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Kakweiken River Watershed Reconnaissance Survey and Preliminary Recommendations For Aquatic Habitat Protection

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INTRODUCTION

The Kakweiken River which flows into the head of Thompson Sound on the mainland coast north of Knight Inlet supports an extremely high value fishery. Logging has been carried out near the mouth of the watershed in McAllister Creek (Fig. 1) and is being planned for the Kakweiken Valley. A reconnaissance survey was carried out August 14-15th, 1972, by Fisheries Service personnel to assess fishery values in the system, to establish the probable consequences of forest harvesting on them and to develop management recommendations for aquatic habitat protection.

Existing information indicates that the estuarine environment is of major importance in maintaining the productivity of the system, and has been discussed separately (Appendix 1). A detailed report on stocks and the fishway necessary to develop the upper system is available from the Fisheries Service (Dept. of Fisheries, 1969).

This report briefly describes the watershed, indicates the objectives and methods used in the 1972 survey, presents the results, and develops preliminary recommendations. Recommendations are necessarily limited by the meager data base, and are thus phrased in the context of types of problems and probable sensitive areas. As additional information becomes available, more site specific comments will be developed.

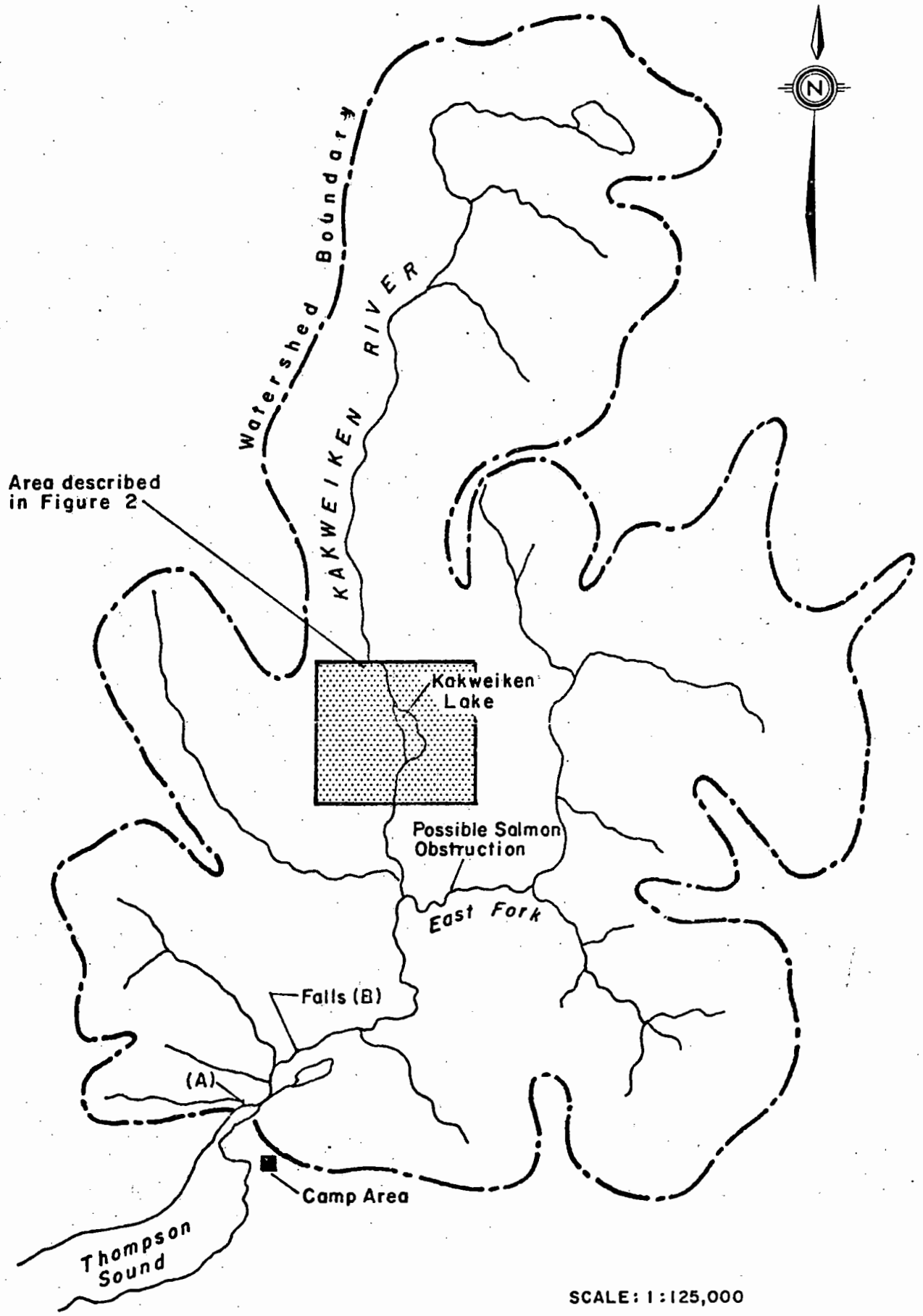


FIGURE I KAKWEIKEN RIVER WATERSHED, (See Text for details)

The Kakweiken Watershed

The Kakweiken watershed is located at the head of Thompson Sound (Fig. 1), and drains about 120 square miles ranging from sea level to 5,000 feet. About 20% of this area is in sub-alpine (above 3500 feet).

Bedrock in the watershed appears dominantly igneous intrusive resulting in relatively coarse-textured cohesionless soils. Post glacial and glacial fluvial processes have resulted in an extensive array of reworked valley bottom silts, sands, and gravels. The break in slope between valley side walls and the valley bottom is characterized by coalescing alluvial fans of well-drained gravelly sandy loam. Soil organic layers are deep in protected sites but thin in valley bottom locations, subjected to frequent flooding.

Rainfall has not been measured in the watershed, but is estimated at 150 in/yr on the basis of nearby stations (Chapman and Turner, 1956) (Province of B.C., 1971). Snow contributes a substantial but unknown portion of yearly precipitation. As a result, the spring melt period represents a dominant segment of the yearly hydrograph, with associated problems for the aquatic habitat. Climatological information suggests that rain or snow events may also take place during winter months.

Drainage patterns in the watershed reflect the high precipitation inputs. Closely spaced sub-parallel valley side wall tributaries join meandering and often braided valley bottom streams, characterized by extreme flow fluctuations and large volumes of bed and natural debris transport. No measurements on minimum or maximum flows exists.

Forest tree species include sitka spruce, western red cedar, and western hemlock in the valley bottoms and seepage sites while hemlock and balsam (amabilis fir) with some cedar are found on slopes. Devil's club characterizes the wetter areas while Vaccinium species are common on the well drained slopes. Alder and elderberry are common along tributary and mainstream banks, as well as over much of the alluvial flats.

Objectives and Methods

This survey gathered information about fish species distribution and timing, spawning gravel distribution and composition, rearing environments, and watershed stability.

Fish escapements and timing were compiled from management records and flight observation reports. Spawning gravels were surveyed from the air and field-checked from below Kakweiken Lake to the estuary by rubber boat. During this survey gravel samples were taken for subsequent particle size distribution analysis using a McNeil type sampler. Concurrent sub-gravel dissolved oxygen samples were taken.

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Rearing environments were located on the ground and their extent plotted from aerial photographs for one representative sensitive area (Fig. 2).

Watershed stability was assessed from flight observations and aerial photo interpretation, and ground checks of soil depths, texture, vegetation, organic layer accumulations, tributary bank stability, and prevalence of natural mass movements and snow avalanches.

Fish Species Distribution and Timing

The Kakweiken River supports annual escapements of all five species of anadromous Pacific salmon, steelhead and resident trout. Historically, odd year pinks have numerically dominated other species (75,000) with documented escapements as high as 220,000 (1971). Even year escapements have ranged from 3,500 to 75,000 with averages of 34,000 since 1950. Spawning is primarily restricted to the lower 2-1/2 miles of river by the lower obstruction (B, in Fig. 1), although high water levels during the period of upstream migration facilitates passage via a temporary ladder constructed in 1964. A permanent installation has been designed and, if constructed, will allow pinks access to an additional 9 miles of river with an estimated spawning population of 300,000. (Department of Fisheries, 1969).

TABLE 1 FISH SPECIES TIMING - KAKWEIKEN RIVER

Species	Stream Arrival	Emergence		Rearing		
		Timing	(Figure 1) Location	Duration	Location	
Trout	August	September-November	A-B	Early spring	6 mos.-1 year	Estuary
Salmon	August	September-November	A-B	Early spring	6 mos.-1 year	Estuary
Chinook	June-July	July-August	A-C	Late winter	3 mos. or 1 yr.	A-C and Estuary
Cockeye	June	July-August	C	Early spring	1-2 years	Kakweiker Lake
Brook	August	October-December	Throughout watershed	Early spring	1-2 years	Throughout Watershed
Steelhead	November	December-February	"	Late spring	1-3 years	" "
Cutthroat	Resident	March-April	"	Early summer	Resident	Throughout Watershed
Arcticolly Varden	Resident	August-November	"	Late spring	Resident	Throughout Watershed

Although chum escapements as high as 75,000 have been documented in the Kakweiken River, recent escapements (since 1954) have averaged 4,500. Their distribution is similar to pink salmon in that spawning presently occurs primarily in the lower 2-1/2 miles of river.

Chinook salmon number a few hundred, and spawn above the falls, while sockeye salmon have reached 7,500 (average 1,900) and spawn to Kakweiken Lake.

Coho salmon and steelhead trout are apparently not significantly delayed by the falls (B, Fig. 1), and are found throughout the watershed. Coho spawners have approached 7,500 historically with annual average escapements of 2,500 since 1958. Although steelhead have not been enumerated, they probably exhibit similar escapements, giving consideration to observed rearing densities.

As noted in Table 1 and historical escapements, the Kakweiken River and estuary provide very significant rearing habitat for anadromous and indigenous salmonids. Rearing coho and steelhead fry were observed in moderately heavy densities upstream from the East Fork confluence to the lower reaches. Preferred rearing areas include noted back and side channels, (Figures 1, 2) tributaries to the mainstem and East Fork, and peripheral bank areas on the East Fork and mainstem. In view of the extreme runoff events in the Kakweiken watershed, the peripheral, tributary, and

back channel environments play an important role in providing a rearing environment for coho, steelhead and resident trout fry through periods of torrent flow in the main channel (Bustard, 1973).

Since dense populations of pink salmon frequent the Kakweiken watershed, the importance of the estuary as a rearing environment must be emphasized. After gravel emergence, pink and chum fry emigrate to the estuary to rear and, accordingly, feed on associated organisms for a period of 6 months to 1 year (McDonald, 1960; Parker, 1970). Giving consideration to the high densities of rearing salmonids and limited area of existing estuarine environment, the maintenance of a high level of water and substrate quality is essential.

Distribution of Spawning Gravels

About 30 percent of the mainstream Kakweiken below the East Fork contains suitable spawning gravels (See Fig. 1). Other areas were considered unsuitable because of either

- a) excessively large bed material or
- b) excessively compacted bed material

The latter condition is, of course, related to the restriction of pink salmon access by the falls. It is possible that much of this gravel will be brought into a productive condition through salmon spawning activity when the fishway is completed. (Wickett, 1958).

Gravels above the East Fork tributary are of higher quality, being smaller in size and somewhat cleaner, particularly between Kakweiken Lake and the East Fork junction. This is to be expected from the effect of the lake on flow regime and suspended sediment transport.

Gravels above Kakweiken Lake were inspected at only two points, but appear suitable for spawning in an estimated 50% of the river's length.

Tributaries to the Kakweiken are limited with respect to extent of satisfactory spawning gravels but do support coho, steelhead, and trout.

The East Fork tributary likewise contains intermittent spawning areas, which may be limited to steelhead and trout utilization above the falls at about 3/4 miles from the junction.

Composition of Spawning Gravels

Gravel samples from the main stem of the Kakweiken just above the East Fork tributary typify good spawning gravel for the Kakweiken system, and represent a "cleanest" state. Fines less than 2.4 mm. and 1.2 mm. are 16.6 and 9.0 per cent by weight respectively of total material. Associated sub-gravel dissolved oxygen levels were similarly high (mean of 10 ppm).

Good gravel sites are distributed intermittently through the system. Increased porosity and consequent increased sub gravel flow velocities will cause these areas to trap fine material which enters the gravel to a greater extent than compacted areas. They will, consequently, act as "sinks" to excessive suspended sediment loads, particularly during periods of low flow. There is no evidence to suggest that areas which have been compacted will be cleaned by subsequent freshets in the Kakweiken system.

It is therefore important not to substantially change the natural seasonal distribution of suspended material.

Rearing Environment - Streambank Conditions

The mainstream Kakweiken between the estuary and the East Fork is characterized by a high proportion (est. 75%) of silt and clay banks, particularly on the outside of meander curves. These banks are anchored by the roots of deciduous and coniferous trees, and associated minor vegetation.

Evidence of active erosion indicates a high potential for excessive sediment production, if subjected to mechanical disturbance by floating debris or logging practices.

Above the east fork, the Kakweiken and its tributary are carved out of a variety of sands and gravels, although banks of fine material are occasionally present. Alder borders most of these tributary channels.

The main stem Kakweiken above Kakweiken Lake is particularly well suited to rearing salmonids, containing an abundance of *what the hell is a back channel?* back channels, low gradient reaches of tributaries and swamp. The integrity of these many bank environments is intimately linked to the maintenance of an undisturbed vegetative-soil interface. In view of the high seasonal runoff volumes and concomitant requirements for protected rearing refuges, it is estimated that any reduction in this rearing territory will proportionately reduce coho, steelhead, and trout populations.

Watershed Stability

The Kakweiken River watershed is a very high energy environment. Slope gradients are high over 5000 feet of relief. High snow accumulations produce frequent avalanching, evidenced on valley side walls and in alluvial deposits. Rain events and spring melt produce peak flows capable of floating whole trees out to sea.

Soils are thin on valley side walls, deepening in alluvial fans, and deepest in valley bottoms. Not surprisingly, the highest forest values are coincident with the most erodible soils, located in the valley flood plain.

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H2O flow of grass

The transition from mixed alluvial sediments in the valley bottom to steep bare rock on the side walls is indicative of the geomorphic youth of the system, and suggests that the vegetative component may be dominantly responsible for present system stability.

Much of the valley bottom is poorly drained, having typical wet side vegetation, frequent back water channels, and braided tributary systems. Open water and swampy ground is common across the entire width of valley bottom in most areas except the middle reach of the East Fork tributary and the extreme upper reach of the main stem Kakweiken. See, for example, Figure 2 on which back channels have been outlined from aerial photos.

Deposited material within the forest adjacent to tributary channels in the valley bottom indicates periodic flooding. Hence it seems crucial that organic cover over soil remain undisturbed in this environment during timber extraction.

On steep valley walls, tributary and/or avalanche track density is very high, and timber distribution seems to be closely related to protection from avalanches. It is probable that much of the present valley side wall timber, particularly on alluvial fans, may be serving a protective function with respect to snow stabilization.

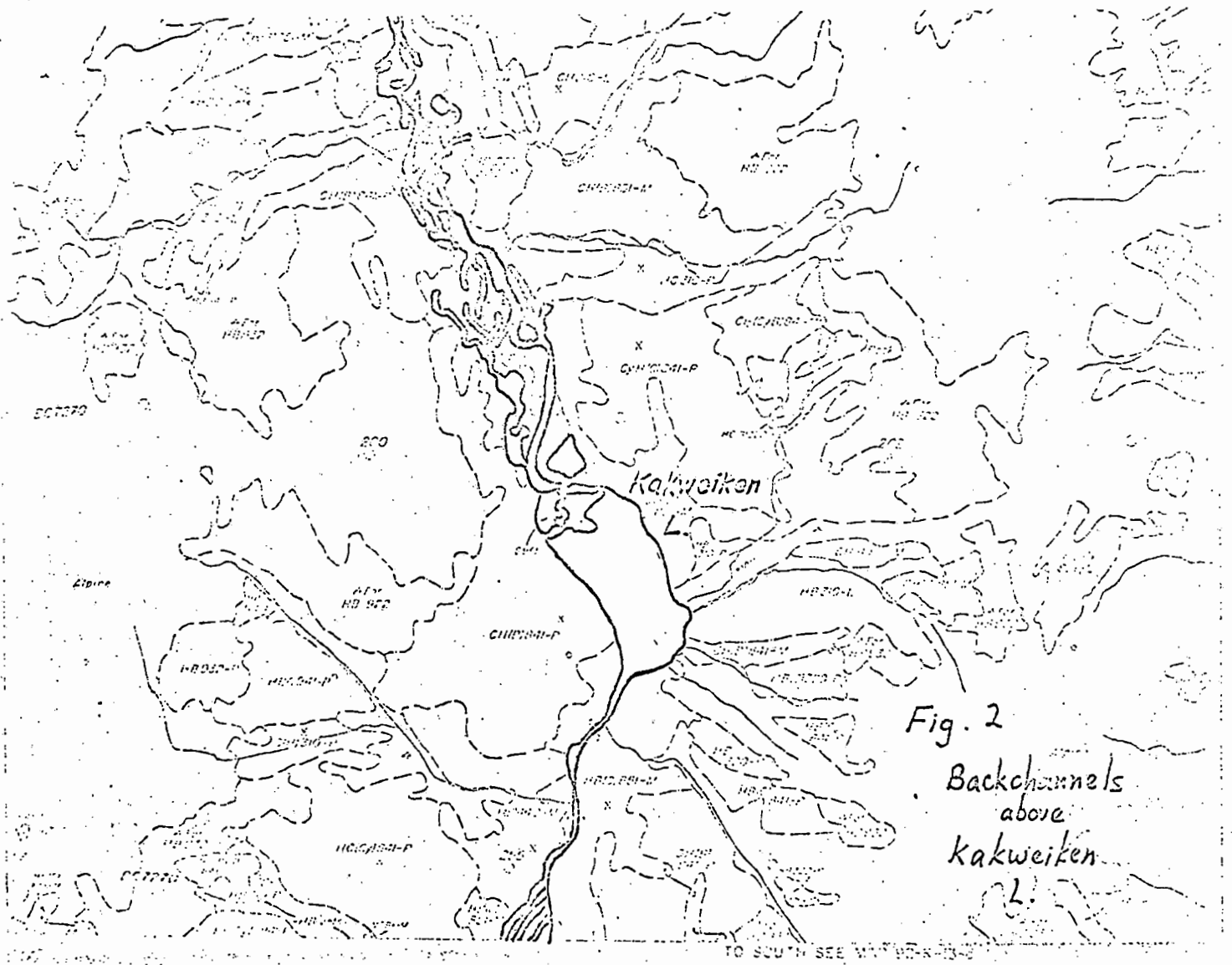


Fig. 2
Backchannels
above
Kakweiken
L.

Figure 2. Backchannel distribution above Kakweiken Lake as plotted from aerial photographs. Channel limits extend to edge of valley bottom.

Some ~~blowdown~~ ^{wind throws} and small slides are common along the base of valley side walls; it seems probable that tree roots are a major stabilizing factor on these 45 degree slopes. Soil depths are generally thin, however, and bedrock ledges common, so that the possibility of massive debris slides is restricted to alluvial fans and areas of colluvial accumulation. This possibility is of immediate concern to fisheries values where steep slopes lead directly into a river, as is the case in several reaches of the East Fork and in the main stem immediately below Kakweiken Lake. In these locations, streamside leave blocks of mature timber may be warranted as a slope stabilization device until such time as they may be economically removed by a selection technique.

Root and trunk form on many of the steeper slopes suggests that active soil creep exists. This may be related to the frequent saturated soil water condition inferred for these slopes, and is an indicator of marginal stability conditions.

Recommendations

The following recommendations fall into two main areas, roads and openings. Recommendations are developed with respect to features particularly characteristic of the Kakweiken system; considerations common to all watersheds (e.g. as developed in the B.C. Forest Service Guidelines for Clearcut Logging) are not listed here.

Roads - Location

Two high hazard land types have been identified in the Kakweiken, snow avalanche zones and debris (soil) avalanche zones. The latter require the concurrence of steep slopes, deep soils and high soil water levels and hence are restricted to basal slope positions. This restricted location may be avoided entirely in most cases.

Snow avalanche tracks, on the other hand, must be frequently crossed by access roads and suggest two recurrent problems with respect to water quality.

1. Road destruction, by snow avalanche, will probably take place. Short of building avalanche sheds over the road it is not likely that this problem can be avoided.
2. Debris accumulation and blockage of culverts and channels with subsequent flow diversion and erosion is likely to be a recurrent problem in snow avalanche areas. This problem can only be countered by ensuring that debris is not permitted to accumulate in channels or avalanche tracks.

A third road location consideration follows from the observation of recurrent bank-overtopping signs in the valley flood plains. Road design must provide drainage during these extreme events when the location of standing water may be quite different than

at moderate or low flows. Since such events may take place when maintenance is not possible, open log culverts are to be preferred.

Roads - Construction

In addition to the principles and procedures expressed in the B.C.F.S. Guidelines for clearcut logging, several aspects of construction in the Kakweiken drainage should be considered.

1. In the valley bottoms, the dense network of stream tributaries and backchannels will require appropriate culverting and/or log bridging to maintain fish passage at all flow levels. In all cases bridges will be preferred over culverts.
2. When crossing steeper tributaries on valley side walls, log bridges should be used instead of culverts wherever a high possibility exists of spring washouts. This will particularly apply where debris accumulation is a potential problem. Log bridges should be designed to pass extreme anticipated high water.
3. The possibility of tributary blockage must be accepted, if roads are to be constructed. To avoid water quality problems, crossing approaches should be sloped into the tributary from both sides for a short distance, to prevent

the diversion of tributaries down roads if culverts are blocked.

4. It is suggested that road construction not take place when soils are at a high water content. "High" in this context means a condition enabling mud flows or mass movements to take place in side cast or worked material. Such condition will probably be confined to the time period following fall rains until snow melt has receded to about 500 feet above the road in question.

Roads - Maintenance

In addition to normal road maintenance procedures (as detailed in B.C.F.S. Guidelines) two additional procedures should be considered for the Kakweiken watershed:

1. An intensive fall inspection of drainage facilities should be made in preparation for spring runoff. Consideration should be given to the removal of culverts at crossings where washout is probable during the spring melt period.
2. Seeding to grass should be utilized on fill slopes below valley side wall slopes where extensive mineral soil is exposed. This should be carried out immediately after subgrade construction.

Openings

Opening locations, as indicated on the Kakweiken development plan, usually extend to streams, lakes and swamp boundaries. The intensive utilization by fish of these water bodies has been indicated.

Where near stream soils are reasonably well-drained, falling of mature conifers only to the streambank may be acceptable. Areas of swamp, high groundwater, and dense tributaries, however, will probably require the retention of existing forest cover unless it can be demonstrated that extraction will not significantly damage the rearing environment, nor result in permanent debris accumulations in these channels.

These stipulations apply particularly to most of the main stem Kakweiken, and especially to the reach above the East Fork tributary. Some reaches of the North Fork of this tributary also fall into this category.

A carefully dispersed layout, together with high road building standards should enable most areas below Kakweiken Lake to be successfully harvested. In view of the limited volume of timber above Kakweiken Lake, its location with respect to a highly productive and sensitive aquatic system and the extreme hazard already indicated by natural snow and debris avalanches, we recommend that its development be deferred until either:

- a) a more comprehensive study of the costs and values indicate that development is feasible, or
- b) forest values permit the economic extraction of timber by methods which will not adversely influence the rearing environment which has been described.

Conclusions

1. The Kakweiken watershed supports a very high value fish population, and has the potential for supporting more.
2. The system is geomorphically young, of very high energy, and is in delicate and dynamic balance with respect to the river system and the aquatic population which it supports.
3. Tributaries and backwater channels represent critical areas for rearing salmon and salmonid populations, and are coincident with much high value timber. Extreme care will be required in the harvesting of this timber, and some sites may require the deferment of harvesting.
4. Most areas below Kakweiken Lake can be harvested without permanent damage to the aquatic system if appropriate precautions are taken. Problems, in the order of their probable importance are:
 - a) Debris accumulations limiting access to or modifying rearing environments.
 - b) Sediment production, particularly in connection with road construction and logging operations during high soil moisture conditions.
 - c) Alteration of food chains through harvesting in riparian zones if deciduous cover is not maintained.

It is not anticipated that flow modifications or water temperature changes will be a serious problem, since from plans submitted, less than 2% of the watershed will be harvested in any one year.

5. The watershed above Kakweiken Lake should be deferred from development until substantial additional resource inventory and analysis work is carried out.

Reference cited:

Bustard, D. 1973. The overwintering habitat of rearing Coho salmon and steelhead trout. Msc. Thesis in progress. U.B.C. Faculty of Forestry.

Chapman, J.D. and D.B. Turner (eds), 1956. B.C. Atlas of Resources. B.C. Natural Resources Conf. 1956.

Department of Fisheries, 1969. An Assessment of the Kakweiken River Falls as an Obstruction to Salmon Migration. Resource Development Branch, Vancouver, B.C. Unpub. Manuscript 15 pp.

McDonald, J. 1960. The behavior of Pacific salmon fry during their downstream migration to freshwater land saltwater nursing areas. Jour. Fish, Res. Board, Canada 17 (5): 655-676.

Parker, R.R. 1970. Observations on the 1964 brood year of Bella Coola pink salmon as juveniles in Burke Channel and Seward Channels in 1965. Manuscript Report Series No. 1074, Biological Station, Nanaimo, B.C.

Province of B.C. 1971. Climate of British Columbia. Province of British Columbia, Department of Agriculture.

Wickett, W.P. 1958. Review of certain environmental factors affecting the production of pink and chum salmon. Jour. Fish Res. Bd., Canada, 15:1103-1126.

APPENDIX 1

KAKWEIKEN LOG DUMP AND BOOMING LOCATION

On February 22nd, 1972, the Kakweiken River watershed and estuary were inspected by P. Slaney and T. Chamberlin, accompanied by Weldwood representative Ken Smith (Chief Forester) and Lyall Long (Camp Superintendent). The following delineates our comments regarding the proposed log dump-sorting location.

The present dump site area was leased February 2, 1963, for a period of 21 years (Rayonier Ltd.). To date the Provincial Lands Branch has not received application for lease of the proposed site.

According to Mr. Long, the existing dump area has the following disadvantages:

1. It is subject to prevailing winds from the south-west.
2. It is subject to a tidal surge which tends to move more rapidly along the east side of the sound, thus interfering with daily log sorting activity.

Other objections to expansion and continued use of the existing dump site are:

1. A fuel storage area is planned for the onshore area above the existing dump site.
2. Truck traffic through the townsite would be unacceptable.

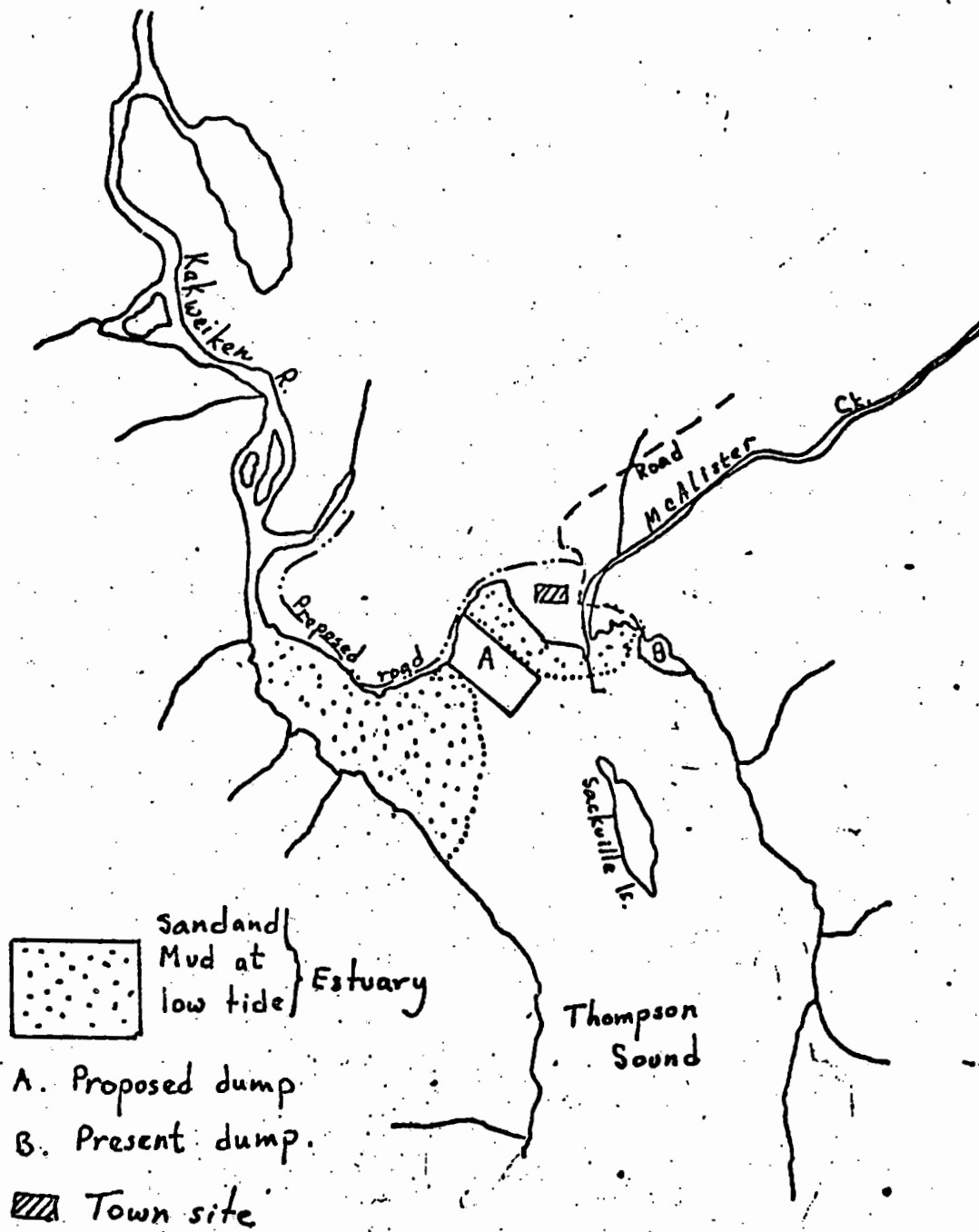


Diagram of the Kakweiken River estuary showing existing and proposed dumps, town site, and roads. Boom storage will be along both sides of Sackville Island.

The proposed dump and booming ground area, according to Mr. Long, will be approximately 650 x 650 feet in size, thereby fully occupying the inter-estuary water. Dumping will be via the cable hoist rather than via the direct vertical drop method and logs will be poked-sorted within the area. Temporary storage of sorted and bundled logs will be on both sides of the nearby island. It is anticipated by Mr. Long that the dump site will not require any dredging in the next twenty years. He further anticipated that the new location will not be significantly influenced by wind and tidal problems of the existing site.

The Kakweiken River is utilized by pink, chum, sockeye, chinook, and coho salmon. Unknown numbers of steelhead trout also spawn and rear within the stream system. Presently, escapements of pink salmon are as large as 135,000, averaging about 50,000. Fisheries development projects when completed may increase escapements to .5 million. Pink salmon fry are thought to utilize the estuary environment for approximately three weeks prior to migrating to deeper water. Lesser numbers of chinook and possibly coho fry and smolts are also considered to utilize the estuarian areas.

No herring are known to utilize the estuary for spawning. However, a crab fishery operates adjacent to it, particularly in the proposed booming site. In addition the area is productive in clam populations.

Accordingly, the proposed dump site location is considered to present a high potential for significant damage to the fishery resource since:

1. It is the only large shallow area that is subtidal and thereby probably utilized by young salmonids, especially pink fry. Intensive booming and sorting activity will probably cause avoidance reactions by some salmon.
2. The crab and clam habitat will be completely eliminated by debris accumulation.
3. Although a "soft dump" method may reduce bark loss by two thirds (Schaumburg, 1970), extensive sorting and bundling operations will cause further bark loss. Utilizing Schaumburg's estimated average 500 lbs. of bark for western conifers and assuming a minimum 10% bark loss at the dump-booming area for Kakweiken conifers, 50 lbs. of bark debris will be lost per M board feet of timber. In harvesting an anticipated 360×10^6 bd ft (17 years of harvest) and assuming a 70% sinkage of bark, an estimated 6300 tons dry weight will accumulate. An additional undetermined accumulation will occur owing to hemlock 'sinkers'.
4. Dispersal of such debris across the estuary should be slight, since the depth regime and location indicates limited flushing of the area.

5. Debris accumulations present a high BOD so that reduced DO above the water-debris interface (especially at higher water temperatures) can be anticipated. This oxygen reduction would not be significant if the area adequately flushes.
6. Tannin and lignin leachates will colour the water thus greatly reducing primary and accordingly secondary production. Although concentrations lethal to fish would not be reached, lethal concentrations for algae and possibly zooplankton are probable. Most log dumping and booming areas in the Johnstone Strait have this deep brown colour.
7. Presence of log booms will further reduce primary production by physically blocking light penetration.

It is thereby considered that the present dump site should be retained for Kakweiken logging purposes. The existing site is presently despoiled with debris, and relocation of the site would only increase the area degraded. Besides, the existing location, owing to its much greater depths and flushing action, presents little damage potential to the fishery resource. Also, it is not considered that the prevailing wind will be significantly less of a problem in the new site, although it is acknowledged that the tidal surge may cause daily, but intermittent difficulty in log sorting. Further, depths of 30 to 40 fathoms, in the existing site, are not excessive for boom stick anchors.

Since neither the camp nor fuel storage developments have been approved by the B.C. Forest Service, there should be no problem in adjusting plans accordingly (i.e. shifting the proposed camp and fuel storage locations further west).

No objection is raised to the utilization of the offshore island for log boom storage.

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