational deficiencies are:

- standardization of inventory methodologies (collection and reporting),
- usage of Geographical Information System (GIS) technology,
- completion and maintenance of fish and fish habitat inventories prior to planned timber harvesting,
- a shared responsibility between government and industry for inventories, and,
- the integration of this information into the development of fisheries resource management strategies, and effective mitigation programs.

The Cooperative Fisheries Inventory Program (CFIP), initiated in 1994, is designed as a mechanism by which current and reliable fish population and aquatic resource information will be collected and made available for inclusion into the timber harvest planning process. This program is a comprehensive and cooperative venture sponsored by the Department of Fisheries and Oceans (DFO), timber harvest companies, and Alberta anglers through the Alberta Conservation Association (ACA). Alberta Environmental Protection, NRS and LFS, are also considered key sponsors through in-kind program support. See Hvenegaard 1994 and 1995 for details on program development and implementation.

Five timber harvest companies participated directly in the CFIP (Table 1, Figure 1). One other, Joint Venture Parties Industries Ltd. (AlPac), participated indirectly by providing regional fish and fish habitat data collected independently but under similar methodologies to increase the data set size (Brown 1995). Partners obtained funds from a variety of sources (Table 1). Timber companies typically obtained monies through trust funds generated from timber dues. The Alberta

Conservation Association provided monies from a trust fund generated by hunting and angling license sales.

Table 1. CFIP participants and funding sources.

Company	Abbreviation[1]	Funding Source
Department of Fisheries and Oceans	DFO	Sustainable Fisheries Program: Action Plan For Fish Habitat
Alberta Conservation Association	ACA	Fisheries Habitat Development Program (formerly Alberta Fish and Wildlife Trust Fund)
Canadian Forest Products Ltd.	Canfor	Forest Resource Improvement Program
Weyerhaeuser Canada Ltd.	WeyCan	Forest Resource Improvement Program
Manning Diversified Forest Products	MDFP	Manning Diversified Forest Products Research Trust Fund
Daishowa Marubeni International Ltd	DMI	General Coffers
Ainsworth Lumber Co. Ltd.	Ainsworth	Ainsworth Integrated Resource Management Program

[1]abbreviation to be used in subsequent discussions

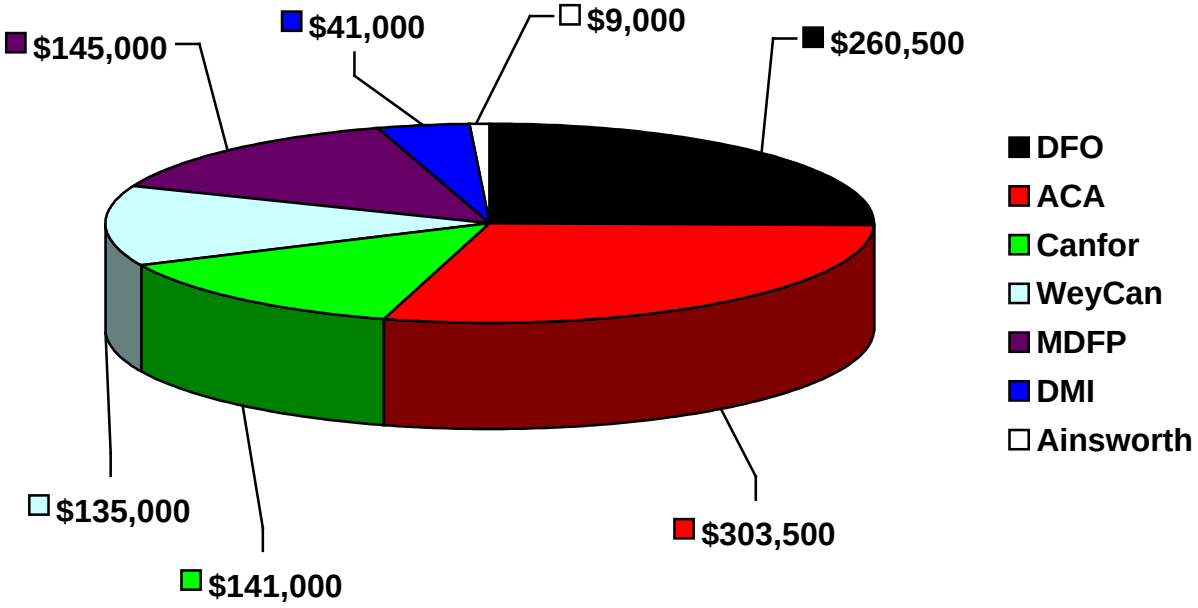

Figure 1. Total contributions by CFIP particapants, 1993/94 - 1997/98 inclusive.

2.1 Study Area

Data collections were conducted in and around the management areas of the respective participating forest companies (Figure 2). The majority of these areas are located within the Northwest Boreal Region of Alberta, as administered by Alberta Environmental Protection. Inventory efforts were restricted to lotic environments within these areas, specifically drainages within the upper Smoky (Cutbank, Kakwa, Simonette, Little Smoky), Wapiti (Narraway), and Notikewin (Hotchkiss, Meikle) River watersheds (Figure 2). Streams surveyed were those low in order (1^{st} – 4^{th}) (Strahler 1957).

The region lies primarily in the boreal forest and to a lesser extent, the foothills natural region (Alberta Environmental Protection 1994) and drained primarily by the Peace River drainage in addition to the Athabasca, Hay, Liard, and Buffalo River drainage basins (Alberta Environmental Protection 1995). Rowe (1972) describes the climate as predominantly dry sub-humid with minor moisture deficiencies. The bulk of the region is in the interior plains physiographic region (flat-lying sedimentary rocks overlying Precambrian deposits) (Lane and Sykes 1982); soils are typically luvosolic in nature.

Main industrial activities in the region include seismograph exploration, hydrocarbon extraction, timber harvesting, and fibre processing. Areas allocated to timber harvest companies through Forest Management Agreements (FMA), represent an appreciable portion (41.1%) of the region (Alberta Environmental Protection 1995).

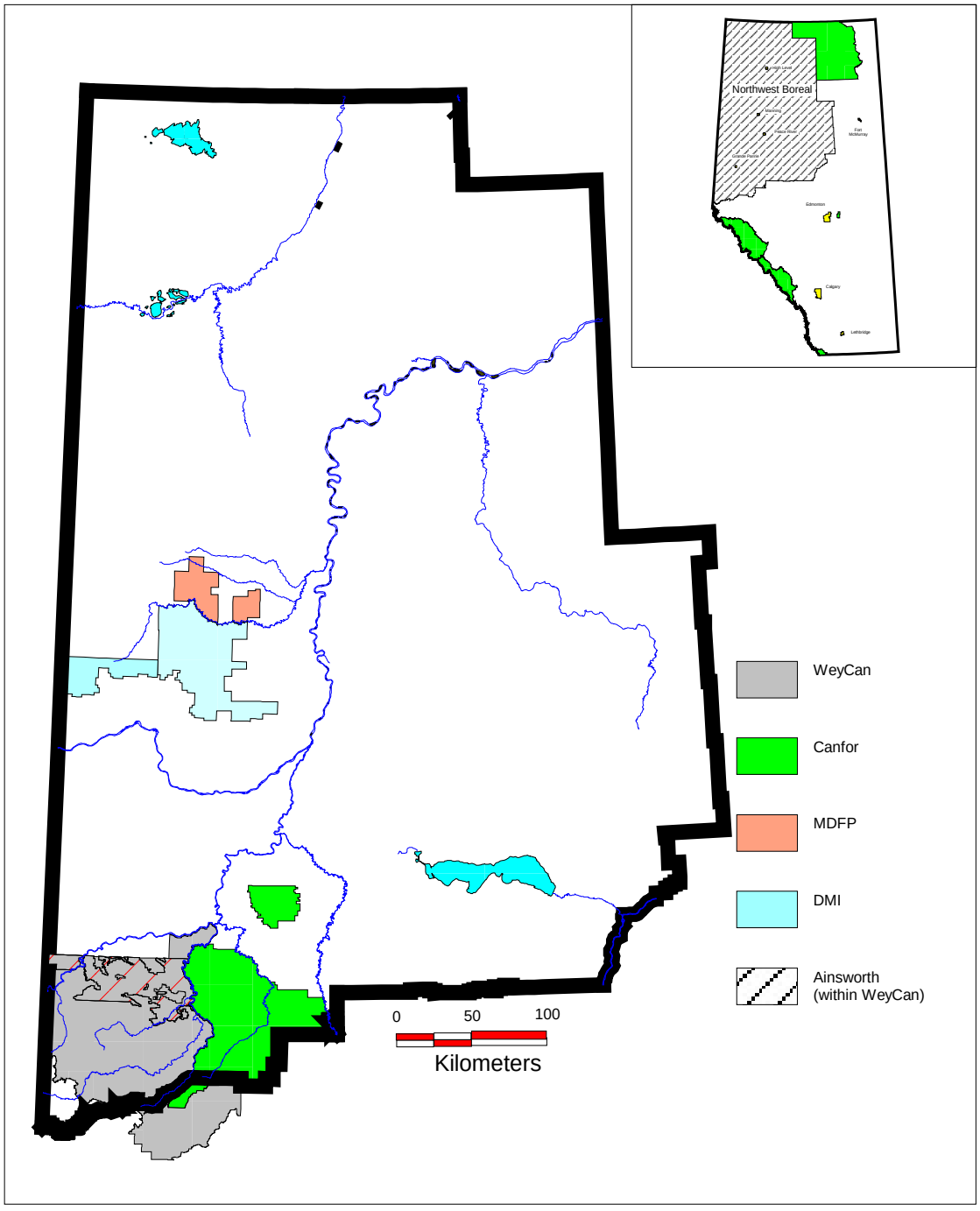

Figure 2. Northwest Boreal region of Alberta showing data collection areas within CFIP participant operating areas.

3.0 METHODS

Fish and fish habitat data were collected and recorded on standardized stream inventory forms (Appendix A). Data on both the biological and physical characteristics were used to classify the stream. These classifications permitted regional fish managers to assign habitat protection categories.

3.1 Biological Parameters (Fish Population Description)

Fish population descriptions focused on determining species assemblages, seasonal distributions, life-stage representation, and relative abundance.

3.1.1 Fish Collection

Backpack electrofishing was the primary capture method, although gillnetting, seining, and angling were also used to compliment the catch. For all methods, effort was recorded to quantify the catch. Specific parameters (those used to quantify the catch) and standardized reporting procedures for each capture method are summarized below:

- electrofishing- number of seconds (s) the system is activated and meters (m) of stream sampled; catch reported as number/kilometre and number/100 s.
- seining - area (m^2) of stream sampled; catch reported as number/100 m^2.
- gill netting- area (m^2) of net fished and duration of the set (h); catch reported as number/ net unit where 1 net unit is the equivalent of 100 m^2 of net fished for 24 h.
- angling - total time (h) a group or individual spent angling; catch reported as number/angler h.

3.1.2 Species Identification

All fish species were identified according to Nelson and Paetz (1992) or Scott and Crossman (1973). Fish species were recorded as indicated in Mackay et al. (1990). Non-sport fish were speciated and enumerated. Fish not captured but speciated with confidence were recorded as observed and included as part of the catch.

3.1.3 Collected Fish Data

All sport fish were measured to the nearest mm at the fork (FL). Sport fish >200 mm FL were marked with numbered FLOY™ tags. Sex and stage were recorded

when discernible. No ageing structures were collected; age class and life stages were interpolated from length frequency distributions (Jearld 1983).

3.2 Physical Parameters (Habitat Description)

Data on the physical attributes considered important to fish production were collected at each site. In addition to reporting the location of the sample site, substrate composition, available cover, morphometry, bank stability, and the presence of barriers to fish passage were also recorded. All measured site characteristics were measured at specific points between and along equally spaced transects as depicted below in Figure 3.

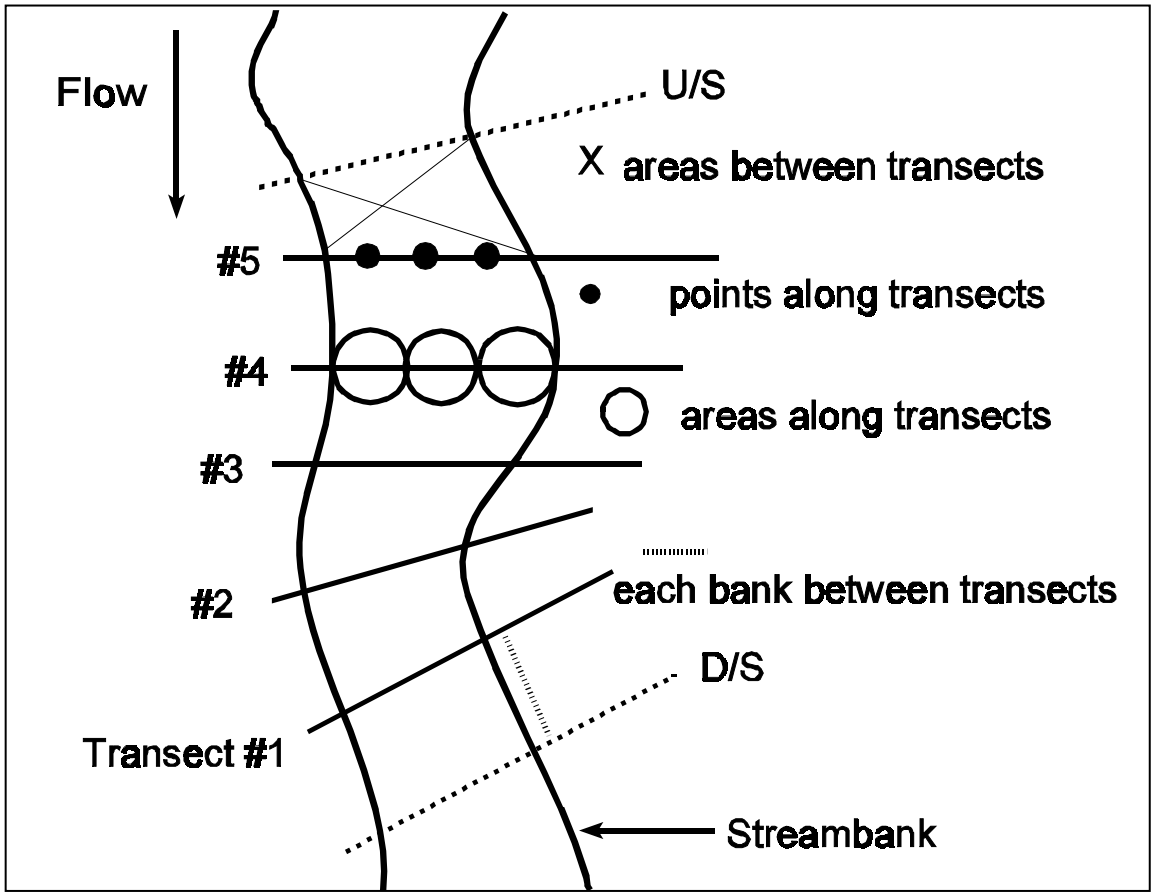

Figure 3. Spatial schematic of CFIP sampling methodology

3.2.1 Location

Sample site locations were geo-referenced using hand held GARMIN™ GPS units. Both the sample site and stream mouth were referred to by UTM and legal

land description. Where available, stream names were recorded. The drainage basin in which the stream is located and its relationship was also provided. The location of the sample site in relation to its location in the longitudinal profile (stream order) was also recorded.

3.2.2 Discharge

Discharge was estimated with the float method (Buchanan and Somers 1969). Calculated discharge was reported as cubic metres per second.

3.2.3 Substrate

Stream channel substrate composition was determined by visual assessment of 3 circular points along 5 evenly spaced transects in the sample section of stream (Figure 3). This provided a sample (n=15) of substrate assessments from which the mean particle size distribution of the site was calculated. The substrate classification by particle size is as follows (Adapted from Platts et al. 1983):

!	<4.7 mm	fines
!	4.8 - 76.0 mm	gravels
!	76.1 - 304.7 mm	cobbles
!	>304.8 mm	boulders

3.2.4 Stream Cover

Eight stream cover components (listed below) were estimated visually and recorded (by percent occurrence) in the areas between the transects established (n=6) or in the case of undercut banks areas along the bank within each transect (n=12) (Figure 3).

1. Terrestrial Canopy: the amount of cover afforded by overhanging tree limbs
2. Instream Debris: a measure of the volume of instream large woody debris
3. Aquatic Vegetation: the proportion of the streambed, which provides hiding cover in the form of aquatic macrophytes
4. Surface Disturbance: the proportion of the section's surface area which has broken water (riffles) and sufficient depth below to provide hiding cover; correlated to riffle percentage
5. Undercuts: the percentage of the banks which have scoured laterally to form hiding sites beneath the banks
6. Depth: the proportion of the section which offers hiding cover in the form of pools
7. Turbidity: the degree of visual isolation from the terrestrial environment

8. Rock / Boulder: the percentage of hiding cover in the form of plunge pools created by instream rocks and boulders

3.2.5 Bank Stability

The stability of the bank and its ability to erode and contribute to sedimentation was rated with the following criteria on each bank within the survey section (n=12) (Figure 3):

1 (ST):	Stable; banks well vegetated or such they are not susceptible to erosion
2 (SU):	Slightly Unstable; > 50% of banks in section are stable, limited indication of silt contribution
3 (MU):	Moderately Unstable; < 50% of banks in section are stable, some indications of silt
4 (HU):	Highly Unstable; massive bank slumping, large deposits of silt

3.2.6 Stream Width/Depth

Along each transect, the wetted width (m) and bankfull width (m) were recorded (n=5). Water depth was recorded at 3 points along each of the 5 transects (n=15). Width/depth and bankfull/wet width ratios are common parameters used in stream typing (Rosgen 1994). These parameters can be incorporated when assessing the channel forming features of a stream (flow regime) and the character of the material that comprise the bank and bed of the stream (Platts 1983).

3.2.7 Water/Air Temperature

Both stream and ambient temperature were measured (^{0}C) with a pocket glass-alcohol thermometer. In addition to temperature, the time of measurement was also recorded.

3.2.8 Photographic Documentation

A representative photo (35 mm slide) was obtained at each sample site to provide a visual representation of the stream. The intent of this photographic library is to convert slides to digital format for inclusion into the regional fisheries resource database.

3.3 Habitat Evaluation

The sample section of stream is evaluated (rated) subjectively as to its potential to provide habitat for adult fish to spawn, juveniles to rear, and the likelihood to overwinter fish. Although these ratings were an interpretation of the survey teams overall visual assessment of the site (in addition to the catch), it provides a valid description of the stream based on all the habitat features combined. Included in this assessment are evidence of potential barriers to fish passage like hanging culverts, beaver dams, and velocity barriers. Each survey teams' inventory experience and the consistency of individuals in specific work areas (at least one person has been dedicated to each FMA) make these valid assessments.

3.4 Other Data Sources

In addition to the active data collections under the CFIP, numerous information sources were identified for inclusion into the database. The primary source of information was NRS file data including fish collection license return forms. Also, “grey literature” such as consultant reports and historic regional inventory programs were retrieved, reviewed for pertinence, and incorporated into the database.

3.5 Data Management

All collected data were inputted into the regional fisheries resource database, a separate CFIP initiative. This database, in ACCESS™ format, is designed to permit retrieval of data at various resolutions plus support transfer of data into the Northwest Boreal Region geographical information system (GIS).

3.5.1 Data Interpretations

As per guidelines provided by regional managers of NRS Fisheries Management Division, with support LFS and timber harvest planners, inventory sites were *classified* according to the presence/absence of sportfish, evidence of successful spawning, and the potential to provide suitable spawning habitat for local sportfish species. Table 3 summarises the stream classification categories. These site classifications (point data) were in turn assigned to stream reaches (line data) as defined by order (Strahler 1957) (Figure 4). It was assumed that the sample site (point data) was representative of the stream reach.

A section of stream was considered a reach through its linear length between order changes. An inherent flaw in this system is the potential for a discontinuous classification throughout a stream’s length due to the availability or absence of data for each reach (Figure 4).

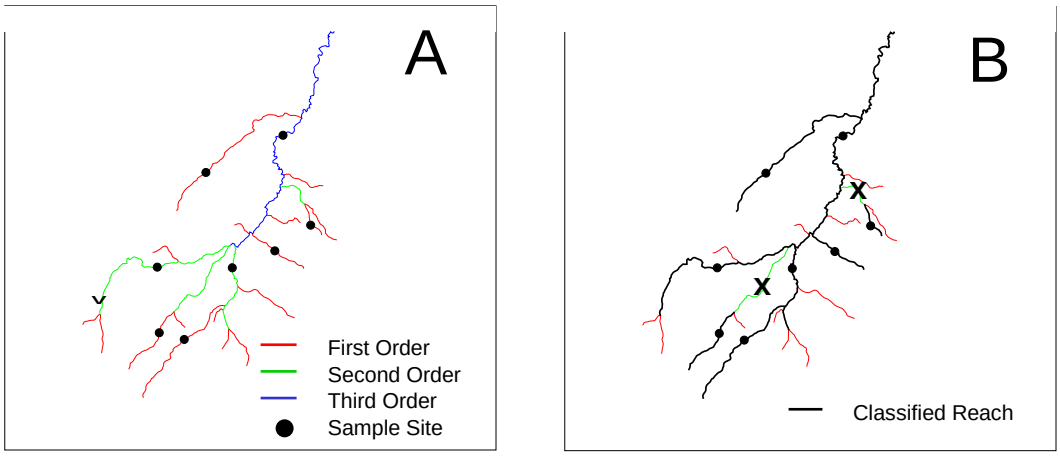

Figure 4. **A**: Stream reach definition methodology as defined by Strahler (1957) and **B**: extrapolation of sample site data to stream reaches.

Note discontinuous stream classifications due to absence of data as indicated by **X**.

Stream reach classifications were depicted through the application of different attributes to the digital (GIS) hydrography coverage provided by each participating timber company. The stream reach classification layer created a digital *coverage* that facilitated the transfer of data onto each participating timber company's GIS timber harvest planning system. This layer in turn provided timber harvest planners spatial data on those stream reaches utilized by sportfish for spawning, those with and without sportfish populations present, and those with suitable habitat for on spawning sportfish.

Table 2. Stream classification categories and appllied attribute type.

Classification Category	Map Attribute Type
Sportfish absent; low or nil spawning potential	Line data
Sportfish present; medium or high spawning potential	Line data
No data available	Line data
Presence of bull trout	Point data
Evidence of spawning sportfish	Line data

3.6 Deliverables

Stream classification maps, specific to each participant's operating area (Figure 2) were produced according to accepted criteria (Table 3) and provided to industry, Alberta Environmental Protection and DFO (Appendix B). In addition to the hard copy map products, these stream classification data were also provided in digital format suitable for inclusion into in-house GIS planning platforms.

4.0 RESULTS AND DISSCUSSION

Stream inventories were conducted during the open water seasons of 1994-97 inclusive. In total, 946 inventory sites were established under the CFIP (Table 4). To date, 11 sportfish and 18 non-sportfish have been recorded through CFIP data collections (Table 5). Stream survey summary forms are provided under a separate supplemental attachment. An overview of activities and results within each participating timber company's respective operating area follows.

Table 3. Fish and fish habitat inventories completed under the CFIP.

CFIP Participant	1994	1995	1996	1997	Total
Canfor	83 (5)	95(9)	118(7)	117(8)	413(29)
WeyCan	25	83	100	99(5)	307(5)
MDFP		39(1)	53(1)	41(6)	133(8)
DMI			44(21)	21(2)	65(23)
Ainsworth				28(3)	28(3)
Total	**108(5)**	**217(10)**	**315(29)**	**306(24)**	**946(68)**

(indicates replicate sites)

4.1 CANFOR

Inventory effort in the Canfor FMA commenced in 1994 and continued throughout 1995-97 inclusive. Primary drainages surveyed included the Simonette, Waskahigan, Latornell, and Little Smoky Rivers (Figure 2).

- 413 fish and fish habitat inventories completed on streams within the Canfor FMA (Table 4)

- 29 sample sites repeated to examine seasonal differences in species occurrence and relative abundance

- bull trout, Arctic grayling, mountain whitefish most abundant sportfish in the FMA (Table 5)
  - bull trout occurred primarily in the south and southwest portion of FMA
  - Arctic grayling and mountain whitefish occurred throughout the FMA

  note: fish species distributions may be reflective of the systematic sampling approach i.e., sample sites were selected based on 10 year operating plans; the sample design was not intended to describe distributions at the FMA level

- Approximately 1/3 of the FMA flown in late winter to map potential groundwater discharge areas (as indicated by areas of open water). These areas are those considered important for bull trout spawning success.

- Active participation in two provincial bull trout research ventures
  - *Quantatative Assessment of the Recovery of Bull Trout (Salvelinus confluentus) and Development of Models of Sustainable Yield*

  - *Genetic Variation Among Alberta Bull Trout (Salvelinus confluentus) Populations*

- On site fish and fish habitat education for Canfor sponsored Junior Forest Ranger Program

- Developed working relationship with Canfor field personnel (planners) and NRS land managers with respect to site inspections with provision of recommendations

- Participation in the development of FMA digital elevation model generated hydrography and watershed data set merged with CFIP data to facilitate strategic and operational forest resource planning

- Provision of oral presentations and field tours to public Forest Management Advisory Committee promoting Canfor resource stewardship and the CFIP

Table 4. Recorded fish species occurrence through CFIP data collections.

Species	Taxa	Acronym[1]	Canfor	WeyCan	MDFP	DMI	AINS
Sportfish							
bull trout	*Salvelinus confluentus*	BLTR	☐	☐			☐
Arctic grayling	*Thymallus arcticus*	ARGR	☐	☐	☐	☐	☐
mountain whitefish	*Prosopium williamsoni*	MNWH	☐	☐		☐	☐
cutthroat trout	*Oncorhynchus clarki*	CTTR		☐			
brook trout	*Salvelinus fontinalis*	BKTR		☐			
rainbow trout	*Oncorhynchus mykiss*	RNTR	☐	☐			
walleye	*Stizostedion vitreum*	WALL	☐	☐	☐	☐	
northern pike	*Esox lucius*	NRPK	☐	☐	☐	☐	☐
yellow perch	*Perca flavescens*	YLPR	☐			☐	
goldeye	*Hiodon alosoides*	GOLD			☐	☐	
burbot	*Lota lota*	BURB	☐	☐		☐	☐
Non Sportfish							
northern redbelly dace	*Phoxinus eos*	NRDC	☐		☐		
finescale dace	*Chrosomus neogaeus*	FNDC	☐		☐	☐	☐
longnose dace	*Rhinichthys cataractae*	LNDC	☐	☐	☐	☐	☐
pearl dace	*Semotilus margarita*	PRDC	☐	☐	☐	☐	☐
northern sqawfish	*Ptychocheilus oregonensis*	NRSQ			☐	☐	
fathead minnow	*Pimpephales promelas*	FTMN				☐	
lake chub	*Couesius plumbeus*	LKCH	☐	☐	☐	☐	☐
flathead chub	*Hybopsis gracilis*	FLCH	☐	☐		☐	☐
longnose sucker	*Catostomus catostomus*	LNSC	☐	☐	☐	☐	☐
largescale sucker	*C. macrocheilus*	LRSC	☐	☐		☐	☐
white sucker	*C. commersoni*	WHSC	☐	☐	☐	☐	☐
slimy sculpin	*Cottus cognatus*	SLSC	☐	☐	☐	☐	☐
spoonhead sculpin	*C. ricei*	SPSC	☐		☐	☐	☐
trout-perch	*Percopsis omiscomaycus*	TRPR	☐	☐	☐	☐	
redside shiner	*Richardsonius balteatus*	RDSH	☐	☐		☐	☐
spottail shiner	*Notropis hudsonius*	SPSH				☐	
emerald shiner	*N. atherinoides*	EMSH					☐
brook stickleback	*Culaea inconstans*	BRST	☐	☐	☐	☐	☐

[1] From MacKay et al. 1990

Table 5. Sportfish catch summary for data collections under the CFIP.

	Canfor		WeyCan		MDFP		DMI		Ainsworth	
Species[1]	catch	%	catch	%	catch	%	catch	%	catch	%
BLTR	568	29	517	25						
ARGR	811	41	463	22	443	90	69	96	20	87
MNWH	533	27	422	20						
CTTR			33	2						
BKTR			144	7						
RNTR	2	<1	504	24						
WALL	17	1			11	2				
NRPK	29	1			38	8	2	3	1	4
YLPR	2	<1								
GOLD										
BURB	25	1	9	<1			1	1	2	9
Total	1987		2092		492		72		23	

[1] from Table 4

4.2 WEYERHAEUSER

To date, areas of inventory effort has focused on priority drainages as provided by in-house forest planners. Fish and fish habitat inventories have been conducted for both the Grande Prairie and Grande Cache operations. Major drainages surveyed included the Torrens, Cutbank, and Kakwa rivers (Grande Prairie operations) and the upper Simonette and Little Smoky rivers (Grande Cache operations) (Figure 2).

- 307 fish and fish habitat inventories completed on streams within the Weyerhaeuser FMA (Table 4)

- 5 sample sites repeated to examine seasonal differences in species occurrence and relative abundance

- bull trout, Arctic grayling, mountain whitefish most abundant sportfish in the FMA (Table 5)

- Active participation in two provincial bull trout research ventures
  - *Biology and Status of Bull Trout (Salvelinus confluentus) in the Kakwa River Drainage*

- *Genetic Variation Among Alberta Bull Trout (Salvelinus confluentus) Populations*

- Documented range expansion of rainbow trout range
- Brook trout range expansion documented and monitored
- Provision of fisheries inventory data for detailed assessment of Torrens River harvest compartment
- Oral presentation to public Environmental Advisory Committee (EAC)
- Identification of 2 critical bull trout spawning areas (Lynx and upper Copton creeks)
- Identification of stream crossings (primarily tributaries to Smoky River) with potential to restrict fish passage; information forwarded to NRS and LFS land managers

4.3 MDFP

Data collections have been conducted in the MDFP timber harvest areas from 1995 to 1997 inclusive. Specifically the focus of effort was placed on the Notikewin River drainage with emphasis in the Meikle and Hotchkiss rivers.

- 133 fish and fish habitat inventories completed on streams within the MDFP timber harvest area (Table 4)
- 8 sample sites repeated to examine seasonal differences in species occurrence and relative abundance
- Arctic grayling the dominant sportfish in the area with a minor occurrence of walleye and northern pike (Table 5)
- Public education through various forums such as Junior Forest Rangers and Forest Explorers ‘97
- Numerous crossings (oil/gas roads) identified as barriers to fish passage
- Fish trap operated in Hotchkiss River (spring 1996); river utilized to some degree by spawning walleye

- 2 critical Arctic grayling spawning areas identified

4.4 DMI

Inventory efforts in the DMI FMA were conducted in the upper Notikewin River drainage in addition to the upper Whitemud and Doig rivers. Inventories were conducted during 1996 through financial support from DMI, and on an opportunistic basis in 1997. In addition to standard CFIP parameters, additional water chemistry and riparian vegetation data were collected.

- 65 fish and fish habitat inventories completed on streams within the MDFP timber harvest area (Table 4)

- 23 sample sites repeated to examine seasonal differences in species occurrence and relative abundance

- Arctic grayling the dominant sportfish in the area with a minor occurrence of northern pike (Table 5)

- preliminary investigations into variations in aquatic resources between drainages of varying size, age, and time since disturbance

- riparian vegetation data collected and forwarded to DMI for comparisons with adjacent upland sites

4.5 AINSWORTH

Data were collected in the Ainsworth timber harvest area commencing 1997. This area overlaps with the Weyerhaeuser Forest Management Area (Figure 2). Inventory effort focused on tributaries to the Wapiti River.

- 28 fish and fish habitat inventories completed on streams within the MDFP timber harvest area (Table 4)

- 3 sample sites repeated to examine seasonal differences in species occurrence and relative abundance

- Arctic grayling were most represented sportfish but were low in abundance

5.0 RECOMMENDATIONS

Through the course of the CFIP initiative, a principal objective, increased knowledge on fish and fish habitat in the Northwest Boreal Region, has been accomplished. However to achieve the primary objective of fish conservation through adequate habitat protection measures, this informational base must be conveyed to the operational level of timber harvest activities. This data usage however must be based on sound scientific analyses and the implications of these data interpretations necessitate agreement from all stakeholders. The following activities are essential to create a framework by which collected data are applied at the operational level and proactive fisheries management can be accomplished:

1. Communication

Liaison between company representatives, non-government stakeholders, and local land management agencies needs to be increased to promote program awareness and its benefits. The availability of fish and fish habitat data to all potential developers should be promoted to prevent duplication of inventory effort and to ensure that the maintenance of the fisheries resource is considered at all planning levels.

2. Partnerships

Partnerships must continue with, but not be restricted to, the timber harvest industry. This would permit the CFIP to include the informational needs of other potential resource stakeholder groups. Access to various funding sources remains critical as does long term funding commitments. At present, there are vast opportunities for program expansion in the form of new partners. These new partners not only include other forest companies operating in the Northwest Boreal Region but also other industrial stakeholder groups. The largest opportunity would seem to be the oil and gas sector. Effort must be made to initiate dialogue with oil/gas sector for partnerships.

3. Program Expansion

In addition to program expansion through increased partnerships, there are also cases for the progression of specific data collection objectives. As baseline informational levels increase, there are needs to answer management level questions, conduct research, and test management strategies. The CFIP can not only contribute baseline data towards day to day planning, but can also play a role in a variety of aquatic research initiatives.

The most immediate area for program expansion lies in the area of aquatic resource monitoring. Both government agencies and industry are unable to comment, with sound scientific data, on the effects of development or success of management strategies. At present the CFIP data set depicts an instantaneous description of fish species distribution and the habitats in which they occur and the data are qualitative in nature. A program needs to be developed to quantitatively document the natural range of fish population characteristics and their aquatic habitats (natural variation). This monitoring program would be designed to separate changes in fish population characteristics due to natural variation versus effects of land-use disturbances. Ideally, specific land disturbance types would be identified and improved mitigative strategies would be implemented. Conversely, the absence of a study of this nature would permit the continuation of potentially negative cumulative effects of the fisheries resources.

5. Data Management

At present, a functional database has been developed to serve as a storage and retrieval mechanism for the vast majority of the recently collected and historic regional fish and fish habitat information. As this database increases in size, there are also increased informational requests. Responsibility and stewardship of this information must be reviewed. This would include maintenance of the database, data updates, and provision of information upon request.

6. Data Analyses and Applications

The CFIP has created a data set of appreciable magnitude from which data were collected under standardized methodologies (Section 3.0). This data set can be enhanced further through the incorporation of a variety of GIS derived parameters particularly stream order, channel gradient, watershed area, elevation, and natural region. With this data set, many analyses should be conducted.

Foremost is a statistical review of the data set and parameters measured under present inventory methodologies and their predictive abilities. This critique would permit future inventories to be more cost effective and allow effort to be applied over a greater spatial area. Also this analyses would assist in future sampling designs if various analytical strata were deemed low in sample size.

Secondly, a predictive model should be developed. The intent of this model would be to predict, with confidence, a stream's classification category given a minimum set of parameters. These would permit streams at a broad landscape level to be classified as to their aquatic resource importance. This activity would

include field verification of the model's accuracy. These analyses would provide information on stream types, which need higher consideration operationally, and those considered important ecologically.

Finally, a descriptive analysis of stream reaches by order (Strahler 1957) is required to permit effective in-house planning prior to field operations. This would include a geomorphic and biological description of streams as defined by order. Some direct practical applications of this type of analysis are the ability to predict stream permanency and channel width. Stream permanency and width is of great importance in harvest block design and the buffering of watercourses.

7. Data Interpretations and Management Implications

Interpretations of the information collected under the CFIP and how these interpretations should be applied to the timber harvest industry, particularly at the operational level must be discussed formally. Understanding that the intent of the CFIP was to provide fish and fish habitat data to timber harvest planners and resource managers, it is recommended that planners from all timber harvest companies and managers (both timber and fisheries) from regional and provisional jurisdictions assemble for discussion. This discussion should include concerns with current operating ground rules and rationalised requests for adjustments.

8. Education

An education process should be implemented to enable planners, contractors, and operators to consider the value of various habitat attributes and how these relate to the maintenance of the fisheries resource. It is very important that this education be conducted at the field operation level so that is applied directly to watercourses. For example, instruction on suitable stream crossing techniques and the importance or permitting fish passage, a description of the detrimental effects of siltation and the benefits of minimising stream bank disturbances, and a display of fish presence in streams which are traditionally viewed a non-fish bearing by the lay person. This education at the field level would permit fish to be considered at the initial planning stages.

6.0 LITERATURE CITED

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Appendix A

Stream Inventory Form

Appendix B

Stream Classification Maps

Instructions:

From the DOS prompt, type *print_filename*