Chapter 7
Mammals and Birds of the Chilko-Chilcotin-Fraser River Basin

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Abstract

This report focuses on interactions between different drivers in the Chilko-Chilcotin-Fraser river system which produce one of the richest areas of biodiversity in British Columbia. The Chilko-Chilcotin-Fraser travels through most of the biogeoclimatic zones of the province, each in their own way shaped by these drivers. The bigger conceptual model which this chapter is part of shows how each of these interactions physically shape the river system and surrounding area, while the chapter below focuses on the wildlife interactions and how they contribute to the ecosystem as a whole.

Introduction

The Chilko-Chilcotin-Fraser (CCR) river system in British Columbia is home to a diverse assemblage of species, due to three major contributing factors. The interior part of the system is an extension of the intermontane steppe of the western Great Basin and the intersection of northern and southern breeding and living ranges for a number of wildlife species. This area is also one of the stops on the Pacific Flyway avian migration route, which increases the biodiversity seasonally (Calbick 2004, Fraser River Basin Council 2010). Finally the CCR river basin contains 11 of the 14 biogeoclimatic zones (BGC) of British Columbia which is a major contributor to the species diversity in the area (Map 7.1). The BGC zone system was developed in British Columbia to be used as a reference in research and management. It is a classification which considers soil, vegetation and climate as a group for easy comparison of areas (Min. of Forest and Range 2008). The CCR watershed is home to one of the largest Sockeye salmon

(Oncorhynchus nerka) runs in the world and many other species of anadromous salmonids such as coho (*O. kisutch)*, Chinook (*O. tshawytscha)* and chum (*O. keta)* salmon. Due to the influence of anadromous fishes marine derived nutrients (MDN) are an intricate part of the nutrient cycle for the CCR watershed and provide important foraging opportunities for bird and mammalian species. The main dispersers of MDN in this area are the black bear *(Ursus americanus)* and grizzly bear *(Ursus arctos horribilis)*, but smaller mammals as well as birds play an important role. A conceptual model (fig. 7.1) was developed to understand the interactions between mammals and birds within the broader CCR ecosystem.

The Conceptual Model

The conceptual model in figure 7.1 describes the key drivers controlling the habitat characteristics and ultimately the type of birds and mammals the CCF river system will support. The key drivers identified in Figure 1 are geomorphology, hydrology, climate and the ocean, giving rise to unique vegetation types (See ch. 6). Each driver exerts varying degrees of influence on each individual outcome, creating the local ecosystem. This report will describe the extent to which specific drivers and intermediate outcomes influence the presence and behavior of the fauna in the watershed.

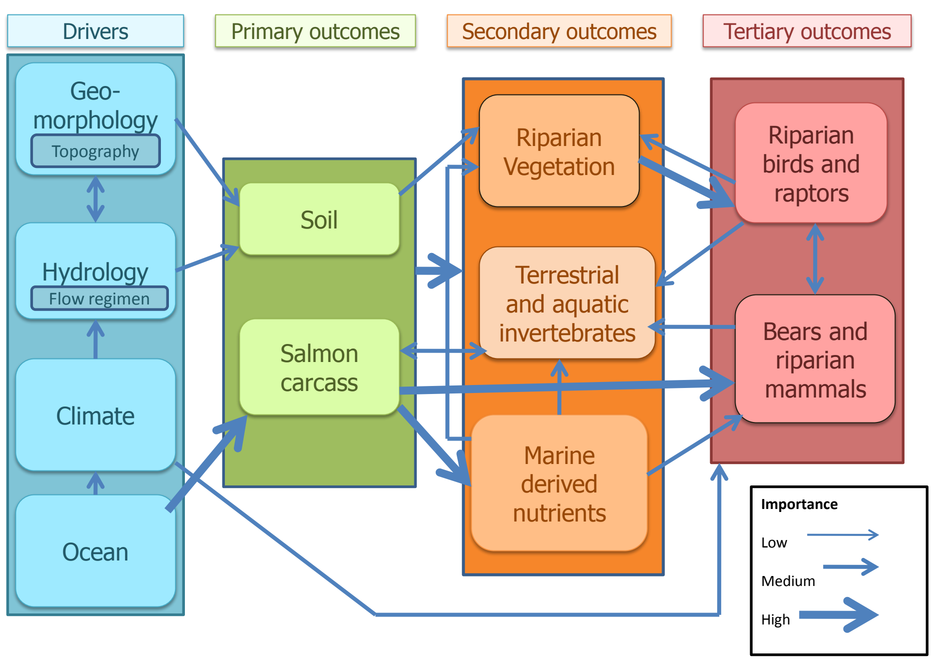


Fig. 7.1 Conceptual model shows the interactions which shape the CCR ecosystem.

Drivers

Geomorphology and Hydrology

Geomorphology and hydrology work together and independently to ultimately provide the physical habitat for flora and fauna. Together they are direct drivers in determining the type of soil development which to some extent dictates the composition and structure of riparian vegetation, as well as the river substrate (See ch. 4 & 6). The vegetation is one of the main drivers in the habitat search for birds and mammals and has been termed "niche gestalt" (James 1971). This is true both for the riparian area and the important foraging opportunities available in the avalanche tracks at higher elevations. Complex habitat morphology increases structural complexity and allows for greater biodiversity (Ministry of Environment 1991, Khutzeymateen 1993). Further, geomorphology and river-flow dictate fishing opportunities for the riparian mammals based on river accessibility and channel morphology and thereby determine how much of the salmon derived nutrients enter the terrestrial ecosystem in a given location (Helfield 2006).

Topography determines the location for excavation of winter dens for bears and their migration routes. Bears require a certain slope angle for den sites. A 3-year study of grizzly bears in British Columbia found most dens were located on a >45% slope under old growth forest (Khutzeymateen 1993). The steep slope allows water to run off and the den to stay dry during snow melts. This is most important in mid-winter, when snow sometimes melts and refreezes during the hibernation. Many of the dens are close to avalanche tracks, where the access to early sprouting vegetation benefits the recently aroused bears. These tracks have been cleared from trees by avalanches which provides disturbed habitat for new growth to occur. This new growth provides excellent foraging opportunities (Khutzeymateen 1993).

Climate

It would be impossible to discuss hydrology and vegetation without including climate, which has a profound impact on both, and so indirectly on geomorphology of the CCR ecosystem. The climate determines the timing of water availability and also the temperature in an area (See ch. 3). Climate is one of the determining factors when a wildlife species evolves coping mechanisms to deal with extreme weather, such as hibernation, caching food or migrating. Climate zones determine species ability to survive both through the vegetation and the temperature range as each species has a temperature tolerance range which it thrives within.

Ocean

Though the ocean is not directly part of the CCR river system it has an impact on the ecosystem which in some areas is considerable due to the salmon spawning. In this system this is especially true of the sockeye. By the anadromous fish migrations and spawning, MDN are brought to the river and riparian area from the ocean. Other smaller contributions are made from other anadromous fish such as the pacific lamprey *(Lampetra tridentata)* (See ch. 9). The ocean also plays a large role in regulating the regional climate.

Primary outcomes

Soil

Soil type available for the vegetation is determined by the geomorphology through hillslope and hydrology interactions working on the system (See ch. 3, 4 & 6). Soil type indirectly affects the distribution of animal species through the potential for foraging, nesting and cover from predators. (Khutzeymateen 1993).

Salmon Carcass

The profound effect of MDN provided to terrestrial ecosystem through the distribution of salmon carcass by predatory and scavenging birds and mammals has been widely documented (Hocking 2006, Quinn 2009, Helfield 2006).This effect is seen both in pristine habitats with very little human influence such as Alaska and British Columbia and in severely human-altered areas such as the Central Valley wine country in California where MDN can be traced in the river adjacent agriculture despite heavily reduced salmon runs (Metz & Moyle 2006).

Secondary outcomes

The two most prominent secondary outcomes of the CCR ecosystem from the perspective of birds and mammals, are the habitat and foraging they provide. These are direct influences on the ability of a species to sustain itself in a particular area and both outcomes benefit directly from the third, the MDN brought by the spawning salmon.

Types of vegetation and vertebrate use thereof

The CCR river system passes through four BGC zones which are investigated below, starting at the Chilko Lake, the source of the Chilko river. The vegetation provides cover from predators, nesting habitat and materials as well as foraging opportunity and is therefore a vital component for the survival of species.

Sub-alpine fir and montane spruce

Around Chilko Lake, sub-alpine fir and montane spruce dominate as vegetation. This allows the wildlife in the area to move from one habitat type to another seasonally. For instance caribou and moose are known to migrate between habitats to cope with climate and for foraging opportunities (Ministry of Environment 1991). Caribou *(Rangifer tarandus)* also graze on the lichen under the snow while the moose *(Alces alces)* stay in the riparian area or migrate to lower elevations.

One of the species common in this habitat is the grizzly bear, a "species of special concern" under the Canadian Species At Risk Act (SARA). Sub-alpine fir and montane spruce zone are the most productive BGC zones for grizzly bear in British Columbia. Despite the grizzly's special status, it is still hunted under strict conditions and only in populations larger than 100 individuals. The estimated total population of grizzly bear in British Columbia is currently 16,000 (Ministry of Environment 1991, 2010, 2012).

The grassland sections on the south facing slopes in these BGCs are small in area, but very important grazing habitat for bighorn sheep. The grassland also provides habitat for pika *(Ochotona princeps)* and golden mantle ground squirrel (*Spermophilus lateralis)* and one of their predators, the Golden Eagle *(Aquila chrysaetos)* nests there. The avalanche tracks are an important foraging area for Rocky Mountain elk *(Cervus Canadensis nelson)* and mountain goat *(Oreamnus americanus)* as well as both the grizzly and the black bear. Smaller mammalian predators who potentially fish or eat spawned out carcasses in this area of the CCR watershed include wolverine *(Gulo gulo)*, marten *(Martes americana)* , mink *(Mustela vision)* and fisher *(Martes pennanti)* (Ministry of Environment 1991).

Sub-boreal pine forest

As the Chilko river starts out of the Chilko Lake, sub-boreal pine forest grows along the riparian corridor down to the Chilcotin confluence. This portion of the river has higher mammal diversity than the area around Chilko Lake. The area has also suffered recent and unprecedented pine beetle out breaks, and increased intensity in forest fires due in part to tree die off associated with the pine beetle. This makes the availability of understory lichen, moss and grass limited as the areas are either burnt or do not receive enough shade (Ministry of the Environment 1991). In this area the black bear is likely more common than the grizzly bear in the riparian zone (Khutzeymateen 1993).

Due to the lower elevation some species reside in the riparian area year around. These include moose, beaver and muskrat. The beavers *(Castor canadensis)* and the muskrats *(Ondatra zibethicus)* prefer calmer water and will stay in pools with slower flow if possible. The Stum Lake which is approximately 23 miles NE of the Chilko-Chilcotin confluence is the only White Pelican *(Pelecanus erythrorhynchos)* breeding site in British Columbia. Though they breed in Stum Lake, the parents fly to fish in nearby lakes to feed the young (Ministry of the Environment 1991).

Interior douglas fir

Around the Chilko-Chilcotin confluence the interior douglas fir (IDF) zone takes over and dominates the area covering the varied topography and provides productive understory vegetation under a great diversity of overstory vegetation. The heterogeneous vegetation provides for a complex assemblage of habitats which include riparian wetlands, fens and grasslands. The riparian area is used as winter habitat for the Coast Range's higher elevation passerines as well as deer and others. It is also used as calving ground for moose *(Alces alces)* and mule deer *(Odocoileus hemionus)* due to the cover and food provided by the highly productive vegetation. Structural heterogeneity also provides habitat for breeding birds and amphibian species who cannot survive in the drier parts which dominate the interior douglas fir zone (Ministry of the Environment 1991).

Bunchgrass

As the Fraser moves into the deep interior valley located in the rain shadow of the Coast Range, the bunchgrass biogeoclimatic zone begins. This area is a stop on the Pacific Flyway and the main foraging area for migrating waterfowl. The estuary of the Fraser River which is further south-west, supports the highest density of wintering shorebirds, waterfowl and raptors in Canada (Calbick 2004). This, together with northern and southern habitat ranges for many vertebrate species overlapping, such as the snowy owl *(Bubo scandiacus)* and burrowing owl *(Athene cunicularia*)makes this the most biologically diverse and productive area in British Columbia. The shrub steppe, grassland and riparian area vegetation contain many microhabitats making it possible to support this great diversity. The stream terraces on either side of the river, the access to river water and the warmer temperatures makes the area ideal to be used for agriculture and rangeland, and therefore, it is heavily overgrazed. This has altered the native flora and the bunchgrasses favored by bighorn sheep *(Ovis canadensis californiana)* which is being replaced by invasive and less nutrient rich species. (Ministry of the Environment 1991)

Marine Derived Nutrients (MDN)

The terrestrial vertebrates which utilize the riparian zone are vital vectors in the transfer of MDN into the river ecosystem (Quinn 2009, Cederholm 1999). In the CCF river system the most important facilitators of this transfer are the brown and the grizzly bears. Since bears eat a large portion of the returning salmon (30-80%) this is an important contribution both to the overwinter survival and reproduction of bears and to the ecosystem (Quinn 2009, Helfield & Naiman 2006). Bears also disperse the nutrients by defecation in the direct riparian area and the forest. A study completed in southern Alaska of the bear predation on sockeye, pink and chum salmon found nearly half of the salmon caught transported from the fishing site, up to 100 m into the forest. It was estimated that this added 12 kg of P and 89 kg of N to a riparian area of 40 000 m^2 (Quinn 2009). This amount of nutrient input comes close to silvicultural applications (Quinn 2009). The amount of salmon the bears removed from the creek depended on the density of bears fishing in the creek, the depth of the stream and the abundance of salmon. Brown and black bears killed half of the salmon in small streams making the MDN available to terrestrial insects, soil and fauna as well as the aquatic environment when the carcass is left in the water or caught by woody debris (Quinn 2009). Other animals such as the bald eagle*(Haliaeetus leucocephalus)*, gulls *(Laurus spp.)*, wolves *(Canis lupus),* mink*(Mustela* *vision)*, fisher *(Martes pennanti)*, marten *(Martes americana)* and river otters*(Lontra Canadensis)* can also serve as transport vectors for the salmon, but do so to a much lesser extent (Darimont 2003, Ben-Davis 1997, Ministry of the Environment 1991).

In some ecosystems the transfer of MDN provides 24% of the riparian N budget. The level of contribution depends on the salmon escapement, channel morphology and the watershed vegetation (Helfield & Naiman 2006). This is an important consideration in the CCR river system where different species of salmon spawn in different locations and the geomorphology of the river channel varies greatly. The important effect of the mutual relationship is seen when comparing spawning areas with high bear density to others without significant bear activity. In the latter areas no change in soil nitrogen cycling was detected emphasizing the need for the large mobile predators to distribute the MDN (Holtgrieve 2009.)

Abiotic factors such as flooding and large woody debris (LWD) can trap carcasses in the riparian area. The aquatic larvae which feed on the carcasses then emerge as terrestrial insects and disperse the MDN in the riparian community. Some of the MDN stays in the water and enters the riparian by hyporheic flow-paths making it available to the riparian vegetation (Helfield et al. 2006, Hocking et al 2006). Loss of woody debris in and along streams diminishes carcass retention and allows the nutrients to flow downstream and be lost as a riparian input (Cederholm 1989). The added nutrients not only fertilize the river and stream beds, but by doing so might alter the composition of the vegetation. It is possible that marine N influx may also decrease the competitive advantage of N-fixing plants such as alder *(Alnus spp.),* resulting in decreased abundance of these species near spawning streams (Helfield & Naiman 2001) The added nutrients are very valuable in drier regions where the vegetation gradient between riparian and upland plant communities is pronounced (McGarigal & McComb1992)(See ch.6).

Terrestrial and Aquatic Invertebrates

Terrestrial invertebrates with an aquatic stage in their lifecycle make an important contribution to the MDN cycle of the British Columbia river systems, including CCR. Meehan et al. (2005) conducted a study of blow-fly *(Calliphoridae spp.)* use of carcasses in their reproductive cycle. The carcasses are most likely to become colonized and provide a transfer between the aquatic and terrestrial environments if they are moved onto the grass or into the forest. In deeper rivers and streams when the salmon died of senescence instead of predation and remained in the water, the carcass would be much less available to the blow-fly larvae.

Hocking et al (2006) conducted a study of springtime isotope analysis of marine derived N and C in emerging *Calliphora spp.* adults which showed salmon based signatures in more than 80% of the adult individuals. These adult flies are a part of the diet for many terrestrial vertebrate and invertebrate species and the MDN have been tracked through riparian communities. During the Hocking study, the fly larvae was preyed on by 13 bird species varying from thrush, songbirds, sparrows to jays and sandpipers. The fly larvae also provided food for newt, salamander and the montane shrew. Many caddisfly, stonefly and midge species directly feed on salmon carcasses left in the stream and others such as mayflies and blackflies feed on the fine particles flowing downstream from the submerged and decomposing carcasses (Helfield et al 2006)(See Ch. 8).

Tertiary outcomes

Riparian vegetation and many of the invertebrates are positively influenced by the MDN provided by the salmon carcasses distributed by mammals and birds using the riparian zone in the CCR watershed. Most, but not all, of the potential vectors are investigated here.

Mink

Coastal mink and riverine mink *(Mustela vision)* have vastly different foraging habits during the spring and summer, but both use Pacific salmon as a food source during the summer and fall runs. Riverine mink which are found in the CCF system depend on salmon year around as a food source. Despite being inefficient swimmers and divers they are quite successful in catching the smaller juvenile fish in loose schools. The riverine mink were found to prey on emerging juveniles of all salmon species in the spring and adult Dolly Varden in early summer. The mink will also cache the salmon for use in early spring, as it freezes overwinter. The coastal mink which is part of the lower Fraser estuary switches from intertidal invertebrates to salmon as the carcasses become available during their fall and winter runs (Ben-David 1997).

Wolves

In British Columbia and Alaska, scat and isotope based studies indicate that salmon provide a considerable amount of dietary protein in wolves over a life time. The wolves have a success rate of over 39% in capturing the spawning salmon making them fair fish predators. Considering the comparatively very small risk of sustaining injury, lack of extensive travel to find the prey, it is an energetically beneficial trade for the traditional ungulate prey at spawning time. The wolves were observed only eating the head of the freshly caught salmon, leaving the rest of the body on the river bank or in the adjacent forest for scavengers to consume or to decompose (Darimont 2003, Hocking et al. 2006, Helfield & Naiman 2006,)

Bears

According to the Ministry of Environment there are about 16,000 grizzly bears and 120-160,000 black bears in British Columbia (Ministry of Environment 2012). Both of these species take advantage of the salmon runs to increase their fat stores before the winter. At feeding areas black bears are normally sub-dominant to the grizzly bear. The close relationship between salmon and bear fits the concept of keystone mutualism, or keystone species and mobile links. A keystone species is a species which exerts disproportional influence on an ecosystem; both bears and salmon are considered such species. When both species are considered together their influence is further magnified. The MDN arrive with the salmon, but the ecosystem benefits to a much greater extent by distribution of the salmon carcasses by the bears, which greatly increases the area of the riparian vegetation which is fertilized during the salmon run (Helfield & Naiman 2006). The sockeye salmon accounts for most of the biomass in the CCR system, spawning mostly at the mouth of the Chilko Lake. Some additional minor spawning grounds are located in other tributaries as the Taseko river. Other anadromous salmon use other sites in the CCR river system to spawn (See ch. 9, 10 & 11).

The social hierarchy of the bears has been found to have a clear effect on the transport distance of the salmon carcass. Subdominant bears will catch fewer salmon as they defer to the more dominant bears, but then transport the carcass further form the river’s edge to protect it from the competition. This extended transport ensures a greater area benefits from the MDN brought by the salmon but decreases the energy intake of socially subdominant bears (Gende and Quinn 2004). Salmon which were ripe, that is ready to spawn, were more often transported by the bears than spawned out carcasses. The largest male salmon were also preferentially transported and the most energy rich parts such as brain, gonads and dorsal musculature was eaten only or first (Quinn 2009, Reimchen 2000).

Birds

The presence of MDN can be traced to the feathers and tissue of the riparian birds in the spawning areas. In a study of winter wrens in a British Columbia conducted above and below a waterfall which blocked salmon migration, Christie et al (2008) found an increased presence of the marine isotope of nitrogen (N) in the feathers. The two sources of MDN was birds directly feeding on the fly larvae colonizing salmon carcasses and through the terrestrial adult invertebrates which also contained higher levels of the marine derived N. Gende and Wilson (2001) found higher densities of passerines in the riparian zones of salmon-spawning streams than non-spawning streams. They concluded that higher terrestrial and aquatic invertebrates after the salmon spawning in fall gave a more abundant food supply for the breeding bird in the spring. Riparian bird species also benefit from the increased growth of riparian plants due to the added MDN. The increased vegetation growth provides better nesting opportunities and foraging for herbivorous birds (Helfield & Naiman 2001, 2006, Ben-David et al. 1997, 1998).

Direct predation on the juvenile salmon is mainly by gulls, herons and mergansers. Bald Eagles prey on the migrating spawners all along the river system. They also congregate at the spawning sites, but will only scavenge the carcasses if bears are present and space is limited (Khutzeymateen 1993, Ministry of Environment 1991).

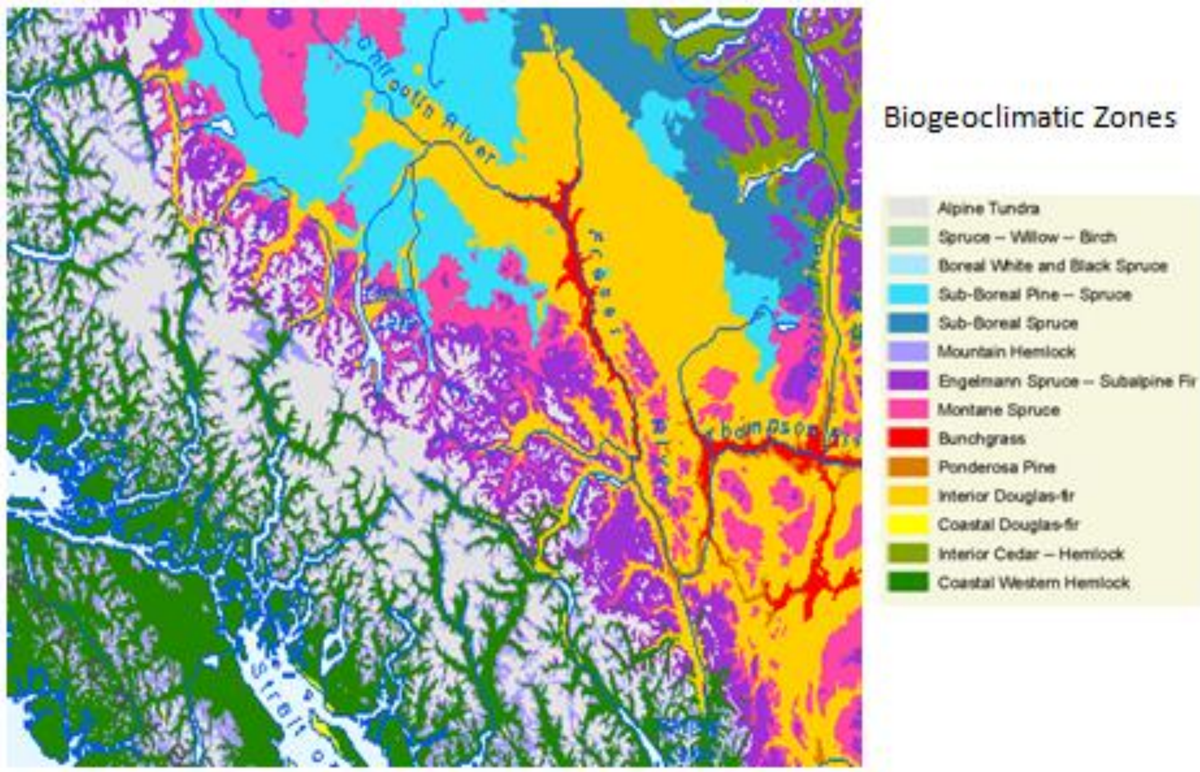
Uncertainties

As the climate change progresses and the ocean temperature increases, the ocean productivity will decrease. Since most of the life cycle and growth of the Pacific salmon occurs in the ocean this could mean smaller salmon runs, or even the disappearance of some anadromous salmon species completely (See ch. 9, 10 & 11). This would dramatically decrease the food available to bears preparing for hibernation and lead to lowered survival and reproductive success. Many birds and smaller mammals would also be adversely affected as they rely on the different life stages of the salmon for foraging. Other climatic effects would include precipitation with would alter the vegetation used for cover and foraging.

Additional threats to the CCR ecosystem are agriculture and urbanization of land in the watershed. Agriculture is predominant adjacent to the river, making it vulnerable to disturbances. Run off, habitat destruction and invasive species are of major concerns in the area as all can affect water quality. Large portions of the valley are protected by the Caribou-Chilcotin Provincial Park. The increasing urbanization of the area is another possible threat (Fraser Basin Council 2010). Much of the land along the CCR is owned by tribal groups who work together with the B.C. Government agencies through for example the Fraser Basin Council, to develop the area sustainably and address concerns of global warming.

Summary

The grizzly and black bears are the main terrestrial predators of the anadromous salmon, including the sockeye salmon. The bears eat both the spawned out fish and the migrating fish before they have a chance to reproduce, sometimes selectively preying on females, eating only the eggs (Quinn 2009). Fish are also carried into the riparian areas and help fertilize the riparian zone which depending on the social status of the bear, can be quite a distance from the river (Gende and Quinn 2004). In the CCR river system the majority of sockeye spawning is very centralized and takes place just below the Chilko Lake. This begs the question how significant the MDN released here are to the rest of the CCR. Wipfli et al (2007) showed the importance of headwater nutrients for downstream ecosystems and I would argue this applies in the CCR watershed. Though the salmon-bear interaction meets the criteria for keystone mutualism, the species in this ecosystem interaction could be considered in some way interchangeable. The MDN could be brought by any anadromous species, but no other species present in the CCR system migrates in the numbers sockeye salmon does. A decrease in the available salmon for terrestrial birds and mammals would have devastating effects, especially on the bears who need the fall supply of lipids and proteins supplied by the migrating fish for hibernation. Bears getting ready for hibernation would suffer most as their reproductive success depends on a large weight reserve as they enter their dens in the fall (Gende 2004). In the absence of bear, other mammalian species would still distribute the MDN in the riparian area but to a significantly lesser extent. These additional sources and interactions may have increased importance in years of low salmon escapement, but cannot replace thesubstantial impact of the bear-salmon interaction has on the CCR river ecosystem..



Map 7.1 Biogeoclimatic zonesof the Chilko-Chilcotin-Fraser River system.

(Ministry of Forest and Range 2008)

Table 7.1 Species present in the Chilko-Chilcotin-Fraser River System

Common Name	Scientific Name	Biogeoclimatic Zone
Mammals		
Beaver	*Castor canadensis*	8, 13, 15
California Big Horn Sheep	*Ovis Canadensis californiana*	8, 10,12, 15
Caribou	*Rangifer tarandus*	12, 13, 15
Black bear	*Ursus americanus*	10, 12, 13, 15
Golden mantle ground squirrel	*Spermophilus lateralis*	8, 10, 12, 15
Grizzly Bear	*Ursus arctos horribilis*	10, 12, 13, 15
Fisher	*Martes pennanti*	12, 13 15
Marten	*Martes americana*	12, 13, 15
Mink	*Mustela vision*	12, 15
Moose	*Alces alces*	10, 12, 13, 15
Mountain Goat	*Oreamnus americanus*	10, 12, 15
Mule deer	*Odocoileus hemionus*	8, 10, 12, 13
Muskrat	*Ondatra zibethicus*	8, 13
Pika	*Ochotona princeps*	12, 15
River Otter	*Lontra Canadensis*	8, 13, 15
Rocky Mountain Elk	*Cervus Canadensis nelson*	8, 10, 12, 15
Gray Wolf	*Haliaeetus leucocephalus*	13, 15
Wolverine	*Gulo gulo*	12, 15
Birds		
American White Pelican	*Pelecanus erythrorhynchos*	13
Bald Eagle	*Haliaeetus leucocephalus*	8, 10, 13
Burrowing owl	*Athene cunicularia*	8
Golden Eagle	*Aquila chrysaetos*	8, 10, 12, 15
Gulls	*Laurus spp*	8, 10, 13
Snowy Owl	*Bubo scandiacus*	8, 13

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