IN-STREAM HABITAT COMPLEXING
1993-1995
-PILOT TESTING-

NECHAKO FISHERIES CONSERVATION PROGRAM
Technical Report No. RM95-3

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ABSTRACT

The Nechako River In-Stream Habitat Complexing Project began in 1988 with pilot tests conducted to increase the complexity of juvenile chinook habitat prior to the implementation of the Long-Term Flow Regime of the Kemano Completion Project. Its immediate objectives were to design, test and monitor habitat complex structures specific to the Nechako River. Different habitat complex designs were constructed and monitored between 1988 and 1992. No new complexes were constructed after 1992. This report documents the work done and the assessments of physical performance of Nechako River habitat complexing from 1993 to 1995.

Physical assessments were performed in the spring of each year. A video recording and visual inspection of the complexes were conducted in the fall of 1993. No new complexes were constructed from 1993 to 1995. Downstream booms were added to two rail-anchored sweepers and two hand-placed anchored sweepers in 1993 to improve debris capture.

Damaged or displaced complexes included:

- 3 pseudo beaver lodges;
- 7 rail-anchored sweepers;
- 8 hand-placed anchored sweepers;
- 1 pipe-pile debris catcher;
- 4 rail debris catchers; and,
- 1 pocket pool.

Of the above, the following 10 complexes were not assessed from 1993 to 1995, principally because of debris loss stemming from damage or displacement:

- 2 pseudo beaver lodges;
- 1 rail-anchored sweeper;
- 3 hand-placed anchored sweepers;
- 3 rail debris catchers; and,
- 1 pocket pool.

Fifty complexes are currently being monitored in the Nechako River.

To date, the Nechako Fisheries Conservation Program (NFCP) habitat complexing project has identified the following parameters as important for biological success in habitat complexing:

- shear velocity;
- cover area; and,
- substrate.

Additionally, it was determined that adequate complex anchoring is crucial for the maintenance of structural integrity during fluctuating flows.

The rail-anchored sweepers, hand-placed anchored sweepers, and rail debris catchers have been constructed in a manner that has maintained velocity criteria. Some early structures altered velocities such that design criteria were no longer met.

INTRODUCTION

The Nechako Fisheries Conservation Program (NFCP) was established as a result of an agreement signed in 1987 by Alcan Aluminum Ltd., the Government of Canada, and the Province of British Columbia (Anon. 1987a). The goal of the NFCP is to ensure conservation of Nechako River chinook salmon and protection of migrating sockeye salmon. An integral component of the program is the testing and implementation of remedial measures including the modification of in-stream habitat and construction of habitat complexes.

This report documents the progress of work done on the habitat complexing project during the 1993/94, 1994/1995, and 1995/1996 program years (April 1 to March 31 of each year). All field work for this project was performed between May and October of each year. Therefore, the work is identified in this report as occurring in 1993, 1994 or 1995.

The focus of this report is on the evaluation of the physical performance of habitat complexes constructed since the inception of the project in 1988 and on the modification of these habitat complexes from 1993 to 1995. The evaluation of the biological performance of habitat complexes from 1993 to 1995 is reported elsewhere (Triton 1996a, 1996b, and 1998a).

RATIONALE

In August 1987, a working group of technical experts from the Department of Fisheries and Oceans (DFO), Alcan, and the Province of British Columbia was established to assess how to ensure the conservation and protection of the fisheries resources of the Nechako River. The working group recognized that changes in Nechako River flows following development of the Kemano Completion Project could influence the amount of cover habitat available to juvenile chinook that use the river. This fact prompted a recommendation to increase the complexity of juvenile chinook cover habitat in the Nechako River prior to the implementation of the Long-Term Flow Regime (Anon. 1987a) to replace what cover habitat might be lost due to the flow changes in the river. A preliminary assessment of the types of habitats utilized by Nechako River chinook was conducted via snorkeling surveys in early 1988. Observations from these surveys were used to identify suitable habitat complexing designs for pilot testing. The suggested designs also benefit from the experience of NFCP Technical Committee members and from the results of previous studies on the Nechako River (Envirocon 1984a) which had developed basic habitat criteria (e.g., depth, velocity, substrate) relevant to the proposed habitat complexes.

The NFCP pilot habitat complexing project was initiated in 1988 to test these habitat complexing techniques and to assess their use by Nechako River juvenile chinook. After the 1988 pilot testing, the information on suitable designs was supplemented by a literature review of in-stream habitat complexing projects (Triton 1998b). The review indicated that, although habitat complexes had been widely used to create fish habitat, most techniques had been directed to small streams supporting fish species other than chinook. In addition, quantitative assessments of the effectiveness of these techniques were limited. A supplemental array of potential remedial measures was prepared and selected techniques appropriate to the Nechako River were pilot tested in 1989 and 1990 (Triton 1996c). Following the 1989 and 1990 tests, a short list of recommended habitat complex designs was prepared for more extensive testing. These designs were based on replicating habitat structures found naturally in the Nechako River. In 1991 pilot testing of new complexes continued, along with the replicate construction of selected complexes (Triton 1996d). In 1992 several complexes were modified (Triton 1996e). From 1993 to 1995 monitoring continued and several complexes were further modified or removed. No new habitat complexes were constructed during that period.

OBJECTIVES

The objectives of the habitat complexing project are:

- to determine the hydraulic performance and durability of a variety of proposed habitat complexes through a series of small scale pilot tests;
- to continue the physical assessment of previously constructed habitat complexes; and,
- to identify cost effective methods of achieving the habitat complexing goal set out in the Nechako River Working Group Report.

SCOPE

The scope of the NFCP habitat complexing project consisted of the following:

(1) Construction of a limited number of habitat complexes that have been demonstrated to work on other river systems for other species of salmon;

(2) Construction of a limited number of habitat complexes that could duplicate naturally occurring habitat on the Nechako River;

(3) Installation of these habitat complexes at accessible sites downstream of known spawning grounds; and,

(4) Assessment of habitat complexes under varying flow and meteorological conditions to determine their hydraulic performance and durability.

TYPES OF HABITAT COMPLEXES

The selection of the types of habitat complexes considered for installation in the Nechako River was based on a review of similar work on other river systems, on Nechako River conditions, and on local availability of materials. Woody debris was identified as the preferred "cover habitat" (Triton 1998b and Lister 1994). Habitat complexes identified for pilot testing in the Nechako River were of two types: structures and in-stream modifications.

- Structures consist of debris bundles and debris catchers placed along the river to provide additional cover habitat for rearing chinook juveniles. Debris bundles are trees or root masses cabled to anchors on the river bank. Debris catchers are structures placed at various locations along the stream margin to intercept and hold any large woody debris (LWD) floating downstream. These structures trap the river's natural supply of debris to provide fish habitat.
- In-stream modifications involve the excavation or placement of river bed materials to replicate existing natural morphological features found on the Nechako River.

Since 1988, 13 different habitat complex designs have been tested in the Nechako River. These designs are categorized below as either "structures" - comprised of debris bundles or debris catchers, or "in-stream modifications".

STRUCTURES

Debris Bundles

1) Rootwad Sweepers
2) Brush Piles
3) Floating Cribs
4) Pseudo Beaver Lodges
5) Deep Water Sweepers
6) Rail-anchored Sweepers
7) Hand-placed Anchored Sweepers

Debris Catchers

1) Channel Jacks
2) Pipe-pile Debris Catchers
3) Rail Debris Catchers

IN-STREAM MODIFICATIONS

1) Excavation of a Side Channel, complexed with debris bundles and a debris boom.
2) Construction of Point Bars with back eddy pools on the Nechako River shoreline.
3) Excavation of Pocket Pools from the Nechako River bed.

No new complexes were constructed from 1993 to 1995. Detailed descriptions of habitat complexes constructed from 1988 to 1990 are presented in Triton (1996c). Complexes constructed in 1991 and work performed in 1992 are described in Triton (1996d) and Triton (1996e). These reports detail the process and criteria for site selection and structure design, and the reader is referred to them for more information.

SITE SELECTION AND DESIGN CRITERIA

Since 1988, the criteria used for site selection and for design of all habitat complexes have been based on a review of the general literature (Everest and Chapman 1972; Lister and Genoe 1970), and on an assessment of chinook life history data collected during field studies on the Nechako River (Envirocon Ltd. 1984a; Russell et al. 1983). Habitat complex designs were based on the Nechako River physical characteristics and natural habitats.

The selection of specific sites for habitat complexes in the mainstream Nechako River was based on criteria developed by the Department of Fisheries and Oceans (Anon. 1987b) and Envirocon Ltd. (1984b). The following criteria have been used in the site selection and design of all habitat complexes installed in the mainstem Nechako River since 1988:

Parameter	Criterion Range	Preferred
Velocity (m/s)	0.15 - 0.4	0.3
Depth (m)	not less than 0.4	0.75-1.0
Substrate	gravel to cobble	gravel to cobble
Extension (m)	site specific	5.0

Note that extension is defined as the perpendicular distance from the wetted edge to the outer edge of the structure.

Habitat complexes installed in the mainstem Nechako River from 1988 through 1990 were designed to operate at the Short-Term Flow Regime spring and summer rearing flows of 56.6 m^3/s (2,000 cfs), and at fall and winter flows of 31.1 m^3/s (1,100 cfs) (Anon. 1987a). By comparison, complexes installed in the mainstem Nechako River in 1991 were designed to operate at expected Long-Term rearing flows of 31.1 m^3/s (1,100 cfs) and were located so that they could also operate during lower water levels and river widths associated with future Long-Term winter flows of 14.2 m^3/s (500 cfs). However, all complexes were only evaluated for design criteria fulfillment at approximate Nechako River high and low flows of 56.6 m^3/s (2,000 cfs) and 31.1 m^3/s (1,100 cfs).

The site selection and design criteria used in the construction of the side channel in the spring of 1988 were developed by DFO (Anon. 1987b) and Envirocon Ltd. (1984b) and are presented below. The construction of the side channel was such that depth and velocity at each complex in the channel would be similar to the preferred depth and velocity criteria of complexes in the mainstem Nechako River. The following criteria were developed for the side channel from the above-noted sources for approximate Nechako River high and low flows of 56.6 m^3/s (2,000 cfs) and 31.1 m^3/s (1,100 cfs).

Parameter	Criterion Range
Maximum Depth (m)	0.6
Avg. Cross-sectionalVelocity (m/s)	approx. 0.5
Side Channel Flow Range (m^3/s)	1 - 2
Nechako River FlowRange (m^3/s)	31.1 - 56.6

Side channel bank slopes were graded such that the right bank approximated the existing stable slope of 1.5H:1V and the left bank provided shallow habitat for newly emergent fry through a lower slope of 3.5H:1V. The side channel was assessed for the above parameters in 1996 to determine if the criteria were being achieved. Cover area was also measured during physical assessments.

It was expected that the installation of a given habitat complex would modify velocities at the site, but that the velocities throughout the complex would remain within the criteria range. Therefore, the criteria ranges apply to both the site selection and to the design of the habitat complexes.

PROJECT IMPLEMENTATION

The 1993 to 1995 habitat complexing project implementation was as follows:

- Modifications were made to several existing complexes;
- Physical assessments were performed following the modifications in 1993, and in the springs of 1994 and 1995; and,
- During the fall of 1993, a video recording and visual inspection of the complexes were conducted.

Modifications to existing complexes in 1993 were based on recommendations stemming from the physical assessments and from biological sampling trips in 1992. A summary of all modifications made is presented in Table 1. Details are shown in Table A1 (Appendix A). Of the 60 structures present along the margins of the Nechako in the fall of 1992, four were modified in 1995 and ten were removed in 1993, 1994 and 1995 (four, one and five respectively). Fifty structures thus remained at the end of 1995.

In 1993, physical assessments of habitat complex performance were done during the spring (from June 5 to 10) and a video recording and visual inspection were completed in the fall, on November 19. In 1994, a physical assessment was performed in the spring from May 22 to 25, while in 1995, the assessment was performed from May 16 to 18. The assessments were general inspections of all complexes remaining in the Nechako River since the beginning of the pilot testing project in 1988. Their goals were to identify any structural damage or instability incurred over the winter period and to evaluate the achievement of design criteria. The video and visual inspection in the fall of 1993 involved an investigation of structural damage and displacement following the summer cooling flows in July and August -

Table 1
Summary of Habitat Complexing Construction Activities, 1993 to 1995

Type of Habitat Complex	Abbr.	Quantity Remaining 1992	Quantity Constructed 1993	1994	1995	Quantity Modified 1993	1994	1995	Quantity Removed 1993	1994	1995	Quantity Remaining 1995
STRUCTURES												
Debris Bundles												
Rootwad Sweepers	RS	1	-	-	-	-	-	-	-	-	-	1
Brush Pile	BP	1	-	-	-	-	-	-	-	-	-	1
Floating Cribs	FC	2	-	-	-	-	-	-	-	-	-	2
Pseudo Beaver Lodges	PBL	4	-	-	-	-	-	-	-	-	2	2
Rail-anchored Sweepers	RAS	10	-	-	-	2	-	-	1	-	-	9
Hand-placed Anchored Sweepers	HAS	10	-	-	-	2	-	-	2	-	1	7
Debris Catchers												
Pipe-pile Debris Catchers	PDC	2	-	-	-	-	-	-	-	-	-	2
Rail Debris Catchers	RDC	23	-	-	-	-	-	-	1	-	2	20
IN-STREAM MODIFICATIONS												
Side Channel	SC	1	-	-	-	-	-	-	-	-	-	1
Side Channel Debris Boom	DB	1	-	-	-	-	-	-	-	-	-	1
Point Bars	PB	3	-	-	-	-	-	-	-	-	-	3
Pocket Pools	PP	2	-	-	-	-	-	-	-	1	-	1
Totals		60	0	0	0	4	0	0	4	1	5	50

Modifications: 1993 Downstream booms added to improve debris capture (LM72.9HAS, LM75.9HAS, LM82.1RAS, RM85.7RAS)

Removal: 1993 Removed from assessment due to loss of debris (LM26.6RAS)
Removed from assessment due to loss of loss of logs and debris (RM29.3RDC)
Removed from assessment as stripped of branches by ice during winter 92/93 (LM80.0HAS, LM80.1HAS)

1994 Removed from assessment. River bed movement resulted in loss of complex (MC15.8PP)

1995 Removed from assessment due to loss of debris (LM22.7RDC to control, RM24.8PBL to control, RM31.0PBL to control, MC85.6RDC to natural site)
Removed from assessment as stripped of branches (RM74.1HAS to natural site)

recorded mean daily flows in Nechako River below Cheslatta Falls typically reach approximately 283 m^3/s (10,000 cfs).

Field investigations consisted of an inspection of each complex and of photographic documentation of its condition. Physical assessments of habitat complexes were conducted from shore, by boat and by snorkeling.

The following features were noted during inspections in 1993, 1994 and 1995 at each habitat complex as applicable:

- water depths and velocities upstream and downstream (at 1/3 and 2/3 of the extension), at the inside and outside shear zones, and at a flow-through point within the complex;
- cover area;
- extension from margin;
- attachment to shore;
- depth of cover;
- erosion/sedimentation;
- local substrate; damage;
- displacement; and,
- debris accumulation or loss.

Physical condition and stability were noted with reference to durability (structural integrity since the installation of the complex) and position in the river. Recommendations or comments were noted to modify or remove some complexes, and are presented in this report. This proposed work may be done in future years .

At each complex, velocity was measured with a Swoffer flow meter (model 2100) at 1/3 and 2/3 of the extension. Water depth at these locations was measured with the flow meter rod. The extension and principal cover dimensions of the complexes were measured with a survey tape. Cover areas were then calculated for each complex. The hydraulic characteristics of the complexes under various flows were documented to determine their compliance with design criteria. The amount of debris accumulation or loss was recorded to document the function of habitat complexes under prevailing Nechako River conditions. Substrate composition was noted as a relative ranking of material present.

Summaries of all activities are presented in Tables 1 through 4. Construction details are presented in Table A1 (Appendix A) and the results of physical assessments are presented in Table B1 (Appendix B). Sketches and photos of the habitat complexes are presented in Appendices C and D, respectively.

1993 Habitat Complex Construction Sites

Maps of the 1993, 1994, and 1995 NFCP habitat complexing project study areas for Reaches 1, 2, and 4 including complex locations, are presented in Figures 1 and 2. The complexes were first installed in Reach 4 in 1991, when severe ice conditions were expected to test complex durability.

Spring 1993 Modifications to Habitat Complexes

Between April 15 and April 27, 1993, modifications were made to:

- 2 rail-anchored sweepers (LM82.1RAS, and RM85.7RAS),
- 2 hand-placed anchored sweepers (LM72.9HAS, LM75.9HAS).

The modification was to attach a tree acting as a stiff-leg or downstream boom to the tip of the sweeper by a cable and to anchor the tree's other end to the shore at a point several m downstream. This design allowed the complexes to maintain their position in the current and to trap floating debris. Small diameter logs were used to permit installation of these booms by hand (due to access problems in Reach 4 and to reduce installation costs). Details of the modifications and information on site locations (km downstream from Kenney Dam) are presented in Table A1 (Appendix A).

The 1993 modifications were based on recommendations from the 1992 physical assessments of similar modifications to the pseudo beaver lodge RM24.8PBL and to the rail-anchored sweeper RM26.9RAS (Triton 1996e).

Spring 1993 Physical Assessment

Physical assessments of all complexes were conducted from June 5 to 10, 1993. During that period, discharge in the Nechako River ranged from 57.5 to 59.5 m^3/s (2,031 to 2,101 cfs). In general, most depths were above

Table 2: Summary of 1993 Physical Assessment Observations

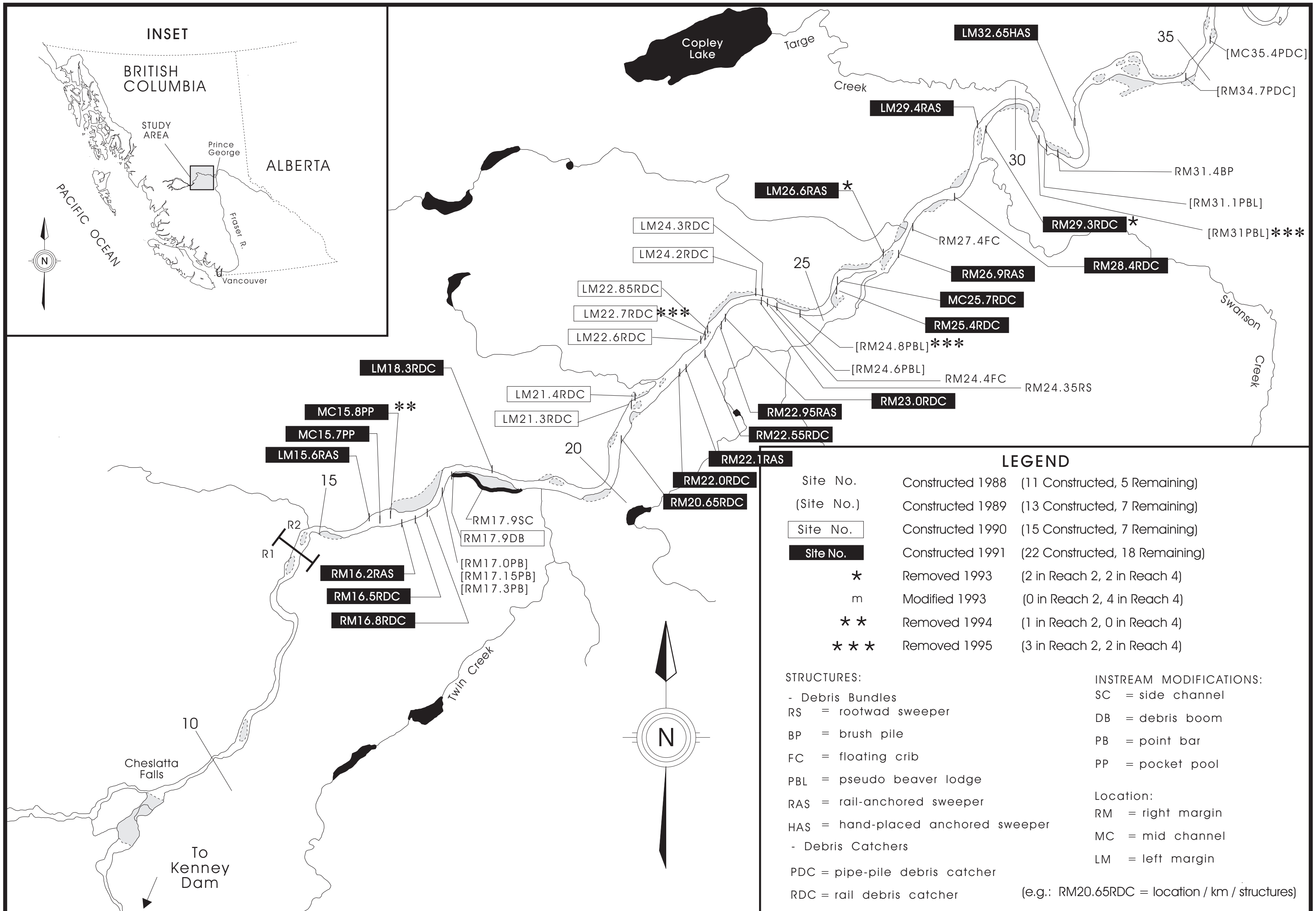
Type of Habitat Complex	Abbrev.	Quantity Remaining 1993	Damage or Displacement in 1993	Cover Area (m^2)	Cover Area Change	Sedimentation or Erosion	Substrate (In order of predominance)	Comments	Recommendations
STRUCTURES									
Debris Bundles									
Rootwad Sweepers	RS	1	No	65	Increased slightly from 1992	Not available	Gravel, fines	None	None
Brush Pile	BP	1	No	13	Increased slightly from 1992	No	Gravel, fines	None	None
Floating Cribs	FC	2	No	48/98	Reduced/Increased slightly from 1992	No	Gravel, fines	None	None
Pseudo Beaver Lodges	PBL	4	Frame broken in 1992 - debris lost - RM31.0PBL. Debris shifted and lost - RM31.1PBL.	7 - 50	Increased from 1992	No	Gravel, fines	Loss of debris at 2 sites, however adequate cover available in the area.	None
Rail-Anchored Sweepers	RAS	9	Broken at outer rail - RM29.4RAS. Loss of shore anchor and debris - LM26.6RAS (removed).	5 - 30	Increased from 1992	Erosion at RM16.2RAS	Gravel, cobble, fines	Two complexes failed to trap new debris. Downstream booms appeared to have helped increase cover area.	None
Hand-Placed Anchored Sweepers	HAS	8	Submerged - RM74.1HAS, Stripped of branches by ice- LM80.0HAS, LM80.1HAS (removed)	7 - 30	Increased from 1992	No	Gravel, cobble, fines	Cover area increased at 2 structures that had downstream booms added.	None
Debris Catchers									
Pipe-Pile Debris Catchers	PDC	2	Rear pile lifted by ice - RM34.7PDC. Outside piles bent on both complexes	150/180	Reduced/Increased slightly from 1992	Sedimentation downstream of larger complex (MC35.4PDC)	Gravel, fines	Complexes stable despite damage.	No
Rail Debris Catchers	RDC	22	Shore cable broken - RM16.4RDC. Loss of logs and debris - RM29.3RDC (removed)	4 - 120	Increased from 1992	Sedimentation (2)/Erosion (5)	Gravel, cobble, fines	Despite damage, most structures were stable and retained debris. Low velocities at some locations due to large cover areas and locations close to shore.	None
IN-STREAM MODIFICATIONS									
Side Channel	SC	1	No	22/27 including natural cover	Increased from 1992	Not available	Not available	Flows blocked by beaver dams since 1989, resulting in no measured velocities.	None
Side Channel Debris Boom	DB	1	No	44	Increased from 1992	Not available	Gravel, cobble, fines	Stable, despite loss of shore anchor in 1992.	None
Point Bars	PB	3	No	Not applicable	Not applicable	Not available	Cobble, gravel	None	None
Pocket Pools	PP	2	No	Not applicable	Not applicable	Erosion at MC15.8PP	Cobble, gravel	Erosion of perimeter, cobbles and gravels deposted in MC15.8PP since 1992, making it difficult to determine boundaries	None

Table 3: Summary of 1994 Physical Assessment Observations

Type of Habitat Complex	Abbrev.	Quantity Remaining 1994	Damage or Displacement in 1994	Cover Area (m^2)	Cover Area Change	Sedimentation or Erosion	Substrate (In order of predominance)	Comments	Recommendations
STRUCTURES									
Debris Bundles									
Rootwad Sweepers	RS	1	No	69	Similar to 1993	No	Gravel, fines, cobbles	None	None
Brush Pile	BP	1	No	37	Increased from 1993	No	Fines	None	None
Floating Cribs	FC	2	No	30/172	Reduced/Increased from 1993	No	Gravel, with fines or cobbles	Smaller crib has little debris - half of complex lifted out of water	None
Pseudo Beaver Lodges	PBL	4	No	14 - 81	Increased from 1993	No	Gravel, fines with some cobbles	Significant debris accumulation at two sites.	None
Rail-Anchored Sweepers	RAS	9	Stripped of branches - RM22.1RAS, RM26.9RAS. Broken - RM22.95RAS.	6 - 43	Increased from 1993	Sedimentation at LM82.2RAS	Gravel, cobble, with boulders and fines at most locations	Two complexes failed to trap new debris. Modified complexes in good condition.	New trees proposed at RM22.95RAS and RM29.4RAS.
Hand-Placed Anchored Sweepers	HAS	8	Broken tree - LM73.0HAS, Stripped of branches - RM74.1HAS, LM80.2HAS.	2 - 45	Increased from 1993	No	Cobbles, fines and gravels	Modified structures in good condition, with good debris accumulation.	New sweeper tree recommended for LM73.0HAS
Debris Catchers									
Pipe-Pile Debris Catchers	PDC	2	No	91/192	Reduced/Increased slightly from 1993	Sedimentation downstream of both complexes	Fines, gravels, cobbles	Complexes stable despite damage.	No
Rail Debris Catchers	RDC	22	No	7 - 136	Increased from 1993	Sedimentation (5)/Erosion (6)	Gravel, cobble, with boulders and fines at most locations	Despite damage, most structures were stable and provided adequate cover areas.	None
IN-STREAM MODIFICATIONS									
Side Channel	SC	1	No	32/96 including natural cover	Increased from 1993	Not available	Not available	Flows blocked by beaver dams since 1989, resulting in no measured velocities.	None
Side Channel Debris Boom	DB	1	No	32	Reduced from 1992	No	Gravel, fines, cobbles	Stable, despite loss of shore anchor in 1992.	None
Point Bars	PB	3	No	Not applicable	Not applicable	No	Cobble, fines, gravels	None	None
Pocket Pools	PP	1	Significant erosion - MC15.8PP (removed).	Not applicable	Not applicable	Continued erosion at MC15.8PP	Cobble, boulders, gravels	Erosion of perimeter, cobbles and gravels deposted in MC15.8PP since 1992, making it difficult to determine boundaries - complex removed from assessment.	None

Table 4: Summary of 1995 Physical Assessment Observations

Type of Habitat Complex	Abbrev.	Quantity Remaining 1995	Damage or Displacement in 1995	Cover Area (m^2)	Cover Area Change	Sedimentation or Erosion	Substrate (In order of predominance)	Comments	Recommendations
STRUCTURES									
Debris Bundles									
Rootwad Sweepers	RS	1	No	55	Reduced from 1994	Sedimentation	Fines and gravel	None	None
Brush Pile	BP	1	No	4	Reduced from 1994	No	Fines and gravel	Movement of river bank resulted in dewatering of the complex.	None
Floating Cribs	FC	2	No	23/91	Reduced from 1994	No	Fines and gravel	Smaller crib has little debris trapped.	None
Pseudo Beaver Lodges	PBL	2	Two removed due to loss of debris - RM24.8PBL, RM31.0PBL.	21/50	Similar to 1994	No	Gravels and fines	None	None
Rail-Anchored Sweepers	RAS	9	Three broken - RM22.1RAS near outside anchor, LM29.4RAS outside anchor lost, LM82.2RAS anchor stump broken. Reduced to bare log - RM22.95RAS. Stripped of branches - RM16.2RAS.	1 - 24	Reduced from 1994	Sedimentation at LM82.2RAS	Gravel and cobble, with boulders or fines at most complexes.	None	None
Hand-Placed Anchored Sweepers	HAS	7	Displaced - LM32.65HAS. Reduced to bare log - LM72.9HAS, LM73.0HAS, LM78.0HAS. Removed - RM74.1.	2 - 15	Reduced from 1994	Sedimentation at 2 sites.	Gravel, fines, cobbles	None	None
Debris Catchers									
Pipe-Pile Debris Catchers	PDC	2	Downstream pile broken - RM34.7PDC.	42/149	Reduced from 1994	Sedimentation downstream of larger complex	Fines and gravel	Smaller complex lost debris due to loss of pile.	No
Rail Debris Catchers	RDC	20	Two removed due to loss of debris - LM22.7RDC and MC85.6RDC.	8 - 137	Similar to 1994.	Sedimentation (3)/Erosion (11)	Gravel, cobble and fines at most locations	None	None
IN-STREAM MODIFICATIONS									
Side Channel	SC	1	No	Not available	Not applicable	Not available	Gravel, fines and cobbles.	Flows blocked by beaver dams since 1989, resulting in no measured velocities.	None
Side Channel Debris Boom	DB	1	No	60	Increased from 1994	Some sedimentation downstream of complex.	Fines, gravel and cobbles	Stable, despite loss of shore anchor in 1992.	None
Point Bars	PB	3	No	Not applicable	Not applicable	No	Cobbles, gravel and fines	None	None
Pocket Pools	PP	1	No	Not applicable	Not applicable	Not available	Cobble, boulders and gravel	None	None



Nechako Fisheries Conservation Program | Map # RM95-3F1

0 5 km

FIGURE 1. NECHAKO RIVER MAINSTEM STUDY AREA 1993,1994, and 1995, REACH 1 & 2

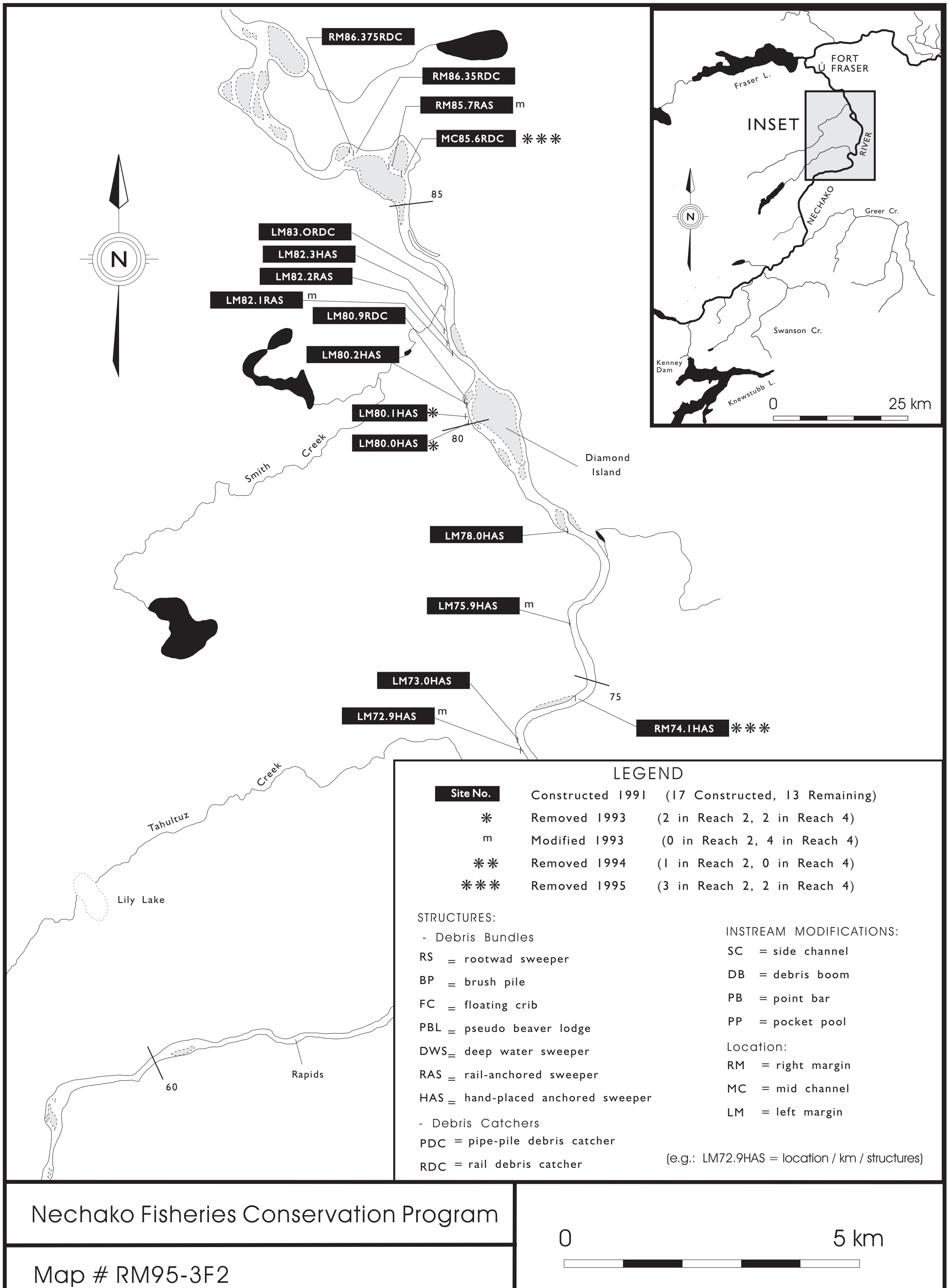


FIGURE 2. NECHAKO MAINSTEM STUDY AREA 1993, 1994, and 1995, REACH 4

the minimum criterion limit of 0.4 m. Overall, 1/3 of the velocities were distributed within the criterion range of 0.15 to 0.40 m/s, 1/3 below and 1/3 above it. Upstream velocities were generally within the criterion range, while flow-through and downstream velocities were generally below that range. Outside and inside shear velocities were generally above the range. Observations from those assessments and recommendations are summarized below and in Table 2. Details are presented in Table B1 (Appendix B).

Structures

Debris Bundles

In 1993, the majority of debris bundles were stable with cover areas generally greater than those measured in 1992. Gravel was the predominant substrate, with fines or cobble also present.

Damage or displacements were noted for two pseudo beaver lodges, two rail anchor sweepers, and three hand placed anchored sweepers. Three structures were removed. Details are as follows:

- The frame on pseudo beaver lodge RM31.0PBL was broken in 1992. As a result, the accumulated debris shifted and was lost from the complex structure.
- Rail-anchored sweeper LM26.6RAS was removed after the loss of its shore anchor and debris. An outer rail broke at rail-anchored sweeper RM29.4RAS.
- Hand-anchored sweepers LM80.0HAS and LM80.1HAS were stripped of branches by ice, and both structures were removed. Complex RM74.1HAS was submerged due to high flows.

Debris Catchers

The two pipe-pile debris catchers continued to maintain very large cover areas of 150 and 180 m^2. The rear pile of the smaller complex had been lifted from the river bed by ice and was near failure. The outside piles were bent on both complexes. Despite the damage, the complexes were stable. Sedimentation was apparent downstream of the larger complex, due to large cover areas and low velocities.

One rail debris catcher (RM29.3RDC) was removed from the 1993 assessment due to the loss of its logs and debris during the 1992 summer cooling flows. Structure RM16.4RDC had its shore cable broken, resulting in a loss of debris. Debris accumulation was observed at several complexes, and cover area of the 22 rail debris catchers had increased, ranging from 4 to 120 m^2. Gravel was the predominant substrate, with cobbles and fines present at the majority of the complexes. Erosion was observed at five of the complexes, and sedimentation occurred behind the complexes at two sites. Large cover areas and positioning in the river resulted in low velocities through some of the complexes, with flow passing outside them.

In-Stream Modifications

No new damage or displacement were noted on the instream modifications in 1993. However, low or near zero velocities were observed in the side channel that became blocked in 1991.

The area of the debris trapped by the boom at the upper end of the channel increased to 44 m^2 and additional debris was observed on the shore. The complex was stable despite the shore deadman anchor having been unearthed in 1992, and no further displacement had occurred.

No damage to the point bars was visible during the spring physical assessment. Cobble and gravel were the dominant substrates.

The pocket pool located in the high velocity area (MC15.8PP) continued to erode along its perimeter. Cobbles and gravels had been deposited within the pool, making it very difficult to locate the complex and determine its boundaries.

Fall 1993 Physical Assessment

On November 19, 1993, a visual inspection and video recording of the habitat complexes were to complete any damage or displacement following summer cooling flows in July and August. The inspection showed that two rail-anchored sweepers were broken in half, yet their cover areas remained similar to their spring values. Information on the fall assessment is presented in Table B2 (Appendix B).

Spring 1994 Physical Assessment

All complexes were assessed from May 22 to 25, 1994. The discharge in the Nechako River below Cheslatta Falls was similar to that of spring 1993, ranging from 56.7 - 57.5 m^3/s (2,002 to 2,031 cfs). Most depths measured were above the minimum criterion limit of 0.4 m. As in 1993, about 1/3 of the velocity measurements were within the criterion range of 0.15 to 0.40 m/s, 1/3 were below and 1/3 were above it. Upstream velocities measured at 1/3 extension were generally below the criterion, while upstream velocities at 2/3 extension were generally above it. Outside and inside shear velocities were generally above the criterion. Flow-through velocities were usually either within or below the criterion, while downstream velocities were generally below it. The observations from the assessments are summarized below and in Table 3. Details are presented in Table B3 (Appendix B).

Structures

Debris Bundles

In 1994, the majority of debris bundles were stable, with cover areas generally increased from 1993. The following damages was noted:

- Rail-anchored sweepers RM22.1RAS and RM26.9RAS were stripped of their branches and the tree at RM22.95RAS was broken.
- Similarly, hand-placed anchored sweepers RM74.1HAS and LM80.2HAS were stripped of their branches and the tree at LM73.0HAS was broken.

Debris Catchers

As in 1993, the two pipe-pile debris catchers maintained very large cover areas of about 91 and 192 m^2. The complexes were stable despite some damage to the pilings. Sedimentation was observed again downstream of both complexes.

The rail debris catchers were generally stable and provided increased cover areas over 1993, ranging from 7 to 136 m^2. Erosion was observed at six complexes, and sediment accumulations were found behind five complexes.

In-Stream Modifications

Low water velocities in the side channel were again observed in 1994. The cover area of the debris bundles within the side channel was estimated at 32 m^2. However, the cover area increased to about 96 m^2 when natural cover was included .

The debris boom's cover area was relatively stable at 32 m^2. The structure continued to be in good condition, with no displacement even with its shore deadman damaged.

The point bars continued to be in good condition in 1994, with no damage or displacement noted.

Due to significant erosion of the pocket pool in the high velocity location, this complex was not assessed in the spring of 1994. In 1994, the remaining lower velocity complex had an area of 49 m^2. The substrate consisted mainly of cobbles and boulders, with no erosion or sedimentation noted.

Spring 1995 Physical Assessment

All complexes were assessed from May 16 to 18, 1995. The discharge at the Nechako River below Cheslatta Falls was higher than in 1993 or 1995 at 62.3 m^3/s (2,200 cfs). Most depths measured were again above the minimum criterion limit of 0.4 m. As in 1993, about 1/3 of the velocity measurements were within the criterion range of 0.15 to 0.40 m/s, 1/3 were below and 1/3 were above it. Upstream velocities at 1/3 extension were generally below or within the criterion, while upstream velocities at 2/3 extension were generally above it. Outside shear velocities were generally above the criterion while inside shear velocities were generally within it. Flow-through velocities were usually below the criterion and downstream velocities were generally below it. The observations from the assessments are summarized below and in Table 4. Details are shown in Table B4 (Appendix B).

Structures

Debris Bundles

In 1995 the debris bundles were generally stable, but cover areas were generally reduced from 1994. Damage or displacements were observed as follows:

- Two pseudo beaver lodges (RM24.8PBL and RM31.0PBL) had lost all debris and were therefore removed.

- Three rail-anchored sweepers were damaged - the tree at RM22.1RAS was broken near its outside anchor, LM29.4RAS had lost its outside anchor and LM82.2RAS had its anchor stump broken.
- Rail-anchored sweepers RM16.2RAS and RM22.95RAS were stripped of branches.
- The hand-placed anchored sweeper LM32.65HAS was displaced to shore, and LM72.9HAS, LM73.0HAS, LM78.0HAS were reduced to bare logs. The complex RM74.1HAS was removed from further assessment as it had been completely defoliated since 1993.

Debris Catchers

The cover areas of the two pipe-pile debris catchers were smaller than in 1994, having been reduced from 91 and 192 m^2 to 42 and 149 m^2. The smaller complex lost a significant amount of debris as its downstream pile finally broke after several years of uplift and loosening during winter. No displacement was observed to the other complex although sediment continued to accumulate immediately downstream of the structure. The substrate generally consisted of fines and gravel. No recommendations were made for any repairs.

In 1995, two rail debris catchers were subsequently removed from ?? biological and physical assessments due to loss of debris after the summer cooling flows in 1994. Complex LM22.7RDC was changed to a control site and complex MC85.6RDC was changed to a natural site. The remaining rail debris catchers were generally stable with cover areas ranging from 8 to 137 m^2. Gravel was the predominant substrate, with cobbles and fines also generally present. Erosion was observed at 11 of the complexes, and sediment accumulation at three complexes.

In-Stream Modifications

In 1995, a beaver dam blocking the flows in the side channel resulted in near zero velocities in the channel. Cover area of the debris bundles or natural debris was not recorded in 1995. Gravel and fines were the dominant substrates.

Cover area of the debris boom increased from 1994 to about 60 m^2. The structure remained stable despite damage to its shore deadman. Fines and gravels were the dominant substrates, with cobbles also present. Some sedimentation was observed downstream of the complex.

No damage or displacement were noted for the point bars. Cobbles were the dominant substrate.

No damage nor erosion nor sedimentation were noted on the remaining pocket pools. The substrate consisted mainly of cobbles and boulders.

Construction Methods

Modifications made to existing habitat complexes in 1993 were completed manually with chain saws, power drills and oxyacetylene cutting torches. A work boat with a jet-converted outboard motor was used for the transport of personnel and miscellaneous materials. Locally available materials used in the modification of complexes included available LWD, and timber such as pine and spruce. Materials transported to the sites included cables, clamps and anchor material. Cables were secured to anchors and / or LWD by threading and looping the cables through holes in the timber, and then attaching the two ends together with cable clamps.

Construction Costs

Approximately $4,400 were spent on the modification of habitat complexes in 1993 (Table 5). The total cost was based on an estimated unit cost of $1,100 ($600 in fees and $500 in disbursements) to add downstream booms to two rail and two hand-placed anchored sweepers. The estimated costs include all charges associated with labour, materials, equipment, and other disbursements.

OBSERVATIONS ON HABITAT COMPLEX PERFORMANCE

The evaluation of the structural performance of some complexes is still at an early stage. It is also early to judge the long-term durability of items used in the anchoring of complexes (cable, chain, clamps) as these items may corrode in the future. However, it is instruc-

Table 5
Summary of Habitat Complexing Construction Costs in 1993*

Type of Habitat Complex	Quantity Modified (Units)	Cost ($/Unit)**	Total Cost	Comments
Rail-anchored Sweeper	2	$1,100	$2,200	Addition of downstream boom to improve debris capture.
Hand-placed Anchored Sweeper	2	$1,100	$2,200	Addition of downstream boom to improve debris capture.
Total Construction Cost - 1993			$4,400	

* Costs presented are estimates for the modification of existing structures only. No new complexes were constructed in 1993.
** Cost estimates based on $600 in fees and $500 in disbursements for reach unit, excluding GST.

tive to examine the performance of the habitat complexes constructed to date to develop some understanding of the factors affecting complex durability and / or performance. These observations can be used to further evaluate the criteria used in the design and siting of the complexes. This section summarizes the condition of complexes since their construction and factors affecting their biological and physical performance.

Structures

Debris Bundles

Rootwad Sweepers

The last remaining rootwad sweeper of the original four complexes constructed in 1988 was modified in 1990 to reduce seeded material. The other three structures were removed due to the failure of the stapling of cable anchors. The last complex has remained stable, with no damage or displacement noted. This is most likely a result of its location in a low velocity, shallow area. No modifications to this complex were recommended as it has performed satisfactorily.

Brush Pile

The brush pile complex installed in 1988 has remained stable. However, its cover area has fluctuated from as high as 37 m^2 in the spring of 1991 to as low as 4 m^2 in the spring of 1995 due to changes in shoreline associated with changes in water levels. Some sedimentation was observed in the fall of 1992 and fines have been the dominant substrate in recent years. No modifications were recommended to this complex from 1993 to 1995. The small sample size (1) limits the conclusion that can be made about stability, design, performance and durability of this type of complex.

Floating Cribs

The two floating cribs installed in 1988 have generally provided significant amounts of cover. In 1991, the smaller complex was moved further into the current in an effort to increase velocities. Anchoring was improved by securing the complex to two steel rails driven into the river bed. However, this complex was displaced onto the shore and its downstream stiff-leg was broken in 1992. The upstream floating crib was colonized by beavers in the fall of 1989 and has been left untouched since. In recent years, the cover areas of these complexes have been reduced, with the smaller complex not providing as much cover as it is partially dewatered and because its woody debris extend over only part of the structure. Both floating cribs have generally been stable, with no damage or displacement noted since 1993.

Pseudo Beaver Lodges

The design of the pseudo beaver lodges was modified in the fall of 1989 to better maintain position in the river following flow recession. However three modified units continued to lose debris in 1991. An extra boom was added to one complex prior to reseeding to provide additional flotation and to assist in debris retention in the spring of 1992. This modification appeared to help retain debris over the summer cooling flows. However, this complex and two others were again damaged or displaced at higher flows. The cover areas of these complexes were therefore significantly reduced at most sites. In 1995, due to continued debris loss, two pseudo beaver lodges (including the structure modified in 1992) were removed from further biological and physical assessments.

Rail- Anchored Sweepers

During the summer of 1991, 10 rail-anchored sweepers were installed along the Nechako River. Three sweepers were modified in 1992 as a result of damage incurred during the 1991 and 1992 summer cooling flows. In 1993, two sweepers were modified with the addition of downstream tree booms to improve debris capture. One of the rail-anchored sweepers was removed after having been repaired in 1992, as it had lost its shore anchor for the second time and lost much debris.

Between 1993 and 1995, most of the nine sweepers were damaged, either at the trees or at the anchor points. Several of the sweepers were stripped to the point of being reduced to bare logs.

As reported in Triton (1996e) the rail-anchored sweepers have required significant repairs during their rather short lives in the Nechako River. The short rails installed on these complexes allow little vertical movement of the sweepers as water levels rise, which may account for the lack of collected debris. They also become submerged at higher flows and lose accumulated debris. Additionally, the single tree which serves to collect debris is susceptible to loss of its branches due to stripping and to damage under larger flows.

The downstream booms added to two complexes in 1993 initially increased debris entrapment and helped to reduce the loss of cover area over time. However, these structures were significantly reduced in size between 1993 and 1995. Only smaller logs could be used as these additional booms were placed by hand. The small booms were not very effective as they became submerged at high flow under the debris load.

Hand-Placed Anchored Sweepers

In 1991, a total of 11 hand-placed anchored sweepers were installed - two in Reach 2 and nine in Reach 4, where there is no heavy equipment access. One of these complexes was displaced in Reach 2 during the 1991 summer cooling flows and omitted from further physical assessment. A second displaced complex in Reach 2 was repaired in the spring of 1992, only to fail again during that summer's cooling flows. Two hand-placed anchored sweepers in the spring of 1993, and another one in 1995, were removed from biological and physical assessments in Reach 4 due to loss of branches reducing their cover area.

As with rail-anchored sweepers, these complexes were not successful in capturing additional debris, and tended to be stripped, damaged or displaced during winter ice movement and high summer flows. Hand-placed anchored sweepers suffer from problems similar to the rail-anchored sweepers, i.e. lack of stability under increased flows and stripping of branches. Downstream booms added to two complexes in 1993 did not prevent one unit from being stripped to the point of turning into a bare log. The second modified unit was significantly reduced in size between 1993 and 1995. As noted above, boom placement by hand does not allow large enough logs to be used.

Debris Catchers

Pipe-Pile Debris Catchers

Since their installation in 1989, the two pipe-pile debris catchers have been generally stable under variable flow conditions, despite both complexes pilings being bent or pulled from the river bed. Sedimentation was observed at both sites from 1993 to 1995, due to the large size of the complexes and low velocities. In 1995, the smaller complex lost a significant amount of debris following the loss of its downstream piling. No recommendations were made for any repairs as the structures are still intact and maintain large cover areas.

Rail Debris Catchers

Seven large-sized rail debris catchers were constructed in 1990. In 1991, an additional 16 smaller catchers were constructed to maintain more manageable debris piles. The first large rail debris catchers have been generally quite durable. However, the smaller structures have required regular repairs and reseeding following summer cooling flows.

From 1993 to 1995, three rail debris catchers (two built in 1991 and one built in 1990) were removed from the assessment due to loss of logs and debris following summer cooling flows. Despite structural damage in 1992, most remaining complexes were stable and maintained cover areas of up to 137 m^2. Triton (1996e) suggested that the repeated damage to the newer complexes may be partially due to the down-scaling of complex size in 1991.

To match the durability of the older complexes, the log boom diameter of future complexes may have to be increased to prevent breakage at the anchor points. Stronger cable anchoring should also be considered. In addition, the attachment of the chains connecting the booms to the rails should be redesigned to prevent loss of accumulated debris and loss of boom logs over the rails during high summer flows. The chains could be directly attached to eyes in the rails with sufficient slack to allow the logs to rise and fall with changes in water level. Finally, the aesthetics of these structures have been an issue since their construction. Methods to camouflage the steel components are being investigated.

In-Stream Modifications

Side Channel

The original side channel with full spanning complexes and a debris boom built in 1988 had problems with excessive debris accumulation. As a result, in 1990, the debris boom was moved upstream of the channel entrance to prevent excessive loading within the channel. In addition, the full spanning habitat complexes in the side channel were removed and replaced with smaller single logs buried at intervals along the margins (Triton 1996c). Despite these modifications, low flows and subsequent construction of dams by beavers within the side channel resulted in velocities well below criteria limits. From 1993 to 1995, flows in the side channel continued to be blocked and velocities measured zero. No recommendations for improvements have been made as lack of adequate flow and continual beaver dam blockage has made the complex undesirable for long term use.

The debris boom installed upstream of the side channel in 1990 was designed to prevent excessive debris accumulation in the side channel. Although the shore deadman anchor was unearthed in 1992, the complex has remained stable, and no further displacement has occurred. The complex has been successful in trapping and retaining debris and has increased in size to approximately 60 m^2 in 1995. No specific recommendations were made; because of the damage incurred, however, the complex should be monitored for displacement during subsequent visits.

Point Bars

The point bars were modified in 1991 to reduce their extension and to increase their elevation. This was done to encourage formation of a back eddy and to reduce erosion of the surface during overtopping of the complexes during high summer flows. There has been no damage to the complexes since these modifications. Fines were deposited in the back eddy pools of these complexes in 1992, indicating that downstream velocities were low.

Pocket Pools

The two pocket pools constructed during the summer of 1991 were subject to either low velocities and sedimentation, or high velocities and channel scouring, depending on the location. In 1992, deposition of fines was apparent within the low velocity pool, while significant erosion of the high velocity pool's sides had taken place, making it difficult to locate and determine its boundaries.

In 1994, due to significant erosion of the high velocity pocket pool, this complex was removed from further assessment. The remaining lower velocity complex continues to provide an adequate pool area with no noted erosion or sedimentation.

Resistance to Winter Physical Conditions

During 1991, complexes were installed in Reach 4 of the Nechako River in an effort to expose the complexes to more severe ice conditions. These complexes were assessed for winter resistance for the first time in 1992.

From 1993 to 1995, several rail-anchored sweepers and hand-placed anchored sweepers lost branches or were damaged. In 1993, two hand-placed anchored sweepers located in high velocity areas of Reach 4 were severely damaged by ice and were removed from biological and physical assessments. Rail-anchored sweepers located in Reach 2 also experienced some damage.

In addition, both pipe-pile debris catchers in Reach 2 have had their pilings lifted from the river bed by ice. Rails used in the construction of other habitat complexes have also been uplifted. If this trend continues, these structures may suffer the same problems as RM34.7PDC, and lose much or all of their debris.

As some sites in Reach 4 experience higher velocities and stage changes than in Reach 2, damage to structures in Reach 4 may also occur during the summer cooling flows. It should be noted that in addition to more severe ice and high flow conditions, Reach 4 also experiences lower debris recruitment which limits the size of its structures compared to those of Reach 2.

Factors Affecting Biological Performance

Visual observations confirm that the man made habitat structures are well used by juvenile chinook salmon during the spring rearing period. Large schools of chinook are often seen in the debris and the shear zones of various structures during the biological assessments (Triton 1996a, b, f, and g, and 1998a). Electrofishing results have shown that the man made structures are also used by overwintering chinook juveniles.

The physical factors affecting the observed density of chinook juveniles in habitat complexes during snorkel surveys have been analyzed since 1991 (Triton 1996a, b, f, and g, and 1998a). Cover area is usually positively correlated with chinook abundance. Other important variables include shear velocity and substrate. Chinook abundance is negatively correlated with fines (Triton 1996f), and complexes should therefore be located in areas of gravel and cobble substrate. These should provide sufficient velocity to maintain adequate flow-through to minimize deposition of fines.

Site selection is essential in establishing a complex which fulfills velocity design criteria over the full range of flows. The target species of fish will also influence the cover area design range and the type of complex . In the case of chinook salmon, habitat complexes which impede velocities should be avoided, and should have the appropriate cover density.

Since the beginning of this project, the rail-anchored sweepers, hand-placed anchored sweepers, and rail debris catchers have generally provided acceptable velocities and cover areas. These designs could be improved to also provide long term durability.

Factors Affecting Physical Performance

Anchoring systems for habitat complexes must be secured adequately. The deadman and rail anchoring systems used in the NFCP habitat complexing project have been successful. The suggested method of attaching cable to anchors and LWD is the looping and threading method. Stapling of cable has proved to be unsuccessful. Anchoring systems must also be designed to function under variable and transient flow conditions. The adaptability of habitat complex anchoring systems to changing flow conditions and site-specific conditions is particularly important for maintaining position and stability following flow recession. Successful complexes move with fluctuating flows so that the structures do not become submerged during high flows. Stripping or other damage to the structure is therefore less likely, and accumulated debris do not drift out of the complex.

SUMMARY AND RECOMMENDATIONS

Since 1988, the NFCP pilot habitat complexing program has constructed and tested 13 different complex designs.

No new complexes were constructed from 1993 to 1995. Downstream booms were added to two rail-anchored sweepers and two hand-placed anchored sweepers in 1993 to improve debris capture.

Damaged or displaced complexes included:

- 3 pseudo beaver lodges;
- 7 rail-anchored sweepers;
- 8 hand-placed anchored sweepers;
- 1 pipe-pile debris catcher;
- 4 rail debris catchers; and,
- 1 pocket pool.

Of the above, the following 10 complexes were removed from assessment from 1993 to 1995, principally due to debris loss stemming from damage or displacement:

- 2 pseudo beaver lodges;
- 1 rail-anchored sweeper;
- 3 hand-placed anchored sweepers;
- 3 rail debris catchers; and,
- 1 pocket pool.

Fifty complexes are currently being monitored in the Nechako River.

To date, the NFCP habitat complexing project has identified the following parameters as important for biological success in habitat complexing:

- shear velocity;
- cover area; and,
- substrate.

Additionally, it has been determined that adequate complex anchoring is crucial for the maintenance of structural integrity during fluctuating flows.

The rail-anchored sweepers, hand-placed anchored sweepers, and rail debris catchers have generally provided acceptable velocities and cover areas.

REFERENCES

Anon. 1987a. Settlement Agreement 1987.

Anon. 1987b. Study of juvenile chinook salmon in the Nechako River, British Columbia, 1985 and 1986. Department of Fisheries and Oceans. Can. Man. Rept. Fish. Aquat. Sci. No. 1954.

Envirocon Ltd. 1984a. Aluminum Company of Canada, Ltd. Kemano Completion Hydroelectric Development - Environmental Studies. Volume 5: Fish resources of the Nechako River system, baseline information.

Envirocon Ltd. 1984b. Aluminum Company of Canada, Ltd. Kemano Completion Hydroelectric Development - Environmental Studies. Volume 15: Environmental Planning and Project Design. Section E: Nechako Habitat Modelling.

Everest, F.H. and D.W. Chapman. 1972. Habitat selection and spatial interaction by juvenile chinook and steelhead trout in two Idaho streams. J. Fish Res. Bd. Can 29: 91-100

Lister, D.B. and Genoe, H.S. 1970. Stream habitat utilization by cohabitating underyearlings of chinook and coho salmon in the Big Qualicum River, B.C. J. Fish. Res. Bd. Can. 27(7):1215-1224.

Lister, D.B. 1994. Preliminary Inventory of Habitat Cover/Cover Opportunities, Nechako River 1989. Nechako Fisheries Conservation Program Report No. RM89-6.

Russell, L.R., K.R. Conlin, O.K. Johansen, and U. Orr. 1983. Chinook salmon studies in the Nechako River: 1980, 1981, 1982. Can. MS Rep. Fish. Aquat. Sci. No. 1728.

Triton Environmental Consultants Ltd. 1996a. Biological Assessment of Habitat Complexing in the Nechako River, 1993. Nechako Fisheries Conservation Program Data Report No. RM93-4.

Triton Environmental Consultants Ltd. 1996b. Biological Assessment of Habitat Complexing in the Nechako River, 1994. Nechako Fisheries Conservation Program Data Report No. RM94-3.

Triton Environmental Consultants Ltd. 1996c. In-Stream Habitat Complexing, 1988 to 1990. Pilot Testing. Nechako Fisheries Conservation Program Technical Report No. RM90-3.

Triton Environmental Consultants Ltd. 1996d. In-Stream Habitat Complexing, 1991. Pilot Testing. Nechako Fisheries Conservation Program Technical Report No. RM91-3.

Triton Environmental Consultants Ltd. 1996e. In-Stream Habitat Complexing, 1992. Pilot Testing. Nechako Fisheries Conservation Program Technical Report No. RM92-3.

Triton Environmental Consultants Ltd. 1996f. Biological Assessment of Habitat Complexing in the Nechako River, 1991. Nechako Fisheries Conservation Program Data Report No. RM91-6.

Triton Environmental Consultants Ltd. 1996g. Biological Assessment of Habitat Complexing in the Nechako River, 1992. Nechako Fisheries Conservation Program Data Report No. RM92-6.

Triton Environmental Consultants Ltd. 1998a. Biological Assessment of Habitat Complexing in the Nechako River, 1995. Nechako Fisheries Conservation Program Data Report No. RM95-3. In Prep.

Triton Environmental Consultants Ltd. 1998b. Investigations into the use of in-stream cover structures by juvenile chinook salmon. Nechako Fisheries Conservation Program Data Report No. RM88-2. In Prep.

Appendix A

1993 to 1995 Summary of Habitat Complexing Modification and/or Removal Rationale

Appendix A
1993 to 1995 Summary of Habitat Complexing Modification and / or Removal Rationale

Location (km)	Site Number	93 Sp	93 Fa	94 Sp	94 Su	95 Sp	95 Su	Nature of Modification	Modification and/or Removal Rationale
Reach 2									
15.6	LM15.6RAS								
15.7	MC15.7PP								
15.8	MC15.8PP			R				Removed from assessment (94Sp).	River bed movement resulted in loss of complex.
16.2	RM16.2RAS								
16.5	RM16.5RDC								
16.8	RM16.8RDC								
17.0	RM17.0PB								
17.15	RM17.15PB								
17.3	RM17.3PB								
17.9	RM17.9DB								
17.9-18.6	RM17.9SC								
18.3	LM18.3RDC								
20.65	RM20.65RDC								
21.3	LM21.3RDC								
21.4	LM21.4RDC								
22.0	RM22.0RDC								
22.1	RM22.1RAS								
22.55	RM22.55RDC								
22.6	LM22.6RDC								
22.7	LM22.7RDC					R		Removed from assessment (95Sp).	Lost almost all debris. Maintained as a control site.
22.85	LM22.85RDC								
22.95	RM22.95RAS								
23.0	RM23.0RDC								
24.2	LM24.2RDC								
24.3	LM24.3RDC								
24.35	RM24.35RS								
24.4	RM24.4FC								
24.6	RM24.6PBL								
24.8	RM24.8PBL					R		Removed from assessment (95Sp).	Lost almost all debris. Maintained as a control site.
25.4	RM25.4RDC								
25.7	MC25.7RDC								
26.6	LM26.6RAS	R						Removed from assessment (93Sp).	Onshore anchor pulled second time. Lost all debris in summer 1992.
26.9	RM26.9RAS								
27.4	RM27.4FC								
28.4	RM28.4RDC								
29.4	LM29.4RAS								
29.3	RM29.3RDC	R						Removed from assessment (93Sp).	Lost logs over rails in summer 1992 and lost all debris.
31.0	RM31.0PBL					R		Removed from assessment (95Sp).	Lost almost all debris. Maintained as a control site.
31.1	RM31.1PBL								
31.4	RM31.4BP								
32.65	LM32.65HAS								
34.7	RM34.7PDC								
35.4	MC35.4PDC								

Appendix A (continued)
1993 to 1995 Summary of Habitat Complexing Modification and / or Removal Rationale

Location (km)	Site Number	93 Sp	93 Fa	94 Sp	94 Su	95 Sp	95 Su	Nature of Modification	Modification and/or Removal Rationale
Reach 4									
72.9	LM72.9HAS	M						Addition of downstream boom.	To improve debris capture.
73.0	LM73.0HAS								
74.1	RM74.1HAS					R		Removed from assessment (95Sp).	Completely stripped of branches, just bare log remaining. Maintained as a natural site.
75.9	LM75.9HAS	M						Addition of downstream boom.	To improve debris capture.
78.0	LM78.0HAS								
80.0	LM80.0HAS	R						Removed from assessment (93Sp).	Branches stripped by ice during winter 92/93
80.1	LM80.1HAS	R						Removed from assessment (93Sp).	Branches stripped by ice during winter 92/93
80.2	LM80.2HAS								
80.9	LM80.9RDC								
82.1	LM82.1RAS	M						Addition of downstream boom.	To improve debris capture.
82.2	LM82.2RAS								
82.3	LM82.3HAS								
83.0	LM83.0RDC								
85.6	MC85.6RDC					R		Removed from assessment (95Sp).	Lost almost all debris. Maintained as a natural site.
85.7	RM85.7RAS	M						Replaced sweeper and added d/s boom.	Old sweeper removed by ice in winter 92/93. D/s boom added to improve debris capture
86.35	RM86.35RDC								
86.375	RM86.375RDC								

Where,

- RS = rootwad sweeper
- BP = brush pile
- FC = floating crib
- PBL = pseudo beaver lodge
- RAS = rail-anchored sweeper
- HAS = hand-placed anchored sweeper
- CJ = channel jack
- PDC = pipe-pile debris catcher
- RDC = rail debris catcher
- SC= side channel
- DB = debris boom
- PB = point bar
- PP = pocket pool

- Sp = Spring
- Su = Summer

- M = modified
- R = removed

Appendix B

1993 to 1995 Physical Assessments of Habitat Complexes

Table B1a
Spring 1993 Assessment of Habitat Complexing Structures

Spring 1993 Assessment (June 5 - 10, 1993): Discharge = 57.5 - 59.5 m³/s (2,031 - 2,101cfs)

Location (km)	Site Number	Depth u/s 1/3 ext. (m)	Depth u/s 2/3 ext. (m)	Depth Outside Shear (m)	Depth Inside Shear (m)	Depth Through (m)	Depth d/s 1/3 ext. (m)	Depth d/s 2/3 ext. (m)	Velocity u/s 1/3 ext. (m/s)	Velocity u/s 2/3 ext. (m/s)	Velocity Outside Shear (m/s)	Velocity Inside Shear (m/s)	Velocity Through (m/s)	Velocity d/s 1/3 ext. (m/s)	Velocity d/s 2/3 ext. (m/s)	Cover Area (m²)	Ext. from Margin (m)	Attached to Shore?	Cover to Bottom?	Erosion/Sedimentation	Substrate B	C	G	F
Reach 2																								
15.6	LM15.6RAS	0.15	0.50	0.93	-	0.15	0.20	0.42	0.14	0.45	0.59	-	0.38	0.08	0.00	10	8.0	Yes	Yes	N/A	3	1	2	-
15.7	MC15.7PP	0.27	-	0.32	0.22	-	0.17	-	0.23	-	0.12	0.26	-	0.26	-	36	N/A	N/A	N/A	N/A	3	1	2	-
15.8	MC15.8PP	0.42	-	0.88	0.42	-	0.35	-	0.52	-	0.60	0.62	-	0.67	-	64	N/A	N/A	N/A	N/A	-	1	2	-
16.2	RM16.2RAS	0.53	0.85	1.05	-	0.60	0.36	0.73	0.39	0.69	1.09	-	0.44	0.19	0.62	5	7.5	Yes	Yes	Sweeper being eroded	3	1	2	-
16.5	RM16.5RDC	0.41	0.71	1.00	0.15	0.45	0.40	0.81	0.11	0.23	0.63	0.49	0.16	0.53	0.05	4	7.0	No	Yes	No	-	1	2	-
16.8	RM16.8RDC	0.60	1.00	1.30	N/A	0.67	0.55	1.01	0.17	0.47	0.75	N/A	0.35	0.10	0.61	7	7.0	Yes	Yes	No	-	2	1	3
17	RM17.0PB	-	-	0.94	-	-	-	-	-	-	0.88	-	-	-	-	0	7.5	Yes	N/A	N/A	-	-	-	-
17.15	RM17.15PB	-	-	1.10	-	-	-	-	-	-	0.74	-	-	-	-	0	7.0	Yes	N/A	N/A	-	1	2	-
17.3	RM17.3PB	-	-	1.00	-	-	-	-	-	-	0.56	-	-	-	-	0	6.0	Yes	N/A	N/A	3	1	2	-
17.9	RM17.9DB	0.35	0.35	0.30	N/A	0.30	0.25	0.27	0.11	0.13	0.39	N/A	0.32	0.08	0.19	44	9.0	Yes	Yes	N/A	-	2	1	3
17.9	RM17.9SC	-	-	-	-	0.52	-	-	-	-	-	-	0.00	-	-	27	-	-	-	-	-	-	-	-
18.3	LM18.3RDC	0.40	0.88	1.90	0.20	0.00	0.40	0.70	0.00	0.50	0.66	0.22	0.00	0.00	0.05	27	8.0	No	Yes	Little erosion	3	1	2	-
20.65	RM20.65RDC	0.76	1.00	1.43	N/A	0.44	0.70	1.02	0.34	0.90	0.87	N/A	0.08	0.00	0.00	40	7.5	Yes	Yes	N/A	-	2	1	3
21.3	LM21.3RDC	0.74	0.87	0.90	N/A	0.28	0.31	0.92	0.11	0.42	0.80	N/A	0.19	0.17	0.00	30	7.5	Yes	Yes	N/A	-	3	1	2
21.4	LM21.4RDC	0.36	0.75	1.95	0.90	0.39	0.28	0.74	0.36	0.52	0.93	0.32	0.29	0.68	0.14	50	16.5	No	Yes	Eroding between complex and shore	-	2	1	3
22	RM22.0RDC	0.55	0.96	0.95	N/A	0.23	0.42	0.65	0.29	0.76	1.50	N/A	0.13	0.00	0.00	60	8.0	Yes	Yes	No	-	2	1	3
22.1	RM22.1RAS	0.56	0.87	1.15	N/A	0.70	0.42	0.67	0.18	0.26	0.57	N/A	0.44	0.23	0.37	20	10.5	Yes	Yes	N/A	-	1	2	-
22.55	RM22.55RDC	0.26	0.76	1.16	N/A	0.00	0.20	0.70	0.50	0.23	0.39	N/A	0.00	0.00	0.02	26	6.5	Yes	Yes	N/A	-	3	1	2
22.6	LM22.6RDC	0.47	0.62	1.17	N/A	0.45	0.40	0.67	0.00	0.08	0.53	N/A	0.09	0.00	0.18	90	9.0	Yes	Yes	N/A	-	2	1	3
22.7	LM22.7RDC	0.34	0.74	1.00	N/A	0.51	0.47	0.85	0.09	0.22	0.63	N/A	0.28	0.19	0.07	21	8.0	Yes	Yes	N/A	-	2	1	3
22.85	LM22.85RDC	0.52	1.00	1.05	0.25	0.45	0.45	0.90	0.21	0.37	0.96	0.46	0.27	0.22	0.00	38	11.0	Yes	Yes	N/A	-	2	1	3
22.95	RM22.95RAS	0.57	0.95	0.94	N/A	0.82	0.43	0.80	0.15	0.54	0.52	N/A	0.23	0.23	0.23	12	5.5	Yes	Yes	No	-	2	1	3
23	RM23.0RDC	0.65	0.90	1.20	N/A	0.57	0.40	0.90	0.17	0.31	1.16	N/A	0.09	0.13	0.18	30	8.0	Yes	Yes	N/A	-	2	1	-
24.2	LM24.2RDC	0.90	1.15	1.30	N/A	0.47	0.40	0.95	0.41	0.60	0.87	N/A	0.02	0.03	0.15	120	9.5	Yes	Yes	N/A	-	2	1	3
24.3	LM24.3RDC	0.85	1.00	1.15	0.45	0.72	0.67	0.95	0.19	0.36	0.65	0.47	0.03	0.11	0.03	20	16.0	No	Yes	N/A	-	2	1	3
24.35	RM24.35RS	0.50	0.71	0.75	N/A	0.67	0.57	0.65	0.19	0.35	0.34	N/A	0.19	0.07	0.14	65	10.0	Yes	Yes	N/A	-	-	1	2
24.4	RM24.4FC	0.45	0.62	0.60	N/A	0.70	0.60	0.65	0.06	0.10	0.29	N/A	0.03	0.00	0.06	98	9.0	Yes	Yes	N/A	-	-	1	2
24.6	RM24.6PBL	0.20	0.60	1.20	N/A	0.33	0.20	0.65	0.22	0.36	0.67	N/A	0.06	0.00	0.00	50	7.0	Yes	Yes	N/A	-	3	1	2
24.8	RM24.8PBL	0.47	0.90	1.20	N/A	0.30	0.50	0.88	0.03	0.24	0.35	N/A	0.27	0.00	0.04	25	6.0	Yes	Yes	N/A	-	-	1	2
25.4	RM25.4RDC	0.36	1.05	2.05	N/A	1.05	0.94	1.10	0.31	0.29	-	N/A	0.05	0.08	0.08	26	10.0	Yes	Yes	Scouring along the shore	-	1	2	-
25.7	MC25.7RDC	0.65	0.65	0.60	0.65	0.45	0.45	0.42	0.46	0.50	0.72	0.81	0.28	0.07	0.02	9	8.0	No	Yes	No	-	3	1	2
26.9	RM26.9RAS	0.20	0.25	0.65	N/A	0.25	0.35	0.60	0.26	0.43	0.73	N/A	0.01	0.00	0.22	30	4.0	Yes	Yes	No	-	2	1	3
27.4	RM27.4FC	0.93	1.80	1.90	N/A	0.30	0.35	1.18	0.01	0.19	0.68	N/A	0.29	0.15	0.14	48	6.5	Yes	Yes	No	-	-	1	2
28.4	RM28.4RDC	0.45	0.97	1.30	N/A	0.17	0.30	0.89	0.03	0.35	0.91	N/A	0.13	0.04	0.00	42	8.0	Yes	Yes	No	-	2	1	3
29.4	LM29.4RAS	0.35	0.60	0.85	N/A	0.20	0.40	0.93	0.56	0.60	0.93	N/A	0.16	0.00	0.00	14	12.0	Yes	Yes	No	-	2	1	3
31	RM31.0PBL	0.30	-	0.85	-	-	0.38	-	0.12	-	0.09	-	0.00	0.00	-	7	2.0	Yes	Yes	No	-	-	1	2
31.1	RM31.1PBL	0.40	0.92	1.18	N/A	0.20	0.40	0.85	0.00	0.32	0.60	N/A	0.24	0.20	0.20	8	5.0	Yes	Yes	No	-	-	1	2
31.4	RM31.4BP	0.30	0.62	0.83	N/A	0.50	0.35	0.60	0.11	0.23	0.51	N/A	0.09	0.03	0.08	13	2.5	Yes	Yes	No	-	-	1	2
32.65	LM32.65HAS	0.33	0.40	0.57	N/A	0.31	0.20	0.48	0.19	0.29	0.61	N/A	0.24	0.20	0.28	7	5.0	Yes	Yes	N/A	-	-	1	2
34.7	RM34.7PDC	0.95	1.40	1.54	N/A	0.32	0.55	1.00	0.08	0.62	0.81	N/A	0.22	0.19	0.03	150	17.0	Yes	Yes	No	-	-	1	2
35.4	MC35.4PDC	1.20	1.20	1.22	1.15	-	0.75	0.83	0.24	0.21	0.61	0.64	0.00	0.00	0.00	180	30.0	No	Yes	Sedimentation d/s of complex	-	-	1	2
Reach 4																								
72.9	LM72.9HAS	0.32	0.63	1.00	N/A	0.40	0.50	0.95	0.00	0.10	0.67	N/A	0.31	0.30	0.18	21	7.0	Yes	Yes	No	3	2	1	-
73	LM73.0HAS	0.32	0.65	0.70	N/A	0.45	0.27	0.54	0.18	0.11	0.92	N/A	0.11	0.07	0.27	9	3.5	Yes	Yes	No	3	1	2	-
74.1	RM74.1HAS	0.30	0.64	1.12	N/A	0.80	0.61	0.97	0.19	0.55	0.24	N/A	0.09	0.00	0.00	9	8.0	Yes	Yes	No	-	1	2	3
75.9	LM75.9HAS	0.35	0.75	1.18	N/A	0.31	0.47	0.84	0.09	0.37	0.69	N/A	0.09	0.04	0.11	30	7.0	Yes	Yes	No	-	1	2	3
78	LM78.0HAS	0.35	0.71	1.12	N/A	0.64	0.30	0.75	0.00	0.36	0.62	N/A	0.13	0.13	0.18	9	4.5	Yes	Yes	No	-	3	1	2
80.2	LM80.2HAS	1.08	1.60	1.90	N/A	1.81	0.95	1.81	0.14	0.48	0.72	N/A	0.45	0.00	0.45	9	3.0	Yes	Yes	No	-	-	1	2
80.9	LM80.9RDC	0.81	0.85	0.94	1.00	0.87	0.65	0.81	0.64	0.61	0.94	0.53	0.10	0.62	0.10	5	14.0	No	Yes	No	-	-	1	2
82.1	LM82.1RAS	0.55	1.11	1.12	N/A	0.34	0.47	0.76	0.18	0.28	1.11	N/A	0.31	0.49	0.05	15	8.0	Yes	Yes	N/A	-	3	1	2
82.2	LM82.2RAS	0.70	1.17	1.45	N/A	0.95	0.38	0.81	0.03	0.17	0.41	N/A	0.08	0.14	0.24	22	6.0	Yes	Yes	N/A	-	-	1	2
82.3	LM82.3HAS	0.50	0.80	0.90	N/A	0.31	0.40	0.96	0.28	0.47	0.54	N/A	0.09	0.00	0.18	13	6.0	Yes	Yes	N/A	-	-	1	2
83	LM83.0RDC	0.68	0.90	1.10	0.77	0.65	0.48	0.55	0.87	0.82	1.43	0.93	0.10	0.39	0.59	8	12.0	No	Yes	Erosion/deposition of sediment/gravel behind complex	-	2	1	3
85.6	MC85.6RDC	1.20	1.40	1.50	1.30	1.05	1.05	1.30	0.61	0.66	0.71	0.84	0.61	0.22	0.10	10	18.0	No	Yes	No	-	3	1	2
85.7	RM85.7RAS	1.10	1.60	1.63	N/A	1.00	0.80	1.21	0.32	0.63	0.91	N/A	0.70	0.51	0.73	16	7.0	Yes	No	N/A	-	-	1	2
86.35	RM86.35RDC	0.45	1.08	1.75	N/A	0.58	0.56	1.02	0.00	0.19	0.55	N/A	0.01	0.00	0.00	15	10.0	Yes	Yes	Some sedimentation	-	-	1	2
86.375	RM86.375RDC	0.60	0.85	1.25	0.17	0.68	1.07	0.82	0.24	0.37	0.91	0.15	0.27	0.33	0.12	44	20.0	No	Yes	Some erosion, pool scoured d/s of complex	-	-	1	2

Where,
RM = right margin
MC = mid-channel
LM = left margin

RS = rootwad sweeper
BP = brush pile
FC = floating crib
PBL = pseudo beaver lodge
RAS = rail-anchored sweeper
HAS = hand-placed anchored sweeper

PDC = pipe-pile debris catcher
RDC = rail debris catcher
SC= side channel
DB = debris boom
PB = point bar
PP = pocket pool

u/s = upstream
d/s = downstream
N/A - Not available

B = boulder
C - cobble
G = gravel
F = fines

Table B3
Spring 1994 Assessment of Habitat Complexing Structures

Spring 1994 Assessment (May 22 - 25, 1994): Discharge = 56.7 - 57.5 m³/s (2,002 - 2,031 cfs)

Location (km)	Site Number	Depth u/s 1/3 ext. (m)	Depth u/s 2/3 ext. (m)	Depth Outside Shear (m)	Depth Inside Shear (m)	Depth Through (m)	Depth d/s 1/3 ext. (m)	Depth d/s 2/3 ext. (m)	Velocity u/s 1/3 ext. (m/s)	Velocity u/s 2/3 ext. (m/s)	Velocity Outside Shear (m/s)	Velocity Inside Shear (m/s)	Velocity Through (m/s)	Velocity d/s 1/3 ext. (m/s)	Velocity d/s 2/3 ext. (m/s)	Cover Area (m²)	Ext. from Margin (m)	Attached to Shore?	Cover to Bottom?	Debris Entrapment	Erosion/Sedimentation	Substrate B	Substrate C	Substrate G	Substrate F
Reach 2																									
15.6	LM15.6RAS	0.31	0.55	1.00	0.86	0.19	0.19	0.41	0.15	0.19	0.47	0.67	0.08	0.00	0.00	33	0.0	Yes	Yes	Yes	No	1	2	3	-
15.7	MC15.7PP	-	-	0.17	-	-	-	-	-	-	0.29	-	-	-	-	49	-	-	-	No	No	2	1	3	-
16.2	RM16.2RAS	0.48	0.77	1.10	0.82	0.60	0.27	0.63	0.31	0.54	0.91	0.45	0.19	0.18	0.46	14	11.0	Yes	Floating	Yes	No	2	1	3	-
16.5	RM16.5RDC	0.50	0.81	1.15	N/A	0.55	0.30	1.10	0.19	0.51	0.76	N/A	0.02	0.20	0.01	7	6.7	No	Yes	Yes	No	-	1	2	-
16.8	RM16.8RDC	0.45	0.75	1.10	N/A	0.42	0.51	0.80	0.00	0.26	0.78	N/A	0.17	0.08	0.27	13	7.5	No	Floating	Yes	No	3	2	1	-
17	RM17.0PB	-	-	0.77	-	-	-	-	-	-	0.80	-	-	-	-	-	7.7	-	-	No	No	-	1	2	3
17.15	RM17.15PB	-	-	0.80	-	-	-	-	-	-	0.73	-	-	-	-	-	6.8	-	-	No	No	2	1	-	3
17.3	RM17.3PB	-	-	0.63	-	-	-	-	-	-	0.81	-	-	-	-	-	5.6	-	-	No		3	1	-	2
17.9	RM17.9DB	0.26	0.35	0.35	N/A	0.30	0.26	0.30	0.22	0.24	0.36	N/A	0.31	0.19	0.18	32	10.4	Yes	Yes	Yes	No	-	3	1	2
17.9	RM17.9SC	-	-	-	0.51	-	-	-	-	-	-	0.00	-	-	-	96	-	-	-	-	-	-	-	-	-
18.3	LM18.3RDC	0.40	1.08	>1.00	0.17	-	0.41	0.73	0.20	0.54	0.82	0.18	-	0.25	0.00	46	8.7	No	Yes	Yes	No	3	1	2	-
20.65	RM20.65RDC	0.50	0.93	1.40	N/A	0.10	0.50	1.04	0.55	0.73	0.79	N/A	0.08	0.00	0.00	49	6.7	Yes	Yes	Yes	No	-	1	2	3
21.3	LM21.3RDC	0.50	0.75	1.73	0.27	0.60	0.36	1.03	0.09	0.33	0.77	0.47	0.00	0.18	0.10	30	7.6	Yes	Yes	Yes	No	-	2	1	3
21.4	LM21.4RDC	0.45	0.80	2.00	0.43	0.51	0.48	0.78	0.36	0.60	0.84	0.38	0.20	0.38	0.00	77	16.5	No	Yes	Yes	No	-	1	2	-
22	RM22.0RDC	0.50	0.85	0.97	N/A	0.27	0.35	0.55	0.32	0.65	1.80	N/A	0.14	0.00	0.07	64	7.8	Yes	Yes	Yes	No	-	1	3	2
22.1	RM22.1RAS	0.51	0.86	1.15	0.13	0.72	0.36	0.56	0.38	0.52	0.67	0.09	0.38	0.18	0.43	43	12.6	No	Floating	No	No	2	1	3	-
22.55	RM22.55RDC	0.25	0.45	1.23	N/A	0.60	0.28	0.60	0.45	0.56	0.55	N/A	0.05	0.03	0.05	35	7.0	Yes	Yes	Yes	Fines behind RDC	-	3	1	2
22.6	LM22.6RDC	0.36	0.92	1.20	N/A	0.40	0.37	0.70	0.06	0.26	0.62	N/A	0.28	0.00	0.04	136	8.0	Yes	Yes	Yes	Some fines behind lodge	-	2	3	1
22.7	LM22.7RDC	0.46	0.80	1.10	N/A	0.31	0.31	0.80	0.07	0.15	0.64	N/A	0.39	0.39	0.18	44	7.7	Yes	Floating	Yes	No	-	3	2	1
22.85	LM22.85RDC	0.50	0.87	1.05	0.27	0.46	0.52	0.80	0.26	0.46	0.78	0.27	0.17	0.26	0.00	48	10.5	No	Yes	Yes	Little fines D/S of RDC	-	1	2	3
22.95	RM22.95RAS	0.37	0.83	1.15	N/A	N/A	0.40	0.80	0.17	0.46	0.69	N/A	N/A	0.06	0.41	18	5.0	Yes	Floating	No	No	-	1	2	3
23	RM23.0RDC	0.50	0.91	1.14	0.15	0.38	0.53	0.83	0.10	0.61	1.09	0.45	0.31	0.06	0.00	21	10.0	No	Yes	Yes	No	-	1	-	-
24.2	LM24.2RDC	0.59	1.06	1.35	N/A	0.45	0.35	1.00	0.01	0.58	0.95	N/A	0.04	0.09	0.00	82	10.8	Yes	Yes	Yes	No	-	1	-	-
24.3	LM24.3RDC	0.52	0.94	1.03	0.20	0.57	0.65	0.85	0.13	0.19	0.56	0.48	0.04	0.18	0.00	24	15.5	No	Yes	Yes	No	-	1	2	-
24.35	RM24.35RS	0.35	0.50	0.75	N/A	0.40	0.50	0.70	0.07	0.24	0.10	N/A	0.04	0.09	0.12	69	2.2	Yes	Yes	Yes	No	-	3	1	2
24.4	RM24.4FC	0.45	0.62	0.96	N/A	0.20	0.53	0.66	0.05	0.08	0.32	N/A	0.05	0.00	0.13	172	0.0	Yes	Yes/Float	Yes	No	-	3	1	2
24.6	RM24.6PBL	0.31	0.76	1.00	N/A	0.75	0.20	0.60	0.28	0.46	0.67	N/A	0.09	0.00	0.00	81	8.3	Yes	Yes	Yes	No	-	3	1	2
24.8	RM24.8PBL	0.25	1.00	1.30	0.25	0.25	0.58	1.10	-0.12	0.20	0.32	0.19	0.19	0.00	0.04	58	7.4	Yes	Floating	Yes	No	-	3	1	2
25.4	RM25.4RDC	0.43	0.74	>2.00	0.60	1.20	0.80	1.12	0.26	0.44	0.79	0.13	0.02	0.01	0.09	52	12.3	No	Yes	Yes	Erosion around outer and inner edges	2	1	3	-
25.7	MC25.7RDC	0.62	0.65	0.55	0.62	N/A	0.41	0.40	0.35	0.44	0.47	0.61	N/A	0.11	0.05	10	9.9	No	Yes	Yes	No	-	3	1	2
26.9	RM26.9RAS	0.16	0.27	0.80	0.15	0.25	0.40	0.80	0.31	0.62	0.73	0.60	0.17	0.04	0.57	12	5.5	No	Floating	Yes	No	3	1	2	-
27.4	RM27.4FC	0.90	1.50	>2.00	N/A	0.20	0.35	0.98	0.00	0.13	0.56	N/A	0.28	0.12	0.05	30	7.0	Yes	Yes	Yes	No	-	2	3	1
28.4	RM28.4RDC	0.57	0.93	1.40	N/A	0.25	0.30	0.92	0.07	0.32	0.25	N/A	0.07	0.00	0.01	127	8.0	Yes	Yes	Yes	No	-	2	1	3
29.4	LM29.4RAS	0.23	0.33	0.72	0.15	0.35	0.40	0.63	0.74	0.72	0.50	0.01	0.02	0.03	0.01	21	7.0	No	Floating	No	No	-	1	2	-
31	RM31.0PBL	0.35	0.75	0.93	N/A	0.44	0.44	0.92	0.17	0.35	0.50	N/A	0.06	0.06	0.40	14	5.0	Yes	Yes	Lost	No	-	3	2	1
31.1	RM31.1PBL	0.50	0.88	1.60	N/A	0.75	0.75	1.20	0.26	0.32	0.70	N/A	0.21	0.21	0.52	17	3.0	Yes	Floating	Lost	No	-	-	-	1
31.4	RM31.4BP	0.25	0.63	0.70	N/A	0.20	0.20	0.30	0.03	0.26	0.49	N/A	0.07	0.00	0.07	37	2.5	Yes	Floating	Yes	No	-	-	-	1
32.65	LM32.65HAS	0.25	0.45	0.60	N/A	0.37	0.25	0.25	0.14	0.35	0.53	N/A	0.04	0.14	0.45	27	4.7	Yes	Floating	No	No	-	1	2	3
34.7	RM34.7PDC	0.57	1.06	2.00	N/A	0.23	0.35	1.40	0.12	-	0.91	N/A	0.30	0.07	0.00	91	15.0	Yes	Floating	Yes	Behind debris pile muddy	-	-	2	1
35.4	MC35.4PDC	-	-	1.20	1.10	-	-	-	-	-	0.56	0.56	-	-	-	192	57.0	Yes	Yes	Yes	No	-	2	3	1
Reach 4																									
72.9	LM72.9HAS	0.48	0.98	1.40	N/A	0.75	0.70	1.00	0.06	0.41	0.56	N/A	0.14	0.44	0.50	16	6.5	Yes	Floating	No	No	3	1	-	2
73	LM73.0HAS	0.30	0.74	0.75	N/A	0.58	0.35	0.55	-0.23	0.21	0.90	N/A	0.21	0.16	0.43	13	3.0	Yes	Floating	No	No	3	1	-	2
74.1	RM74.1HAS	0.25	0.50	1.20	N/A	N/A	0.58	0.98	0.16	0.57	0.19	N/A	N/A	-0.04	0.09	2	6.0	Yes	Yes	No	No	-	1	-	-
75.9	LM75.9HAS	0.30	0.75	1.15	N/A	0.75	0.47	0.77	0.12	0.39	0.57	N/A	0.38	0.02	0.30	45	9.0	Yes	Floating	No	No	3	1	-	2
78	LM78.0HAS	0.30	0.76	0.80	N/A	0.47	0.21	0.40	-0.05	0.05	0.41	N/A	0.08	0.14	0.22	8	3.0	Yes	Floating	No	No	-	1	3	2
80.2	LM80.2HAS	0.55	1.28	>2.00	N/A	1.30	0.66	1.30	0.13	0.28	0.67	N/A	0.31	0.06	0.31	16	3.5	Yes	Floating	No	No	-	3	2	1
80.9	LM80.9RDC	0.90	1.00	0.92	0.90	0.60	0.60	0.67	0.71	0.76	0.92	0.78	0.25	0.78	0.10	7	13.9	No	Yes	Yes	Erosion in front of RDC and sides	-	2	1	3
82.1	LM82.1RAS	0.75	1.10	0.95	N/A	0.15	0.27	0.75	0.06	0.29	0.56	N/A	0.52	0.44	0.61	32	4.8	Yes	Floating	Yes	No	-	1	2	3
82.2	LM82.2RAS	0.80	1.15	1.15	N/A	1.15	0.35	0.75	0.02	0.05	0.13	N/A	0.13	0.10	0.30	31	6.0	Yes	Floating	No	Fines behind (D/S) of SWPR	-	2	3	1
82.3	LM82.3HAS	0.43	0.78	0.95	N/A	0.45	0.45	0.95	0.27	0.47	0.45	N/A	0.09	0.04	0.25	20	6.0	Yes	Floating	No	No	-	1	-	2
83	LM83.0RDC	0.70	0.85	1.20	1.00	0.70	0.55	0.55	1.14	1.17	1.11	0.68	0.20	0.28	0.55	7	12.0	No	Yes	Yes	Erosion under and around RDC	2	1	3	-
85.6	MC85.6RDC	0.90	0.96	1.80	1.05	0.40	1.00	1.00	0.92	0.80	0.77	0.84	0.56	0.07	0.07	7	22.0	No	Yes	Yes	Erosion under and around	-	1	2	-
85.7	RM85.7RAS	1.20	>2.00	>2.00	0.60	1.00	1.10	Too Deep	0.80	0.92	1.25	0.16	0.36	0.76	Too Deep	6	6.5	No	Floating	Yes	No	-	3	1	2
86.35	RM86.35RDC	0.68	1.20	2.00	N/A	0.45	0.45	0.65	0.15	0.27	0.49	N/A	0.61	0.33	0.00	21	10.5	Yes	Yes	Yes	Fines behind RDC, erosion under outer section	-	-	2	1
86.375	RM86.375RDC	0.16	1.00	>2.00	0.20	0.92	0.66	0.90	0.49	0.60	0.98	0.36	0.25	0.58	0.03	42	21.0	No	Yes	Yes	Erosion under and around	-	3	1	2

Where,
RM = right margin
MC = mid-channel
LM = left margin

RS = rootwad sweeper
BP = brush pile
FC = floating crib
PBL = pseudo beaver lodge
RAS = rail anchored sweeper
HAS = hand-placed anchored sweeper
PDC = pipe-pile debris catcher

RDC = rail debris catcher
SC= side channel
DB = debris boom
PB = point bar
PP = pocket pool

u/s = upstream
d/s = downstream
N/A - Not available

B = boulder
C = cobble
G = gravel
F = fines

Table B3.
Spring 1994 Assessment of Habitat Complexing Structures

Location (km)	Site Number	Damage	Displacement	Debris Accumulation/Loss	Recommendation/Comments
Reach 2					
15.6	LM15.6RAS	No	No	-	-
15.7	MC15.7PP	No	No	-	-
16.2	RM16.2RAS	No	No	Very little debris entrapment, small branches	Sweeper still intact
16.5	RM16.5RDC	No	No	-	-
16.8	RM16.8RDC	No	No	-	-
17.0	RM17.0PB	No	No	-	-
17.15	RM17.15PB	No	No	-	-
17.3	RM17.3PB	No	No	-	-
17.9	RM17.9DB	No	No	-	Debris boom in good shape
17.9	RM17.9SC	No	No	-	-
18.3	LM18.3RDC	No	No	-	Beaver Lodge
20.65	RM20.65RDC	No	No	-	Good stable debris pile
21.3	LM21.3RDC	No	No	-	-
21.4	LM21.4RDC	No	No	-	Good stable debris pile
22.0	RM22.0RDC	No	No	-	Good stable debris pile
22.1	RM22.1RAS	Branches on D/S side of SWPR only	No	Very little debris trapped	Sweeper in good shape
22.55	RM22.55RDC	No	No	-	50% of debris is on the shore, boat launch right behind RDC, stable debris pile
22.6	LM22.6RDC	No	No	-	Beaver lodge, very stable RDC
22.7	LM22.7RDC	No	No	-	RDC U/S is affecting flows here
22.85	LM22.85RDC	No	No	-	Stable RDC
22.95	RM22.95RAS	SWPR is broken, few branches left on them	No	-	New SWPR needed
23.0	RM23.0RDC	No	No	-	Good stable RDC and debris
24.2	LM24.2RDC	No	No	-	Old beaver lodge
24.3	LM24.3RDC	No	No	Smaller type of entrapment debris gone at high water	Structurally sound
24.35	RM24.35RS	Two separate complexes now	No	-	-
24.4	RM24.4FC	No	No	-	Structurally sound
24.6	RM24.6PBL	No	No	-	Good sound structure
24.8	RM24.8PBL	Debris weak, gone at high water	No	-	Structure sound
25.4	RM25.4RDC	No	No	90% of debris on U/S side of rails	Debris wash off at high flows
25.7	MC25.7RDC	No	No	-	All the debris looks like it was placed and is holding
26.9	RM26.9RAS	No branches on SWPR	No	-	Debris will be lost at high water

Table B3.
Spring 1994 Assessment of Habitat Complexing Structures

Location (km)	Site Number	Damage	Displacement	Debris Accumulation/Loss	Recommendation/Comments
27.4	RM27.4FC	No	No	Not much debris on structure	Floating crib structure is solid, FC middle is open, half of FC out of water
28.4	RM28.4RDC	No	No	-	Solid complex
29.4	LM29.4RAS	SWPR broken between rails, velocity too fast	No	-	New SWPR needed ?
31.0	RM31.0PBL	No	No	No debris entrapment	Structure together
31.1	RM31.1PBL	No	No	Very little debris caught	Structure sound
31.4	RM31.4BP	No	No	-	-
32.65	LM32.65HAS	No	No	-	SWPR in good shape
34.7	RM34.7PDC	No	No	-	Solid debris pile
35.4	MC35.4PDC	No	No	-	-
Reach 4					
72.9	LM72.9HAS	No	No	Some small debris trapped in branches of SWPR	SWPR still in good shape
73.0	LM73.0HAS	SWPR broken	No	-	New SWPR needed
74.1	RM74.1HAS	SWPR is just a pole no branches	No	Some debris is piled up on the shore, cover at higher water	No cover provided
75.9	LM75.9HAS	No	No	-	SWPR's are in good shape
78.0	LM78.0HAS	No	No	-	SWPR in good shape
80.2	LM80.2HAS	No branches on SWPR	No	-	SWPR does provide some cover
80.9	LM80.9RDC	No	No	-	-
82.1	LM82.1RAS	No	No	-	SWPR in good shape
82.2	LM82.2RAS	No	No	-	-
82.3	LM82.3HAS	No	No	-	SWPR in good shape, natural SWPR 1m D/S of site SWPR
83.0	LM83.0RDC	No	No	-	-
85.6	MC85.6RDC	No	No	-	-
85.7	RM85.7RAS	No	No	-	SWPR holding OK
86.35	RM86.35RDC	No	No	-	RDC in good shape
86.375	RM86.375RDC	No	No	-	Good stable RDC

Where,	RM = right margin	RS = rootwad sweeper	u/s = upstream
	MC = mid-channel	BP = brush pile	d/s = downstream
	LM = left margin	FC = floating crib	N/A - Not available

Table B4
Spring 1995 Assessment of Habitat Complexing Structures

Spring 1995 Assessment (May 16 - 18, 1995): Discharge = 62.3 m³/s (2,200 cfs)

Location (km)	Site Number	u/s 1/3 ext. (m)	u/s 2/3 ext. (m)	Outside Shear (m)	Depth Inside Shear (m)	Through (m)	d/s 1/3 ext. (m)	d/s 2/3 ext. (m)	u/s 1/3 ext. (m/s)	u/s 2/3 ext. (m/s)	Outside Shear (m/s)	Velocity Inside Shear (m/s)	Through (m/s)	d/s 1/3 ext. (m/s)	d/s 2/3 ext. (m/s)	Cover Area (m²)	Ext. from Margin (m)	Attached to Shore?	Cover to Bottom?	Debris Entrapment	Erosion/Sedimentation	Substrate B	C	G	F
Reach 2																									
15.6	LM15.6RAS	0.30	0.65	0.91	-	0.20	0.15	0.29	0.13	0.54	0.40	-	0.30	0.06	0.00	20	10.00	-	Y	Y	No/No	-	1	2	3
15.7	MC15.7PP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NA	N/A	-	Y	N	NA	2	1	3	-
16.2	RM16.2RAS	0.65	0.90	1.02	-	0.72	0.40	0.73	0.49	0.66	0.71	-	0.70	0.41	0.66	20	9.90	-	N	N	No/No	3	1	2	-
16.5	RM16.5RDC	0.40	0.78	1.20	0.15	0.70	0.36	0.85	0.01	0.52	0.68	0.46	0.06	0.00	0.03	10	8.20	-	N	Y	Erosion on end of SWPR/No	3	1	2	-
16.8	RM16.8RDC	0.63	0.84	1.10	0.12	0.46	0.49	0.78	0.00	0.32	0.84	0.28	0.47	0.38	0.00	27	10.50	-	Y	Y	Erosion, and Silts u/s of SWPR	-	2	1	3
17	RM17.0PB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NA	-	-	NA	NA	No/No	-	1	2	3
17.15	RM17.15PB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NA	-	-	NA	NA	No/No	-	1	3	2
17.3	RM17.3PB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NA	-	-	NA	NA	NA	-	1	2	3
17.9	RM17.9DB	0.40	0.36	0.44	-	0.30	0.30	0.38	0.25	0.15	0.41	-	0.01	0.09	0.00	60	12.00	-	Y	Y	No erosion/ a little silt d/s of DB	-	3	2	1
17.9	RM17.9SC					0.58							0.00	-	-	NA	N/A	-	NA	NA	NA	-	3	1	2
18.3	LM18.3RDC	0.38	0.97	1.26	-	0.18	0.18	0.59	0.00	0.33	0.52	-	0.02	0.02	0.07	57	6.60	-	Y	Y	No/No	-	2	1	-
20.65	RM20.65RDC	0.75	1.30	1.80	-	0.15	0.51	1.00	0.56	0.53	0.89	-	0.08	0.00	0.00	36	6.00	-	Y	Y	No/No	-	1	2	3
21.3	LM21.3RDC	0.48	0.82	1.20	0.38	-	0.38	0.96	0.00	0.42	0.69	0.31	-	0.19	0.00	18	11.00	-	Y	Y	Erosion outside of RDC/ No sedimentation	-	2	1	3
21.4	LM21.4RDC	0.35	0.75	1.30	-	0.54	0.18	0.75	0.17	0.29	0.53	-	0.22	0.41	0.09	74	16.60	-	Y	Y	Erosion on both sides of RDC/ No sedim.	-	2	1	3
22	RM22.0RDC	0.64	0.90	0.90	-	0.75	0.38	0.61	0.37	0.78	1.37	-	0.01	0.00	0.00	61	9.20	-	Y	Y	Erosion outside edge of RDC/ No sedim.	-	2	1	3
22.1	RM22.1RAS	-	0.16	0.29	-	-	-	0.15	-	0.00	0.12	-	-	-	0.10	6	1.00	-	Y	N	No/No	-	1	2	3
22.55	RM22.55RDC	0.80	1.10	1.00	-	-	0.50	1.05	0.22	0.40	0.74	-	-	0.00	0.00	49	9.00	-	Y	Y	No/No	-	3	2	1
22.6	LM22.6RDC	0.88	1.20	1.23	-	-	0.34	0.80	0.24	0.50	0.50	-	-	0.00	0.00	136	8.00	-	Y	Y	Erosion outside of RDC/ No sedim'n	-	-	-	-
22.85	LM22.85RDC	0.38	0.75	1.20	0.30	0.41	0.55	1.05	0.36	0.00	0.92	0.44	0.31	0.44	0.56	29	9.80	-	Y	Y	No/No	-	3	1	2
22.95	RM22.95RAS	0.50	0.95	1.10	-	-	0.50	0.50	0.24	0.67	0.71	-	-	0.20	0.51	1	N/A	-	Y	N	No/No	-	2	1	3
23	RM23.0RDC	0.54	1.05	1.20	0.20	-	0.44	0.80	0.28	0.81	0.66	0.24	-	0.03	0.00	42	10.60	-	Y	Y	No/No	-	2	1	3
24.2	LM24.2RDC	0.50	0.85	1.30	-	0.24	0.38	0.82	0.04	-	0.63	-	0.02	0.05	0.00	137	13.50	-	Y	Y	No/No	-	2	1	3
24.3	LM24.3RDC	0.47	0.44	1.00	0.20	0.65	0.65	0.77	0.00	0.03	0.34	0.17	0.01	0.50	0.01	26	8.70	-	Y	Y	No/No	-	2	1	3
24.35	RM24.35RS	0.65	0.75	0.75	0.26	0.71	0.60	0.70	0.00	0.10	0.30	0.22	0.14	0.01	0.09	55	10.70	-	Y	Y	No erosion/ silt deposition	-	-	2	1
24.4	RM24.4FC	0.45	0.62	0.71	-	-	0.46	0.80	-	0.00	0.40	-	-	0.01	0.19	91	6.60	-	Y	Y	No/No	-	-	2	1
24.6	RM24.6PBL	0.35	0.73	1.00	-	-	0.45	0.75	0.00	0.01	0.59	-	-	0.28	0.46	50	6.30	-	Y	Y	No/No	-	-	1	2
25.4	RM25.4RDC	0.30	0.91	2.00	0.15	1.80	1.00	0.60	0.24	0.56	0.54	0.04	0.13	0.09	0.10	44	16.10	-	N	Y	Erosion around and under RDC/ No sedim'n	-	1	2	3
25.7	MC25.7RDC	0.45	0.65	0.50	0.40	0.55	0.30	0.40	0.45	0.46	0.81	0.37	0.01	0.34	0.33	10	N/A	-	Y	Y	No/No	-	-	2	1
26.9	RM26.9RAS	0.30	0.55	0.88	-	0.54	0.46	0.65	0.35	0.68	1.01	-	0.36	0.01	0.19	24	8.00	-	N	Y	No/No	-	1	2	
27.4	RM27.4FC	0.84	1.23	0.98	-	0.35	0.26	0.31	0.13	0.30	0.66	-	0.07	0.00	0.15	23	6.20	-	Y	Y	No/No	-	-	2	1
28.4	RM28.4RDC	0.89	1.22	1.50	-	-	0.51	0.90	0.41	0.52	0.49	-	-	0.00	0.00	112	12.90	-	Y	Y	No/No	-	2	1	3
29.4	LM29.4RAS	-	-	0.38			0.47	0.70	-	-	0.79			0.00	0.04	11	1.40	-	Y	N	No/No	-	2	1	3
31.1	RM31.1PBL	0.72	1.04	1.35	-	-	0.41	0.87	0.01	0.55	0.72	-	-	0.22	1.27	21	N/A	-	N	Y	No/No	-	-	2	1
31.4	RM31.4BP	0.34	0.61	1.10	-	0.36	0.50	0.48	0.15	0.26	0.43	-	0.00	0.00	0.00	4	2.60	-	Y	NA	No/No	-	-	2	1
32.65	LM32.65HAS	0.22	0.38	0.59	-	0.26	0.17	0.44	0.22	0.19	0.55	-	0.23	0.28	0.32	3	3.60	-	Y	N	No/No	-	-	1	2
34.7	RM34.7PDC	0.79	1.23	1.50	-	0.44	0.35	0.66	0.48	0.53	0.75	-	0.06	0.00	0.00	42	11.90	-	Y	Y	No/No	-	-	2	1
35.4	MC35.4PDC	0.30	1.24	1.00	1.03	-	0.69	0.56	0.25	0.05	0.46	0.61	-	0.00	0.00	149	52.20	-	Y	Y	No erosion/ Silt behind PDC	-	3	2	1
																						-	-	-	-
Reach 4																						-	-	-	-
72.9	LM72.9HAS	0.38	0.75	0.90	-	0.59	0.40	0.64	0.00	0.12	0.31	-	0.22	0.02	0.32	4	6.00	-	N	Y	No/No	3	2	1	
73	LM73.0HAS	0.30	0.51	0.86	-	0.50	0.32	0.50	-0.12	-0.11	0.33	-	0.09	0.02	0.00	6	3.20	-	Y	N	No/No	-	2	1	3
75.9	LM75.9HAS	0.40	0.70	1.18	-	0.74	0.40	0.70	0.10	0.16	0.58	-	0.25	0.00	0.13	15	7.50	-	N	Y	No erosion/ silt d/s of SWPR	-	-	-	-
78	LM78.0HAS	0.32	0.70	1.12	-	-	0.30	0.60	0.00	0.05	0.33	-	-	0.20	0.37	2	N/A	-	Y	N	No erosion / sediment'n behind SWPR	-	-	1	2
80.2	LM80.2HAS	-	0.92	1.30	-	-	0.15	0.32	-	0.10	0.32	-	-	0.00	0.02	3	N/A	-	Y	N	No/No	-	-	2	1
80.9	LM80.9RDC	0.75	1.00	1.14	0.75	0.85	0.39	0.70	0.59	0.70	0.51	0.62	0.22	0.56	0.68	8	N/A	-	N	Y	Erosion around edge/ No sediment	-	-	1	2
82.1	LM82.1RAS	0.52	0.84	1.40	-	0.80	0.28	0.65	0.15	0.30	0.99	-	0.18	0.46	0.16	5	N/A	-	N	N	No/No	-	-	1	2
82.2	LM82.2RAS	0.26	0.54	1.26	-	0.80	0.20	0.60	0.04	0.12	0.27	-	0.14	-0.09	0.01	6	5.00	-	Y	N	No erosion / Some silt	-	-	2	1
82.3	LM82.3HAS	0.26	0.65	0.93	-	0.23	0.25	0.47	0.16	0.12	0.56	-	0.06	0.12	0.31	8	6.00	-	Y	NA	No/No	-	3	1	2
83	LM83.0RDC	0.28	0.68	0.93	1.00	0.80	0.47	-	0.72	1.03	1.58	0.44	0.04	0.94	-	11	13.00	-	Y	Y	Erosion around RDC / No sediment'n	-	1	2	3
85.7	RM85.7RAS	1.10	-	1.65	0.54	1.15	0.78	-	0.65	-	1.07	0.40	0.36	0.59	-	9	6.00	-	N	Y	No/No	-		1	2
86.35	RM86.35RDC	0.46	1.10	1.90	-	0.60	0.81	0.70	0.00	0.27	0.86	-	0.46	0.02	0.03	12	9.60	-	Y	Y	Erosion outside of RDC / Silt behind complex	-	-	2	1
86.375	RM86.375RDC	0.35	0.88	1.50	1.20	1.05	0.40	1.05	0.32	0.66	0.48	0.63	0.01	0.25	0.49	10	N/A	-	Y	Y	Erosion each side of RDC / Sediment behind RDC	-	3	1	2

Where,
RM = right margin
MC = mid-channel
LM = left margin

RS = rootwad sweeper
BP = brush pile
FC = floating crib
PBL = pseudo beaver lodge
RAS = rail-anchored sweeper
HAS = hand-placed anchored sweeper
PDC = pipe-pile debris catcher
RDC = rail debris catcher
SC= side channel
DB = debris boom
PB = point bar
PP = pocket pool

u/s = upstream
d/s = downstream
N/A - Not available

B = boulder
C = cobble
G = gravel
F = fines

Table B4
Spring 1995 Assessment of Habitat Complexing Structures

Spring 1995 Assessment (May 16 - 18, 1995): Discharge = 62.3 m³/s (2,200 cfs)

Location (km)	Site Number	Damage	Displacement	Debris Accumulation/Loss	Recommendation/Comments
Reach 2					
15.6	LM15.6RAS	-	-	-	-
15.7	MC15.7PP	-	-	-	-
16.2	RM16.2RAS	No bark, branches on d/s side of SWPR only	-	-	-
16.5	RM16.5RDC	-	-	Loose debris, gone at higher flows	-
16.8	RM16.8RDC	-	-	-	-
17	RM17.0PB	-	-	-	-
17.15	RM17.15PB	-	-	-	-
17.3	RM17.3PB	-	-	-	-
17.9	RM17.9DB	-	-	-	-
17.9	RM17.9SC	-	-	-	-
18.3	LM18.3RDC	-	-	-	-
20.65	RM20.65RDC	-	-	-	-
21.3	LM21.3RDC	-	-	-	-
21.4	LM21.4RDC	-	-	-	-
22	RM22.0RDC	-	-	-	-
22.1	RM22.1RAS	-	SWPR broken near anchor (outside)	-	-
22.55	RM22.55RDC	-	-	-	-
22.6	LM22.6RDC	-	-	-	Beaver Lodge
22.85	LM22.85RDC	-	-	-	-
22.95	RM22.95RAS	-	-	SWPR bare log	-
23	RM23.0RDC	-	-	-	-
24.2	LM24.2RDC	-	-	Additional debris	Beaver Lodge
24.3	LM24.3RDC	-	-	-	Lots of silt
24.35	RM24.35RS	-	-	-	-
24.4	RM24.4FC	-	-	-	-
24.6	RM24.6PBL	-	-	-	-
25.4	RM25.4RDC	-	-	Loose debris u/s will be lost at higher flows	-
25.7	MC25.7RDC	-	-	-	-
26.9	RM26.9RAS	-	-	-	-
27.4	RM27.4FC	Complex ok	-	Very little debris trapped; some sticks	-
28.4	RM28.4RDC	-	-	-	-
29.4	LM29.4RAS	Outside anchor gone	SWPR pushed against shore	-	-
31.1	RM31.1PBL	-	-	-	-

Table B4

Spring 1995 Assessment of Habitat Complexing Structures

Spring 1995 Assessment (May 16 - 18, 1995): Discharge = 62.3 m³/s (2,200 cfs)

Location (km)	Site Number	Damage	Displacement	Debris Accumulation/Loss	Recommendation/Comments
31.4	RM31.4BP	-	-	-	-
32.65	LM32.65HAS	-	SWPR pushed against shore	-	-
34.7	RM34.7PDC	Loss of d/s pile	-	Loss of debris due to damage	-
35.4	MC35.4PDC	-	-	-	-
					-
Reach 4					-
72.9	LM72.9HAS	Very little cover area, branches stripped, bare log left	-	-	-
73	LM73.0HAS	Bare log with bare branches and no bark	-	-	-
75.9	LM75.9HAS	-	-	-	30 cm of silt between SWPR; 40 cm of silt d/s of d/s SWPR
78	LM78.0HAS	Bare logs (3)	-	-	-
80.2	LM80.2HAS	Bare log held with rope, bank sluffing away	Log against bank	-	Site a lot shallower than last year
80.9	LM80.9RDC	-	-	Lost debris from last year	-
82.1	LM82.1RAS	-	-	-	SWPR in reasonable shape
82.2	LM82.2RAS	Anchor stump broken	-	-	SWPR in reasonable shape
82.3	LM82.3HAS	-	-	-	-
83	LM83.0RDC	-	-	-	-
85.7	RM85.7RAS	-	-	-	-
86.35	RM86.35RDC	-	-	-	-
86.375	RM86.375RDC	-	-	-	-

Where,
RM = right margin
MC = mid-channel
LM = left margin

RS = rootwad sweeper
BP = brush pile
FC = floating crib
PBL = pseudo beaver lodge
RAS = rail anchored sweeper
HAS = hand-placed anchored sweeper
PDC = pipe-pile debris catcher
RDC = rail debris catcher
DB = debris boom
SC= side channel
PB = point bar
PP = pocket pool

u/s = upstream
d/s = downstream
N/A - Not available

Table B1b
Spring 1993 Assessment of Habitat Complexing Structures

Spring 1993 Assessment (June 5 - 10, 1993): Discharge = 57.5 - 59.5 m³/s (2,031 - 2,101cfs)

Location (km)	Site Number	Damage	Displacement	Debris Accumulation/Loss	Recommendation/Comments
Reach 2					
15.6	LM15.6RAS	No	No	-	-
15.7	MC15.7PP	No	No	-	-
15.8	MC15.8PP	No	No	-	-
16.2	RM16.2RAS	Branches stripped	No	Fails to capture debris	-
16.5	RM16.5RDC	Shore deadman cable broken	No	Appears to have lost some debris	-
16.8	RM16.8RDC	No	No	Caught a few logs, very little small debris	-
17	RM17.0PB	No	No	-	Max. pool depth - 1.10 m
17.15	RM17.15PB	No	No	-	Max. pool depth - 1.14 m
17.3	RM17.3PB	No	No	-	Max. pool depth - 1.30 m
17.9	RM17.9DB	No	No	Lots of debris on the shore	-
17.9	RM17.9SC	No	No	-	-
18.3	LM18.3RDC	No	No	Complex solid beaver lodge	-
20.65	RM20.65RDC	No	No	Lots of debris	Shear zone runs along outside of complex
21.3	LM21.3RDC	No	No	-	-
21.4	LM21.4RDC	No	No	Large log jam since construction	-
22	RM22.0RDC	No	No	-	-
22.1	RM22.1RAS	Cable very close to breaking	No	Fails to capture debris	-
22.55	RM22.55RDC	No	No	-	No visible flow, shear zone flows along outside of the complex
22.6	LM22.6RDC	No	No	Lots of debris on the shore	-
22.7	LM22.7RDC	No	No	-	-
22.85	LM22.85RDC	No	No	-	-
22.95	RM22.95RAS	No	No	-	-
23	RM23.0RDC	No	No	-	-
24.2	LM24.2RDC	No	No	-	Complex colonized by beavers
24.3	LM24.3RDC	No	No	-	-
24.35	RM24.35RS	No	No	-	-
24.4	RM24.4FC	No	No	-	-
24.6	RM24.6PBL	No	No	-	-
24.8	RM24.8PBL	No	No	-	-
25.4	RM25.4RDC	No	No	-	-
25.7	MC25.7RDC	No	No	-	-
26.9	RM26.9RAS	No	No	-	-
27.4	RM27.4FC	No	No	-	Outside of complex floating
28.4	RM28.4RDC	No	No	-	-
29.4	LM29.4RAS	Sweeper broken at outer rail	No	-	-
31	RM31.0PBL	PBL frame broken	No	-	Debris compressed into a small bundle
31.1	RM31.1PBL	No	No	-	Debris shifted to d/s onshore corner of PBL frame
31.4	RM31.4BP	No	No	-	-
32.65	LM32.65HAS	No	No	-	-
34.7	RM34.7PDC	D/S pipe pile being lifted by ice, just about falling over	No	-	-
35.4	MC35.4PDC	No	No	-	Filling in d/s of complex with weeds and sediments

Table B1b
Spring 1993 Assessment of Habitat Complexing Structures

Location (km)	Site Number	Damage	Displacement	Debris Accumulation/Loss	Recommendation/Comments
Spring 1993 Assessment (June 5 - 10, 1993): Discharge = 57.5 - 59.5 m³/s (2,031 - 2,101cfs)					
Reach 4					
72.9	LM72.9HAS	No	No	Debris added	Modified April 1993
73	LM73.0HAS	No	No	-	Swpr not modified due to lack of suitable anchoring and material
74.1	RM74.1HAS	Complex almost completely submerged	No	-	-
75.9	LM75.9HAS	No	No	Debris added	D/s sweeper added April 1993 to improve debris collection
78	LM78.0HAS	No	No	Debris added	-
80.2	LM80.2HAS	No	No	-	-
80.9	LM80.9RDC	No	No	-	High water flows over the top of rails
82.1	LM82.1RAS	No	No	-	-
82.2	LM82.2RAS	No	No	-	-
82.3	LM82.3HAS	No	No	-	-
83	LM83.0RDC	No	No	-	-
85.6	MC85.6RDC	No	No	-	Water flows over rails at high flows
85.7	RM85.7RAS	Branches reduced in size by beavers	No	Debris added	Repl.in Apr. 1993 and d/s boom added. Old sweeper rem. by ice
86.35	RM86.35RDC	No	No	Complex plugged with grasses and pollen	-
86.375	RM86.375RDC	No	No	-	-

Where,
RM = right margin
MC = mid-channel
LM = left margin

RS = rootwad sweeper
BP = brush pile
FC = floating crib
PBL = pseudo beaver lodge
RAS = rail-anchored sweeper
HAS = hand-placed anchored sweeper
PDC = pipe-pile debris catcher
RDC = rail debris catcher
DB = debris boom
SC= side channel
PB = point bar
PP = pocket pool

u/s = upstream
d/s = downstream
N/A - Not available

Table B2
Fall 1993 Assessment of Habitat Complexing Structures

Fall 1993 Assessment (November 19, 1993): Discharge = 32.7 m^3/s (1,155 cfs)

Location (km)	Site Number	Damage	Displacement	Debris Accumulation/Loss	Recommendation/Comments
Reach 2					
15.6	LM15.6RAS	-	-	-	-
15.7	MC15.7PP	-	-	-	-
15.8	MC15.8PP	-	-	-	-
16.2	RM16.2RAS	-	-	-	-
16.5	RM16.5RDC	-	-	-	-
16.8	RM16.8RDC	-	-	-	-
17	RM17.0PB	-	-	-	-
17.15	RM17.15PB	-	-	-	-
17.3	RM17.3PB	-	-	-	-
17.9	RM17.9DB	-	-	-	-
17.9	RM17.9SC	-	-	-	-
18.3	LM18.3RDC	-	-	-	-
20.65	RM20.65RDC	-	-	-	-
21.3	LM21.3RDC	-	-	-	-
21.4	LM21.4RDC	-	-	-	-
22	RM22.0RDC	-	-	-	-
22.1	RM22.1RAS	-	-	-	-
22.55	RM22.55RDC	-	-	-	-
22.6	LM22.6RDC	-	-	-	-
22.7	LM22.7RDC	-	-	-	-
22.85	LM22.85RDC	-	-	-	-
22.95	RM22.95RAS	Sweeper broken in half	-	-	-
23	RM23.0RDC	-	-	-	-
24.2	LM24.2RDC	-	-	-	-
24.3	LM24.3RDC	-	-	-	-
24.35	RM24.35RS	-	-	-	-
24.4	RM24.4FC	-	-	-	-
24.6	RM24.6PBL	-	-	-	-
24.8	RM24.8PBL	-	-	-	-
25.4	RM25.4RDC	-	-	-	-
25.7	MC25.7RDC	-	-	-	-
26.9	RM26.9RAS	d/s boom broke	-	Major loss of debris	-
27.4	RM27.4FC	-	-	-	-
28.4	RM28.4RDC	-	-	-	-
29.4	LM29.4RAS	Sweeper broken in half	-	-	-
31	RM31.0PBL	-	-	-	-
31.1	RM31.1PBL	-	-	-	-
31.4	RM31.4BP	-	-	-	-
32.65	LM32.65HAS	-	-	-	-
34.7	RM34.7PDC	-	-	-	-
35.4	MC35.4PDC	-	-	-	-

Table B2
Fall 1993 Assessment of Habitat Complexing Structures

Fall 1993 Assessment (November 19, 1993): Discharge = 32.7 m^3/s (1,155 cfs)

Location (km)	Site Number	Damage	Displacement	Debris Accumulation/Loss	Recommendation/Comments
Reach 4					
72.9	LM72.9HAS	-	-	-	-
73	LM73.0HAS	-	-	-	-
74.1	RM74.1HAS	-	-	-	-
75.9	LM75.9HAS	-	-	-	-
78	LM78.0HAS	-	-	-	-
80.2	LM80.2HAS	-	-	-	-
80.9	LM80.9RDC	-	-	-	-
82.1	LM82.1RAS	-	-	-	-
82.2	LM82.2RAS	-	-	-	-
82.3	LM82.3HAS	-	-	-	-
83	LM83.0RDC	-	-	-	-
85.6	MC85.6RDC	-	-	-	-
85.7	RM85.7RAS	-	-	-	-
86.35	RM86.35RDC	-	-	-	-
86.375	RM86.375RDC	-	-	Significant debris capture	-

Where,
RM = right margin
MC = mid-channel
LM = left margin

RS = rootwad sweeper
BP = brush pile
FC = floating crib
PBL = pseudo beaver lodge
RAS = rail-anchored sweeper
HAS = hand-placed anchored sweeper
PDC = pipe-pile debris catcher
RDC = rail debris catcher
DB = debris boom
SC= side channel
PB = point bar
PP = pocket pool

u/s = upstream
d/s = downstream
N/A - Not available

Appendix C

1993 to 1995 Sketches of Habitat Complexes (As Built)

Appendix D

1993 to 1995 Habitat Complex Physical Assessment Photos

Photograph 1: Stable rootwad sweeper (RM24.35RS) providing 55 m² of cover area (May 1995).

Photograph 2: Brushpile (RM31.4BP) with little cover area due to mobile river bank (May 1995).

Photograph 3: Stable floating crib (RM24.4FC) showing large cover area of 91 m² (May 1995).

Photograph 4: Floating crib (RM27.4FC) not providing much cover as its upstream end pushed onto the shore (May 1995).

Photograph 5: Pseudo beaver lodge (RM24.6PBL) still retaining debris, providing 50 m² of cover area (May 1995).

Photograph 6: Pseudo beaver lodge (RM31.0PBL) removed from 1995 physical assessment due to loss of all debris (May 1995).

Photograph 7: Downstream boom added to rail anchored sweeper (LM82.1RAS) to improve debris capture (November 1993).

Photograph 8: Rail-anchored sweeper (LM29.4RAS) broken in half, stripped of majority of branches and not providing much cover area (November 1993).

Photograph 9: Downstream boom added to hand-placed anchored sweeper (LM75.9HAS) to improve debris capture (April 1993).

Photograph 10: Hand-place anchored sweeper (RM74.1HAS) reduced to bare log due to ice and summer flows. Removed from physical assessment in 1995 (May 1994).

Photograph 11: Smaller pipe-pile debris catcher (RM34.7PDC) providing 42 m² of cover area despite loss of downstream pile (May 1995).

Photograph 12: Large accumulation (149 m²) at pipe-pile debris catcher (MC35.4 PDC, May 1995).

Photograph 13: Rail debris catcher (RM86.375RDC) showing significant debris capture (November 1993).

Photograph 14: Rail debris catcher (MC85.6RDC) removed from 1995 physical assessment due to loss of all debris during summer cooling flows (May 1994).

Photograph 15: Stable debris boom (RM17.9DB) providing 60 m² of cover area (May 1995).

Photograph 16: Side channel (RM17.9SC) showing low water level, dewatered complexes and no velocity due to beaver dam blockage (May 1995).

Photograph 17: Stable point bar RM17.0PB showing shear zone (May 1995).

Photograph 18: Location of remaining pocket pool (MC15.7PP, May 1995). MC15.8PP removed from further physical assessment due to significant erosion..