Abstracts - Habitat Complexing

In-Stream Habitat Complexing 1988-1990 Pilot Testing (RM90-3)
Prepared by Triton Environmental Consultants Ltd. April 1996

This report documents the progress of work and physical performance of instream habitat complexes in the Nechako River from the inception of the project in 1988 to the fall of 1990. Habitat complexes were installed in the Nechako River based on recommendations to increase the complexity of juvenile chinook habitat prior to the implementation of the Long-Term Flow Regime, following development of the Kemano Completion Project. The objectives of the pilot habitat complexing project were to determine the hydraulic performance, durability and cost effectiveness of a variety of potential habitat complexes through a series of small scale pilot tests.

The majority of habitat complexes identified for pilot testing in Nechako River were generally 2 types, structures or instream modifications. Structures consisted of debris bundles and debris catchers, while instream modifications consisted of a side channel developed on the right side of the mainstem Nechako River and 3 point bars constructed on the Nechako River shoreline.

Design criteria utilized in site selection and construction of habitat complex complexes were based on a review of pertinent literature and an assessment of chinook life history data from Nechako River. Selection of habitat complex structure designs was based on Nechako River physical characteristics and natural habitats.

During 1988, the first year of the habitat complex pilot testing, 10 habitat complexes were installed in the mainstem Nechako River. Additionally, a side channel was developed, which included additional complexes and a debris boom installed within the downstream portion of a 735 m side channel excavated on the right margin of the Nechako River. On the mainstem Nechako, debris bundle complexes constructed included 4 rootwad sweepers, 2 floating cribs, and a brush pile. Debris catchers comprised of 3 sets of channel jacks. In 1988, the total cost for the construction of complexes was $58,260. No monitoring of these complexes was done in 1988 as all complexes were installed during the fall.

During 1989, 13 additional habitat complexes were installed in the mainstem Nechako River. Modifications were made to existing and newly constructed complexes based on recommendations from physical monitoring assessments conducted during the spring and fall. New structures included the addition of 1 rootwad sweeper, 7 pseudo beaver lodges, 2 pipe-pile debris catchers, and 3 point bars. Modifications were made to 2 rootwad sweepers, 1 floating crib and all pseudo beaver lodges, channel jacks, and side channel complexes. In 1989, the total cost for the construction of complexes was $26,870.

In 1990, 14 additional habitat complexes were installed in the mainstem Nechako River. Modifications were made to existing and newly constructed complexes based on recommendations from physical monitoring assessments conducted during the spring, summer and fall. New structures included the construction of 7 deep water sweepers and 7 rail debris catchers. All side channel complexes were removed and replaced with smaller complexes and the debris boom was relocated upstream of the side channel to reduce entry of floating debris. Other modifications were made to 1 rootwad sweeper, 3 pseudo beaver lodges, 4 deep water sweepers and 2 rail debris catchers. Four rootwad sweepers, 3 pseudo beaver lodges, 12 deep water sweeper, and 2 channel jacks were removed due to inadequate velocities or design. In 1990, the total cost for the construction of new complexes and side channel remediation was $18,660.

Evaluation of the structural performance of some complexes is in an early stage. Of the debris bundle type habitat complexes installed in 1988 (which included rootwad sweepers, brush piles and floating cribs), rootwad sweepers were oversized. Debris bundles installed in 1989 (which included original and modified pseudo beaver lodges) and in 1990 (deep water sweepers) were subject to stability problems during high flows due to inadequate anchoring. The velocities measured at the debris bundles were generally within the lower portion of the design criteria range or below the design criteria range, either due to oversizing of the complex or placement of the complex in a low velocity area. Recommendations for future installations would be to reduce cover size to approximately 15 m2, locate the complexes in areas of sufficient velocity to meet criteria, and provide an anchoring system that retains debris yet is flexible enough to adapt to flow fluctuations.

Debris catcher type habitat complexes installed in 1988 (which included original and modified channel jacks) experienced stability problems and lost the majority of their debris. As a result, sufficient cover was lacking, and velocity distributions were within the upper portion of the design criteria range or above the design criteria range. Pipe-pile and rail debris catchers, installed in 1989 and 1990 respectively, were stable and trapped a significant amount of debris. Due to the large amounts of accumulated debris, velocity distributions at the pipe-pile debris catcher sites were within the lower portion of the design criteria range or below the design criteria range. Velocity distributions at the rail debris catcher sites were below, above, or within the design criteria range, depending on their location and the amount of debris caught. Deducing the size of the rail debris catchers resulted in improved velocities, as debris entrapment was reduced.

The full spanning habitat complexes installed in the side channel in 1988, and thinned in 1989, became clogged with small organic debris which acted as a barrier to water flow through the channel. The debris boom, which was installed within the downstream portion of the channel to prevent the loss of seeded debris, also contributed to the lowering of velocities in the side channel. Velocities through the side channel were eventually reduced to below design criteria. In 1990, in an effort to prevent flow blockage due to excessive accumulation of material within the side channel, the debris boom was moved upstream of the side channel entrance to divert floating debris. The full spanning habitat complexes were removed and replaced with smaller complexes more proportional to the size of the side channel, resulting in improved water velocities.

The 3 point bars installed in 1989 experienced some erosion during high flows. The point bars were also found to be oversized as a large area of still water was created downstream of the complexes rather than creating a back-eddy as expected.

With the exclusion of the 1988 channel jack designs, the habitat complexes did not suffer any significant structural damage and/or stability problems over the 1988 and 1989 winter seasons. However, the seasonal conditions observed were relatively mild in comparison to previous years and icing events experienced by most of the complexes were transient and of short duration, since the habitat complex complexes are located upstream of the leading edge of ice cover.

To date, the Nechako Fisheries Conservation Program (NFCP) pilot habitat complexing project has constructed and tested 10 different complex designs in the mainstem Nechako. These designs are categorized below as either "structures" - comprising debris bundles or debris catchers, or "instream modifications".

Structures

Debris Bundles
1. Rootwad Sweepers
2. Brush Pile
3. Floating Cribs
4. Pseudo Beaver Lodges
5. Deep Water 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.

All of the debris bundles have good potential with limited modifications required to their designs and placement locations in the future. The pipe-pile and rail debris catcher designs were also successful. The range in unit cost of all habitat complexes identified as successful and/or promising is $470 to $3,300. The least expensive promising design was that of the deep water sweeper, while the most expensive was the rootwad sweeper. Successful debris catcher costs per unit varied from $1,525 for the pipe-pile debris catchers to $1,610 for the rail debris catchers. Modifications that have been recommended to improve the performance of promising complexes could result in increased costs per unit for future installations. Maintenance costs of complexes require several years of data. Therefore, these costs were not presented in this report but may be developed as long term durability is assessed.

The NFCP pilot habitat complexing project has identified several parameters which are important for success in habitat complexing, namely, the provision of required velocities, substrate, appropriate structure sizing, and adequate complex anchoring. The project has also distinguished several successful habitat complex designs from those that were constructed and replicate tested.

Biological Assessment of Habitat Complexing and Stream Fertilization (RM89-5)
Prepared by Triton Environmental Consultants Ltd. March 1998

In the spring of 1989, the NFCP, under the terms of the 1987 Settlement Agreement, implemented two pilot projects to test habitat remedial measures applicable to juvenile chinook salmon (Oncorhynchus tshawytscha Walbaum) on the Nechako River: the experimental installations of habitat complexes and pilot stream fertilization. The objective was to assess both the performance of artificial habitat complexes (a mixture of Large Organic Debris (LOD) and small debris), in providing rearing habitat for underyearling chinook (post emergence to overwintering); and the response of chinook growth and relative abundance to stream fertilization.

Habitat complexing consisted of five LOD structure types: rootwad sweepers; brush piles; floating cribs; channel jacks; and a side channel containing rootwad sweepers, sweepers and brush piles. All of the habitat complexes were utilized by juvenile chinook. The percentage of chinook fry (migrating along or utilizing the right river margin), that inhabited complexes, rose from 14% in May, to 68% in June, and to 79% in July. Habitat complexes were more highly utilized (0.15/0.67, 6.0/26.2, and 0.48/2.1 fry/m2 of total available area/effective area of cover for May, June and July; respectively) than spatial controls, the existing river margins (0.067, 0.19, and 0.008 fry/m2 of river margin for May, June and July, respectively). There was a trend that the rootwad sweepers were more highly utilized by chinook fry than floating cribs and brush piles, and the least utilized were the channel jacks because of limited debris trapping. The effectiveness of the habitat complexes was related to the capacity to maintain LOD in an area that provided an acceptable range of water velocity, substrate, and perhaps water depth, plus orientation to shore for chinook fry utilization. During June, chinook fry in the habitat complexes were slightly larger (5.8% in length and 19.7% in weight; $p<0.05$) than chinook fry not associated with the complexes.

Inorganic fertilizer was added at km 29 to pilot test whole river enrichment as a remedial measure. Juvenile chinook sampled downstream of the point of fertilizer introduction were slightly larger (4.9%, 2.3% and 6.1% in length for May, June and July, respectively; and 8.0% and 19.7% in weight for June and August, respectively; $p<0.05$), than chinook fry sampled upstream of the treated area. However, because of a lack of temporal controls, the suggested effect on growth is inconclusive without further confirmation.

Despite the benefits of increased available cover and possibly an enriched food chain, chinook fry in the treated areas migrated out of the upper Nechako River at the same time as other chinook fry from untreated areas. Numbers of juvenile chinook utilizing the LOD complexes and spatial controls declined markedly. This suggests that some factor other than lack of rearing habitat or limitations in the available food supply, cause chinook fry to migrate downstream. Regardless, improved rearing conditions should increase overall survival rates to the late spring migration stage and for the juveniles that remain in the upper Nechako River.

Biological Assessment of Habitat Complexing in the Nechako River, 1990 (RM90-6)
Prepared by Triton Environmental Consultants Ltd. April 1996

The Strangway Working Group (Anon. 1987) recognized that the change from the short term to the long term flow regime, post Kemano Completion Project, may reduce the amount of debris cover habitat that is currently available to juvenile chinook salmon (Oncorhynchus tshawytscha Walbaum) rearing in the Nechako River. To ensure the conservation of chinook, one of the remedial measures recommended was that the available rearing habitat be increased by installing artificial habitat complexes. The objective of the 1990 project was to assess juvenile chinook usage of habitat complexes in Reach 2 by reporting on chinook behavioural patters, numbers, size and condition. During April 1990, a series of forced spills of up to 255m3/s were released from Skins Lake Spillway at the request of the BC Ministry of the Environment, Comptroller of Water Rights. Although the forced spill in April, 1990 may have been responsible for the reduction in the abundance of the chinook (0+) in Reach 2 to an order of magnitude less than that observed in 1989, the chinook (0+) seasonal behavioural patterns did not appear to be altered. Greater than 90% of the chinook (0+) were associated with cover habitat on the river margins in May and June, and in October they were no longer observed during snorkel floats. In addition, a similar proportion of chinook (0+) observed along the right margin utilized the habitat complexes (47%) and the natural cover (46%) in June. Although chinook (0+) were not observed on the river margins in the fall during the day snorkel floats, they were captured from night electroshocking suggesting a shift in the behaviour of the fall life history stage. Chinook (0+) which utilized the complexes were similar to those from natural sites. There was a common weight/length regression and similar mean monthly lengths, weights and condition factors. In addition, there was an indication that the complexes were utilized as overwintering habitat since 70% of the chinook (1+) observed in March and April were within complexes.

Biological Assessment of Habitat Complexing in the Nechako River, 1991 (RM91-6)
Prepared by Triton Environmental Consultants Ltd. March 1996

The Strangway Working Group (Anon. 1987) recognized that the change from the short term to the long term flow regime, post Kemano Completion Project, may influence the amount of debris cover habitat that is currently available to the chinook salmon (Oncorhynchus tshawytscha Walbaum) of the Nechako River. To ensure the conservation of chinook, one of the remedial measures recommended was that the complexity of habitat in the Nechako River be increased by installing artificial habitat complexes to replace and offset any habitat lost after the change to the long term flow regime. The objective of the 1991 project was to assess the chinook usage of habitat complexes, installed in Reach 2, as rearing and overwintering habitat by reporting on chinook abundance, behavioural patterns, size and condition. In addition, some preliminary information is available for Reach 4 even though complexes were not installed until just prior to the July assessments.

Two methods, snorkel surveys and electrofishing, were used to enumerate and determine the relative abundance of chinook associated with artificial habitat complexes and high quality natural habitat sites. Sampling was conducted from April to November, 1991. Although overwintered chinook (1+) were not observed during snorkel surveys they were captured during electrofishing in April and May. In these months they were most abundant at the complex sites during the night. Complex sites were disproportionately well utilized by chinook fry. Although the complex sites represented 2% and 4% of the total area surveyed during snorkel surveys in May and June respectively, and the natural sites 5% and 4%; 26% and 70% of the chinook (0+) enumerated May (19,864) and June (9,621) were associated with complex sites and only 18% and 3% were associated with natural sites. Similarly, during day electrofishing the CPUE from complex sites was significantly greater than that from the natural sites. The geometric mean density of chinook associated with the instream complex cover sites was 190 fry/100m2 in May and 69 fry/100m2 in June. By July the majority of chinook (0+) had emigrated from Reach 2 and although snorkel surveys suggested that 67% of the 2,454 chinook observed were associated with 72% of the complex sites, and 4% of the chinook with natural sites, the CPUE from electrofishing were similar between complex and natural sites. Similarly, in Reach 4, 98% of the 40 chinook observed were associated with complexes. By the fall, very few chinook (<10) were observed during the snorkel surveys of Reaches 2 and 4, however, more were enumerated during electrofishing. At this time, the CPUE from complex sites were either similar to or greater than that observed for natural sites. From April to November, the morphological parameters; length, weight and condition factor, did not differ greatly (<11%) between chinook captured from complex and natural sites. Where differences were found they most often indicated that chinook during the night and particularly those associated with complexes were longer, heavier and of a greater condition factor. There was little difference in the community structure of complex and natural sites in Reach 2. Cyprinids, particularly redside shiners and squawfish, and chinook were the dominant members.

In-Stream Habitat Complexing, 1991 Pilot Testing (RM91-3)
Prepared by Triton Environmental Consultants Ltd.  April 1996

The Nechako River In-Stream Habitat Complexing Project began in 1988 based on the objective of increasing the complexity of juvenile chinook habitat prior to the implementation of the Long-Term Flow Regime of the Kemano Completion Project. This report documents the progress of work and physical performance of Nechako River habitat complexing during the 1991/92 program year (April 1, 1991 to March 31, 1992). All of the field work for this project was performed between June and October 1991, therefore, the work is identified in this report as occurring in 1991.

In 1991, pilot testing of new complexes continued, along with the replicate construction and modification of selected complexes. Physical assessments of complexes took place during the spring, summer and fall.

Complexes constructed in 1991 were designed to operate at expected Long-Term rearing flows of 31.1 m3/s (1,100 cfs). They were located so that they could also operate during future Long-Term winter flows of 14.2 c3/s (500 cfs). However, all complexes were evaluated only for design criteria fulfillment at Nechako River high and low flows of 56.6 m3/s (2,000 cfs) and 31.1 m3/s (1,100 cfs), respectively. Sites within Reaches 2 and 4 of the river were selected for the installation of complexes in 1991. This was the first year that complexes were installed in Reach 4, where more severe ice conditions were expected to test durability.

Construction of new complexes and modification of previously built complexes took place between June 11 and July 5, 1991. Thirty-nine additional habitat complexes were installed in the mainstem Nechako River. New complexes consisted of the construction of 10 rail anchored sweepers, 11 hand-placed anchored sweepers, 16 rail debris catchers, and 2 pocket pools. Based on results of previous physical assessments, modifications were made to 1 floating crib and 3 point bars. All 6 deep water sweepers were displaced on shore during the winter of 1990/1991 and were omitted from further physical assessment in 1991. One hand anchored sweeper was displaced following 1991 summer cooling flows and was also removed from further physical assessment. Sixty-one complexes currently remain active in the Nechako River.

In 1991, the total cost for the construction of new complexes and modification to existing complexes was $66,140. Of the new complexes, the range in unit cost of those identified as successful and/or promising was from $940 to $1,800. The least expensive design was that of the hand-placed anchored sweeper, while the most expensive design was that of the rail anchored sweepers and rail debris catchers. Modifications to two types of complexes were required in 1991 to improve performance. However, so that the durability of complexes could be assessed, no general maintenance was performed. As maintenance becomes required in future years, associated costs will be reported so that the durability of the complexes may be compared.

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

Structures

Debris Bundles
1. Rootwad Sweepers
2. Brush Pile
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.

An analysis of covariance of 1991 data (Triton 1995a) indicated that shear velocity was the most important predictor of chinook fish abundance, followed by cover area and substrate (negatively correlated with fines). Therefore, these specific parameters are judged to be the key variables in determining the biological success of habitat complexes.

In-Stream Habitat Complexing 1992 Pilot Testing (RM92-3)
Prepared by Triton Environmental Consultants Ltd. April 1996

The Nechako River In-Stream Habitat Complexing Project began in 1988 based on the objective of increasing the complexity of juvenile chinook habitat prior to the implementation of the Long-Term Flow Regime of the Kemano Completion Project. This report documents the progress of work and physical performance of Nechako River habitat complexing during the 1992/93 program year (April 1, 1992 to March 31, 1993). All of the field work for this project was performed between May and October 1992, therefore, the work is identified in this report as occurring in 1992.

In 1992, no new complexes were constructed; however, monitoring of and modifications to habitat complexes continued. Modification of complexes occurred in the spring (May 12, and 20), and summer (July 1). Physical assessments were performed in the spring (June 9 to 15) and fall (October 3 to 6). Complexes installed in Reach 4 during 1991 were assessed for winter resistance to ice conditions for the first time in 1992. Of these complexes, several rail anchored sweepers and hand-placed anchored sweepers had shown signs of defoliation, which may have occurred during winter as ice flows stripped branches from these complexes.

Modifications were made to 12 existing complexes in 1992. One pseudo beaver lodge, 3 rail anchored sweepers, 1 hand-placed anchored sweeper, and 7 rail debris catchers were modified. The work generally consisted of modification and maintenance to complexes, including reseeding and repair of complexes damaged due to summer cooling flows. Additionally, the last remaining channel jack debris catcher was removed due to repeated toppling and loss of debris. The total cost for the modification, maintenance or removal of complexes was approximately $8,400. Sixty complexes currently remain active in Nechako River.

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

Structures

Debris Bundles
1. Rootwad Sweepers
2. Brush Pile
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.

The rail anchored sweepers, hand-placed anchored sweepers, and rail debris catchers generally provided velocities and cover areas within the required criteria range. However, their designs could be improved to also provide long term durability.

To date, the NFCP habitat complexing project has identified several parameters important for biological success in habitat complexing, namely, the provision of appropriate shear velocities;

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

Biological Assessment of Habitat Complexing in the Nechako River, 1992 (RM92-6)
Prepared by Triton Environmental Consultants Ltd. March 1996

The Strangway Working Group (Anon. 1987) recognized that the change from the short term to the long term flow regime, post Kemano Completion Project, may influence the amount of debris cover habitat that is currently available to chinook salmon (Oncorhynchus tshawytscha) of the Nechako River. In response to chinook conservation concerns, and as part of the remedial measures outlined by the Strangway Working Group, artificial habitat complexes were installed from 1989 through 1991. The objective of the 1992 study was to continue the assessment of juvenile chinook use of the habitat complexes for rearing and overwintering habitat by reporting on chinook abundance, behavioural patterns, size and condition.

Chinook relative abundance was determined using two techniques; underwater snorkel surveys and electrofishing. Indices of chinook relative abundance (fry density and catch per unit effort) were calculated in order to determine the degree to which chinook were associated with the complexes and natural sites. The length, weight, and condition factor of chinook sampled at complexes and natural sites were also determined. As well, the composition of the fish community at natural and complex sites was described.

Snorkel surveys were conducted in April, May, June, July and November, 1992. The total number of chinook fry (0+) observed by snorkel surveys peaked at 11,950 in May. Habitat complexes were well utilized by rearing chinook fry. Although the complex sites represented only 3% of the total area surveyed during May and June, most of the 0+ chinook observed by snorkel surveys in Reach 2 were found in complex sites (73% in May and 61% in June). In Reach 4, complex sites represented 2% of the total area surveyed in May and June, but 27% and 47% of the chinook observed in May and June, respectively, were found in complex sites. In these same months, 70% to 76% of the habitat complexes were used by chinook fry.

The mean CPUE for fish enumerated by electrofishing at night was generally greater than during the day; however, within each time period the mean CPUE for complex sites was either greater than or not significantly different from that of natural sites. As well, within sampling periods, there were no significant differences between the mean CPUE for the two types of complex structures, debris bundles and debris catchers. There were few significant differences in mean lengths, weights and condition factors between chinook 0+ enumerated in complex and natural sites within a sample period. The majority of the chinook 1+ were electrofished in April, and also showed a preference for habitat complexes over natural sites. In Reach 2 in April, 98% of the chinook 1+ enumerated were from complexes.

The composition of the fish community within complex sites was similar to that within natural sites. The composition of fish communities did change over time: chinook fry dominated both complex and natural sites throughout the spring, then their percent composition decreased through the summer and into the fall, whereas cyprinids increasingly dominated all sites through to November.

Biological Assessment of Habitat Complexing in the Nechako River, 1993 (RM93-4)
Prepared by Triton Environmental Consultants Ltd. March 1996

The Strangway Working Group (Anon. 1987) recognized that the change from the short term to the long term flow regime, post Kemano Completion Project, may influence the amount of debris cover habitat that is currently available to chinook salmon (Oncorhynchus tshawytscha) of the Nechako River. To ensure the conservation of chinook, one of the remedial measures recommended was that the complexity of habitat in the Nechako River be increased by installing artificial habitat complexes to replace and off-set any habitat lost after the change to the long term flow regime. The objective of the 1993 project was to assess the chinook usage of habitat complexes, installed in reaches 2 and 4, as rearing and overwintering habitat, and to report on chinook abundance, behavioural patterns, size and condition.

Chinook relative abundance was determined using two techniques; underwater snorkel surveys and electrofishing. Indices of chinook relative abundance (fry density and catch per unit effort) were calculated in order to determine the degree to which chinook were associated with the complexes and natural sites. The length, weight, and condition factor of chinook sampled at complexes and natural sites were also determined. As well, the composition of the fish community at these sites was described.

Sampling was carried out from April to November, 1993. The total number of chinook 0+ observed by snorkel surveys was 4,898 in May and peaked at 12,763 in June. Although complex sites represented only 3% of the total area surveyed during May and June, most of the chinook 0+ observed by snorkel surveys in Reach 2 were found in complex sites (May, 52%; June, 73%). In Reach 4, complex sites represented 53% in May and 2% in June of the total area surveyed, and 81% and 48% of the chinook 0+ observed in May and June respectively were found in complex sites. In these same months, 74% and 97% of the habitat complexes were utilized by chinook 0+. In addition, most of the chinook 1+ enumerated by electrofishing were found in complex sites in April and May, suggesting that the complexes are also selected by overwintered pre-smolts. The mean CPUEs for fish enumerated at night was generally greater than during the day. However, within each time period the mean CPUEs for complex sites were either greater than or not significantly different from those of natural sites. As well, within sampling periods, there were no significant differences between the mean log10(CPUE + 1) for debris bundles and debris catchers. There were few significant differences in mean lengths, weights and conditions factors between chinook 0+ enumerated in complex and natural sites within a time period. As well, the composition of the fish community associated with complex sites was similar to that within natural sites.

Biological Assessment of Habitat Complexing in the Nechako River, 1994 (RM94-3)
Prepared by Triton Environmental Consultants Ltd. April 1996

The Strangway Working Group (Anon. 1987) recognized that the change from the short term to the long term flow regime post Kemano Completion Project, may influence the amount of debris cover habitat available to chinook salmon (Oncorhynchus tshawytscha Walbaum) of the Nechako River. In response to chinook conservation concerns, and as part of the remedial measures outlined by the Strangway Working Group, artificial habitat complexes were installed from 1989 through 1991 to increase the complexity of habitat in the Nechako River and to replace and offset any cover habitat lost after the change to the long term flow regime. The objective of the 1994 study was to assess juvenile chinook use of the habitat complexes as rearing and overwintering habitat and to report on chinook behavioural patterns, size and condition.

Chinook relative abundance was determined using two techniques; underwater snorkel counts and electrofishing. Indices of chinook relative abundance (fry density and catch per unit effort (CPUE)) were calculated in order to determine the degree to which chinook were associated with the complexes and natural sites. The length, weight, and condition factor of chinook sampled at complexes and natural sites were also determined. As well, the composition of the fish community at these sites was described.

Complex utilization during the spring and summer tended to be high even though the amount of habitat represented by the complexes was small compared to the total area of the river. For example, complex sites represented 3% of the total area snorkel surveyed in Reach 2, but 74% of the chinook 0+ enumerated in June were associated with complex sites. In comparison, the natural sites represented 2% of the total area surveyed, and only 1% of the total chinook observed in June. Up to 81% of complex sites were observed to be occupied by chinook 0+. In addition, within the habitat complexes in Reach 2, the debris catchers were better utilized than the debris bundles (95% and 67%), and also had greater fry density (maximum geometric mean of 25 fry/100 m2). Electrofishing also indicated that the habitat complexes were well used by chinook fry. Complexes frequently had a significantly greater CPUE of chinook fry than the natural sites for the same month and sampling period. The tendency to underestimate CPUE from areas of large woody debris (LWD) suggests that chinook were more abundant in complex sites than in natural sites. As well, within complexes the mean CPUE was greater for debris catchers than debris bundles in Reach 4, but there was no significant difference between the two types in Reach 2. In addition, most of the chinook 1+ enumerated by electrofishing were found in complex sites from April and May, suggesting that the complexes are selected by chinook 1+ at this stage in their life history. The trends observed in the 1994 study were similar to those in previous years.

There were generally no significant differences in the morphological parameters of length, weight and condition factor for chinook 0+ enumerated in complexes and natural sites within day and night samples. However, there were indications that chinook 0+ enumerated at night were slightly longer, heavier and of higher condition factor than those enumerated during the day.

The structure of the fish communities within complex and natural sites varied with season, time of day and sampling method, but was predominated by cyprinids, chinook 0+ and suckers in both types of sites.

Biological Assessment of Habitat Complexing in the Nechako River, 1995 (RM95-4)
Prepared by Triton Environmental Consultants Ltd. July 1999

The Nechako River Working Group (Anonymous 1987) recognized that the expected changes in river flows associated with the Kemano Completion Project may influence the amount of debris cover habitat available to chinook salmon (Oncorhynchus tshawytscha Walbaum) of the Nechako River. In response to chinook conservation concerns, and as part of the remedial measures outlined by the Nechako River Working Group, pilot tests of artificial habitat complexes were undertaken from 1989 through 1991 to demonstrate that habitat complexity in the Nechako River could be increased to replace and offset any potential habitat losses after the change from the current short term flow regime to the long term flow regime. The objective of the 1995 study was to assess juvenile chinook use of the habitat complexes as rearing and overwintering habitat by reporting on chinook abundance, behavioral patterns, size and condition.

Chinook relative abundance was determined using two techniques; underwater snorkel counts and electrofishing. Indices of chinook relative abundance (fry density and catch per unit effort) were calculated in order to determine the degree to which chinook were associated with the complexes and natural sites. The length, weight, and condition factor of chinook sampled at complex and natural sites were also determined. As well, the composition of the fish community at natural and complex sites was described.

During the assessment, complex utilization tended to be high even though the amount of habitat represented by the complexes was small compared to the total area of the river. For example, complex sites represented 2.5% of the total area snorkel surveyed in Reach 2, but 67% of the chinook 0+ sampled in June were associated with complex sites. In comparison, the natural sites represented 2.3% of the total area surveyed, and only 4% of the total chinook observed in June. Up to 94% of complex sites in Reach 2 and 92% of complexes in Reach 4 were observed to be occupied by chinook 0+. Electrofishing also indicated that the habitat complexes were well used by chinook fry (0+) and chinook pre-smolts (0+ and 1+). There was also evidence that the complexes provided preferred overwintering habitat. The mean CPUE of chinook pre-smolts in complexes was significantly greater than the mean CPUE of chinook pre-smolts in natural sites during both day and night sample periods in April and November. The tendency to underestimate CPUE from areas of large woody debris (LWD) also suggests that chinook 0+ and 1+ were at least as abundant in complex sites as in natural sites. Between complex types, there were no significant differences in utilization of debris bundles or debris catchers in either Reach 2 or Reach 4. Similar trends of complex utilization have also been observed in previous Nechako River studies.

There were generally no significant differences in the morphological parameters of length, weight and condition factor for chinook 0+ sampled in complexes and natural sites within day and night samples. However, there were indications that chinook 0+ sampled at night were slightly longer, heavier and of higher condition factor than those sampled during the day although this may have been due to the differences in sample sizes between day and night sampling.

The structure of the fish communities within complex and natural sites was generally similar although it varied with season, time of day and sampling method. Electrofishing indicated that the fish community was predominated by cyprinids, suckers and chinook 0+ respectively. Snorkel surveys indicated that chinook 0+ were the predominant species observed at complex and natural sites, followed by cyprinids and suckers.