AQUATIC RESOURCE SURVEY: INDIAN RIVER, SITKA NATIONAL HISTORICAL PARK, ALASKA

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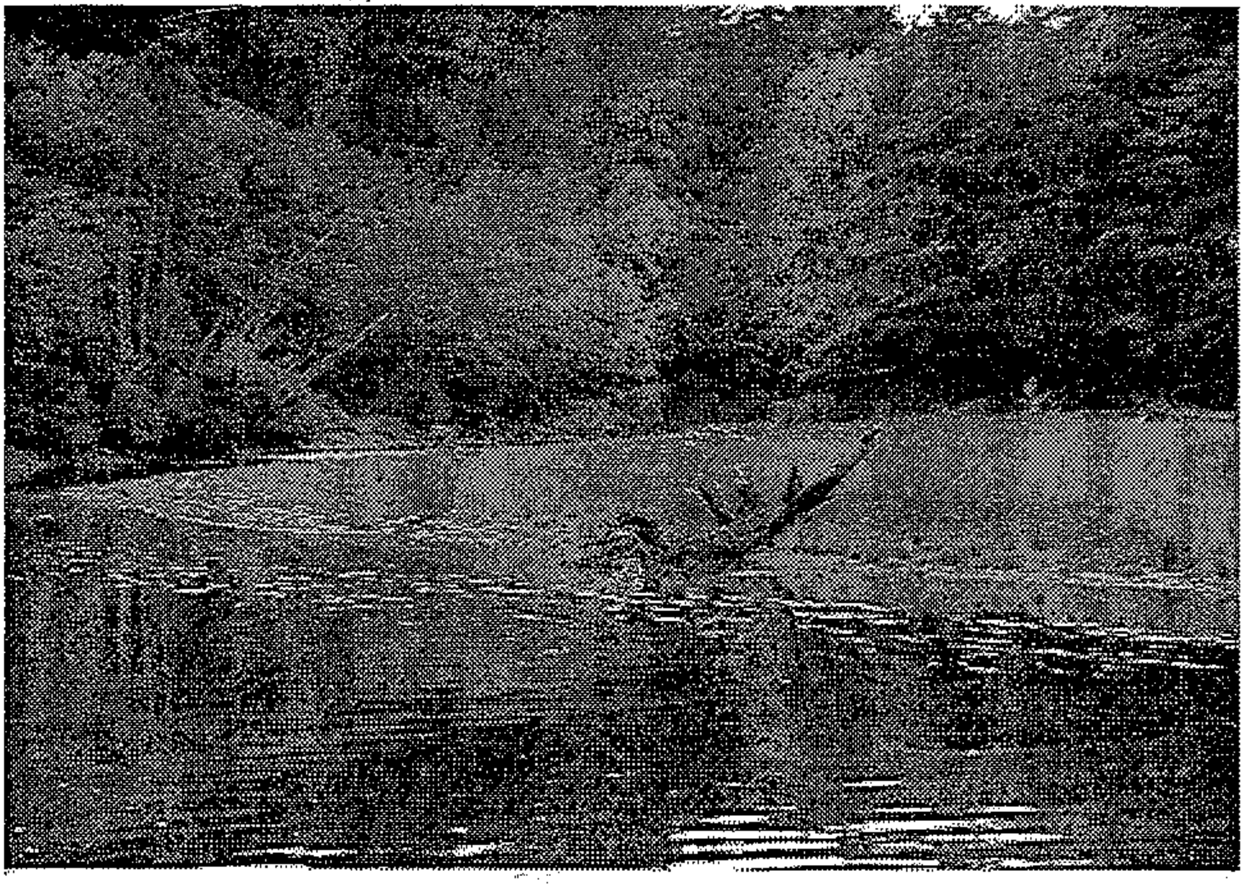
November 1995



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Prepared for: U.S. Department of Interior, National Park Service, Alaska Regional Office, Anchorage AK.
(Under Interagency Agreement No. IA 9700-2-9017)

EXECUTIVE SUMMARY

This report presents the results of a ecological survey designed to assess aquatic reource conditions and trends within Sitka National Historical Park. The report compliments the existing ecological inventory for soils and plant communities (USDA 1993). Principal areas of investigation include: watershed hydrology, fish habitat, channel morphology and stability, and water quality.

Summary of Key Results:

- Watershed and climatic characteristics of Indian River cause large, flashy peak flow events in the lower river. Historic flood events in the park have damaged or swept away inchannel structures, and caused major changes in stream channel morphology.
- Localized areas of stream bank erosion, along the east bank of Indian River, were identified in this survey. However, current flood plain and channel conditions are stable, relative to natural streams systems.
- Fish habitat within the Park is primarily suited for pink and chum salmon spawning. The lack of pool habitat and large woody debris habitat make this portion of Indian River less suitable for juvenile salmonid rearing habitat.
- Relatively low diversity and the presence of pollution tollerant macro-invertebrate general indicate slight water quality impairment in lower Indian River.

Recommendations

- Riparian management objectives should strive to 1) maintain healthy shrub and tree communities along stream banks and active flood plain area, and 2) allow natural recruitment of large woody debris from the riparian area to increase aquatic habitat diversity. .
- Additional macroinvertebrate monitoring is needed to determine water quality trend in lower Indian River.
- A riprap dike constricting the lower flood plain should be modified to reduce stream bank erosion at the head of the Indian River estuary.

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ACKNOWLEDGEMENTS

The authors would like to acknowledge Jim Papio and Glenn Cross for their work collecting field data for this project. Gene Griffen, Tim Stone and Gary Vequist of the National Park Service provided administrative help neccessary to implement this study. Dr. Ross Kavanagh, Sue Trull and Micheal Shephard reviewed initial drafts of this paper. Their comments greatly improved the final manuscript.

INTRODUCTION

OBJECTIVES

The purpose of this report is to provide Sitka National Historical Park with baseline information to assess riparian and aquatic resource conditions and trends for use in the Park's comprehensive resource plan. The aquatic-riparian resource survey was conducted for the Park Service in 1994 under Interagency Agreement IA 9700-2-9017. Specific objectives of this report are to:

- Provide an ecological context for assessing riparian and aquatic resources in the Park.
- Identify key factors influencing stream channel and flood plain dynamics.
- Provide baseline information for monitoring aquatic and riparian resource health.
- Make general recommendations for sustaining and restoring riparian and aquatic habitat condition.
- Identify future information needs.

This report is intended to supplement the Ecological Inventory: Sitka National Historical Park (USDA 1993) that included soils, geomorphology, plant community, plant disease, and disturbance surveys. The scope for this report includes fluvial geomorphic, fish species, aquatic macroinvertebrate, aquatic habitat, and hydrologic investigations on the segment of Indian River which falls within the Park boundaries.

SETTING

The Sitka National Historical Park is situated at the mouth of Indian River which drains the rugged central Baranof Island mountains. The Indian River adjacent riparian zone, and estuary delta forms the core of the Park properties. The Indian River watershed has annual precipitation of about 100 in (394 mm), an elevation range of 0 to 3800 ft (1151 m), and a 12.6 mi^2 (32.6 km^2) drainage basin. The Indian River riparian area in the Park consists of estuary, flood plain and stream terrace ecological land units described in USDA (1993) (fig. 1). The genesis of park landforms is late Wisconsin glacial deposits (14,000 years B.P.) reworked by marineand human transgressions. Since deglaciation, isostatic rebound has resulted in the Park land mass rising up a total of 35 ft (10.6 m) (USDA 1993). The current elevation of Park riparian stream terraces is about 15 ft (4.5 m) above mean sea level (fig. 1).

The riparian land units highlighted in figure 1 are dominantly influenced by fluvial erosion and deposition processes associated with the historic Indian River flood plain. Soils in the *estuary unit* are Typic Cryaquepts and Typic Cryaquents with hairgrass-forb and sedge wetland plant communities. Areas subjected to persistent tidal inundation have bare gravel with algal communities. Soils in the *flood plain unit* are Typic Cryumbrepts and Aquic Cryumbrepts which support a red alder-salmonberry plant community. Soils in the *stream terrace unit* are coarse-loamy to sandy skeletal Typic Cryochrepts. Stream terrace forest communities consist of spruce/devils' club-salmonberry, hemlock/devils' club and hemlock/blueberry plant associations. Refer to USDA 1993 for a more detailed description of these terrestrial ecological units.

Two aquatic ecological units have been defined for the segment of Indian River within the park boundaries (Paustian et. al. 1992). The *estuary* (ES4) channel unit extends about 600 ft (183 m) from the mouth of the river to the upper extent of the grass-forb wetland vegetation community. The *flood plain* (FP5) channel unit extends from the ES4 boundary to the northern Park boundary (fig. 1). These stream reach units are characterized as low gradient, gravel-cobble bed, alluvial channels. Average stream gradient ranges from 0.5% to 1.5%. Stream channel morphology is shallow rectangular cross-section with a mostly smooth or plane bed profile. Channel bed width is greater than 75 ft (23 m). Natural streambank materials are poorly sorted sands, gravels and cobbles. There are relatively slight differences in channel morphology between the FP5 and ES4 stream reaches. The main distinction between these units is that shrub-forest riparian vegetation is associated with the FP5 reach while estuary forb-grass communities dominate the riparian vegetation along the ES4 reach. Characteristics of each of these aquatic ecological units will be covered in greater detail in the body of this report.

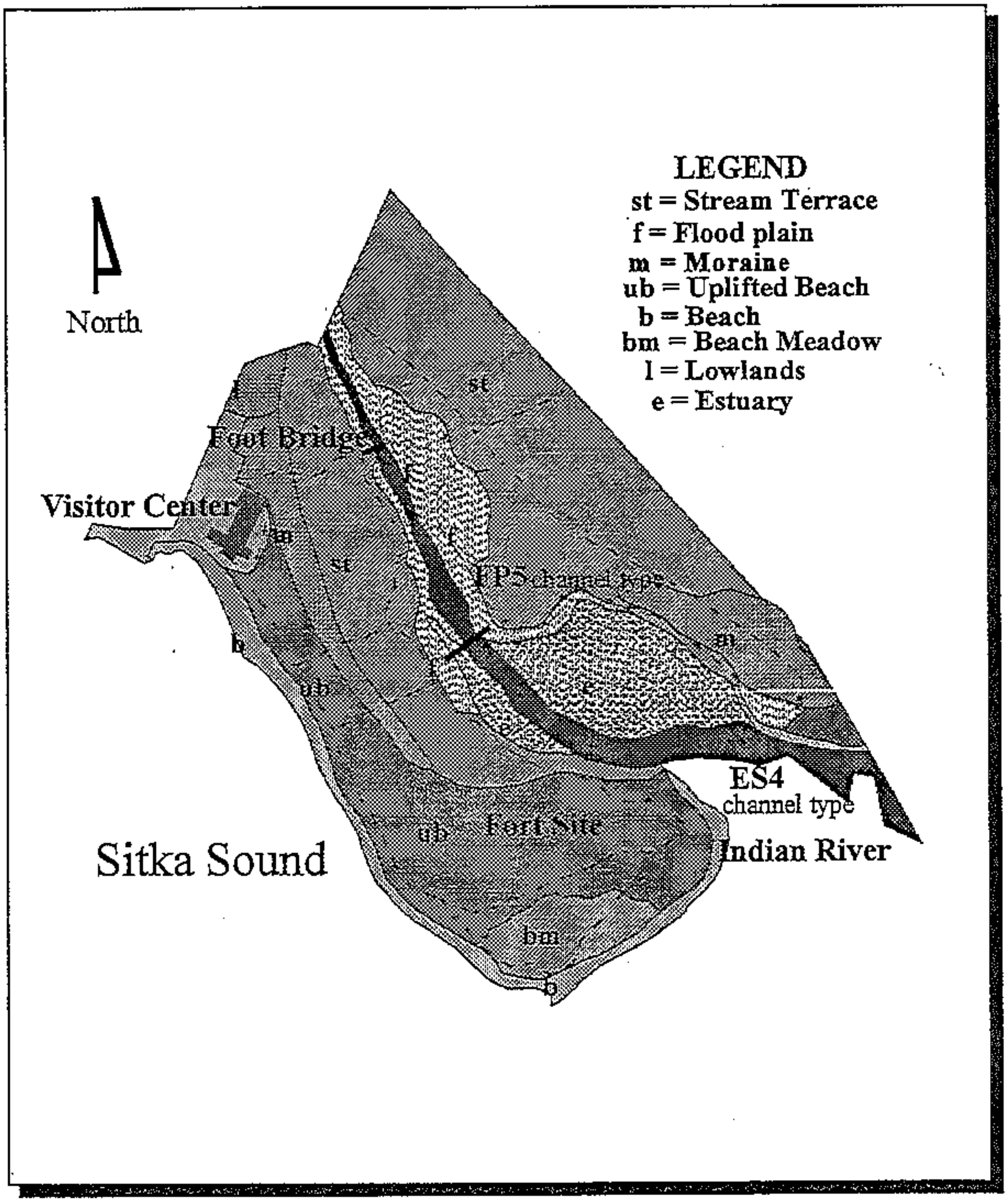

Figure 1. Riparian and aquatic ecological map units SNHP (scale: 1"= 500')

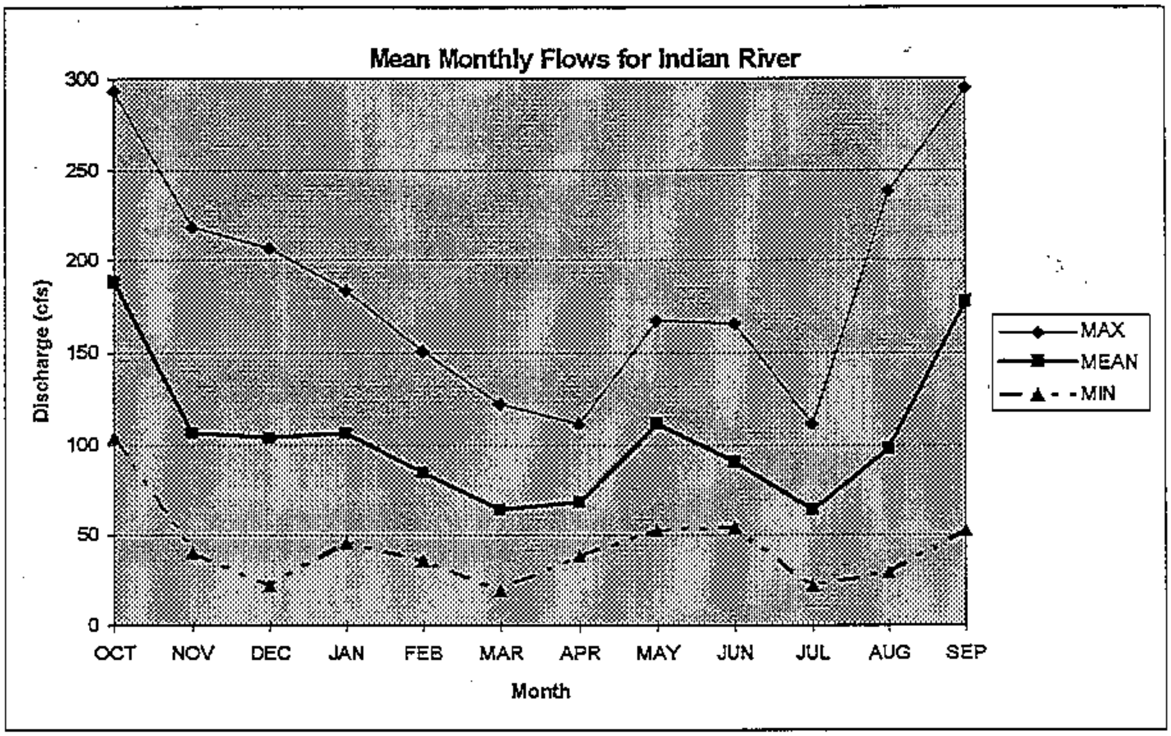

Figure 2. Average monthy stream discharge (maximum, mean, and minimum) for Indian River, U.S. Geological Survey Gaging Station 15087690.

Stream runoff from the Indian River watershed is very flashy due to steep basin relief, high drainage density, and relatively shallow soils. Flood peaks are seldom more than 24 hours in duration and the flow hydrograph closely tracts rainfall delivered from Gulf of Alaska storm fronts. The mean monthly flow hydrograph for 11 years of record is shown in figure 2. River discharge generally peaks in September and October and gradually declines throughout the winter and early spring. Moderate flow increases occur in May and June as a result of high elevation snowmelt. Minimum flows are most common in December, March and July. Instantaneous peak flows generally occur in the fall, however, rain-on-snow flood events occasionally occur during the winter. Figure 3, shows the annual peak discharge flood frequency curve for Indian River. This curve can be used to predict the return interval for a given flood magnitude. For example, 1,300 cfs (36.8 cms), 3,500 cfs (99 cms) and 5,100 cfs (144.4 cms) discharges correspond to 1 yr (P=.99), 2 yr (P=.50), and 10 yr (P=.10) flood return intervals. The storm of record was 5,700 cfs (161.4 cms) in 1990. The estimated 100 yr flood is 6,400 cfs (181.2 cms) based on 11 years of gaging data.

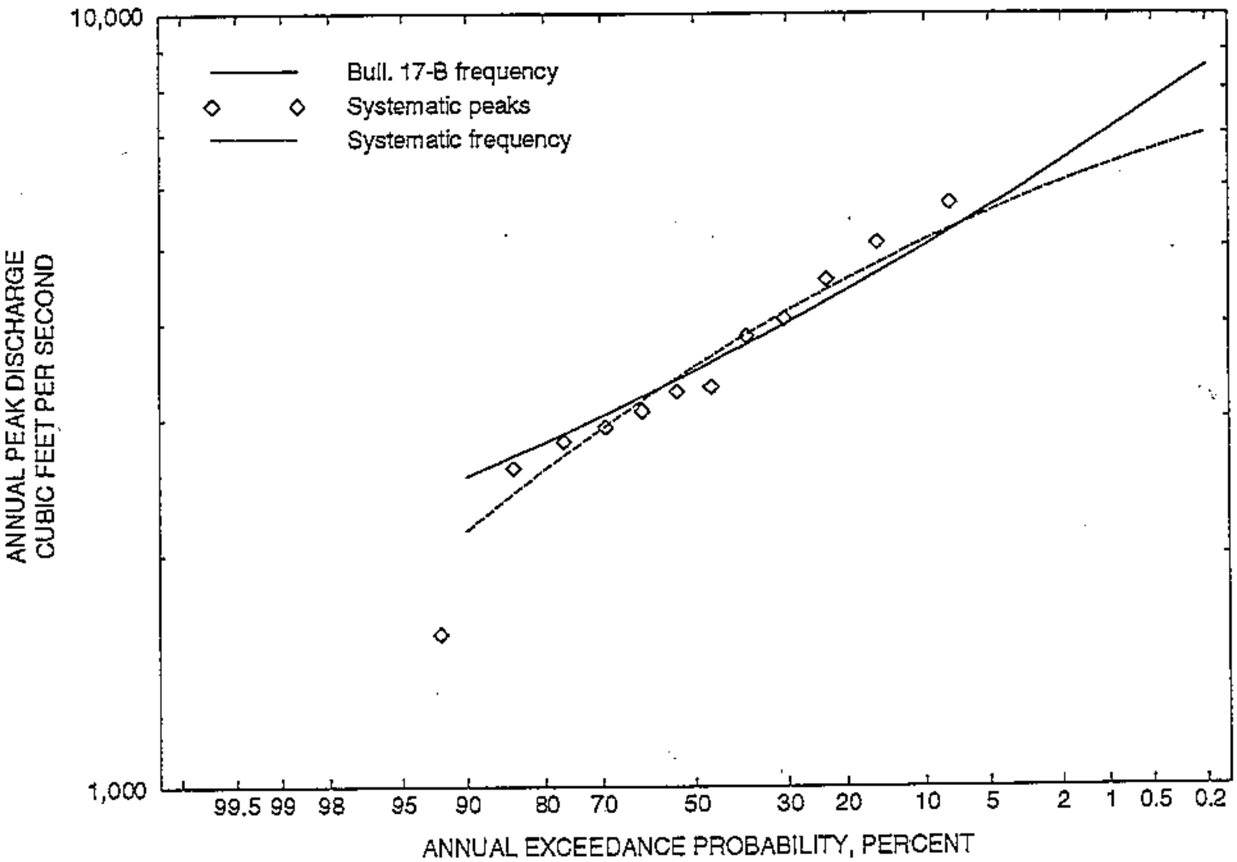

Figure 3. Annual flood frequency curves (exceedance probability) for Indian River, U.S. Geological Survey Gaging Station 15087690.

FISHERIES

A fairly detailed description of the fisheries resources of Indian River is contained in a report by Nadeau and Lyons (1987). They summarized salmon escapement data through 1986 for the Indian River watershed. Table 1 summarizes salmon escapement data from 1987 thru 1994.

Table 1. Salmon escapement records for Indian River (1987-1994), courtesy of Alaska Department of Fish and Game Commercial Fish Division, Sitka.

YEAR	PINK	CHUM	COHO
1987	3,000	1,372	53
1988	1,651	53	--
1989	--	--	603
1990	1,750	500	20
1993	800	--	--
1994	55,000	--	--

The 55,000 pink salmon escapement level in 1994 far exceeded the previous peak escapement record of 21,000 adults in 1983. This large return may reflect favorable ocean survival conditions (USDA 1995). However, escapement into the river is strongly influenced by straying of fish from the Sheldon Jackson Hatchery (personal communication, Dave Hardy, ADFG Habitat Biologist). Therefore, hatchery smolt production and cost recovery activities are important factors influencing salmon escapement to the river.

Access to upstream spawning habitat for pink and chum salmon is restricted by a bedrock falls at river mile 0.6 (1 km). The primary rearing and spawning habitat for coho salmon and steelhead is located above the Sheldon Jackson College diversion dam at river mile 0.8 (1.3 km). The dam is a partial barrier to upstream coho and steelhead migration, but a fish pass does allow upstream access for these species under certain flow conditions.

The intertidal and lower flood plain channel segments of Indian River in the Park are primarily utilized for pink and chum salmon spawning and incubation (Nadeau and Lyons, 1987). Coho or steelhead salmon have not been observed spawning within the Park boundaries but fry migrating downstream do rear in the lower river, at least on a seasonal basis. Lack of suitable rearing habitat limits the numbers of stream rearing salmonids within the Park, however, juvenile Dolly Varden, coho and steelhead are present in the lower river. During our stream survey, minnow traps set in one large pool near the Sawmill Creek Bridge habitat unit yielded primarily Dolly Varden juveniles (13), and few coho (3) or steelhead (1) juveniles. These numbers of rearing juveniles are somewhat lower than those typically found by minnow trapping similar habitat in this channel type.

WATER USES & ISSUES

A variety of historic water uses and development including water diversion, gravel borrow, channel stabilization activity, and recreation use has affected the lower segment of Indian River over the past century (Antonson and Hanable 1987). A significant portion of the riparian forest was harvested prior to 1900, and trails and a road paralleled the river banks.

Sheldon Jackson College began diverting water for hydropower generation in 1934. The college appropriated a 50 cfs (1.42 cms) water right for this purpose and applied for an additional 5 cfs (.14 cms) for fish hatchery use in 1975. In the early 1980's, the college upgraded its dam and water intake facility at river mile 0.8 (1.3 km). The City of Sitka has an appropriated water right for 3.9 cfs (.11 cms) dated in 1914. Since the 1980's the city has used Blue Lake for the municipal water supply, but still maintains a diversion structure at river mile 1.4 (2.3 km) for an emergency water source.

The Indian River riparian corridor is a key element of the Park's natural setting. Instream flow uses of the river include aesthetics,salmonid spawning, incubation, and rearing, salmon viewing, and sport fishing. Approximately 80,000 park visitors and 3,000 picnickers use the riparian trails and picnic facilities annually (Carol Burkhart Pers Comm.). This use has increased from 20,000 and 1,100 people respectively, in 1986 (Hyra 1987). Sport fishing for salmon is limited to the river mouth, while the river is open to angling for Dolly Varden and steelhead. The Park and the U.S. Fish and Wildlife Service recently conducted instream flow evaluations to determine the range of stream flows needed in Indian River to protect these resources (Nadeau and Lyons 1987). To date, the water use issues for Indian River have not been resolved.

Channel stability and stream bank protection have also been important issues during the recent history of the Park. Gravel borrow excavation in the esturary channel was extensive between 1940 and 1978 (Antonson and Hanable 1987). An excess of 60,000 cubic yds (46,000 m^3)of gravel was extracted from the estuary channel by the Navy during the war. Extensive gravel borrow operations by several entities continued near the mouth of Indian River up to 1978. Gravel borrow activities were said to contribute to severe bank erosion in 1945 along 600 ft (183 m) of the estuary channel. Efforts by the Navy in 1945 to stabilize the banks by straightening the channel and installing log cribbing along the banks failed shortly after the work was completed. Additional channel modification in 1961 and rock riprap placement along the west bank of the river in 1985 culminated erosion control work to protect the 1804 fort site and trail. The owner of the trailer park placed an illegal fill along the east bank of the river adjacent to the Park in 1979. Flood events in the mid-1980's resulted in significant erosion to the trailer park fill. In 1987, large rock riprap was placed along the east bank of the river to protect the trailer park fill from additional erosion. Currently, accelerated bank erosion continues to be a problem along the east bank of the river on adjacent Park property.

Maintenance of water quality is an emerging issue for the Park. As urban development in the Indian River basin expands, the potential for water quality impairment in the lower reaches of the river will increase. Construction activities for the Sheldon Jackson subdivision (near river mile 1.0 (1.6 km)) have recently increased the potential for non-point source sediment delivery to Indian River. Other potential pollution sources include de-iceing chemicals and herbicide use along roads, and human refuse and animal waste associated with housing developments and expanding recreation use. To date, no comprehensive water quality monitoring program has been implemented for Indian River.

METHODS

This study was designed to provide a holistic approach for assessing riparian and aquatic resources in Sitka National Historical Park. Procedures used follow standard, widely accepted methods for assessing stream health and conditions (MacDonald 1991 and Harrelson et. al. 1994). Channel morphology and substrate evaluations were conducted to assess channel stability and sediment transport characteristics. Fish habitat and macroinvertebrate evaluations were done to assess aquatic habitat capability and water quality. Field sampling and data analysis procedures are summarized below.

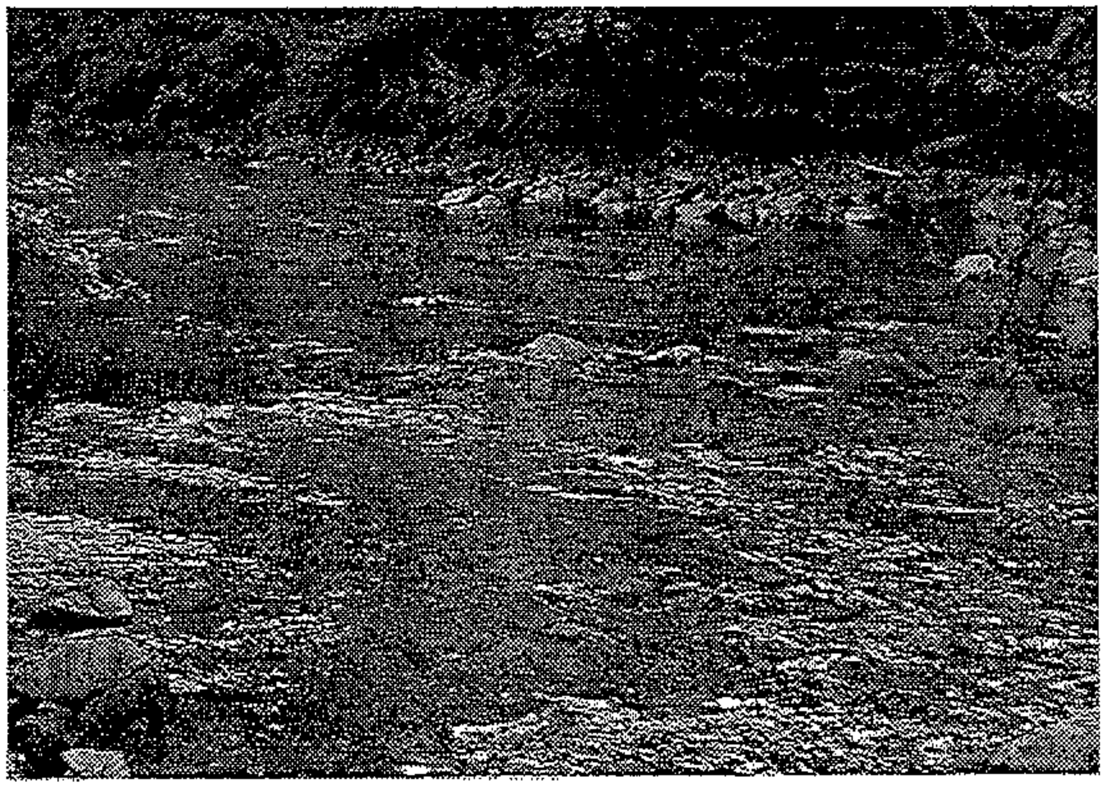

Figure 4. Typical glide habitat unit Indian River FP5 stream segment.

CHANNEL MORPHOLOGY

Channel morphology measurements consisted of detailed channel cross-section surveys and a longitudinal profile along the channel thalweg for the segment of Indian River within the Park boundaries. Channel cross-sections were located in representative stream reaches and sites where channel adjustment was evident. All cross-sections are marked at each stream bank with 3 ft (1 m) re-bar stakes. Cross-section locations were also monumented using spikes driven into the base of trees located well back from the edge of the river (appendix A). Measurements were taken with a surveyors level and rod (Harrelson et. al. 1994). Elevations and distances were recorded to the nearest hundredth meter. Field measurements were entered into XSPRO, a channel cross-section analyzer program (Grant et. al. 1992). Detailed cross-section plots and tabular hydraulic outputs are located in appendix A. These channel morphologic data are useful for channel design, restoration of riparian areas, placement of instream structures, instream flow assessment, and analysis of channel-stability (Grant et al. 1992).

STREAM SUBSTRATE

A simple pebble count procedure (Potyondy and Hardy 1994, Bevenger and King 1995) was used to characterize streambed materials at two reaches of Indian River within the Park (above the foot bridge and near high tide level) and a control reach (RM2) on Forest Service land at river mile 2. Stream substrate metrics are useful in determining channel stability and sediment transport characterictics of a channel.

At each reach three transects are walked across a riffle and a total of 200 bed particles are randomly selected using the boot-tip procedure (Leopold 1970). Particle diameter is measured at the intermediate axis with a metric ruler. The modified Wentworth Scale was used to define standard (Potyondy and Hardy 1994) particle size classes (appendix C).

FISH HABITAT

The amount, variety and distribution of stream habitat units are major factors that influence aquatic community diversity and productivity in southeast Alaska watersheds (USDA 1995). A complete habitat unit survey was conducted of the flood plain (FP5) stream segment in the Park beginning at the upstream end of the estuary (ES4) stream segment and ending at the Sawmill Creek bridge crossing. Habitat units were characterized using a hierarchical stream habitat classification approach decribed by Hawkins et. al. (1993) that has been modified to suit Alaska's conditions (USDA 1995). The location of each habitat unit is referenced to stream thalweg distance measured from the beginning of the survey reach. The surface area of each habitat unit was measured using a tape or electronic range finder. Pool depth measurements were made with a surveyors rod. Fish density sampling was not done as a part of this initial habitat survey. Minnow traps were used to establish presence of juvenile salmonid species within the survey reach. The survey technique was designed to be repeatable so that trends in fish habitat condition can be easily measured. Detailed field survey protocols and habitat unit definitions can be found in appendix B.

MacroInvertebrates

The diversity of aquatic insect communities has proven to be a very useful indicator of water quality condition due to differential tolerance of macroinvertebrates to pollutants (Milner and Oswood 1991). Unimpaired waters typically support a wide diversity of macroinvertebrate taxa from the orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies)--EPT for short. Macroinvertebrates provide an index of stream health integrated over time, whereas most chemical sampling procedures provide only a snap-shot of water quality condition.

The original sampling design for the Park survey called for macroinvertebrate samples to be collected at representative sites in lower Indian River FP4 channel segment in the spring and again in the fall of 1994. A valid sample during the fall period was not obtained for the lower river due to disturbance of stream substrate by a record run of pink salmon. However, a second fall sampling station was added upstream at a similar FP4 stream reach located on Forest Service land at the U.S. Geological Survey stream gaging station at river mile 2 (3.2 km). The upstream station is not influenced by urban development or land disturbing activities. This site was a control station for interpreting sampling results at the Park stations.

Macroinvertebrate sampling in Indian River followed a general protocol being used in Alaska to assess watershed and stream health (USDA 1995, Milner and Oswood 1991). Each sample station represents a channel type reach with fairly uniform habitat conditions in terms of stream gradient, substrate size and riparian vegetation. In addition to recording these habitat variables, stream temperature, alkalinity, pH, specific conductance, and sulfate concentration are measured to establish baseline water chemisty. A surber sample was used to collect between 3 and 5 macroinvertebrate samples per station. All samples at a station are taken in riffle habitat units with flow velocity between 1 fps and 3 fps (.3 to .9 mps), with a flow depth between 4 in (100 mm) and 16 in (406 mm) and substrate sizes between 1 and 6 in (25 mm to 150 mm). Samples are collected by securely positioning the surber sampler on the stream bottom and carefully turning over, and rubbing cobbles and large gravel particles, and then stirring remaining gravel and sands to a depth of 4 in (100mm) for at least 30 seconds. After large sticks or debris are removed using tweezers, the surber net is carefully rinsed to dislodge organisms clinging to the net. Sample material is then transferred to a pre-marked wide-mouth polyethylene bottle and preserved with alcohol.

Sample analysis was contracted with the University of Alaska, Environment and Natural Resources Institute in Anchorage. Metrics include: ratio of EPT individuals to total individuals, number of EPT genera present, and Hilsenoff's family biotic index (FBI).

RESULTS

Figure 6. Streambank erosion at the head of the Indian River estuary channel near XS 2

CHANNEL MORPHOLOGY

Alluvial channels tend to seek a dynamic equilibrium between sediment load and stream discharge. Channel shape, sinuosity, gradient, and bed roughness are all factors that can adjust to accomodate the river's load (Leopold 1994). Therefore, lateral bank erosion and channel migration is a normal adjustment process for river segments such as the Indian River flood plain and estuary.

As discussed previously, the lower flood plain and the estuary of Indian River have been influenced to a large degree by human disturbance over the last 50 years. Three major changes to lower Indian River have occurred during recent history: 1) In 1945, a meander in the channel was straightened, diverting most of the river flow along the west bank of the estuary. 2) A riprap wall was placed above a gravel island in 1961, significantly constricting the natural channel at the head of the estuary. 3) Finally, in 1985, the entire west bank of the estuary was lined with toed-in shot-rock riprap. As a consequence, Indian River has made numerous adjustments through streambank and bed erosion processes to accomodate these disturbances. The precise cause-effect relationships between erosion processes and the channel modifications are difficult to identify. However, existing areas of channel instability are most likely the result of this legacy of channel and streambank modifications, and gravel borrow activities.

A detailed topographic map[1] of the lower Indian River riparian area, along with six surveyed stream channel cross-sections, are shown in figure 6. These channel cross-sections in the lower portion of the river (XS 1-4, fig 6) are located in areas where channel adjustment and erosion are currently most active. A longitudinal profile of the stream bed and water surface from XS 1 (in the estuary) to XS 6 (located above the foot bridge) is shown in figure 7.

The channel XS 6 (fig 6) located above the foot bridge, was selected as a reference because this appears to be a very stable channel reach. Slope-area discharge estimates for XS 6 (Grant et al. 1992) indicate channel capacity at a bankfull stage of 4.5 ft (1.4 m) is 2,300 cfs (65 cms)(see appendix A). This estimate falls within the theoretical channel-forming flows represented by the .99 and .50 annual exceedance flows (fig 3) of 1300 cfs (36.8 cms) and 3500 cfs (99 cms). These data support the hypothesis that this reach is relatively stable and in dynamic equilibrium with current flow regime for the river.

The channel configuration for the stream reach located at the head of the estuary is less stable as indicated by active stream bank erosion along both sides of the river. It should be noted that this reach is frequently influenced by back-water effects of high tides requiring a greater relative channel area to contain peak stream flow. Results of our geometry surveys at XS 2-4 (fig. 6) indicate the 1961 riprap wall has constricted the high flow channel between 15% and 25% (see section details in appendix A). The effect of the riprap wall is also reflected in a discontinuity in the longitudinal bed profile (fig. 7) at this location. These results indicate that active streambank erosion on the east bank of the river and along the west bank immediately downstream from the riprap wall are directly related to the channel constriction caused by the wall.

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[1] Topographic map base from Stragier Engineering, Sitka Alaska, 1982.

Historic maps and photos circa 1910 (Antonson and Hanable 1987) indicate that the estuary channel had at least two branches and occupied a channel along the east side of the estuary. Gravel borrow activities in the lower estuary during WW II and intermittently up to 1978 likely resulted in increased channel bed scour and channel entrenchment in the estuary channel segment due to temporary lowering of the rivers base level. Subsequent dredging activities that straightened the channel resulted in excess potential energy in this reach that had to be dissipated through channel and stream bank scour. Observations of rapid stream bank retreat along the west side of the estuary between 1950 and 1985 (Antonson and Hanable, 1987) corroborates this interpretation. Currently, active erosion is evident along the east side of the estuary near XS 1 (fig 6). It appears that the estuary channel segment is now establishing a new meander pattern that is nearly a mirror image of the pre-war (1940) channel configuration.

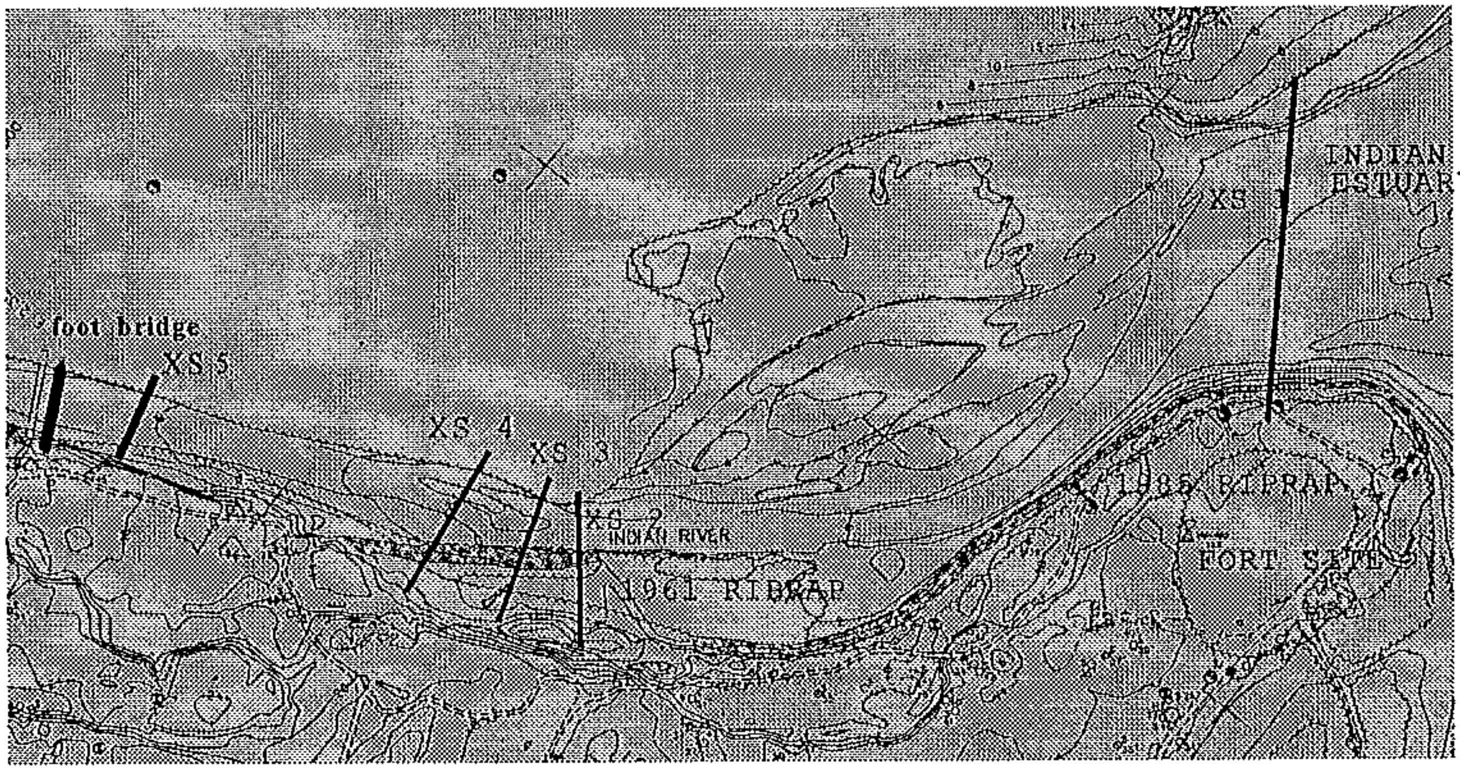

Figure 6. Location of channel cross-section profiles, lower Indian River, Sitka.

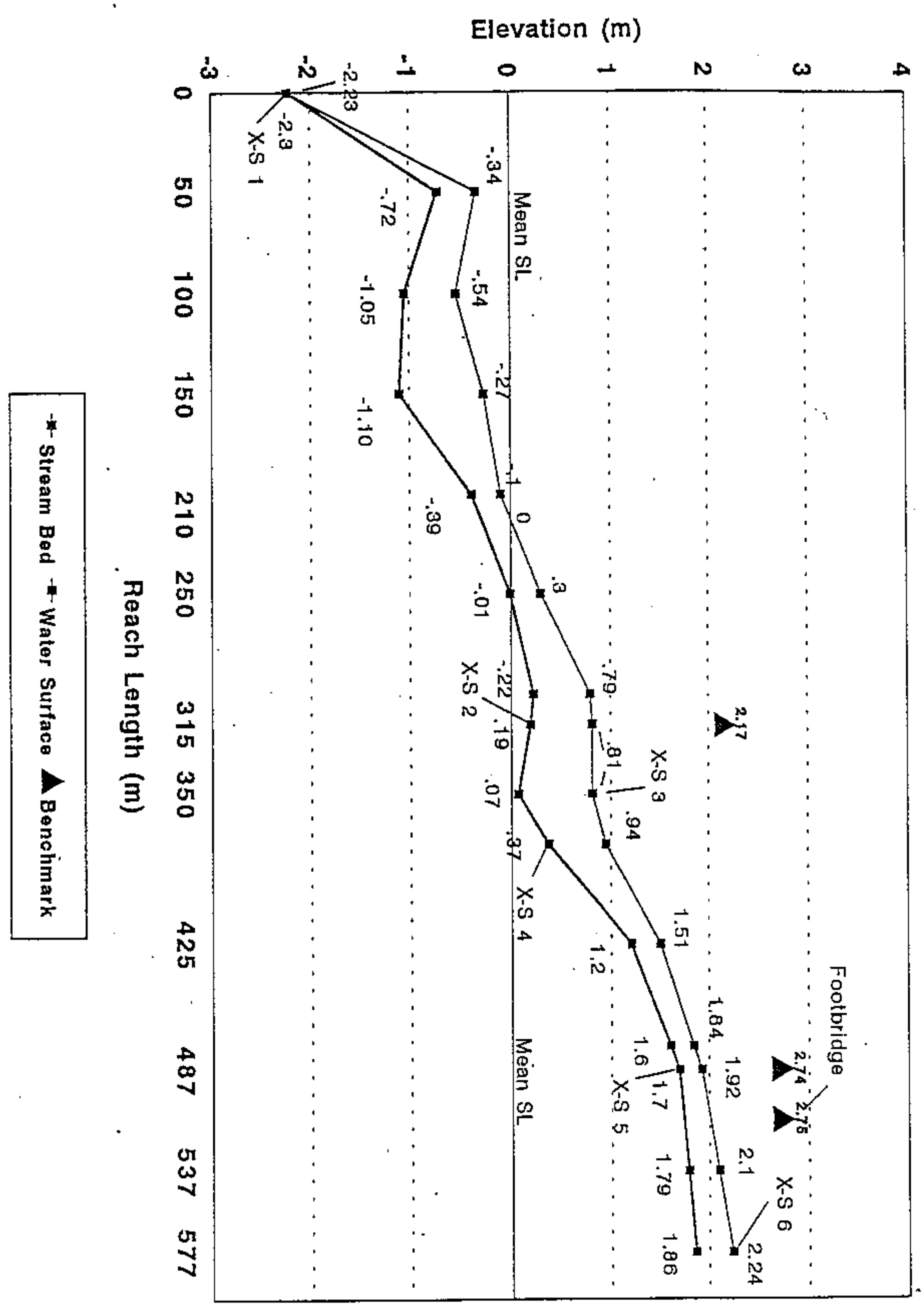

Figure 7. Longitudinal stream thalweg profile of the Indian River estuary and flood plain reaches, SNHP.

STREAM SUBSTRATE

Streambed substrate analysis is a useful adjunct to the preceeding channel geometery analysis for evaluating channel stability and sediment transport characteristics (Potyondy and Hardy 1994). Substrate data is also important for tracking trends in spawning gravel condition (MacDonald 1991; Bevenger and King 1995).

Figure 8, summarizes streambed particle size distributions for two FP5 riffle units within the Park, a control riffle upstream at river mile 2 (RM2) of the Indian River FP5 channel type, and the regional average for FP5 channel types. A tabular summary of streambed sample results can be found in appendix C.

Several factors including geology, headwater erosion sources, and variations in channel geometry should be considered when interpreting substrate data. Comparing Indian River flood plain reaches to the regional average shows a distinctly coarser substrate size distribution for the Indian River samples. The regional average has 70% of the streambed substrate particles in size classes less than 2.5 in (64 mm) (very coarse gravel to small cobble substrate) while the Indian River samples have between 30% and 50% of the bed particles finer than 2.5 in (64mm). This is indicative of streambed conditions that trend toward channel degradation and streambed armoring. Lack of large, active gravel bars associated with the Indian River reaches corroborates this assessment. These conditions may be related to relatively low amounts of gravel recruitment from headwater source areas and relatively competent bedrock lithology. Upstream dams and water diversion structures likely have a strong influence on bedload transport and substrate particle size distributions in the lower reaches of Indian River as well.

Streambed particle distribution between the up-river RM2 control reach and the riffle section located above tidewater at XS 2 are similar except for a higher proportion of cobbles (5 in (128 mm)) in the lower river reach (fig 8). Streambed particle size distribution in the other Park reach above the footbridge has a higher percentage of particles in the coarse gravel (2 in (48mm)) to cobble (5 in (128mm)) size range. These results support other observations including stable banks, lack of gravel bars, and narrow flood plain that indicate the portion of Indian River within the Park boundary has little tendency toward streambed aggradation.

FISH HABITAT

Habitat availability and habitat condition or suitability are the two factors commonly used to describe fisheries productivity for a given watershed. The focus of this survey was to assess habitat availability and condition for the lower flood plain segment of Indian River within the Park boundary.

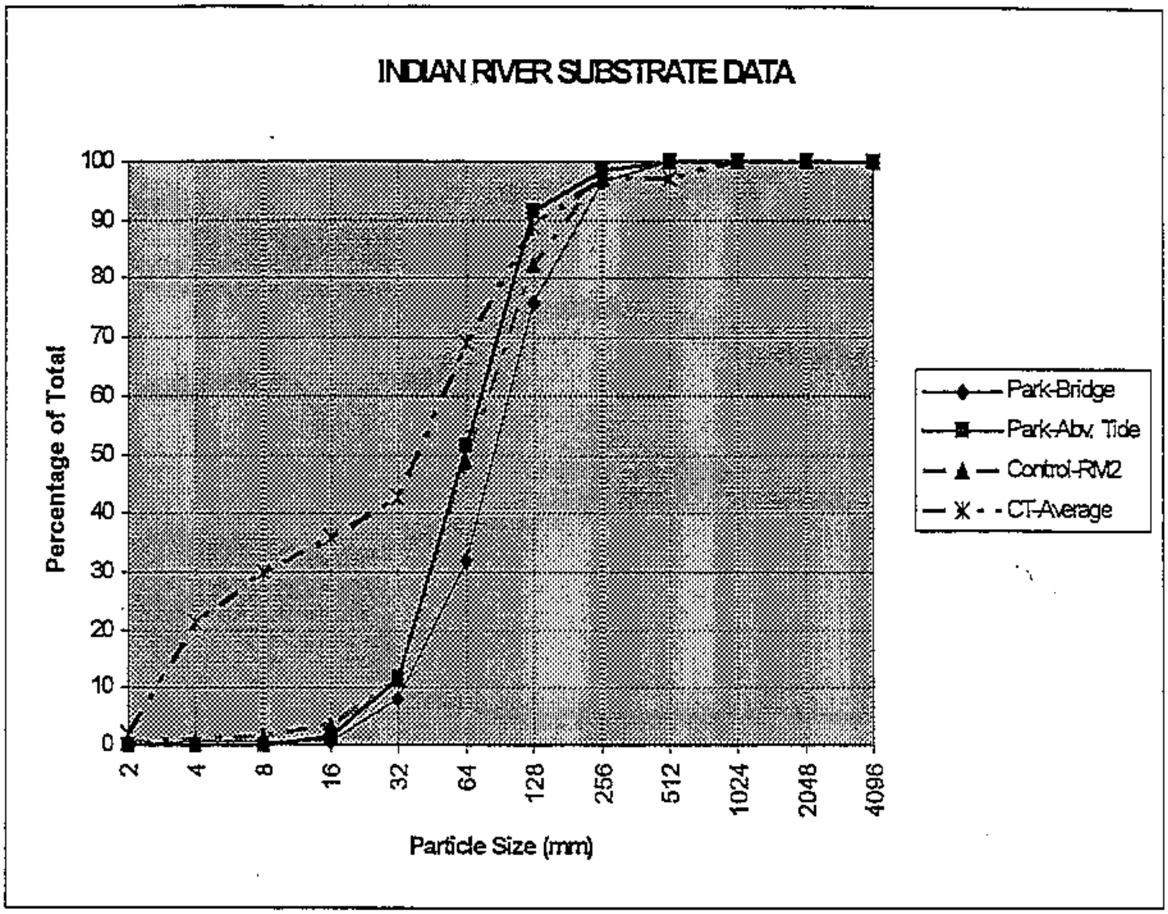

Figure 8. Substrate particle size distribution for Indian River sample reaches and regional average FP5 channel type substrate distribution (USDA 1995).

Habitat suitability for pink and chum salmon, which are salt water rearing species, is primarily determined by spawning gravel composition, and flow depth and velocity (Nadeau and Lyons 1987). Nadeau and Lyons found the channel substrate composition in lower Indian River to be generally suitable for spawning pink and chum. A detailed assessment of instream flow requirements to maintain spawning and incubation capability can be found in their report.

Our fish habitat assessment incorporates data on additional physical habitat features such as pools, large woody debris, habitat complexity, and cover that are important adult and juvenile rearing habitat requirements (USDA 1995).

Habitat Units. Results of our habitat unit survey for the FP5 reach of lower Indian River are shown in figure 9. Three meso level habitat types, glide, pool and riffle, are

found in the survey reach. Riffles are relatively shallow units with fast water velocity. Pool units have slower water and are deeper than the reach average. Glides have uniform depth and moderate water velocity with relatively smooth water surface. Each of these three habitat types provide specific niches for aquatic communities. Pool habitat represents only 8% of the total habitat area for lower Indian River. Data from similar channel types in pristine watersheds in Southeast Alaska often average 50% of the total habitat area in pools (USDA 1995). Limited pool habitat found in Indian

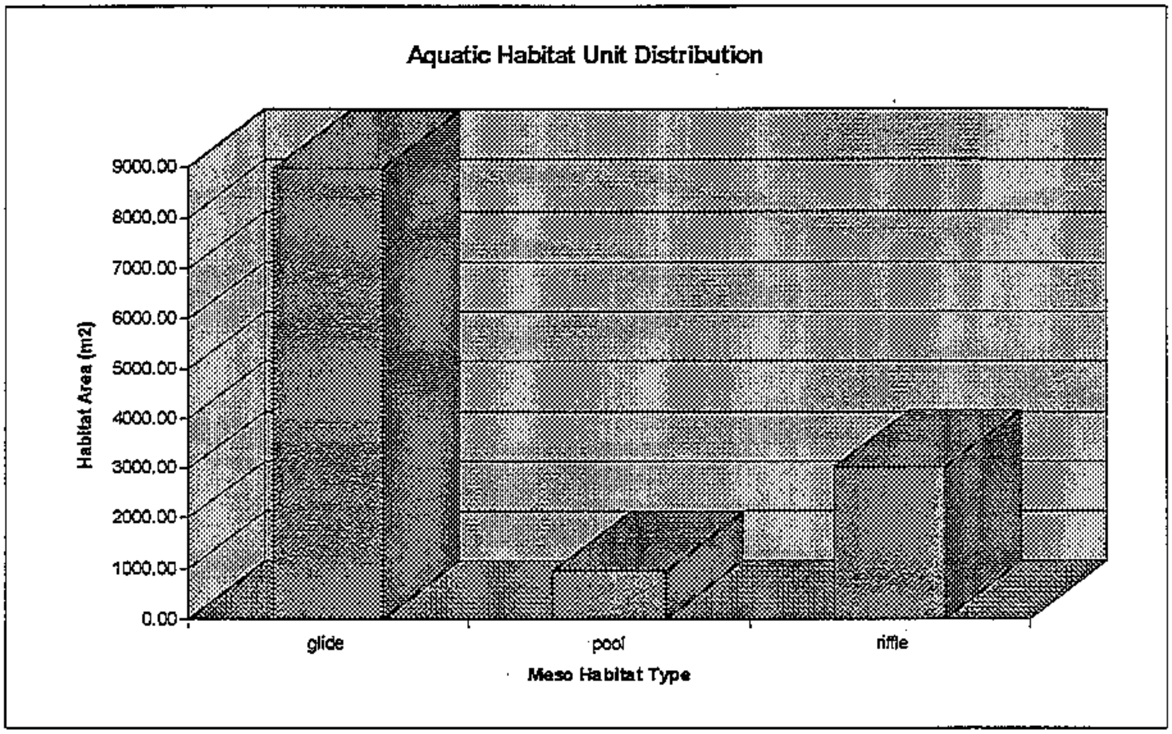

Figure 9. Meso level aquatic habitat unit area for FP5 sample reach SNHP.

River is probably corrollated with a lack of large woody debris (LWD) in the channel. The distribution of micro-level pool habitat units is shown in figure 10. These data show that the pool habitat that is available in the survey reach consists of mid-channel scour pools (Pl-msc), associated with channel constrictions, and lateral scour pools (Pl-lsc), associated with stream bank obstructions. Scour pool habitat is generally less suitable rearing than backwater or eddy (Pl-ed) pool habitat, commonly associated with LWD accumulations, for rearing salmonids. A more detailed breakdown of habitat unit data can be found in appendix B.

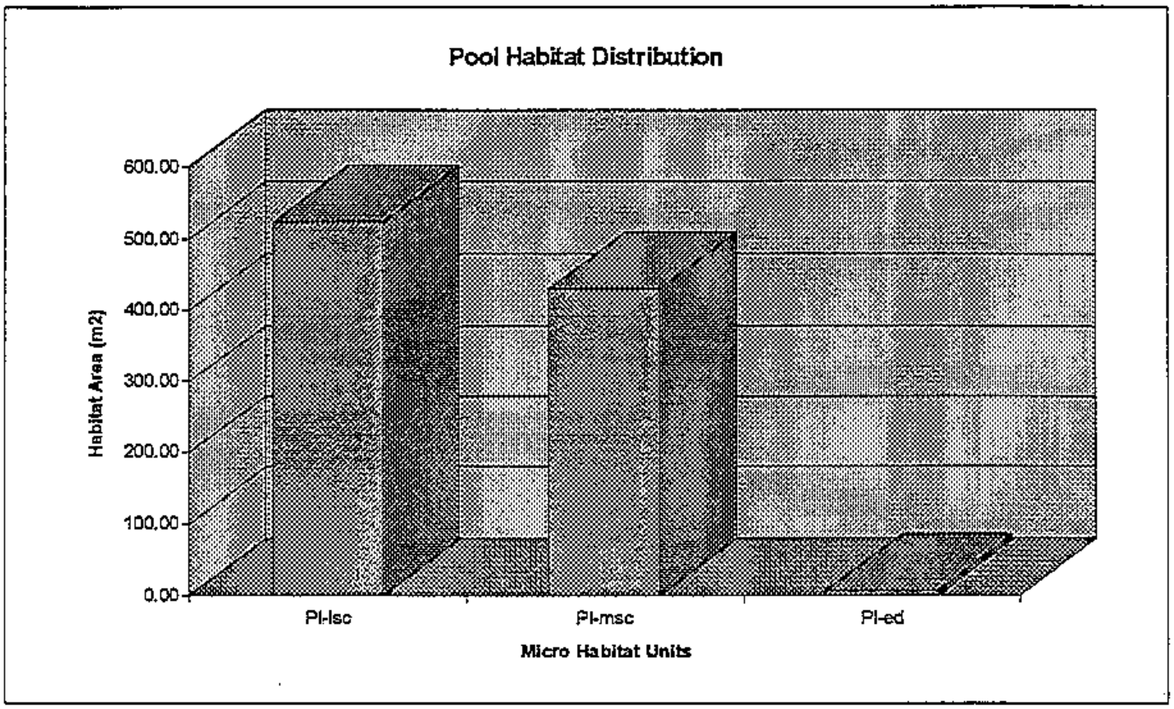

Figure 10. Pool micro habitat unit area, FP 5 sample reach, SNHP.

Pool depths for the Indian River survey reach are relatively shallow and widely spaced. The only large pool is located just below the Sawmill Creek bridge crossing at a sharp bend and bedrock constriction. Average maximum pool depth is 2.75 ft (84 m) and mean pool depth is only 1.6 ft (.5 m) in the survey reach. Pool depths greater than 1.6 ft (.5 m) are considered optimum for providing cover for spawning adults, and over-winter habitat for juvenile salmon in channel types similar to Indian River. A total of 6 pool habitat units were catalogued in the 1,968 ft (600m) survey reach, or a pool frequency of 1 pool per 3 channel widths. This corresponds closely with a mean pool spacing of 2 to 4 channel widths for this channel type with free-formed pool-riffle structure observed by Montgomery and others (1995). However, the preponderance of streams with forested riparian areas in Washington State and Southeast Alaska had a much higher frequency of pools (pool spacing of .6 to 1.3 channel widths) that was "forced" by large woody debris accumulations in the channel.

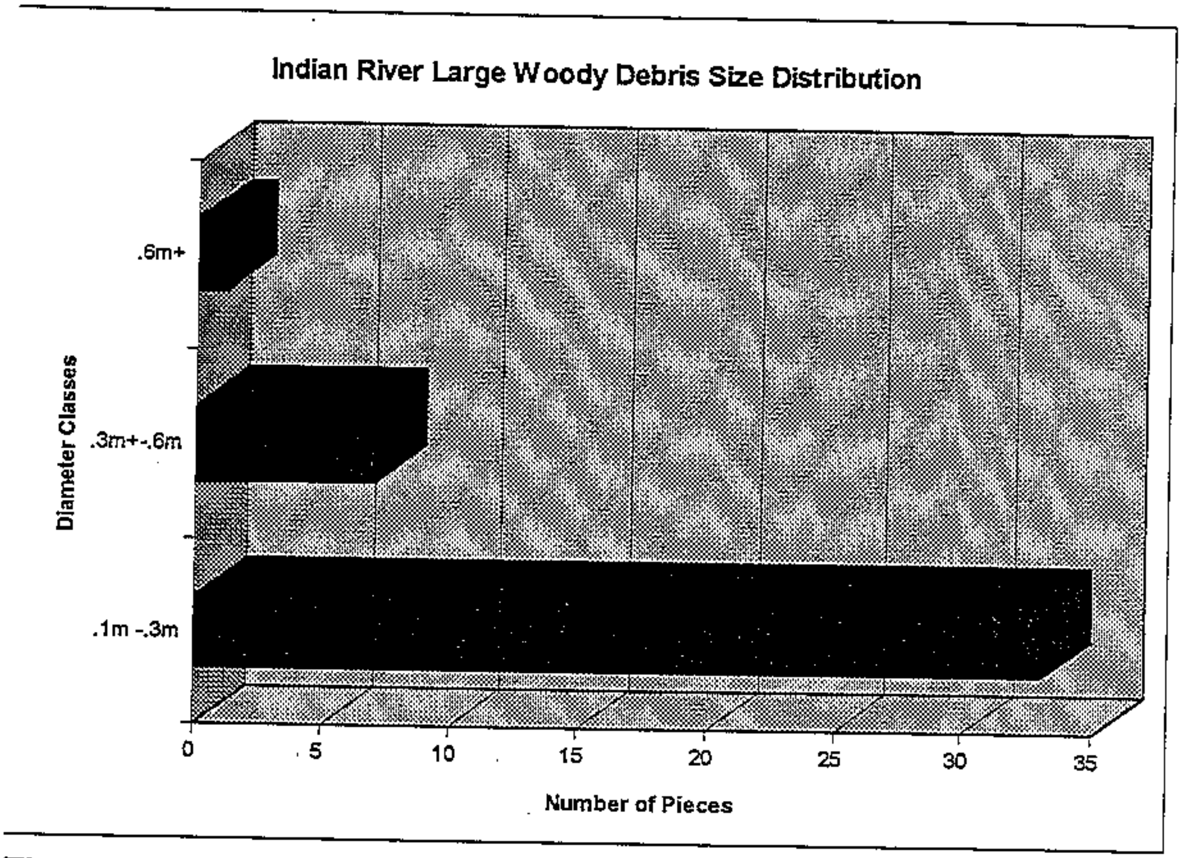

Figure 11. Distribution of large woody debris by diameter size class for lower Indian River flood plain reach, SNHP.

Large Woody Debris. A total of 41 pieces of large woody debris (LWD) were inventoried in the lower Indian River FP5 stream reach. Of these pieces, 16 had an attached rootwad. Most of the LWD stems are relatively small diameter (.34 ft (.1m) to .98 ft (.3m)) pieces situated near stream banks (fig. 11). The density of LWD in the survey reach is only .003 pieces per m^2 compared to a density of .05 to .15 pieces per m^2 observed in similar channels (Montgomery et. al. 1995). These data indicate that the segment of Indian River in the Park is relatively depauperate of LWD. This is significant due to the importance of LWD in forming pools as discussed previously, and the role of LWD in providing cover and food to a variety of aquatic organisms.

Two factors have probably played a major role in limiting LWD accumulations: 1) Removal of LWD for aesthetics or to reduce damage to bridge structures during floods, and 2) lack of recruitment, from second growth timber stands, of large diameter channel spanning LWD pieces that will key into the channel and remain in place during large floods.

Cover. Instream cover provides a variety of habitat niches for aquatic organisms as well as protection from predation. Cover components inventoried in lower Indian River included bed substrate, organic debris and overhanging vegetation. Water depths are too shallow to provide significant cover in this reach. Boulder to cobble size streambed substrate provides cover in at least half of the habitat units. Large substrate provided on the average cover for 15% of the habitat area in these units. Organic cover components including overhanging bank vegetation, LWD, slash and rootwads were represented in only about 17% of the habitat units. These cover types influenced between 1% and 15% of the habitat area in the units where they occur. A more detailed breakdown of habitat cover data can be found in appendix B.

In summary, general fish habitat suitability in the lower reaches of Indian River is limited by a lack of pool habitat, few deep pools and lack of cover. These habitat conditions are directly related to paucity of LWD, which has important functions by providing habitat cover and diversity, and is the major pool forming agent in Southeast Alaska watersheds.

MACROINVERTEBRATES

Two sets of macroinvertebrate samples were collected in Indian River in the vicinity of the foot bridge in early May, 1994. The purpose of the macroinvertebrate sampling was to gather some baseline data to assess water quality conditions in the Park. It was anticipated that followup sampling would be done to evaluate future water quality trends that could adversely effect Park resources. Attempts to collect a fall sample in the Park were thwarted by a very large run of pink salmon spawners. An additional sample was collected in the fall upstream near the USGS gaging site (RM 2) to act as a control site. This upstream site is not accessible to spawning pinks and is not affected by human disturbances. A detailed report of results of the macro invertebrate analyses by Elaine Major (ENRI) can be found in appendix D. Table 2 is a summary of macroinvertebrate metrics for the Indian River sample sites.

Table 2. Biotic metrics for flood plain channel types, Indian River near Sitka.

Station	Total EPT Genera	Ratio of EPT to Total Indiv.	% Dominant Taxa	FBI Index
Footbridge (XS5)	8	0.26	70	2.5
Above Footbridge (XS 6)	11	0.43	57	4.8
Gauging Sta. (RM 2)	12	0.93	31	3.3

All four metrics indicate good water quality at the gaging station control (RM 2). This station has diverse EPT genera, a high ratio of EPT individuals to total individuals, a low percent of dominant taxa, and relatively low FBI index. Two of the metrics, EPT ratio and % dominant taxa, indicate slight water quality impairment for the two stations within the Park. These stations have relatively low EPT diversity and are dominated by Chironomidae, a pollution tolerant genera. Caution must be used in interpreting data from a single sample year. These results warrant further investigation to determine if potential upstream pollution sources are impacting Park resources in lower Indian River.

RECOMMENDATIONS

RIPARIAN VEGETATION PROTECTION

The current condition of the Indian River riparian area within the Park is generally good. The riparian conifer stand is succeptable to windthrow (USDA 1993). Therefore, creating openings in adjacent timber stands that could trigger major blowdown along the river corridor should be discouraged. The current trail system provides good visitor access to the river and riparian habitats. Additional unimproved foot access or trails along the stream channel banks should be discouraged by leaving down woody debris and shrub thickets in the riparian area. Heavy foot traffic along alluvial stream banks could locally accelerate bank erosion and degrade important fish habitat.

WATER QUALITY MONITORING

Increased urban development in portions of the Indian River watershed upstream of the Park may pose a threat to water quality and aquatic resources within the Park. A more comprehensive investigation of water quality in the lower reaches of Indian River may be warranted based on the results of macroinvertebrate sampling. At a minimum, macroinvertebrate sampling should be continued on an annual basis to validate 1994 results and to establish water quality condition trends for the lower portion of Indian River within the Park.

STREAM CHANNEL RESTORATION & STABILITY MONITORING

A few areas of active stream bank erosion were noted during this survey, however, additional structural mitigation measures such as expanding channel riprap are not recommended. Modification of the existing rock riprap structure at the head of the estuary just above XS 4 is recommended to alleviate bank erosion between cross-section stations XS 2 and XS 4 (fig 6). The riprap dike above XS 4 should be lowered 2 to 3 ft to allow bankfull floods to dissipate over a broader portion of the natural flood plain. In the same area, concrete footing from an old bridge deflect the stream thalweg against the stream bank. These concrete blocks should be removed at the same time the dike is modified.

Erosion control measures to reduce bank cutting along the east bank of the estuary channel near XS 1 are not recommended at this time. This channel segment should attain an equilibrium configuration soon. No significant Park resources are being threatened by bank cutting in this area. Permanent cross-section profiles should be remeasured following major floods or tidal action to evaluate trends in channel condition.

AQUATIC HABITAT PROTECTION

Habitat diversity in the lower channel segments of Indian River is low when compared to similar channel types in Southeast Alaska. This condition is likely related to a paucity of large woody debris in the channel. Natural recruitment of large wood from the riparian area should occur over time as a result of stream bank cutting and windthrow. Periodic introduction of woody debris, especially large conifer stems and rootwads, is a natural process and **should not** be perceived as a negative impact to water quality or fish habitat. Removal of large woody debris from the channel and along streambanks should be discouraged. Concerns over aesthetics or visitor perceptions of woody debris accumulations can be off-set by using intrepretive displays that educate the public about the essential role large woody debris plays in the maintenance of productive aquatic habitats.

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APPENDIX A: CHANNEL MORPHOLOGY DATA

Pin Monumentation 1994 Field Season
Indian River, Totem National Park, Sitka Alaska

Left Bank					Right Bank				
X-S#	Species	Diam.	AZ. to Pin	Dist.	X-S#	Species	Diam.	Az to Pin	Dist.
1	Alder	7in	258	4.3M	1	Hemlock	6in	36	2.22M
2	Alder	9in	166	1.54M	2	Alder	8in	324	1.25M
3	Sit Spru	6in	306	3.18M	3	Alder	7in	176	35M
4	Alder	14in	186	2.33M	4	Alder	8in	106	2.5M
5	Alder	10in	178	.52M	5	Alder	10in	152	3.52M
6	Alder	8in	204	.93M	6	Alder	15in	158	2.32M

STAGE-DISCHARGE DATA FOR CROSS-SECTION FILE INDXS1.DAT
CROSS-SECTION NUMBER 1
DATE OF CROSS-SECTION MEASUREMENT: 940712

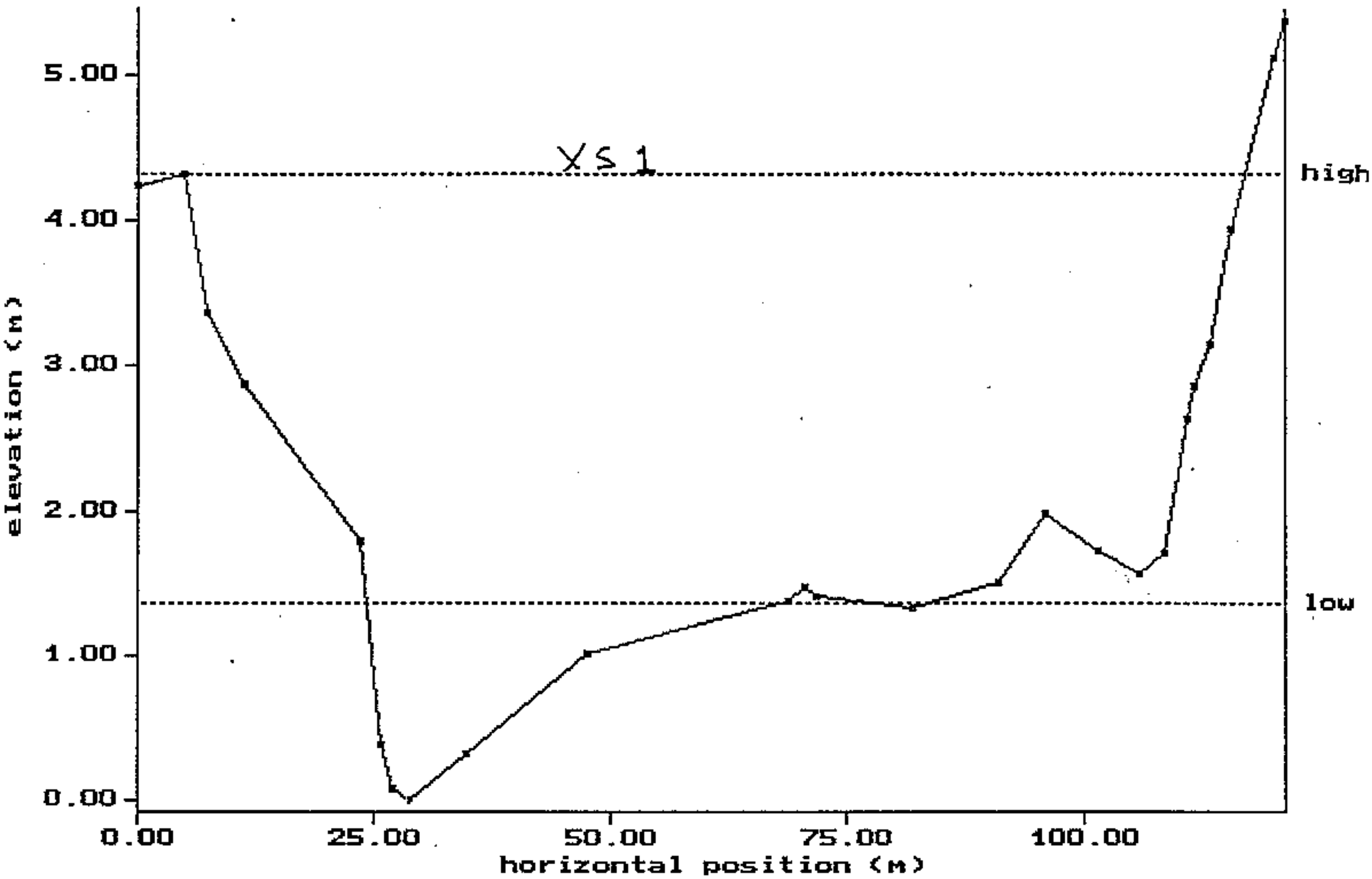
CHANNEL SLOPE RANGE: 0.0000 to 0.0066

VELOCITY FORMULA: Thorne & Zevenbergen
D84 = 0.625 (ft)

cross-section treated as one sectionX-S 1 Indian river, VCU 311, FP4, Sitka, AK

STAGE m	#SEC	AREA m^2	PERIM m	WIDTH m	R m	DAVG m	SLOPE	n	VAVG m/s	Q cms
1.36	1	24.6	50.4	50.0	0.5	0.5	0.0001	0.048	0.4	3.18
1.54	1	35.8	67.9	67.5	0.5	0.5	0.0004	0.047	0.9	9.98
1.72	1	48.7	77.2	76.7	0.6	0.6	0.0008	0.046	1.5	22.35
1.90	1	63.1	84.6	84.1	0.7	0.8	0.0012	0.044	2.1	40.68
2.09	1	78.8	89.8	89.2	0.9	0.9	0.0016	0.043	2.8	66.82
2.27	1	95.1	92.4	91.7	1.0	1.0	0.0020	0.043	3.5	102.12
2.45	1	111.8	94.9	94.2	1.2	1.2	0.0024	0.042	4.3	146.03
2.63	1	129.0	97.4	96.7	1.3	1.3	0.0028	0.042	5.1	199.02
2.81	1	146.7	100.1	99.3	1.5	1.5	0.0032	0.041	5.8	261.42
2.99	1	164.8	102.7	101.9	1.6	1.6	0.0036	0.041	6.6	333.70
3.17	1	183.4	105.3	104.4	1.7	1.8	0.0040	0.040	7.5	416.63
3.35	1	202.3	107.3	106.4	1.9	1.9	0.0044	0.040	8.3	511.96
3.53	1	221.6	108.4	107.5	2.0	2.1	0.0048	0.040	9.2	621.69
3.71	1	241.0	109.4	108.4	2.2	2.2	0.0052	0.040	10.1	743.81
3.89	1	260.6	110.4	109.4	2.4	2.4	0.0056	0.040	11.1	878.18
4.07	1	280.4	111.6	110.4	2.5	2.5	0.0060	0.039	12.0	1024.29
4.25	1	300.4	113.1	111.9	2.7	2.7	0.0064	0.039	12.9	1180.55
4.32	1	309.0	118.2	117.0	2.6	2.6	0.0066	0.039	12.9	1218.56

DISCHARGE-TO-RADIUS RELATIONSHIP: Q = aR^b
a = 72.735, b = 3.052
r^2 = 0.9729, n = 18

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  high stage (m) 4.32          slope (%) .659                 F1 for Help
  output table  stage increment (m) .18                       ESC to exit
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STAGE-DISCHARGE DATA FOR CROSS-SECTION FILE INDXS2.DAT
CROSS-SECTION NUMBER 2
DATE OF CROSS-SECTION MEASUREMENT: 940713

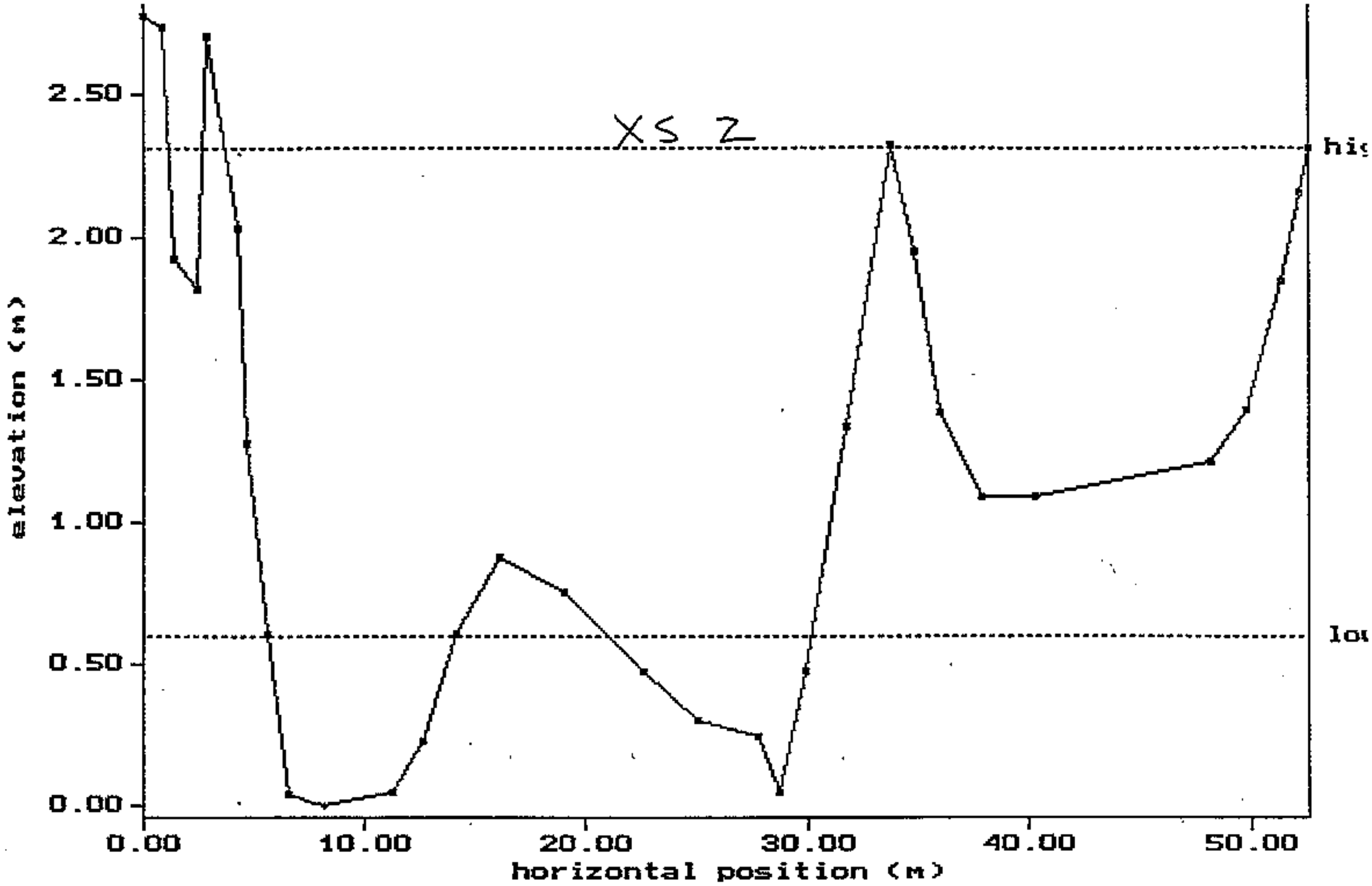
CHANNEL SLOPE RANGE: 0.0096 to 0.0066

VELOCITY FORMULA: Thorne & Zevenbergen
D84 = 0.625 (ft)

cross-section treated as one sectionX-S 2 Indian river, VCU 311, FP4, Sitka, Ak.

STAGE m	#SEC	AREA m^2	PERIM m	WIDTH m	R m	DAVG m	SLOPE	n	VAVG m/s	Q cms
0.60	1	6.1	17.8	17.4	0.3	0.4	0.0096	0.057	2.8	5.19
0.72	1	8.4	20.7	20.3	0.4	0.4	0.0094	0.054	3.2	8.29
0.84	1	11.0	24.6	24.1	0.4	0.5	0.0092	0.052	3.6	11.97
0.96	1	14.1	26.4	25.8	0.5	0.5	0.0090	0.050	4.1	17.65
1.08	1	17.2	26.9	26.3	0.6	0.7	0.0088	0.048	4.7	24.94
1.20	1	21.1	37.4	36.7	0.6	0.6	0.0085	0.048	4.3	27.63
1.32	1	25.7	40.5	39.7	0.6	0.6	0.0083	0.047	4.7	36.91
1.44	1	30.6	42.4	41.4	0.7	0.7	0.0081	0.046	5.2	48.39
1.56	1	35.6	43.5	42.4	0.8	0.8	0.0079	0.045	5.7	61.69
1.68	1	40.8	44.6	43.4	0.9	0.9	0.0077	0.044	6.1	76.17
1.80	1	46.0	45.7	44.3	1.0	1.0	0.0075	0.044	6.5	91.72
1.92	1	51.4	47.8	46.2	1.1	1.1	0.0073	0.043	6.8	106.82
2.04	1	57.1	49.3	47.4	1.2	1.2	0.0071	0.043	7.1	123.81
2.16	1	62.8	50.8	48.7	1.2	1.3	0.0069	0.042	7.4	141.56
2.28	1	68.8	52.4	50.0	1.3	1.4	0.0067	0.042	7.6	160.02
2.31	1	70.6	52.8	50.4	1.3	1.4	0.0066	0.042	7.7	165.70*

DISCHARGE-TO-RADIUS RELATIONSHIP: Q = aR^b
a = 89.692, b = 2.499
r^2 = 0.9832, n = 16



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high stage (m) 2.312 slope (%) .659 F1 for Help
output table stage increment (m) .12 ESC to exit

STAGE-DISCHARGE DATA FOR CROSS-SECTION FILE INDXS3.DAT
CROSS-SECTION NUMBER 3
DATE OF CROSS-SECTION MEASUREMENT: 940713

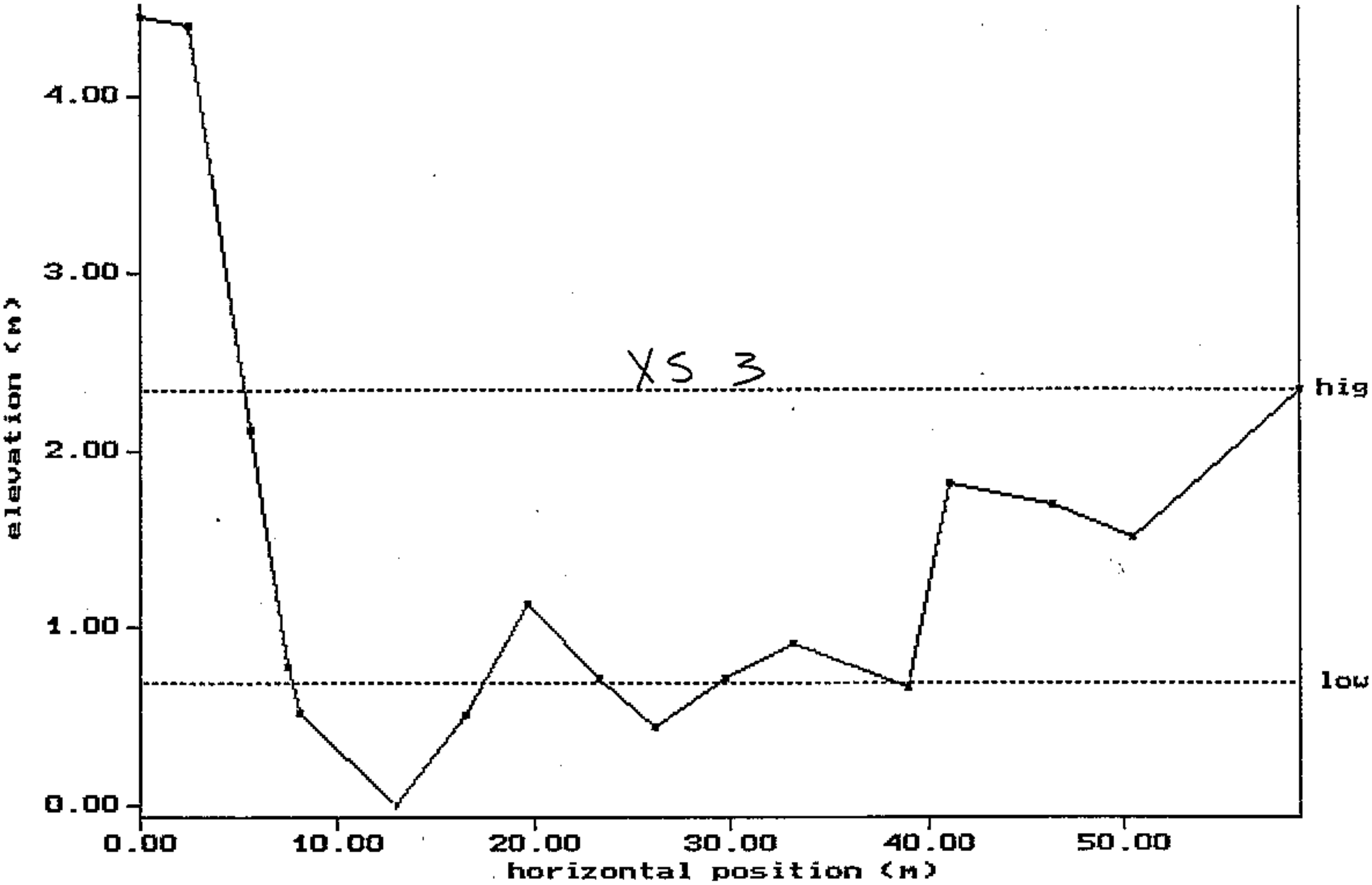
CHANNEL SLOPE RANGE: 0.0000 to 0.0066

VELOCITY FORMULA: Thorne & Zevenbergen
D84 = 0.625 (ft)

cross-section treated as one sectionX-S 3 Indian river, VCU 311, FP4, Sitka, Ak.

STAGE m	#SEC	AREA m^2	PERIM m	WIDTH m	R m	DAVG m	SLOPE	n	VAVG m/s	Q cms
0.70	1	4.5	16.1	16.0	0.3	0.3	0.0001	0.058	0.2	0.33
0.81	1	6.6	22.7	22.4	0.3	0.3	0.0004	0.056	0.5	1.10
0.92	1	9.4	29.3	29.0	0.3	0.3	0.0009	0.054	0.9	2.45
1.03	1	12.7	31.3	30.9	0.4	0.4	0.0013	0.051	1.3	4.98
1.14	1	16.2	33.2	32.8	0.5	0.5	0.0018	0.049	1.7	8.59
1.25	1	19.9	33.8	33.2	0.6	0.6	0.0022	0.048	2.3	13.75
1.36	1	23.5	34.2	33.6	0.7	0.7	0.0026	0.046	2.8	20.32
1.47	1	27.3	34.6	34.0	0.8	0.8	0.0031	0.046	3.4	28.37
1.58	1	31.1	37.0	36.2	0.8	0.9	0.0035	0.045	3.9	36.59
1.69	1	35.3	40.9	40.1	0.9	0.9	0.0039	0.045	4.2	45.22
1.80	1	40.0	46.9	46.1	0.9	0.9	0.0044	0.044	4.4	53.89
1.91	1	45.2	49.4	48.5	0.9	0.9	0.0048	0.044	4.9	67.83
2.02	1	50.7	50.8	49.8	1.0	1.0	0.0053	0.043	5.5	84.98
2.13	1	56.2	52.1	51.1	1.1	1.1	0.0057	0.043	6.1	104.44
2.24	1	61.9	53.4	52.4	1.2	1.2	0.0061	0.042	6.7	126.28
2.35	1	67.7	54.7	53.6	1.2	1.3	0.0066	0.042	7.3	150.61

DISCHARGE-TO-RADIUS RELATIONSHIP: Q = aR^b
a = 81.062, b = 3.546
r^2 = 0.9663, n = 16



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(high stage values can range between 0.70 and 5.85 meters

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high stage (m) 2.353 slope (%) .659

output table stage increment (m) .11

F10 to restart
F1 for Help
ESC to exit

STAGE-DISCHARGE DATA FOR CROSS-SECTION FILE INDXS4.DAT
CROSS-SECTION NUMBER 4
DATE OF CROSS-SECTION MEASUREMENT: 940701

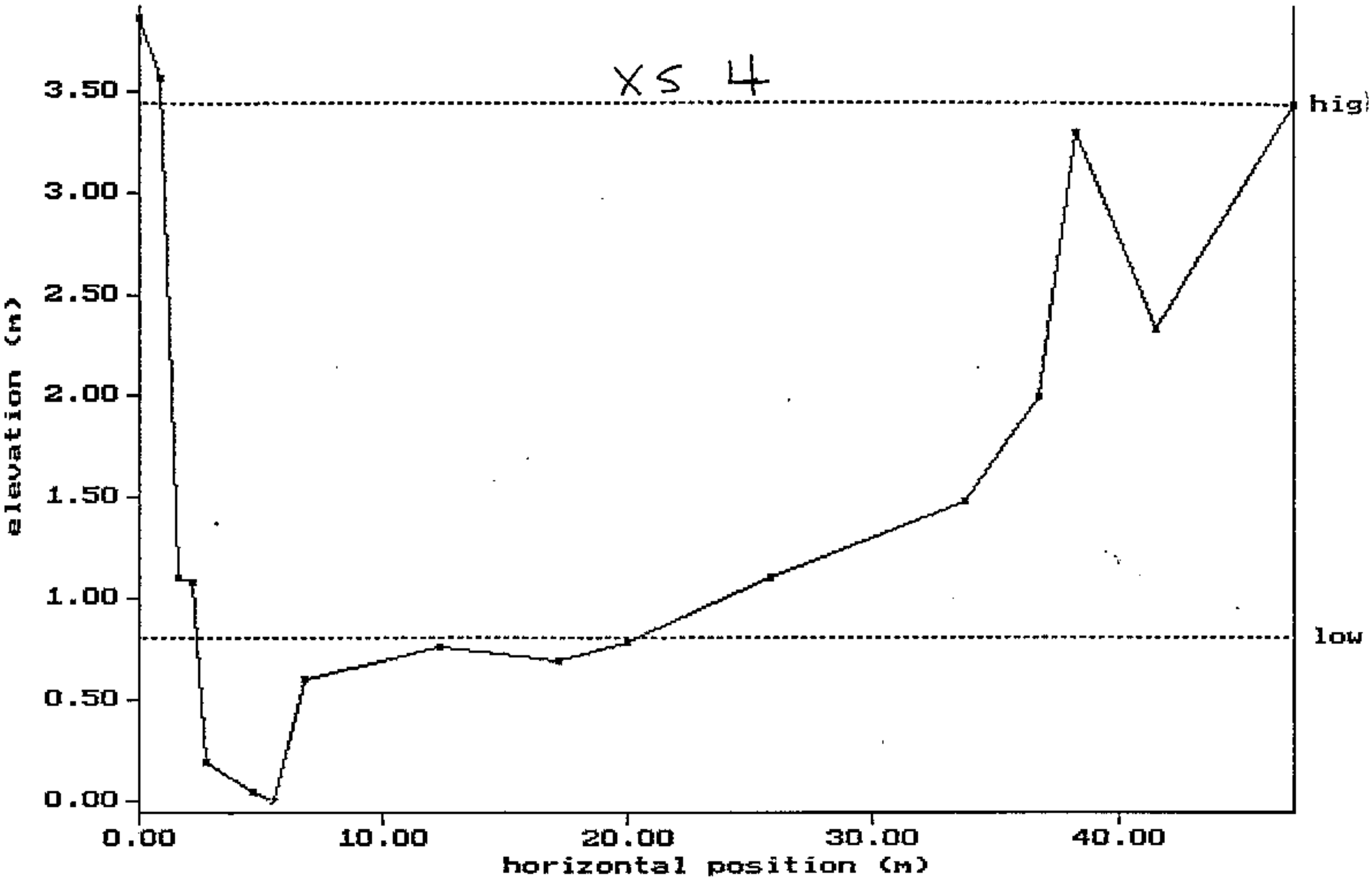
CHANNEL SLOPE RANGE: 0.0163 to 0.0066

VELOCITY FORMULA: Thorne & Zevenbergen
D84 = 0.625 (ft)

cross-section treated as one sectionX-S 4, Indian river, VCU 311, FP4, Sitka, Ak

STAGE m	#SEC	AREA m^2	PERIM m	WIDTH m	R m	DAVG m	SLOPE	n	VAVG m/s	Q cms
0.81	1	4.0	18.4	17.9	0.2	0.2	0.0163	0.060	2.6	3.15
0.98	1	7.4	21.8	21.2	0.3	0.3	0.0157	0.053	3.8	8.45
1.15	1	11.3	25.8	25.1	0.4	0.4	0.0150	0.050	4.7	16.00
1.32	1	15.9	29.6	28.7	0.5	0.6	0.0144	0.048	5.5	26.35
1.49	1	21.0	33.2	32.3	0.6	0.7	0.0138	0.046	6.2	39.48
1.66	1	26.6	34.4	33.3	0.8	0.8	0.0132	0.045	7.1	57.43
1.83	1	32.4	35.6	34.4	0.9	0.9	0.0125	0.044	7.9	77.63
2.00	1	38.3	36.8	35.4	1.0	1.1	0.0119	0.043	8.5	99.78
2.17	1	44.3	37.2	35.6	1.2	1.2	0.0113	0.043	9.2	124.88
2.34	1	50.4	37.7	36.0	1.3	1.4	0.0107	0.042	9.8	150.84
2.51	1	56.7	39.7	37.7	1.4	1.5	0.0100	0.042	10.1	173.70
2.68	1	63.2	41.6	39.4	1.5	1.6	0.0094	0.041	10.2	197.20
2.85	1	70.1	43.5	41.1	1.6	1.7	0.0088	0.041	10.3	221.03
3.02	1	77.2	45.4	42.8	1.7	1.8	0.0082	0.041	10.4	244.86
3.19	1	84.6	47.3	44.4	1.8	1.9	0.0075	0.040	10.4	268.30
3.36	1	92.3	48.9	45.8	1.9	2.0	0.0069	0.040	10.4	292.18
3.45	1	96.2	49.4	46.3	1.9	2.1	0.0066	0.040	10.4	304.60*

DISCHARGE-TO-RADIUS RELATIONSHIP: Q = aR^b
a = 85.332, b = 2.050
r^2 = 0.9955, n = 17



Specify lower and upper bounds of output discharge stages:
(high stage values can range between 0.81 and 5.37 meters
low stage (m) .813 slope (%) 1.63 F10 to restart
high stage (m) 3.448 slope (%) .659 F1 for Help
output table stage increment (m) .17 ESC to exit

STAGE-DISCHARGE DATA FOR CROSS-SECTION FILE INDXS5.DAT
CROSS-SECTION NUMBER 5
DATE OF CROSS-SECTION MEASUREMENT: 940701

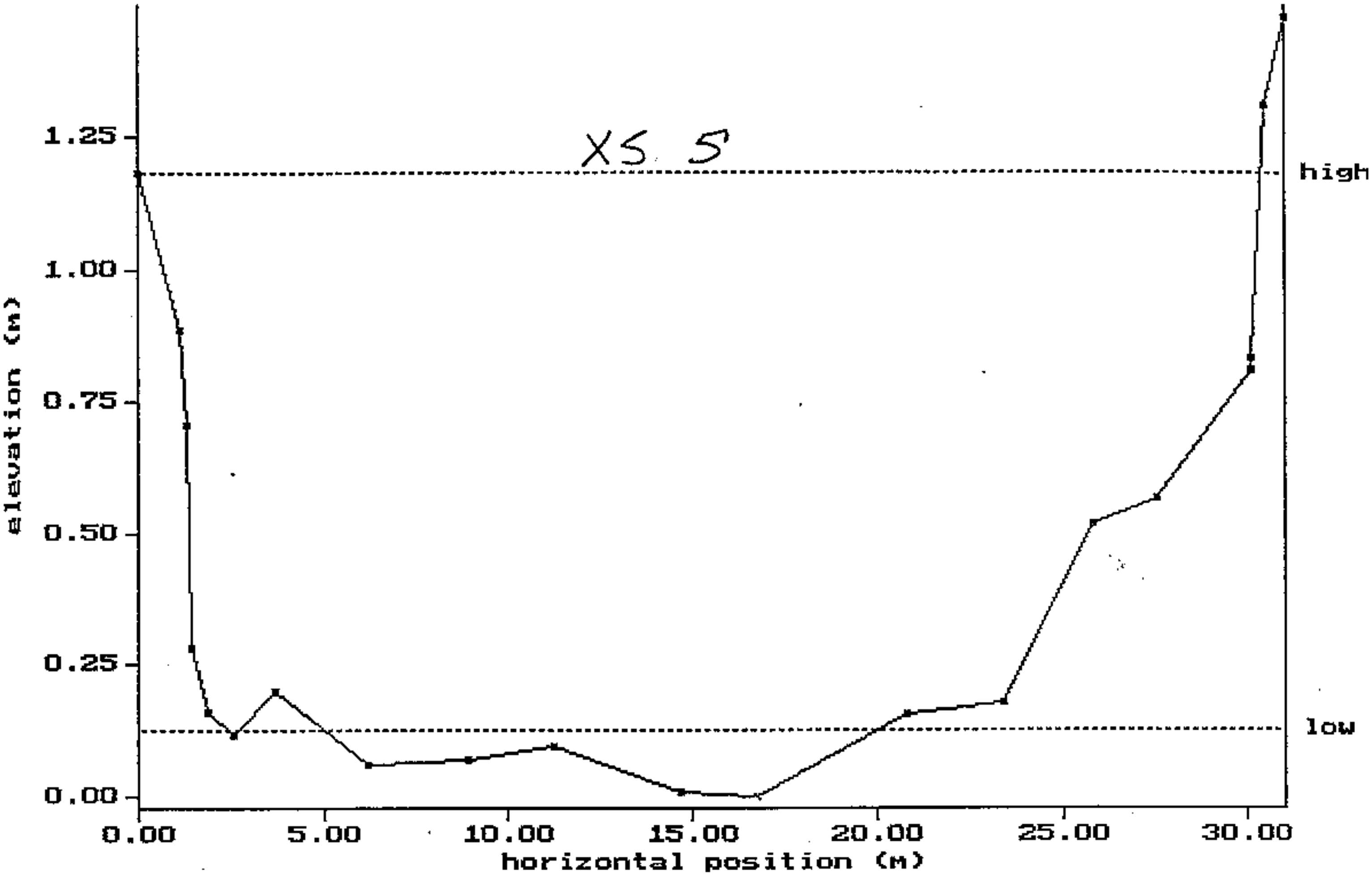
CHANNEL SLOPE RANGE: 0.0064 to 0.0066

VELOCITY FORMULA: Thorne & Zevenbergen
D84 = 0.625 (ft)

cross-section treated as one sectionX-S 5, Indian river, VCU 311, FP4, Sitka, Ak

STAGE m	#SEC	AREA m^2	PERIM m	WIDTH m	R m	DAVG m	SLOPE	n	VAVG m/s	Q cms
0.12	1	1.0	15.2	15.2	0.1	0.1	0.0064	0.096	0.4	0.14
0.20	1	2.5	21.9	21.9	0.1	0.1	0.0064	0.101	0.6	0.47
0.28	1	4.3	22.8	22.7	0.2	0.2	0.0064	0.091	1.0	1.25
0.36	1	6.1	23.4	23.3	0.3	0.3	0.0064	0.067	1.6	3.03
0.44	1	8.0	24.1	23.9	0.3	0.3	0.0065	0.061	2.1	5.12
0.52	1	10.0	24.9	24.6	0.4	0.4	0.0065	0.057	2.5	7.67
0.60	1	12.0	26.9	26.6	0.4	0.5	0.0065	0.055	2.8	10.41
0.68	1	14.2	27.8	27.5	0.5	0.5	0.0065	0.053	3.2	13.92
0.76	1	16.4	28.8	28.4	0.6	0.6	0.0065	0.051	3.6	17.91
0.84	1	18.7	29.4	29.0	0.6	0.6	0.0065	0.050	4.0	22.58
0.92	1	21.0	29.7	29.2	0.7	0.7	0.0065	0.049	4.4	27.91
1.00	1	23.4	30.1	29.6	0.8	0.8	0.0066	0.048	4.7	33.67
1.08	1	25.8	30.5	29.9	0.8	0.9	0.0066	0.047	5.1	39.90
1.16	1	28.2	31.0	30.3	0.9	0.9	0.0066	0.046	5.4	46.61
1.19	1	28.8	31.1	30.4	0.9	0.9	0.0066	0.046	5.5	48.44

DISCHARGE-TO-RADIUS RELATIONSHIP: Q = aR^b
a = 60.019, b = 2.243
r^2 = 0.9993, n = 15



Specify lower and upper bounds of output discharge stages:
(high stage values can range between 0.12 and 2.98 meters

low stage (m)	.125	slope (%)	.64	F10 to restart
high stage (m)	1.186	slope (%)	.659	F1 for Help
output table stage increment (m)	.08			ESC to exit

STAGE-DISCHARGE DATA FOR CROSS-SECTION FILE INDXS6.DAT
CROSS-SECTION NUMBER 6
DATE OF CROSS-SECTION MEASUREMENT: 940701

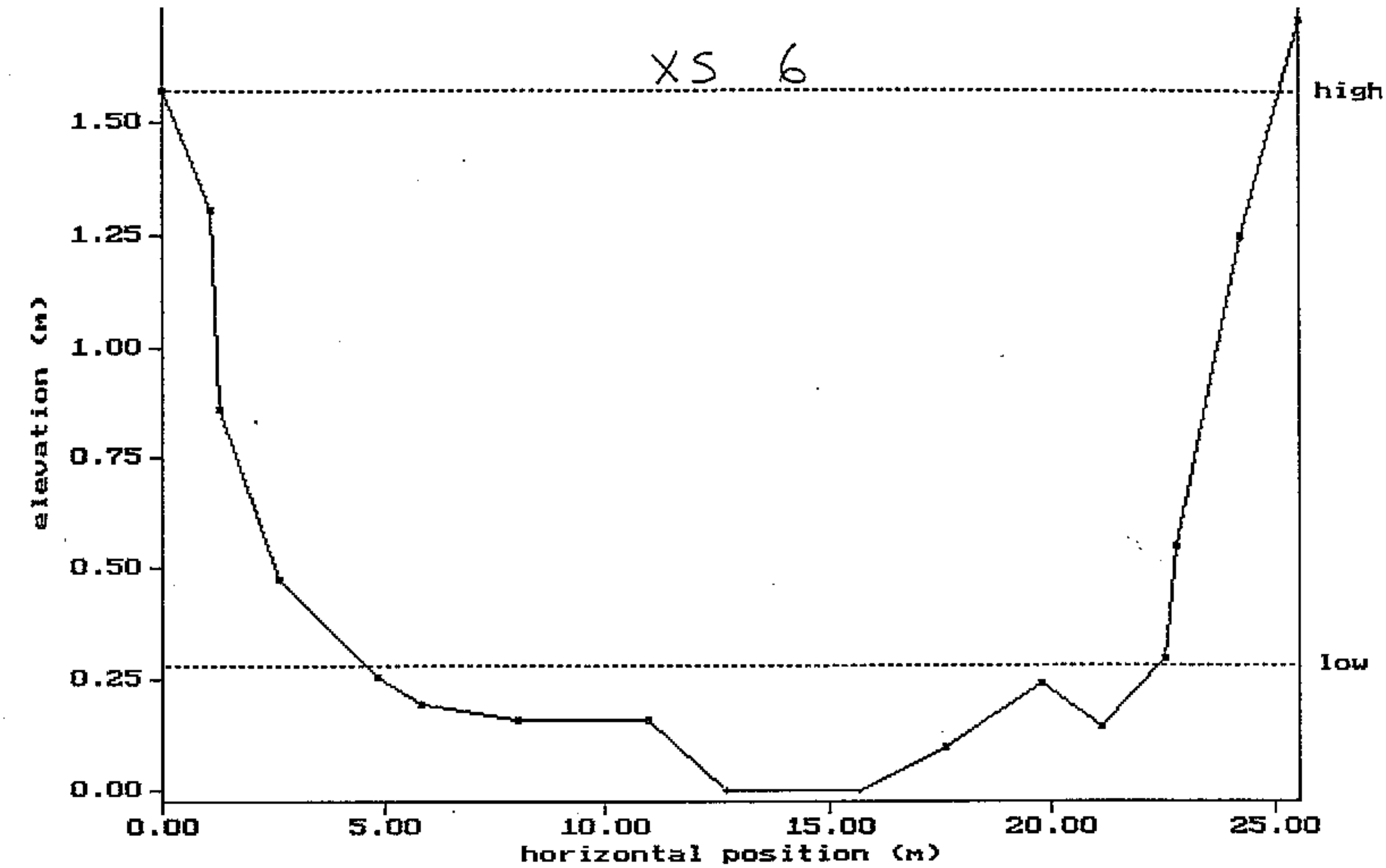
CHANNEL SLOPE RANGE: 0.0006 to 0.0066

VELOCITY FORMULA: Thorne & Zevenbergen
D84 = 0.625 (ft)

cross-section treated as one sectionX-S 6, Indian river, VCU 311, FP4, Sitka, Ak

STAGE m	#SEC	AREA m^2	PERIM m	WIDTH m	R m	DAVG m	SLOPE	n	VAVG m/s	Q cms
0.28	1	2.7	17.8	17.7	0.2	0.2	0.0006	0.093	0.3	0.21
0.36	1	4.2	18.9	18.8	0.2	0.2	0.0010	0.070	0.5	0.69
0.44	1	5.7	19.8	19.7	0.3	0.3	0.0014	0.063	0.9	1.48
0.52	1	7.3	20.4	20.3	0.4	0.4	0.0017	0.058	1.2	2.66
0.60	1	9.0	20.9	20.7	0.4	0.4	0.0021	0.055	1.6	4.27
0.68	1	10.6	21.3	21.1	0.5	0.5	0.0025	0.053	2.0	6.32
0.76	1	12.3	21.8	21.6	0.6	0.6	0.0028	0.051	2.4	8.85
0.84	1	14.1	22.3	22.0	0.6	0.6	0.0032	0.050	2.8	11.86
0.92	1	15.9	22.6	22.3	0.7	0.7	0.0036	0.049	3.2	15.46
1.00	1	17.6	22.8	22.5	0.8	0.8	0.0039	0.048	3.6	19.63
1.08	1	19.5	23.1	22.7	0.8	0.9	0.0043	0.047	4.1	24.36
1.16	1	21.3	23.4	22.9	0.9	0.9	0.0047	0.046	4.6	29.66
1.24	1	23.1	23.7	23.1	1.0	1.0	0.0051	0.046	5.0	35.55
1.32	1	25.0	24.0	23.3	1.0	1.1	0.0054	0.045	5.5	41.93
1.40	1	26.9	24.6	23.9	1.1	1.1	0.0058	0.045	5.9	48.63
1.48	1	28.8	25.1	24.4	1.1	1.2	0.0062	0.044	6.4	55.93
1.56	1	30.8	25.7	25.0	1.2	1.2	0.0065	0.044	6.8	63.87
1.58	1	31.1	25.8	25.1	1.2	1.2	0.0066	0.044	6.9	65.43

DISCHARGE-TO-RADIUS RELATIONSHIP: Q = aR^b
a = 39.447, b = 2.695
r^2 = 0.9989, n = 18




```
Specify lower and upper bounds of output discharge stages:
  (high stage values can range between    0.28 and    3.24 meters
  low stage  (m) .28            slope (%) .064              F10 to restart
  high stage (m) 1.575          slope (%) .659              F1 for Help
  output table  stage increment (m) .08                     ESC to exit
```

APPENDIX B: FISH HABITAT MEASUREMENTS

Key to Habitat Data Summaries:

1. HAB_NUM = Sequential number for discrete stream habitat units starting from the downstream end of the survey area. Hab_Num 1 is at mean high tide level in the Indian River Estuary and Hab_Num 24 is located just below the Sawmill Creek Bridge.

2. MEASURED = Denotes if the habitat dimensions were estimated or measured using a tape and statia rod. All habitat units in the survey are coded as "M" meaning all units were measured by the stream surveyers.

3. HAB_MESO = This column denotes meso level habitat codes described in Bryant et al 1992. These codes include:

- GL = Glides, relatively deep, slow moving water with a smooth surface.
- PL = Pool, water is slower and deeper than reach average.
- RF = Riffel, water is fast and shallow, stream gradient is between 2 and 4 percent, and less than 20 percent of the streambed cobbles break the surface.

4. HAB_MICRO = This column denotes micro levle habitat codes including:

- gl = glide with even surface flow and roughness greater than 3.
- mcs = mid-channel scour pool usually associated with a channel constriction.
- cb = cobble glide or riffle unit having somewhat uneven surface flow and a roughness coefficient between 1 and 3.
- bd = boulder dominated glide or riffle unit with moderately turbulent flow and pockets of slow water behind boulders. Roughness coefficient is less than 1.
- lsc = later scour pool, usually long and narrow, located along the stream bank and formed by a constriction or obstruction.
- ed = eddy pool, usually found downstream from an obstruction along the streambank.

5. UPSTRM_WDTH = This column contains measurements of the upstream width, in meters, for each descrete habitat unit in the survey area.

6. DOWNSTRM_WDTH = This column contains measurements of the downstream width, in meters, for each descrete habitat unit in the survey area

7. HAB_LNGTH = This column contains measurements of the total length, in meters, for each descrete habitat unit in the survey area

8. COV1_TYP = This column denotes dominant habitat cover type associated with a given habitat unit.

9. COV2_TYP = This column denotes secondary habitat cover type associated with a given habitat unit. Codes for both dominant and secondary habitat cover types include:

- B = Boulder, rocks greater than 25 cm in diameter.
- C = Cobble, rocks between 64mm and 25 cm in diameter.
- D = Depth, water depth greater than 1 meter.
- RW = Rootwad, base of tree with extensive root structure.
- LWD = Large woody debris, pieces of wood or tree stems greater than 30 cm and 1 meter in length.
- SL = Slash, pieces of wood between 10 mm and 30 cm in diameter.
- OV = Overhanging vegetation along streambanks, not touching the water surface.
- T = Turbulence associated with cascades or step pool drops.

10. COV1_PC/ COV2_PC = Percentage of primary and secondary habitat area with respect to total wetted area of the stream channel.

11. PD_MAX = Maximum pool depth in meters.

12. PD_AVG = Average pool depth in meters based on minimum of five measurements.

13. PD_RC = Riffle crest depth from depth at tail of the pool or head of the riffle in meters.

HAB_NUM	MEASURED	HAB_MESO	HAB_MICRO	UPSTRM_WDTH	DWNSTRM_WDTH	HAB_LNGTH
1	M	GL	gl	13.1	20.4	48.8
2	M	PL	msc	8.4	7.5	18
3	M	RF	cb	7.9	8.3	7.8
4	M	PL	msc	7.4	7.9	17.5
5	M	PL	msc	4.3	6.7	27.9
6	M	RF	cb	18.9	17	26.4
7	M	GL	cb	20.2	18.9	32.9
8	M	RF	cb	17.5	20.2	38.8
9	M	PL	ed	2.4	3.3	12
10	M	GL	cb	19	17.5	37
11	M	RF	cb	20.9	19	14.5
12	M	GL	cb	9.2	20.9	68.7
13	M	RF	cb	12.5	16	28
14	M	PL	lsc	3.8	4.4	24
15	M	GL	cb	15.5	14.67	37.35
16	M	RF	CB	7.95	15.5	47.2
17	M	GL	gl	8.96	7.14	30.1
18	M	GL	gl	4.9	4.5	21.08
19	M	GL	cb	15.21	18.72	44.11
20	M	PL	lsc	3.6	3.2	17.71
21	M	RF	cb	16.99	15.21	17.74
22	M	GL	bd	13.64	16.99	30.4
23	M	PL	lsc	10.7	10.14	35
24	M	RF	cb	9.48	11.09	22

HAB_NUM	MEASURED	HAB_MESO	HAB_MICRO	COV1_TYP	COV1_PC	COV2_TYP	COV2_PCT
1	M	GL	gl	B	3	SL	2
2	M	PL	msc	RW	4	SL	2
3	M	RF	cb	C	5		
4	M	PL	msc	LWD	8	C	5
5	M	PL	msc	LWD	8	OV	2
6	M	RF	cb	C	10	OV	1
7	M	GL	cb	C	10	OV	1
8	M	RF	cb	C	10		
9	M	PL	ed	RW	15	LWD	7
10	M	GL	cb	C	15	RW	1
11	M	RF	cb	C	10	SL	2
12	M	GL	cb	C	15	B	8
13	M	RF	cb	C	30	LWD	5
14	M	PL	lsc	B	35	C	10
15	M	GL	cb	OV	10	T	7
16	M	RF	CB	C	15	T	10
17	M	GL	gl	OV	7	C	5
18	M	GL	gl	B	2		
19	M	GL	cb	B	10		
20	M	PL	lsc	B	3		
21	M	RF	cb	B	15	T	8
22	M	GL	bd	B	30	SL	15
23	M	PL	lsc	B	35	D	15
24	M	RF	cb	B	30	T	20

HAB_NUM	MEASURED	HAB_MESO	PD_MAX	PD_AVG	PD_RC
1	M	GL		0.35	
2	M	PL	0.95	0.5	0.44
3	M	RF		0.11	
4	M	PL	0.97	0.45	0.2
5	M	PL	0.66	0.4	0.34
6	M	RF		0.12	
7	M	GL		0.2	
8	M	RF		0.25	
9	M	PL	0.5	0.36	0.13
10	M	GL		0.28	
11	M	RF		0.16	
12	M	GL		0.35	
13	M	RF		0.3	
14	M	PL	0.98	0.61	0.26
15	M	GL		0.36	
16	M	RF		0.25	
17	M	GL		0.2	
18	M	GL		0.19	
19	M	GL		0.38	
20	M	PL	0.49	0.36	0.12
21	M	RF		0.28	
22	M	GL		0.45	
23	M	PL	1.3	0.8	0.33
24	M	RF		0.3	

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APPENDIX C: STREAM-BED SUBSTRATE MEASUREMENTS

Stream Name : Indian river @ high tide
Stream Reach: 311003 Survey Date: 06/30/94

------------ CUMULATIVE PARTICLE SIZE DISTRIBUTION -------------

GRAIN SIZE	%ILE	GRAIN SIZE	%ILE	GRAIN SIZE	%ILE
2	0.0	84	67.4	340	99.0
3	0.0	86	68.7	350	99.1
4	0.0	88	70.0	360	99.2
5	0.0	90	71.3	370	99.2
6	0.0	92	72.6	380	99.3
7	0.0	94	73.9	390	99.3
8	0.0	96	75.1	400	99.4
10	0.5	98	76.3	410	99.5
12	1.0	100	77.4	420	99.5
14	1.3	102	78.6	430	99.6
16	1.7	104	79.7	440	99.6
18	3.4	106	80.8	450	99.7
20	4.9	108	81.9	460	99.7
22	6.3	110	82.9	470	99.8
24	7.5	112	84.0	480	99.8
26	8.7	114	85.0	490	99.9
28	9.7	116	86.0	500	99.9
30	10.7	118	87.0	512	100.0
32	11.7	120	87.9	520	100.0
34	15.2	122	88.9	540	100.0
36	18.5	124	89.8	560	100.0
38	21.6	126	90.8	580	100.0
40	24.5	128	91.7	600	100.0
42	27.4	130	91.8	620	100.0
44	30.0	140	92.5	640	100.0
46	32.6	150	93.2	660	100.0
48	35.1	160	93.8	680	100.0
50	37.4	170	94.4	700	100.0
52	39.7	180	94.9	720	100.0
54	41.9	190	95.5	740	100.0
56	44.0	200	96.0	760	100.0
58	46.0	210	96.4	780	100.0
60	47.9	220	96.9	800	100.0
62	49.8	230	97.3	820	100.0
64	51.7	240	97.7	840	100.0
66	53.4	256	98.3	860	100.0
68	55.2	260	98.4	880	100.0
70	56.8	270	98.5	900	100.0
72	58.5	280	98.5	920	100.0
74	60.0	290	98.6	940	100.0
76	61.6	300	98.7	960	100.0
78	63.1	310	98.8	980	100.0
80	64.5	320	98.9	1000	100.0

Stream Name : Indian river above footbridge
Stream Reach: 311002 Survey Date: 06/30/94

------------ CUMULATIVE PARTICLE SIZE DISTRIBUTION -------------

GRAIN SIZE	%ILE	GRAIN SIZE	%ILE	GRAIN SIZE	%ILE
2	0.0	84	49.3	340	97.9
3	0.3	86	50.8	350	98.1
4	0.5	88	52.2	360	98.2
5	0.5	90	53.6	370	98.4
6	0.5	92	55.0	380	98.5
7	0.5	94	56.4	390	98.6
8	0.5	96	57.7	400	98.8
10	0.5	98	59.0	410	98.9
12	0.5	100	60.3	420	99.0
14	0.5	102	61.6	430	99.1
16	0.5	104	62.8	440	99.2
18	1.8	106	64.0	450	99.3
20	2.9	108	65.2	460	99.5
22	3.9	110	66.4	470	99.6
24	4.9	112	67.5	480	99.7
26	5.8	114	68.6	490	99.8
28	6.6	116	69.8	500	99.9
30	7.3	118	70.8	512	100.0
32	8.0	120	71.9	520	100.0
34	10.1	122	73.0	540	100.0
36	12.1	124	74.0	560	100.0
38	14.0	126	75.0	580	100.0
40	15.7	128	76.0	600	100.0
42	17.4	130	76.5	620	100.0
44	19.0	140	78.7	640	100.0
46	20.6	150	80.7	660	100.0
48	22.0	160	82.6	680	100.0
50	23.5	170	84.4	700	100.0
52	24.8	180	86.1	720	100.0
54	26.1	190	87.7	740	100.0
56	27.4	200	89.2	760	100.0
58	28.6	210	90.6	780	100.0
60	29.8	220	92.0	800	100.0
62	30.9	230	93.3	820	100.0
64	32.0	240	94.6	840	100.0
66	34.0	256	96.5	860	100.0
68	35.8	260	96.6	880	100.0
70	37.7	270	96.8	900	100.0
72	39.5	280	97.0	920	100.0
74	41.2	290	97.1	940	100.0
76	42.9	300	97.3	960	100.0
78	44.6	310	97.5	980	100.0
80	46.2	320	97.6	1000	100.0

Stream Name : Indian river @ RM.2
Stream Reach: 311004 Survey Date: 09/08/94

------------ CUMULATIVE PARTICLE SIZE DISTRIBUTION -------------

GRAIN SIZE	%ILE	GRAIN SIZE	%ILE	GRAIN SIZE	%ILE
2	0.5	84	62.1	340	99.1
3	0.8	86	63.3	350	99.2
4	1.0	88	64.4	360	99.2
5	1.2	90	65.5	370	99.3
6	1.3	92	66.5	380	99.4
7	1.4	94	67.6	390	99.4
8	1.5	96	68.6	400	99.5
10	2.1	98	69.6	410	99.5
12	2.7	100	70.6	420	99.6
14	3.1	102	71.5	430	99.6
16	3.5	104	72.5	440	99.7
18	4.9	106	73.4	450	99.7
20	6.1	108	74.3	460	99.8
22	7.2	110	75.2	470	99.8
24	8.2	112	76.0	480	99.9
26	9.1	114	76.9	490	99.9
28	10.0	116	77.7	500	99.9
30	10.8	118	78.6	512	100.0
32	11.5	120	79.4	520	100.0
34	14.8	122	80.2	540	100.0
36	17.9	124	81.0	560	100.0
38	20.8	126	81.7	580	100.0
40	23.6	128	82.5	600	100.0
42	26.2	130	82.9	620	100.0
44	28.7	140	84.6	640	100.0
46	31.1	150	86.2	660	100.0
48	33.4	160	87.7	680	100.0
50	35.6	170	89.1	700	100.0
52	37.8	180	90.4	720	100.0
54	39.8	190	91.6	740	100.0
56	41.8	200	92.8	760	100.0
58	43.7	210	93.9	780	100.0
60	45.5	220	95.0	800	100.0
62	47.3	230	96.0	820	100.0
64	49.0	240	97.0	840	100.0
66	50.5	256	98.5	860	100.0
68	51.9	260	98.5	880	100.0
70	53.3	270	98.6	900	100.0
72	54.7	280	98.7	920	100.0
74	56.0	290	98.8	940	100.0
76	57.3	300	98.8	960	100.0
78	58.6	310	98.9	980	100.0
80	59.8	320	99.0	1000	100.0

APPENDIX D: MACROINVERTEBRATE ANALYSIS REPORT

MACROINVERTEBRATE ANALYSIS SUMMARY DATA
INDIAN RIVER, SITKA NATIONAL HISTORICAL PARK

Final Report by Elaine Major and Alexander Milner
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For
USDA Forest Service
Tongass National Forest, Chatham Area
204 Siginaka Way, Sitka, AK 99835

December 1994

INTRODUCTION

This report presents results of macroinvertebrate analysis conducted by the University of Alaska Anchorage's Environment and Natural Resources Institute (ENRI) for the U.S. Forest Service (USFS) under reference numbers FWWE-102-03-94 and FWWE-4-03-95, dated 5-27-94 and 10-10-94 respectively , ENRI W.O.s # 763 and #772. Samples were collected by USFS and provided to ENRI. The purpose of the project was to assess current water quality conditions and collect baseline data for monitoring upstream disturbances in Sitka National Historical Park.

Macroinvertebrates serve as useful biological indicators of aquatic ecosystem health by integrating the health of a system over a time prior to sampling rather than the time of sampling provided by chemical analysis. Unimpaired streams typically support a wide diversity of taxa from the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), (EPT). EPT taxa typically become reduced in number with water quality degradation. Chironomids may dominate samples as water quality degradation increases but are also found in pristine waters. Sample areas are generally selected according to optimum substrate size in riffle areas to investigate the potential maximum diversity of macroinvertebrates that a site can support.

The samples were sorted and identified to genera for the EPT taxa and to family for the other taxa. Biotic metrics, including number of EPT genera present, EPT/total individuals ratio, percent dominant taxa, and Hilsenhoff's Family Biotic Index (FBI), were calculated for the data. Table 1 provides the range of biotic metrics and their relationship to water quality. Table 2 exhibits the tolerance levels of different invertebrate families used in calculation of Hilsenhoff's (1988) FBI value. These tables provide information for overall comparisons with the metrics calculated.

Table 1. Range of biotic metrics and their relationship to water quality.

Metric	Range	Water Quality
No. of EPT Genera	0 to ~14	Increasing
EPT/Total Individuals	0 to 1.0	Increasing
Average % Dominant Taxa	0 to 100	Decreasing
FBI	0 to 10	Decreasing

Table 2. Different tolerances of invertebrate families to changes in water quality on scale of 0 to 10 [0 = least tolerant, 10 = most tolerant] (Adapted from Hilsenoff 1988).

Scale	Plecoptera (Stoneflies)	Ephemeroptera (Mayflies)	Trichoptera (Caddisflies)	Diptera (True flies)
0	Leuctridae Pteronarcyidae		Glossosomatidae Rhyacophilidae	
1	Chloroperlidae Perlidae Capniidae	Ephemerellidae	Brachycentridae	
2	Nemouridae Perlodidae Taeniopterygidae			
3				Tipulidae
4		Baetidae	Limnephilidae	
5		Heptageniidae		
6				Chironomidae Simuliidae Empididae Ceratopogonidae
7				
8				Oligochaeta (not Diptera)
9				
10				Psychodidae

STATION RESULTS

Samples were collected from Indian River Sitka National Historic Park in Sitka. Samples were collected by USFS personnel in May and September from a total of three different stations. Table 3 summarizes the biotic metrics calculated for each station.

Station 1, at the footbridge, was only sampled in May. Several species of salmon and trout were observed. This site supported a total of 8 EPT genera. The average EPT/total individuals ratio was 0.26, the percent dominant taxa was 70%, and the FBI value 2.5. Chironomidae was the dominant taxa at this station.

Station 2, above the footbridge, was sampled in both May and August to compare seasonal results. The site supported a total of 11 EPT genera in May but only 5 in August. However in August, the site did not meet minimum density requirements necessary to calculate biotic metrics for evaluating water quality and may have accounted for the low diversity of EPT. A major run of pink and chinook salmon adults was noted in the stream at that time. The average EPT/total individuals ratio was 0.43 in May. Percent dominant taxa was 57% in May, with chironomids dominating the sample, and the FBI value was 4.8.

The third site, the gauging station on river mile 2, was selected as a control site for background fall conditions and where fish spawning would not potentially influence the invertebrate community. This site supported 12 EPT genera. The average EPT/total individuals ratio was 0.93, with the percent dominant taxa at 31%, with Ephemeropterans dominating the sample. The FBI value was 3.3.

Table 3. Summary of biotic metrics for Indian River stations.

STATION	DATE	TOTAL EPT GENERA	AVG. EPT/ TOTAL INDIV.	% DOM. TAXA	FBI VALUE
1) Footbridge	5-6-94	8	0.26	70	2.5
2) Above Footbridge	5-6-94	11	0.43	57	4.8
Above Footbridge*	8-31-94	5			
3) Gauging Stn	9-8-94	12	0.93	31	3.3

*denotes station that did not meet minimum density of 300 organisms/m2 required to calculate biotic metrics.

SUMMARY

The station at the footbridge indicated possible impairment based on the low average EPT/total individuals ratio, and the relatively high percent dominant taxa. The high predominance of Chironomidae with a FBI tolerance value of 6 caused the relatively high percent dominant taxa. However, the FBI value was relatively low.

The station above the footbridge in May indicated slight impairment based on EPT/total individuals ratio, the percent dominant taxa, and the FBI value. Nevertheless, a high diversity of EPT genera were represented. These samples were also dominated by the Chironomidae. The numbers of organisms present above the footbridge in August was too low to calculate biotic metrics which could possibly be attributed to the documented extensive spawning activity.

The gauging station appears to be a suitable control site as it supported a high diversity of EPT genera, a high average EPT/total individuals ratio, a low percent dominant taxa, and a relatively low FBI value. The EPT genera were dominated by the Ephemeroptera. All of these metrics indicate no impairment and good water quality.

REFERENCES

Hilsenhoff, W.L. 1988. Rapid field assessment of organic pollution with a family level biotic index. Journal of the North American Benthological Society, 7:65-68.

MACROINVERTEBRATE SUMMARY DATA

SITE: *Indian River* DATE: *5-6-94*

pH: ______ CONDUCTIVITY(umhos): ______ TEMPERATURE(°C): ______

COMMENTS: *At footbridge*

Replicate	R1 SAMPLE 1	R2 SAMPLE 2	R3 SAMPLE 3	R4	R5	MEAN	MEAN /m2	95% con.limits
VELOCITY (cm/sec)								
DEPTH (cm) *Siphlonuridae Ameletus*						0.3	4	
TAXA (tolerance value)								
EPHEMEROPTERA *Leptophlebiidae Paraleptophlebia*			1			0.3	4	
Baetidae -Baetis (4)	3	17	14			11.3	122	
Ephemerellidae-Ephemerella (1)								
-Drunella (1)								
Heptageniidae-Epeorus (4)	1		2			1.0	11	
-Cinygmula (4)	14	18	22			18.0	194	
PLECOPTERA								
Nemouridae -Zapada (2)	1					0.3	4	
Chloroperlidae-Plumiperla (1)	7	4	17			9.3	100	
Perlodidae-Isoperla (2)								
Capniidae - Capnia	7	2	5			4.7	50	
TRICHOPTERA								
Rhyacophilidae-Rhyacophila (0)								
Glossosomatidae-Glossosoma (0)								
Brachycentridae								
-Brachycentrus (1)								
Limnephilidae-Ecclisomyia (4)								
-Onocosmoecus (4)								
-Psychoglypha (4)								
-Hesperophylax (4)								
Hydropsychidae-Hydropsyche (4)								
DIPTERA								
-Chironomidae (6)	99	129	133			120	1294	
[-pupae]	1					0.3	4	
-Empididae (6)		2	2			1.3	14	
-Simuliidae (6)								
-Tipulidae (3)	1	1	1			1.0	11	
OLIGOCHAETA (8)	1	6	4			3.7	40	
MOLLUSCA-Pelecypoda								
ARTHROPODA-Arachnida								
COLLEMBOLA								
TOTAL EPT	34	41	61				489	
TOTAL ORGANISMS	136	179	201				1852	
EPT/TOTAL	0.25	0.23	0.30					
% DOMINANT TAXA	0.73	0.72	0.66					
FBI VALUE	5.15	5.49	5.08					

		RBA RATING
TOTAL EPT GENERA	8	____
AVERAGE FOR SITE:		
EPT/TOTAL	0.26	____
% DOMINANT TAXA	70	____
FBI VALUE	5.24	____

RBA for site: ____

MACROINVERTEBRATE SUMMARY DATA

SITE: Station X DATE: 5-6-94

pH: ________ CONDUCTIVITY(µmhos): ________ TEMPERATURE(°C): ________

COMMENTS: Above ~~Foot~~bridge

Replicate	R1 1	R2 2	R3 3	R4	R5	MEAN	MEAN /m2	95% con.limits
VELOCITY (cm/sec)								
DEPTH (cm) Siphlonuridae-Ameletus			1			0.3	4	
TAXA (tolerance value)								
EPHEMEROPTERA Leptophlebiidae-Paraleptophlebia	1					0.3	4	
Baetidae -Baetis (4)	12	2	8			7.3	79	
Ephemerellidae-Ephemerella (1)								
-Drunella (1)								
Heptageniidae-Epeorus (4)	2		3			1.7	18	
-Cinygmula (4)	12	4	36			17.3	186	
-Rithrogena	1		1			0.7	7	
PLECOPTERA -[illegible]			1			0.3	4	
Nemouridae -Zapada (2)								
Chloroperlidae-~~Plumiperla (1)~~ Sweltsa	10	6 1	11			~~9.0~~ 0.3	~~97~~ 4	
Leuctridae - Leuctra	1					0.3	4	
Perlodidae-Isoperla (2)								
Capniidae - Capnia	1	5	2			2.7	29	
TRICHOPTERA								
Rhyacophilidae-Rhyacophila (0)								
Glossosomatidae-Glossosoma (0)								
Brachycentridae								
-Brachycentrus (1)								
Limnephilidae-Ecclisomyia (4)								
-Onocosmoecus (4)								
-Psychoglypha (4)								
-Hesperophylax (4)								
Hydropsychidae-Hydropsyche (4)								
DIPTERA								
-Chironomidae (6)	19	167	60			82.0	882	
[-pupae]								
-Empididae (6)								
-Simuliidae (6)								
-Tipulidae (3)		1				0.3	4	
OLIGOCHAETA (8)			2			0.7	7	
MOLLUSCA-Pelecypoda								
ARTHROPODA-Arachnida								
COLLEMBOLA								
TOTAL EPT	40	18	63				436	
TOTAL ORGANISMS	59	186	125				1,329	
EPT/TOTAL	0.68	0.10	0.50					
% DOMINANT TAXA	0.32	0.90	0.48					
FBI VALUE	3.98	5.60	4.72					

RBA RATING

TOTAL EPT GENERA 11 ____

AVERAGE FOR SITE:

EPT/TOTAL 0.43 ____

% DOMINANT TAXA .57 ____

FBI VALUE 4.77 ____

RBA for site: ____

MACROINVERTEBRATE SUMMARY DATA

SITE: Indian River DATE: 8-31-94

pH: ______ CONDUCTIVITY(umhos): ______ TEMPERATURE(°C): ______

COMMENTS: Above footbridge

Replicate	R1	R2	R3	R4	R5	MEAN	MEAN /M²	95% con.limits
eggs	.5	.4	4.	3				
VELOCITY (cm/sec)								
DEPTH (cm)								
TAXA (tolerance value)			0					
EPHEMEROPTERA			4					
Baetidae -Baetis (4)	1	2		1		1.0	11.	
Ephemerellidae-Ephemerella (1)				1		0.25	3	
-Drunella (1)		1					3	
Heptageniidae-Epeorus (4)								
-Cinygmula (4)				2		0.50	5	
PLECOPTERA								
Nemouridae -Zapada (2)								
Chloroperlidae-Plumiperla (1)								
Perlodidae-Isoperla (2)								
TRICHOPTERA								
Rhyacophilidae-Rhyacophila (0)								
Glossosomatidae-Glossosoma (0)								
Brachycentridae								
-Brachycentrus (1)								
Limnephilidae-Ecclisomyia (4)	1					0.25	3	
-Onocosmoecus (4)								
-Psychoglypha (4)								
-Hesperophylax (4)								
Hydropsychidae-Hydropsyche (4)								
DIPTERA								
-Chironomidae (6)	1	1				0.50	5	
[-pupae]								
-Empididae (6)								
-Simuliidae (6)								
-Tipulidae (3)								
OLIGOCHAETA (8)								
MOLLUSCA-Pelecypoda								
ARTHROPODA-Arachnida								
COLLEMBOLA								
TOTAL EPT	2	3	0	4			25	
TOTAL ORGANISMS	3	4	0	4			30	
EPT/TOTAL	0.67	0.75	0	1.00				
% DOMINANT TAXA								
FBI VALUE								

RBA RATING

<300/m²

TOTAL EPT GENERA 5 ______

AVERAGE FOR SITE:

EPT/TOTAL ______ ______

% DOMINANT TAXA ______ ______

FBI VALUE ______ ______

RBA for site: ______

MACROINVERTEBRATE SUMMARY DATA

SITE: Indian River DATE: 9-8-94

pH: ________ CONDUCTIVITY(µmhos): ____________ TEMPERATURE(°C): ________

COMMENTS: River Mile 2; - Gauging Station

Replicate	R1	R2	R3	R4	R5	MEAN	MEAN /M2	95% con.limits
VELOCITY (cm/sec)								
DEPTH (cm) Leptophlebiidae - Paraleptophlebia			1			0.25	3	
TAXA (tolerance value)								
EPHEMEROPTERA								
Baetidae -Baetis (4)	8	12	44	3		16.8	180	
Ephemerellidae-Ephemerella (1)								
-Drunella (1)	5	12	7	7		7.8	83	
Heptageniidae-Epeorus (4)		3	5	1		2.3	24	
-Cinygmula (4)	17	8	9	2		9.0	97	
-Rithrogena	2	4	12	7		6.3	67	
PLECOPTERA Podmosta	1	1				0.5	5	
Nemouridae -Zapada (2)	3	2	1			1.5	16	
Chloroperlidae-Plumiperla (1)	5	7	14	8		8.5	91	
Perlodidae-Isoperla (2)								
Capniidae - Capnia		1		4		1.3	13	
TRICHOPTERA								
Rhyacophilidae-Rhyacophila (0)	2	2	5	1		2.5	27	
Glossosomatidae-Glossosoma (0)		1		2		0.8	8	
Brachycentridae								
-Brachycentrus (1)								
Limnephilidae-Ecclisomyia (4)								
-Onocosmoecus (4)								
-Psychoglypha (4)								
-Hesperophylax (4)								
Hydropsychidae-Hydropsyche (4)								
DIPTERA								
-Chironomidae (6)		1	1	1		0.8	8	
[-pupae]								
-Empididae (6)	1		2	3		1.5	16	
-Simuliidae (6)								
-Tipulidae (3)								
OLIGOCHAETA (8)	2		1	2		1.3	13	
MOLLUSCA-Pelecypoda								
ARTHROPODA-Arachnida								
COLLEMBOLA								
TOTAL EPT	43	53	98	35			614	
TOTAL ORGANISMS	46	54	102	41			651	
EPT/TOTAL	0.93	0.98	0.96	0.85				
% DOMINANT TAXA	37	22	43	20				
FBI VALUE	4.61	2.59	3.23	2.71				

		RBA RATING
TOTAL EPT GENERA	12	____
AVERAGE FOR SITE:		
EPT/TOTAL	0.93	____
% DOMINANT TAXA	30.5	____
FBI VALUE	3.29	____

RBA for site: ____