Coastal Giant Salamander

Dicamptodon tenebrosus

Original prepared by Barbara E. Johnston

Species Information

Taxonomy

The Coastal Giant Salamander belongs to the Dicamptodontidae family (Good 1989). This group was originally considered to be a subfamily of Ambystomatidae. However, taxonomic analysis by Edwards (1976) and Estes (1981) found *Dicamptodon* to have several unique morphological and neurological traits that warrant distinct family status. Dicamptodontidae is an ancient lineage (Peabody 1954) that first appears in the fossil record of the lower Pliocene.

Within the subfamily Dicamptodontinae, Good (1989) recognized four distinct species on the basis of allozymes: *Dicamptodon aterrimus, D. copei, D. ensatus, and D. tenebrosus.* Prior to this analysis, *D. tenebrosus* and *D. ensatus* were considered to be one species called *D. ensatus*. These two species are similar in appearance and life history, but geographically disjunct. There are no recognized subspecies of *D. tenebrosus*.

Description

Coastal Giant Salamander larvae are ~33–35 mm in total length at hatching (Nussbaum and Clothier 1973). They are dark dorsally with light underbellies, have shovel-shaped heads, gills, and tail fins. If larvae transform into terrestrial adults, they usually do so between the sizes of 92 and 166 mm total length (Nussbaum et al. 1983). Some adults do not transform and remain obligate streams dwellers. These neotenes can grow up to 351 mm total length (Nussbaum et al. 1983). Terrestrial adults are heavy bodied and broad headed. They are dark brown to black dorsally and usually marbled with tan or copper (Farr 1989). Larger adults are noticeably less marbled than small individuals, suggesting these markings fade with age (B. Johnston, pers. obs.). Coastal Giant Salamanders are the only salamanders capable of true vocalization, with adults emitting bark-like cries when disturbed (Nussbaum et al. 1983).

Distribution

Global

The range of the Coastal Giant Salamander extends along the western coast of North America from southwestern British Columbia, through the Cascade and Coast Ranges, to northwestern California (Nussbaum and Clothier 1973; Nussbaum et al. 1983).

British Columbia

In British Columbia, the Coastal Giant Salamander is restricted to the Chilliwack River Valley and a few small nearby tributaries of the Fraser River. In this region, larvae have been recorded in ~60 headwater streams (Farr 1989; Haycock 1991; Richardson and Neill 1995, 1998). Their range appears to be continuous, extending from the west side of Vedder Mountain to the slopes east of Chilliwack Lake (Richardson and Neill 1995). The population on the west side of Vedder Mountain may now be isolated because of modifications to the drainage system of this area (Farr 1989).

Forest region and district

Coast: Chilliwack

Ecoprovinces and ecosections

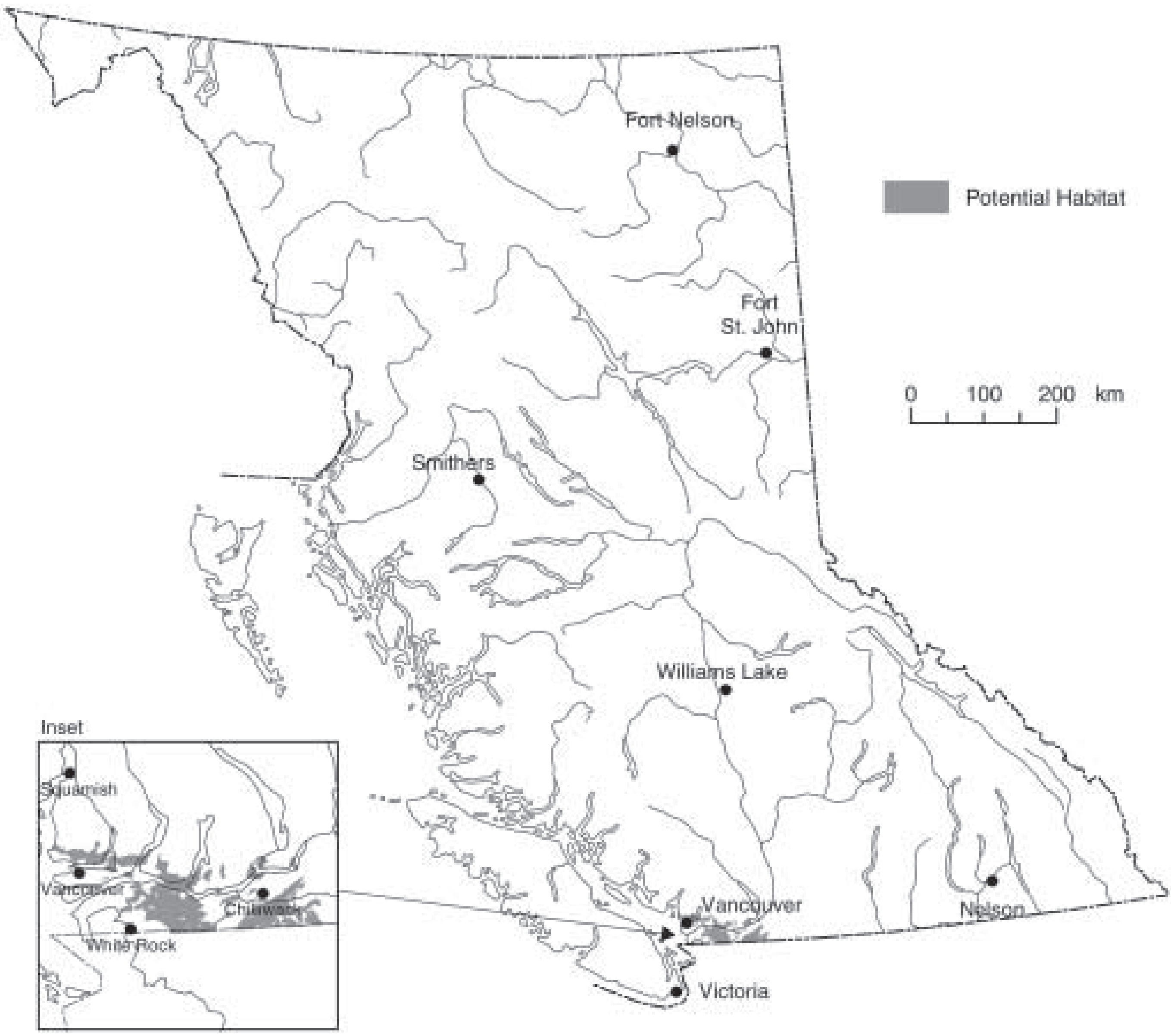
COM: NWC, SPR
GED: FRL, GEL

Biogeoclimatic units

CWH: dm, ds1, ms1, vm2, xm1
MH: mm1, mm2

Coastal Giant Salamander

(Dicamptodon tenebrosus)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Broad ecosystem units

CR, CW, FR, LL, LS, MF

Elevation

Sea level to 2160 m

Life History

Diet and foraging behaviour

Both larval and adult Coastal Giant Salamanders are opportunistic feeders. The aquatic larvae feed nocturnally on aquatic insects (i.e., caddisflies, stoneflies, dipterans, and beetles), benthos, small fish, and Tailed Frog larvae (Antonelli et al. 1972; Nussbaum et al. 1983; Parker 1994). Terrestrial adults feed on land snails, slugs, beetles, caddisfly larvae, moths, flies, small mammals such as shrews, and other amphibians (Stebbins 1951). Other unusual items such as lizards, garter snakes, and feathers have been found in the stomach contents of adults (Bury 1972; Nussbaum et al. 1983). Cannibalism has been noted in both larval and adult life stages of this species (Anderson 1960; Nussbaum et al. 1983).

Reproduction

Coastal Giant Salamanders are believed to breed once every 2 years (Nussbaum 1976). In California and Oregon, breeding can occur in either spring or fall (Nussbaum et al. 1983). Preliminary evidence from British Columbia suggests the timing of breeding is variable and may occur throughout the May to October active season (Haycock 1991; Ferguson 1998). Age at first reproduction remains unknown.

Montane streams are implied as breeding habitat for this species based on the observation of very small larvae in this habitat type (Haycock 1991; Nussbaum 1969; Henry and Twitty 1940). Only four known nest sites have been described from the field, all within the United States (Jones et al. 1990). The nests were located (1) in a stable talus and earth bank adjacent to a stream (Nussbaum 1969), (2) within a rock pile at the base of a waterfall (Nussbaum 1969), (3) on a submerged piece of lumber from a bridge crossing a fast flowing stream (Henry and Twitty 1940) and (4) on a partly rotted log in a riffle at the edge of a small stream (Jones et al. 1990).

On the basis of a few field and aquaria observations, Nussbaum et al. (1983) suggested that courtship occurs in hidden, water-filled nest chambers beneath logs and stones.

Males deposit up to 16 spermatophores. Females pick up one or two spermatophores with their cloacae and deposit a clutch of 135–200 eggs in the nest chamber (Nussbaum et al. 1983). Eggs are usually attached singly on the chamber roof.

In the field, adult salamanders have been observed near a developing clutch. This observation has been interpreted as females tending their own eggs (Farr 1989). Nussbaum et al. (1983) state a female will stay in the nest until the eggs hatch and the young abandon the nest chamber, a period of up to 200 days.

Coastal Giant Salamanders take approximately 35 days to develop to tail bud stage (Nussbaum 1969) and a further 5 months until hatching (Henry and Twitty 1940). Newly hatched larvae remain buried in the substrate and attached to their yolk sac for a further 3–4 months before appearing in streams at 45–51 mm in total length (Nussbaum and Clothier 1973). The larval period is believed to last between 2 and 6 years, averaging 3–4 years (Duellman and Trueb 1986; Ferguson 1998). Larval survivorship until adulthood is estimated at ~1–4% (Ferguson 1998), with predation and desiccation acting as the chief agents of mortality (Nussbaum and Clothier 1973).

At the end of the larval period, Coastal Giant Salamanders either transform into terrestrial salamanders or remain in their natal habitat as neotenes. The frequency of neoteny varies between populations and it is unclear whether this phenomenon is genetically or environmentally determined. The lifespan of this species is unknown. Studies of similarly sized aquatic salamanders suggest they may live up to 25 years (Duellman and Trueb 1986).

Home range

In aquaria, Coastal Giant Salamanders are reported to exhibit territorial behavior (Nussbaum et al. 1983). Terrestrial Coastal Giant Salamanders do not appear to occupy a home range. Over the course of one active season (June to September), individuals rarely returned to previously visited locations (Johnston 1998).

Site fidelity, movement, and dispersal

Coastal Giant Salamanders are highly sedentary, generally spending their entire life cycle in one creek (Farr 1989). Two mark-recapture studies conducted on larvae in the Chilliwack Valley found, respectively, that 73% of larvae remained within 10 m of their initial location of capture over 3 years (Neill 1998), and that only 10% of larvae moved farther than 20 m over 2 years (Ferguson 1998).

Terrestrial adults travel farther than larvae (commonly moving 10–50 m over a short time), but rarely move between streams (Johnston 1998). A radio-telemetry study in the Chilliwack Valley found that terrestrial adults are primarily active at night, with 70% of all movements occurring between dusk and dawn. The animals moved more frequently when it was raining. During dry periods, their movements were restricted to times of low temperatures (Johnston 1998). Based on the frequency and distance of movements, Johnston (1998) estimated that the probability of a terrestrial adult dispersing to an adjacent stream 0.5 km away was well below 1 in 1000 over the yearly active period. A genetic study conducted in the Chilliwack Valley found subpopulations to be moderately linked, indicating at least some dispersal between adjacent streams (Curtis and Taylor 2003).

The movement and dispersal patterns of juvenile Coastal Giant Salamanders (individuals recently transformed from aquatic to terrestrial phase) have not been studied. It is possible that juveniles are responsible for most of the dispersal, as is the case in many other species including some amphibians (Horn 1983; Duellman and Trueb 1986).

Habitat

Structural stage

4: pole/sapling
5: young forest
6: mature forest
7: old forest

Usually associated with structural stages 6 and 7, but have been recorded in stages 4–7. Habitat use may be more associated with specific habitat features than with structural stage.

Important habitats and habitat features

Aquatic

Suitable habitat for aquatic Coastal Giant Salamanders is generally found in clear, cool, fast-flowing and well-oxygenated streams with step-pool morphology and sufficient hiding cover (i.e., rocks, debris, and overhanging stream banks). Investigations into habitat use suggest that larvae predominantly use pocket pools (pools of small size) (Haycock 1991; Mallory 1996; Hatziantoniou 1999). Both stream depth and stream width are good predictors of larval salamander abundance, with abundance frequently decreasing with increasing wetted width (Richardson and Neill 1995) and with increasing depth (Southerland 1986; Tumlinson et al. 1990). Larval abundance has also been positively correlated with the number of substrate crevices and cover objects available (Hall et al. 1978; Murphy and Hall 1981; Conner et al. 1988; Parker 1991).

Terrestrial

Suitable terrestrial habitat is generally found in moist forested areas with ample hiding cover and in close proximity to streams. Eighty-four percent ($n = 19$) of the terrestrial adults captured using time-constrained searches in unmanaged forests in Oregon were found within 10 m of a stream (Vesely 1996). Johnston (1998) radio-tracked 18 terrestrial Coastal Giant Salamanders in old-growth and second-growth habitat in the Chilliwack and Nooksack River valleys. On average, 67% of each animal's recorded locations were within 5 m of the water's edge. The most common refuge locations used by terrestrial adults in this study were in/under coarse woody debris (38% of recorded refuges), underground (likely in small mammal burrows and root channels) (31%), and under rocks (26%). Any structure that provides a moist microsite appears to make a suitable resting site. When using coarse woody debris, terrestrial Coastal Giant Salamanders appear to select older wood in advanced stages of decay (classes 3–5) over newly fallen wood (Johnston 1998). Overwintering habitat does not appear to be a limiting factor for terrestrial adults. They tend to overwinter in the same types of refuges used throughout the active season, most commonly in underground burrows and seeps (B. Johnston, pers. obs.).

Suitable nesting sites may be the most critical habitat attribute for Coastal Giant Salamanders (Farr 1989). Only four nest sites have been described from the field (Henry and Twitty 1940; Nussbaum 1969; Jones et al. 1990). Each was located in a secure area (under rocks or wood) in or adjacent to a stream.

Conservation and Management

Status

The Coastal Giant Salamander is on the provincial *Red List* in British Columbia. It is designated as *Threatened* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	CA	OR	WA	Canada	Global
S2	S?	S4	S5	N2	G5

Trends

Population trends

Population estimates for Coastal Giant Salamanders are very difficult to determine. The terrestrial life stage is primarily fossorial (only above ground and visible about 1% of the time; Neill 1998) and aquatic individuals are remarkably discrete within streams. Roughly estimated, the population of Coastal Giant Salamanders in British Columbia is ~13 000 terrestrial adults and 4500–9000 neotenic adults (Ferguson and Johnston 2000). Coastal Giant Salamanders have been found in 15 of 20 stream systems in the Chilliwack Valley and associated areas, for a total of 75 occupied streams.

No long-term study of Coastal Giant Salamanders has been conducted to monitor the population's stability in the Chilliwack area. The Sumas Lake and the Vedder River areas may have historically supported populations of this species. In the 1920s, these populations were likely lost when Sumas Lake was drained for agricultural purposes and Vedder Creek was channeled north, becoming the VedderCanal.

Habitat trends

Suitable habitat is declining in British Columbia. The Lower Mainland is the most populated area of the province. Since 1827, the area of coniferous forest declined from 71 to 54% in the lower Fraser Basin ecosystem, while urban and agriculture use increased by 26% (Boyle et al. 1997).

Headwater streams receive little or no protection during timber harvesting. Timber harvesting is occurring throughout the Chilliwack River Valley. In the past 15 years (since ~1985), ~2500 ha have been logged (either clearcut or partial cut) within the known range of the Coastal Giant Salamander (MOF, Chilliwack Forest District). Following an 80-year harvest rotation, much of the remaining mature second growth will likely undergo second rotation cutting beginning around 2013. Urban development also continues to progress east up the Chilliwack Valley and into surrounding hillsides. Increasing habitat fragmentation (forest and stream habitats) is further reducing the quality of the remaining habitat.

Threats

Population threats

Like all amphibians, Coastal Giant Salamanders are highly dependent on moisture for dermal respiration. Transformed adults receive ~66% of their oxygen through the skin (Clothier 1971) and are thus sensitive to a loss of shading and cover objects. This water dependence limits the habitats they can exploit.

Studies conducted in the Chilliwack Valley suggest that both larval and terrestrial Coastal Giant Salamanders have limited dispersal tendencies. From 1996 to 1998, W.E. Neill (unpubl. data) found that fewer than 2% of marked larvae (*n* >2500) traveled >50 m annually. Mean annual movements were estimated at <2 m from the site of first capture. Similarly, Ferguson (1998) found that 90% of marked larvae moved <20 m (cumulative distance) over 1 year. In 1996 and 1997; Ferguson (2000) experimentally depleted 25–40 m reaches of four streams in the Chilliwack Valley to assess recolonization rates. One year after depletion, only 4–5% of the marked larvae from neighbouring reaches had colonized the depleted area. Ferguson (2000) estimated that full recolonization of a 400 m disturbed reach would require 8–55 years. Terrestrial Coastal Giant Salamanders also appear to have limited dispersal. Using a dispersal probability model developed from radio-telemetry data, Johnston (1998) concluded that the probability of a terrestrial adult dispersing between streams in the Chilliwack Valley was far less than 1 in 1000 over the yearly active period.

Dispersal or recolonization limitation in this species is supported by survey work conducted by Richardson and Neill (1995) in the Chilliwack Valley, where Coastal Giant Salamanders were detected in only 22 of 59 (37%) seemingly habitable streams. Results of a transplant experiment conducted in 1996 in the Chilliwack Valley, in which 53 larvae were introduced into an unoccupied stream, suggest that at least some of these uninhabited streams are able to sustain populations of aquatic giant salamanders (W.E. Neill, unpubl. data). Larval survival and growth estimates in the 2 years following introduction were indistinguishable from those at naturally occupied streams.

Several fish species have been shown to prey on giant salamander larvae, and it has been suggested that fish stocking in the Chilliwack River may inflict significant mortality on this species (Orchard 1984).

Coastal Giant Salamanders reach the northern extent of their range 19.5 km north of the Canada–U.S. border. Populations found in the Chilliwack region may therefore be particularly vulnerable. Populations on the periphery often have lower population densities, slower growth rates, and lower fecundity than those in the centre of a species' range (Hengeveld 1990; Lawton 1993). This lower viability is presumably due to climatic, competitive, or predation gradients, which increase towards range margins and, ultimately, limit species expansion. Larval densities and growth rates in British Columbia (Ferguson 1998; W.E. Neill, unpubl. data) appear to be lower than reported in Oregon (Nussbaum and Clothier 1973), the centre of the species range. The larval phase tends to be prolonged in Canadian populations (2–3 times longer than in Oregon; Ferguson 1998). If the annual survival rate of larval Coastal Giant Salamanders is relatively consistent across the species' geographic range, the fact that Canadian salamanders take longer to reach adulthood (reproductive age) means that the average survival rate to reproductive age is lower in British Columbia than in areas farther south.

Little is known of the effects of pesticides on Coastal Giant Salamanders. A common herbicide used in the Chilliwack Valley is glyphosate. This chemical is thought to hve low toxicity; however, some authors have suggested that adverse affects my be subtle (Ferguson and Johnston 2000). Ouellet et al. (1997) found a high prevalence of hindlimb deformities in some frog (*Rana* spp.) and toads (*Bufo americanus*) from agricultural sites exposed to pesticide runoff.

Habitat threats

Forest management and urban development are the main threats to the habitats of Coastal Giant Salamanders. There are several possible causes for declines in amphibian populations following forest harvesting. Some direct mortality occurs during logging operations. This has been observed at three sites in the Chilliwack Valley (K. Mallory, pers. comm.). Canopy removal results in microclimatic changes (Chen et al. 1993, 1995; Brosofske et al. 1997) that may increase physiological stress on terrestrial amphibians, leading to reduced fitness or death. Logging and associated road building degrades stream habitat by increasing sedimentation and causing increases in summer stream temperatures (Newbold et al. 1980; Beschta et al. 1987; Hartman and Scrivener 1990). These changes may influence the growth rate of aquatic amphibians, as well as their ability to respire, find food, and take refuge from predators. Streams may become ephemeral after logging or dry up altogether. Given that many amphibian species, including Coastal Giant Salamanders, are obligate stream dwellers for a portion of their life, these changes constitute critical habitat loss.

Most studies of aquatic Coastal Giant Salamanders in the coastal Northwest have inferred logging effects by correlating larval density to the age of the surrounding forest. Results of these studies have been mixed, with some finding reduced density in logged stands (Bury 1983; Bury and Corn 1988; Connor et al. 1988; Corn and Bury 1989; Cole et al. 1997), others finding no effect (Hawkins et al. 1983; Kelsey 1995), and still others finding increased density in logged areas (Murphy et al. 1981; Murphy and Hall 1981). In their recent study conducted in Oregon, Biek et al. (2002) compared the abundance of larvae on the interface of recent clearcuts and mature forest. They found the abundance of larvae in headwater streams to be markedly lower in clearcuts than in downstream mature forest stands. Without examining demographic rates, it is difficult to interpret why abundance varies after logging, increasing at some sites and decreasing at others. Studies conducted on aquatic Coastal Giant Salamanders in the Chilliwack Valley have yielded inconsistent results (Ferguson 1998; Richardson and Neill 1998; Hatziantoniou 1999; W.E. Neill, unpubl. data).

Radio-telemetry studies of Coastal Giant Salamanders in Chilliwack and northwestern Washington suggest that the terrestrial phase of this species may be adversely affected by logging (Johnston 1998; Johnston and Frid 2003). Catch per unit effort was lower in clearcut habitat than in forested habitat, and salamanders in clearcuts altered their behaviour in ways consistent with a water stress hypothesis. In comparison with salamanders at forested sites, animals in clearcuts remained closer to the stream, spent more time in subterranean refuges, had a more restricted range, and were more dependent on precipitation for their movement during the driest field season. These changes in behaviour could reduce the fitness of animals in clearcuts by influencing their ability to find food and mates (Johnston 1998). These findings are consistent with results of a study in Oregon, where Vesely (1996) found terrestrial Coastal Giant Salamanders at fewer logged sites (1 of 13 sites, 7%) than sites with forest cover (5 of 12 sites with riparian buffer strips, 42%).

Curtis and Taylor (2003) also found that Coastal Giant Salamander populations at eight sample streams found had lower levels of genetic variation and heterozygosity in recent clearcut sites than in second-growth or old-forest sites. These results suggest that clearcut logging is associated with low population densities or population bottlenecks.

Logging roads constructed to gain access to timber may act as dispersal barriers to aquatic Coastal Giant Salamanders. Culverts are installed to enable uninterrupted stream flow below the roads. Most culverts, however, extend beyond the road edge, creating a considerable drop to the stream below (>1 m in many instances). Waterfalls created by the culverts likely prevent upstream movements of aquatic salamanders and the effect of the downstream drop is not known.

Farr (1989) cited housing development on the north side of Vedder Mountain as a potential threat to Coastal Giant Salamanders. Urbanization continues throughout the Chilliwack Valley, including in the Vedder Mountain area. The population of the City of Chilliwack has nearly doubled in the past 10 years, and the growth rate is expected to increase as the Vancouver metropolitan area extends up the Fraser Valley. With 20% of the region's population living in rural areas, housing developments are encroaching up mountainsides and into Coastal Giant Salamander habitat.

Legal Protection and Habitat Conservation

The Coastal Giant Salamander is protected in that it cannot be killed, collected, or held in captivity without a permit, under the provincial *Wildlife Act.* In areas where salmonid habitat exists downstream, some protection may be provided by the *Canadian Fisheries Act.*

Some areas of the Chilliwack River Valley receive some level of protection as parks, recreation areas, and ecological reserves. Coastal Giant Salamanders have been detected within Chilliwack Lake Provincial Park (9122 ha). This park is contiguous with a large park (North Cascades National Park) in Washington State. There are anecdotal observations for Cultus Lake Provincial Park (656 ha), Chilliwack River Provincial Park, and Liumchen Ecological Reserve (948 ha). Numbers present are not known (M. Turner, pers. comm.).

The vast majority of this species' habitat falls on Crown land managed for forestry. The results based code may ensure habitat protection through the establishment of old growth management areas, provided these areas overlap sites inhabited by Coastal Giant Salamanders. Habitat is also protected by riparian management recommendations that recommend reserve zones along S1–S3 streams. As is the case with the *Fisheries Act*, however, this does not afford significant habitat protection because Coastal Giant Salamanders rarely occur in fish-bearing streams. Most of this species' habitat falls along small headwater streams (S5 and S6). Riparian management recommendations also recommend that forest practices in management zones adjacent to these streams be planned and implemented to meet riparian objectives such as wildlife, channel stability, and downstream water quality.

Protected areas or special resource management zones created for other species with overlapping ranges with the Coastal Giant Salamander (e.g., Spotted Owl, Pacific Water Shrew, tall bugbane) may afford additional protection.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

- ❖ Establish old growth management areas to protect suitable riparian habitats (i.e., small streams within range of species) or increase forest retention on small streams (i.e., S4–S6) and on stream reaches adjacent to Coastal Giant Salamander WHAs.
- ❖ Maximize connectivity of riparian areas.
- ❖ Maintain stream flow characteristics and water quality.
- ❖ Fall and yard away from stream channels and minimize site disturbance during harvesting to reduce risks of water diversion and stream sedimentation.
- ❖ Minimize the use of chemical applications within suitable Coastal Giant Salamander habitat.

Wildlife habitat area

Goal

Maintain and link important aquatic and riparian habitats not addressed through strategic or landscape level planning.

Feature

Establish WHAs at streams characterized by (1) presence of Coastal Giant Salamander larvae, (2) year-round flow, (3) small size (<5 m channel width), (4) intermediate gradient, (5) step-pool morphology, (6) stable channel beds, and (7) forest cover. In choosing WHA sites, priority should be given to sites that have the highest density of larvae and low levels of historical harvest, and that are adjacent to mature or old forest, closest to the headwaters, and free of fish.

Size

Typically between 20 and 100 ha depending on site-specific factors such as the number and length of streams included and whether overland connectivity is required.

Design

Wherever possible, include more than one stream or stream reach that contains Coastal Giant Salamanders within the WHA. A 30 m core area and 20 m management zone should be maintained on either side of all stream reaches with the WHA. When a WHA contains upland areas needed to connect adjacent stream reaches, include the upland area as part of the management zone. Maximize connectivity of streams and consider overland dispersal requirements of terrestrial adults in the design of the WHA.

General wildlife measures

Goals

1. Preserve the structure, flow regime, water quality and temperature of within-stream habitat.
2. Maintain microclimatic conditions in adjacent forest areas.
3. Maintain important habitat features such as cover objects (e.g., coarse woody debris), clear cold water, ample food supply, understorey vegetation, and subterranean channels.
4. Maintain connectivity between streams.

Measures

Access

- Do not construct roads or crossings. Approved roads should be constructed with minimum road bed and right-of-way widths, and whenever possible, downslope of WHAs. If constructed upslope, implement sediment-control measures and prevent water diversion.
- Approved crossings should use open-bottom structures (i.e., bridges or open-bottom culverts).
- When no longer in use, roads should be deactivated using methods that minimize the risk of water diversion and stream sedimentation.

Harvesting and silviculture

- Do not harvest in the core area.
- Within all riparian areas in the management zone, use partial harvesting systems that maintain 70% basal area, ensure windfirmness, and maintain forest structure and cover by retention of multi-layered canopy and snags. Within all upland areas within the management zone, ensure harvesting maintains shade, microclimatic conditions, coarse woody debris, and ground structure (i.e., small mammal burrows, root channels) to facilitate dispersal between streams.
- Do not salvage timber.
- Fall and yard away from streams.
- Remove slash and debris that inadvertently enters the stream (unless this will destabilize the bank or channel).
- Use silviculture strategies and equipment that minimize ground disturbance.
- Retain wildlife trees, non-merchantable conifer trees, understorey deciduous trees, shrubs, herbaceous vegetation, and coarse woody debris.
- Avoid burning.

Pesticides

- Do not use pesticides.

Recreation

- Do not establish recreation sites.

Additional Management Considerations

Manage stream reaches adjacent to WHAs according to the best management practices outlined in the *Riparian Management Area Guidebook*.

At S5 and S6 streams containing Coastal Giant Salamanders, retain riparian vegetation to provide stream shading.

Minimize debris entering the stream channel from logging operations.

To maintain coarse woody debris, avoid piling or burning residue (leave it well distributed across the stand) and retain non-merchantable material on site.

Recommendations for urban and rural land development are available from the MWLAP lower mainland office.

Avoid introducing fish into waters supporting Coastal Giant Salamanders.

Information Needs

1. Demographic responses of Coastal Giant Salamanders to habitat change (i.e., reproductive success, age-class distribution).
2. Movement and dispersal patterns of juvenile (recently transformed from aquatic to terrestrial phase) Coastal Giant Salamanders.
3. Population trends (long-term monitoring at established sites in the Chilliwack Valley).

Cross References

Coastal Tailed Frog, Keen's Long-eared Myotis, Pacific Water Shrew, Red-legged Frog, Short-eared Owl, Spotted Owl, tall bugbane

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