2009

Comparison of Policies for Run-of-River Projects and Forestry Activities

Nicola Farrer

Faculty of Forestry, UBC

4/17/2009

Submitted to: Peter Marshall

On April 17th, 2009

Submitted by: Nicola Farrer

Primary Advisor: George Hoberg

Secondary Advisor: John Richardson

Abstract: *The province of British Columbia is made of vast wilderness. Consequently many natural resource based industries have become prominent in BC's economy. There is growing concern over the impacts these industries will have on the environment. This paper will focus on the impacts of forestry activities and run-of-river hydro projects, as well as give a comparison and analysis of the policies and regulations each follow while conducting their activities.*

Keywords: *Run-of-River, hydro projects, forest industry, environment, impacts, policies, regulations.*

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

The province of British Columbia (BC) is globally respected for its vast amount of wilderness and all that it encompasses. BC is a hot spot for nature enthusiasts who travel from afar to enjoy the land, wildlife, trees, and many streams and rivers BC has to offer. Two thirds of the land in BC is considered forested land, and amongst this land are endless mountains and valleys with many streams and rivers running through.

BC has built many industries based around the use of natural resources, including forestry, mining, oil and gas, and hydroelectric generation. Products from these sectors account for about 75% of total provincial exports and is currently heavily comprised of forestry exports (Province of British Columbia, 2007). In the future, BC is aiming to increase the export of hydroelectric power with the development of many new projects. There is great concern that the cumulative impacts of all the resource based industries will have irreversible destructive consequences to BC's wilderness.

Since the 1970's, the BC forest industry has been at the forefront of environmental concern with respect to its impacts on the environment. More recently, the proposals for and construction of hundreds of independent power projects (IPP's) on a significant number of BC's watersheds has emerged as one of the top concerns for BC's environment. Of these IPP's, many are run-of-river (ROR) projects that generate small amounts of electricity to be sold to BC Hydro and the US.

There is much controversy over the regulations that IPP's, more specifically, run-of-river projects, follow in order to be approved. There is perception that hydro project developments are more lenient in their policies than those forest companies are bound to.

This paper will give a brief background on each industry, their impacts on the environment, and conduct a comparison and analysis of the policies hydro developers and forest companies follow while engaging in their operations.

2 BACKGROUND

2.1 FORESTRY

The province of British Columbia is comprised of two thirds of forested land which is almost entirely owned by the provincial government (Crown). The dominance of forests in BC has resulted in the extensive development of the lumber and pulp and paper industries dating back to the mid 1800's. In 1912 the first forestry legislation was implemented and required the Crown to grant licences to harvest to timber companies (Marchak, 1983). Since the implementation of this legislation, there have been many changes made to the policies that companies and the government must follow, but one thing remains the same; the government is a major actor that has a large influence on the structure of the forest industry (Marchak, 1983, p. 29).

The forestry sector, including forestry, logging, manufacturing (lumber and pulp & paper production) plays a huge role in the economy of BC employing just under 80 000 in the province in 2005 (Province of British Columbia, 2007). Currently numbers are likely significantly lower due to the economic crisis, but this has left thousands without work all over the province. Close to 60% of people in the industry have been employed in areas that are unique to this primary industry (Province of British Columbia, 2007). An additional 14% are employed in the natural and applied sciences side of forestry, made up mainly of forestry technicians and professional foresters (Province of British Columbia, 2007).

The forest industry has access to over 25million hectares (ha) of forested land to harvest, encompassing almost all of BC's watersheds. Within this land, licenses are granted for timber harvest and holders of the license are bound by the most recent Forest Range and Practices Act (FRPA) and the Forest Act. These acts regulate all practices that are related and linked to timber harvesting, including road building, stream crossings, working near streams, and management of wildlife and other resources within the forest.

2.2 HYDRO

Over the past 50 years, residents of BC have used electricity that has been generated from large hydro dams, including the Columbia River projects (Revelstoke and Mica dams) and the Peace River project in northern BC (Ministry of Forests and Range, 2008). These large hydroelectric projects generate roughly 90% of the total energy requirements of the province (Ministry of Forests and Range, 2008).

The independent power production (IPP) industry in BC began in 1989 when BC Hydro put out a call for proposals for private power. The IPP Association of British Columbia (IPPBC) was created in December 1991 with the goal of developing a viable independent power industry in BC to provide cost-effective electricity in an efficient, environmentally responsible manner (IPP Watch , 2008). IPP projects generate electricity using rivers, wind, biomass, tides and ocean, geothermal, solar, and/or natural gas (Ministry of Forests and Range, 2008). In BC, the majority of the power that is produced by various IPP projects is sold to BC Hydro (Ministry of Forests and Range, 2008, p. 146). This paper focuses on energy generated through water use, mainly in the form of run-of-river projects.

Run-of-river projects are small scale hydroelectric projects that depend on the natural flow and elevation of a river to generate power and according to IPPBC, they do not require a dam, reservoir, or flooding (IPPBC, 2009a).

However, all projects require either some form of a dam or weir (can be seen in figure 1), otherwise they divert the water to generate the electricity. They are created by diverting water from a fast flowing portion of the river into a penstock or pipe that directs it to a turbine, and back into the river (IPPBC, 2009a). They are claimed to have a small environmental footprint compared to larger scale hydro projects such as the Peace River, Columbia, Mica, and Revelstoke dam sites (IPPBC, 2009a). Figure 1 below illustrates the typical layout of a run-of-river project.

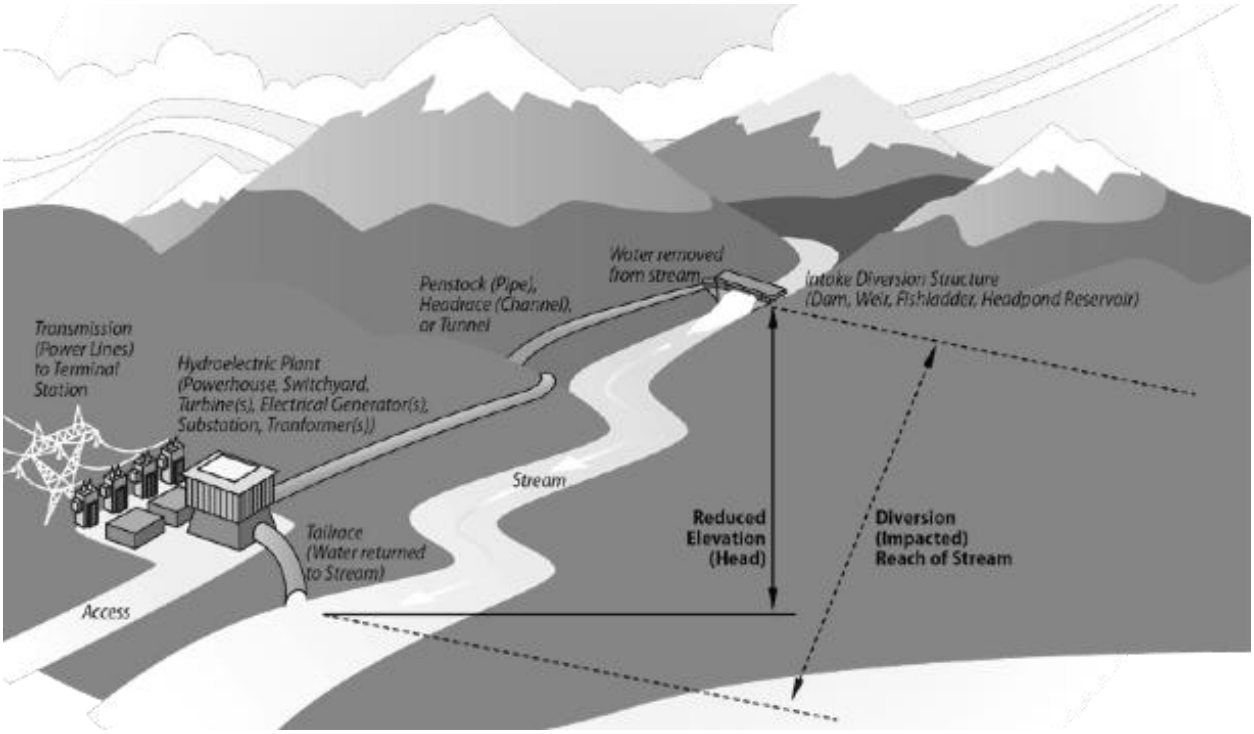

Figure 1: A typical layout of a water power project (Ministry of Agriculture and Lands, 2008, p. 67).

Currently in BC there are 35 IPP run-of-river projects in BC (IPPBC, 2009a), and as of December 2007 there were 585 applications for power (Ministry of Agriculture and Lands, 2008); 130 of these applications have been approved on 115 different watercourses across the province (IPP Watch , 2008). The 585 applications include 707 points of diversion on 466 streams in BC (IPP Watch , 2008).

IPP's can be beneficial to local communities and the province by creating economic activity, involving First Nations in the development and providing them with training and employment opportunities, and help to fulfill BC's goal of becoming energy self sufficient (IPPBC, 2008b). IPPBC also claim that their projects will provide an environmentally sustainable development of resources and generate green renewable energy with minimal environmental impacts (IPPBC, 2008b).

However, much skepticism lies behind the environmental impact these projects will have. Pacific Gas and Electricity Company (PGE) based out of San Francisco stated "BC ROR [run-of-river] hydro facilities would not be qualified as clean, environmentally-friendly renewable energy because of their significant environmental impacts" and that they are "not green, not sustainable, and not economical" (COPE 378, 2008). This view has been supported by others, including the Watershed Watch Salmon Society, stating "all forms of electricity generation will cause some environmental damage, and the potential effects of run-of-river projects include impacts to

aquatic and terrestrial ecosystems, wildlife, species at risk, recreational and aesthetic values, and First Nations and communities" (Douglas, 2007).

In order to be approved, potential sites must have nearby transmission access, meet government guidelines and regulations, and be commercially viable (IPPBC, 2008b). IPPBC states that of all the water licence applications, over half are for projects that will produce less than 10 MW and under 5% are for projects over 50 MW (IPPBC, 2008b). Only power projects 50MW or over are required to undergo an environmental assessment. This means that 95% of the power projects currently under application, some 555 projects, are not required to undergo the environmental assessment process.

Hydro projects also play a role in the socio-economics of British Columbia by contributing jobs and income to the province and communities. Employment numbers BC Hydro has 5200 employees, plus the employment that would be generated through the construction of projects in local communities (BC Hydro, 2009a). BC Hydro also makes payments to the province based on 85% of their distributable surplus, which in 2008 totaled $288 million (BC Hydro, 2009b). In addition to this, BC Hydro also paid $802 million in water rental, school taxes, and grants (BC Hydro, 2009b).

3 IMPACTS OF INDUSTRIES IN THE ENVIRONMENT

3.1 FORESTRY IMPACTS ON LAND

The disturbances on the landscape caused by forestry activities including road building and harvesting are discussed by area of land affected, changes to ecosystem diversity, and recreational impacts.

AREA

BC is a large province, with about 59 million ha of forested land (Ministry of Forests and Range, 2006). Of this 59 million ha, 25.3 million is considered to be a part of the timber harvest land base managed by the Ministry of Forests and Range and various forms of tenure holders (Ministry of Forests and Range, 2006, p. 61). Of this area, 6% is less than 20 years old based on numbers in 2006 (Ministry of Forests and Range, 2006). This percentage is likely to be much higher now as a result of the mountain pine beetle (MPB) and the large scale salvage harvesting that is occurring throughout the interior of BC.

Much of the impact caused by timber harvesting results from the fragmentation of the landscape caused by the removal of forest and the construction of roads. The results are:

- a direct loss of habitat for wildlife
- a degradation of wildlife habitat quality;
- a reduction in habitat patch size;
- isolation of and decrease in population size; and
- an increase in spread of invasive plant species (Ministry of Forests and Range, 2006, p. 41).

Timber harvesting in BC has led to only 26% of the watersheds being undeveloped in 2005, which is a decrease from 44% undeveloped in the 1980s (Ministry of Forests and Range, 2006, p. 41). This number is expected to continue to decrease to 18% (Ministry of Forests and Range, 2006, p. 41). Undeveloped watersheds provide important habitat, rich in quality, for wildlife and fish. These areas are often difficult to access due to the lack of development, thus can act as a refuge for wildlife, undisturbed by any human impacts; industrial, hunting or otherwise. Forestry practices and the access roads that are required for the operations have led to a small percentage of BC being left as an 'intact area'. An intact area can be defined as an area at least 2000ha in size that is 5km or more away from any road, railroad, power right of way, seismic line, or air strip (Ministry of Forests and Range, 2006). Figure 2 below displays the areas in BC that are considered intact. The northwestern part of the province could be considered mainly intact. However, this area is also very limited in the potential for timber harvest as it holds a very small percentage of the province's timber harvest land base.

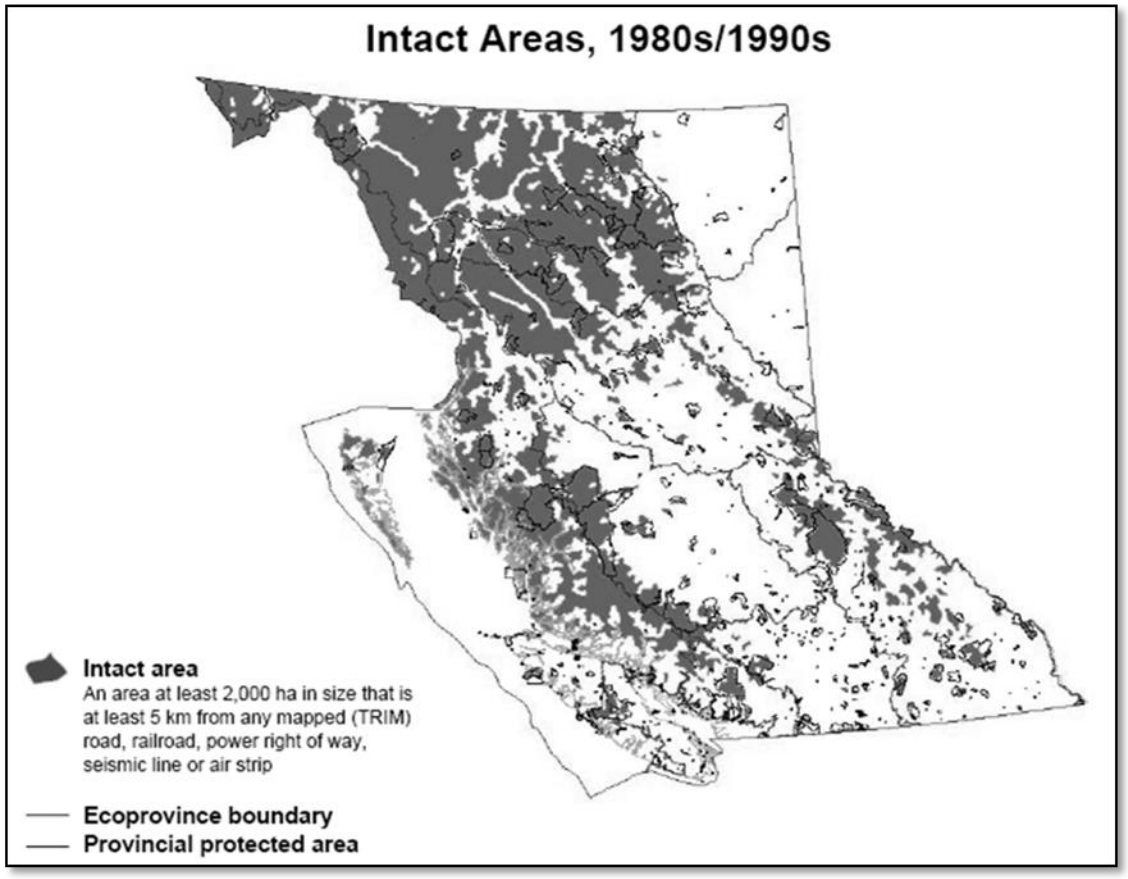

Figure 2: Intact areas in BC (Ministry of Forests and Range, 2006, p. 41).

Ecosystem Diversity

Biologically, Canada is a very diverse country with British Columbia being the most diverse province, containing six of the world's 30 terrestrial eco-regions and 14 different biogeoclimatic zones (BEC zones) (Ministry of Forests and Range, 2006). Timber harvesting affects the ecosystem diversity by causing:

- fragmentation of the landscape by creating openings (cutblocks);
- construction of roads;
- increase hunting pressures and recreation effects; and
- decrease actual habitable area and quality (Ministry of Forests and Range, 2006).

Tree species diversity in BC is negatively affected by timber harvesting. Traditionally, most of BC's forests contain a mixture of at least two tree species, and about 25-33% of the forests are dominated by one single tree species which makes up more than 80% of the total standing volume prior to harvest (Ministry of Forests and Range, 2006). Areas that have been harvested after 1987 have shown an increase in area dominated by a single tree species (Ministry of Forests and Range, 2006). This is primarily due to species selection during harvesting and re-planting with fewer species than were taken off the site.

RECREATION

Timber harvesting in BC has impacted recreation by creating and improving access to remote areas. This has provided greater access for hunters, tour guides, snowmobilers, 4x4'ers, hikers, kayakers, bikers, and any other outdoor enthusiasts wanting access to remote areas. Typically recreationalists view increased access as a positive impact as they are able to reach more and more remote areas of the province and enjoy their activities where few people have visited. However, increases in some recreation can have negative impacts on wildlife communities as they tend to avoid areas of heavy traffic and noise, causing their habitat to be decreased even more.

3.2 HYDRO IMPACTS ON LAND

Hydro projects have an impact on the land by removal of timber for construction of power lines and right-of-ways (RoWs), as well as the construction of roads within the RoWs for maintenance access and roads for access to hydroelectric plants. BC Hydro reports that their total land area owned or managed is 378 600ha (BC Hydro, 2008). This number is broken down into land use types in table 1 below, showing how the land area has changed over the past five years. In addition to the land area owned and managed by BC Hydro, there are 196 101ha of IPP projects currently proposed and under review that are not yet reporting to BC Hydro (IPP Watch , 2008). This leads to 574 701 hectares at risk.

Table 1: Estimates of the land area owned or managed by BC Hydro (in hectares). Totals shown are estimated as of March 31 of the listed year. In 2005 BC Hydro stopped reporting to the BC Transmission Corporation, and therefore Transmission RoWs were no longer included. The average RoW clearance used to calculate the land area occupied by distribution lines was six meters (BC Hydro, 2008).

	2003	2004	2005	2006	2007	2008
	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)
Transmission RoWs	77 650	77 650	N/A	N/A	N/A	N/A
Distribution RoWs	32 460	33 860	28 830	33 130	33 440	33 780
Reservoir & Recreational	332 460	332 460	332 460	332 460	332 460	332 460
Facilities & Buildings	56 740	56 750	56 750	12 200	12 370	12 340
Total Land Area	**499 300**	**500 700**	**418 000**	**377 800**	**378 300**	**378 600**
… as % of B.C.	0.529	0.53	0.442	0.4	0.4	0.4
… as % of Canada	0.05	0.0501	0.0419	0.0378	0.0379	0.0379

The land area numbers provided by BC Hydro is an underestimate of the total land area designated to BC Hydro power projects in BC, as private run-of-river projects are not included in this number. Also, based on personal field experience and investigation on GoogleEarth, the accuracy of a six meter average width for RoWs is brought into question. Through brief analysis on GoogleEarth, there are over 1400km of power lines that are between 100-200m in width.

ROR projects claim to have minimal environmental impacts by using existing logging roads for site access, and do not require dams, reservoirs, or flooding of land (IPPBC, 2009a). However, projects developed in remote areas have had negative impacts on both plant and wildlife communities in BC (Douglas, 2007). These problems are mainly due to habitat fragmentation from construction of roads and transmission corridors but also from the introduction and spread of invasive species, increased pressure from hunting both legal and illegal, and physical reduction in habitat size (Douglas, 2007).

3.3 COLLECTIVE IMPACTS ON STREAMS AND RIPARIAN AREA

Activities related to timber harvesting and the creation of hydro projects can have similar effects on streams. Below, the effects on flow rates, temperature, sedimentation, habitat alteration, and recreation are discussed for both forestry and hydro activities.

FLOWS

Both forestry and hydro activities change the flows of the streams by altering the magnitude and frequency of low and peak flows.

Firstly, the amount of runoff can increase in springtime directly after harvesting or any other activity surrounding a stream (Hinch, 2005). This increase is partially due to excessive soil compaction leading to an impermeable surface created by heavy equipment, roads, and landings (Hinch, 2005). The changes in the magnitude of the runoff alters the morphology of the stream by reducing the distinction between the riffle-pool sequences[1], often eliminating many of the pools normally present (Hinch, 2005). This consequently changes the ability of fish to hide from predators, alters feeding patterns, and forces changes in territories (Hinch, 2005).

Secondly, alterations in peak flows can be a result of harvesting activities and controlled releasing by hydro dam facilities. Peaking causes an increase in the frequency of low flows, which are critical time periods for the survival of fish and aquatic invertebrates (Geis, 1982). Low flows, similar to high flows, can alter the morphology of the stream by decreasing the amount of riffle habitat (Geis, 1982). Impacts can be quite significant when water is removed and streams dry up, causing organisms that normally survive on the rock surfaces to die resulting in a disruption in the food chain by making less food available for fish (Geis, 1982). Also, with lower velocity water (caused by using water for hydropower generation), there is a concern that food and nutrients will not be transported downstream, and consequently, less food is available for the fish (Yeow, 2009). This can also cause fish to gather in greater numbers where food is available creating an increase in competition, and putting fish under stress, which makes them more susceptible to other changes in the environment (Geis, 1982).

TEMPERATURE

Temperature increases are closely linked to flow changes as well as the removal of streamside vegetation.

First, if low flows occur more frequently and for longer duration during summer months, the temperature of the water will rise (Geis, 1982). Since fish are cold blooded, they do not regulate their body temperature and require a certain temperature range to survive. During low flow periods in hot summer months, the temperature can approach or exceed the critical temperature of many fish species causing them to die (Geis, 1982). There is also concern over hydro projects decreasing water levels, and consequently increasing temperatures (Yeow, 2009). This may lead to low oxygen levels for insects and microorganisms in the stream, leading to a decline in their population (Yeow, 2009).

[1] Riffle-pool sequence: The alternating sequence of deep, calm pools and shallow riffles along the relatively straight course of a river or stream (Mayhew, 1997).

Secondly, removal of streamside vegetation increases the amount of solar radiation reaching the water surface which in turn increases the temperature (Hinch, 2005). Some streams on the coast and interior BC have reached 30°C after removal of vegetation which is well above the critical range for salmon species (Hinch, 2005).

SEDIMENT

The amount of sediment in streams is another important factor for fish and aquatic organisms' survival that is altered by both forestry and hydro projects. The presence of roads is a major contributor to sediment loads entering streams which can ultimately change the in-stream habitat for the fish by filling up pools thus eliminating cover (Hinch, 2005). Sediment can also cause problems by eliminating fish spawning habitat, decreasing oxygen supply for their eggs, and clogging the gills of fish causing them to die (Hinch, 2005).

HABITAT LOSS

The above effects are happening on hundreds of streams around the province. Forestry companies alone build hundreds of stream crossings a year on fish bearing streams losing approximately 400-700m^2 of riparian habitat per crossing (Hinch, 2005). This causes a loss of over 300,000m^2 (30ha) of fish and riparian habitat a year (Hinch, 2005). Hydro power development currently has 128 licences approved on 115 different waterways, with an additional 435 applications for 513 'points of diversion'[2] on a total of 466 streams (IPP Watch , 2008). For each hydro project there are also multiple applications for land use (IPP Watch , 2008). Using data only for the water land use applications, involving the riparian zones and streams themselves a total of 198,772ha are at risk because of powerhouse sites, quarrying, road building, transmission line building, and many more (IPP Watch , 2008).

RECREATION

Hydro projects and forest harvesting also have effects on the recreational use of streams that in turn can increase the level of tourism for an area. Forestry companies tend to have a positive influence on the recreation activities through the creation of road access to streams for paddlers, anglers, and hunters. Hydro companies claim that they will be able to control the level of flows during times of years that are usually undesirable for kayaking, thus increasing the length of time the creek is available for paddlers (Ashlu Creek Green Power Project, 2008). However, many recreationalists are skeptical of the claims made by hydro companies as they feel that these promises have been made before but have not been followed as kayakers represent only a handful of people who use the resource for recreation and thus will not be a priority (Dickson, 2008). In addition, for these controlled flows to be meaningful to kayakers a gauge with available verifiable flow data would have to be made available (Dickson, 2008). This data would also prove that they are having a beneficial impact in terms of creating windows of opportunities for kayakers (Dickson, 2008). Hydro projects also construct in-stream structures that can be dangerous obstacles for kayakers, as well as for people canoeing and fishing (Geis, 1982).

[2] The place on the natural channel of the stream where an applicant proposes, or a licencee is authorized, to divert water from the stream (IPP Watch , 2008).

4 COMPARISON OF POLICIES

4.1 GENERAL

FORESTRY

In order for a forestry company to be permitted to do work, they must create and submit a harvest plan to the Ministry of Forests and Range (MoFR). This plan must comply with the Forests and Range Practices Act (FRPA) and the associated statutes and regulations which took effect on January 31st, 2004. They must also notify the district manager before commencing any timber harvesting or the construction of roads.

HYDRO

Before a run of river hydro project can be built, it is required to obtain over 50 permits, licences, reviews, and approvals from over 14 different regulatory bodies. These regulatory bodies include federal, provincial, and local governments, as well as aboriginal groups.

For most IPPs, the projects will require applying for land tenure, a water licence, and approval must be received in order to conduct site investigations, research studies, construction, permanent water works, transmission lines, and access roads (Ministry of Forests and Range, 2008, p. 43). In addition to the applications, projects producing 50MW or greater, must also be assessed based on their potential for environmental impact including impacts on fish, wildlife, birds, habitat, navigation within waters, and air and water quality (Ministry of Forests and Range, 2008, p. 43).

In order to gain access to Crown land, a hydro project is required to gain land tenure under the *Land Act* through the Integrated Land Management Bureau (ILMB) (Ministry of Agriculture and Lands, 2008). The ILMB issues various types of land tenure throughout the lifespan of a hydro project including investigative use, temporary, works, licence of occupation, lease, right of way, and easement permits[3] (Ministry of Agriculture and Lands, 2008).

4.2 HARVESTING

FORESTRY

In order for a holder of a forest licence to be allowed to harvest timber, they must comply with FRPA. This includes developing a Forest Stewardship Plan (FSP) and site plans (SP).

Section 3 (1) of FRPA states that the holder must prepare and obtain the minister's approval of a FSP that includes a forest development unit which entirely contains the area from which the timber will be harvested (Ministry of Forests and Range, 2008b). The FSP must also contain a map, specify intended results or strategies with relation to

[3] See Appendix 1 for further description of Crown Land Tenures.

objectives[4] set by the government, and must conform to the prescribed requirements (Ministry of Forests and Range, 2008b). These FSP's can be created for a term no longer than 5 years.

Beyond creating and gaining approval for a FSP, a holder of a forest licence must also prepare a site plan to be approved by the Ministry of Forests and Range (MoFR). Site plans must be prepared in accordance to the prescribed requirements before any harvesting occurs. It must include the locations of all cutblocks within the cutting permit; it must be consistent with the developed FSP, FRPA and its regulations; and it must identify how the results or strategies apply to each site (Ministry of Forests and Range, 2008b).

In accordance with FRPA section 21, a holder of a FSP must ensure that they meet all intended results and strategies described in the plan (Ministry of Forests and Range, 2008b). Upon expiration of the plan, they are still required to meet the results and strategies stated in the expired FSP unless it is clearly re-stated in another plan that is applicable for the same area (Ministry of Forests and Range, 2008b).

HYDRO

All hydro project developers in BC must apply to the MoFR to obtain a licence to cut trees. This includes harvesting trees for the development of permanent infrastructure as well as removing trees for power line rights of way on Crown land. According to the Forest Act, a district manager, regional manager, or the forest minister may enter into an agreement which grants the rights to the applicant to harvest Crown timber as a licence to cut (Ministry of Forests and Range, 2009).

Hydro projects are exempt from preparing a FSP and site plans as they fall under section 32.4 (b) where timber harvesting is needed in support of activities authorized/required under an enactment other than the Forest Act (Ministry of Forests and Range, 2004).

ANALYSIS

For the most part, hydro projects and forestry activites are bound by the same policies as hydro projects are required to gain approval and a licence to cut from the Ministry of Forests and Range. The main difference is that hydro projects do not have to prepare forest stewardship plans or site plans for their forest harvesting activities. The lack of preparation of a FSP mean that hydro projects are not required to adhere to the 11 objectives set forth by FRPA and thus do not take visual quality and forage into consideration, and only briefly touches upon recreation through the navigable waters act [5]. The other objectives are included in other aspects of the planning and approval process for hydro projects. Although the development of a hydro project does not require planning for visual quality, forage and only slightly for recreation, in order to sell their power production to BC Hydro and be recognized as a 'green' project under the Environmental Choice Program (Eco-Logo), they must consider recreational values and scenic losses.

[4] The 11 values set forth by Forest and Range Practices Act are soils, resource features, timber (including forest health), recreation resources, fish, visual quality, wildlife, cultural heritage resources, biodiversity, forage, and water.

[5] See Appendix 2 for a list of FRPA's 11 objectives and details on the comparison between hydro projects and the 11 objectives

The nature of harvesting for power line right of ways, or for the development of permanent infrastructure, means that trees will not be replaced and there will be a decrease in the amount of available Crown timber in the timber harvest land base (THLB) for forest companies, community forests, etc. The amount of disturbance created by hydro development on the landscape is significant with 574 701 ha already disturbed or under application for access roads, transmission lines, and permanent infrastructure needed for hydroelectric power generation plants. This land is considered a loss in the potential timber harvest land base and thus eliminates the potential for stumpage revenue to be received from this land. As a large majority of the hydro projects proposed are located on the coast[6], a rough estimate can be made to calculate the future loss of stumpage revenue to the province. Using $650m^3/ha$, and the current stumpage cost of $\$5/m^3$, just under $1.87 billion dollars is being lost in future stumpage fees. This number could vary significantly depending on the future of the forest industry and what stumpage rates will be, or if they even continue to exist. Also, as previously stated, the area that BC Hydro estimates as a disturbance includes an average width of six meters for RoWs. This width is questioned due to a brief analysis on GoogleEarth showing over 1400km in the province with power line RoWs that are between 100-200m in width. This amount of stumpage could also change depending on how much land is actually removed from RoWs.

Overall, the policies that must be followed by both hydro companies and forestry land tenure holders are quite similar. However, the effects on the land base should be looked at in greater detail to determine the actual amount of land lost in the THLB to hydro production activities, and how this in turn will affect the environment and the economy.

4.3 ROADS

Currently in BC, resource road tenure and management is conducted by multiple government organizations including the MoFR, Ministry of Transportation and Infrastructure, Ministry of Energy, Mines and Petroleum Resources, Oil & Gas Commission, and the Ministry of Agriculture and Lands (Ministry of Forests and Range, 2008c). All of these authorities have different tenures, enforcement procedures, processes for approval, and varying standards of construction, maintenance, and deactivation. In 2008, the provincial government developed and proposed the Resource Road Act (RRA) in an effort to consolidate legislation surrounding the use, maintenance, and rules of resource roads (Ministry of Forests and Range, 2008c). The purpose of the RRA was to propose a single legislative framework for the administration, construction, maintenance, use, and deactivation of all resource roads with the hopes of improving safety and efficiency (Ministry of Forests and Range, 2008c). However, the RRA was introduced as Bill 30 in April 2008 to the legislative assembly but was not debated, and therefore will not proceed (Ministry of Forests and Range, 2008c).

FORESTRY

According to the Forest Act section 115 (1), a person who has the right to harvest timber under a licence granted by the government may also apply for a permit to build or maintain a road or apply for a road use permit in order to use a forest service road (Ministry of Forests and Range, 2009). The district manager must grant these permits in accordance to section 115 (2) and (3) if the location of the proposed road is identified in a prescribed manner, or if maintenance is to be performed on a road without an active permit (Ministry of Forests and Range, 2009).

[6] See Appendix 3 for locations of power project proposals in BC.

Under the Forest Planning and Practices Regulation, part 5 – roads, only a person who is granted a permit and is thus authorized may construct, maintain or deactivate the road (Ministry of Forests and Range, 2004). They are also responsible for maintenance of all roads under permit, including ensuring that bridges, culverts, fords, and other structures are structurally sound and safe for use by industrial users (Ministry of Forests and Range, 2004). In accordance to section 78, the permit holder is also responsible for ensuring clearing widths are a minimum width needed to accommodate for safety, topography, drainage, stability of terrain, operation requirements, storage of stream crossing material, snow removal, etc (Ministry of Forests and Range, 2004). The responsibility is held by the permit holder until the road is deactivated, the permit is issued to another user, or the road is declared a forest service road (Ministry of Forests and Range, 2004).

A holder of a road permit must not construct a road within a riparian management area (RMA) unless building the road outside the RMA would increase the risk of sediment transport into the stream, lake, or wetland, or there are no other practicable options for road location, or the road is required as part of a stream crossing (Ministry of Forests and Range, 2004). If the road is constructed within the RMA, the permit holder must not perform road maintenance beyond the width of the clearance of the road, except if it aids in maintenance of stream crossing (Ministry of Forests and Range, 2004). They must also not remove gravel or fill from the RMA during construction, maintenance, or deactivation of the road unless it is within the road prism, is at the stream crossing, or there is no other option (Ministry of Forests and Range, 2004).

Stream crossings (bridges or culverts) must be designed to pass the highest peak flow that the given stream can expect within specified return periods shown in table 2 below and are dependent on the amount of time the crossing will remain on site.

Table 2: Design period and peak flow period for stream crossings. This table displays the anticipated period the bridge or culvert will remain on the site and the given peak flow return period that it should be designed to withstand (Ministry of Forests and Range, 2008)

Anticipated period the bridge or culvert will remain on the site	Peak flow return period
For a bridge or culvert that will remain on site for up to 3 years	10 years
For a bridge that will remain on site from 3 to 15 years	50 years
For a bridge that will remain on site for over 15 years	100 years
For a culvert that will remain on site for over 3 years	100 years
For a bridge or culvert within a community watershed that will remain on site for over 3 years	100 years

HYDRO

Prior to the construction of hydro projects, an application must be submitted to the MoFR to obtain road-related permits, obtain requirements for maintenance of access roads, and the load limitations on forestry bridges (IPP Watch , 2008). The forest minister may grant permission for industrial use of the road if, in accordance with section 22.1 (4) of FRPA, they are satisfied that the use will not unnecessarily impact forest resources, affect the use of the road by others, or increase the need for maintenance (Ministry of Forests and Range, 2008b). Once approved the permit will allow the holder to use a forest service road for industrial purposes, construct or modify the road, and replace or install structures (Ministry of Forests and Range, 2008, p. 73). The permit holder must maintain the road for the duration of its use, and must give at least 5 days notice of the date that they will begin to use the road (Ministry of Forests and Range, 2008b).

Upon approval, the MoFR will inspect operations for compliance and enforcement purposes ensuring that all activities meet relevant legislation and regulations (Ministry of Forests and Range, 2008, p. 73).

ANALYSIS

The major difference between construction of roads between hydro projects and forestry activites surround the design of stream crossings. According to the IPPBC Guidebook, bridges and culverts for run-of-rivers projects are to be designed to meet the 1 in 200 year maximum flow (Ministry of Forests and Range, 2008, p. 42), whereas under the FPPR, bridges and culverts are designed to meet 10-100 year peak flows depending on the duration the feature will remain on the site (Ministry of Forests and Range, 2008). Potential reasons for this difference in policies may be the longevity of a proposed hydro project compared to a forestry access road. In many areas, forestry activities can be completed after 10-20years and the forests are left alone to regenerate, and bridges and culverts are removed from the site. Hydro projects have a longer lifespan, and thus being more permanent are designed for greater flow rates as a result. Also, hydro projects have more at stake if failure of the structure were to occur. The design of their projects and amount of infrastructure involved lead to a greater risk, and could therefore explain the increased peak flow that stream crossings are designed to accommodate. Another possibility is that a large percentage of run-of-river power projects are proposed for coastal streams which are much steeper in nature, and therefore a failure in a steeper coastal stream may lead to a greater level of devastation on the environment, through increased debris flows, and greater velocity, than interior streams (Alila, 2009).

4.4 STREAM WORK

FORESTRY

The Forest Planning and Practices Regulations outline various riparian management areas (RMA)[7], which consists of a riparian reserve zone (RRZ) and a riparian management zone (RMZ). Within the RMA there are three main restrictions with which an agreement holder must comply. These were discussed in section 3.3.1 Policies – Forestry.

Within the RRZ, the holder of the permit or agreement must not cut or modify trees unless they fall within the list of exceptions listed in FPPR section 51 (1). These include exceptions such as safety, creating an interpretive forest site or recreation site or trail, creating guyline tiebacks or corridors for yarding, or felling the tree under other forms of tenure, including the Land Act (Ministry of Forests and Range, 2004, p. Section 51 (1)). If a tree is to be felled within the RRZ, the agreement holder may only remove the tree if it will not have a material adverse effect on the RRZ (Ministry of Forests and Range, 2004, p. Section 51 (2)). Also, silvicultural practices that can be performed within the RRZ are limited and do not include grazing, herbicide application, mechanized site preparation, broadcast burning, spacing, or thinning (Ministry of Forests and Range, 2004, p. Section 51 (3)).

Agreement holders are also restricted within the RMZ and are required to retain a percentage of the basal area depending on the riparian class (Ministry of Forests and Range, 2004). Table 3 below shows the riparian

[7] See Appendix 3 for description of RMA for streams, lakes, and wetlands.

classifications and the corresponding basal area retention requirement. The trees that are retained are to be representative of the existing physical structure prior to harvest (Ministry of Forests and Range, 2004). Holders are also restricted in the RMZ for S4, S5, or S6 streams requiring that trees that contribute to the maintenance of the bank or to channel stability must be retained if the stream is a direct tributary to a larger stream, or the stream feeds directly to the ocean at a point with important noted habitat[8] (Ministry of Forests and Range, 2004).

Table 3: Required basal area retention for various riparian classes (Ministry of Forests and Range, 2008)

Column 1 Riparian Class	Column 2 Basal Area to be Retained Within Riparian Management Zone (%)
S1-A or S1-B stream	≥ 20
S2 stream	≥ 20
S3 stream	≥ 20
S4 stream	≥ 10
S5 stream	≥ 10
S6 stream	Not applicable
All classes of wetlands or lakes	≥ 10

Forestry companies working in and around a stream, according to FPPR, must construct the crossing or structure in a manner that will protect the stream channel, maintain bank stability immediately above and below the crossing, and minimize the amount of disturbance to the channel and bank (Ministry of Forests and Range, 2008). The crossing must also be removed when it is no longer required by the agreement holder and must ensure that through the lifespan of the structure, it and the activities it is required for, do not have any material adverse effect on fish passage in a fish stream (Ministry of Forests and Range, 2008). If construction is required in a fish stream, and requires a negative effect on fish passage in order to construct, maintain, or deactivate the structure or road, work is permitted so long as fish are not migrating or spawning and the cause of the negative effect is removed immediately upon completion (Ministry of Forests and Range, 2008).

HYDRO

All work for hydro projects around a stream, including construction of intakes, diversion structures, dams, power houses, tailraces, bridges, and culverts must be designed to accommodate a 1 in 200 year maximum daily flow rate (Ministry of Forests and Range, 2008, p. 42).

For development and maintenance of bridges and culverts related to road crossings as well as roads within riparian areas, hydro projects must apply to the Ministry of Forests and Range which provides information regarding load limits on forestry bridges and requirements for maintenance of the access roads (IPPBC, 2008a). If streams are tributaries that feed into the ocean, the Department of Fisheries and Oceans must be contacted to provide information and permits regarding acceptable construction methods and practices, fish passage criteria for in-stream structures, gravel recruitment requirements, habitat and riparian disruption compensation, working timelines and schedules for in-stream work, and also performs environmental monitoring during construction and post-construction (IPPBC, 2008a).

[8] Herring spawning area, shellfish bed, saltwater marsh area, aquaculture site, or juvenile salmonid rearing area or adult salmon holding area.

In addition to the above applications, a hydro project developer must also apply to the Ministry of Environment Water Stewardship Division under the *Water Act.* In order to be eligible for a permit under the *Water Act*, the hydro project developer must already have approval through the *Land Act* and hold tenure to the land for the purpose of hydro development (Ministry of Agriculture and Lands, 2008, p. 70). Under the *Water Act*, any diversion or use of water from a stream in order to produce power requires a water licence, as well as any disruption to the stream during the construction process (Ministry of Agriculture and Lands, 2008). Section 8 of the *Water Act* states that a permit must be issued in order to authorize short term (less than one year) use of water from a stream, and section 9 states the need for a permit for any changes in or about streams, including installation of road crossing or any in stream fish mitigation work (Ministry of Agriculture and Lands, 2008).

ANALYSIS

Under the *Water Act*, it appears that forestry does not have to apply to the Water Stewardship Division under section 8 and 9 and instead they are bound by the regulations written into the Forest Act, FPPR, and FRPA. There seems to be more regulation on in-and-around stream activity for construction of hydro projects than for forestry activities. This could be a result of the invasiveness of hydro projects and their potential for damage on the environment. However, there is a lack of information pertaining to the regulation of transmission lines built near streams taking energy produced to link up with the main grid. Some considerations for transmission corridors in riparian areas might be:

- requiring a narrower widths of ROWs until a certain distance away from the stream has been reached;
- requiring a certain degree of vegetation be present at all times to help maintain the integrity of the stream and riparian area; and/or
- a different set of restrictions for the maintenance of these transmission lines versus ones outside the riparian area in order to minimize impacts.

Currently, there is a lack of information surrounding hydro project development and the effects that their development will have on the streams and the surrounding environment. Pilot projects should be set up and more research performed in order to gather all data needed to evaluate the sustainability of these projects. At the current level of development, there are watersheds that have proposals for all major streams and tributaries present. Douglas has stated concern that developing multiple projects without considering the collective impacts, watershed-level impacts could be triggered (Douglas, 2007). These impacts will have significant impacts to the health of streams and the surrounding riparian environment (Douglas, 2007). The environmental impacts of this level of development are unknown and the effects need to be determined before the rush of development occurs throughout the province and BC's environment is irreversibly damaged. As of current, Environment Canada is the only agency that addresses the cumulative impacts on streams (IPPBC, 2008a). However, this only addresses the impacts on streams immediately surrounding the project and is restricted to the effects of the individual project. It does not take into consideration the impacts of other activities in the area, or consider the landscape as a whole.

The IPP Guidebook has acknowledged that every power project has its own challenges, that the level of existing data is sparse, there is a difficulty in accessing study sites, and sampling data conditions are difficult (Ministry of Agriculture and Lands, 2008, p. 72). This has led the Ministry of Environment to avoid a prescriptive approach to developing guidelines for construction. With this limited information acknowledged by regulatory agencies, there

should be a halt in the development of these projects until further information is gathered and a prescriptive approach to development can be undertaken.

5 CONCLUSION

Through conducting this comparison of policies between hydro project development and forestry activities, it can be seen that there are many similarities in the regulations, while there are also unique regulations for each industry.

For the harvesting a hydro developer is required to do to meet the needs of the project, they are governed by the Ministry of Forests and Range and are bound by almost all of the same regulations as forestry companies. There was a slight difference in that hydro developers are not required to produce site plans or forest stewardship plans and therefore are exempt from FRPA's 11 objectives. However, it was found that 9 out of the 11 objectives are met in other reviews and processes that hydro developers are required to complete.

The policies surrounding the construction of roads were found to be very similar for both. However, a major difference was found in the design for stream crossings (bridges and culverts). Forestry companies are only required to design their crossings to meet a 1 in 100 year peak flow event, whereas hydro developers are required to meet a 1 in 200 year peak flow. The reason behind this difference is not explained but could be speculated to be a result of the permanency of hydro projects; there is greater infrastructure at risk if failure were to occur, or failure could result in much larger consequences.

There were many differences in the regulations surrounding stream work. This is likely due to the different nature of each industry, and that one is more centralized around the stream, whereas forestry is typically crossing streams or working at the sides of them and not in them. There seemed to be greater regulation for hydro development and the in-stream work. Part of this included hydro developers submitting applications to Environment Canada who consider cumulative impacts on surrounding streams, and this does not occur for forestry practices.

The major difference between the information surrounding hydro development and forestry activities was the volume. Many studies have been done to determine the effects of forestry practices on the environment as a whole. However, there was a significant lack of research and studies to show the effects of hydro projects. There is little to no research on the effects of both forestry and hydro combined. Information needs to be gathered on the cumulative impacts on the land. This will allow for a greater understanding, and changes in regulations can be made accordingly.

By itself, a localized hydro project or a few cutblocks may not have the significant environmental impacts discussed, and may in fact be considered 'green' or sustainable. However, the large scale disturbance forestry currently has made on the forest, and the high number of proposed and approved hydro projects could lead to cumulative effects on the province. These impacts could include significant environmental damage that in most cases is irreversible. A collective effort needs to be made by all involved regulatory bodies and BC Hydro in order to determine and evaluate these cumulative impacts. The current level of development needs to be slowed in order to give agencies time to gather information and properly understand all the impacts before too much irreversible damage is inflicted on our environment.

BIBLIOGRAPHY

Alila, Y. (2009, March 20). P.Eng, Associate Professor. (N. D. Farrer, Interviewer)

Ashlu Creek Green Power Project. (2008). *Impact Upon Kayaking*. (Ledcor Power Inc.) Retrieved October 20, 2008, from http://www.ashlucreek.com/impact-upon-kayaking

BC Hydro. (2009a, January 21). *Careers*. Retrieved February 13, 2009, from http://www.bchydro.com/careers/

BC Hydro. (2009b, January 12). *Economic Bottom Line*. Retrieved February 13, 2009, from http://www.bchydro.com/about/company_information/reports/gri_index/economic.html

BC Hydro. (2008, July 17). *Total Land Area Owned or Managed by BC Hydro*. Retrieved February 13, 2009, from http://www.bchydro.com/about/company_information/reports/gri_index/en6_1_total_land_area_owned_or_managed_by_bc_hydro.html

COPE 378. (2008, June 26). *News Release: BC's Private Hydro Projects Not Green: California Utility*. Retrieved March 20, 2009, from http://www.cope378.ca/news/news-release-bc%E2%80%99s-private-hydro-projects-not-green-california-utility

Dickson, D. A. (2008, October 20). Recreational Kayaker. (N. D. Farrer, Interviewer) Salmon Arm, British Columbia, Canada.

Douglas, T. (2007). *"Green" Hydro Power: Understanding Impacts, Approvals, and Sustainability of Run-of-River Independent Power Projects in British Columbia.* Watershed Watch Salmon Society.

Geis, J. (1982, October). *Hydropower's Unexpected Side Effects*. Retrieved September 28, 2008, from Minnesota Department of Natural Resources: http://www.dnr.state.mn.us/waters/surfacewater_section/stream_hydro/sideeffects.html

Hinch, S. G. (2005). Fish and Stream Protection. (S. B. Watts, & L. Tolland, Eds.) *Forestry Handbook for British Columbia* , 155-187.

IPP Watch . (2008, January 14). *Water Licences & Land Use Applications*. Retrieved March 15, 2009, from http://www.ippwatch.info/w/index.php?option=com_content&view=section&layout=blog&id=1&Itemid=3

IPPBC. (2008a). *Permits, Licences, & Approvals List for Run of River Power Projects in BC.* Retrieved December 20, 2008, from IPPBC - Permits: http://www.ippbc.com/media/Permits.pdf

IPPBC. (2008b). *Quick IPP Facts*. Retrieved February 13, 2009

IPPBC. (2009a, February 2). *Run-of-River Fact Sheet*. Retrieved March 2, 2009, from http://www.ippbc.com/media/Run%20of%20River%20Fact%20Sheet.pdf

Marchak, P. M. (1983). *Green Gold.* Vanouver: University of British Columbia.

Mayhew, S. (1997). *Pool and Riffle Sequence*. (Oxford University Press) Retrieved April 15, 2009, from A Dictionary of Geography: http://www.yamasa.org/japan/english/destinations/aichi/ayu_pool_riffle.html

Ministry of Agriculture and Lands. (2008). *Independent Power Production in B.C: An Inter-agency Guidebook for Proponents.* (J. Carter, Ed.) Victoria, British Columbia, Canada: Province of British Columbia.

Ministry of Forests and Range. (2009). *Forest Act RSCB 1996, c. 157*, 2007 Bill 41 (B.C. Reg. 55/2009). Retrieved April 2, 2009, from http://www.for.gov.bc.ca/tasb/legsregs/forest/foract/contfa.htm

Ministry of Forests and Range. (2008b, May 29). *Forest and Range Practices Act*, 2008 Bill 8. Retrieved March 1, 2009, from http://www.for.gov.bc.ca/tasb/legsregs/frpa/frpa/frpatoc.htm

Ministry of Forests and Range. (2004). *Forest Planning and Practices Regulation*. Retrieved February 13, 2009, from http://www.for.gov.bc.ca/tasb/legsregs/frpa/frparegs/forplanprac/fppr.htm

Ministry of Forests and Range. (2008). *Forest Planning and Practices Regulations*. Retrieved December 25, 2008, from Statutes and Regulations - Forest and Range Practices Act: http://www.for.gov.bc.ca/tasb/legsregs/frpa/frparegs/forplanprac/fppr.htm#part4-div3

Ministry of Forests and Range. (2008c). *Resource Road Act*, Bill 30 - 2008. Retrieved February 13, 2009, from http://qp.gov.bc.ca/38th4th/1st_read/gov30-1.htm

Ministry of Forests and Range. (2006). *The State of British Columbia's Forests.* Victoria.

Province of British Columbia. (2007). *Forestry & Logging*. Retrieved December 25, 2008, from A Guide to the BC Economy and Labour Market: http://www.guidetobceconomy.org/major_industries/foresty.htm

Water Licences & Land Use Applications. (2008, January 14). Retrieved October 20, 2008, from http://www.ippwatch.info/w/index.php?option=com_content&view=article&id=23:liquid-gold-rush&catid=16uncategorized&Itemid=3

Rivers at Risk: Koch Creek (2009). [Motion Picture].

APPENDIX 1 – UNDERSTANDING CROWN LAND TENURES

There are many forms of Crown Land tenure government can grant independent power producers. Different tenures are granted at different times for different purposes, as explained below. Further information is available from FrontCounter BC or online at www.al.gov.bc.ca/clad/land_prog_services/policies.html

INVESTIGATIVE USE PERMIT

During the preliminary phase of an independent power project, an investigative permit allows proponents to access Crown land and begin studying the area in which they plan to build their project. . The permit allows proponents to access Crown land but does not allow the construction of any improvements on the land. Investigative Use Permits are usually for a two year term.

TEMPORARY PERMIT

Temporary permits grant the right to carry out specified activity(s) for a short term. They are issued for one-time events, sustained or repeated Crown land usage, where a business is better served by a permit than a licence of occupation.

WORKS PERMIT

Works permits may be issued for the construction of a road, non-commercial airstrip, bridge, or trail. Works permits do not entitle holders to deny to other people the right to use the road, non-commercial airstrip, bridge or trail.

LICENCE OF OCCUPATION

A licence of occupation may be issued where minimum improvements are proposed or where medium term tenure is required (5 to 45 years). A licence of occupation may also be issued where it is in the best interest of the Crown to allow high demand areas or parcels to be used by numerous users.

LEASE

A lease should be issued where long term tenure is required, where substantial improvements are proposed, and/or where definite boundaries are required in order to avoid land use and property conflicts. Leases are usually issued for 30 to 45 year terms.

RIGHT OF WAY

A statutory right of way is normally granted to authorize linear uses of Crown land for transportation, communication, energy production and utility developments (e.g. roads, power lines, cable telecommunications, oil and gas pipelines etc.). Applicants must pay for a legal survey to define the tenured area. A Right of Way is issued for 30 to 45 year terms in order to be consistent with the terms of the Electricity Purchase Agreement.

EASEMENT

An easement is a right to do something, or to prevent something from being done, on one parcel of land (the “servient tenement”) which benefits another parcel of land (the “dominant tenement”).

APPENDIX 2 – COMPARISON OF FRPA'S 11 VALUES AND HYDRO PROJECT REQUIREMENTS

Forest Range and Practices Act (Section 149)

Objectives set by government are:

1. soils;
2. visual quality;
3. timber;
4. forage and associated plant communities;
5. water;
6. fish;
7. wildlife;
8. biodiversity;
9. recreation resources;
10. resource features; and
11. cultural heritage resources (Ministry of Forests and Range, 2008b).

According to IPPBC Permits, licences, and approvals list they cover the following objectives:

1. Soils – applications through the MoFR
2. Visual Quality – not covered
3. Timber – applications through the MoFR
4. Forage and associated plant communities – not covered
5. Water – applications through MoFR, Fisheries and Oceans Canada (Habitat Protection Branch), Ministry of Environment, and Environment Canada
6. Fish – applications through MoFR, Fisheries and Oceans Canada (Habitat Protection Branch), Ministry of Environment, and Environment Canada.
7. Wildlife – applications through Environment Canada, Ministry of Environment
8. Biodiversity – Ministry of Environment, Environment Canada
9. Recreation resources – Canadian Coast Guard (Navigable Waters), recent changes to the Act put decisions in the hands of the government to approve construction on navigable streams.
10. Resource features – covered through multiple applications to various agencies
11. Cultural heritage resources – applications to First Nations, no non-aboriginal cultural heritage review

By comparing the 11 objectives set forth by the MoFR, which required to be planned for in the creation of FSP's, with the applications, reviews, and approval process of IPP's, it can be seen that visual quality and forage are not covered. Recreation is only considered under the Navigable Waters Act, and is currently undergoing changes to put more power in the hands of government, making it easier for IPP's to gain approval for projects on streams considered navigable.

APPENDIX 3 – LOCATION OF WATER POWER PROJECT PROPOSALS IN BC

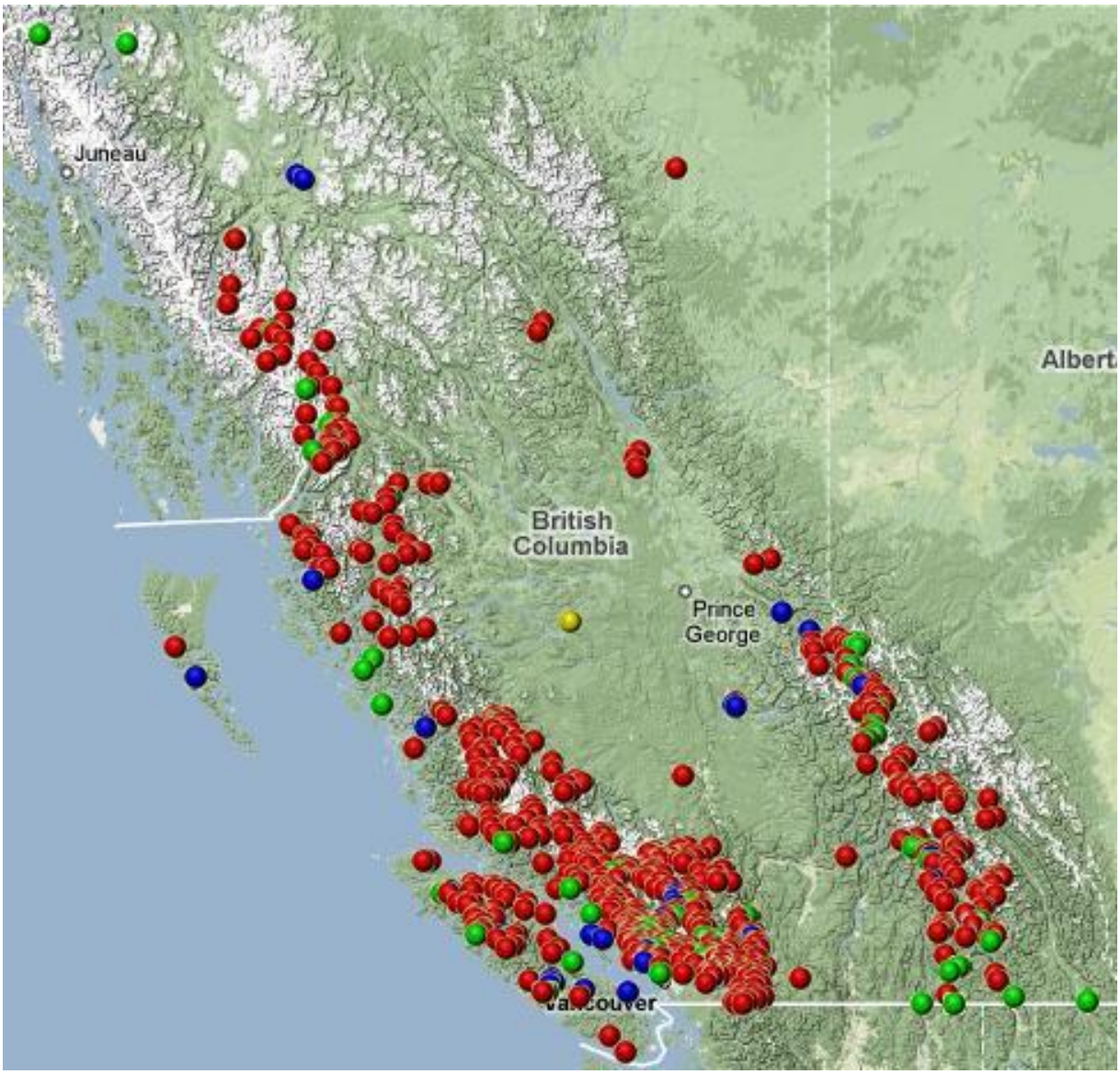

Figure 3: Location of water power projects throughout BC. Green dots represent granted power licence, red represents a current application for a licence, and blue represents currently generating licence. This figure shows the dominance of projects being located on the coast due to the steep terrain and wet climate (IPP Watch , 2008)

APPENDIX 4 – RIPARIAN CLASSES AND REQUIRED RIPARIAN MANAGEMENT AREAS

Table 4: Stream riparian classes and corresponding management areas and zones (Ministry of Forests and Range, 2008)

Riparian Class	Riparian Management Area (metres)	Riparian Reserve Zone (metres)	Riparian Management Zone (metres)
S1-A	100	0	100
S1-B	70	50	20
S2	50	30	20
S3	40	20	20
S4	30	0	30
S5	30	0	30
S6	20	0	20

Table 5: Wetland riparian classes and corresponding management areas and zones (Ministry of Forests and Range, 2008).

Riparian Class	Riparian Management Area (metres)	Riparian Reserve Zone (metres)	Riparian Management Zone (metres)
W1	50	10	40
W2	30	10	20
W3	30	0	30
W4	30	0	30
W5	50	10	40

Table 6: Lake riparian classes and corresponding management areas and zones (Ministry of Forests and Range, 2008).

Riparian Class	Riparian Management Area (metres)	Riparian Reserve Zone (metres)	Riparian Management Zone (metres)
L1-A	0	0	0
L1-B	10	10	0
L2	30	10	20
L3	30	0	30
L4	30	0	30

Table 7: Retention requirements within the Riparian Management Zone (Ministry of Forests and Range, 2008).

Column 1 Riparian Class	Column 2 Basal Area to be Retained Within Riparian Management Zone (%)
S1-A or S1-B stream	$\geq$ 20
S2 stream	$\geq$ 20
S3 stream	$\geq$ 20
S4 stream	$\geq$ 10
S5 stream	$\geq$ 10
S6 stream	Not applicable
All classes of wetlands or lakes	$\geq$ 10