TER 2 Appendix 2

Lewis River HEP Models

Mink Model

The mink model was not modified by the HEP Team.

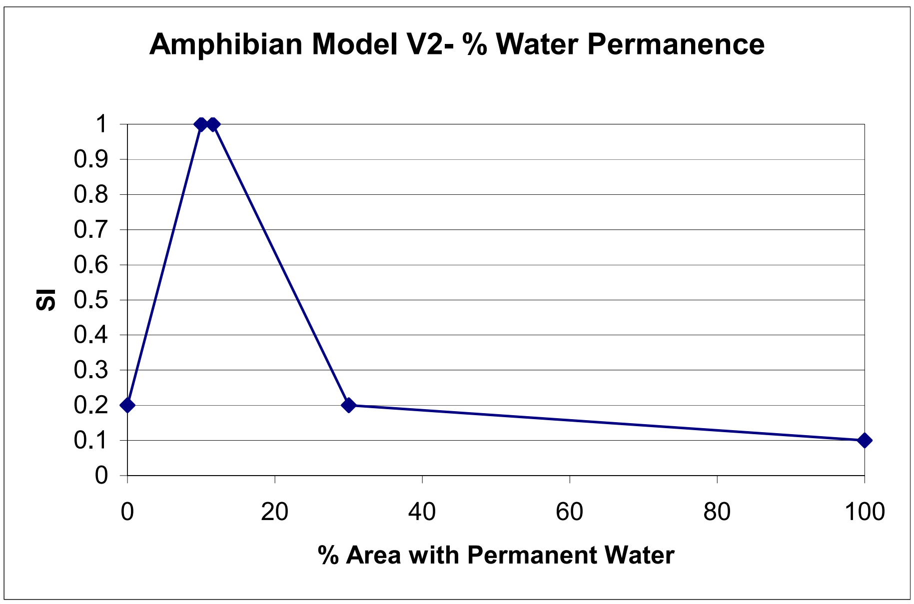
Black-Capped Chickadee Model

The black-capped chickadee model was not modified by the HEP Team.

Amphibian Model

The Amphibian Model was revised as follows
V7--adjacent land use.
Clearcuts. 2 years old = 0.75
Clearcuts > 2 years old = 1.0

It was agreed that V2 be modified as depicted below.



The Team revised the water permanence graph so that a 12-month duration receives an SI of 0.2 and 11 months receives a 0.4 SI. It was felt that permanent ponds, although conducive to ranid frogs, also allow bullfrogs to establish, which is an undesirable outcome.

HABITAT SUITABILITY INDEX MODEL:
POND BREEDING AMPHIBIAN
AND COVER MODEL *

LEWIS RIVER RELICENSING HEP
WDFW DRAFT HEP MODEL, November 1997

This model addresses the habitat needs of selected amphibians occurring in standing water in riparian, agriculture and wetland habitats. In this particular model, the value of the standing water habitat is more important than surrounding habitat and is therefore weighted higher for native pond breeding amphibians. The focus of the model is on the following species:

Northwestern salamander (*Ambystoma gracile*)
Long-toed salamander (*Ambystoma macrodactylum*)
Roughskin newt (*Taricha granulosa*)
Red-legged frog (*Rana aurora*)
Pacific treefrog (*Hyla regilla*)
Oregon Spotted frog (*Rana pretiosa*)
Western toad (*Bufo boreas*)

HABITAT USE INFORMATION

Distribution/Elevation

<u>**Frogs and Toads**</u>

The **red-legged frog** (*Rana aurora)* is a common native ranid found west of the Cascade Mountains from southwestern British Columbia to northern California (Gordon 1939; Slater 1964; Dumas 1966; Nussbaum 1983; Stebbins 1985). This species ranges from sea level to 4680 ft (1427 m) in the Umpqua National Forest (Oregon) (Leonard et al. 1993). The **Pacific treefrog** (*Hyla regilla*) is the most widely distributed frog in Washington and Oregon and may be found at elevations ranging from near sea level to at least 5200 ft (1585 m) (Leonard et al. 1993). The **Western Toad** (*Bufo boreas*) can be found in all natural regions of Washington and Oregon with the exception of arid portions of the Columbia Basin, northern Coast Range in Oregon, and the Willamette Valley. They are known from near sea level to 7370 ft (2247 m) (Leonard et al. 1993). The **Oregon spotted frog** (*Rana pretiosa*) is currently found in southwest British Columbia, western Washington, and the Cascade Mountains of Washington and Oregon. Historically they were found in portions of the Puget Sound Lowlands and the Willamette Valley, and they appear to have been eliminated from most of this area (Leonard et al. 1993). They can be found at elevations ranging from near sea level to 4,900 ft (1500 m) (Hayes 1997).

<u>**Salamanders**</u>

The **northwestern salamander** (*Ambystoma gracile*) occurs along the Pacific coast from western British Columbia to northwestern California. In Washington and Oregon they are found from the coast to just over the Cascade crest (Leonard et al. 1993). They occur from sea level up to about 10,230 ft (3,100 m) elevation in humid coniferous forests and subalpine forests (Nussbaum et al. 1983). The **long-toed salamander** (*Ambystoma macrodactylum*) is distributed from southeast Alaska, British Columbia and western Alberta, through western Montana, Idaho, Washington, and Oregon into northern California (Leonard et al. 1993). They have the broadest distribution of any salamander in Washington and Oregon and occur in semiarid sagebrush deserts, dry woodlands, humid forests, alpine

meadows, and all kinds of intermediate habitats (Nussbaum et al. 1983). They occur from sea level to 6190 ft (2030 m) (Leonard et al. 1993).
The **roughskin newt** (*Taricha granulosa*) occurs primarily west of the Cascade Mountains from southeast Alaska through western British Columbia, Washington, and Oregon into northern California (Leonard et al. 1993). Habitats include: humid coastal forests and open grasslands within or near streams, lakes, ponds, and reservoirs (Stebbins 1954). They range from sea level up to 9240 ft (2800 m) (Nussbaum et al. 1983).

Food

Adult red-legged frogs prey on a variety of terrestrial invertebrates. Prey items include beetles (Coleoptera), caterpillars (Lepidoptera), sowbugs (Isopoda) (Stebbins 1972), earthworms (Annelida), and slugs (Gastropoda) (Lardie 1969). Tadpoles probably feed on decomposed plant and animal material, green algae, and bacteria (Morris and Tanner 1969). Adult red-legged frogs are primarily sit-and-wait predators. They forage in damp, well-shaded areas (Storm 1960). Dense shoreline vegetation is used during the breeding season; foraging areas during the non-breeding season include downed logs, ferns, and blackberry *(Rubus* sp.*)* thickets (Dunlap 1955; Porter 1961).

Insects are the main food of the Pacific treefrog. Beetles (Coleoptera) and flies (Diptera) composed 53% of the winter diet of this species in northern California (Johnson and Bury 1965).
During the breeding season, adult treefrogs forage primarily above water (Carl 1943; Brattstrom and Warren 1955).

Oregon spotted frogs are opportunistic feeders, and may forage to some extent under water (Nussbaum et al. 1983). Adult spotted frogs feed primarily on invertebrates, generally within one-half meter of shore on dry days. During and after rains, they may move away from permanent water to feed in wet vegetation or ephemeral puddles (Licht 1986).

Long-toed salamander larvae eat zooplankton, immature insects, aquatic snails, and occasionally they are cannibalistic. Terrestrial long-toed salamanders eat spiders, lepidopteran larvae, crickets, earthworms, flies, snails and slugs, aphids, springtails, fly and beetle larvae, amphipods, and a variety of other invertebrates, both terrestrial and aquatic (Nusssbaum et al. 1983).

Water

Breeding habitats for red-legged frogs include marshes, bogs, swamps, ponds, lakes, and slow- moving streams (Leonard et al. 1993). Spotted frogs require water as breeding, foraging, and wintering habitat. These species are closely associated with standing water during the breeding season. In the central Willamette Valley, Oregon, and the Puget Lowland, Washington, they frequently use temporary waters, usually ponds or overflows that will be dry by late May or early June. However, connections to more permanent water must be present, allowing tadpoles to continue to develop to metamorphosis. In southwestern British Columbia, researchers studied red-legged frogs in a temporary pond (dried up in July) where they bred sympatrically with Oregon spotted frogs, in the slow part of a river, and in a small overflow pond of a large lake (Licht 1971). Slow-moving streams and large ponds were used for breeding in British Columbia (Licht 1969); breeding occurred in marshes in Oregon (Storm 1960). Standing water must be present long enough for eggs to hatch and tadpoles to transform. The period from egg deposition to metamorphosis in the red-legged frog was estimated at 180 days in western Oregon (Storm 1960). In Oregon spotted frogs this period lasted 135-232 days in Utah (Morris and Tanner 1969) and from 87-111 days in Yellowstone National Park (Turner 1958) depending on water temperatures.

In the early spring, adult long-toed salamanders can be seen at night in ponds and lakes, often in considerable numbers (Leonard pers. comm.). Eggs of northwestern salamanders are laid in a variety of wetlands, lakes, ponds, and slow-moving streams (Leonard et al. 1993).

Non-breeding adult red-legged frogs can be found in damp microhabitats up to 1000 yds. (914 m) from standing water (Porter 1961; Dumas 1966). The species may also range widely at night during warm rains (Storm 1960). Western toads occupy many habitats from sea level into the mountains, frequenting relatively dry to humid situations (Stebbins 1954). They are nocturnal during dry weather, but forage during daylight on rainy or overcast days (Nussbaum et al. 1983).

Cover

Adult red-legged frogs use emergent aquatic and shoreline vegetation for cover during the breeding season. Sedges (*Carex* sp*.),* rushes (*Juncus* sp.), and submerged vegetation provide cover during breeding activities (Licht 1969). Riparian vegetation may be used as escape cover by resting red-legged frogs; one population of frogs in British Columbia responded to predators by seeking dense vegetation on streambanks (Licht 1972). Another British Columbia population, however, escaped by leaping into the water when disturbed by a predator (Gregory 1979).

Young red-legged frog tadpoles use both mud and vegetation for cover (Calef 1973a). Optimal tadpole habitat is characterized by emergent willow *(Salix* sp*.)* stems, grasses, cattails *(Typha* sp*.)*, submerged weed stems, and filamentous algae (Wiens 1970).

Oregon spotted frogs are highly aquatic, inhabiting marshes, and marshy edges of ponds, streams, and lakes. They usually occur in slow-moving waters, with abundant emergent vegetation, and a thick layer of dead and decaying vegetation on the bottom. The frogs take refuge in this layer when disturbed (Nussbaum et al. 1983).

Aquatic vegetation provides cover for the breeding activities of adult Pacific treefrogs (Jameson 1957; Whitney and Krebs 1975).

Larvae of the northwestern salamander lie hidden in the mud or under leaves, logs, and other cover on lake and pond bottoms during the day, but emerge at night to feed (Nussbaum et al. 1983). When on land, the northwest salamander is usually found in damp places beneath surface objects near streams or ponds (Stebbins 1954). Long-toed salamander adults can be found under pond-side debris during early spring, and recently metamorphosed juveniles can be found in late summer and autumn in mud, and under debris beside drying ponds (Nussbaum et al. 1983).

Reproduction

Near sea level, egg laying by red-legged frogs occurs December through February, and at any given locality the majority of eggs are laid over a period of two to seven weeks (Olson and Leonard 1997). Timing is influenced by latitude, elevation, and weather (Dumas 1966). Breeding habitats include marshes, bogs, swamps, ponds, lakes, and slow-moving streams (Leonard et al. 1993).

Most red-legged frog breeding males in British Columbia were found in weedbeds of pondweed *(Potamogeton* sp*.)* and quillwort *(Isoetes* sp*.)* (Calef 1973b). The courtship behavior of males is somewhat unusual in that they call from beneath the water; they will also call from among surface vegetation (Leonard et al. 1993). Males usually remained within the same weed bed, but they sometimes moved over 327 yds (300 m) during one breeding season (Calef 1973b).

Red-legged frog oviposition sites were usually located in the same microhabitat as male calling sites (Calef 1973b). Egg masses are deposited in quiet water with little or no current (Licht 1969; Stebbins 1972). Eggs are usually found attached to vegetation near the surface in water depths ranging between 20 in (50 cm) and 40 in (100 cm). However, in deep prairie potholes on Fort Lewis, Washington, eggs are often attached near the surface in water approximately 6.6 ft (2 m) deep (Hallock and Leonard 1997) . The female lays from 750 to 1300 eggs in a large (about 8-12 in or 20-30 cm), gelatinous cluster (Leonard et al. 1993). Flexible, herbaceous, and thin-stemmed emergent plants are ideal oviposition sites for northwestern salamanders, red-legged frogs and many other wetland breeding species (Richter and Roughgarden pers. comm.).

Towards the end of embryonic development, red-legged frog egg masses deteriorate and float to the surface. The embryos develop and hatch from their jelly covering after about four weeks of development. Tadpoles grow and develop over a period of three to four months, and in June or July the swimming tadpoles metamorphose into terrestrial froglets approximately 3/4 in (17-21 mm) long, snout-vent length (Leonard pers. comm). Limited evidence from western Oregon studies indicates that red-legged frogs become sexually mature in their second year after metamorphosis when males are about 2 in (50 mm), and females about 2.4 in (60 mm) snout-vent length (Nussbaum et al. 1983).

Breeding by Oregon spotted frogs occurs between February and April in western Washington. Oregon spotted frogs use the same locations for egg-laying in successive years, which may indicate unique characteristics at egg-laying sites (Licht 1969). Female Oregon spotted frogs tend to deposit their eggs on, or immediately next to, other spotted frog egg masses (Leonard et al. 1993). The rounded and globular masses are unattached to vegetation, and are in only a few inches of water at the margins of the breeding pools (Licht 1971).

Breeding sites for Pacific treefrogs in western Oregon include seasonal and perennial wetlands, semipermanent ponds, roadside ditches, and quiet pools along mountain streams (Jameson 1957). Frogs seemed to prefer the shallow portions of these ponds where vegetation cover was highest. Breeding in California often occurred in grassy, water-filled depressions (Brattstrom and Warren 1955).

Red-legged frogs first become active when air has been at least 41°F (5°C) for several days. Most movement to breeding sites occurs at night and seems to be stimulated by cloud cover and precipitation (Licht 1969).

Water temperature is an important factor in reproductive success for pond breeding amphibians. Breeding for red-legged frogs throughout the Pacific Northwest occurs when the water temperature of breeding ponds is 46 to 64° F (8 to 18° C) (Dumas 1966). The temperature range for normal development of red-legged frog embryos is 39 to 70° F (4 to 21° C) (Licht 1971). For Pacific treefrogs the optimal water temperature for egg-laying in California 54 to 59°F (12 to 15°C). Development and growth rates of embryos and larvae increase at warmer temperatures. The breeding strategy of the red-legged frog is adapted to cool, and permanent breeding waters (Brown 1975). For both red-legged and Oregon spotted frogs, more than 6 months may elapse between egg deposition and metamorphosis (Storm 1960; Morris and Tanner 1969). Red-legged frogs are capable of relatively rapid embryonic development at low temperatures, but larval development is protracted, and larvae grow to a large size prior to transformation (Brown 1975).

Western toad eggs are deposited in masses of as many as 16,500 eggs which are extruded in two strings; ordinarily laid in shallow water, not deeper than 12 in (30 cm) and usually less than 6 in (15 cm) (Stebbins 1954). The larvae are usually restricted to areas over muddy bottoms where they feed by filtering suspended plant material or feed on detritus on the bottom (Nussbaum et al. 1983). Embryos develop and hatch in 3-10 days depending on water temperature (Leonard et al. 1993).

During the breeding season adult long-toed salamanders may be found under logs, rocks, and other objects near ponds and lakes or may be seined from the water (Stebbins 1954). The method of egg laying is variable. In some places eggs are deposited singly, attached to vegetation in shallow water, and in other places clusters of 5-100 eggs are deposited in shallow to deep water, either attached to vegetation or under the surface of logs. Eggs may be placed loosely on the bottom (Nussbaum et al. 1983). They hatch in 5-15 days and may transform at sea level in July, while in the high mountain ponds most of the larvae do not transform until the beginning of their second year (Slater 1936).

Northwestern salamander eggs are laid in wetlands, ponds, and slow-moving streams (Bishop 1943). Females lay their gelatinous egg masses under the surface of the water, attaching them to thin branches of shrubs, trees, or thin-stemmed emergent plants (Leonard et al. 1993; Richter pers. comm.). They vary in size from small clusters containing 25-30 eggs to large elongate masses containing as many as 270 (Bishop 1943). The larvae hatch after about one month when they measure from .56-.6 in (14-15 mm) in total body length (Watney 1941). Metamorphosis may occur in the second summer (Watney 1941) but in some populations a high percentage of individuals may remain neotenic (Logier 1932; Slater 1936) especially at high altitudes (Snyder 1956).

Roughskin newts breed in quieter parts of streams and in lakes, ponds, and reservoirs (Stebbins 1954). This animal lays its eggs singly (Olson and Leonard 1977). Eggs are attached to grass stems, twigs, and other objects in water (Stebbins 1954). Eggs hatch in 20-26 days; the hatchlings are about .72 in (18 mm) total length after the yolk is gone. Larvae typically metamorphose late in their first summer at .92-3 in (23-75 mm) total length, but they may over- winter where growing seasons are short, metamorphosing in their second summer (Nussbaum et al. 1983).

Interspersion

Red-legged frogs utilize moist upland cover adjacent to wetlands during the non-breeding season. There is no information in the literature on home range size of this species. Individuals have been observed in upland areas 1000 yds (914 m) from potential breeding areas (Dumas 1966), but no quantitative study of movements between breeding and post-breeding habitats has been made.

The Pacific treefrog inhabits a variety of upland cover types as long as wetland areas for reproduction are available nearby. Adults in western Oregon wintered up to 1 mi (1.6 km) from breeding areas (Jameson 1957).

Special Habitat Requirements

The red-legged frog, Pacific treefrog, western toad and Oregon spotted frog are all ectotherms; environmental temperature has a strong influence on their activity patterns. The red-legged frog may be active almost year around in the warmer portions of its range. It is reported to breed in December along the coast and may remain active year around (Leonard pers. comm). In British Columbia, this frog started breeding activities when water temperatures reached 41 to 43°F (5 to 6°C), but became inactive at temperatures of less than 50°F (10°C) during the non-breeding season (Licht 1969). Red-legged frogs seek protection in deep muck or silt at the bottom of permanent water; similar behavior has been described for the related spotted frog (Morris and Tanner 1969; McAllister pers. comm). May also overwinter in moist leaf litter, duff or beneath large woody debris in forested habitats, or at the muddy bottom of ponds (Leonard pers. comm.).

In Oregon spotted frogs, torpidity and hibernation occur at environmental temperatures below 41°F (5°C) (Middendorf 1957). Pacific treefrogs are active year-around along the coast of Washington and Oregon where winters are mild (Carl 1943; Cochran and Goin 1970). Elsewhere in the Pacific Northwest, treefrogs escape temperature extremes by hibernating in moist, well-protected sites, such as rock crevices, underground burrows, debris piles, and building foundations (Brattstrom and Warren 1955).

The tadpoles of the western toad seek out areas of warmer temperatures within a lake, and this behavior undoubtedly speeds up metamorphosis (Nussbaum et al. 1983).

Long-toed salamander adults spend most of the year underground or inside large rotting logs. Juveniles range from concentrating under debris, logs, and mats of dead vegetation on former pond bottoms to utilizing burrows as conditions change. Adults require heavy rainfall before emerging and moving to the breeding ponds (Anderson 1967). Northwestern salamanders
are also found under bark and logs in damp situations, and utilize underground burrows (Bishop 1943; Leonard et al. 1993). Terrestrial forms are seldom seen except when they cross roads and trails on warm rainy nights (Nussbaum et al. 1983).

Roughskin newts are often found under logs, boards, rocks, and other surface objects or, in wet weather, crawling on the surface. During dry periods or at times of temperature extremes, they stay underground, in rotten logs, or in the water (Stebbins 1954).

Special Considerations

Severe water fluctuations in breeding areas may reduce hatching success, tadpole survival, and the quality of emergent vegetation, thereby, decreasing the success of lentic breeding amphibians. Northwestern salamanders, red-legged frogs, and roughskin newts were significantly absent from wetlands with high water level fluctuations in King County (Richter and Azous 1995).

Stream channelization, urbanization, logging, severe livestock grazing, and other alterations of stream courses and ponds may affect the availability of suitable oviposition sites, hibernacula, and cover (Olson and Leonard 1997). Red-legged frogs are sensitive to changes in environmental temperatures; water temperatures above 70° F (21°C) will cause high mortality among the young (Licht 1971).

In some instances, the red-legged frog may be absent from apparently suitable habitat in which there is a high population of bullfrogs (*Rana catesbeiana)* (Moyle 1973). This introduced species has similar habitat requirements and is an aggressive predator of frogs. Predation on all life stages of the red-legged frog may be high and is probably the strongest factor limiting population numbers (Licht 1974). Both common (*Thamnophis sirtalis*) and western terrestrial garter snakes (*Thamnophis elegans*) and bullfrogs are known to eat adult long-toed salamanders (Nussbaum et al. 1983). The more typical habitat for the bullfrog is exposed permanent shallow marshes with extensive emergent vegetation (Richter pers. comm). Bullfrogs are aquatic and require a permanent source of water, particularly in northern areas where larval development may take three years (Adams 1994).

Reed canarygrass (*Phalaris arundinacea*) is an introduced aquatic vascular plant that has become widespread and is difficult to control. It can eliminate all native plants where it grows by crowding them out. Its growth form is so dense as to be almost impenetrable and it tends to develop into a floating mat that displaces open water habitats. Reed canarygrass may significantly reduce the amount of cover and feeding habitat available for the larvae of native anurans (Adams 1994).

Recent research on the effects of fish introductions into the North Cascades ecosystem indicates that long-toed salamanders may be unable to coexist with introduced fish (larvae are preyed upon by the fish) (Liss et al. 1995). The introduction of exotic wildlife (i.e. , fishes, bullfrogs) may further degrade the suitability of waters for native amphibians (Olson and Leonard 1997).

HABITAT SUITABILITY INDEX (HSI) MODEL

Overview

This model has been developed to track changes in the quality of standing water and adjacent habitats of emergent, shrub-scrub, and forested wetlands used by pond breeding amphibians as reproductive and cover habitat. Breeding habitat of red-legged frogs include marshes, bogs, swamps, ponds, lakes, and slow-moving streams (Olson and Leonard 1997). Breeding sites for Pacific treefrogs in western Oregon include seasonal and perennial wetlands, semipermanent ponds, roadside ditches, and quiet pools along streams (Jameson 1957). Northwestern salamander eggs are laid in wetlands, lakes, ponds, and slow-moving streams (Leonard et al. 1993).

The successful breeding of amphibians is contingent on the following aquatic habitat elements: (1) water depth; (2) moderately dense emergent vegetation (excluding monotypic stands of reed canarygrass (*Phalaris arundinacea*) and purple loosestrife (*Lythrum salicaria*); (3) temporary and permanent bodies of water; (4) vegetative cover along wetland edge (5) water current and (6) associated habitats.

Model Applicability

<u>Geographic Area</u>

This model is applicable to standing water habitats supporting red-legged frogs, northwestern salamanders, long-toed salamanders, roughskin newts, Pacific treefrogs, western toads and Oregon spotted frogs in low lying areas (elevations < 2000 ft) of western Washington and Oregon.

<u>Season</u>

This model addresses the breeding and larval development periods (December through July) and covers habitat needs of pond breeding amphibians.

<u>Cover Types</u>

This model encompasses the aquatic habitats used by pond breeding amphibians for life requisite activities, including breeding and feeding. On the Columbia River Channel Deepening Study, habitats include standing water and adjacent habitats of palustrine emergent wetland (PEM), palustrine shrub-scrub wetland (PSS), palustrine forested (PFO), and associated cover types. Associated cover types consist of land use practices or habitats adjacent to the wetland or standing water. On this project they include forest woodland and shrub-scrub wetland, unmanaged grassland/herbaceous, grazed pasture, row crops, and development. Dense woody cover of trees and shrubs surrounding a wetland or standing water provides cover, hibernation sites, attenuates ambient air and water temperature, and enhances prey diversity.

Verification Level

This model was developed using available literature, professional expertise, and knowledge of the study area to determine appropriate values and parameters. The pond breeding amphibian HSI model will provide habitat information useful for impact assessment and habitat management. Previous drafts were reviewed by Kelly McAllister, Bill Leonard and Klaus Richter and their comments were incorporated into the current draft.

Habitat Components

Water presence is based on pond breeder requirements for standing water during the breeding season. All native lentic-breeding northwest amphibians use permanently flooded wetlands (Richter pers. comm.). Quiet, cool, and relatively deep permanent water is preferred breeding habitat for the red-legged frog (Licht 1969; Stebbins 1972). Standing water must be present long enough for eggs to hatch and tadpoles to transform. The period from egg deposition to metamorphosis in the red-legged frog was estimated at 180 days in western Oregon (Storm 1960). Northwestern salamanders, Oregon spotted frogs, and roughskin newts also require water permanence for at least six months to successfully reproduce (Leonard pers. comm). Six to twelve consecutive months of permanent water equals a SI value of 1.0.

Extensive temporary bodies of water (dries up by July) as part of a larger water system are very important in minimizing predation from bullfrogs (Leonard and McAllister, pers. comm.). Semi-permanence is beneficial to many species because it precludes the establishment of predators including bullfrogs (Richter pers. comm.). Bullfrog eggs and larvae will become stranded in ponds that dry up during summer, killing bullfrog eggs and larvae, and hence improving conditions for native pond breeding amphibians. Oregon spotted frogs are known to use non-permanent water bodies for egg laying (Turner 1958). Fifteen to thirty-five percent of an area with permanent water present will equal an SI value of 1.0 and will optimize native-amphibian habitat while minimizing same for the introduced bullfrog.

The optimal time frame to survey standing water conditions is January through June depending on rainfall for the winter/spring. Standing water assessments should not be taken between July 1 and December 1. Measurements taken in late May or June may under represent the total area and therefore need to be adjusted accordingly. It is recommended surveyors refer to the following for specific hydrology information to supplement their data: National Wetland Inventory (NWI), aerial photographs, soil maps, and field indicators. Field indicators include assessing drift lines, water marks, algae scum, water-stained leaves, drainage patterns within wetlands and sediment deposits to determine the extent of seasonal standing water.

Lentic-breeding amphibians spawn only in vernal ponds, depressional wetlands, or in slow-moving or quiescent water of riverine backwaters and slope wetlands (Savage 1961; Nussbaum et at. 1983; Blaustein et al. 1995). Water current at breeding sites is based on published literature which indicates that slow-moving and zero-current water is optimal for pond breeding amphibians (Storm 1960; Licht 1969; Leonard and McAllister pers. comm.). Egg masses are deposited in quiet water with little or no current (Licht 1969; Stebbins 1972). Increased discharge to riverine and slope wetlands can increase current velocity preventing breeding, reducing the success of fertilization, dislodging eggs from oviposition sites, or physically damaging eggs with suspended silt, sediment and large floating debris (Lind et al. 1996; Richter pers. comm.). Velocities exceeding 2 in/s (5 cm/s) precludes breeding by both red-legged frog and northwestern salamander (Richter and Roughgarden pers. comm.). Slow-moving water equals an SI value of 1.0 for breeding.

Moderately shallow water is required for breeding Oregon spotted frogs (Storm 1960; Licht 1969). Oviposition by most temperate amphibian species occurs at depths between 4-40 in (10-100 cm) (Cooke 1975; Seale 1982; Waldman 1982). Percent of a wetland area covered by water 4 to 40 in. (10 to 102 cm.) deep December through March pertains to the aquatic requirements of these species (Leonard and McAllister, pers. comm.). Wetlands that are completely flooded by this optimal water depth (approximately 100% = 1.0 SI) are more suitable than wetlands that do not have standing water or water depths that are not suitable.

Floating-aquatic, emergent, and woody macrophytes are used for cover by adults and tadpoles (Licht 1969; Calef 1973a) and for egg attachment sites (Storm 1960; Porter 1961). Oregon spotted frogs usually occur in slow-moving waters, with abundant emergent vegetation (Nussbaum et al. 1983; McAllister and Leonard 1997). Emergent vegetation is used by Pacific treefrogs in foraging, thermoregulation, and breeding (Whitney and Krebs 1975; Brattstrom and Warren 1955). Vegetation cover of ≥50% equals a value of 1.0 SI. One exception is the presence of a non-native invasive species such as reed canarygrass, in this case ≥75% equals SI of .1.

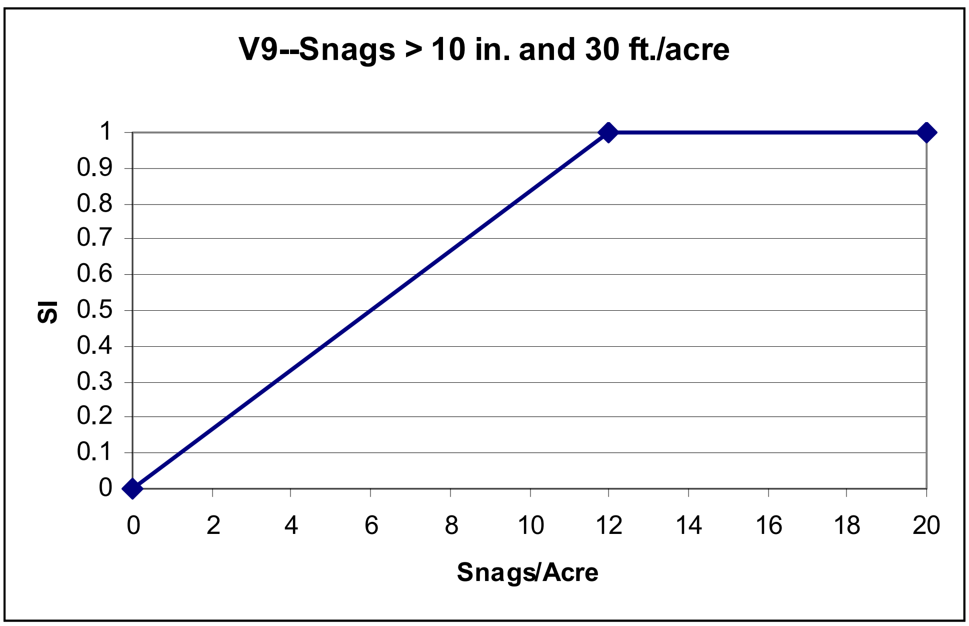
Shoreline vegetation provides important cover for breeding amphibians. Adults frogs and salamanders are often found among downed logs, ferns, blackberry thickets, and other dense cover during the non-breeding season (Dunlap 1955; Porter 1961). Optimum ground cover along the water edge is ≥75% which provides escape and thermal cover, or SI of 1.0.

During the non-breeding season, red-legged frogs may occur at considerable distances from water. Nussbaum (1983), have encountered frogs in moist forest situations 656 to 984 ft (200 to 300 m) from any standing water. A measurement of 656 ft (200 m) surrounding the wetland should be adequate to measure the associated habitat value.

Habitat surrounding standing water and the value of the standing water influences the quality of the wetland system in terms of providing adequate cover and breeding habitat for native amphibians. Associated habitat on the Columbia River Channel Deepening Project would consist of either forested woodland/emergent wetland/shrub-scrub wetland (1.0 SI), unmanaged grassland/herbaceous (0.75 SI), grazed pasture (0.5 SI), row crops (0.1 SI) and/or development (0.0 SI). Forested woodlands and shrub-scrub wetlands provide the optimal habitat. This model assumes that sufficient cover must be adjacent to a water source in order to provide escape cover, thermal buffering, hibernation sites, and enhanced prey diversity. Because pond breeding amphibians use upland cover types during the non-breeding season, optimal habitat must also support suitable cover adjacent to the standing water. Application of this model and determination of habitat suitability index is based on evaluation of standing water quality for supporting pond breeding amphibians and associated habitats in a 656 ft (200 m) band surrounding standing water, and each will have a distinct HSI.

Pileated Woodpecker Model

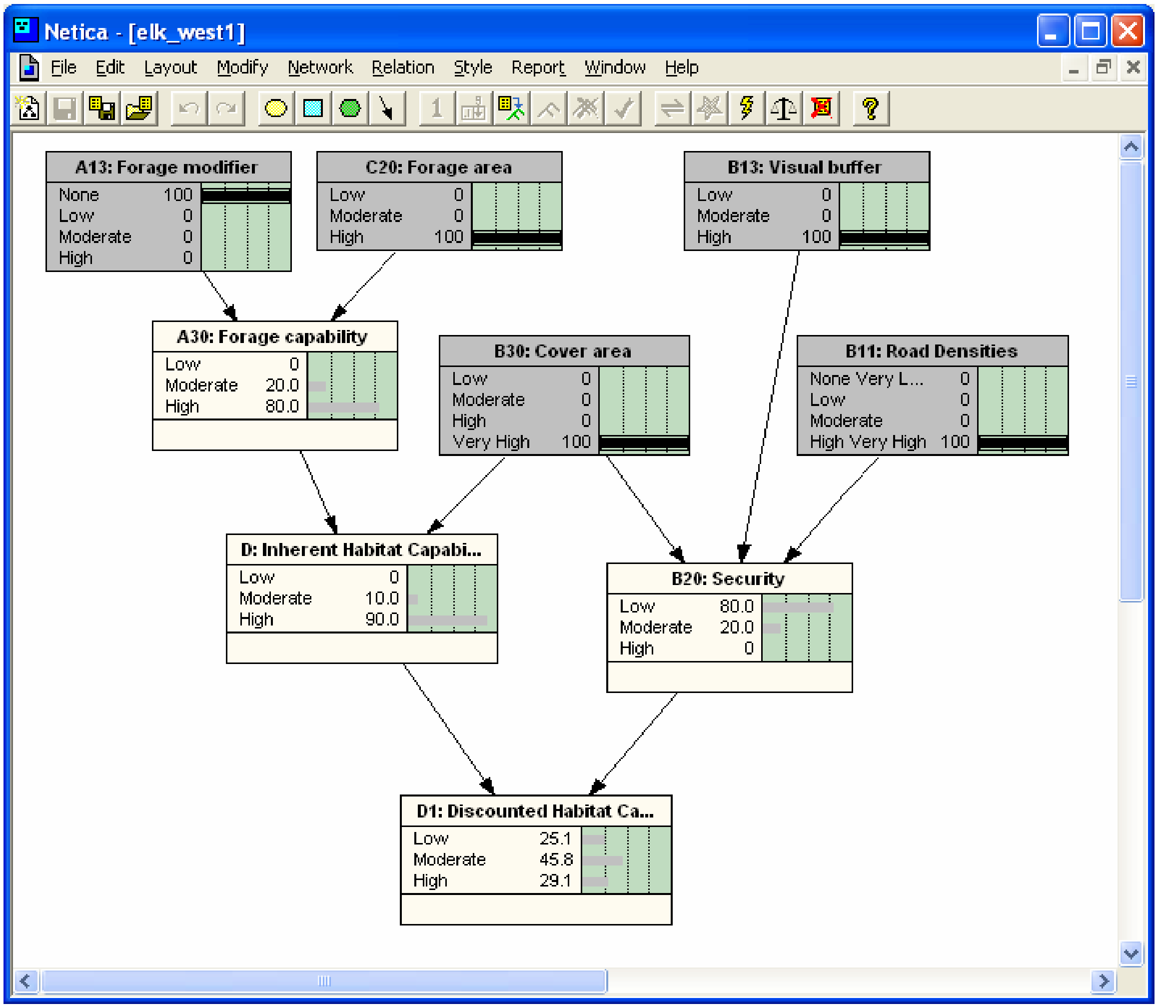
- V6 (no. snags > 51 cm) will be included as expressed in the published model.
- A new variable—V7—will reflect the presence or absence of snags > 30 inches dbh and 75 ft. tall. The SI function for V7 will be as follows: Abundance less than 0.0046 snags/acre—SI=0.9, Abundance equal to or greater than 0.0046 snags/acre—SI=1.0.
- A new variable—V8—will reflect the presence or absence of redcedar snags. If one or more snags are redcedar—SI=1.0, no redcedar snags—SI=0.9
- V9 will reflect abundance of snags/acre that are > 10 in. dbh and 30 ft tall. The V9 SI graph will be as follows.



- The final HSI will be calculated by taking the average the following two equations:
  $(V1 \times V2 \times V3)^{1/3}$
  and
  $(V6 \times V7 \times V8 \times V9)^{1/4}$
- This HSI calculation represents a change from the published version that uses the minimum of the two equations. The HEP Team agreed that the change was appropriate so that areas that may not represent breeding habitat but do provide foraging habitat receive habitat value.

Elk Model

WDFW Elk Model



A13--Forage enhancement variable. A proxy variable defined from GIS database to be a surrogate for the quality of forage present beyond "typical" conditions. The input is defined as the percentage of forage area in actively managed forage types (wildlife openings, fertilized cuts, and other areas actively managed for nutritional quality beyond natural revegetation):

NONE = 0%; LOW = <5%; MODERATE = 5 - 25%;
HIGH = >25%

C20--Forage habitat area calculated as a percentage of each subwatershed or other evaluation area. Forage habitat was estimated by summing the percentage of terestrial community types used as forage in each evaluation unit. Terrestrial community types were defined by grouping veg cover type and structural stage combinations. Forage habitat definitions vary for elk and deer.

Categories were defined as: LOW = <25%; MODERATE =
26 - 50%; HIGH = >50%.

B13--Vegetative screening or topographical screening variable. The proportion of open roads adjacent to unstocked or shrub/sapling stands/plantings with a vegetative screening or physcal obstruction sufficient to break up the sight profile.

Low = <25%
Moderate = 25-50%
High = >50%

A30--Forage habitat capability as a function of forage area (quantity) and the qualitative effects of forage enhancing practices.

B30--Cover habitat area calculated as a percentage of each evaluation unit.

Cover habitat was estimated by summing the percentage of terestrial community types used as cover in each evaluation unit. Terrestrial community types were defined by grouping veg cover type and structural stage combinations.

Cover habitat definitions vary for elk & deer.

Categories were defined as: LOW = <25%; MODERATE =
26 - 50%; HIGH = 51 - 75%; VERY HIGH = >75%.

The amount of cover influences the Inherent Habitat Capability and Security (from human disturbance) nodes in the model differently. See descriptions of those nodes for an explanation.

B11--Road Density Classes summarized from road density index, provided by the Landscape Team as follows:

None_Very_Low = <0.1 mi/sq mi

Low = 0.1-0.7 mi/sq mi

Moderate = 0.7-1.7 mi/sq mi

D--Inherent habitat capability for the analysis unit as a function of forage capability and cover area. Forage capability was generally weighted much greater than cover area. Cover was considered in terms of its security from predation value; security from human disturbance is modeled in the "Security" branch of the model.

In general, at low forage levels increasing cover had little influence. At moderate forage levels increasing cover increased habitat capability about 10% with each increment in cover. With high forage capability, cover had relatively little influence on habitat capability; habitat capability increased only with high to very high cover levels.

B20--Security from human disturbance. Cover area, open road
density, and terrain complexity interact to determine the relative security of ungulates in a watershed from human disturbance, primarily vulnerability to and harassment from hunters. Increasing open road density was considered negative. Increasing cover and terrain complexity negated the effects of roads by increasing security in the presence of roads.

D1--Habitat capability as a function of inherent habitat capability and the relative security of elk from human disturbance within the watershed.

Savannah Sparrow Model

The savannah sparrow model was not modified by the HEP Team

Yellow Warbler Model

All shrub species rated with a wetland indicator status of Facultative (FAC), Facultative-Wetland (FACW), and Obligate Wetland (OBL) will be considered hydrophytic. The variable equation on page 6 should be changed from square to cube root.

Savannah Sparrow Model

No modifications were made to the savannah sparrow model.