Bull Trout

Salvelinus confluentus

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Disclaimer: The following document was compiled based on the Ministry of Environment Bull Trout Accounts and Measures for Managing Identified Wildlife in addition to a review of information currently available for this species as of January 11, 2006. This document can be used to assist with the identification of this species and to support the development of management recommendations as they relate to forestry activities. For more information on this species, please refer to the reference section or consult with a Species at Risk specialist.

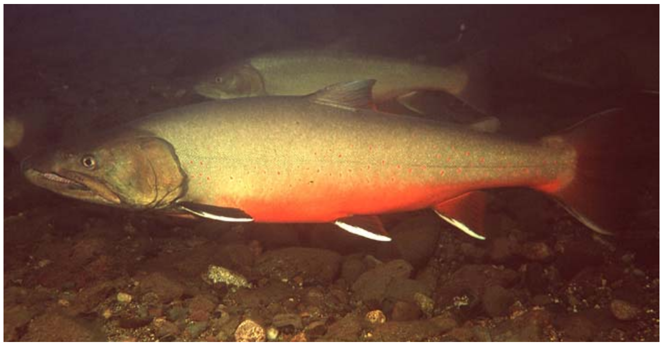
Description

Bull Trout have a large head and jaws in relation to their long, slender body[1,2]. Colouration ranges from green to greyish-blue, with lake-resident fish often displaying silvery sides[3]. The dorsum and flanks are spotted with pale yellowish-orange spots. The absence of black spots on the dorsal fin distinguishes Bull Trout from other species of char and trout that are native to western Canada[3]. The pelvic and anal fins of mature male Bull Trout develop a tri-colour sequence beginning with white leading edges progressing to a black band fading to grey and ending with a bright orange trailing edge. Mature female Bull Trout exhibit a similar pelvic and anal fin colouration, though the colour contrast is not as pronounced as that of male fish[4].

Bull Trout are large fish relative to other char and trout species[5]. Stream-resident populations often reach maturity and maximum length at 20–33 cm[6]. The maximum size of mature Bull Trout has been reported to vary from 20 to 40 cm in some habitats[4]. However, it has been reported that the mean size of mature Bull Trout in a selection of large lakes, reservoirs, and rivers in British Columbia can range from 60 to 66 cm for females and from 65 to 73 cm for males. The minimum size for spawners typically exceeded 50 cm[7].

Sexual dimorphism exists in Bull Trout and male fish are often larger than females. Spawning males often develop a pronounced hook, or kype, on the lower jaw[8].

Photo courtesy of Ernest Keeley, Idaho State University

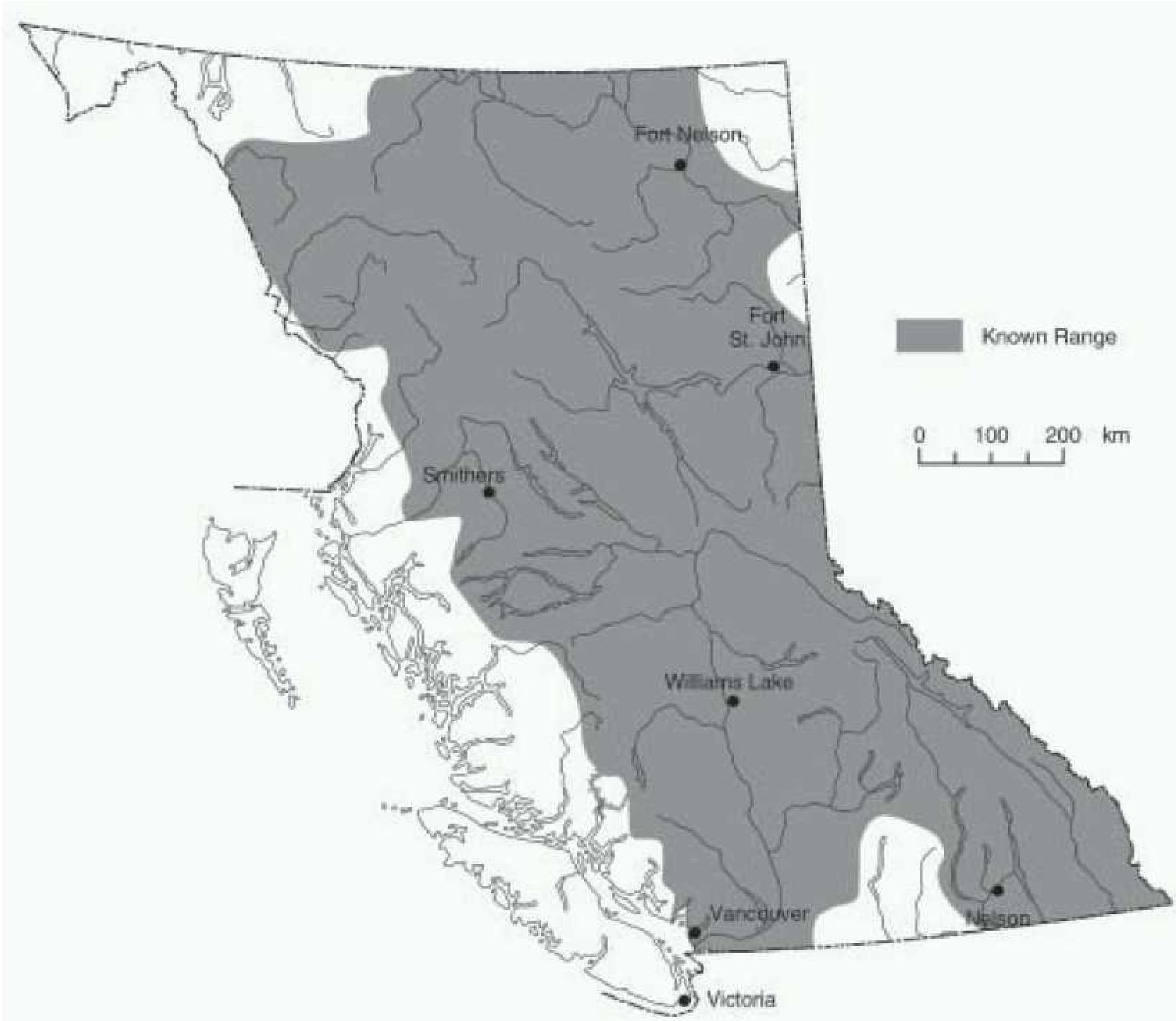


Male (left) and Female (below) Bull Trout during spawning. Photos courtesy of Ernest Keeley, Idaho State University

Distribution

In British Columbia, Bull Trout are found in practically every major mainland drainage, including those major coastal drainages which penetrate the Coast Mountains into the interior of the province (e.g., Fraser, Homathko, Klenaklini, Bella Coola, Dean, Skeena and Nass rivers). In addition, some coastal populations of Bull Trout have been recognized (e.g., Squamish River)[7].

Drainages/locations where they do not occur include Vancouver Island and the Queen Charlotte Islands; the lowermost reaches of some of the major drainages penetrating the Coast Mountains; the Petitot and Hay river systems in the north-east; most of the headwaters of the Yukon River system, except for Swan Lake in the Teslin drainage; and the Alsek system on the north coast[8].



Known range of Bull Trout in British Columbia[7]

Forest Districts[7,9]

- Arrow Boundary Forest District (DAB)
- Central Cariboo Forest District (DCC)
- Chilcotin Forest District (DCH)
- Chilliwack Forest District (DCK)
- Columbia Forest District (DCO)
- **Cascades Forest District (DCS)**
- Fort Nelson Forest District (DFN)
- **Headwaters Forest District (DHW)**
- North Island - Central Coast District (DNI)
- Fort St. James Forest District (DJA)
- **Kamloops Forest District (DKA)**
- Kootenay Lake Forest District (DKL)
- Kalum Forest District (DKM)
- **100 Mile House Forest District (DMH)**
- Mackenzie Forest District (DMK)

- Nadina Forest District (DND)
- Okanagan Shuswap Forest District (DOS)
- Peace Forest District (DPC)
- Prince George Forest District (DPG)
- Quesnel Forest District (DQU)
- Rocky Mountain Forest District (DRM)
- Squamish Forest District (DSQ)
- Skeena Stikine Forest District (DSS)
- Vanderhoof Forest District (DVA)

Ecoprovinces and ecosections[7]

- BOP: CLH*, HAP, KIP, PEL
- CEI: BUB, BUR, CAB, CAP, CCR, CHP, FRB, NAU, NEU, QUL, WCR, WCU
- COM: CBR*, CPR*, CRU, EPR, KIM, MEM*, NAB, NAM*, NBR*, NWC, SBR*, SPR*
- GED: FRL
- NBM: CAR, EMR, HYH, KEM, LIP, MUF, NOM, SBP, SIU, STP, TEP*, THH*, TUR*, WMR
- SBI: BAU, ESM, HAF, MAP, MCP, MIR, NEL, NHR, NSM, PAT, PEF, SHR, SOM, SSM
- SIM: BBT, BOV, CAM, CCM, COC, CPK, EKT, ELV, EPM, FLV, FRR, MCR, NKM, NPK,
- QUH, SCM, SFH*, SHH, SPK, SPM, UCV, UFT
- SOI: GUU, HOR*, LPR, NIB, NOH*, NTU, PAR, SCR, SHB, STU*, THB, TRU
- TAP: ETP*, FNL*, MAU*, MUP

* = presence in portion of ecosection only

Biogeoclimatic Units[7,9]

- BG - Bunchgrass - all
- BWBS - Boreal White and Black Spruce - all
- CWH - Coastal Western Hemlock - all
- ESSF - Engelmann Spruce – Subalpine Fir - all
- ICH - Interior Cedar – Hemlock - all
- IDF - Interior Douglas-fir - all
- MS - Montane Spruce - all
- PP - Ponderosa Pine - all
- SBPS - Sub-Boreal Pine – Spruce - all
- SBS - Sub-Boreal Spruce - all
- SWB - Spruce - Willow -Birch- all

Broad ecosystem units[7]

FS, IN, LL, LS, OW, RE, SP

Elevation

The occurrence of Bull Trout is strongly associated with lavational and thermal gradients in streams; however, there is no conclusive elevational data for British Columbia. Temperature tends to be more important in determining Bull Trout distribution[7].

Map of Known Locations

Although this species is known to occur in the Kamloops, Headwaters, Cascade and 100-Mile House Forest Districts, occurrence data from the Conservation Data Centre is not available. For the most recent information about British Columbia lakes and streams and the fish in them, please refer to FishWizard, a database maintained by BC Fisheries and Fisheries and Oceans Canada at http://pisces.env.gov.bc.ca. Additionally, stream surveys are recommended for streams with characteristics outlined in this report to determine presence or absence of this species.

Biology

Diet and foraging behaviour

In general, Bull trout fry tend to stay near the substrate to avoid being swept downstream[5]. Juvenile Bull Trout predominantly feed on aquatic insects and amphipods from benthic (river or lake bottom), pelagic (within the water column), and littoral (stream or lake edge) zones[10]. The three life history strategies of Bull Trout largely influence diet and foraging behaviour. Steam-resident Bull Trout are often smaller than migratory fish. Of the migratory strategies, adfluvial (spawn in tributary streams and reside in lakes or reservoirs) populations tend to experience greater growth than fluvial (spawn in tributaries, but live in mainstem rivers) fish[11]. The growth rate of Bull Trout rapidly increases in populations that enter rivers and lakes with plentiful fish prey[4]. Adfluvial fish are predominantly piscivorous (fish-eating)[10], which plays a large role in the more rapid growth rate of adfluvial fish over fluvial or resident populations[7].

Reproduction

Bull trout often reach sexual maturity at 5–7 years of age, but the range is 3–8 years[4]. The body size of mature Bull Trout varies according to their life history strategy[12]. Fecundity of females is proportional to body size; small, resident females may produce 500 eggs, while the much larger migratory fish will produce 2000–5000 eggs[3].

Bull trout spawn between mid-August and late October[4]. Northern Bull Trout populations generally spawn earlier than southern populations and may be affected by annual climatic conditions[6]. Distance covered during spawning migrations and timing of migration varies and depends upon life history strategy[12]. Resident populations tend to migrate short distances to spawning grounds, while migratory populations may travel up to or over 250 km[13].

Approximately 9°C appears to be the temperature threshold below which Bull Trout begin their spawning activities[4]. Females select redd sites and excavate the nest. Courtship and spawning are carried out at the redd and a complete round of spawning requires several days to complete[8].

Site fidelity

Approximately 50% of radio-tagged Bull Trout in one study exhibited signs of spawning migration and post-spawning homing behaviour[14]. The results of the study suggested that Bull Trout in the McLeod system in west-central Alberta occupy a small home range and exhibit strong fidelity to their range[14]. Another study reported mixed fidelity to summer and fall habitat for feeding and spawning in the Halfway River system in northeastern British Columbia; some radio-tagged Bull Trout had returned to locations where they had been previously located, but other fish remained in streams where they had not been previously observed[13].

The homing ability of Bull Trout appears to be variable and is perhaps an adaptive trait that is subject to natural selection[8]. The degree of homing may be related to stream size and stability. Furthermore, different females will select previously used redd locations in different years suggesting some degree of spawning site fidelity[15].

Home range

Bull Trout home range is highly variable depending upon life history strategy. The home range for resident populations is much smaller than that of migratory fluvial or adfluvial populations, which can have very large home ranges, usually because resident populations are restricted to stream reaches located above barriers to migration. Annual movement has been reported in the Halfway River system to be up to 275 km[13].

Movements and dispersal
Bull Trout populations may move long or short distances to and from feeding, spawning, and overwintering sites depending upon their life history strategy. Timing of the spawning migration depends on a number of variables that include water temperature, habitat, genetic stock, and possibly daylight (photoperiod regulates endocrine control of these types of behaviour in other salmonids)[5]. Mature fish from fluvial populations that make spawning migrations from large to smaller rivers in mid- to late summer when the water temperatures are relatively high and water levels are typically declining[16]. Many of the juvenile fish from fluvial populations migrate from their natal areas during their third summer, but some do not emigrate until their fourth summer. Juvenile migrations begin in spring and continue through summer months[17].

Fluvial forms in the Peace River system make long distance migrations to and from spawning locations[13], as do populations in the Columbia River system. Adfluvial populations exhibit similar migratory patterns as the fluvial form where mature Bull Trout migrate from lakes to spawning streams. Juvenile fish (fry, 1+, 2+, and 3+) emigrate from natal streams to lakes or reservoirs through summer months[4].

Habitat

Structural stage
Forest health and the maintenance of riparian forests are very important in maintaining the integrity of fish habitat. In addition, the forest structural stage surrounding streams may also play an important role. Generally, mature structural stages (5–7) produce more large woody debris than younger seral stages; more sediment trapping and storage; more nutrient cycling; and more fish habitat structure[7].

Important Habitats and Habitat Features
Bull Trout are cold water specialists which have identified as having more specific habitat requirements than other salmonids[18].

Spawning
Bull Trout spawn in flowing water[8] and show a preference for gravel and cobble sections in smaller, lower order rivers and streams. Bull Trout tend to be very selective when choosing spawning locations. Spawning sites are characterized by low gradients (~1.0–1.5%); clean gravel <20 mm; water velocities of 0.03–0.80 m/s; and cover in the form of undercut banks, debris jams, pools, and overhanging vegetation[8].

Water temperature plays an important role in Bull Trout spawning success. A threshold temperature of 9°C has been suggested as the temperature below which spawning is initiated[4], at least for more southern stream systems. More recent data on temperature/spawning timing in northern B.C. systems suggest that temperature thresholds are lower or that temperature is not as important a cue because mean stream temperatures at spawning locations rarely exceed 9°C at any time of the year[7].

The stability of the temperature environment in natal streams is likely a much more critical feature of high quality spawning locations. There may also be a lower temperature threshold below which spawning is suspended. It has been reported that Bull Trout in Line Creek in the east Kootenay region of British Columbia stopped spawning when water temperatures dropped below 5°C[19]. Egg incubation requires temperatures <8°C and an optimal range of 2–4°C[3].

Groundwater interaction with surface water likely creates thermal stability at spawning sites that can act to minimize winter hazards for incubating eggs[20]. During the winter, stream temperatures in parts of British Columbia are at or very near 0°C; therefore, anchor ice formation is a constant threat to incubating eggs. A stable winter environment would be a spawning site that (1) could be predicted to be anchor ice free for most winters, or (2) demonstrates a stable thermal signature above 0°C year over year[7].

Rearing and foraging
In general, all Bull Trout (regardless of the life stage or life history strategy) are cold water specialists. Bull Trout are seldom found in systems where water temperature is above 15°C for prolonged periods[4]. Adults are primarily piscivorous (fish eating) and depend on an adequate forage base to support growth and reproduction. Bull Trout appear to be primarily ambush predators and are highly dependent on cover, usually in the form of deep pools, woody debris jams and undercut banks[7]. Bull Trout fry are often associated with shallow water, low-velocity side channels, and abundant instream cover in the form of cobble and boulders[15]. Bull Trout fry focus their feeding on aquatic insects near or on the bottom of the stream[7].

Most juveniles rear in streams and appear to prefer pools over riffles, runs, or pocket water. Adequate instream cover is an important component of juvenile habitat. Juveniles in Line Creek in the east Kootenay region of southeastern British Columbia were associated with large woody debris (LWD), undercut banks, and coarse substrate. Juveniles are benthic and drift foragers that feed on aquatic insects until the fish reach about 11 cm, at which time they usually switch to preying on other fish[7].

Photo courtesy of Stacey Tress

Photo courtesy of Forsite

Conservation and Management

Status[7]
Provincial Rank: S3 (Special Concern)
BC Rank: Blue (Special Concern)
COSEWIC Status: not determined

Threats
Of all the salmonid species, Bull Trout have the most specific habitat requirements and are very sensitive to habitat degradation[18]. Their specialization as a cold water species makes them highly susceptible to activities such as riparian timber harvesting. Loss of stream shading can lead to elevated water temperatures (both daily mean and peak temperatures), which can be problematic for a species that is seldom found in streams or lakes where temperatures rise above 15°C. Increasing water temperatures can lead to population fragmentation and increase the risk of invasion by other species that may displace Bull Trout and lead to further decreases in their abundance[21].

Bull Trout require clean, well-oxygenated water; as a result, the distribution and abundance of all Bull Trout are strongly influenced by channel and hydrologic stability. The eggs and young of this fall spawning species are vulnerable to winter and early spring conditions such as low flows, which can strand eggs and embryos or lead to freezing within the substrate. These life stages are also susceptible to flooding and scouring. Success of embryo survival, fry emergence, and overwinter survival of juveniles is related to low sedimentation levels, because increased sediment leads to losses in pool depth and frequency; reductions in interstitial spaces; channel braiding; and potential instabilities in the supply and temperature of groundwater inputs[18].

Forest harvesting, petroleum and mining development, and associated access; livestock grazing; and urban development are all anthropogenic threats to the integrity of Bull Trout habitat. The effects of these threats can be separated into three general categories[7]:

1) elimination of habitat or restriction of fish access;

2) sedimentation and erosion; and
3) alteration or loss of required habitat characteristics.

Elimination or restriction
Pre-Forest Practices Code forest harvesting and forestry road development, and development access construction, have contributed to the decline in Bull Trout populations around the province by disrupting migration corridors. Perched culverts, debris, channelization, increased water temperatures, and increased water velocities are all capable of influencing access to important habitats utilized by adfluvial, fluvial, and resident Bull Trout populations. Construction of dams and reservoirs in the Peace River and Columbia River watersheds eliminated significant amounts of stream habitat through inundation and also created barriers that, in some cases, have altered historical migration patterns. The resultant isolation and restriction of populations related to these access barriers may reduce the gene flow within and between populations and negatively affect the long-term success of distinct Bull Trout populations throughout the province[7].

Sedimentation and erosion
Significant changes in unit area peak flows, unit area storm volumes, and response time to storm events are known to be associated with increased development within a watershed (e.g., forest harvest; grazing; petroleum resource, mining, and urban development). As the area of a clearcut increases, a corresponding increase in storm volume occurs. Road development leads to earlier, higher peak flows and can also alter groundwater flows. In addition to influencing peak flows, roads may act as sediment sources[7].

An increase in sediments and erosion (above natural background levels) are undesirable as they can degrade spawning and rearing habitat, and cause direct injury to fish, by[7]:

- infilling gravel spawning substrate;
- infilling pool and riffle habitat;
- impairing feeding ability, through increased turbidity;
- reducing food availability for juvenile fish and lowering stream productivity, through smothering of aquatic insects; and
- clogging and abrading of fish gills.

Alteration of habitat characteristics
The presence of riparian vegetation is a critical factor in the maintenance of many important habitat features required by Bull Trout and other fish species. However, riparian vegetation is frequently removed as a result of development activities within a watershed, and this loss has significant negative impacts on fish habitat. Riparian vegetation[7]:

- Provides a source of short- and long-term LWD recruitment, which is a key component in the creation of optimal salmonid habitat such as pools and cover;
- Maintains lower water temperatures by shading the channel—a critical habitat factor for Bull Trout;
- Increases bank stability and maintains integrity of channel morphology;
- Provides a substrate for many terrestrial insects, which are in turn an important aquatic food source, and provides organic matter (in the form of leaf litter) that supports the aquatic food chain; and
- Acts as a buffer zone to intercept runoff and filter for sediment and pollutants.

As for other fish and aquatic organisms, climate change and associated global warming are predicted to reduce Bull Trout habitat by leading to increased water temperatures and leaving even more areas unsuitable for all life stages of this cold water specialist[22].

Management Recommendations[7]

- Identify locations where Bull Trout occur: for the most recent information about British Columbia lakes and streams and the fish in them, please refer to FishWizard, a database maintained by BC Fisheries and Fisheries and Oceans Canada at http://pisces.env.gov.bc.ca. Additionally, stream surveys are recommended for streams with characteristics outlined in this report to determine presence or absence of this species.

- In sub-basins where Bull Trout are present, and where forest development is planned for the next 5-year period, any of the following are recommended as supplementary triggers for the watershed assessment procedure (WAP)[7].:
  - more than 10% of the watershed has been logged in the 20 years prior to the start of the proposed development plan, or will be logged in the 25 years prior to the end of the proposed development plan;
  - a "significant" number of mass-wasting events are known to have occurred in the watershed (i.e., more than one event/km^2 and more than two events reaching the mainstem);
  - the presence in the watershed of either high stream channel density (i.e., more than 1 km of channel/km^2), high road density (i.e., more than 150 m of road length/km^2), or a significant number of stream crossings (i.e., more than 0.6/km^2 in the interior or more than 1.4 km^2 on the coast); or
  - evidence of significant stream channel stability problems.

- In sensitive watersheds, the following conservation measures, based on the metapopulation concept, should be demonstrated by strategic and operational planning processes, and reflected in the temporal and spatial layout of cutblocks, road layout and design, and hydrologic green-up and recovery standards[7]:
  - Minimization of upstream and upslope disturbances to prevent siltation, temperature, and hydrologic impacts (including disruptions of groundwater flows) in areas influencing critical reaches of Bull Trout habitat;
  - Minimization of road networks, total road length, and number of stream crossings, and avoidance of linear road developments adjacent to stream channels, where practical from an engineering perspective;
  - Maintenance of riparian habitats in a properly functioning condition, to ensure LWD recruitment is based on life expectancy and decay periods of naturally occurring adjacent tree species;
  - Minimization of obstructions to movements, and isolation of populations (e.g., ensure stream crossings will pass migrating Bull Trout at all flows and life history stages, etc.);
  - Minimize road construction within 0.5 km of known Bull Trout congregations; and
  - Maintain riparian reserves on S4 streams with or suspected to have Bull Trout, or S5 and S6 streams that are tributary to streams with Bull Trout, where local managers deem necessary to protect natural stream processes and limit erosion and sedimentation.

- Maintain important habitat features including cover, substrate quality, pool depth and volume, groundwater flow, water quality, temperature, channel structure, and hydrologic characteristics of the site.

- Maintain migration corridors and prevent isolation of Bull Trout population.
- Do not construct roads and excavated or bladed trails. Where there is no alternative to road or trail development, close to public during staging and spawning times and rehabilitate as soon as possible. Ensure that roads do not impact stream channel integrity, water quality, groundwater flow, substrate composition, cover, and natural temperature regimes.
- Avoid stream crossings at Bull Trout concentrations. Stream crossings should be built to the highest standards to minimize the risk of sediment input or impacts to the channel.
- Plan harvest to meet goals of maintaining stream channel integrity, water quality, groundwater flow, and substrate composition; and to minimize disturbance.
- Do not use pesticides.

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