Conserving Kispiox Fish Populations and their Habitat

Kispiox Watershed Fish Sustainability Plan

Stage II Briefing Backgrounder

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Kispiox Watershed Fish Sustainability Plan

Preamble

This backgrounder is designed for the use of the Kispiox Watershed-based Fish Sustainability Plan (KWFSP) planning table. It briefly describes the origin, purpose, and benefits of Watershed-based Fish Sustainability Planning (WFSP), a four-stage planning sequence that governments, organizations, and individuals with an interest in fish conservation can use now to effectively promote the long-term health of fish and fish habitat and provides background information on the biophysical characteristics of the Kispiox Watershed and its fish populations.

In 1997, the federal and provincial governments signed the Canada-British Columbia Agreement on the Management of Pacific Salmon Fishery Issues. The agreement included a commitment to "work jointly in watershed fish production, planning, and processes". The purpose of this agreement was to create a partnership for conserving and managing west coast salmon populations and their habitat. As a result of this agreement, the Watershed-based Fish Sustainability Planning process was developed. This four-stage process is intended to involve communities and stakeholders through the development of a fish sustainability plan for prioritized watersheds.

Stage I for the Skeena Watershed was completed in 2002 and is presented in the report "Conserving Skeena Fish Populations and Their Habitat" (Gottesfeld *et al,* 2002). This report provides a biophysical profile of the Skeena Basin as well as an assessment of eleven tributary sub-basins. The watershed overview describes environmental issues, cumulative effects, anthropogenic factors, Skeena fish and community values, and a ranking of productive sub-basins. The Kispiox, Lakelse, and Morice Watersheds were identified as priority Stage II candidates.

Skeena WFSP Process

The WFSP process focuses on sustainability. The intention is to sponsor projects that create or maintain aquatic environments and fish populations that can carry on by themselves. In most cases it is simpler to prevent damage to fish populations and habitats in the first place than it is to restore them once damage has occurred. For this reason, WFSP places a strong emphasis on the protection of fish, fish habitat, and natural ecosystem processes. It promotes restoration of priority fish populations and/or habitat that have been adversely affected by past activities. It promotes enhancement only to supplement these other approaches (BC Ministry of Environment Lands and Parks, and Fisheries and Oceans Canada. 2001).

The WFSP takes a "fish first" approach. WFSP places a stronger emphasis on the needs of fish than on other interests. This means that management efforts will be directed to sites that have important fish populations and valuable fish habitat.

Planning takes place in the natural landscape units – watersheds. Streams carry water and sediments downstream and affect downstream natural processes. Protection of riverine fish resources requires concern for activities upstream and upslope. Similarly, the continuation or maintenance of First Nations, commercial, and sports fishing opportunities requires conservation of upstream water quality in spawning and rearing areas.

The Skeena WFSP is based on the standard WFSP four-stage planning sequence.

- Stage I – Produces a biophysical and sociopolitical profile of a region and identifies watersheds within the region that are the highest priorities for further planning.
- Stage II – Produces a biophysical and sociopolitical profile of each of the priority watershed planning units identified in Stage I and identifies objectives, strategies, and targets that must be met to achieve fish sustainability within these watersheds.
- Stage III – Produces a detailed fish sustainability action plan that spells out how these objectives, strategies, and targets will be met and by whom.
- Stage IV – Implements and monitors the plan effectiveness.

Stage I of this planning sequence addressed and identified priority sub-basins at the Skeena Watershed level. Stages II to IV address priorities within smaller tributary watersheds. governments, First Nations, fish conservation and stewardship groups can use this planning sequence to identify those fish populations and habitats that most urgently require attention, and particularly those that are most likely to benefit from such attention.

Kispiox WFS Plan

Stage II lays the foundation for the development of detailed WFSP action plans to maintain or restore the productive capacity of the Kispiox Watershed. Parties with an interest in the Kispiox Watershed Plan:

- develop a working protocol or terms of reference that describes the responsibilities of the planning team,
- develop a strategic overview of local values,
- establish the overall direction for management,
- establish specific management targets, objectives, and strategies,
- bring the resulting plan to the Skeena Watershed Steering Committee for review and approval.

Social, political, and economic factors influence the status of fish and habitat in the Kispiox Watershed. For example, they may influence the rate of agricultural development or forest harvesting, resulting in riparian, in-stream, or associated effects within the watershed. These factors can also affect the location, timing, and focus of fish sustainability planning. There is likely to be a high interest in rehabilitating fish populations or habitat with high social, cultural, or economic values.

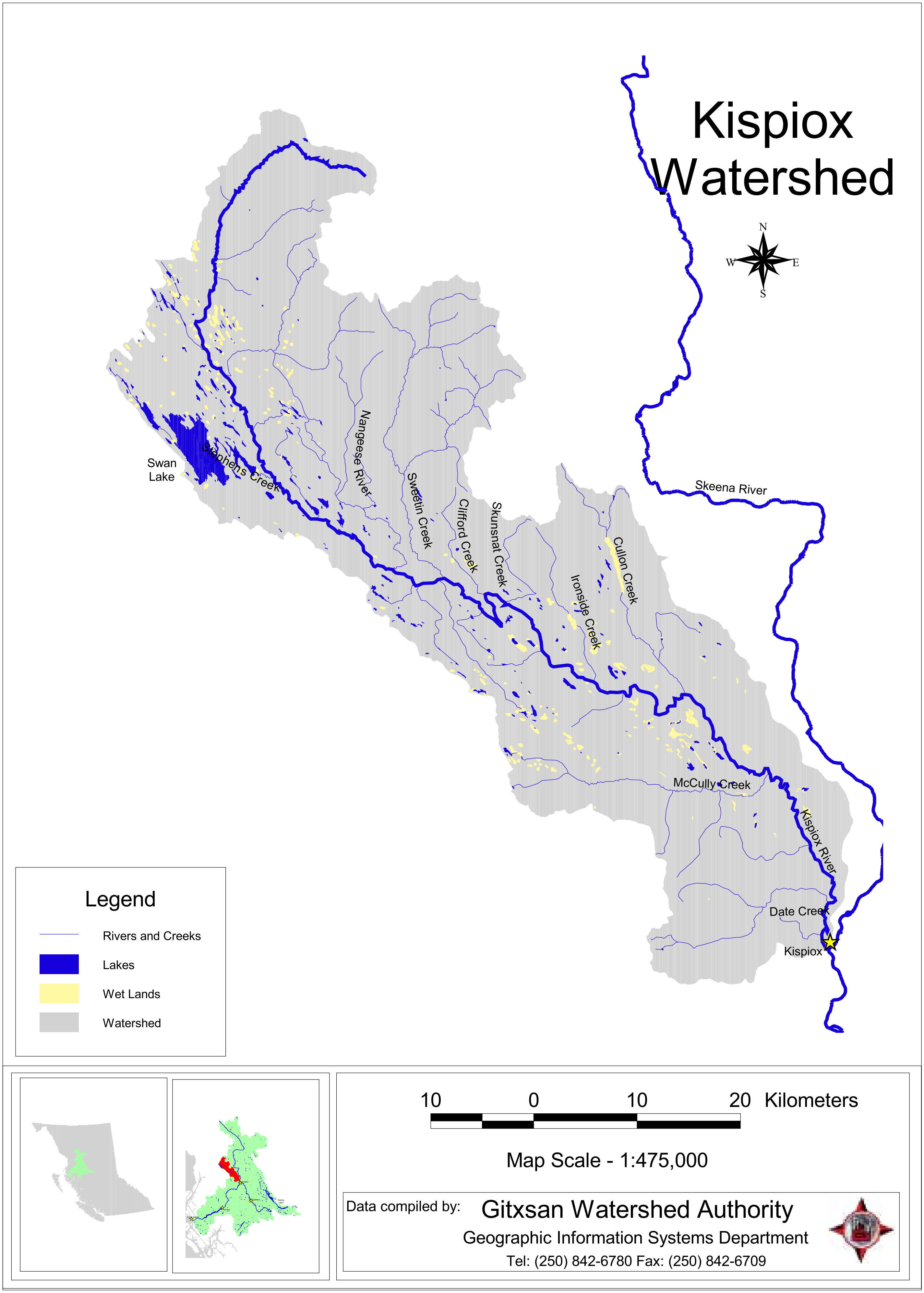
Within Kispiox Watershed, there are currently other land use plans or planning processes that are inclusive or semi-inclusive of fish and fish habitat. Current plans being implemented include the Kispiox Land and Resource Management Plan (LRMP), the Kispiox Zoning Bylaw No. 53, and the Management Direction Statement applied to Swan Lake Kispiox River Park.

The Kispiox Land and Resource Management Plan was initiated and led by the Ministry of Forests and implemented in 1996, with the Upper Kispiox land use recommendations added in 1999. This sub-regional land use plan is biased towards timber development, but includes other objectives involving water, fisheries, and riparian areas. All recommendations are general and open to varying interpretation at the site-specific and watershed levels. This situation is further exasperated by inter-agency disputes, and the lack of commitment by government agencies and planners to fund programs such as the Watershed Restoration Program (WRP) or to monitor the effectiveness of the plan. Fish definitely do not come first.

The Kispiox Zoning Bylaw No. 53 applies to land use on fee simple land that, for the most part, lies south of Elizabeth Lake. This bylaw provides regulations under current community needs and land development pressures on approximately 5% of the watershed land base.

The Management Direction Statement for Swan Lake Kispiox River Park identifies key management issues and proposed strategies to be completed as funding and agency priorities permit. Objectives and strategies involve: conservation, cultural heritage values, recreation and access.

A new generation of forest planning is underway. Proposed planning for the watershed consists of three different levels: Sustainable Resource Management Plans (SRMP), Sustainable Forest Management Plans (SFMP), and Forest Stewardship Plans (FSP). SRMPs are the consolidated approach by the Ministry of Sustainable Resource Management to planning on provincial Crown lands at the landscape level. SFMPs are an output from the Land Base Investment Program, which is a component of the Forest Investment Account. These plans are expected to select, plan for, and execute cost-effective activities related to forest productivity, resource information, and sustainable utilization. SFMPs are forest licensee driven and funded according to an allocation formula based on the volume harvested during the previous three years. Forest Stewardship Plans are expected to describe licensee forest development activities within the framework directions stated in higher-level plans such as SRMPs and LRMPs.


Kispiox Watershed
N
W
E
S
Skeena River
Swan Lake
Stephens Creek
Nangeese River
Sweetin Creek
Clifford Creek
Skunsnat Creek
Cullon Creek
Ironside Creek
McCully Creek
Kispiox River
Date Creek
Kispiox
Legend
Rivers and Creeks
Lakes
Wet Lands
Watershed
10 0 10 20 Kilometers
Map Scale - 1:475,000
Data compiled by:
Gitxsan Watershed Authority
Geographic Information Systems Department
Tel: (250) 842-6780 Fax: (250) 842-6709

Kispiox Watershed Environmental Setting

Location

The Kispiox River is a large tributary of the Skeena River. It flows 140 km southeast from its headwaters to the confluence with the Skeena River (right bank) at Kispiox Village, approximately 12 km north of Hazelton. The watershed is bounded in the north and the east by the Southern Skeena Mountains, to the south, predominantly by the Kispiox Range, and to the west, by the low relief Nass Basin.

Hydrology

The Kispiox is a fifth order stream with a catchment area of 2,088 km^2. Elevation ranges from approximately 200 m at the mouth to 1,750 m on Moonlit Mountain and to 1,950 m in the Skeena Mountains. The Kispiox River contributes about 9% of the Skeena River flows (Remington 1996). The Skeena Mountains, to the north, and the Nass Basin, which broaches the northwest and western perimeter of the watershed, exert the major hydrological influences. The Kispiox Valley presents a low gradient valley bottom, but the watershed as a whole has a moderately high response from water input due to the topography of the Skeena Mountains drained by the upper Kispiox River and its major tributaries. The low elevation watershed divide to the Nass drainage in the west, allows coastal weather systems to enter the watershed, leading to heavy snow packs in the mountains and the upper half of the drainage.

Kispiox River peak discharges typically occur in May and June due to spring snowmelt, then decrease through July and August. In September, fall rain and run off from early snow melt once again increases stream flows through to October. Stream flows decrease through November and December when precipitation falls as snow, with low discharges recorded January through March. The Hydrometric Station (08EB004), located downstream from the McCully Creek confluence, recorded a monthly mean discharge of 128 m^3/s for June, while low flows in February average 7.8 m^3/s over a thirty-year observation (1963-1993). Summer low flows are typically 4 to 8 times greater than winter stream flows and are principally sustained by high elevation snowmelt draining from the Skeena Mountains, while winter low flows are derived from groundwater, lakes and unfrozen wetlands (Wilford 1985).

Climatic information from the Murder Creek weather station (AES 1993), located in the lower Kispiox at an elevation of 244 m, shows mean annual precipitation of 631 mm, of which, rainfall accounts for 71%. Total annual precipitation (TAP) is greater in the upper watershed, particularly at higher elevations. This is shown with the 1500 mm TAP recorded at Swan Lake, situated at 525m (Stockner and Shortreed 1979).

Tributaries to the upper Kispiox from the northeast, principally the East Kispiox River, Sweetin River, and to a lesser extent the Nangeese River, drain glacial headwaters and transport moderate amounts of sediment from natural sources. These mountainous headwaters receive sufficient winter snowpack to maintain summer season base flows that are generally glacially turbid and unstable. The wide variations in water flows in the Kispiox mainstem is primarily attributed to these mountainous areas.

The Kispiox Range to the southwest is principally drained by Date and McCully Creeks, which both transport relatively large amounts of bedload and suspended sediment originating from natural sources and have active alluvial fans at their confluences with the Kispiox River (Weiland 2000a). North of the Kispiox Range, a myriad of various-size lakes and wetlands mostly originating from ice-related erosion, provide a moderate amount of water storage capacity. This results in relatively stable stream flows and notably moderated water temperatures. The two largest lakes, Swan and Stephens Lakes, are located close to the Nass drainage divide in the upper watershed. These two lakes had studies conducted under the auspices of the DFO to investigate limnological characteristics and trophic status. The results are summarized in Stockner and Shortreed (1979) and Shortreed *et al,* (1998).

South of Nangeese River there are several low elevation lakes and many minor lakes that contribute to water storage. Major lakes on the east side include Elizabeth Lake, Kline Lake, and Sammon Lake. Major lakes on the west side include Mitten Lake, Helen Lake, Pentz Lake, Affleck Lake, Bras Lake, and Sunday Lake. Local climate conditions determine the hydrology of the small, valley-initiated drainages and streams of the lower Kispiox valley. Climatic characteristics such as amount of snowfall, seasonal distribution of rainfall, soil type and topography are the primary factors influencing these systems.

Water retention or residence time for lakes and wetlands in the Kispiox system varies considerably due to water inputs as well as surface size and depth. Climate change could lead to potential changes as seasonal amounts and timing of precipitation in the drainage differ. Presently, a lack of base weather and stream flow data does not allow a clear historical benchmark that could be useful in relation to the potential enormous web of consequences stemming from climate change.

Figure 2. Elizabeth Lake in the central portion of the Kispiox Watershed.

Water Quality

Water connects land, air, plants, and animals while flowing throughout the varied ecosystems in the watershed. Water appears as rivers, streams, lakes, ponds, wetlands, as well as underground storage. Forests, water, fisheries, wildlife, and humans are linked together by the hydrologic cycle. Water quality is defined as the natural physical, chemical, and biological characteristics of water. Water quality criteria are policy guidelines concerning the acceptable range of conditions, usually safe levels for a given water use for particular kinds or classes of water use. Setting water quality objectives involve taking the set of criteria and adapting them to a specific body of water.

For example, water quality objectives or guidelines are applied to drinking water, fish and aquatic life, agricultural and mining activities, or forest development. Province wide ambient water quality criteria include pH, substances that degrade water quality such as nutrients, algae, and particulate matter, low level toxic substances and high level toxic substances such as cyanide, PCBs, and metals respectively, and microbiological indicators of risks to humans (fecal coliforms, *Giardia*). Other common criteria include dissolved oxygen, total suspended solids, water stage, and biochemical oxygen demand (BOD).

Figure 3. Wetlands and pond, headwaters of Cullon Creek.

Critical to the review and understanding of water quality is long-term data, which are essential to detect changes or trends in water quality. There are no long-term monitoring stations within the watershed, even though forest resource extraction has been intense.

Community watersheds are located on Dale and Quinmas Creeks, supplying domestic water for Kispiox Village. Licensed water withdrawals within the Kispiox Watershed are mainly from small tributaries presenting minor impacts on instream flows for fisheries. The effects of logging and the rate of cut on increased peak flows in the Kispiox River have been a persistent issue raised by the public. Loedel and Beaudry (1993) noted that their investigation of interception and throughfall water at Date Creek was initiated by concerns from waters licensees, native peoples, and others that clearcutting may increase peak flows; decrease low flows, and/or alter the timing of these flows. Keeping logging debris out of small creeks, particularly in winter logged areas, was reported to be a major difficulty (Remington 1996).

Water quality monitoring between 1982 and 1987 concluded that Kispiox River is a soft water river, with neutral to slightly alkaline pH and clear, slightly tea coloured waters for most of the year due to natural organic substances contributed by swamps and wetlands in the drainage. Total suspended solid loadings are much higher during freshets than the remainder of the year. Nutrient concentrations are low (Wilkes and Lloyd 1990).

The Kispiox WRP Overview (Jyrkkanen *et al.* 1995) concluded that erosion, obstructions, sedimentation, gravel aggradation, and altered water yield are the primary sources of impacts to the aquatic resources of the Kispiox Watershed. Concerns about turbidity and poor water quality from tributaries and the impact on sports fishing were also noted. Nortec (1997) conducted a stream and fish habitat assessment in 1997 and reported that water quality was impacted from forest development activities.

Weiland (2000a, 2000b, 2002) conducted reconnaissance sediment source mapping surveys, which identified natural sources and activity in the watershed. These surveys provided more detailed information related to sediment source areas for the on-going Watershed Assessment Procedure (Hudson 2002). In summary, the sediment source surveys concluded that in comparison with natural sediment sources, the sediment contribution to the Kispiox River and its main tributaries from roads and forestry is low in the Sweetin, East Kispiox, upper Kispiox drainages, and as well, in the Date and McCully drainages. In sub-basins with low natural sediment loading and a low sediment hazard, chronic or discrete sedimentation from roads can have a relatively high impact on water quality and channel integrity (Weilland 2002). These sub-basins include Murder, Cullon, Corral, Clifford, Ironside, Brown Paint, and Skunsnat.

Figure 4. Landslides are a major source of fine and coarse sediment in the Kispiox Watershed. This slump at the edge of a cutblock adds sediment directly to the Sweetin river (Photo from Nortec 1997).

Aquatic integrity monitoring of selected streams in the Kispiox Watershed has been on-going since 1997 (Dykens and Rysavy 1998), utilizing benthic indexes of biological integrity (B-IBI) to monitor, calibrate, and to implement a strategy for B-IBI based monitoring (Biologic Consulting 2000, Bennett and Hewgill 2002). These studies sampled eighteen streams that varied from lightly influenced to heavily degraded by human activity within or adjacent to the watershed.

Since 1995, water quality data has been collected as a component of GWA stock assessments and habitat studies, particularly on small streams that are typically used by coho and steelhead spawners and juveniles (GWA unpublished data 1995-2003, Gottesfeld 2001). Basic records of water stage, dissolved oxygen, and temperature help provide information that permits an evaluation of stewardship activities against the backdrop of changing environmental and climatic conditions.

Stream Channels

From the Skeena River upstream to Sweetin River, the Kispiox River is divided into three distinct reaches and the channel presents a regular profile, with a gradient of 0.3 % slope or less (MoE 1979). These lower three reaches are composed of a mix of pools, riffles and runs, which offers holding, rearing and spawning habitat. Bedrock outcrops are infrequent and bank erosion is common. Minor amounts of sediment are received from most tributaries other than Date Creek and McCully Creek, which contribute comparatively large amounts of natural sediment. Low summer flows may compromise off-channel habitat rearing capacity.

Reach Four, from Sweetin River upstream to Gitangwalk Canyon, is frequently confined by bedrock, which becomes more evident in reach five that starts at the bottom end of Gitangwalk Canyon. Gitangwalk Canyon, defined as Reach Five, is approximately 1 km in length with an average gradient of 0.6%. The lower end of the canyon presents a 200+ m long cascade with two 1-2 meter drops that restrict pink and chum salmon access to the upper reaches of the river. In some years of low water flows, late running sockeye have been unable to ascend these falls and have been observed spawning just below.

Adjacent to this section of the river is the ancient village site of Gitangwalk and the river crossing location of the grease trail (Rabnett *et al.* 2001). Wadley and Gibson (1998) noted that the DFO carried out blasting in the cascade-falls section to facilitate fish passage. Above Gitangwalk Canyon, the river has gravel banks and a lower gradient. Reach 7 and 8 both have average gradients of 0.4%. Another falls, about 3 meters in height, is found past the confluence of the East Kispiox River. Generally, the Kispiox River mainstem channel is stable with few direct impacts known to be caused by development activities. Sediment budget and transport in the mainstem appears to be in an overall steady-state equilibrium.

The Kispiox River channel assessment in 1998 (Nortec 1998), noted that of the ten reaches surveyed, one was considered stable, six reaches were relatively stable, and three reaches were indicating light disturbance. This study suggested that due to the level of disturbance in the surrounding drainages, any major flow event could act as a trigger to set off downstream impacts to the mainstem channel.

Floodplain stability mapping (FSM) of the Kispiox River mainstem and selected tributaries is currently in progress with a preliminary report by Hudson (2001). The direction of the work is to develop a tool to track changes in the floodplain geomorphology of the Kispiox River. Specific floodplain features have been digitized from air photos for the periods from 1950-1975 (period 1) and from 1975 to 1992 (period 2). Maximum bank retreat numbers are greater during period 1, for 10 of the 11 reaches surveyed. Bank retreat is most dramatic in

Reach One for both periods. The active channel area and the active channel width for most of the reaches expanded from period 1 to period 2 (Hudson 2001).

Further analysis of the floodplain stability mapping reported by Hudson (2002) indicates that a widening of the channel and the generation of sediment pulse followed the initial phase of watershed and floodplain development. Subsequent reworking of this sediment, agricultural and forestry development of alluvial floodplain areas, and an increasing trend towards higher magnitude fall rain-on-snow events has resulted in accelerated channel change. The channel impacts are greatest in sediment storing, lower gradient reaches along the lower end of the river. Direct forestry related peak flow effects are obscured by scale effects such as lake and channel storage and groundwater effects. Channels with high natural levels of overbank flooding, lateral migration, and avulsion (for example, Reach 1 of Sweetin River) can be expected to display the greatest degree of instability with future development (Hudson 2002).

Overall, most Kispiox River tributary channels downstream of Hodder Creek have received a degree of impacts ranging from light to high when compared to ambient, natural conditions prior to large-scale industrial logging. These impacted channel effects include sediment deposition at some tributary mouths that has caused concerns for fish passage at low flows, channel avulsions at high flows, and sub-surface flows in several tributaries (Triton 2001). Murder and McCully Creeks have avulsions in their lower reaches due to agricultural clearing of the floodplain and riparian zones, then high stream flows, with downstream sediment deposition contributing to channel instability (Wadley and Gibson 1998).

Weiland (2000b) noted that several tributaries in their lower reaches have very low gradient channels with very low sediment transport capability. Triton (2001) stated that forestry impacts to fish habitat are extensive through the low-gradient reaches of most tributaries due to obstructions to fish passage, logged riparian zones, surface erosion, reduced instream habitat complexity, and degraded habitat quality.

Low-gradient reaches of many tributaries in the watershed contain relatively large numbers of beavers. Nortec (1997) described twelve creeks where channel changes, bank erosion and decreases in riparian suitability for conifers were due to beavers and their dams. Riley and Lemieux (1998) found that beaver activity on Kispiox River tributaries created large areas of habitat that supported high densities of coho fry. They recommended no removal of beaver dams unless it could be demonstrated that beaver activity has resulted in negative effects on coho populations. They suggested that beaver dam removal contravened the DFO's No Net Loss policy.

The Kispiox Forest District has been conducting a Watershed Assessment Procedure (WAP) since 1997. The WAP involves the compilation and analysis of numerous watershed indicators in order to estimate the level of hydrologic impact that has occurred due to forest development. General recommendations include:

1. completing the proposed WRP works (Triton 2001),
2. begin a monitoring program to track road-related sediment sources,
3. continue researching the index of biological integrity (IBI) monitoring,
4. develop "Best Management Practices" for temperature sensitive streams,
5. develop a methodology to recruit sufficient large woody debris and a riparian zone retention strategy,
6. complete the floodplain stability mapping project,
7. mitigate sediment production and hazards from roads construction, deactivation, cut slope erosion, and beaver dam failure floods.

Specific recommendations were developed based on the review of the WAP results, uncompleted WRP works (Triton 2001), and the Kispiox LRMP equivalent clearcut area (ECA) strategy. The ECA strategy states that no more than 22% of the forested land in a watershed will be in a clearcut hydrological condition (Ministry of Forests 2001b). Specific recommendations arising from the review were directed to the 17 sub-basins in the watershed. Seven sub-basins including Brown Paint, Clifford, Corral, Cullon, Deep Canyon, Ironside, and Skunsnat had either priority uncompleted WRP works, or an ECA at or above 22% with no further conventional harvesting recommended. A conservative rate of cut is recommended for Date and McCully sub-basins. Nangeese, Hevenor, Lower Kispiox, and the Sweetin sub-basins were recommended for alternative silviculture systems due to high fisheries values, terrain stability issues, riparian concerns, or peak flow risks.

Geography

Three physiographic units are present in the Kispiox Watershed: the Nass Basin, the southern Skeena Mountains to the north and northeast, and the Kispiox Range. The Nass Basin is an area of low relief, which generally falls below 700m and forms the generally broad valley floor. The southern Skeena Mountains possess substantial glacial fields with rugged peaks that form the headwaters of the major Kispiox River tributaries, which are the Sweetin and East Kispiox Rivers. The Kispiox Mountain Range, which bounds the watershed to the southwest, is largely drained by Date and McCully Creeks. The watershed is approximately 100 km long and averages 20 km wide, and in its broadest sense, is an extension of the trough system trending from Telkwa in the Bulkley Valley northwesterly to Meziaden Lake, reflecting the basin and range topography.

Folded and faulted Bowser Basin marine sediments characterize the underlying bedrock in the Kispiox Watershed, while minor amounts of intrusive granitic stocks appear in the Kispiox Range. The ice that covered and flowed down the Kispiox Valley during the last glacial period strongly glaciated the mountain slopes and the basin, leaving a legacy of drumlin fields, hundreds of small lakes, and a generally linear drainage pattern. The three basic types of surficial materials in the watershed include ground moraines and basal tills, glaciofluvial kames and blankets, and alluvial terraces and floodplains (Kerby 1997).

The deposition of glacial materials in the watershed is extensive. Ground (basal) moraines, till blankets and till veneer, differentiated by the depth of the deposit, are materials laid down directly from melting ice with little or no resorting by water. These glacial materials cover the main and tributary valleys extending up the valley sidewalls with the surface expression generally conforming to the underlying bedrock surface. Bedrock is exposed along deeply incised streams, on steep-sided hillocks, and on high mountain slopes. (Weiland 2000b). Rock colluvium is most often associated with slopes below unstable rock faces.

On the lower elevations of the Kispiox Valley south of Swan Road, alluvial terraces of gravel and sand, often separated by moderately steep scarp faces, dominate the surficial materials. This is primarily due to the river downcutting into outwash materials from the end of the Pleistocene glaciation. On the very lowest elevations, within the current Kispiox River floodplain recent alluvial deposits range from sand and gravels to predominantly silty materials.

The soils of the watershed have been influenced by the sedimentary origins of the parent materials with relatively fast weathering and a higher natural fertility than comparable till from granitic bedrock (Kerby 1997). The forest cover, climatic factors, topography, drainage, and elevation differentiate the six basic soil types found. Soil series identified (Farstad and Laird 1954, RDKS 1991) in the valley bottom primarily include the Moricetown Series, the Kispiox Series, Barrett Series, and the McCully Series. The majority of soils off the higher river terraces north of Elizabeth Lake possess limitations to agriculture.

The coastal/interior transition climate is reflected in the major ecological zones. Vegetation in the wide, gently sloping valley below approximately 750m is part of the Interior Cedar Hemlock (ICH) biogeoclimatic zone, which is dominated by forest stands of hemlock, spruce, subalpine fir and, in the southern half, red cedar. Before industrial logging, the majority of forest stands were mature hemlock and fir. These stands have been replaced with plantations of spruce and pine, with a large portion of the valley bottom replaced by deciduous forests. With increasing elevation, the ICH zone passes into a forest dominated by mature and overmature subalpine fir, represented by the Engelmann spruce-subalpine fir (ESSF) biogeoclimatic zone (Pojar *et al.* 1988). Meidinger and Pojar (1991) comprehensively describe the above ecological zones.

Geology

The geology of the Kispiox Watershed is a product of complex geological events over a very long time. Volcanic and sedimentary rocks of the Triassic Period; sedimentary rocks of the Middle to Late Jurassic Bowser Lake Group; and primarily volcanic rocks from the Late Cretaceous Skeena Group, followed by the Bulkley Intrusives with minor amounts of Early Tertiary Babine Intrusions, underlie the Kispiox Watershed. In geologic time, this era, called the Mesozoic Era, is divided into three main Periods: the oldest rock formations of this era date from the Triassic Period 225-190 million years ago (ma), the Jurassic Period being 190-136 ma, and the Cretaceous Period, 136-65 ma.

About 225 million years ago (ma), off the west coast of the North American continent, a chain of islands, called an island arc system, similar to present day Indonesia existed. These islands originated from volcanic activity caused by plate tectonics. This activity produced great quantities of volcanic flow rocks such as basalt and andesite, as well as ash and mud that flowed into the sea and formed sedimentary deposits of sandstone, siltstone, and shale. This process was continuous during the Jurassic period, greater than 160 ma (Gottesfeld 1985).

At about 157 million years ago, these island arcs were pushed into and accreted with the North American continent forming a shallow sea along the west coast. This resulted in the formation of the Bowser Lake Group of rocks 157-136 ma in the Jurassic Period. Of the majority of rocks in the watershed, approximately 83% are the Bowser Lake Group, which is a series of marine and non-marine sedimentary rocks formed in an island arc environment. Massive and rapid erosion caused volcanic sand and mud, predominantly from the west, to be deposited by turbidity currents throughout the deep oceanic Bowser Lake Basin (Gottesfeld 1985). This deposit of sand and mud centred in the island-rimmed basin primarily formed sedimentary mudstone and greywacke rocks.

At about 136 ma, tectonic uplift caused the area to be pushed up, initiating a mountain building process. The primarily volcanic Skeena Group of rocks formed 136-100 ma is a series of lava flows interspersed with sediments in a shallow sea to a river environment, which included large swampy areas where peat and plant life accumulated to form coal beds. The Skeena Group rocks represent approximately 20% of the rock underlying the watershed.

From 100 to 65 ma, uplifting, volcanic, and plutonic activity created the Bulkley and Babine Intrusives that are chiefly composed of porphyritic rocks with minor amounts of granitic rocks. These intrusions into the sedimentary and volcanic rocks occurred at depth, and provided heat to produce alteration zones of local mineral deposits including metallic ore bodies. These alteration zones are in close proximity and relationship to the three major faults that occur through the watershed.

The broad northwest-southeast trending Kispiox Valley, approximately 100 km long and averaging 20 km wide, resulted from a block fault zone associated with plate tectonics and accreted terranes on the west coast of North America. The down-faulted block fault lines control the break between the valley and the mountains. This form of basin and range topography has resulted in the broad, linear down-faulted Kispiox Valley, being separated by the uplifted mountain blocks, which are the southern Skeena Mountains, the Kispiox Range, and the Babine Range that lies east of the Skeena River.

Numerous faults and contacts prevail with a strong regional pattern at 340^0. The structure is dominated by block faulting, which has controlled the location of the major mountain valley systems, as well as the many rock suites and mineral deposits (Richards 1990). Overall, metamorphism is light, aside from the contact effects near intrusive bodies.

Forests

Other than the mountainous high country, which is dominated by the Kispiox and southern Skeena Mountain Ranges, the majority of Kispiox Watershed is covered with dense, coniferous forests. Considerable deciduous seral stands in the lower valley are due to frequent aboriginal landscape burning over long periods of time. Smaller amounts of non-forested alpine ground are located on the Kispiox Range, while large areas of non-forested alpine areas are present in the upper mainstem, major tributary headwater areas, and the high country areas located in the southern Skeena Mountains.

The coastal/interior transition forests are reflected in the major ecological zones that are due to two predominant climatic gradients: a west to east gradient of increasing continentality, and an elevational gradient of decreasing temperatures and increasing precipitation and snowiness. The forests are characterized by four principal types represented by the two bio-geoclimatic ecosystem classification (BEC) zones: the Engelmann Spruce-Subalpine Fir (ESSF) zone, and the Interior Cedar Hemlock (ICH) zone.

The BEC system groups and classifies similar ecosystems of the terrestrial landscape to form categories of a hierarchical classification system. A terrestrial ecosystem is a result of a complex interaction of vegetation, animals, microorganisms, and the physical environment. While boundaries between ecosystems can be abrupt, ecosystems more often tend to grade slowly from one another (Banner *et al*, 1993). Climate is the most important factor influencing the development of terrestrial ecosystems; however, ecosystems also vary because of differences in topography and soil. Vegetation is an important indicator of ecosystem type because it is readily visible. Changes in vegetation over time - a process called succession - can take multiple pathways.

Vegetation in the wide, gently sloping valley below approximately 750m is typified by the Interior Cedar Hemlock (ICH) biogeoclimatic zone, which is dominated by forest stands of hemlock, spruce, subalpine fir and in the southern half, to a certain extent, with red cedar that appears in localized stands (Banner *et al* 1993). Due to the pervasive aboriginal and natural fire history, lodgepole pine and deciduous seral stands on upland sites are extensive, particularly along stream terraces and on southern aspect slopes. Black cottonwood prevails in floodplain stands, typically mixed with spruce and cedar. Before industrial logging, the majority of forest stands were mature hemlock and fir. These stands have been replaced with plantations of spruce and pine.

The ICH zone passes into forests dominated by mature subalpine fir, represented by the Engelmann spruce-subalpine fir (ESSF) biogeoclimatic zone (Pojar *et al.* 1988). This zone transition occurs with increasing elevation that ranges from 900-1300 m, dependent on local topography and climatic conditions, particularly in the major tributary valleys. The ESSF zone possesses a shorter, cooler, and moister growing season, with continuous forests passing into subalpine parkland at its highest elevations (Banner *et al* 1993). Subalpine fir is the dominant tree species, with lesser amounts of lodgepole pine and white spruce hybrids in drier slope positions or fire-influenced areas.

Black huckleberry, bunchberry and five-leaved bramble are the dominant shrub layer species. Non-forested wetlands occur on many slope positions and show mostly sedges, along with a diversity of herbs. Dry grass meadows are relatively uncommon. Avalanche tracks are common in many ESSF forests in the watershed; vegetation can range from shrubby slide alder to cow parsnip to hellebore. Within the watershed, these coniferous forests typically include a diversity of species with dominant and co-dominant trees varying from stand to stand and slope positions.

Access

The upper Kispiox, including the mainstem and tributaries upstream of the confluence of the Nangeese River, which encompasses a third of the watershed, remains unroaded and contains little forestry development. Most of this area has been designated as the Swan Lake Kispiox River Provincial Park. The park management direction is to ensure that users have a limited impact on the natural ecosystem and respect the conservation focus of the park. Access to this area is by canoe and portage from the Brown Bear lake recreation site or by foot trail (6 km) from the end of the Kispiox Main road. Floatplane and motorboat use is restricted to special circumstances by park regulations. From the Nangeese River downstream, motorized boats are restricted, though the river is floatable with several launch sites easily accessible.

The east side of the river hosts the major road, the approximately 85 km long Kispiox Trail, which heads northwest from Kispiox Village. The road branches twice to accommodate two crossings of the Kispiox River and provides access infrastructure on the west side. Both west side roads, the Helen Lake Forest Service Road (FSR) and Mitten Main FSR, converge 58 km upstream to provide access northwest out of the drainage and into the Nass Watershed. The Kuldo FSR, located at 45.5 km on the Kispiox Trail, swings north providing access to the Upper Skeena and Shedin drainages. There are numerous branch access roads, in various states of deactivation and repair that accommodate forest development within the majority of tributary basins. It is unknown how many kilometres of main and secondary road exist in the watershed.

Fish Values

The Kispiox River Watershed is composed of approximately 100 km of mainstem and 300 km of tributary streams that are considered high value fish spawning and rearing habitat. The watershed is a productive basin yielding abundant salmon runs, however, the fish populations and quality habitat are to sensitive to disturbance and finite. The numerous salmonids utilizing the watershed habitat include: sockeye, coho, pink, chum, chinook, and steelhead salmon, rainbow, cutthroat trout, lake trout Dolly Varden and bull trout char, kokanee, and mountain whitefish. Lamprey and a variety of coarse fish (*Cottidae* and *Cyprinidae*) are also found in the watershed (DFO 1991).

This fish community contributes to the ecology, nutrient regime and structural diversity of the drainage and provides strong cultural, economic and symbolic linkages, particularly for the Gitxsan and to a lesser extent, Gitanyow people, as well as supporting recreational and commercial fisheries. The presence of salmon is a strong part of cultural and community values and identity within the watershed. The very high fishery values are rooted in the outstanding spawning and rearing habitat. The Kispiox River is probably the most famous steelhead river in the world today. When the water is low and clear, the river is an angler's paradise with easy wading, many pools and stretches of swift water.

The richest source of data on the status of salmon stocks within the watershed is the Salmon Escapement Database System (SEDS) maintained by the Department of Fisheries and Oceans (DFO 2001). This data set consists of annual spawning ground observations of census areas collected since 1950 by the DFO and more recently by the Gitxsan Watershed Authorities (GWA). Spawning area counts are made with different techniques, including aerial counts, ground counts, counts from boats, swimming counts, counting weirs, and mark and recapture experiments. Most counts are simple estimates made from one or more ground visits or aerial surveys. Because of this variety in technique and natural conditions, particularly visibility, these data vary in quality in often-unknown temporal and spatial ways. The data quality varies from observer to observer and place to place.

The SEDS database is most reliable for the larger and more consistent spawning stocks, . The bulk of salmon spawning areas appears to be represented; however, very small and infrequently used spawning areas are often overlooked. For example, in years of large pink salmon runs, spawning occurs at numerous sites that are not utilized under most conditions and may even appear to be unsuitable. These sites do not consistently appear in the SEDS database. Many small streams tributary to the Kispiox River, and specific spawning sites on the mainstem are not documented.

The SEDS records can only be utilized as indicators of general trends and at best reflect relative abundance, rather than actual values. Whatever the shortcomings, this data set is the best available and exceeds the quality of data available for steelhead, trout and other nonanadromous, freshwater species. In general, the number of stocks counted increased from 1950 to 1990 and declined after 1992. Coho are probably the most poorly estimated fish.

Data for steelhead is more dispersed. Since they spawn in the spring at high water conditions direct counts are usually not possible. Catches in the Tyee test fishery give aggregate abundance indices for the whole Skeena River. In general, enough is known to infer the order of importance of spawning streams.

Although there are many salmon spawning areas represented in the SEDS database, the bulk of the salmon production is from a much smaller set of localities. These localities are not randomly distributed within the watershed but are sites of very high or high habitat quality. If these tributary streams are examined more closely, it is likely that even within the productive systems, small portions of the stream produce the bulk of the fry. In stream-rearing species such as coho and chinook, the fry may be widely dispersed from the spawning beds. Lake-rearing populations such as sockeye are dependent on the productive capacity of the associated rearing lake.

The following section reviews the habitat and status of the six Pacific salmon species and selected indigenous, freshwater fish in the Kispiox Watershed. For each species, the nature of their habitat and life history is described, major stocks and status are identified, and the genetic structure of the population is described where information is available.

Chinook

Chinook are the largest species of salmon in the Skeena Watershed. In general they are fish of larger streams and spawn in faster moving water with coarser gravel than other salmon; chinook stocks are usually relatively small (Healey 1991). Chinook are the first salmon species to return to freshwater, resulting in the popular name, "springs." Early stocks arrive in May and June; late stocks in June and July. Late stocks tend to be more coastal and/or tend to spawn downstream of lakes.

Most chinook spawning occurs in August and September. Fry emerge from the gravel early in the spring. After hatching many fry move or are displaced downstream. Chinook fry are territorial and as they grow, individual territories expand and the excluded fish are displaced downstream. Chinook return after one to five years at sea, though most return after three seasons. Chinook with longer ocean residence times are larger as adults.

Chinook originating from Oregon through Alaska are widely mixed along the Pacific coast. Coastal fisheries therefore intercept fish originating in many rivers. This classic mixed-stock fishery has been difficult to manage without serious impacts on less productive stocks. Chinook stocks have probably been in decline since 1920; and there was a definite decline after 1950. This led to management actions that progressively decreased the commercial and sports catches. Restrictions on the North Coast chinook commercial fisheries and on river sports fishing began in the mid 1970s (Ginetz 1976), and the 1985 Canada-U.S. Pacific Salmon Treaty, with its subsequent amendments, has also put in place provisions to help stop the decline of chinook.

It is likely that the increase in escapement from 1985 on is due to the restriction on chinook harvest in Alaska that took effect with the Pacific Salmon Treaty. It should be noted that the recent recovery of Skeena chinook escapement to 1950s levels is in the absence of a large commercial fishery in B.C. It is likely that the long-term depression in chinook production and the recent increase in stock productivity are due not only to changes in exploitation rate, but also to changes in ocean survival.

Chinook salmon are an important part of the Kispiox River aboriginal fisheries, being next in importance to sockeye. In the last few years, the marine sports fishing component, although small, has increased and sports fishing on the lower Skeena River below Terrace is an important part of the overall Skeena chinook exploitation.

The genetic structure of chinook stocks is discussed by Beacham *et al.* (1996), who focuses on the separation of regional stocks and defines the Vancouver Island, Fraser area, and North Coast aggregates. Chinook from the Skeena tributary rivers such as the Babine River and the Kispiox River are clearly separable. Assuming that individual spawning stocks are genetically distinct, then conservation units are narrowly drawn and concern must be placed on preservation of the smaller stocks as well as the more productive larger stocks.

Information on Skeena Watershed chinook stocks prior to 1950 is available only from catch data. Catches from 1899 to 1930 in the Skeena River fishery averaged over 100,000 chinook; peak catches exceeded 200,000 (Ginetz 1976, Riddell and Snyder 1989). Chinook catches declined steadily from 1930 to the 1970s. Escapement data based on some spawning ground counts has been collected since 1950. Total Skeena River escapement was about 50,000 in the 1950s, declining to about 25,000 from 1965 to 1985. Chinook escapement has been recovering in the past 15 years and is now approaching levels of fifty years ago.

Kispiox River chinook salmon are one of the large and important stocks in the Skeena Watershed. Since the 1950s, a long-term population decline occurred due in part to the mixed-stock fishery and incidental interception, and a targeted sports fishery. This has slowly turned around with escapement numbers recovering to near 1950s levels in the last five years. Chinook escapement has varied widely in the past, from about 400 in many years of the 1970s and 1980s to15,000 in 1957 and 1992 (SEDS). The ten-year mean escapement for the 1950s was 12,560, for the 1980s, 2,801, and for the 1990s, was 5,493 chinook.

Typically, chinook salmon enter the Kispiox system in June and disperse to their spawning areas where they spawn through July and August. A variety of bedrock pools in reach three support holding areas for mature chinook, coho and steelhead (Wadley and Gibson 1998). The bulk of the spawning is concentrated in the mainstem. Critical chinook spawning areas include: portions of reach three upstream and downstream of Murder Creek, (DFO 1991a, Wadley and Gibson 1998); sections of reach three, particularly south of Elizabeth Lake (DFO 1991a), and dispersed areas throughout the mainstem often just downstream of tributary outlets that provide sources of fresh sediment and increased shallow intragravel flow.

Reach four contains moderate to heavy spawning in suitable sections with good holding pools. Reach five is essentially Gitwangak Canyon with no known reports of chinook spawning. Reach six, located above the canyon upstream to the mouth of Stephens Creek, has excellent spawning beds in the upper section. Dispersed, heavily used spawning areas exist in reach seven, especially in the upper portion. Reach eight and nine, which are above Williams Creek, have no record of spawning (DFO 1991a, MoE 1979).

Tributaries with noted chinook spawning in their lower reaches include: Date Creek, McCully Creek, McQueen Creek, Cullen Creek, Sweetin River, Nangeese River, Stephens Creek particularly near the mouth, Lower Club Creek, and lower Williams Creek (DFO 1991a, Hancock *et al.* 1983, Smith and Lucop 1966). Stuart (1981) conducted a biophysical assessment of the Kispiox mainstem and thirteen of the major tributaries, and reported that chinook fry were only present in Date Creek and in the Kispiox mainstem. Chinook rearing occurs virtually throughout the high value habitat located in the watershed, with migrants for the most part migrating at age 1 downstream to the Skeena River, into the estuary, and then into saltwater.

Pink Salmon

The Kispiox River is one of the major pink salmon producing areas of the Skeena River system. Pink salmon are exclusively two years old at spawning time, meaning that odd and even-year stocks are genetically separate. Pink salmon return at a smaller size than other salmon due to their short life cycle. In the ocean they grow faster than other salmon species (Heard 1991).

Pink salmon tend to stray at higher rates than other salmon (Horrall 1981). Heard (1991) summarizes mark and recapture experiments that show approximately 10% straying in pink salmon. Most straying is to nearby streams. In years of large escapement many pinks wander into previously unused spawning areas and even spawn in places that appear to be unsuitable. The genetic structure of pink salmon populations reflects this pattern of straying, though only regional patterns of stock separation have been described. Beacham *et al.* (1985) report allozyme studies that result in identification of three stock groups: Fraser River, Puget Sound and B.C. non-Fraser. In general the odd and even-year lineages of pink salmon are more different genetically than stream populations over large areas (Heard 1991).

Kispiox River pink salmon are distinguished by their early run timing, with no dominant cohort year. Pink escapement fluctuates widely from cycle to cycle. Relative to recent pink salmon escapements in the Skeena, Kispiox River pinks have not experienced a dramatic increase in escapement. The ten-year mean escapement for the period of 1990-1999 shows 33,500 for the even-year mean, and 56,800 for the odd-year mean (DFO 2001). Typically, pink salmon enter the system in mid to late August and disperse to spawn throughout the mainstem and its lower tributaries. Gitangwalk Canyon is a barrier to pink salmon upstream movement.

The area of heaviest spawning occurs from Seventeen Mile Bridge upstream to Cullon Creek (Smith and Lucop 1966). Wadley and Gibson (1998) report moderate mainstem pink spawning in areas of suitable substrate upstream from McQueen Creek; heavy pink spawning from McCully Creek up to Cullon Creek; and dispersed patchy spawning in reach 4. Pink salmon also utilize the lower reaches of the following tributaries: Date Creek, McQueen Creek, McCully Creek, Murder Creek, Cullon Creek, Ironsides Creek, Twin Creek, Corral Creek, Skunsnat Creek, Clifford Creek, Sweetin River and the Nangeese River. Upon emerging from the gravel in spring, pink salmon fry migrate immediately to the saltwater.

Chum Salmon

Chum salmon are the least abundant of the six Pacific salmon species in the Skeena Watershed. They are much more abundant in southern BC and in Southeast Alaska where hatchery production enhances some of the stocks. In the Skeena Watershed, chum salmon live two to five years. Three year old returning fish are most abundant, but four year old fish are generally present at spawning time (Halupka et al. 2000). There is an extraordinary variability in year to year chum salmon returns. Annual escapement estimates in the SEDS have varied one hundred fold over the past fifty years.

Chum salmon arrive in the Skeena Watershed from late July to early September. Their migration coincides with the much larger runs of pink salmon, and they usually spawn in places that also have spawning pink salmon. Unlike coho and sockeye, which may hold for a month or two before spawning, chums spawn soon after traveling up the Skeena River. Fry emerge early in the spring and migrate to the Skeena estuary immediately upon hatching. Chum salmon smolts typically remain in estuaries for one to several months, growing rapidly before dispersing in the ocean (Healey 1980). There is apparently a high degree of variability in the survival rate of chum early in their marine life.

Chum are most common in the coastal portion of the Skeena Watershed. The most important spawning area is the Ecstall River and the multi-channel reach of the Skeena River below Terrace. Other spawning areas are near the mouths of large tributary streams and in back-channels along the Skeena River from Terrace to Kispiox. There is significant spawning in the Kitwanga and Kispiox Rivers. Smaller stocks are present in the lower portions of several other Skeena River tributaries. Chum are rare in the Bulkley River and in the Skeena River above the Kispiox River confluence.

Field observations suggest that chum are highly specialized in their selection of spawning sites. Several of the Skeena River spawning sites used every year are less than a few hundred meters long. Chum continue to use these patches of gravel even when channel reorganization separates them from their former source of flow.

There are no genetic studies aimed at separating stocks of chum at the river tributary level. Beacham *et al.* (1987) used electrophoretic analysis to distinguish five large-scale population assemblages in chum salmon from the Queen Charlotte Islands, the north and central coast, the west coast Vancouver Island, the south coast, and the Fraser River system. Kondzela *et al.* (1994) used similar techniques to divide Southeast Alaska and northern British Columbia stocks into six groups.

Chum salmon stocks were apparently much more abundant early in the twentieth century. The commercial catch of chum salmon in the Skeena Area between 1916 and 1928 was over 200,000 per year (Argue *et al.* 1986). This suggests an escapement about ten times larger than that of the recent past. Chum salmon escapements have been low for the last 50 years. With the exception of the spectacular high escapement in 1988, the average escapement has been declining over this period. The decline in chum salmon stocks is basin wide, suggesting that much of the problem is in the marine realm. Similar declines have taken place in the mid-coast region and in southeast Alaska non-enhanced stocks. This suggests that a major component of the decline in chum salmon is decreased ocean survival.

Skeena River chum salmon are taken as incidental catches in the sockeye and pink salmon fisheries of Area 3, 4, and 5 and to a lesser extent in the Noyes Island and Cape Fox fisheries in Alaska. Charles and Henderson (1985) calculate an overall exploitation rate of between 50% and 83% for the years between 1970 and 1982. This relatively high exploitation rate has probably also contributed to the decline of the Skeena stocks. They are also taken in small numbers in First Nations food fisheries.

The average overall escapement to Area 4 in the 1990s was only 10,000 to 14,000 chum salmon. The Ecstall and the West Skeena areas contain the only strong stocks, accounting for over 9, 000 of this total. In the 1990s, 29 enumerated stocks had escapements below 200, of which 26 had average escapements of below 100. In general, one can conclude that chum are probably the Skeena Watershed salmon species in the greatest danger of significant loss of spawning stocks and genetic diversity.

Kispiox River chum spawn the farthest upstream of any large chum population in the Skeena system, but the escapement has been severely depressed since the late 1950s. The ten-year mean escapement for the 1950s decade was 4,083; for the 1960s, 553; for the 1970s, 1,108; the period from 1980-1989 was 131 chum, while the ten-year mean escapement for the period from 1990-1999 was 400 spawners – there are spawning chum observed during surveys in 1994 and 1999 (DFO 2001).

Generally chum move into the Kispiox system in August, spawning in selected sections of the mainstem, principally reach one and two. Chum spawners have also been observed scattered along the mainstem close to the mouths of Date Creek, McCully Creek, McQueen Creek, Murder Creek, Elizabeth Creek, Steep Canyon Creek, Sweetin River and Nangeese River, as well in the lowest reaches of these tributaries. Migration downstream to the saltwater begins immediately following fry emergence in the spring.

Sockeye

The Kispiox River Watershed is one of the eight most important sockeye producing watersheds in the Skeena system. Kispiox River sockeye are a unique population with spawning taking place primarily in streams tributary to the Swan, Club and Stephens Lakes. From DFO's BC16 and SEDS records, the population size seems stable, although variable from year to year.

Sockeye salmon are the most valuable commercial fish of the Skeena Watershed and have consequently received much research and management attention. Important sources of information are found in Brett 1952, Larkin and McDonald 1968, Smith *et al.* 1987, Rutherford *et al.* 1999, Shortreed 1998, and Wood *et al.* 1997. The total annual Skeena sockeye run size (i.e. before harvest) averages several million fish. The vast majority of Skeena sockeye return as 4 and 5 year old fish, although 3 year old males (jacks) are common in some years. Skeena sockeye fry typically rear in lakes; therefore, the adults usually spawn in streams either tributary to lakes or near the outlet of lakes.

Figure 5. View northwest across Swan Lake. Swan Lake and the adjacent Stephens Lake are the principal sockeye nursery lakes in the Kispiox Watershed.

Sockeye fry spend one or two years rearing in lakes. Productive sockeye stocks, such as those of Babine Lake, spend one year as lake residents. The lake is biologically productive with abundant plankton populations, the main food source for sockeye fry. Sockeye derived from colder subalpine lakes such as Onerka Lake and Sicintine Lake spend two years rearing in the lake. This unique life cycle is different from other Pacific salmon.

Babine sockeye studies and investigations began with the Fisheries Research Board of Canada in the 1940s. Construction of the Babine Lake Development Project (BLDP), an approximately 10 million dollar project, consisted of artificial spawning channels and dams to provide for water flow regulation located at Pinkut Creek and Fulton River, tributaries of Babine Lake.

Sockeye salmon production from Babine Lake increased significantly as a result of the BLDP program. At least 90% of Skeena sockeye salmon now originate from the Babine-Nilkitkwa system (McKinnell and Rutherford 1994) compared with less than 80% prior to 1970. The relative increase in Babine Lake sockeye is due to an increase in abundance of enhanced sockeye and a decrease in all other wild Skeena sockeye sub-populations. Most wild sockeye stocks have declined since the 1970s, probably in response to increased exploitation rates supported by the success of the Babine Lake enhancement.

The mixture of enhanced and wild stocks in the commercial mixed-stock fishing areas has generally depressed wild stocks – some to a greater extent than others – particularly non-Babine sockeye, coho, chinook and steelhead stocks. Management concerns regarding this situation are dual in nature: ensuring the conservation and continuity of non-Babine stocks, and maximizing the catch of enhanced Babine sockeye salmon (Wood *et al.* 1997).

The high commercial value of sockeye salmon led to a high exploitation rate of Skeena River sockeye in a series of fisheries in Alaska, on the BC coast, and in-river. The commercial fishery for Skeena sockeye began in 1877, and from 1910 to 1970, the total return (catch plus escapement) of Skeena sockeye fluctuated between 1 and 3 million fish. There was an overall decline of 50% in the catch from 1910 to 1955. Beginning in 1930, effort declined as a result of regulation and poor returns per boat, levelling off at an exploitation rate of approximately 50%. Since 1970, after enhancement of the Babine sockeye stocks catch of Skeena sockeye increased steadily until a large decline in 1997 that was due to disease problems in the Babine stocks. Over this period, exploitation rates have been fairly constant, averaging 61%, but since 1970 have exceeded 70% four times (Rutherford *et al.* 1999). These relatively high exploitation rates may have led to the decline of less productive wild sockeye stocks.

Research advances over the past ten years have identified genetic markers in sockeye that can separate sockeye from different spawning areas and provide a tool to help understand their population structure (Wood *et al.* 1994, Beacham and Wood 1999). This information has important conservation implications. Sockeye salmon appear to be highly specific to individual lakes, and each lake system is genetically distinct. Different spawning areas in a single lake system have sockeye that are similar genetically to one another and have modest amounts of genetic interchange between different spawning streams (Varnavskaya *et al.* 1994, Wood and Foote 1996, Withler *et al.* 2000). Each lake complex is an evolutionary significant unit and hence an important fisheries management unit (Waples 1995). In contrast, river dwelling sockeye are relatively similar genetically (Wood 1995, Beacham and Wood 1999). This pattern is quite unlike that of coho where populations seem to vary by degree along river systems. Consequently the preservation of even small sockeye populations is important to the preservation of species diversity.

Sockeye adults typically enter Stephens Creek in August and the beginning of September (Sterritt and Gottesfeld 2002) and migrate upstream to spawn in Club Creek and other Swan Lake tributaries. A small number of sockeye also spawn in the lower reaches of Stephens Creek. Once through Stephens Creek the sockeye will hold until spawning maturity in either Stephens Lake or Swan Lake. The major spawning grounds are located on upper and lower Club Creeks (FRB 1948). The sockeye spawning in Club Creeks may be unique in the Skeena in that the spawning substrate is primarily boulder size. Other spawning areas are found on four creeks tributary to Swan Lake, of which Falls Creek is the most important. Some sockeye also spawn in Swan Lake and possibly Stephens Lake. Spawning takes place in September (Sterritt and Gottesfeld 2002). Following emergence from the spawning beds, most juvenile sockeye (>95%, Rutherford *et al.* 1999) spend 1 year in Swan, Club or Stephens Lakes before migrating to the sea.

Figure 6. Sockeye in lower Falls Creek, a tributary of Swan Lake, prior to spawning in September 2001.

Figure 7 shows the historical escapement estimates for the Swan Lake system. Estimates prior to 1992 were based primarily on Upper and Lower Club Creek. In 1992, the GWWA included Jackson and Barnes Creeks, and in 2001, the GWA enumerated all known spawner areas in the Swan Lake system, including Club Creek. A counting weir was set up in 2001 to obtain accurate escapement for the Swan Lake Watershed; 10,109 sockeye were enumerated. These data compliment the SEDS data enabling a clear 1990s decadal picture.

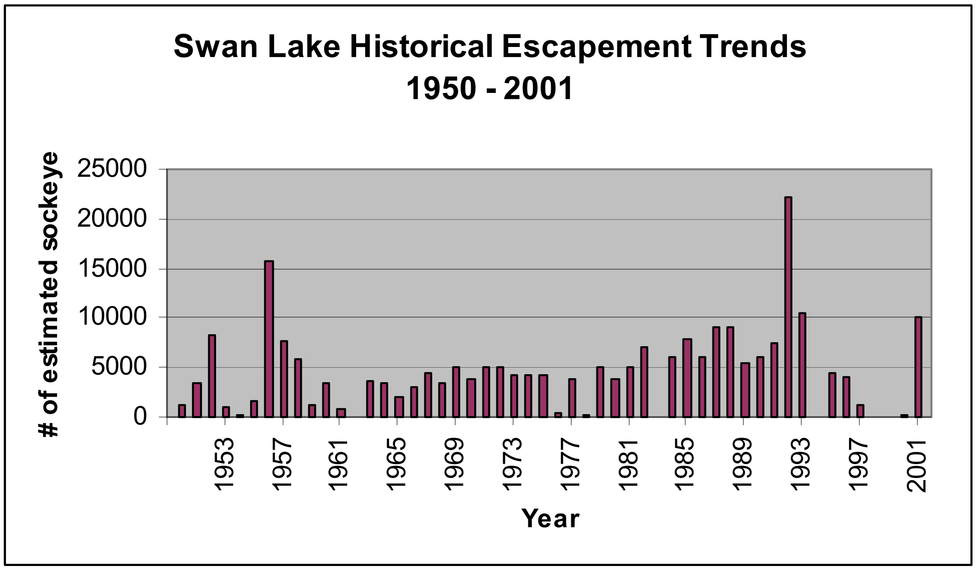


Figure 7. Historical Escapement Estimates for Swan and Stephens Lake Sockeye.

Small numbers of sockeye regularly spawn in downstream sections of Ironside, Clifford, and Skunsnat Creeks and the Nangeese River (GWA, unpublished data). Since there are no lakes accessible to sockeye from these sites, with the possible exception of Skunsnat Creek, it is presumed that these fish are river type sockeye. River type sockeye are rare in the Skeena Watershed although this life history type is common in Asia and makes up a significant part of the total escapement of sockeye to the Stikine River and to a lesser extent, the Nass River.

Coho

Coho salmon are widely dispersed throughout the Skeena Watershed and show the least amount of concentration into a few, large productive stocks. Coho usually spend one to two winters in freshwater before migration to the ocean. They typically return as two or three year olds after spending one winter in the ocean (Holtby *et al.* 1994).

Coho rearing typically takes place in low gradient streams, ponds, and lakes. In ponds and lakes, juveniles inhabit the near-shore littoral zone (Irvine and Johnston 1992). Riverside channels and small streams often provide preferred habitat with structural complexity that includes stones, logs, and overhanging vegetation. Coho are dependent on low gradient streams (<2%) for rearing habitat (Nass *et al.* 1995). Coho frequently occupy small upstream habitats, often moving into these small spawning streams when heavy fall rains increase water flows, allowing them to get over obstacles such as beaver dams.

Coho are fish of small streams and are often dependent on off channel habitat such as beaver ponds, back channels, and seasonally flooded areas for rearing. These small stream and flood plain habitats are highly susceptible to damage from logging. Prior to the Forest Practices Code (1994) protection of small streams was often inadequate.

Coho migrate into the Skeena River between late July and the end of September as recorded by the Tyee test fishery. The annual peak of the migration is in late August. In general the fish destined for upstream tributaries arrive first because they spawn earlier in cold-water tributaries and have longer travel times. The early arrivals pass through the various coastal fisheries along with the large sockeye run destined for Fulton River, a tributary of Babine Lake. Coho are usually the last salmon to spawn in the fall with spawning occurring from the end of September through December.

The vast majority of coho return to their natal stream. However, when compared to other species like sockeye and chinook, coho typically have a higher amount of straying, and in years of low flows may typically stray to other nearby streams or spawn further downstream after holding. Sandercook (1991) suggests that typical straying rates are less than 1% with most straying to nearby similar streams. The genetic structure of coho reflects this pattern of straying of adult fish, and straying rates of less than 1% are sufficient to ensure gene flow between nearby streams (Wood and Holtby 1999). Coho appear to wander freely within their spawning stream, taking advantage of fall floods to pass barriers such as beaver dams in order to occupy new upstream areas.

The coho of the Skeena and Nass Watersheds constitute a genetically distinct regional group of populations (Small *et al.* 1998). Within the Skeena Watershed, variation appears to be roughly proportional to the distance between spawning streams. Wood and Holtby (1999) suggest that the effective size of subpopulations is approximately 100 to 400 km. Important evolutionary units are then at the major tributary level of separation, suggesting that there are several functional subpopulations in the Skeena, of which, for example, the Kispiox drainage would be one of the genetically distinct populations. The implication of this model is that decline of coho in a single stream is not an evolutionary concern if nearby streams retain healthy populations.

The decline in coho stocks is attributed to a combination of Alaskan net fisheries, the Skeena mixed-stock net fishery, and a decline due to unknown ocean survival factors. Tagging information available for Babine coho suggests that the stocks have a distinct ocean distribution off southeast Alaska. With complete closure of the Skeena commercial fishery in 1998, the estimated exploitation rate of 60% on Babine coho indicates an intense Alaskan net impact (DFO 1999).

Total exploitation rates before 1998 ranged for the most part from 60% to 80%. Few if any of the Skeena coho stocks can be expected to thrive at the upper range of this rate of exploitation. One third to one half of the total exploitation during this time period was in Alaska. Counts of coho spawners in streams are notoriously difficult and often underestimate true escapement numbers. The concern for coho individual stocks should be assayed against the generalized pattern of genetic differentiation and the ability of coho to reoccupy available habitat. Rebuilding coho in the Skeena region will require continued conservation efforts.

The low escapements of Skeena coho in the 1980s and 1990s raised concerns about coho survival, especially survival of stocks spawning upstream of Terrace. DFO responded to this management crisis by instituting substantial changes to the commercial and sports fisheries in 1998 and 1999, directed at reducing the catch to zero. Severe restrictions on commercial fishing continued through 2001. These actions have met with some success as escapements increased in 1999, 2000 and 2001, with the added benefit of better-than-average ocean survivals. Smolt to adult survival rates are a measure of ocean survival. The general pattern in the past decade in Oregon, Washington, and British Columbia is a decline in ocean survival. Mortality is highest in the first year at sea and probably in the first months. Ocean survival rates for Skeena coho are extremely variable (from 0.2% to 20%) and seem to have decreased in the 1980s through 1996.

Coho salmon are widely distributed throughout the Kispiox River system. The greatest abundance is within the Kispiox mainstem where escapements as high as 35,000 (1958) have been recorded. Coho escapement within the watershed has decreased by an order of magnitude over the last few decades (Plate *et al,* 1999). The Gitxsan Watershed Authority has been conducting coho synoptic and stock assessment studies to determine distribution and densities within the greater watershed (Plate *et al,* 1999, GWA 2000, GWA 2001a, Wilson and Gottesfeld 2001, Sterritt 2001). The Kispiox Watershed coho escapement declined steadily from the 1950s until the last few years, when widespread fishing restrictions and improved ocean survival led to a marked rebound.

Generally, coho return to the Kispiox system to spawn throughout September, with spawn timing occurring from late September through December, usually dependent on water flow and levels. Coho spawning grounds are concentrated in the upper half of the mainstem; however, select areas adjacent to creek mouths in the lower portion are also used. The Nangeese River and the Stephens Watershed have large escapements. Approximately twenty other streams support smaller spawning groups. Recent (1999-2001) escapement of the Kispiox coho aggregate stock is in the range of 2,300 (1990) to 6,400 (2001, GWA unpublished data).

The majority of tributaries support coho rearing, while mainstem rearing principally occurs in side-channels. Comprehensive mark and recapture sampling, as well as smolt out-migration fence counts conducted by the GWA, have resulted in delineation of wild smolt and enhanced smolt habitat distribution, density, and migration timing. These studies (Plate *et al,* 1999, GWA 2000, GWA 2001a, Sterritt 2001) also identified under-utilized stream sections that are suitable for future coho hatchery releases.

Steelhead

Summer run steelhead arrive relatively late in the Skeena along with coho salmon and continue to arrive in the lower Skeena River throughout the winter. The earliest part of the steelhead run overlaps the much larger sockeye run; most of the steelhead arrivals take place while pink salmon are entering the Skeena.

Overall, the Tyee Test Fishery best estimates escapement to the Skeena Watershed. This site provides a useful estimate for the summer run portion of the steelhead. Total summer run escapement estimates based on the Tyee index data began in 1956. Steelhead declined from about 1985 to 1992. The low escapements in these years led to changes in the timing of the Area 4 commercial fisheries to decrease the impact on steelhead, and to the beginning of mandatory catch and release in the sports fishery. The total closure of the Area 4 fishery in

1998, and improving ocean survival, contributed to the high escapement of that year. Spence and Hooton (1991) suggest a minimum escapement target of 26,500 for Skeena River summer run steelhead, assuming no upriver harvest. Allowing for aboriginal food fisheries, the minimum escapement should be set at least 28,000; however, only 9 of the last 45 years have met this criterion.

Low levels of straying are characteristic of steelhead (Quinn 1993, Heath *et al.* 2001). Where straying occurs, it is likely to streams close to the spawning stream. This pattern results in a moderate degree of genetic separation of steelhead. Heath *et al.* (2001) analysed the genetics of steelhead stocks in the Skeena and Nass Rivers. They found significant differences between stocks from the various tributary watersheds of these two rivers. Steelhead from the Morice, Babine, Kispiox, Sustut, and Zymoetz Rivers are genetically distinct, and differences increase proportional to the geographic separation of the watersheds.

Changes to steelhead populations in tributary watersheds in the Skeena are hard to identify due to a shortage of relevant information. While Catch Per Unit Effort (CPUE) applied to sports fisheries is not a solid measure of abundance, the most useful source of data is the Steelhead Harvest Analysis (Ministry of Water, Lands and Air Protection 1991). There are few good data to record steelhead escapements at individual streams. This is in large part because they spawn in spring at high water conditions when counts are usually not possible and they are typically spread out at many sites within a stream. Steelhead spawning typically occurs from March through May, coinciding with warming water temperatures and an increase in stream flows.

Steelhead fry emerge between mid-August and mid-September and are widespread throughout smaller tributaries that offer suitable refuge. It is suggested that freshwater residency time relates to the location of juvenile steelhead habitat in the system; slower growth rates are apparent when rearing in glacial fed stream systems, compared to nutrient rich lake habitat.

Though uncertainties exist as to steelhead escapement levels, given the large estimated population size (Tautz *et al.* 1992), as well as the continuing high sports fishery catches, the steelhead population appears to be relatively stable. Ward *et al.* (1993) predicted commercial harvest rates of Kispiox River steelhead for the period of 1986 to 1991, with the mean being 41.2% incidental harvest in the Area 4 commercial fishery. It was estimated that 4,027 steelhead returned in 1994 (Koski *et al.* 1995), and 2,514 in 1995 (Alexander and English 1996).

The world-renowned Kispiox River summer run steelhead population is distinct from other Skeena River stocks due to the large average size of the returning adults. Steelhead migrating up the Skeena River enter the Kispiox system in late August and September and overwinter in deep pools, mainly in the lower Kispiox River below Cullon Creek, and in the mainstem Skeena below the confluence (Lough 1980, 1983). Steelhead have been observed spawning from mid May through to mid June, primarily in mainstem side channels, though Stephens Creek and the Club Creek system are most likely the most concentrated spawning grounds (Chudyk 1972b). Lough (1983) reported a small concentration of fish spawning in the mainstem between Date and McQueen Creeks. As well, two steelhead left the Kispiox and spawned in Skeena River side channels, while one steelhead moved over to the Shegunia River to spawn. In 1979, a radio tagging study showed 80% of the radio tagged steelhead spawning in tributaries including Cullon Creek, Ironside Creek, Skunsnat Creek, and the Nangeese River (Lough 1980).

Other tributaries known to support steelhead spawners include the lower reaches of Date Creek, Williams Creek and Sweetin River (DFO 1991, Baxter 1997). In late May, kelts leave the river. In a detailed study of Kispiox River steelhead during 1975, Whately (1977) found 17.6% of steelhead adults were repeat spawners, with 12.1% being first time repeat spawners (S1+), and 0.6% second repeat spawners (S1S1+). Most of the repeat spawners were females, because males experience a higher mortality during spawning.

Steelhead juveniles remain in the Kispiox system for 1+ to 4+ years. Scale sample analysis of upstream migrating adults show an average age of three years in the river before moving to the ocean; Whately (1977) estimated that Kispiox steelhead smolt at age 3 or 4. Fry densities are generally lower in the mainstem than in sampled tributary sites; however, parr densities in both rearing areas are largely similar. Cullen Creek has the highest fry densities by a factor of five, in relation to other monitored or sampled sites (Stuart 1981, Tredger 1983). Recent mark and recapture sampling conducted by the GWA (Gottesfeld *et al,* 2000) reported generally low densities (0.01-0.31/m^2) and that at most sites steelhead are less abundant than other salmonid species. Results suggest that the Kispiox Watershed as a whole is underutilized. It is likely that juvenile recruitment is low due to incidental catch from high exploitation rates in the mixed-stock fishery and to the winter First Nations harvest.

Indigenous Freshwater Fish

In comparison to salmon, information is sparse on resident, non-anadromous or freshwater fish in both fluvial (or river) and lacustrine (or lake) habitats of the Skeena Watershed; indeed, much of the watershed is poorly known and may contain populations of special interest or status that are presently unknown. Ecological and life history information that permits good conservation planning is simply not available. There are 21 known species of fish in the Kispiox Watershed system; of these, 15 are freshwater species (McPhail and Carveth 1993).

Known freshwater species and documented populations inhabiting the Kispiox Watershed include Rainbow trout (*Oncorhynchus mykiss*), Cutthroat trout (*Oncorhynchus clarki clarki*), Kokanee (*Oncorhynchus nerka*), Bull trout (*Salvelinus confluentus*), Lake trout (*Salvelinus namaycush*), Dolly Varden char (*Salvelinus malma*), Mountain whitefish (*Prosopium williamsoni*), Lake whitefish (*Coregonus clupeaformis*), Northern pikeminnow (*Ptychocheilus oregonesis*), Largescale sucker (*Catostomus macrocheilus*), Longnose sucker (*Catostomus catostomus*), River lamprey (*Lampetra ayresi*), Longnose dace (*Rhinichthys cataractae*), Redside shiner (*Richardsonius balteatus*), and Prickly sculpin (*Cottus asper*).

The focus of government management efforts in the past on a narrow range of game fish has recently given way to interest in the characteristics and conservation of populations of all species. Defining conservation levels requires understanding fish values and the status of the fish resources, as well as basic habitat knowledge and values. What and where are critical areas for fish? What are the capability and constraints for production? What are the population and habitat sensitivities?

Currently, it is important to define conservation levels and to preserve biodiversity outside protected areas, as well as in conjunction with forestry and other development activity practices that potentially could impact fish abundance and habitats. Responsibility and jurisdiction for the freshwater species lies with the provincial government. The following section briefly reviews the habitat and status of selected trout and char species in the Kispiox Watershed.

Rainbow Trout

Within the Kispiox Watershed, rainbow trout have been documented in most of the tributaries and in the mainstem and are one of the most widely distributed fish. Rainbow trout have recently undergone a name change from *Salmo gairdneri* to *Oncorhynchus mykiss* (Smith and Stearly 1989), with anadromous forms being commonly referred to as steelhead, or steelhead trout. Rainbow trout are present throughout the Skeena Watershed as residents in lacustrine, resident fluvial and adfluvial life history forms and are an important, popular sport fish – likely the species most frequently caught by anglers in the watershed.

It is generally thought that Skeena Watershed populations of rainbow trout exhibit three different life history strategies, with considerable variation depending on geographic location and habitat: populations that live their entire lives in small streams, those that spawn in small streams and migrate to rivers to rear and mature, and those that spawn in small streams and move into lakes to rear and mature.

Rainbow are most often a lake fish, but they enter streams to spawn in the spring before ice break-up. Females construct redds in the gravel into which the eggs are deposited. Young emerge from the gravel in the summer and usually migrate in the first year to rearing areas within streams or lakes. Juveniles spend up to a year in the stream following hatching, then return to lakes to grow and mature. Normally, the fish remain in the rearing lake or river until they reach maturity in 2 to 4 years, before moving back to natal streams for spawning. Scott and Crossman (1973) reported that survival after spawning is usually low and the number of repeat spawners is often less than 10% of the total spawning population.

Rainbow trout exhibit a wide range of growth rates dependent on habitat, food type and availability, and life history strategy. Generally the growth of rainbow trout is slower in streams than in lakes and is greatest in marine environments (Carlander 1969). The fish show seasonal movement to access suitable habitat for feeding and overwintering. Generally, the type of food eaten reflects the size of rainbows and the season, with principal prey being zooplankton, benthic invertebrates, terrestrial insects, and fish. Small rainbows may eat zooplankton crustaceans and small insects, while larger trout may take leeches, larger insects, molluscs, and a variety of juvenile fish (Griffiths 1968). Griffiths documented growth and feeding habits, primarily by stomach analysis of rainbow trout in Babine Lake.

Hatchery raised rainbow trout are the predominant species used for stocking lakes in the Skeena watershed. The majority of hatchery-produced fish are put into lakes that either cannot support rainbow trout or have insufficient natural production to satisfy sport fishing demands. Current daily catch quotas allow the keeping of 5 rainbow trout.

Cutthroat Trout

Cutthroat trout comprise a popular sport fishery in limited instances in the Kispiox River drainage. Within the Kispiox Watershed, cutthroat trout distribution is documented throughout most of the system; along with rainbow trout it is one of the most abundant fish species.

The species of cutthroat trout in the Skeena River watershed is the coastal cutthroat trout (*O. clarki clarki*), which is blue listed by the BC Conservation Data Centre (CDC) as a species of concern. It is not, however, an identified wildlife species under the Forest Practices Code, nor is it listed by COSEWIC (Committee on the Status of Endangered Wildlife in Canada). Lacustrine populations of cutthroat trout exist throughout the Skeena Watershed, but are rare in Skeena tributaries upstream of the Babine/Skeena confluence and are not documented in the uppermost tributaries that include Slamgeesh, Kluatantan and Sustut Rivers.

Cutthroat trout are very adaptable to their environments, resulting in considerable variation in life histories. Generally there are three life history types of cutthroat trout in the watershed. Anadromous life forms of cutthroat exist in the Skeena but are poorly studied and understood. For regulation purposes, populations upstream of Cedarvale are not considered to be anadromous. There are adfluvial populations that spawn in tributary streams and migrate to lakes to grow to maturity, and fluvial populations that move between mainstems and headwater streams, as well as resident populations that remain in headwater tributaries for their entire lives.

Cutthroat trout exhibit considerable variation in spawning time, though it normally occurs from mid-May to mid-June (Hart 1973). The fish usually spawn in small gravel substrate streams that are tributary to rivers and lakes, with redds constructed by the females. Emergent fry spend variable lengths of time in their natal streams, while migratory populations may spend as little as a few months to as long as 4 years in their original streams (Liknes and Graham 1988). Once in rearing areas, the river and tributary dwelling populations may make minor migrations to access preferred food and appropriate winter habitats. Cutthroat trout in lakes generally grow faster than those in streams; Carlander (1969) suggests the smaller the stream, the slower the growth.

Cutthroat trout are opportunistic feeders that consume a variety of freshwater invertebrates and may feed heavily on other fishes, crustaceans, and freshwater insects. Moore and Gregory (1988) studied cutthroat habitat preferences in tributary streams and found that fry abundance was proportional to the area of lateral habitat, meaning stream margins, backwaters, and isolated pools. Cutthroat living in association with other trout species generally alter their feeding behaviour to minimize competition with the other species.

Lake Trout

Within the Kispiox drainage, lake trout (*Salvelinus namaycush*), actually a char, have been documented in Kispiox River, Swan Lake, and Stephens Creek (FISS 2002). Lake trout are known to exist in 22 lakes in the Skeena Watershed (FISS 2002). Lake trout are a cold-water fish usually frequenting deep lakes with limited distribution to upper Skeena tributaries; however, they have been occasionally observed in streams tributary to lakes. Of the north coast watersheds, the Skeena is the only one to contain lake trout, which are suspected of being of eastern origin (McPhail and Carveth 1993b). Lake trout, white sucker, and lake whitefish probably entered the Skeena drainage from the east by way of glacial lake connections between the Skeena, Fraser, and Peace Rivers (McPhail and Carveth 1993a).

The lake trout life cycle takes place entirely within lakes, with spawning occurring in late summer or early fall in relatively shallow areas. Eggs are usually deposited on large rubble substrate and incubate for 4 to 5 months over the winter and early spring. Fry emerge and usually remain at inshore nursery areas adjacent to the spawning beds to feed on insects and crustaceans for a period ranging from several weeks to several months. Diets change as the juveniles grow and the fish move into deeper waters offshore. Lake trout are the top aquatic predator in most lakes where they are found (Martin and Oliver 1980). On average, maturity first occurs at age 11, with mature adults leaving offshore waters and returning inshore to spawn.

The lake trout may prey on kokanee and whitefish while in deep water, and while in shallow water, usually in the spring and fall, may eat aquatic insects and shore dwelling minnows (Griffiths 1968). Lake trout are capable of reaching ages in excess of 50 years and achieving weights over 20 kg. Due primarily to their large size, and palatable flesh, they are a prized sport fish by many anglers and are vulnerable to overexploitation. They are also taken in some First Nations fisheries (e.g. Babine Lake). deLeeuw (1991) reported reduced abundances of lake trout in road accessible lakes as a result of increased angler effort. Fourteen of the 22 lakes in the Skeena watershed are known to be road accessible and are therefore likely suffering from reduced abundances. Current daily catch quotas allow the keeping of 5 lake trout.

Dolly Varden Char

Dolly Varden char (*Salvelinus malma*) are blue listed by the BC CDC as a species of concern, but are not listed as identified wildlife by the Forest Practices Code or by COSEWIC. Dolly Varden are common in the greater Skeena Watershed and are probably the most common freshwater fish in the Kispiox Watershed after rainbow and cutthroat trout. Small resident Dolly Varden are predominant in the upper reaches of small streams throughout the watershed. Dolly Varden char also exist in lacustrine-adfluvial populations. Beyond knowledge of distribution and general life history, Dolly Varden char have not received extensive management or biological study in the Kispiox Watershed.

Spawning takes place in streams in the autumn with maturity usually reached in the fifth year. Regular seaward migrations may take place in spring with return migrations in the fall. Hart (1973) suggests that in the Skeena Watershed most fish spend 3 years in fresh water and 2-3 years in the ocean, with males tending to stay longer at sea. Generally, food consists of fishes, including herring, sticklebacks, juvenile salmon, salmon eggs, molluscs, insects and crustaceans (Hart 1973).

Cedarvale constitutes the regulatory upper limit of Dolly Varden anadromy; the remaining populations are fluvial or adfluvial residents. Dolly Varden char are only targeted as sport fish in the lower Skeena and its coastal tributaries, due primarily to their small size in upper watershed drainages. Current daily catch quotas allow the keeping of five Dolly Varden.

Bull Trout

Bull trout (*Salvelinus confluentus*) is actually a char that are blue listed as a species of concern by the BC CDC, as well as by COSEWIC, due primarily to limited global distribution and threatened status in their southern US range. They are also listed as an *identified wildlife* species (species at risk) under the FPC. Studies on bull trout in the Skeena watershed are limited to the Morice Watershed (Bahr 2002) and the Shelagyote River (Giroux 2002). Despite differences in life history traits and morphometry, bull trout are often confused with Dolly Varden and much of the available information on distribution is suspect (Hass 1998).

Fluvial and adfluvial populations spawn in small tributary streams and over-winter in larger rivers or lakes. Maturity is generally reached at 5 years of age, though precocious males may mature by age 3 (Shepard *et al* 1984). Recent observations by (Giroux 2002, Bahr 2002) show watershed populations typically spawning in gravel and cobble pockets in streams during late summer and early fall. Usually eggs hatch before the end of January with emergence occurring in late spring. After hatching, bull trout fry rear in low velocity backwaters and side channels and avoid riffles and runs (McPhail and Murray 1979). Juveniles tend to utilize a variety of stream and lake habitats and are most abundant where water temperatures are 12^0C or less. Their intra-watershed distribution patterns indicate they are sensitive to water temperatures, preferring cold natal streams.

Bull trout are a long-lived, repeat spawning fish that can exceed 20 years of age and 10 kg in weight; however, in general terms, most bull trout char captured by anglers range between 45-60 cm in length, and are 8-17 years old. Bull trout are a popular sport fish and are frequently harvested by sport anglers as by-catch during targeted recreational fisheries for summer-run steelhead, chinook, sockeye and coho.

As adults, they are an aggressive piscivorous (fish eating) fish and vulnerable to overharvest by anglers. Limiting angler access, as well as critical habitat identification and protection, are the most significant issues for the protection of bull trout in the Skeena River drainage. Bull trout are suspected to be found throughout the Kispiox Watershed and its tributaries, though there is uncertainty whether the identified fish are bull trout or Dolly Varden. Bull trout occurrence is considered common in Skeena tributaries upstream of Cedarvale.

Kokanee

Kokanee distribution within the Kispiox Watershed is limited to the Swan-Stephens system though they have been documented in the Kispiox mainstem (FISS 2002). Kokanee are an important sport fish mostly caught by trolling in Swan and Stephens Lakes. The deep red flesh is frequently considered by many to be the tastiest and finest eating in the watershed. Current daily catch quotas allow 10 kokanee from lakes, but none from streams.

Kokanee salmon (*Oncorhynchus nerka*) are a landlocked form of anadromous sockeye salmon and the only Pacific salmon species in North America to form natural populations living their entire life cycle in freshwater. Kokanee are generally accepted to have evolved independently from anadromous populations of sockeye salmon. Within the Skeena Watershed, Kokanee have been observed primarily in the Babine, Sustut, Lakelse, Zymoetz, Kispiox, Kitwanga, Morice and Bulkley systems. There is a current lack of knowledge concerning kokanee distribution (Foote *et al* 1989).

Kokanee usually mature at smaller sizes than sockeye, and where the two forms occur together, they exhibit other morphological differences such as gill raker number, male secondary sexual characteristics, and colouration (Nelson 1968). Within the Skeena Watershed, the geographic distribution of kokanee is believed to be a result of landform or drainage changes that have isolated anadromous populations of sockeye salmon (Foerster 1968).

Juvenile kokanee and sockeye are difficult to distinguish and most of the understanding concerning kokanee developmental biology, fry behaviour and juvenile ecology is based on sockeye-focused studies (Foerster 1968). Kokanee eggs are deposited on gravels of nursery lake inlet streams or on lake beach gravels. Over fall and winter eggs develop and fry emerge in the spring. As juveniles, they move offshore, feeding primarily on zooplanktons, though also feeding on benthic invertebrate food sources. Juvenile kokanee growth and survival rates are relatively variable and are dominated by lake productivity and the intensity of feeding competition. Adults usually sexually mature at age 2 to 4 and migrate to spawning grounds in the early fall to deposit their eggs.

Whitefish

Mountain whitefish and lake whitefish are present within the Kispiox Watershed. Godfrey (1955) reported that lake whitefish has been found in only six lakes in the Skeena drainage, all of which have oligotrophic characteristics and are relatively deep, cold bodies of water. These are Swan, Stephens, Babine, Morrison, Bear, and Azuklotz Lakes. Lake whitefish, also called common whitefish, is rated by Scott and Crossman (1973) as the most important commercial freshwater fish species in Canada.

In general, lake whitefish are pelagic and restricted to cool, well-oxygenated regions of lakes in close association with the bottom. Spawning occurs usually during October through December with eggs incubating over the winter and emergence in April or May. Lake whitefish fry remain in shallow inshore waters where they feed on planktonic and benthic organisms, then move into deeper waters as water temperature increases and gradually adopt the benthic feeding habits typical of whitefish (Scott and Crossman 1973). Age of maturity varies widely, but is typically 4 to 9 years.

Mountain whitefish, also commonly called Rocky Mountain whitefish, are the most widely distributed fish species of the greater Skeena Watershed fishes, with occurrence throughout tributaries and lakes of the Skeena system (Godfrey 1955). They have been found in moderate abundance in the 20-plus sockeye rearing lakes in the system, which vary from deep, cold and opaque bodies of water to small, shallow and warm ponds (Ibid).

Mountain whitefish use a wide range of habitats for spawning and do not construct redds. Mainstream river resident and lake dwelling populations move into tributary streams to spawn (Northcote and Ennis 1994); however, McPhail and Lindsey (1970) report some cases of spawning occurring within lakes. Clearly, the habitat used for spawning should be determined for local populations. Mountain whitefish are generally nocturnal spawners (McPhail and Lindsey 1970). The eggs hatch in early spring usually at the time of ice break-up. Under-yearlings leave lateral habitat generally during the summer; there appears to be relatively little specific information in regards to yearling and sub-adult feeding, migration and habitat.

Although this whitefish has attracted moderate attention from anglers, there are surprising gaps in its essential life history and biological processes. As well, there appears to be little attention given to its fishery management or the protection and conservation of its habitat. Information gaps also exist in relation to stock recognition and the impacts from forestry or other causes affecting water quality and habitat.

Salmon and Habitat Enhancement

In 1977, Fisheries and Oceans Canada announced the Salmon Enhancement Program, commonly called SEP, with the primary goal of doubling salmon production. The Kispiox Hatchery was established as one of the five major hatcheries in the Skeena Watershed under the Community Economic Development Program. Under the auspices of SEP, habitat projects conducted throughout the watershed include incubation boxes, bioengineering investigations, biophysical studies, and habitat inventories.

The Kispiox Hatchery was initiated as a pilot project at Kispiox in 1977; however, water quantity and quality problems were not resolved until 1983, when three wells were developed that supplied stable quality and constant water temperature. Initially operated by the Kispiox Band, the hatchery was constructed close to the Kispiox-Skeena confluence in 1983. The hatchery was designed to increase the severely depressed Kispiox River chinook and coho stocks (FOC and MoE 1984). The hatchery continued to operate until 1995, when it was closed due to SEP program budget review cuts.

Re-opened in 1997, under the auspices of the GWA, and with funding from a variety of sources, the hatchery allows for a flexible fish culture program. The total chinook and coho fry and smolts from the Kispiox Hatchery and released by the Kispiox Band and the GWA between1984 to 2001 is 893,684 coho and 1,086,252 chinook, with priority stock building efforts directed to the Nangeese River, Clifford Creek and Skunsnat Creek.

In the mid-1990s, the Watershed Restoration Program (WRP) was established by the BC Government to accelerate the natural restoration of watersheds impacted by logging. The majority of the work in the first seven years of the program was comprised of instream/riparian assessments and upslope/road assessment and deactivation. In the Kispiox Watershed, fish access is the major overall impact, due to road crossings that were originally constructed as, or have become, barriers to fish migration.

In the Kispiox Watershed, impacts are complex due to naturally unstable soils when disturbed, high-energy stream systems, and low gradient valley-bottom reaches incapable of transporting large amounts of forestry-related generated sediment. Completed and identified potential restoration activities include road deactivation to prevent erosion and landslide potential, off-channel habitat restoration, riparian zone restoration to stabilize channels and diverse habitats, and stabilization of highly mobile stream channels and gravel bars often associated with logged alluvial fans. Modification of degraded or marginal fish habitat has been a major component of the WRP.

Table 1. Kispiox Hatchery Fry Release Summary (1984-2001)

		Year Released																	
		Kispiox Band													Gitxsan Watershed Authorities				
Stream	**Species**	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996*	1997**	1998	1999	2000	2001
Nangeese River	coho	22068	28196	12663	14937	27488		51223		20500							85674	58716	
	chinook				40100														
Clifford Creek	coho	5210		10000	8767	10000		2904		20486							9020	39551	
	chinook																		
Skunsnat Creek	coho	4790	12807		8765	10000		19672		19990							29611	52037	48308
	chinook																		
McCully Creek	coho	5662			16245														
	chinook		7094	14676															
Cullon Creek	coho	6265															5381		24506
	chinook		10306		4622														
Pentz Lake	coho	10000	10006																
	chinook																		
McQueen Creek	coho	3333			30656		31166				22105								
	chinook																		
Murder Creek	coho	3333		8000		30604			1276		22429								
	chinook																		
Hodder Creek	coho					10000													
	chinook																		
Salmon Creek	coho			15000															
	chinook																		
Sweetin River	coho																		
	chinook				40632	65161													
Kispiox R. - 10 mile	coho	3334																	
	chinook		10630		26135	16930													
Kispiox R. - 41 km	coho																		
	chinook		9262		8100	15026													
Kispiox River - Marty Allen's	coho																		
	chinook		9560		39300														
Date Creek	coho																		
	chinook		6139	14676	16848			1385											
Other	coho			1000															
	chinook	115	47357		85962	144304	123489	123828		98615			106000						
Total	coho	63995	51009	46663	79370	88092	31166	73799	1276	60976	44534	0	0				129686	150304	72814
	chinook	115	100348	29352	261699	241421	123489	125213	0	98615	0	0	106000				0	0	0

*Hatchery shut down in 1995 - no releases for 1996

** Broodstock taken in 1997 and 1998 but no releases until 1999

Fisheries

For the Gitxsan, salmon are the most important food source and an important cultural icon. Traditionally, sockeye followed by coho have been the most important species to First Nations groups harvesting Kispiox River fish stocks. Kispiox Village, also called Ans'payaxw, is one of seven main Gitxsan villages spread along the Skeena River and its tributaries. Gitangwalk and Lax Didax, both abandoned in the early 1900's were important villages strategically located to intercept the upstream migration of the sockeye and coho salmon migrating to the Upper Kispiox River spawning areas.

Gitxsan Fishery

The Gitxsan salmon fishery formed the principal foundation of the Gitxsan economy. Hereditary House Chiefs exercised authority for management and decision-making. The principal management tools included ownership of specific sites, access allocation, control of harvest techniques and harvest timing, and harvest limitations imposed by processing capacity. All fishing sites were considered property of the House, with particular sites being more or less delegated to individual chiefs or sub-chiefs within the House. The chief typically decided who would be fishing at specific sites and at which time. Most often, sites were delegated to wing chiefs more or less permanently, with the responsibility to ensure that the fishing ground and its products were used in accordance with Gitxsan law. Morrell (1985) comprehensively outlines the organization and management of the Gitxsan fishery on the territories before the advent of the coastal industrial fisheries and Canadian government involvement.

Fishing sites are treated as the property of a particular House. How that property right is exercised depends on the nature of the fishing gear used. The House owns dipnet and small basket trap sites. However, several Houses from various clans might share in the harvest distribution from productive weir and trap sites at villages, which were strategically located to access the fishery. It was and is also the responsibility of the chiefs to oversee the processing and distribution of the fish, so that all members of the House received sufficient amounts, even if they could not provide for themselves directly because of age, disability, or other circumstances.

Fundamental conservation elements were practiced; waste was forbidden. Processing capacity was limited by smokehouse infrastructure, particularly the amount of space available on the lower poles, where fish were hung in the first stages of the drying process, and by the number of fish that could be dressed in the available time. When the daily processing limit was reached, the traps were removed from the water, and the salmon were allowed to proceed upstream. The predominant use of live-capture gear enabled the people to selectively harvest desired species, with the remainder released unharmed (Morrell 1985).

Fishing Site Name	Site Location	Site UTM (NAD 27)
Anspayaxw	Mouth of Kispiox River	582550, 6134000
Agwi'tin	Kispiox River R & L banks	582900, 6137370
Xsi Ankalamsit	Kispiox River R & L banks	581420, 6143600
Xsa Gailexan Xsa Angexlast	Kispiox River R. bank	581280, 6143180
Antkilakx	Kispiox River L. bank	580060, 6147010
Tsihl 'niit'in	Kispiox River R. Bank	597310, 6150515
Xsa An Seegit	Kispiox River L. Bank	576940, 6151080
Wiluuskeexwt	Kispiox River R. Bank	unknown
Miinhlgwoogoot	Kispiox River L. Bank	unknown
An'Uxwsdigehlxw	Kispiox River R & L banks	unknown
Katgaidem	Kispiox River L. Bank	569250,6158270
Xsi Luukailgan	Kispiox River R & L banks	569890,6158140
Wiluuwak	Kispiox River L. Bank	560410,6159460
Nadak	Kispiox River R. Bank	588190,6160100
Sgansnat	Kispiox River L. Bank	549800,6168050
Luu'Andilgan	Kispiox River L. Bank	543400,6168740
Gitangwalk	Kispiox River L. Bank	539150,6170590
Lax Didax	Stephens Creek	527610,6179830

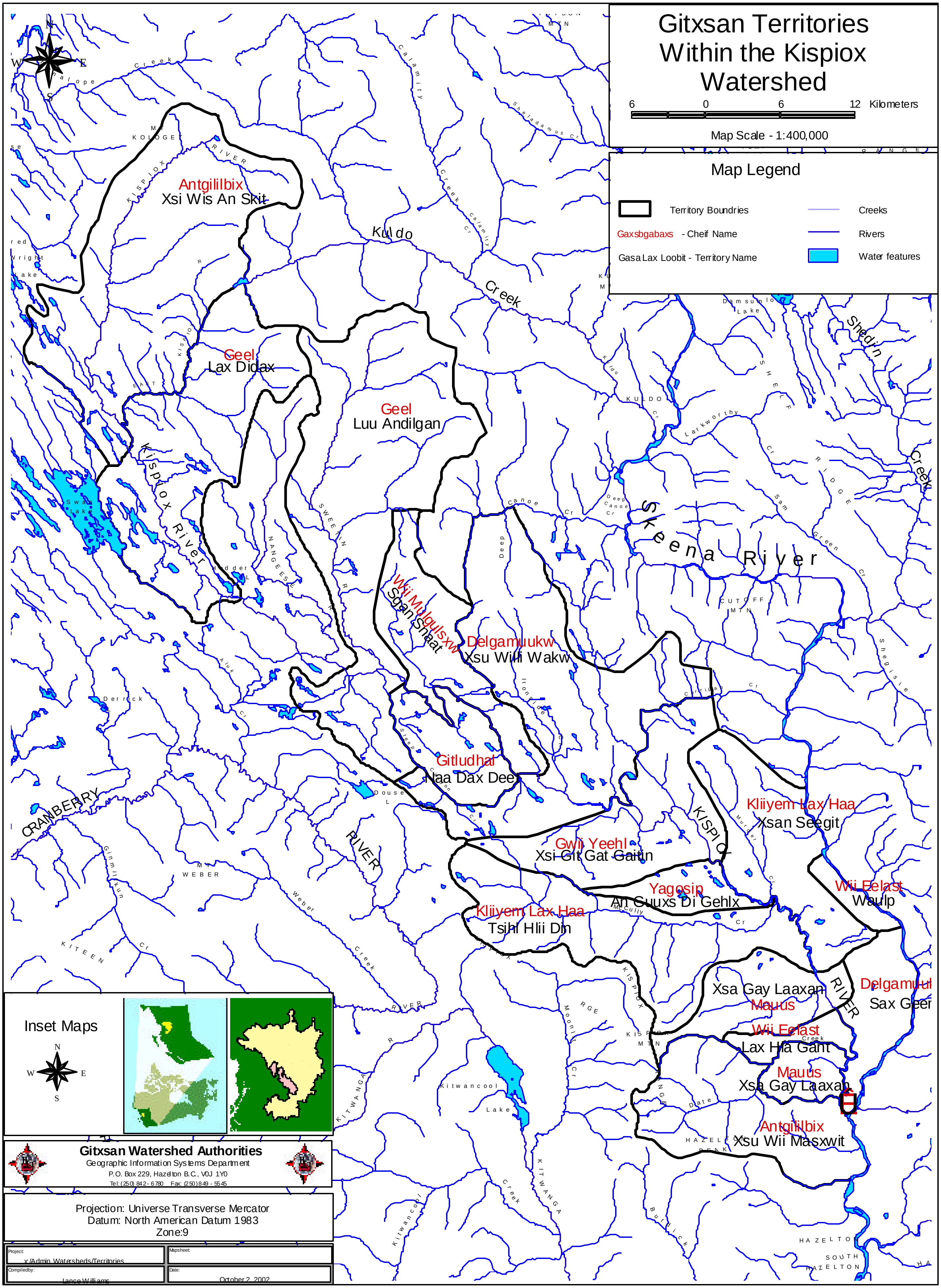
Table 2. Traditional fishing sites and fishing villages on the Kispiox River.

Harvest and Processing

The abundant and predictable salmon runs provided the opportunity for the people to harvest and preserve a high quality staple food in a few months of intensive effort. In June, the majority of House groups would congregate in their seasonal villages to prepare fishing gear and firewood and generally get ready for the salmon fishery.

The first salmon, the chinook or spring, usually reached the Kispiox River in late June, marking the start of the fishery. This was the occasion for celebration and thanksgiving with the First Salmon Ceremony, in which the salmon were ritually prepared to ensure and herald an abundant harvest. At Kispiox River villages, springs were readily caught in season, as they were concentrated by the strong river currents during the snow melt season. Following the spring salmon came the two dominant Babine sockeye runs. The sockeye were the most desired fish owing to a fat content that facilitated smoke-drying and were fished heavily until the pink salmon showed up, by which time sockeye needs were usually met. Pinks are generally much less desirable, and if sockeye were still needed, fishing would take place in the deeper and swifter waters that the pinks avoided. The peak of the pink salmon marked the end of the sockeye and signalled the beginning of berry picking and high country hunting.

Coho and steelhead would reach the Kispiox in mid to late August and be harvested there, but the main coho fishery would occur in the many smaller, though important, tributary streams on the territories. The coho were especially useful to the people who did not go to the Kispiox mainstem, but stayed out at their villages or camps on the territories. Due to their widely dispersed nature throughout the watershed, coho were often harvested and processed in headwater locations. In the same way, lake and stream fish such as rainbow trout, steelhead, Dolly Varden, bull trout and whitefish were also fished and processed in their respective habitats.



Gitxsan Territories Within the Kispiox Watershed
6 0 6 12 Kilometers
Map Scale - 1:400,000
Map Legend
Territory Boundries
Gaxsbgabaxs - Cheif Name
Gasa Lax Loobit - Territory Name
Creeks
Rivers
Water features
Antgililbix
Xsi Wis An Skit
Geel
Lax Didax
Geel
Luu Andilgan
Wii Mulgulsxw
Sgan Snaat
Delgamuukw
Xsu Wilii Wakw
Gitludhal
Haa Dax Dee
Kliiyem Lax Haa
Xsan Seegit
Gwii Yeehl
Xsi Git Gat Gaitin
Yagosip
An Guuxs Di Gehlx
Kliiyem Lax Haa
Tsihl Hlii Din
Wii Eelast
Waulp
Xsa Gay Laaxan
Mauus
Delgamuukw
Sax Geer
Wii Eelast
Lax Hla Gant
Mauus
Xsa Gay Laaxan
Antgililbix
Xsu Wii Masxwit
Kuldo Creek
Skeena River
Kispiox River
CRANBERRY RIVER
KISPIOX RIVER
Inset Maps
Gitxsan Watershed Authorities
Geographic Information Systems Department
P.O. Box 229, Hazelton B.C., V0J 1Y0
Tel: (250) 842 - 6780 Fax: (250) 849 - 5545
Projection: Universe Transverse Mercator
Datum: North American Datum 1983
Zone:9
Project: x:/Admin Watersheds/Territories
Compiledby: Lance Williams
Mapsheet:
Date: October 2, 2002

Salmon were eaten fresh during the summer, but the major directed fishing effort was focused on the preserving of salmon for use during the rest of the year. The salmon was split and hard-dried over slow, smoky fires in smokehouses, then stored in bark-lined excavated storage pits and covered over with the excavated dirt. These pits, often called cache pits, were usually located on drier (sandy or gravelly) soil types, and close to the village, winter camps or other home places.

At the Kispiox River canyon and swift water locations, where the salmon tended to be concentrated by strong currents, large woven baskets and/or lashed wooden strip traps were ingeniously made, some incorporating delivery chutes that moved the trapped fish to a waiting fisher who transferred it to the shore. Trap sizes varied, with larger ones being lowered and raised with stout poles operated by a strong and frisky crew. The various traps and dip net gear used depended on site location, fish quantities needed, and the number of people available to fish the gear and provide processing capacity.

At some locations on the Kispiox River mainstem, and particularly on its tributaries, salmon and steelhead were traditionally caught primarily with weirs (t'in) inset with a variety of large woven cylindrical or barrel basket (moohl) traps. Undoubtedly the most productive and ingenious of fishing gear, these weirs were built either right across smaller streams or on the mainstems, built out on an angle to guide the migrating fish into shore-side traps. The wide variety of weirs and contiguous traps used were matched to the species, environment, placement, and building materials available.

Many seasonal fish camps positioned along the mainstem were used to harvest fish. Table 2 describes selected presently known traditional fisheries ascending upstream from Kispiox Village at the Skeena River confluence. The "grease trail," which runs from Kispiox Village to the Nass drainage passed along the eastern side of the Kispiox River and provided access to the above fish harvesting sites, as well as many other resource gathering localities.

Smaller tributaries often were fished with weir placements just upstream of the confluence with the mainstem, while larger tributaries had weirs strategically positioned at lake outlets. These two types of sites are hydrologically suited for weirs because they are relatively protected from sudden floods following intense rainstorms. Gear types suited to single fish harvest included specialized dipnets with a closable mouth (bana) and spears. Spears were utilized in shallow, clear tributary streams where fish were readily visible.

For the Gitx̲san, salmon represented the most important cultural foundation as well as the substantial, singular element of diet. Ans'payaxw was the heartland of many adjacent Gitx̲san villages and was the largest aboriginal settlement in the Kispiox Watershed. Many other ancient fishing and processing locations existed on the Kispiox mainstem, particularly at tributary mouths. The Sweetin, Nangeese, Skunsnat, Cullon, Murder, and McCully mainstems and their larger tributaries had camps strategically located to take advantage of fishing opportunities.

The Gitx̲san fishery maintained an understanding of the tools and techniques that allowed management for optimal utilization and escapement on a stock-by-stock basis. These modes of management enabled the fishery system to adapt to changing natural situations and conditions, and facilitated allocation and regulation in managing the fishery, while encouraging habitat protection.

Post-Contact Cultural Context

First Nations peoples of the upper Skeena and Kispiox Watersheds managed the coho, sockeye, chinook, pink salmon and steelhead fisheries of their territories up to the mid 1870's. At this point, the incursion of Euro-Canadians with their colonial society concepts and the establishment of coastal industrial fisheries at the mouth of the Skeena River initiated a period of transition.

Early industrial development on the British Columbia coast saw the development of many new canneries, including, in 1877, the first commercial salmon cannery on the Skeena River. Thirty years later, as markets were developed and investors looked for a certain return on their capital, fourteen canneries supported by a fleet of 870 wind and people-powered boats were in operation. This period was characterized by steady growth in both the number and size of the canneries, competition for sockeye, and the move to begin canning other species besides sockeye. In 1907, the canned pack totalled just over 159,000 cases (48 pounds each) of which two-thirds were sockeye, or approximately 1.6 million sockeye.

At the turn of the century, consolidation within the fishing industry due to two years of strikes and the introduction of the "Iron Chink," sent the surviving cannery management on renewed hunt for fish (Meggs 1991). A campaign by cannery operators wanting a larger share of the fish and a guarantee of harvesters and plant workers - two good reasons to get Indian food fishers away from their weirs - was enforced by the Department of Marine and Fisheries (Newell 1993). The legal action prohibited weirs used by aboriginal fishers and the sale of fresh and processed fish throughout the Skeena Watershed. The legal action focused on the weirs at Wud'at, also known as Tsa Tesli (where the lake ends), which was the principal salmon season village on Babine Lake (Helgerson 1906). It was located primarily on the left bank of Babine River and is, for the most part, currently overlaid by DFO's counting weir camp. Salmon fishing was conducted as a cooperative clan endeavour with the fish caught in weirs across Nilkitkwa Lake and the upper Babine River. The dispute was somewhat settled with the Barricade Agreement of 1906; however, to this day, there are bitter feelings remaining with the Lake Babine Nation.

At the turn of the twentieth century and continuing up to 1990, as fish stocks steadily declined, federal fishery administrators directed pressure against native fishers. Enforcement of the Fisheries Act, prohibiting weir utilization from 1905 to 1913, made it difficult for Gitxsan fisheries to continue as in the past. To replace the banned weirs and traps, gillnets were introduced. This change in gear required a change in fishing sites with new areas of harvest being established. In general, government fisheries policies in the upper Skeena Watershed in the period between 1870 and 1980 resulted in a legacy of over-fished stocks, conflict, and marginalization of Gitxsan people.

The trend to relocate the Skeena River salmon fishery, from one dispersed and close to spawning grounds to the mouth of the Skeena, had many effects. This impact on the Gitxsan, particularly Kispiox River fisheries, coupled with encountering another culture socially and politically, was considerable.

Over the period of the last century, the Skeena salmon fishery has seen the traditional management concepts of optimal utilization and single stock conservation replaced by two objectives. First, management and fishing effort has been directed to an oceanic, mixed-stock fishery with highly efficient capture methods, which have led to a depletion of many stocks. Secondly, this loss of diversity has been intensified by the enhancement of two already productive Babine sockeye stocks, leading to further over fishing and increased fishing pressure on the remaining natural coho, steelhead, chum, chinook and sockeye stocks.

Over the last decade, the Gitxsan Watershed Authorities, as part of the Skeena Fisheries Commission, and working with the support of the Aboriginal Fisheries Strategy, have been active in fishery management on the Kispiox River. A two-pronged strategy has been developed based on Gitxsan practices and concomitant rights, and the tremendous changes in the Skeena River salmon fishery. The first involves the prioritization and implementation of strategic changes related to community adjustment, particularly economic development. The second refers to operational objectives that are a refinement of selective fishing methods, alongside an emphasis on quantitative and qualitative habitat and stock assessments applicable to sensible decision-making.

Currently, Kispiox Watershed salmon harvested for personal use, societal use, and ceremonial use are primarily gillnetted and to a small degree dip-netted. The importance of the fishery, which is a blend of food resource, trade capital, cultural expression, and connection to ancestral practices, cannot be overstated.

Recreational Fisheries

The Kispiox Watershed attracts a large sports fishery that includes local residents and non-residents. Adult steelhead returning to the Kispiox River are among the largest steelhead in the world and the river is an international destination for anglers. Generally, angler access to fishing sites is easy.

Local anglers fish trout and char in the many lakes of the Kispiox Watershed. River angling effort is directed primarily to steelhead, coho and chinook from mid summer to late October. Since 1969, various creel surveys (Pinsent 1970, Remington *et al.* 1974, Whately 1977, Lewynsky and Olmstead 1990, Tallman 1997) have estimated or determined the angling effort, catch per unit effort (CPUE), gear fished, rate of release and use of guide services. There were recently two licensed guides that operate on the river, and an additional guide who has not operated since 1993, with a total allocated quota of 493 angler days (Baxter 1997). Seldom are quotas fully utilized, because water conditions, and thus fishing conditions, can deteriorate rapidly due to seasonal heavy rains in the watershed.

The Kispiox River is designated Class II Waters, September 1 to October 31, and a Steelhead Stamp is mandatory for that period. General restrictions state no fishing in any stream January 1 to June 15. Regulations include a bait ban except on McQueen Creek, with no angling from boats. Powerboats are not allowed. The annual catch quota is one steelhead a year from the Skeena Watershed, with no fishing in any stream, from January 1 to June 15 (Anonymous 2002). Tallman (1997) reported that in the fall of 1996, according to those anglers interviewed, all steelhead caught were released, 62% of the anglers were of foreign residence, fly fishing was the predominant method used (80%), and compliance with required regulations was fairly high (over 90%). A sports harvest of Kispiox steelhead most likely occurs in the Skeena River bar fishery, downstream from Terrace. Total estimate of the angled fish is unknown for the Kispiox Watershed.

Land Use and Development Activities

The principal development activities are logging, agriculture, population and settlement, linear development, and recreational activities, which are described in the following section.

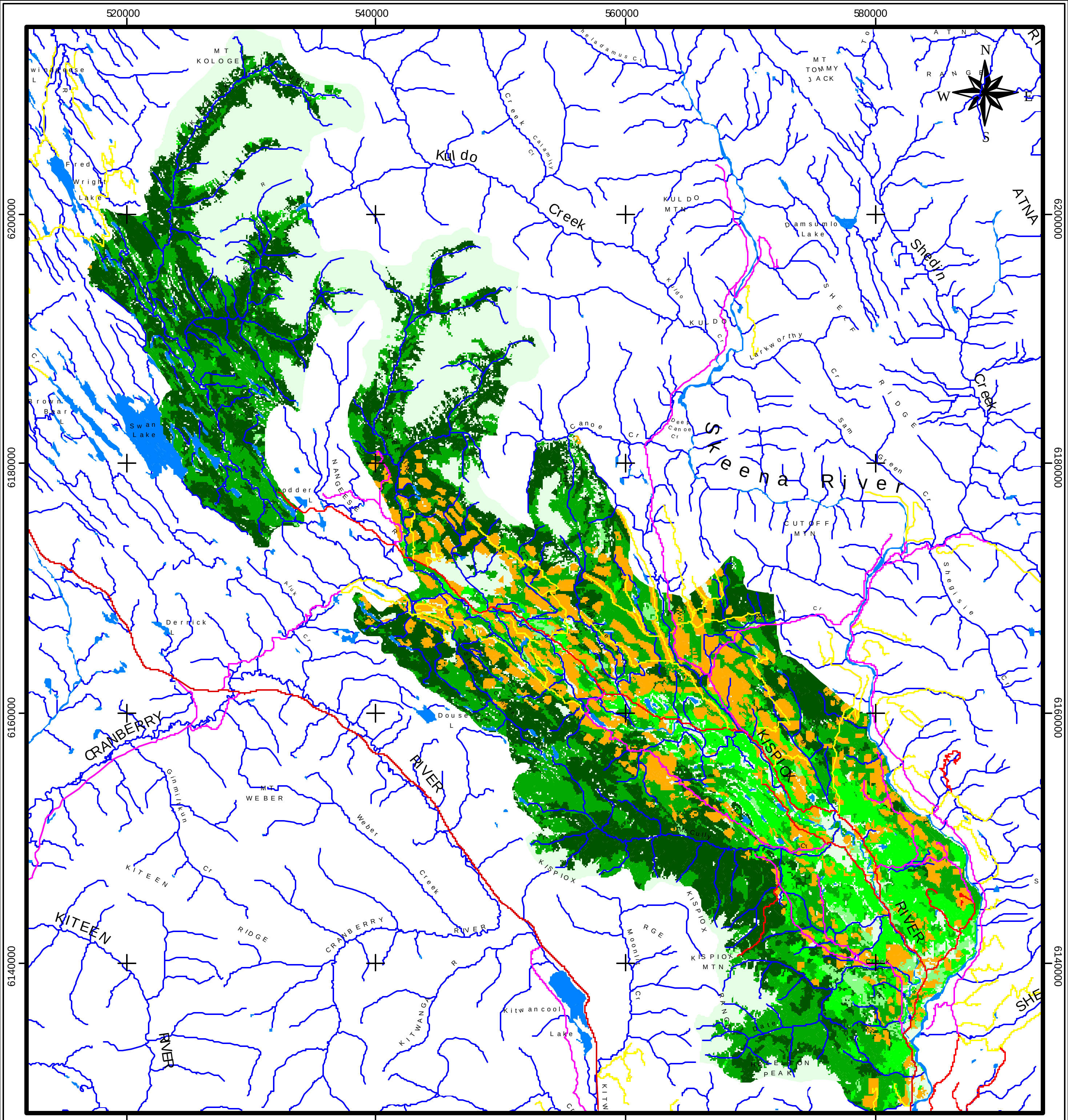
Forest Resource Development

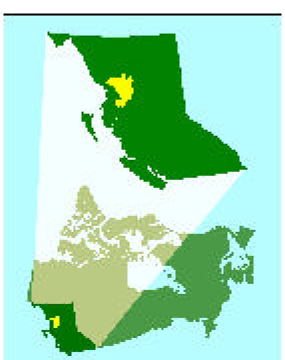
The Kispiox River Watershed is located within the Ministry of Forests, Kispiox Forest District. With completion of the railroad to the Skeena in 1912, forest development activity began with agricultural clearing by settlers, and by 1920 the pattern of land use and settlement was well established. Small-scale lumbering led to small bush mills when the post-WW II demand for lumber skyrocketed. In the early 1950's, Columbia Cellulose was granted TFL # 1, which initiated the centralization of license holding and milling capacity in the Skeena Watershed that is observed today.

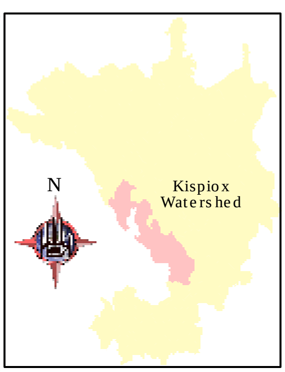
In 1958, only 23 km of road were completed on the Kispiox River, with logging operations concentrating on easily available, high quality timber. In 1959, some 70 km of road bordered the river, while by 1966, approximately 90 km of road accessed the east side of the river (Taylor and Seredick 1968). Over the years up to the present, industrial forest activities within the watershed have waxed and waned, as the cut was concentrated on other watersheds (Gitsegukla and Suskwa), and as distance off the highway increased.

The 1980's and the early 1990's saw the volume and rate of development expand dramatically, particularly across the northern, low elevation portion of the watershed, from Murder Creek through to the Nangeese River. The early 1980's also saw completion of the Mitten Main connecting the Kispiox Valley to Highway 37; this road facilitated development on the western flank of the river and transport of logs to the saltwater Port of Stewart. The 1990's also saw development established in Date and McCully Creeks, though to a lesser extent than the northeastern development.

For the last five years, a common problem throughout the Interior Cedar Hemlock (ICH) zone has been the escalation of *Dothistroma* needle blight affecting pine stands regenerating in cutblocks (Ministry of Forests 2002). This disease is endemic throughout pine forests worldwide, and when active, causes pine trees to lose all their needles, thereby killing the trees. The spread of *Dothistroma* has been facilitated by the last five cool, moist summers that are due to the changing climate. Stands that have been affected the most are where pockets of cold, moist air can be stagnant, i.e. valley bottoms and depressions between ridges. Basically 90% of all pine plantations in the Kispiox and Cranberry Timber Supply Areas (TSA) are affected to a degree, with 2% of stands having greater than 10% mortality currently. The disease will continue to persist unless there are hot, dry summers for a decade.







Map Legend

- Highways
- Forestry Service Roads
- Logging Roads
- Canadian National Railroad
- British Columbia Railroad
- Abandoned BCR
- Roads
- Creeks and Rivers
- Water Features
- Cutblocks

Watershed Stand Age

- Stand Age 0 - 1 (0 - 20 years)
- Stand Age 2 - 4 (21 -80 years)
- Stand Age 5 - 6 (81 - 120 years)
- Stand Age 7 - 8 (121 - 250 years)
- Stand Age 9 (251 + years)

Kispiox Watershed Showing Forestry

10 0 10 Kilometers

Map Scale - 1:440,000

Map Prepared By:
Gitxsan Watershed Authorities
Geographic Information Systems Department
P.O. Box 229, Hazelton B.C., V0J 1Y0
Tel: (250) 842 - 6780 Fax: (250) 842 - 6709
Map Drawn By: Lance Williams
Projection: North American Datum 1983
Zone: 09
Date: February 28, 2003

The forest development activities described above raised fish habitat and population concerns with First Nation peoples, local residents, and government fisheries agencies. Since 1995, the Watershed Restoration Program (WRP) has been involved in assessing the logging related disturbance in relation to fish, fish habitat, and upslope sediment producing areas. Watershed health has benefited from hydrological recovery, road deactivation, as well as riparian, in-stream, and off-channel site works. A large contribution of the WRP has been to increase the awareness in the forest sector of best management practices regarding water quality, fish and fish habitat. Currently, very little information exists that delineates cumulative effects on fish and fish habitat.

The 2000-2005 Kispiox Watershed Restoration Plan (Triton 2001) summarizes the WRP investment to date ($1.1 million) and outlines proposed watershed restoration goals, presenting a four-year plan focusing on in-stream and riparian rehabilitation components. Proposed works include riparian and instream assessments and treatments occurring in thirteen of the sixteen sub-basins to rehabilitate impacted conditions as well as reduce risk through road deactivation and restoring fish passage with culvert replacements. Priority restoration activities budgeted investment totals approximately $1.3 million dollars.

Future trends regarding forest development activities are uncertain. Skeena Cellulose Incorporated (SCI), which holds the majority of the allocated cut in the Kispiox Watershed has terminated its forest development activities due to a series of financial difficulties. This also affects the Small Business Program cuts, as SCI was the predominant buyer of the Small Business Program timber. Adding to this uncertain future are high softwood tariffs, high stumpage rates, and BC Government forestry legislation and policies that are predicted to change. The watershed continues to be managed under the direction of the Kispiox Land and Resources Management Plan, which provides land use management zoning with objectives and strategies (Ministry of Forests 2001b).

Mineral Resource Development

Exploration and utilization of rocks, crystals and minerals within the watershed have been occurring since Gitxsan people settled into the watershed many thousands of years ago. Currently, mining development in the Kispiox Watershed is limited to exploration of mining claims for coal and vein metallic mineralization located close to Kispiox. The 13 mineral occurrences are centred in the Kispiox Village area. The main type of mineral occurrence is in sedimentary types with 5 coal showings, 1 marl showing, and 1 fireclay occurrence. There are 3 polymetallic veins containing silver, lead, zinc, and gold as well as 3 porphyry copper-molybdenum-gold showings. Metallic mineral potential evaluations for the watershed are broad based and non-specific. Based on geology and distribution of known mineral occurrences, the area has been delineated into mineral tracts that rate the watershed as having a low mineral potential rating.

Transportation and Utilities

The Kispiox Valley has been used for thousands of years as a transportation corridor and to access territorial resources. The existing transportation network in the watershed reflects 80 years of steady development based on Gitxsan trail infrastructure. Generally, trails were initially widened for packhorses and later improved for wagons, then further improved for vehicular traffic. Overall, the transportation development pattern has been spurred by the motive to extract forest products.

The east side of the Kispiox River hosts the major road, the Kispiox Trail, which heads northwest from Kispiox Village, branching twice to accommodate two crossings of the river and provide access infrastructure on the west side. Both west side roads provide access out of the drainage and into the Nass Watershed. Close to Cullen Creek, the Kuldo FSR swings north to provide access to the Skeena and Shedin drainages. There are numerous branch access roads, in various states of deactivation and repair, to accommodate forest development activities within most of the tributary basins. Most roads, both major and secondary, are gravel surface. Fish access has been impeded to an extent due to culvert placement and rerouting of watercourses on the Kispiox Trail. Secondary forest development roads crossing unstable slopes, and roads crossing alluvial fans of high-energy systems, have caused impacts to fish bearing streams and could have a high rehabilitation cost. The Kispiox River lends itself to riverboat travel in limited sections and is non-motorized use only. Rafting is by far the most popular method of on-river travel, with many parties descending the river spring through fall.

Utility corridors consisting of BC Hydro transmission lines and Telus phone cable servicing residential developments, pass up the east side of the valley for approximately 40 km, and, to a limited extent, on the west side of the river. These corridors usually parallel access roads and the river is crossed twice to service residents.

Population and Settlement

The Kispiox valley has been home to Gitxsan people for thousands of years. Euro-Canadian settlers arrived following completion of the railroad in 1914, attracted by the agricultural possibilities. This population base remained relatively stable until the early 1970's, when rural living and hobby farming became a more popular lifestyle. Currently, approximately 650 people reside in Kispiox Village (SNDS 1998) and an additional 250 people reside on valley bottom lands, mostly north of Kispiox Village and adjacent or close to the Kispiox River.

Historically, and up to the recent past, many valley residents derived their income from the fishing and forestry sectors; however, severe job losses have curtailed this income. There are currently an estimated 18-23 relatively small ranches in the Kispiox, with approximately 460 breeding cows that graze on Crown land. Most residents derive their income from service sector employment in the Hazelton area. Land titles are typically large (greater than 60 ha), with Agriculture Land Reserve restrictions regulating the majority of holdings. Population trends project growth for Kispiox Village and a stable rural resident factor for the rest of the valley. Recreational and tourism-based incomes are projected to grow over the next decade.

Cumulative Effects

The decline of various salmon stocks in the watershed has resulted from the cumulative effects of land use practices, fish harvest management, enhancement practices, and natural fluctuations in environmental conditions. Because of the longitudinal nature of river and stream ecosystems, the accrual of effects is significant along both spatial and temporal dimensions. Activities that take place in headwater streams influence the suitability of habitats in downstream reaches – for example, temperature change and sediment input – can affect the response of ecosystem components to additional stresses. Similarly, activities that have occurred in the past may influence current habitat conditions through residual effects.

Accumulation of localized or small impacts can result in cumulative watershed level changes to fisheries. Accumulations of effects, often from unrelated human activities, pose a serious threat to fisheries (Burns 1991). The effects of increased sedimentation on spawning gravels will be the same, whether the sediment resulted from livestock grazing, logging, road building, or other activities. The same is true of other variables such as water temperature, dissolved oxygen concentrations, channel morphology, or quantity and distribution of instream cover (Remington 1996). Loss of habitat elements such as large woody debris can have effects lasting from 80 to 160 years (Sedell and Swanson 1984). Cumulative losses of one element of fish habitat may result in long-term problems.

Within the context of conserving and restoring fish populations and their habitats in the Kispiox Watershed, the concept of cumulative effects has two significant and important underlying premises. Fundamentally, individual actions that are by themselves relatively minor may be damaging when coupled with other actions that have occurred or may occur elsewhere in the watershed. Historical and current patterns of land use activities and practices, particularly forest development, though other factors as well, have a significant bearing on how salmonid populations will respond to further anthropogenic disturbances. Within the Kispiox Watershed, traditional resource extraction management strategies that have relied on site-specific analysis without regard for other activities that have or may occur within the watershed have generally failed to protect salmonid populations against cumulative effects.

Secondly, declines in the Kispiox Watershed salmonid populations are the product of numerous incremental changes in the environment and fish populations. Recovery and conservation of salmonid populations may proceed in a similar way - through incremental improvements in habitat conditions, using alternative management strategies in relation to fish harvesting, and viewing the watershed as connected in regard to land use activities and practices. This means that individuals can and must play an active role in salmonid conservation and restoration even if tangible efforts are slow to manifest.

To define cumulative impacts to fish habitats in the Kispiox Watershed, short-term and long-term datasets that measure water quality are critical. Few adequate datasets exist within the greater Skeena Watershed, except, perhaps for studies conducted in Babine Lake. Environmental parameters not usually included in water quality sampling are also important to stream health. These include measures of the integrity of riparian areas, timing and measures of snowmelt rates in non-forested areas (hydrological recovery after logging or other land disturbance), measures of runoff rates in settlement areas, measures of stream channel form and rates of change, and monitoring of climatic changes.

Kispiox Watershed Management Issues

The Kispiox Watershed has highly productive habitat for all six Pacific salmon species as well as being one of the top five salmon producers for each of the species in the Skeena Watershed. This fish community contributes to the ecology, nutrient regime and structural diversity of the drainage and provides strong cultural, economic and symbolic linkages, particularly for First Nation peoples, as well as supporting recreational and commercial fisheries. The very high fishery values are rooted in the outstanding spawning and rearing habitat.

The Kispiox Watershed has been impacted to a certain extent by large-scale industrial forestry activities, particularly from the mid 1970's through to the late 1990's; however, it is difficult to define post-logging impacts due to a lack of land use analysis. There is concern regarding timber harvesting impacts to mainstem and tributary channels, riparian zones, as well as to valley-bottom, low-gradient fans from sediment and bedload aggradation at tributary mouths. Changes in snowmelt timing and spring flood volumes are unknown in the heavily logged tributaries.

Kispiox Watershed land use issues include agriculture, rural residential development, recreation and tourism, and forestry activities with a high, unsustainable rate of cut. These activities need to take into consideration fish habitat conservation at both the site specific and watershed levels. Maintaining adequate escapement of salmon through the Alaskan and Canadian mixed stock commercial fishery is critical to sustaining fish populations in the watershed. Funding directed towards stock assessment and habitat studies within the watershed is relatively small and needs to be seriously considered.

Defining conservation levels requires understanding fish values and the status of the fish resources, as well as basic habitat knowledge and values. What and where are critical areas for fish? What are the capability and constraints for production? What are the population and habitat sensitivities? To answer these questions, funding is required. In relation to defining conservation levels and hence sustainability, current planning to date in the watershed has been unsustainable.

Information constraints prevent many parameters from being articulated that define cumulative impacts to the tributary sub-basins and the Kispiox Watershed as a whole. The lack of detailed information about fish populations and their habitats, currently and in the past, limits knowledge that relates to conservation goals. The first and most critical step in resolving land and resource use planning problems is in recognizing that problems exist, then their nature and magnitude can be defined. This lack of basic information concerning the status of fish populations and habitats does not facilitate strategic and operational conservation solutions.

Knowledge of run timings, an inventory of critical rearing habitats, and a fisheries management regime directed toward preserving Kispiox Watershed salmon stocks will do much to ensure fish conservation goals.

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Glossary and Acronyms

100-year floodplain: That area adjacent to the channel that has a 1 in 100 chance of being flooded in any given year.

abiotic: Something that is not living, for example, rock.

adfluvial: Migrating between spawning areas in streams and rearing areas in lakes or ponds.

aggradation: The general accumulation of unconsolidated sediments on a surface, which thereby raise its level. A large range of mechanisms can be involved, including glacial, fluvial, aeolian, marine, and slope processes. In terms of channel morphology, its means raising of the channel bed elevation due to sediment deposition.

alluvial fan: An area where large amounts of sediment are deposited by a stream as the stream gradient rapidly decreases. This is common where smaller steep streams enter wide valleys with a low gradient. The decrease in gradient as the stream enters the wide valley causes a decrease in stream power, which allows sediment to be deposited, forming an alluvial fan. At any one time, only a portion of the fan is active and actively being built up by sedimentation. As sedimentation continues and the height of the channel increases, it becomes unstable since lower areas are located on other parts of the fan. At some point, often during a major flood, the channel location will switch to a steeper gradient and the old channel will become abandoned.

alevin: Stage of development of the salmonid embryo from hatching to absorption of the yolk sac. The yolk sac is generally the sole source of energy at this stage,

anadromous fish: Fish that move from the sea to fresh water for reproduction.

annual maximum 24-hour precipitation: The largest amount of precipitation that has occurred in a 24-hour period over the course of one year.

annual minimum flows: The lowest daily water flows in a stream, that have occurred within a given water year.

annual peak flow: The highest streamflow or discharge recorded at a stream gage during each water year. Annual peak flows are reported on a water-year basis, defined as October 1 through September 30.

aquifer: A body of rock or soil that can collect groundwater, and can yield water to wells and springs. A groundwater reservoir that can be either confined or unconfined.

aspect: Aspect of a slope is the direction toward which the slope faces.

avulsion: lateral displacement of a stream from its main channel into a new course, usually across its floodplain or alluvial fan. Normally this is caused by channel aggradation or channel blockage.

backwater: A pool type formed by an eddy along channel margins downstream from obstructions such as bars, rootwads, or boulders and sometimes separated from the channel by sand or gravel bars.

bank erosion: A loosening and tearing away of soil and rock by water from the edge of a stream, usually resulting in an enlargement of the stream.

baseflow: Typical flow for a given stream at a particular time of the year. The flow of water derived from the seepage of groundwater or through-flow forms only a proportion of the flow, with snowmelt, glacial melt, and rainfall representing various amounts.

bed fining: An increase in the amount of fine sediment (<2mm) in the stream channel bed.

bench: A horizontal surface or step in a slope.

benchmark: An initial context for evaluating stream or terrestrial habitat quality. Derived from reference conditions, analysis of regional survey data, and published information.

(BMP) best management practice: Structural, nonstructural, and managerial techniques recognized to be the most effective and practical means to reduce surface- and groundwater contamination while still allowing the productive use of resources.

bioengineering: The application of vegetative practices combined with structural practices to provide a stable site condition. Common structures include brush layers, cuttings, live stakes, willow wattlings, and live pole drains used unstable slopes or disturbed hillside seepage zones..

biota: Living matter.

biotic: Something that is living, or pertaining to living things.

borrow pit: An area where rock or soil is excavated from the hillside.

braiding: Branching of a stream into many channels.

broodstock: Fish collected and spawned artificially for purposes of artificial propagation or transplantation.

calving-off: The rapid movement of soil from the steep leading edge of a large landslide.

canopy cover: The overhanging vegetation over a given area.

carrying capacity (biological): The maximum average number of a given organism that a stream or section of stream can maintain under a given set of conditions and over a specified period. Carrying capacity may vary from season to season or from year to year.

channel: the preferred linear route along which surface water and groundwater flow as streams, usually in a concave-based depression.

channel complexity: A term used in describing fish habitat. A complex channel contains a mixture of habitat types that provide areas with different velocity and depth for use by different fish life stages. A simple channel contains fairly uniform flow and few habitat types.

channel confinement: Ratio of bankfull channel width to width of modern floodplain. Modern floodplain is the flood-prone area and may correspond to the 100-year floodplain. Typically, channel confinement is a description of how much a channel can move within its valley before it is stopped by a valley wall hill slope, bedrock, or terrace.

channel gradient class: Channel gradient is the slope of the channel bed along a line connecting the deepest points (thalweg) of the channel. Channel reaches are then grouped according to gradient into stream gradient classes (<1%, 1-2%, 2-4%, etc.)

(CHT) Channel Habitat Types: Groups of stream channels with similar gradient, channel pattern, and confinement. Channels within a particular group are expected to respond similarly to changes in environmental factors that influence channel conditions. In this process, CHTs are used to organize information at a scale relevant to aquatic resources, and lead to identification of restoration opportunities.

channel pattern: Description of how a stream channel looks as it flows down its valley (for example, braided channel or meandering channel).

channelization: Zones of artificially stabilized or diverted channels, usually resulting in straighter and deeper channels.

char: A close relative to trout, another salmonid. Bull trout, Dolly Varden and lake trout are species of char.

Class I and II angling waters: The *Wildlife Amendment Act*, 1989, enabled the designation of Class I and II angling waters in recognition of extremely high sport fishing values. This includes the existence of special fish, as well as a highly desirable fishing experience.

Clearcut equivalency: A measure of hydrologic recovery. As a clearcut regenerates, the impacts of cutting decrease and it becomes less of a clearcut. Such an area is assigned a clearcut equivalency percentage, which diminishes over time with increasing vegetative cover.

CMP: Corrugated metal pipe, usually round.

cohesive: When describing soil, tendency of soil particles to stick together. Examples of soils with poor cohesion include soils from volcanic ash, and those high in sand or silt.

complex pool: Portion of stream with reduced velocity, a smooth surface, and deeper water; usually with undercut banks, thick bank vegetation and/or associated with large woody debris.

conifer: Cone-bearing tree, generally evergreen (although certain exceptions occur; for example, larch is a deciduous conifer), having needle-like leaves. Examples include pine, subalpine fir or balsam, cedar, and hemlock.

connectivity: The physical connection between tributaries and the river, between surface water and groundwater, and between wetlands and these water sources.

consumptive use: The quantity of water absorbed by the crop and transpired or used directly in the building of plant tissue, together with the water evaporated from the cropped area.

contour interval: A line of equal elevation drawn on a topographic map.

counting weir: A fence constructed across a stream to enable accurate counts of fish by species, sex, sexual maturity, etc.

cover: An area of shelter in a stream that provides aquatic organisms with protection from predators and/or a place to rest and conserve energy. This is often overhanging banks, LWD, or boulders.

cross-drain culvert: A culvert that drains water which collects within the inside ditch of a road to the outside slope of the road.

crown closure: The amount of canopy cover in a given area.

cutblock: An area from which trees have been harvested, also called a block.

cut slope: The sloping excavated surface on the inside of a road.

debris flow: A type of landslide characterized by water charged, predominantly coarse-grained soil and rock fragments, and sometimes large organic material, flowing down a pre-existing channel. Sometimes referred to as channelized debris flow, debris torrent, or mudflow.

delta: At a river's mouth, the sediment deposits found between the diverging channels.

detention pond: A pond constructed to temporarily store water, thereby allowing sediment to settle out of the water. Also known as a settling pond.

DFO: Department of Fisheries and Oceans, a federal agency whose legislative mandate is management and administration of Pacific salmon.

discharge: The volume of water flowing in a given stream at a given place and within a given period of time, usually expressed as cubic meter per second (m^3/s).

disturbance: Events that can affect watersheds or stream channels, such as floods, fires, human related land use activity, or landslides. They may vary in severity from small-scale to catastrophic, and can affect entire watersheds or only local areas.

downcutting: When a stream channel deepens over time.

drainage basin: A geographic and hydrologic subunit of a watershed, often referred as a sub-basin.

ecoregion: Land areas with fairly similar geology, flora and fauna, and landscape characteristics that reflect a certain ecosystem type.

ecosystem: An ecological system or unit that includes living organisms and nonliving substances which interact to produce an exchange or cycling of materials.

elevation: The vertical reference of a site location above mean sea level, measured in meters.

embryo: For salmonid fish, the stage of development between egg fertilization and absorption of the yolk sac, at which time the emerging fry begins to seek external sources of food.

emergence: For salmonids, the time of year when fry swim up from gravels in their nesting site and begin to swim in the stream.

energy dissipation: The loss of kinetic energy of moving water due to bottom friction, pools, large rock, debris, and similar obstacles that impede flow.

ephemeral: A stream that is dry for a portion of the year and most often contains water during and immediately after a rainfall event or snowmelt. Most often there is not sufficient volumes to create well-defined channels.

epilimnion: The relatively warm, circulating and fairly turbulent surface layer of water in a lake which thermally stratifies during the summer.

estuarine: pertaining to, or in, an estuary.

estuary: Area of a river mouth where the fresh water of a river mixes with ocean water.

eutrophication: The process by which lakes and streams become biologically more productive due to increased supply of nutrients (phosphorous and nitrogen). It sufficiently large amounts of nutrients enter natural waters, negative consequences may result from the presence of excessive amounts of algae.

evaporation: As water is heated by the sun, its surface molecules become sufficiently energized to break free of the attractive force binding them together; they evaporate and rise as invisible vapor in the atmosphere.

(ET) evapotranspiration: The amount of water leaving to the atmosphere through both evaporation and transpiration.

eyed egg: The stage of embryonic development when the body shape and eyes have formed within the egg.

fecundity: General term used to describe the number of eggs produced in relation to fish. Fecundity of an individual female may vary according to species, stock, size and age.

fill slope: The outer edge of a road that extends downhill of the road surface that has been filled to help create the road subgrade.

fine sediment: Sand-sized particles that readily settle to the bottom of a stream and fill in the substrate.

fish life stage: See life stage.

flood attenuation: When flood levels are lowered by water storage in wetlands.

flood peak: The highest amount of flow that occurs during a given flood event.

floodplain: The flat area adjoining a river channel constructed by the river in the present climate, and overflowed at times of high river flow.

fluvial: pertaining to a river.

fluvial fish: Fish that rear in larger rivers and spawn in smaller river tributaries.

fluvial processes: The set of mechanisms that operate as water flows within and at times beyond its channel, bringing about erosion, transfer, and deposition of sediment.

freshet: A rapid rise in river discharge and level caused by heavy rains or melting snow.

full-bench construction: A practice of constructing a road on steeper slopes whereby excess excavated soil or rock is hauled away in trucks to a stable storage area rather than disposed of by pushing it downhill of the road or being used as part of the subgrade.

foot slope: Area located at the bottom of a hill slope.

gaining reach: Reach where groundwater is flowing into the stream channel to become surface water.

gauging station: A selected section of a stream channel usually equipped with a staff gauge, stage recorder, stage logger for measuring stream discharge.

(GIS)Geographic Information System: A computer system designed for storage, manipulation, and presentation of geographical information such as topography, elevation, geology, etc.

gradient: Channel gradient is the slope of the channel bed along a line connecting the deepest points (thalweg) of the channel. The general slope or rate of change in vertical elevation per unit of horizontal distance of the water surface of a flowing stream.

groundwater: Water stored in the earth that occupies pores, cavities, cracks, and other spaces in the crustal rocks and soil.

hazard delineation: Mapping the boundaries of areas with inherently unstable slopes and applying a risk factor to delineate the degree of hazard.

high grading: uneven-aged harvest systems where the most valuable trees or forest stands are removed, and trees or stands of lesser quality and value are left to grow.

hydraulic continuity: The connection between groundwater and surface water such that withdrawal from an underground aquifer affects the streamflow level in the channel (surface water).

hydraulic gradient (hydraulic head): Water level from a given point upstream to a given point downstream; or the height of the water surface above a subsurface point. Used in analysis of both ground- and surface-water flow, and is an expression of the relative energy between two points.

hydraulic jump: An abrupt, turbulent rise in the water level of a flowing stream, normally occurring at the transition from shallow, fast flow to deeper and slower flow.

hydric soil: A soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part.

hydrograph: A graph of runoff rate, inflow rate, or discharge rate, past a specific point over time. This can help to show stream characteristics such as baseflow and precipitation runoff.

hydrologic: Refers to water in all its states, and its properties, distribution and circulation through the hydrologic cycle.

hydrologic cycle: The circulation of water around the earth, from ocean to atmosphere and back to ocean again.

(HSG) hydrologic soil group: Soil classification to describe the minimum rate of infiltration obtained for bare soil after prolonged wetting.

hydrology: The science of the behavior of water from the atmosphere into the soil.

hydrophobic soils: Soils that do not easily soak up water, and thus increase the rate of surface runoff.

hypolimnion: The relatively cold, undisturbed deep waters of a lake which thermally stratifies in the summer.

impervious surface: surface (such as pavement) that does not allow, or greatly decreases, the amount of infiltration of precipitation into the ground.

incised channel: A stream that through degradation has cut its channel into the bed of the valley.

infiltration: The rate of movement of water from the atmosphere into the soil.

lag time: In a hydrological sense, the interval between the center of mass of the storm precipitation and the peak flow of the resultant runoff. It is the delay between upstream production of flow and its arrival at a downstream location.

(LRMP) Land & Resource Management Plan: A consensus-building process involving a cross section of the public, interest groups, and government agencies to establish resource-management objectives and strategies for a sub-regional management area, usually a timber supply area (TSA).

landing: An area adjacent to a road where logs are skidded, accumulate, and are loaded onto trucks or forwarded during timber harvesting.

(LWD) large woody debris: Logs, stumps, or root wads in the stream channel, or nearby. These function to create pools and cover for fish, and to trap and sort stream gravels.

legacy activities: Past land use practices that have contributed to current watershed and stream channel conditions.

lentic riparian/wetland area: Lentic riparian areas have standing water, such as lakes, ponds, seeps, bogs, and meadows.

life stage (fish life stage): A part of a fish’s life cycle, with identifiable habitat requirements associated with it; for example, summer rearing, spawning, and juvenile outmigration to ocean waters.

low flows: The minimum rate of flow for a given period of time.

ma: million years ago

machine reserve: A machine reserve is a system of selective cutting along a stream in which leaning commercial trees and immature trees are left within a specified distance of the streambank and equipment operation is minimized in this strip.

mass wasting: (also soil mass movement): Downslope transport of soil and rocks due to gravitational stress.

meandering: When a stream channel moves laterally across its valley meandering is characterized by a clearly repeated pattern of curvature as seen from above.

mg/L: Milligrams per liter. Unit of chemical concentration that is essentially equivalent to parts per million (PPM)>

μ/L: Micrograms per liter. Unit of chemical concentration that is essentially equivalent to parts per billion (ppb).

monitoring: Actions undertaken to evaluate the efficacy and effects of any management activity on species, processes, habitats, flows, landscape and ecosystem characteristics, and outputs. Monitoring provides a feedback loop to ecosystem management experiments that addresses accountability and validity of actions.

montane: Of growing in, or inhabiting mountain areas.

morphologic features: From the Greek root meaning structure or form; in stream channels, those physical features (such as gradient and confinement) that reflect the influence of processes which operate on a landscape scale (such as geology and climate).

morphologic response: In stream channels, the response or change in the characteristics that define the channel.

morphology: A branch of science dealing with the structure and form of objects. Geomorphology as applied to stream channels refers to the nature of landforms and topographic features.

morphometry: The form or shape of a lake or stream, including the contour of the bottom.

(NTU) nephelometer turbidity unit: Turbidity is a measure of the suspended particles such as silt, clay, organic matter and microscopic organisms in water. The measure of turbidity as the amount of light detected in a sample after it is scattered 90° from the source in a nephelometer, is expressed in NTU units.

nonpoint source pollution: Variable, unpredictable, and dispersed pollution sources from agriculture, silviculture, mining, construction, saltwater intrusion, waste disposition and disposal, and pollution from urban-industrial development areas. ("Point sources" are steady, predictable, and concentrated usually through "end of pipe" discharges from manufacturing, waste, or water treatment plants.)

oligotrophic: An oligotrophic lake is low in nutrients and productivity, with large amounts of dissolved oxygen in the deepest water. Water clarity is high, as is diversity of phytoplankton, but total algal biomass is low.

order: see stream order.

orthophoto: A combined aerial photograph and planimetric map without image displacements and distortions. Orthophotos may or may not have contours indicated.

oxbow: A bow-shaped river bend.

perennial surface water: Surface water that persists all year.

pipe-arch culvert: A corrugated metal pipe that is wider than it is tall.

peak flow: The maximum instantaneous rate of flow during a storm or other period of time.

percolation: The act of surface water moving downwards, or percolating, through cracks, joints, and pores in soils and rocks.

periphyton: Various types of algae growing on submerged surfaces, firmly or loosely attached.

pH: A measure of the relative acidity or alkalinity of water.

point bar: A sediment deposit in a river that protrudes above the water surface and is located primarily on the inside of channel bends.

pool: That portion of a stream where the water is relatively deeper and slow moving, which is frequently used by fish for resting, cover, and overwintering. A plunge pool is formed by water passing over or through a complete or nearly complete channel obstruction, and dropping vertically, scouring out a basin in which the flow radiates out from the point of entry.

pool-riffle ratio: The ration of the surface length of pools to the surface length of riffles in a given stream reach, frequently expressed as the relative percentage of each category.

precipitation: The liquid equivalent (inches) of rainfall, snow, sleet, or hail collected by storage gages.

precipitation intensity: The rate at which water is delivered to the earth's surface.

raindrop splash: Erosion created when a raindrop hits a bare soil surface.

rain-on-snow (event): When snowpacks are melted by warm rains, causing peak flow events. Rain-on-snow events usually occur within the transient snow zone.

rating curve: A graphed result showing the relationship between the stream stage and the discharge at the gauging station measured.

ravel, or raveling: Erosion caused by gravity, especially during rain, frost, and drying periods. Often seen on steep cutslopes immediately uphill of roads.

reach: A stream reach is a fundamental landscape unit that consists of a homogenous channel based on channel pattern, floodplain width, and flow regime.

recurrence interval(s) (return interval): Determined from historical records. The average length of time between two events (rain, flooding) of the same size or larger. Recurrence intervals are associated with a probability. (For example, a 25-year flood would have a x probability of happening in any given year.)

recruited large woody debris: A term assessing the amount or size of large trees in a riparian area that could potentially fall in (recruit) to the stream channel. Mechanisms for recruitment include small landslides, bank undercutting, wind throw during storms, individual trees dying of age or disease, and transport from upstream reaches.

recruitment: In the context of riparian function, recruitment refers to adding new LWD pieces to a stream channel. It is the physical movement of LWD into the stream channel. As used in fisheries management, recruitment refers to the addition of new individuals to a fish population resulting from reproduction of the adult stock.

redd: The salmonid gravel nest.

relic channel: A channel historically occupied by a river or stream, but that currently does not convey flow.

resident fish: Non-migratory fish that remain in the same stream network their entire lives.

return flow: The portion of a diversion that returns to the river system via subsurface pathways.

riffle: A shallow, rapid section of stream where the water surface is broken into waves by obstructions wholly or partly submerged.

rilling (surface rilling): Erosion caused by water carrying off particles of surface soil.

rills: Very shallow gullies that can develop on a hillslope that is eroding.

riparian area(s): Areas bordering streams and rivers whose soils, and vegetation are influenced by the presence of pooled or channelized water.

(RCU) Riparian Condition Unit: A portion of the riparian area for which riparian vegetation type, size and density remain approximately the same.

Riparian Recruitment Situation: Groups of RCUs that have similar characteristics and that may be treated similarly for the purposes of restoration and/or enhancement.

riparian zone(s): An administratively defined distance form the water's edge that can include riparian plant communities and upland plant communities. Alternatively, an area surrounding a stream, in which ecosystem processes are within the influence of stream processes.

riparian vegetation: Vegetation growing on or near the banks of a stream or other body of water in soils that are wet during some portion of the growing season. Includes areas in and near wetlands, floodplains, and valley bottoms (from Meehan 1991).

riprap: Rock material, usually boulders or blasted fragments, placed along a stream bank to prevent erosion of the bank.

rock pit: An area where rock is excavated from a hillside and is usually processed as subgrade or riprap material.

run: A stream section of varying depth with moderate velocity and surface turbulence. Intermediate in character between a pool and a riffle.

runoff: Surface runoff is water that moves overland across the surface into creeks, ponds, lakes, and rivers that eventually take the water back to the ocean.

salmonid: Fish of the family *Salmonidae*, including salmon, trout, char, whitefish, ciscoes, and grayling. Generally, the term refers mostly to salmon, trout, and char.

scarification: The mechanical loosening of compacted soil usually using subsoilers attached to a crawler tractor.

scour: Removal of sediment from the bed or banks of a river by the energy of moving water.

screening-level assessment: An initial evaluation of information using simplified methods.

seasonal surface water: Surface water that is normally only present during a portion of the year.

sediments, fine and coarse: Fragments of rock, soil, and organic material transported and deposited into streambeds by wind, water, or gravity.

seral stage: Plant species of early, middle, and late successional communities of any plant associations, though most commonly expressed in a more limiting sense as the dominant vegetation following forest disturbance.

sheet erosion: Soil erosion caused by surface water that occurs somewhat uniformly across a slope.

side-channel: A channel that is separated from the main channel, usually by an island.

s**ingle-thread channel:** A stream channel that has no side channels, braiding, or islands.

skid trail: Trail that is planned or develops when logs are hauled by ground-based machinery to a landing.

slash: Detached tree limbs, branches, and other woody material that is left on the ground after logging is completed.

slough: A side channel within an estuary.

smolt: A seaward migrating juvenile salmonid which is silvery in color, has become thinner in body form, and is physiologically prepared for the transition from fresh- to saltwater. The term is normally applied to the migrants of species such as coho, sockeye and steelhead that rear in freshwater for a period before migrating to sea.

soil creep: When gravity moves the soil mantle downhill at rates too small to observe.

species: The smallest unit of plant or animal classification commonly used. Members of a species share certain characteristics that differ from those of other species, and they tend not to interbreed with other species.

specific heat (of water): The amount of heat required to make a 1° change in water or air temperatures.

splash damming: Historical practice where a small dam was built across a stream to impound water and logs. The dam was then removed (usually with explosives) to release the impounded logs and water, causing scour downstream.

spring snowmelt: The time when the seasonal snowpack melts out.

stadia rod: Surveying rod used for measuring changes in elevation from one point to another.

staff gauge: A measuring ruler for measuring stream stage; is often seen attached to a tree, post, bridge pier, or other easily observed site in the stream bed.

stage: the water level in a stream or lake. The height of the water surface above some arbitrary, chosen zero level.

standing wave: A turbulent condition in a stream which produces a fixed wave pattern at a specific location. Standing waves are often caused by two similar waves traveling at the same time in opposite directions.

stand-replacing fire: A fire of enough severity, at a local level, to kill the forest stand.

stereo aerial photo: Pairs of photos taken from the air that can be viewed through a stereoscope to reveal three-dimensional features of the landscape.

stereoscope: An instrument used to observe stereo aerial photographs in three dimensions.

stock: A population of one species of fish which inhabits a particular stream and tends to spawn at a place or time separate from the other stocks.

stream cleaning: The removal of large wood or fine organic matter (i.e., branches, twigs, leaves, etc) from stream channels. Historically, this practice was used to remove debris jams that were thought to block fish passage, or to remove fine organic matter that was thought to cause water quality problems such as reducing aquatic oxygen levels. Because stream cleaning was found to damage fish habitat, it is currently not a common practice.

stream density (drainage density): Total length of natural stream channels in a given area, expressed as kilometers of stream channel per square km of area.

stream order: First order channels are non-branching headwater channel segments. Second order channels are those that receive only 1st order channels. Third order channels are those where two 2nd order channels join; fourth order channels are those where two 3rd order channels join, etc. Most salmonid spawning and rearing takes place in 2nd to 4th order streams.

stream reach: A section of stream possessing similar physical features such as gradient and confinement.

stream segment: Contiguous stream reaches that possess similar stream gradient and confinement and which can be used for analysis.

substrate: Mineral or organic material that forms the bed of a stream.

surface runoff: Water that runs across the top of the land without infiltrating the soil.

surrogate measure: An indirect measure of a pollutant; for example, the use of turbidity to measure suspended sediment.

suspended sediment: Fine soil particles (e.g., silts and clays) that do not readily settle out. Compare to "fine sediment" – which is sand-sized particles that readily settle to the bottom of a stream and fill in the substrate.

tailings: Washed or milled rock that has been processed for ore removal.

talus slope: A sloping mass of rock fragments which has been dislodged from a mountain side, rock outcrop, or cliff due to the process of weathering. The rock fragments accumulate faster than the forces of erosion are able to remove them or reduce them to smaller particles.

TCU: True colour units. A measure of the dissolved coloring compounds in water. The colour of water is attributable to the presence of organic and inorganic materials; different material absorb various light frequencies. Water whose color is less than 10TCU passes unnoticed to visual inspection; water with a value of 100 resembles tea. Water from swamps and bogs may exhibit values in the 200 to 300 TCU range.

thalweg: The path of maximum depth in a river or stream. This path normally follows a meandering pattern, back and forth across the channel.

(TSA) Timber Supply Area: An area of the province designated by MOF for the purpose of analysis, planning and management of timber resources. The harvesting limits for TSAs, called allowable annual cuts (AACs) are determined by the chief forester. Many types and sizes of harvesting agreements may exist within a TSA.

(TDS) total dissolved solids: TDS is the amount of dissolved substances in water, and gives a general indication of the chemical quality. TDS is defined analytically either by total filterable residue (the portion in a sample which passed through 0.45 μm glass fiber filter and dried at 180° C) or by conductivity (specific conductance is a measure of the ability of an aqueous solution to carry an electrical current).

total nitrate: A measurement form of nitrogen in surface- and groundwater that is composed of nitrate and nitrite.

total phosphorus: A commonly used measurement of phosphorus that includes most forms of phosphorus which are biologically available (or can be readily converted to available forms) to algae and aquatic plants.

TSS: total suspended solids: TSS are particles such as silt, clay, organic matter, plankton, and microscopic organisms which are held in suspension by turbulence and Brownian movement in lakes and streams. Particulate matter can be quantified by measuring non-filterable residue (NFR).

transpiration: Loss of water to the atmosphere from living plants.

transport velocity: The velocity of flow required to maintain particles of a specific size and shape in motion along the stream bed.

TCU: True colour units. A measure of the dissolved colouring compounds in water. The colour of water is attributable to the presence of organic and inorganic materials; different material absorbs various light frequencies. Water whose colour is less than 10 TCU passes unnoticed to visual inspection; water with a value of 100 resembles tea. Water from swamps and bogs may exhibit values in the 200 to 300 TCU range.

turbidity: An optical measure of the murkiness of water. An indirect measure of the affect of suspended sediment in water.

upland vegetation: Vegetation typical for a given region, growing on drier upland soils. The same plant species may grow in both riparian and upland zones.

waterbar: A deep trough in a skid trail or road that is excavated at an angle to drain surface water from the skid trail or road to an adjacent area that is not compacted or to the ditchline.

water quality criterion: A maximum or minimum physical, chemical or biological characteristic, applicable province-wide, which must not be exceeded to prevent detrimental effects from occurring to a water use, including aquatic life. Water quality criteria are safe levels of contaminants for the protection of a given water use.

(WQO) Water Quality Objectives: Water quality objectives are environmental quality conditions set as targets for specific water bodies based on three main factors 1)the designated uses for the water 2) the water quality criteria that have been adopted for the most sensitive designated use, and 3) the local conditions, including the actual measured water quality in the area.

water quality station: A designated location on a stream at which water samples are collected.

water table: The water table marks the change in the groundwater zone between the zone of aeration, where some pores are open, and the underlying zone of saturation, in which water fills all the spaces in the soil and rocks.

water year: The water year in North America is referred to as the 12-month period beginning October 1 in one year and ending September 30 of the following year. The water year is designated by the calendar year in which it ends. For instance, the annual peak flow for water year 1996 would be the highest flow recorded from October 1, 1995, through September 30, 1996.

weir: A low dam or fence constructed across a stream or river primarily to control water levels or to divert water into another facility. A counting weir is a fence across a stream to enumerate fish.

wetland vegetation: Plants that are adapted to living in saturated or inundated conditions for at least part of the growing season.

wind throw (also blowdown): The uprooting and felling of trees by strong gusts of wind.

WRP: Watershed Restoration Program of British Columbia.

year class: The fish spawned or hatched in a given year.