2018 Chehalis ASRP
Instream Amphibian Survey Report

Marc Hayes, Julie Tyson, Keith Douville & Robert Vadas, Jr.

24 May 2018

2018 Chehalis ASRP
Instream Amphibian Survey Report
Final Report for Post-Feasibility Effort

Marc Hayes, Julie Tyson, Keith Douville & Robert Vadas, Jr.
Washington Department of Fish and Wildlife, Habitat Program
Science Division, Aquatic Research Section

EXECUTIVE SUMMARY: ***Introduction***: The purpose of instream amphibian surveys was to determine the distribution of Western toad (*Anaxyrus boreas*) breeding and their associated aquatic fauna in the Chehalis River mainstem and its tributaries. Western toads, one of the nine non-fish species targeted in the Chehalis River Aquatic Species Restoration Plan (ASRP), engage in instream breeding during recessional flows before the drier season, which results in lentic-breeding pools along typically large, sunny, instream channels. Instream amphibian surveys support ASRP goals to help identify occupancy patterns of Chehalis Basin biota, support Programmatic Environmental Impact Statement (PEIS) and project-specific Environmental Impact Statement (EIS) development, help evaluate selected potential changes in Western toad instream habitat from flood control alternatives, and help inform and prioritize restoration efforts in the Chehalis floodplain. Importantly, one ultimate goal of this work is to compare Western toad breeding locations in the footprint of the proposed dam and reservoir to potential toad habitat elsewhere in the basin to estimate basinwide impacts on Western toad that flood control alternatives might create. This report updates efforts begun in 2014 that extend through the 2017 field season, summarizes those surveys, and provides initial interpretation of likely changes in Western toad habitat as a potential consequence of flood control alternatives. Interpretation of likely changes is preliminary because basin-wide instream surveys are incomplete, and will be refined in the continued ASRP development.

Methods: We performed instream surveys by (a) slowly walking and/or kayaking both margins of stream reaches, and (b) stopping to record all locations where Western toads had bred and their associated aquatic fauna. Our selection of reaches to survey annually was a systematic effort that progressively worked outwards from the point of discovery of breeding Western toads on the Chehalis River mainstem in May 2014. The purpose of that sampling effort was to characterize the general limits of Western toad breeding, both on the Chehalis mainstem and for those tributaries with potential habitat for this species.

Results: From 2014 to 2017, we surveyed 214.9 river miles (RM) [344.4 river kilometers (RKm)] of the Chehalis River and its major tributaries; 196.5 RM (315.6 RKm) were unique reaches and 18.4 RM (29.6 RKm) were resurveyed reaches. Western toad breeding in the Chehalis River mainstem was found in the upper 36.5 RM [58.8 RKm] of its length.[1] However, it also extends

[1] From the vicinity of RM 82 [RKm 131.7] upstream to RM 118.5 [RKm 194.5], which is at the East and West Forks confluence with the mainstem.

some distance upstream into three upper mainstem tributaries: 2.6 RM [4.2 RKm] up the East Fork Chehalis River, 1.7 RM [2.7 RKm] up the West Fork Chehalis River, and 14.8 RM [23.8 RKm] up the South Fork Chehalis River. Our surveys also revealed Western toad instream breeding over 43.3 RM [69.3 RKm] on the Wynoochee River[2] and near RM 2.0 [RKm 3.2] on the Satsop River. Except for historical Western toad records upstream of our survey areas on the Satsop and Wynoochee Rivers, and a few records on the Humptulips and upper Chehalis Rivers, these data collectively represent the knowledge base for the geographic distribution of Western toad in the Chehalis Basin. Notably, Western toads remain unrecorded (a) in the downstream, large-riverine portion of the Chehalis River mainstem and (b) from all headwater streams in upper mainstream tributaries, defined here as upstream of the 4th- to 3rd-order stream-network boundary. In the upper Chehalis headwater streams, canopy shading appears to limit Western toads breeding, but what limits Western toad breeding in the large-riverine Chehalis mainstem is unclear.

Within the stream network footprint where Western toads occurred, breeding densities of Western toads varied greatly. They ranged from one to 32 breeding sites per RM [0.6-19.9 per RKm]. The highest breeding densities of Western toads occurred along the Chehalis mainstem between RM 108 and 118 [RKm 173.4 and 186.3]. Notably, most (~80%) of this breeding hotspot is within the footprint of the proposed Flood Reduction Flow Augment (FRFA) dam and reservoir alternative.[3] Under the Flood Retention Only (FRO = seasonal) dam and reservoir alternative, a somewhat lesser amount (~70%) of this area would occur within its footprint.[4]

Most Western toads deposit eggs in well-insolated (<20% canopy cover) backwater pools that are connected to, or disconnected but near, the main channel when flows drop to near base levels. Flow in the most of these pools is either zero or too slow to measure. However, a low percentage (<15%) of oviposition occurs in the main channel itself when flows drop to ~110 cfs based on USGS' Doty gage. Main-channel oviposition occurs on either shallow (~10 cm) marginal shelves or in main-channel connected pools that possess very low flow velocities (averaging 0.03-0.04 cm/sec), which we call instream-associated (non-floodplain) habitats.

Several other amphibians and fishes occupy the instream breeding and rearing habitats that Western toads use. Most prominent among these (based on co-occurrence and relative abundance) were Pacific treefrogs (*Hyliola regilla*) and juvenile salmon; most of the identifiable juvenile salmon were Coho (*Oncorhynchus kisutch*). Less frequent at Western toad breeding and rearing sites were Roughskin newts (*Taricha granulosa*), exotic American bullfrogs (Rana

[2] Specifically, between RM 5.1 [8.2 RKm] and RM 48.5 [77.9 RKm] on the mainstem Wynoochee River.

[3] The footprint of the proposed dam and reservoir for the FRFA alternative lies between RM 108.3 [RKm 173.9] and RM 116.6 [RKm 187.3]. The upstream end of this estimate is the full pool location of the reservoir surface.

[4] The footprint of the proposed FRO alternative has essentially the same location for the toe of its dam, but its reservoir would extend to 6.74-6.80 RM [10.82-10.92 RKm] above the toe of the dam during normal operations (CBS-ASEP 2014) and to RM 115.5 [RKm 185.5] at maximum pool. In contrast, though the reservoir of the proposed FRFA alternative largely overlaps that of the FRO during normal operations (extending to 6.71-7.49 RM [10.77-12.03 RKm] (CBS-ASEP 2014), at full pool, it would reach RM 116.6 [RKm 187.3].

catesbeiana), Northern red-legged frogs (*Rana aurora*), and at least ten fish species. Only one fish species, Rock bass (*Ambloplites rupestris*), was exotic. We found the two exotic species in association with Western toad egg masses only in Chehalis River mainstem reaches below Elk Creek.

Conclusions: Western toads breed instream in selected areas of the Chehalis Basin stream network, between approximately the lower limit of headwater streams and an uncertain downstream boundary in large-riverine areas. Shading by riparian canopy likely limits Western toads upstream. Our understanding of the downstream limiting factor is less clear; historical changes that have altered the suitability of river-adjacent uplands or an unrecognized aspect of geomorphology or hydrology are possible. The highest breeding densities of Western toads extensively overlap the footprint of both proposed dam/reservoir alternatives, which may reflect juxtaposed and particularly suitable breeding and upland habitat within the proposed footprint.[5] How this might affect the overall Western toad population in the Chehalis Basin is unclear. However, concern exists because:

1) Companion Chehalis aquatic-species studies have not revealed breeding Western toads in any of the many (>182) floodplain off-channel habitats that we have examined. This may reflect their shaded or steep-sided nature, in contrast to off-channel habitats farther from the mainstem in farmland production and instream-associated habitats on the mainstem;
2) Western toads in the tributaries of the Chehalis that drain the Olympics and the upper Chehalis mainstem may be spatially (and potentially genetically) disparate units; and
3) A focal component of the currently preferred flood control alternative is some form of dam. A broad literature describing negative dam effects on biota, which has led to dam breaching elsewhere in the Pacific Northwest, makes any dam alternative concerning.

Evaluation of flood control alternatives detailed in the PEIS (project environmental-impact statement) and Chehalis Basin Strategy reveals that only the dam designs (FRFA, FRO and FRX) are likely to adversely affect Western toads. In particular, based on them requiring well-insolated stillwater habitats for breeding and rearing, we expect several effects. Either dam design could eliminate instream breeding and rearing via creation of either a permanent (FRFA) or irregularly appearing (FRO) large deep stillwater pool. The FRX alternative is a simply hybrid that applies FRO and FRFA alternative sequentially. With the FRO, Western toads may still be compromised even if appearance of the large deep stillwater pool is outside of the breeding and rearing period. We based the latter on uncertainty about habitat quality in the Chehalis mainstem, given the initially denuded, adjacent-upland habitat within the reservoir footprint, subsequent riparian management of that upland habitat, and other complicating factors like induction of local landsliding. The full pool condition might also create breeding and rearing habitat along its

[5] A potential contrast exists between a managed timber landscape (potentially higher quality uplands) and an agricultural landscape (potentially lesser quality uplands for Western toad).

margins, particularly at its upstream end, where we expect fines deposition to broaden shallow-water habitat over time. However, though less likely in the FRO than the FRFA, this positive response and its extent is uncertain because of the magnitude and timing of water level fluctuations from potential dam operations or reservoir filling/emptying patterns that may cause mortality by either stranding or undesirable depth effects. Further, FRFA tailwater may reduce or eliminate suitable breeding and rearing habitat for Western toad for an unspecified distance downstream due to cooler temperatures and/or elevated flows that inhibit oviposition and rearing. Negative effect severity may be greater for the FRFA than the FRO alternative, but enough uncertainty exists about both alternatives and their projected habitat conditions that this conclusion is also uncertain. Some combination of these factors may result in loss of a significant proportion of Western toad populations in the mainstem Chehalis Basin, as breeding of Western toad appears to be much more limited outside of the potential reservoir footprint.

Next Steps: Our basinwide conclusions about Western toad in the Chehalis Basin need refinement and/or verification. Elements that need addressing are:

1) Completion of surveys of unsampled areas of the Chehalis mainstem and tributaries, to reveal the true extent of Western toad distribution;
2) Identification of controls on the upper and downstream limits of instream breeding and rearing across the stream network. Such an effort may require modeling distributional limits against at least one “control” stream with little alteration (for example, the Queets, Hoh, or Quinault Rivers);
3) Modeling habitat factors that most affect breeding and rearing habitat quality, as evaluated via variable instream-breeding densities;
4) Reducing uncertainty about the effects of FRFA and FRO dam alternatives on Western toad;
5) If the Olympic and upper Chehalis River mainstem Western toad units are shown to be disjunct, genetic analysis would be needed to address potential differences.

To date, habitat restoration for instream breeding Western toads has yet to be attempted, and available data make it unclear whether restoration is even possible. Specifically, if we find upland habitat along the large-riverine Chehalis mainstem (well below the footprint) to be limiting because of lesser suitability, restoration improving its suitability to Western toads may be possible. In contrast, if hydrologic or geomorphic factors limit Western toads in the middle/lower mainstem, that kind of restoration may not be an option. Further, whether mitigation for Western toads within the potential reservoir is even possible under the FRFA or FRO alternatives is uncertain. Next steps 1-4 above would help determine whether any restoration or mitigation might be possible. If that conclusion is affirmative, it would reveal which habitat features could be manipulated to restore Western toads and their associated fauna. If floodplain backwaters are too shaded (cold) for Western toad breeding, then partial timber harvest there could potentially enhance toad populations.

INTRODUCTION

Western toad use of the stream network for breeding is a poorly explored aspect of their stillwater-focused life history. Since Carpenter (1953) and Metter (1961) observed Western toads breeding along large-riverine habitats over a half-century ago,[6] one finds Western toad use of stream networks rarely cited. Nearly all of those citations are conservation assessments or reviews, and most simply note Metter's original observations (Nussbaum et al. 1983, Maxell 2000, Davis 2002, McGee and Keinath 2004; but see Cavallo 1997 and Frissell and Cavallo 1997 for overlooked exceptions). Phil Peterson (West Fork Environmental, pers. comm.) and other biologists had previously observed or monitored instream breeding by Western toads in the Chehalis Basin in the Satsop and Wynoochee Rivers draining the Olympics (Washington Department of Fish and Wildlife [WDFW] WSDM database).[7] However, until 10 September 2001, Western toads remained unrecorded from the Chehalis River mainstem. During surveys supporting PHABSIM modeling on that date (Caldwell et al. 2004), one of us (Robert Vadas, Jr.) found numerous Western toad larvae in the Chehalis River mainstem in the vicinity of river mile (RM) 111.9 (river kilometer [RKm] 180.1).[8] Subsequently, during Aquatic Species Enhancement Plan (ASEP)[9] surveys on 20 August 2013, John Winkowski (WDFW, Fish Program, pers. comm.) encountered Western toad tadpoles during fish surveys at RM 102.25 (RKm 164.2) and later, at RM 118.5 (RKm 190.3) in the upper Chehalis River mainstem. Further, in May 2014, our field crew[10] sampled stream-associated amphibians[11] near the Panesko Bridge, observing Western toad egg masses in a side pool connected to the mainstem. These finds led us to initiate systematic instream channel-margin surveys in May 2014. Through the 2017 field season, we have examined over 200 RM (321.2 RKm) of the Chehalis River mainstem and its major tributaries. This report describes those surveys, the pattern of distribution of instream breeding Western toads in the Chehalis Basin, their associated fauna, how flood control alternatives may affect Western toads, and the importance of Western toads in the Chehalis Basin ASRP.

METHODS

REACH SELECTION: We expressly designed surveys to maximize coverage across the stream network. In 2014, our surveys expanded from our find of Western toad egg masses near the Panesko Bridge in May. These surveys covered the entire instream area within the footprint of the proposed dam and reservoir upstream (hereafter footprint)[12] on the mainstem Chehalis River

[6] Carpenter (1953) and Metter (1961) made observations, respectively, during the summers of 1951, and 1958-1960.
[7] The WSDM database is the WDFW wildlife records database.
[8] Vadas, Jr. returned to the same site on 30 September 2004 and found many Western toadlets on the floodplain. This location is roughly 2 RM [3.2 RKm] below the proposed dam footprint.
[9] This is now termed the Aquatic Species Restoration Plan [ASRP]).
[10] Specifically David Snyder.
[11] Dunn's and Van Dyke's salamanders.
[12] Footprint here means that for the dam and reservoir, as defined for the FRFA dam alternative at full pool.

and extended to the mainstem terminus at the confluence of the East and West Forks of the Chehalis River (**Figure 1**). Those surveys also included segments of major tributaries in the footprint with enough suitable breeding and rearing habitat to suggest Western toad presence. These tributaries included Big, Crim, Lester, Roger, and Thrash Creeks (**Figure 1**), which are fish-bearing. During the Western toad breeding season, we also surveyed downstream of the footprint as far as our sampling time window (see **Sampling**) allowed (**Figure 1** and **Table 2**).

From 2015 forward, our impression from 2014 surveys that suitable Western toad habitat might reflect the degree of insolation – as linked to stream size – helped guide survey reach selection. This idea is not novel; breeding habitat among better-studied pond-breeding Western toads is also well-insolated (Karlstrom 1986, Crisafulli et al. 2005, Pearl and Bowerman 2006), such that tadpoles are found in warmer backwaters (Cavallo 1997, Frissell and Cavallo 1997; Carey et al. 2005). For this reason, we extended selection to habitats potentially suitable based on similarity in structure but that might be suboptimal because of less insolation. This approach allowed us to develop a preliminary understanding of how insolation might limit habitat.

In 2015, our surveys were more limited than in 2014 because other non-salmon studies in the Chehalis Basin had workplan priority. That constraint resulted in our sampling being limited to lower reaches of three spatially separated Chehalis mainstem reaches located further downstream than our 2014 effort (**Figure 1**) and three mainstem tributaries not sampled previously: the Newaukum, Skookumchuck, and Satsop Rivers (**Figure 1**).

In 2016, we repeat sampled selected areas to obtain a sense of inter-year variability and expanded surveys into previously unsampled reaches. With minor exceptions, resurveys consisted of a third of the footprint distance sampled in 2014 in 500-m long segments (**Figure 1**),[13]; and ~3 RM (4.8 RKm) and 1.6 RM (2.6 RKm) of the Chehalis mainstem between (a) Porter Creek and the Black River and (b) Elk Creek and the footprint, respectively (**Figure 2**). New reaches surveyed were 2-8 miles in each of the remaining eight river segments (**Figures 1** and **2**), and not previously surveyed areas outside the footprint up to 5 miles upstream from their Chehalis confluence (**Figure 2**). These tributaries included the Black River; Cedar, Cinnabar, Independence, Lincoln, Porter, Roger, and Scatter Creeks; and the East, South, and West Forks of the Chehalis River.

In 2017, surveys focused on the Wynoochee and South Fork Chehalis Rivers to (a) confirm breeding locations found in those two rivers in 2016; and (b) enable covering as much unsurveyed area as possible within the seasonal sampling window (**Figure 1**).

[13] Intervening spacer sections of 1000-m separated the sampled sections.

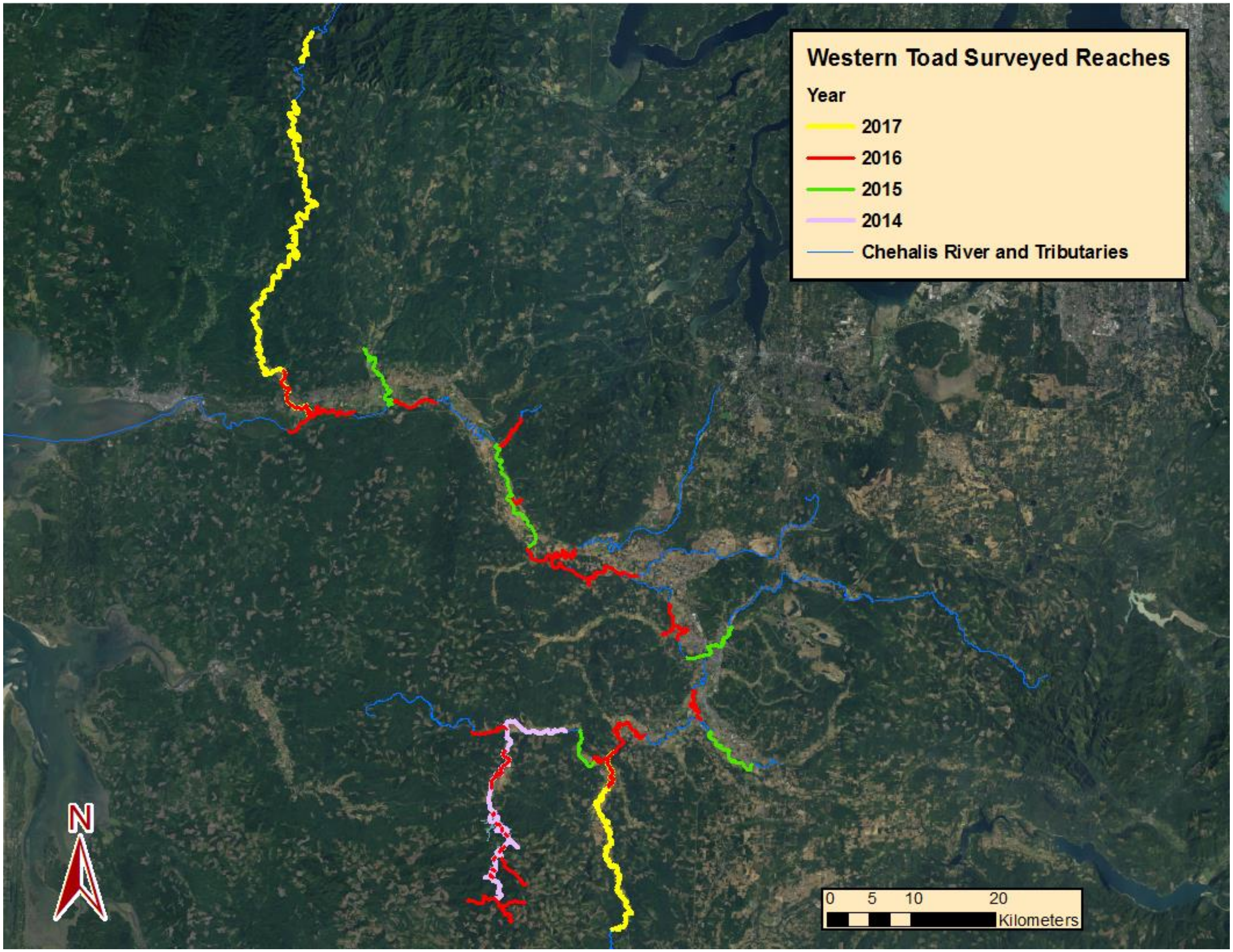
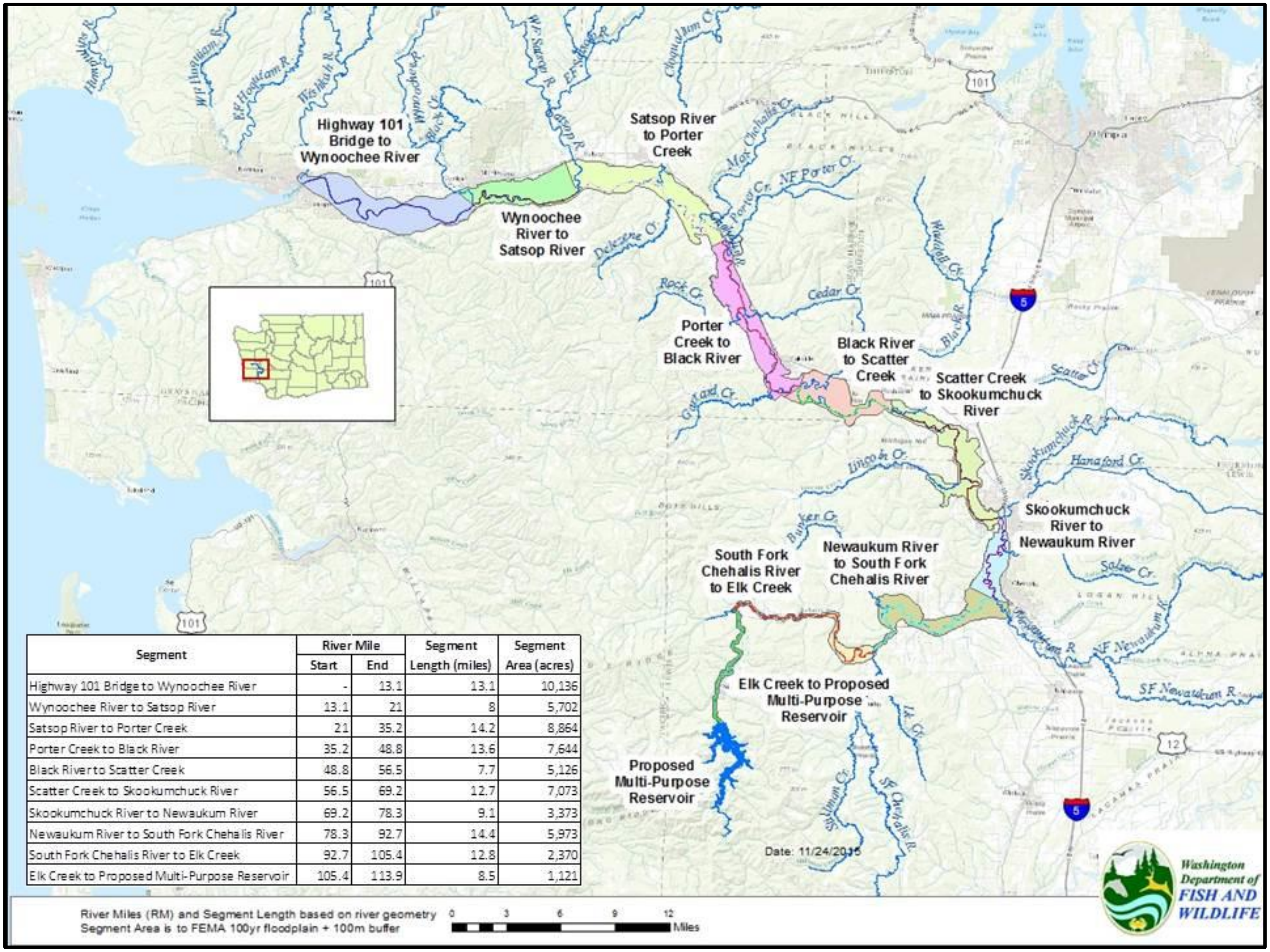


Figure 1. Instream survey reaches for Western toads for the years 2014-2017.



Segment	River Mile		Segment	Segment
	Start	End	Length (miles)	Area (acres)
Highway 101 Bridge to Wynoochee River	-	13.1	13.1	10,136
Wynoochee River to Satsop River	13.1	21	8	5,702
Satsop River to Porter Creek	21	35.2	14.2	8,864
Porter Creek to Black River	35.2	48.8	13.6	7,644
Black River to Scatter Creek	48.8	56.5	7.7	5,126
Scatter Creek to Skookumchuck River	56.5	69.2	12.7	7,073
Skookumchuck River to Newaukum River	69.2	78.3	9.1	3,373
Newaukum River to South Fork Chehalis River	78.3	92.7	14.4	5,973
South Fork Chehalis River to Elk Creek	92.7	105.4	12.8	2,370
Elk Creek to Proposed Multi-Purpose Reservoir	105.4	113.9	8.5	1,121

Figure 2. Chehalis River mainstem segments used to stratify sampling of instream surveys.

SAMPLING: We used several indicators to guide initiation of sampling for Western toad breeding surveys, given uncertainty about the precise conditions that trigger breeding and the length of the oviposition window. We paid particular attention to the Chehalis mainstem hydrograph because of Metter's (1961) comment that riverine Western toads may delay initiation of breeding until flows subside to a level unlikely to wash away their eggs.[14] To do this, we used the gage at Doty (USGS 12020000; latitude: 46.6175; longitude: -123.2763) on the upper Chehalis mainstem because it was most proximate to the 2001 and 2004 finds by Vadas, Jr. of Western toad larvae and toadlets, respectively; and the 2013 finds of Western toad larval stages by the WDFW Fish Program. We also used monitoring data that Phil Peterson (pers. comm.) and Aimee McIntyre (WDFW, Aquatic Research Section, pers. comm.) had collected on breeding Western toads in the Satsop drainage to indicate that hydrographs typically decline to a level suitable for breeding during mid-May to early June.[15] For each year after 2014, we also monitored the first known 2014 breeding location on the mainstem Chehalis at relatively high frequency (1-4 day intervals), in the course of other Chehalis headwater surveys. Lastly, we paid some attention to air and water temperatures because pond-breeding Western toads:

(a) Reproduce when the water temperature reach ~14°C (57.2°F; personal observation) and
(b) Grow (as tadpoles) when water temperatures exceed 10°C (50°F; Carey et al. 2005).

However, we considered the degree to which the hydrograph had declined more important than temperature when both are considered (cf. Metter 1961).

We conducted western toad surveys with 2-5 surveyors. Survey reaches typically had an upstream entry point and surveyors worked downstream to an exit point. Where a stream reach had more than one braid, we surveyed all channel braids. Surveys were by visual encounter, where surveyors slowly walked and/or kayaked both margins of stream reaches, stopping to record all locations where Western toads had bred (eggs or non-feeding hatchling tadpoles) or there was evidence of recent breeding (i.e., aggregated feeding tadpoles or metamorphosing [transforming] animals). We regarded breeding locations as different if separated by at least three meters.

At Western toad breeding locations, we recorded a suite of biotic data. If we found Western toad egg masses, we estimated the number of masses based on the number of jelly strings with eggs/embryos divided by two,[16] but also recorded the number of non-egg/embryo life stages as

[14] Western toads deposit jelly strings of eggs unattached to any substrate.

[15] First observed breeding dates for Western toad in the Satsop drainage ranged from 12 May to 17 June based on 9 years of data. Variation reflects inter-year variability and location of surveys on either the West or Middle Forks of the Satsop River. The actual first-breeding date may be earlier in some cases because 16 of the 18 surveys (surveys were always done on both of these forks each year) the first-observed breeding date was also the first survey date. Though we had these data from the Satsop, we recognized that differences in behavior there compared to elsewhere in the Chehalis River network might result in breeding periodicity differences of Western toads in those places (cf. Carey et al. 2005; Reaser and Blaustein 2005).

[16] Individual strings are recognizable by a 6-12-cm length of tapered jelly at each end of the string that does not contain embryos.

larvae, metamorphs, juveniles, or adults.[17] We also recorded presence data on the other amphibian and fish species, as well as predatory invertebrates of Western toad life stages.[18]

Physical data of breeding pools recorded included location and structural features. Location data recorded were the GPS[19] and RM (RKm) location[20] of each oviposition site, and the bank location (as right or left bank).[21] Structural features recorded were water depth, pool width, substrate composition, water velocity, and a description of connection to the riverine main channel, if any. We scored substrate into five standard categories[22] and estimated each to the nearest 5% in a 1-m diameter circle centered on each egg mass. We also took photographs as an archive of conditions at the site at the time of the survey.

In 2016 and 2017, we also obtained a parallel set of data for a random location not used for Western toad oviposition, but adjacent to the breeding locations.[23] We collected these data to understand how Western toads might be selecting breeding and rearing habitat based on the key variables of canopy cover, depth, flow, substrate, and temperature. In 2016, however, we did not record depth for the random points. Originally, we intended this to be part of the PHABSIM effort to model changes in Western toad habitat under different flood control options, but the relative limited applicability of PHABSIM to Western toad breeding and rearing habitat in off-channel areas (see **Discussion**) resulted in this being an analysis in its own right.

DATA HANDLING AND ANALYSIS: We report Western toad breeding data as either the number of breeding locations or egg masses per RM (and RKm) where we obtained at least one breeding location. Stream width increased with downstream position along the stream network, so these data represent indices of breeding location or egg mass densities rather than true area-based densities. We averaged indices and provided a measure of variation (standard deviation) as appropriate. For repeat surveys between years, we compared data across the same RM (RKm). However, repeat surveys often covered only a portion of the same RM or RKm, so resurveys represent estimates for entire RMs or RKms, and shifts in breeding site locations that may occur between years will contribute to error in between-year comparisons.

Identification of stream RM (RKm) locations merits brief discussion because of uncertainty in describing current locations. Chehalis Basin investigators used USGS RM due to convenience,

[17] Embryos (eggs) are the pre-hatching life stage; larvae are post-hatching and pre-metamorphosis; metamorphs are at metamorphic climax (possess 3-4 legs and a tail); juvenile are non-adult post-metamorphs; adults are reproductive mature post-metamorphs.

[18] Key predatory invertebrates recorded were crayfish, giant water bugs, diving beetles, backswimmers, and water scorpions (cf. McCafferty and Provonsha 1981; Carey et al. 2005).

[19] In decimal degrees to four decimal places.

[20] Obtained from GIS post-processing to the nearest 0.10 mi (0.16 km).

[21] We evaluate right or left bank facing upstream.

[22] Fines (sand or smaller), gravel, cobble, boulder, and bedrock.

[23] We chose the adjacent location from a random direction, and random distance within 5 m of the center of the Western toad oviposition to the nearest cm. If this random adjacent location did not fall in water, we continued choosing a new random distance and direction until we found one that fell within aquatic habitat.

which originated from mapping developed for historic 7.5' topographic quadrangles.[24] However, stream migration has altered RM (RKm) locations from the original USGS mapping through differential lengthening or shortening of local streams reaches (see Pierce et al. [2017] for a sense of the degree of local meandering over time here). For this reason, USGS RMs fail to generate precise distances in GIS-based distance calculations on current maps, and we found actual locations and distances could vary by as much as 0.5 mi (0.8 km), regardless of whether we used an upstream or downstream control point to calculate distance. We point this out because we based our calculation of Western toad breeding indices on USGS RM (RKm), so these indices are, at best, approximate estimates. We did this because various entities involved in the Chehalis Basin us USGS RM as the descriptive standard for comparison. However, we based our measurements of survey distances surveys on GPS tracklines and the NAIP map closest to the year of survey. Importantly, precise estimates of RM (or RKm) will require regular GIS re-measurement of stream distances because of changes in the mainstem channel.

We compared Western toad breeding location and egg- mass density indices descriptively by river mile for locations below, within, and above the footprint, and other tributaries; and among different years for different parts of the stream network. We formally compared Western toad breeding location and egg mass density indices for the same RMs to provide a sense of inter-year variation using paired sample t-tests. We also characterize Western toad oviposition sites descriptively with up to five variables: canopy cover, depth, flow, substrate, and temperature. We indexed substrate by scoring the five categories 1-5, multiplying each by their location-specific percentage, summing them per location, and dividing by five. Further, we compared points at which breeding and rearing occurred with random points – for the same five variables with paired sampled t-tests – to suggest how Western toads may select oviposition habitat.

RESULTS

SURVEY EFFORT: Over 2014-2017, we surveyed over 6-17 entire days within a time window of 21 to 61 days each year (**Table** 1). We surveyed more extensively temporally in 2014 because we wanted to understand the seasonal pattern of Western toad breeding in the area.

SURVEY DISTANCE: Overall (2014-2017), our instream surveys have covered 214.9 RM (345.1 RKm), of which 18.4 RM (29.6 RKm) were resurveys (**Figure 2** and **Tables 2** and **3**). This includes 11.9 RM (19.2 RKm) of the mainstem within the footprint (of which 2.8 RM [4.5 RKm] were resampled), 3.3 RM (5.3 RKm) of tributaries within the footprint, and 2.5 RM (4.0 RKm) in the

[24] The Washington Department of Ecology created the Washington State GIS RM point layer in March 2007 by digitizing river mile points from the USGS 7½ minute (24k) topographic quadrangle maps created during the 1950s-1980s. Some of the rivers have gaps in the river mile progression because several quadrangle maps lack RM points, while a few were missing a point or two. In November 2014, Ecology added RM points for the missing areas using WDFW's 1975 Stream Catalog, which covered only WRIAs 1 through 24. The Stream Catalog showed RMs for nearly every stream; however, only those watercourses that have RMs from USGS quadrangle maps were added.

Chehalis River mainstem above the footprint. We also surveyed 10.9 RM (17.5 RKm) in tributaries upstream of the footprint, 71.4 RM (114.7 RKm) in Chehalis River mainstem below the footprint (of which 5.9 RM [9.5 RKm] were resampled), and 114.3 RM (183.6 RKm) in tributaries of the Chehalis River mainstem downstream of the footprint (of which 9.7 RM [15.6 RKm] were resampled). Collectively, repeat surveys represented 9.4% of the 196.5 RM (315.6 RKm) of the stream network surveyed at least once.

Table 1. Chehalis Basin Survey Effort for Instream Amphibian Surveys, 2014-2017.

Year	Time Window			Days Surveyed
	Start	End	Total Days	
2014	28 May	28 July	61	17
2015	1 July	28 July	27	6
2016	9 May	15 June	37	15
2017	6 June	27 June	21	8

In 2014, instream surveys covered 21.9 RM (35.1 RKm) of the Chehalis mainstem, which comprised the entire 9.1 RM (14.6 RKm) within footprint, 2.5 RM (4.0 RKm) immediately above that footprint, and 10.3 RM (16.5 RKm) immediately below the footprint downstream to about 95 RM (152.6 RKm) (**Figure 2** and **Table 2**). We also surveyed the five major tributaries within the footprint with potential Western toad breeding habitat (**Figure 2** and **Table 3**), including Big, Crim, Lester, Roger, and Thrash Creeks. We also surveyed a small reach of Thrash Creek beyond the footprint and a small reach of Katula Creek (a Chehalis mainstem tributary just downstream of Pe Ell).

In 2015, instream surveys covered 15.6 RM (25.0 RKm) of the Chehalis mainstem and 19.1 RM (30.7 RKm) of tributaries downstream of the footprint (**Figure 2**), which were the lowermost portions of the Newaukum, Satsop, and Skookumchuck Rivers (**Tables 2** and **3**).

In 2016, we surveyed 84.9 RM (136.4RKm) of the mainstem and its tributaries (**Figure 2**), including 2.8 RM (4.5 RKm) of the mainstem within the footprint, and 44.9 RM (72.3 RKm) of the mainstem below the footprint (**Tables 2** and **3**). We also surveyed 10.8 RM (17.3 RKm) of tributaries upstream of the footprint (**Table 3**), including portions of the East and West Forks of the Chehalis River, and Roger and Cinnabar Creeks. In addition, we surveyed 26.0 RM (41.8 RKm) that collectively included nine major tributaries with potential Western toad breeding habitat, which were downstream and outside of the footprint (**Table 3**). These included portions of the Black, South Fork Chehalis, and Wynoochee Rivers, and portions of Cedar, Elk, Independence, Lincoln, Porter, and Scatter Creeks. In 2016, we resampled 7.4 RM (11.9 RKm) from 2014-2015.

In 2017, we surveyed 70.3 RM (113.1 RKm), of which 69.6 RM (112.0 RKm) was in two tributaries downstream of the footprint (**Figure 2**), including large sections of the Wynoochee and South Fork Chehalis Rivers (**Figure 2** and **Table 3**). The remaining 0.7 RM (1.0 RKm) surveyed was in the Chehalis River mainstem below the footprint.

Table 2. Mainstem survey distance summary for instream surveys partitioned by river segments, 2014-2017. Survey distances are in river miles (RM) and river kilometers (RKm). Inundation footprint (or footprint) refers to the footprint of the proposed dam and reservoir at full pool.[25] Resurveyed stream distances are those that were resurveyed in a different year, unique stream distances are those surveyed only once, and stream distance gaps estimates the unsurveyed stream length with potential Western toad habitat.

Survey Unit	2014		2015		2016		2017		Stream Distance Totals					
									Resurvey		Unique		Gaps	
	RM	RKm	RM	RKm	RM	RKm	RM	RKm	RM	RKm	RM	RKm	RM	RKm
Mainstem – Within Footprint	9.1	14.6			2.8	4.5			2.8	4.5	9.1	14.6	0.0	0.0
Mainstem - Upstream of Footprint	2.5	4.0									2.5	4.0	0.0	0.0
Mainstem - Downstream of Footprint														
1 – Highway 101 Bridge to Wynoochee River					2.0	3.2					2.0	3.2	11.0	17.7
2 – Wynoochee River to Satsop River					5.5	8.8					5.5	8.8	3.2	5.1
3 – Satsop River to Porter Creek			0.4	0.6	3.5	5.6					3.9	6.2	10.3	16.5
4 – Porter Creek to Black River			10.4	16.7	6.0	9.6			3.0	4.8	13.4	21.5	0.0	0.0
5 – Black River to Scatter Creek					7.8	12.5					7.8	12.5	0.0	0.0

[25] Inundation footprint distances are for the FRFA dam alternative; full pool under the FRO alternative would inundate only 6.7-6.8 RM (10.8-10.9 RKm; CBS – ASEP 2014).

6 – Scatter Creek to Skookumchuck River			1.2	1.9	4.3	6.9					5.5	8.8	7.1	11.4
7 – Skookumchuck River to Newaukum River					4.0	6.4					4.0	6.4	4.9	7.9
8 – Newaukum River to South Fork Chehalis River					7.9	12.7	0.7	1.0	1.3	2.1	7.3	11.6	6.8	10.9
9 – South Fork Chehalis River to Elk Creek	5.6	9.0	3.6	5.8	2.3	3.7					11.5	18.5	1.1	1.8
10 – Elk Creek to Proposed Dam	4.7	7.5			1.6	2.8			1.6	2.6	4.7	7.5	0.0	0.0
Downstream of Footprint Subtotals	**10.3**	**16.5**	**15.6**	**25.0**	**44.9**	**72.3**	**0.7**	**1.0**	**5.9**	**9.5**	**65.6**	**105.4**	**44.4**	**71.3**
Mainstem Totals	**21.9**	**35.1**	**15.6**	**25.0**	**47.7**	**76.8**	**0.7**	**1.0**	**8.7**	**14.0**	**77.2**	**124.0**	**44.4**	**71.3**

Table 3. Tributary survey distance summary for instream surveys, 2014-2017, using the format of Table 1. Mainstem subtotals are also drawn from Table 1. Internal gaps estimate unsurveyed stream lengths between previously surveyed units in a named drainage; external gaps estimate unsurveyed stream lengths upstream of any of our surveys.

Survey Unit	2014		2015		2016		2017		Stream Distance Totals							
									Resurvey		Unique		Gaps			
													Internal		External	
	RM	RKm	RM	RKm	RM	RKm	RM	RKm	RM	RKm	RM	RKm	RM	RKm	RM	RKm
Within Footprint																
Big Creek	0.9	1.4									0.9	1.4				

Crim Creek	0.8	1.3									0.8	1.3			2.4	3.9
Lester Creek	0.1	0.2									0.1	0.2			0.9	1.4
Roger Creek	0.4	0.6			0.4	0.6					0.8	1.3	0.3	0.5		
Thrash Creek	0.7	1.1									0.7	1.1				
Within Footprint Subtotals	**2.9**	**4.6**	**0.0**	**0.0**	**0.4**	**0.6**	**0.0**	**0.0**	**0.0**	**0.0**	**3.3**	**5.3**	**0.3**	**0.5**	**3.3**	**5.3**
Upstream of Footprint																
Big Creek															1.0	1.6
Cinnabar Creek					1.8	2.9					1.8	2.9			1.6	2.6
East Fork Chehalis					3.5	5.6					3.5	5.6			4.2	6.7
George Creek															2.2	3.5
Roger Creek					2.5	4.0					2.5	4.0			0.8	1.3
Thrash Creek	0.1	0.2									0.1	0.2			3.9	6.3
West Fork Chehalis					3.0	4.8					3.0	4.8			0.7	1.1
Sage Creek															0.5	0.8
Upstream of Footprint Subtotals	**0.1**	**0.2**	**0.0**	**0.0**	**10.8**	**17.3**	**0.0**	**0.0**	**0.0**	**0.0**	**10.9**	**17.5**	**0.0**	**0.0**	**14.9**	**23.9**

Table 3. Tributary survey distance summary for instream surveys, 2014-2017, using the format of Table 1 (continued). Mainstem subtotals are also drawn from Table 1. Internal gaps estimate unsurveyed stream lengths between previously surveyed units in a named drainage; external gaps estimate unsurveyed stream lengths upstream of any of our surveys.

Survey Unit	2014		2015		2016		2017		Totals							
									Resurvey		Unique		Gaps			
													Internal		External	
	RM	RKm	RM	RKm	RM	RKm	RM	RKm	RM	RKm	RM	RKm	RM	RKm	RM	RKm
Downstream (D) or Outside (O) of the Footprint																
Black River					4.3	6.9					4.3	6.9			24.0	38.5
Beaver Creek															7.5	12.0
Allen Creek															3.3	5.3
Dempsey Creek															1.0	1.6
Salmon Creek															2.7	4.3
Waddell Creek															5.0	8.0
Unnamed Creek															0.8	1.3
Cedar Creek					1.8	2.9					1.8	2.9			9.9	15.9
Elk Creek					2.8	4.5					2.8	4.5			13.3	21.4
Independence Creek					0.9	1.4					0.9	1.4			6.6	10.6
Katula Creek	0.1	0.2									0.1	0.2			2.5	4.0
Lincoln Creek					1.4	2.2					1.4	2.2			16.6	26.7
South Fork Lincoln Creek															2.0	3.2
Newaukum River			7.0	11.3							7.0	11.2	2.0	3.2	3.0	4.8
North Fork Newaukum River															17.0	27.3
Lucas Creek															0.6	1.0

Table 3. Tributary survey distance summary for instream surveys, 2014-2017, using the format of Table 1 (continued). Mainstem subtotals are also drawn from Table 1. Internal gaps estimate unsurveyed stream lengths between previously surveyed units in a named drainage; external gaps estimate unsurveyed stream lengths upstream of any of our surveys.

Survey Unit	2014		2015		2016		2017		Totals							
									Resurvey		Unique		Gaps			
													Internal		*External*	
	RM	RKm	RM	RKm	RM	RKm	RM	RKm	RM	RKm	RM	RKm	RM	RKm	RM	RKm
Downstream (D) or Outside (O) of the Footprint (continued)																
South Fork Newaukum River															28.0	45.0
Kearney Creek															2.0	3.2
Porter Creek					3.9	6.3					3.9	6.3			2.4	3.9
Satsop River			7.3	11.7							7.3	11.7				
East Fork Satsop River															19.5	31.3
Middle Fork Satsop River															28.0	45.0
West Fork Satsop River															38.5	61.8
Canyon Creek															15.0	24.1
Still Creek															1.4	2.2
Scatter Creek					1.2	1.9					1.2	1.9	0.2	0.3	20.0	32.1
Skookumchuck River			4.8	7.7							4.8	7.7			35.5	57.0
Johnson Creek															0.4	0.6
South Fork Chehalis River					3.5	5.6	24.2	38.9	3.5	5.6	24.2	38.9			8.5	13.7
Lake Creek															1.0	1.6
Stillman Creek															13.3	21.4
Halfway Creek															0.5	0.8

Table 3. Tributary survey distance summary for instream surveys, 2014-2017, using the format of Table 1 (continued). Mainstem subtotals are also drawn from Table 1. Internal gaps estimate unsurveyed stream lengths between previously surveyed units in a named drainage; external gaps estimate unsurveyed stream lengths upstream of any of our surveys.

Survey Unit	2014		2015		2016		2017		Totals							
									Resurvey		Unique		Gaps			
													Internal		*External*	
	RM	RKm	RM	RKm	RM	RKm	RM	RKm	RM	RKm	RM	RKm	RM	RKm	RM	RKm
Downstream (D) or Outside (O) of the Footprint (continued)																
West Fork Stillman Creek															2.1	3.4
Wynoochee River					6.2	10.0	45.4	72.9	6.2	10.0	45.4	72.9	5.0	8.0	13.5	21.7
Schafer Creek															3.8	6.1
Wedekind Creek															1.2	1.9
D or O of the Footprint Subtotals	**0.1**	**0.2**	**19.1**	**30.7**	**26.0**	**41.8**	**69.6**	**111.8**	**9.7**	**15.6**	**105.1**	**168.9**	**7.2**	**11.6**	**202.2**	**324.7**
Tributary Totals	**3.1**	**5.0**	**19.1**	**30.7**	**37.2**	**59.7**	**69.6**	**111.8**	**9.7**	**15.6**	**119.3**	**191.6**	**7.5**	**12.0**	**220.4**	**353.9**
Mainstem Totals (from Table 2)	**21.9**	**35.1**	**15.6**	**25.0**	**47.7**	**76.8**	**0.7**	**1.0**	**8.7**	**14.0**	**77.2**	**124.0**	**44.4**	**71.3**	**0.0**	**0.0**
Grand Totals	**25.0**	**40.1**	**34.7**	**55.7**	**84.9**	**136.4**	**70.3**	**112.8**	**18.4**	**29.6**	**196.5**	**315.6**	**51.9**	**83.4**	**220.4**	**353.9**

WESTERN TOAD BREEDING AND REARING LOCATIONS**:** Combining all years, we recorded 279 breeding locations and a minimum of 438 egg masses[26] in instream-associated habitats. Besides main-channel habitats, these included perennial side channels and connected backwaters, but not isolated (floodplain) backwaters (sensu Chamberlin and Humphries 1977, Vadas 1992, Vadas and Orth 1998). We recorded 219 of those breeding locations and 359 of those egg masses in stream networks associated with the Chehalis mainstem above RM 82 [RKm 131.7] (**Figure 3**), located 6 RM [9.6 RKm] below its confluence with the South Fork. We found the 60 remaining breeding locations and 79 egg masses in large tributaries draining the Olympics (**Figure 3**).

Western toad breeding site and egg-mass density indices varied by both region and locally.

Upper Chehalis Area: Within the upper Chehalis region (above RM 82 [RKm 131.7]), density indices below the footprint (between RM 82 and 108 [RKm 131.7 and 173.4]) varied by year, averaging 0 to 1.14 breeding sites/RM (0 to 0.71 breeding sites/RKm) (**Figure 4**). In contrast, within-footprint (RM 108 to 119 [RKm 131.7 and 191.1]) density indices varied from an average of 5.92 to 14.60 breeding sites/RM (3.69 to 8.51 breeding sites/RKm) and 16.00 to 24.50 egg masses/RM (9.96 to 14.1 egg masses/RKm) (**Figure 4**). For years available for contrast (2014 versus 2016), mean density indices within the footprint for both breeding-site mileage and egg masses were over an order of magnitude larger than below the footprint (**Figure 4**). If we compare years for only the same RM (RKm) within the footprint, mean density indices averaged 14.56 breeding sites/RM (9.07 breeding sites/RKm) and 25.33 egg masses/RM (15.77 egg masses/RKm) in 2014. In contrast, mean density indices averaged 5.92 breeding sites/RM (3.69 breeding sites/RKm) over the same reaches in 2016. These differences were significant for breeding sites (paired t-test: df = 8, $P = 0.0386$), but not for egg masses (paired t-test: df = 8, $P = 0.2145$). For an equivalent comparison across 7 RM (11.2 RKm) below the footprint (all single or paired RM [RKm] from RM 20 [RKm 32.1] to RM 91 [RKm 146.1]) and between 2015 and 2016, we recorded no Western toad breeding sites in both years. For another equivalent comparison across 6 RM (9.6 RKm) below the footprint (from RM 100 [RKm 160.6] to RM 107 [RKm 171.8]) between 2014 and 2016, we recorded, respectively, an average of 1.57 and 1.43 breeding sites/RM (0.97 and 0.89 breeding sites/RKm). The difference between years was not significant (paired t-test: df = 5, $P = 0.2145$). For both years, egg mass numbers were identical to breeding site numbers.

Above the footprint, we have data for the remaining 1.0 RM (1.6 RKm) on the mainstem Chehalis in 2014; and 7 RM (11.2 RKm) on the East and West Forks of the Chehalis River (above the mainstem terminus) in 2016. The 2014 RM on the Chehalis mainstem had 4.3 breeding sites/RM (2.68 breeding sites/RKm); and the 7 RMs on the East and West Forks from 2016 averaged, respectively, 2.29 breeding sites/RM (1.43 breeding sites/RM) and 2.43 egg masses/RM (1.51 egg masses/RM). We did not repeat survey these above-footprint reaches.

[26] This represents a minimum count given the likelihood of underestimating the egg mass number if the number of egg masses at an oviposition site exceeded three.

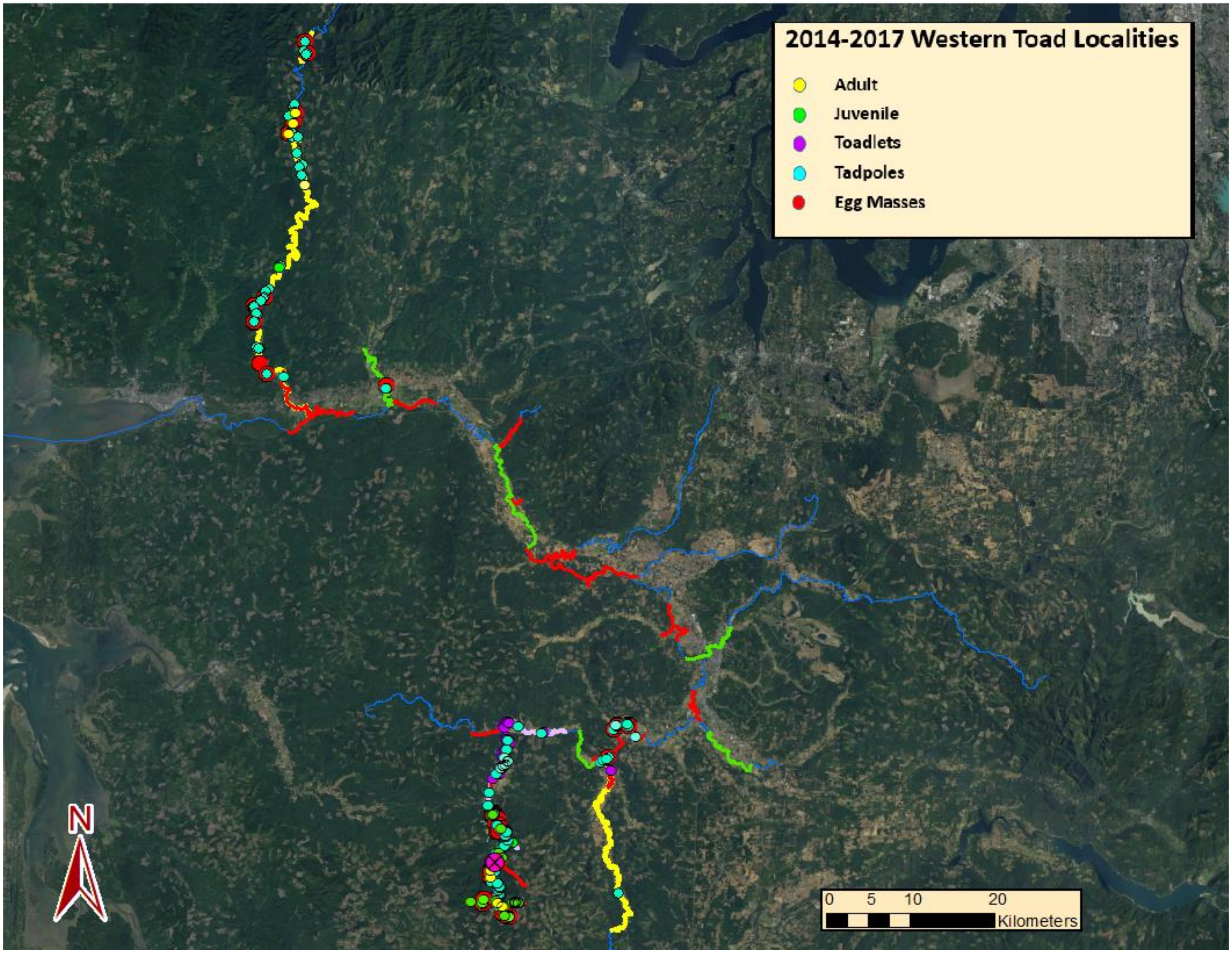


Figure 3. Instream surveyed reaches and Western toad locations by life stage. Colors indicate survey years: Orange = 2014, Green = 2015, Red = 2016, and Yellow = 2017; Blue is unsurveyed reaches. Appendices have year-specific maps where detail is better resolved.

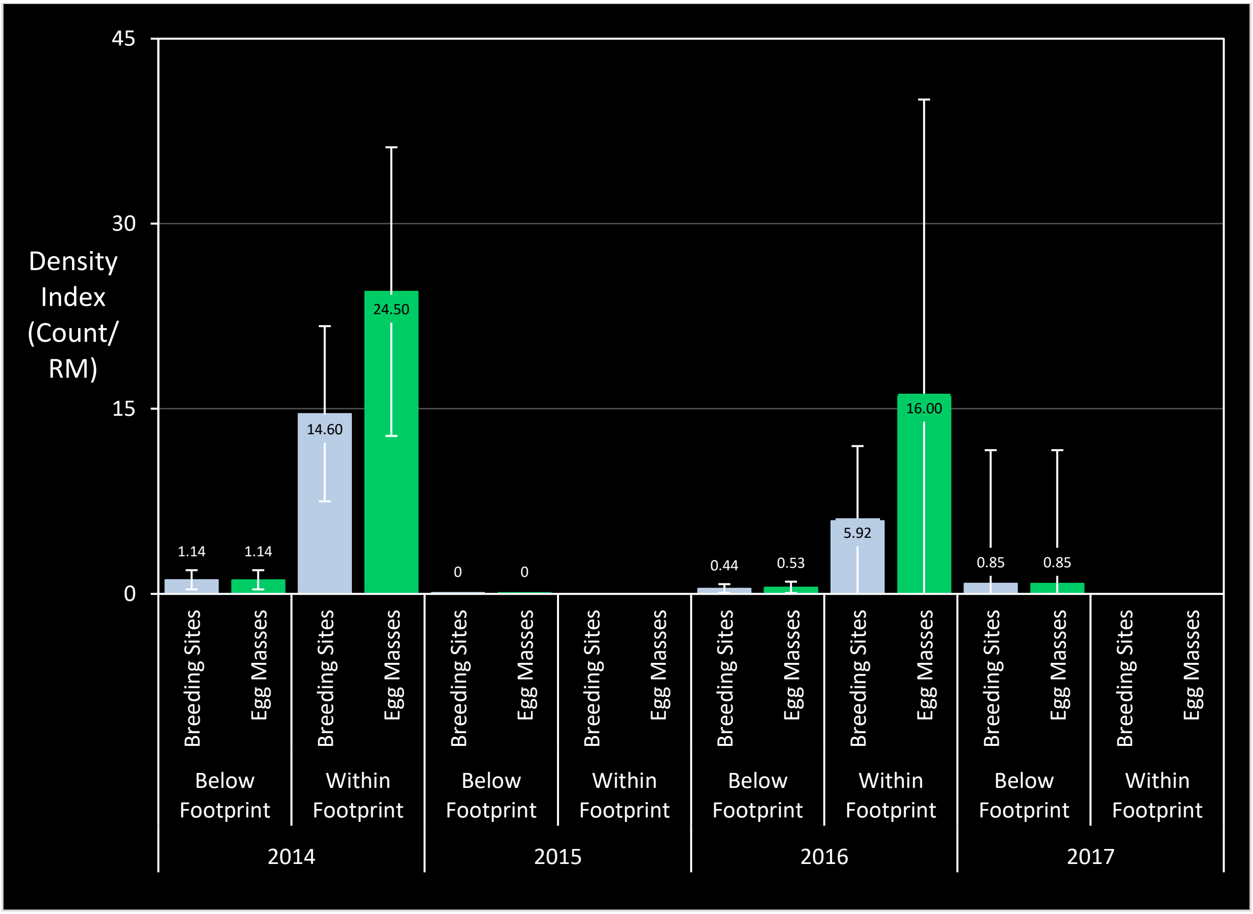


Figure 4. Breeding Site and Egg Mass Density Index Variation in the Upper Mainstem Chehalis Basin. Values indicate means; whiskers are 95% confidence intervals. Density index values shown are in rivers miles; see text for their river kilometer equivalents. Blanks denote no surveys.

We found no Western toad breeding sites in any of the small- to medium-sized tributaries of the upper Chehalis River mainstem or in its in East and West Forks. Such smaller tributaries include Big, Cinnabar, Crim, Elk, Lester, Roger, and Thrash Creeks. All of these streams except Big and Roger Creeks had either limited insolation, reflecting (a) riparian tree cover (less than 25% on average) or (b) limited or no shallow shelf structure typical of Western toad oviposition sites. Big and Roger Creeks appeared to have some open reaches with shelves, but whether the relatively smaller area with this habitat had flows low enough to allow oviposition is unclear (see **Oviposition Habitat** section). The only upper Chehalis mainstem tributary where we recorded any breeding was the South Fork Chehalis River, a large relatively well-insolated stream where we recorded two breeding sites with three egg masses total. One of these breeding sites, recorded in 2016, was at RM 1.1 (RKm 1.8); the other, recorded in 2017, was at RM 14.6 (RKm 23.4), reflecting low-density indices. Based on the 3 RM [4.8 RKm] surveyed in 2016, the Western toad density index of breeding sites and egg masses averaged, respectively, 0.33/RM ± 0.58 SD and 0.21/RM ± 0.36 SD. Based on the 20 RM [32.1 RKm] surveyed in 2017, the Western toad density index of breeding sites and egg masses both averaged 0.05/RM ± 0.22 SD and 0.03/RM ± 0.36 SD. We repeated the 3 RM [4.8 RKm] surveyed in 2016 during 2017, but we found no WT egg masses over that reach that year.

Olympics Area: We found all remaining Western toad breeding during our Chehalis Basin surveys exclusively in large streams draining the Olympics, namely the Satsop and Wynoochee Rivers. For the 7.3 RM [11.7 RKm] surveyed on the Satsop River above its confluence with the Chehalis River in 2015 (**Table 3**), we found one Western toad egg mass at one breeding location. This results in breeding site and egg-mass density indices of 0.14/RM ± 0.38 SD [0.09 RKm ± 0.24 SD] (**Figure 5**). On the Wynoochee River, where we surveyed 6.2 RM [10.0 RKm] and 45.4 RM [73.1 RKm][27] above the Chehalis River confluence in 2016 and 2017, respectively (**Table 3**), we recorded one Western toad egg mass at one breeding site in 2016, and 76 Western toad egg masses at 57 breeding sites in 2017. These numbers result in mean breeding site and egg-mass density indices of 0.28/RM ± 0.68 SD [0.17 RKm ± 0.42 SD] in 2016 (**Figure 5**). In 2017, it yielded a mean breeding site density index of 1.34/RM ± 1.92 SD [0.83 RKm ± 1.20 SD] and mean egg-mass density index of 1.81 RM ± 2.83 SD [1.13 RKm ± SD] (**Figure 5**). The higher Western toad breeding sites and egg mass density indices in 2017 in the Wynoochee reflect concentrations of Western toad oviposition over three river reaches, RM 6-18 [9.6-29.0 RKm], RM 31-41 [49.8-65.8 RKm], and RM 45-49 [72.3-78.6 RKm]. In these reaches, breeding site and egg-mass density indices reached, respectively, the 4-7/RM [6.4-11.2 RKm] and 8-11/RM [RKm] range. We found no Western toad oviposition in 2017 in the 5.4 RM [9.0 RKm] of the Wynoochee that had been surveyed in 2016.

OTHER AQUATIC FAUNA**:** We recorded at least 14 aquatic or semi-aquatic vertebrate species[28] associated with Western toad breeding sites and pools. Five of these species were amphibians; all are native except the American bullfrog (**Table 4**). The remaining 10-11 species were fishes (**Table 4**). Unidentified lamprey were all larvae (ammocoetes), so they might have been either *Entosphenus* or *Lampetra.* Except for Rock bass, all fish species were native.

We collectively recorded a relatively high diversity of aquatic or semi-aquatic species at Western toad breeding sites, but we found few species frequently. Among amphibians, Pacific treefrog was most frequent, whereas Coho salmon (entirely fry) and Speckled dace were the most frequent fishes. We recorded all other species less frequently, many very infrequently. We

[27] Our surveys extended upstream to RM 48.5 [77.9 RKm] from the Chehalis River confluence in 2017, but they excluded an ~5.0 RM [8.0 RKm] gap involving a waterfall and fast water between RM 40.7 [65.4 RKm] and RM 45.7 [73.4 RKm]. We made this exclusion on the basis of a combination of safety and lack of suitable habitat.

[28] We also found five other amphibian species in or near aquatic habitat lacking Western toad breeding. Two were riparian-dwelling or terrestrial amphibians (Dunn's salamander [*Plethodon dunni*] and Western red-backed salamander [*Plethodon vehiculum*]) found infrequently on terrestrial margins of toad breeding pools. We also recorded Coastal tailed frog (*Ascaphus truei*) and Giant salamanders (*Dicamptodon*, either *copei* or *tenebrosus*) only in tributaries to larger river areas with toad breeding. Lastly, we found one salamander (Columbia torrent salamander [*Rhyacotriton kezeri*]) in seeps outside of, but relatively close to, breeding pools.

recorded the two exotic species (American bullfrog and Rock bass) only at Western toad breeding sites in the Chehalis mainstem below its confluence with Elk Creek (RM ~100 [RKm 160.6]).

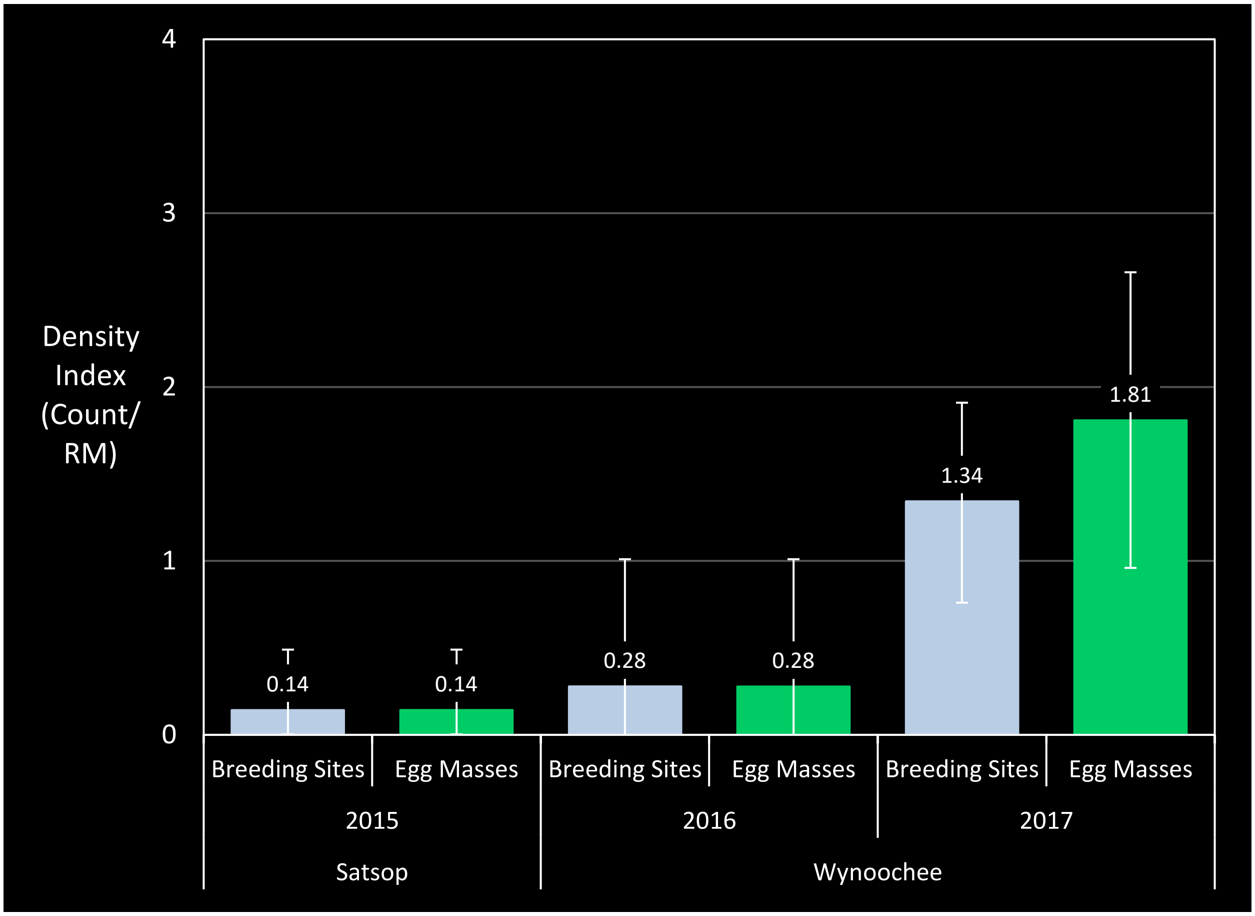


Figure 5. Breeding Site and Egg Mass Density Index Variation in the Olympic Drainages. Values indicate means; whiskers are 95% confidence intervals. Density index values shown are in rivers miles; see text for their river kilometer equivalents.

In upper Chehalis mainstem (above the South Fork Chehalis) and tributary areas in 2016, we recorded Coho salmon fry in 20 of 33(61%) sites where Western toads bred. Of those 20 sites, 15 (75%) were either instream in (a) the margin of the Chehalis mainstem (n = 4 [20%]) or (b) a pool connected to the Chehalis mainstem (n = 11 [55%]); the remaining 5 sites (25%) were disconnected from but within the ordinary high water mark of the Chehalis mainstem. In 2017, we also recorded juvenile salmon[29] at over 41 of 57 (72%) Western toad breeding sites on the Wynoochee; 22 (39%) were either instream in (a) the margin of the Chehalis mainstem (n = 2 [6%]) or (b) a pool

[29] Most of these were probably Coho (eight were positively identified), but water quality conditions prevented easy visual identification and we did not examine the fishes in hand.

connected to the Chehalis mainstem (n = 20 [35%]); the remaining 19 sites (33%) were disconnected (but nearby) from the Chehalis mainstem.

Table 4. Summary of aquatic and semi-aquatic vertebrates associated with Western toad breeding habitats by year. We provide the extent of surveys by year in **Table 3**.

Standard English Name	Scientific Name	Status	Year			
			2014	2015[a]	2016	2017
Amphibians						
1) American bullfrog	*Rana catesbeiana*	Exotic			X	X
2) Northern red-legged frog	*R. aurora*	Native	X		X	X
3) Pacific treefrog	*Hyliola regilla*	Native	X		X	X
4) Roughskin newt	*Taricha granulosa*	Native	X		X	X
Fishes						
1) Coho salmon	*Oncorhynchus kisutch*	Native	X		X	X
2) Cutthroat trout	*O. clarkii*	Native			X	
3) Largescale sucker	*Catostomus macrocheilus*	Native			X	X
4) Northern pikeminnow	*Ptychocheilus oregonensis*	Native			X	
5) Pacific Lamprey	*Entosphenus tridentatus*	Native			X	
6) Redside Shiner	*Richardsonius balteatus*	Native			X	
7) Rock bass	*Ambloplites rupestris*	Exotic			X	
8) Speckled dace	*Rhinichthys osculus*	Native	X		X	X
9) Threespine stickleback	*Gasterosteus aculeatus*	Native			X	X
10) Unidentified lamprey	*Entosphenus* or *Lampetra*	Native	X		X	[b]
11) Unidentified sculpin	*Cottus* spp.	Native	X		X	X

[a]We recorded only one Western toad breeding site in 2015 and we observed no aquatic vertebrates at that site during the survey.
[b]We recorded unidentified lamprey in 2017, but not in association with Western toad breeding sites.

OVIPOSITION HABITAT: Western toad oviposition sites had noticeably little canopy cover. Oviposition sites averaged only 2.5% ± 7.7% SD (n = 36) canopy cover in 2016 and 5.5% ± 6.2% SD (n = 21) in 2017. The small difference in canopy cover between sites measured between years was not significant (t-test, two-tailed: $P = 0.1367$).

Western toad oviposition sites were shallow. Western toad oviposition sites averaged 9.5 cm ± 5.5 SD (n = 35) in water depth in 2016 and 10.1 cm ± 6.6 SD in depth in 2017. We found no significant different in oviposition site depth between years (t-test, two-tailed: $P = 0.7304$; **Figure 6**) despite the fact that all 2016 locations were in the upper Chehalis mainstem and all 2017 locations were in the mainstem Wynoochee River. In 2017, we compared depth at Western toad oviposition sites along the Wynoochee with randomly selected points, which revealed that oviposition sites were significantly shallower than the random points (paired t-test: df = 20, $P = 0.0075$; **Figure 7**).[30]

[30] We had depth data for oviposition points in 2016, but lacked depth data for random points to make the same comparison.

Our comparison of water velocity data with random points yielded similar results. Data from 2016 showed that Western toads utilized oviposition sites with significantly lower water velocities than random points (paired t-test: df = 33, *P* = 0.0065; **Figure 8**). Water velocities at oviposition sites measured in 2016 averaged 0.04 cm/sec ± 0.06 SD. Data from 2017 trend in a similar direction, though the contrast with random points was not significant (paired t-test: df = 20, P = 0.1447; **Figure 8**). Water velocities at oviposition sites measured in 2017 averaged 0.03 cm/sec ± 0.03 SD. Notably, water velocities at oviposition sites in 2016 were near identical to those measured in 2017 (two-sample t-test: df = 53, *P* = 0.1789; **Figure 8**).

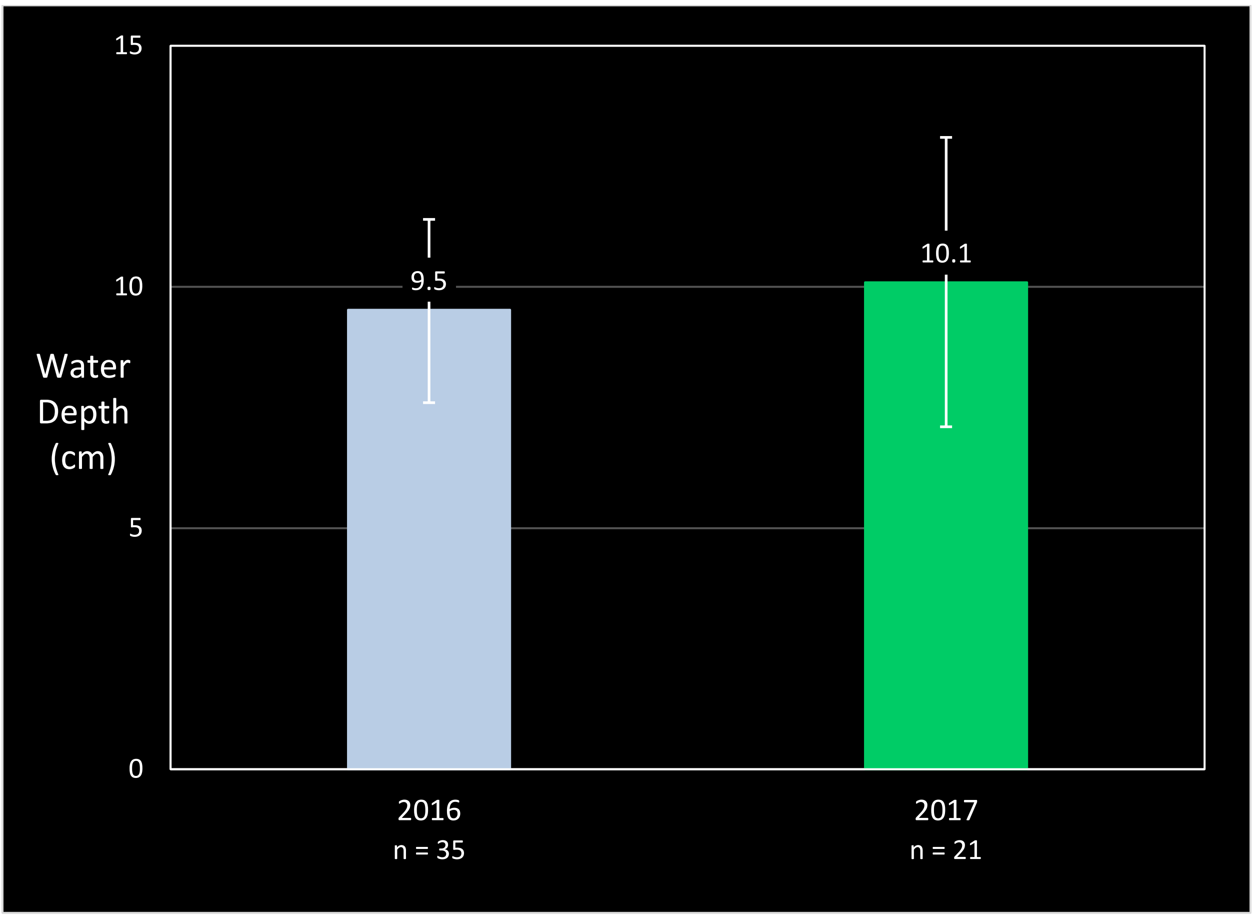


Figure 6. Comparison of water depths at Western toad oviposition sites in 2016 versus 2017. Values indicate means; whiskers are 95% confidence intervals. The 2016 locations are in the upper Chehalis mainstem, whereas the 2017 locations are in the Wynoochee River.

In contrast, substrate data revealed no general differences at Western toad oviposition versus random sites. In particular, for 36 oviposition sites measured in 2016, the absolute value of the mean difference in the substrate index between oviposition and random sites was 2.0 ± 12.8 SD (n = 36; paired t-test: *P* = 0.3542). We found a similar pattern for oviposition and random sites measured in 2017 (absolute value of the mean difference in substrate index 0.5 ± 5.7 SD (n = 21; paired t-test: *P* = 0.7062).

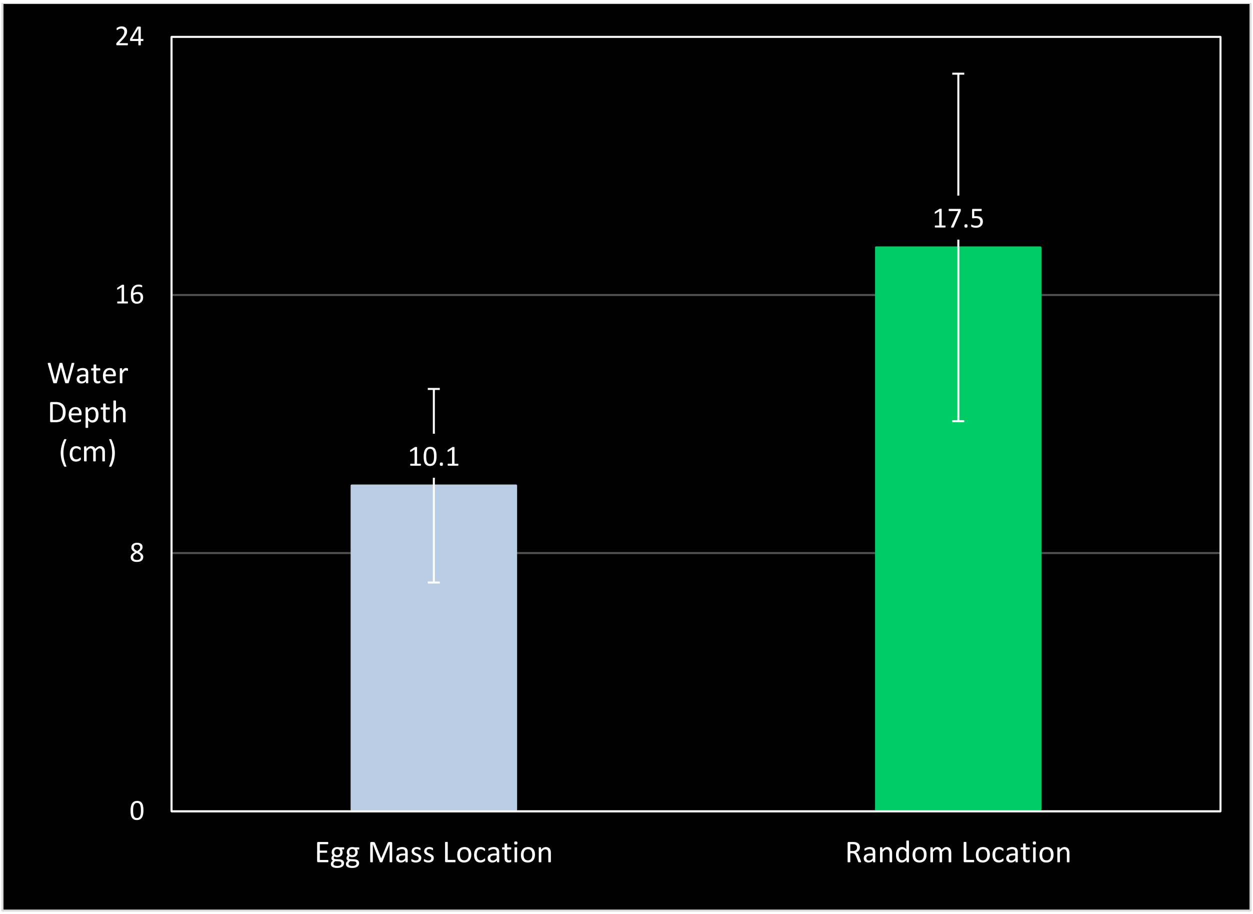


Figure 7. Comparison of water depths at Western toad oviposition sites with paired random locations (n = 21) in 2017. Values indicate means; whiskers are 95% confidence intervals. All locations are oviposition sites within the Wynoochee River.

DISCUSSION and CONCLUSIONS

Based on the instream surveys reported here and studies in off-channel habitats in the mainstem Chehalis floodplain (i.e., egg mass [Hayes et al. 2017a] and extensive surveys [Hayes et al. 2017b]), we have recorded Western toad breeding in the lowland Chehalis Basin (i.e., <1,500 ft [457 m]) almost exclusively in instream-associated habitats.[31] The lack of toad oviposition seen in floodplain off-channel habitats may reflect their often well-shaded margins, modification that has steepened their margins eliminating their shallow footprints, or both. This contrasts with the well-insolated shallow margins of instream-associated habitats where we observed nearly all Western toad breeding. Some well-insolated shallow-margined off-channel habitats do exist further from the main channel in the mainstem floodplain, but these are almost invariably in

[31] Elsewhere in western Washington (Joanne Schuett-Hames (personal communication) and other western states (Carey et al. 2005), Western toad occupy numerous highland lakes and ponds. Although such lentic habitats are rare in the Chehalis Basin, the few that exist have not yet been examined for Western toads.

farmland production (Hamer et al. 2017), and compatibility with Western toad breeding is uncertain.

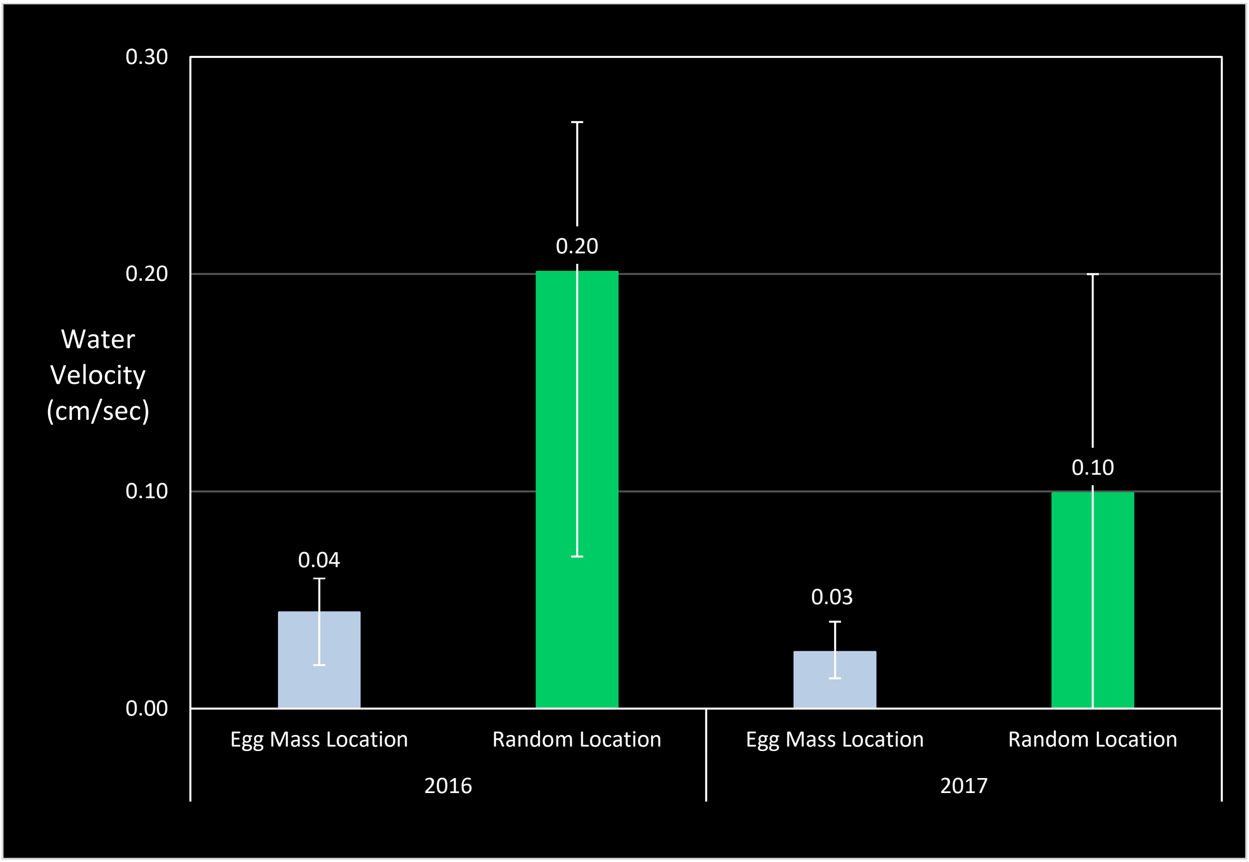


Figure 8. Comparison of water velocity at Western toad oviposition sites with paired random locations in 2016 (n = 35) and 2017 (n = 21). Values indicate means; whiskers are 95% confidence intervals. All 2016 locations are from the upper Chehalis River, whereas all 2017 locations are from the Wynoochee River.

Furthermore, we recorded that Western toads almost exclusively selected instream-associated habitats.[32] Specifically, we have observed their breeding in the upper one-quarter of the Chehalis mainstem length, some larger tributaries above there (mostly in the East and West Forks of the upper Chehalis River), and a few larger tributaries of the middle and lower Chehalis mainstem (the South Fork Chehalis, Satsop, and Wynoochee Rivers). Beyond the areas where we have recorded Western toads, additional data show that Western toads are present in the Humptulips River and higher up on the Satsop River than we have yet surveyed; and in the lower

[32] One historical record exists of Western toads breeding in an isolated, stillwater pond in the Chehalis Basin. This was a human-built, upland pond near Porter Creek, which was later filled in. We also found Western toad breeding at one pond at the Briscoe site along the Wynoochee River that had a direct connection to the river and behaved more like a connected off-channel habitat.

Stillman Creek system in the upper Chehalis. Collectively, these data are the balance of knowledge about Western toads in the Chehalis Basin.

Although some areas have not yet been surveyed for Western toads, the emerging picture is that they are distributed in two general areas: 1) The upper Chehalis River mainstem and its tributaries, and 2) the large tributaries of the Chehalis that drain the Olympics. If remaining survey effort in 2018 and 2019 shows that this pattern holds up, it would raise the question of whether separation of Western toads in these two regions is a recent or long-term condition. Indeed, recent glaciation has influenced the Chehalis Basin (McPhail 1967). It will also raise the equally important question of whether Western toads in these two regions show some degree of genetic differentiation.

At a landscape scale, the common denominator of Western toad breeding habitat appears to be unvegetated stillwater or slow-water conditions that are unshaded (insolated). This is evident near the upper limit of its breeding distribution where shading in narrower streams from overhead canopy closure appears to be the limiting factor. For example, besides such shading from canopy closure, structural habitat conditions in Crim Creek seemed similar to those on the nearby mainstem Chehalis River where Western toads breed. Yet, we never found oviposition on Crim Creek. This pattern is consistent with Western toads occupying open, early-successional habitat for reproduction (Karlstrom 1986, Crisafulli et al. 2005, Pearl and Bowerman 2006), thus rearing in relatively warm waters (Cavallo 1997, Frissell and Cavallo 1997, Carey et al. 2005). In the instream habitat, annual freshets and wide (mainstem) widths maintain habitat openness. Based on the egg mass and extensive studies, Western toad breeding was not found in off-channel habitats on the floodplain where it was expected, perhaps reflecting shading there and/or lack of shallow shelf habitat that this warmwater breeder utilizes. Moreover, instream-associated oviposition sites lacked aquatic cover, although other (notably, land-overwintering) life stages may use near-stream cover that includes rodent burrows, beaver dam crevices, undercut streambanks, and overhanging shrubs (Carey et al. 2005).

Factors limiting the downstream extent of Western toads in the Chehalis mainstem and its tributaries are less clear. However, the area of the Chehalis mainstem where we found no Western toads breeding is where the river changes geomorphically and hydrologically, i.e., near the Twin Cities (Bob Montgomery, personal communication). This is below the Newaukum River confluence and above the bedrock control near the confluence of Skookumchuck River (Phinney et al. 1975), where pools become predominant (AQ et al. 2012). This is concordant with our impression that substrate fines become dominant and water turbidity and depth generally increase below this point and limited presence of shallow shelves. Whether these factors interact to limit Western toad oviposition habitat and thus reproductive success is unclear.

Casual observation of Western toad oviposition sites suggests that locations are not random with respect to depth and water velocity, as our data corroborate. Notably, our finding of depth of ~10 cm is similar to what Carey et al. (2005) found for this species in southern Rockies ponds, where gently sloping shorelines were used for oviposition. Moreover, Joanne Schuett-Hames (personal communication) found Western toad oviposition in shallow-shoreline habitats of Lake Cushman reservoir, but these spots were consistently deeper than what we found (see also Carey et al. 2005). For our own study, oviposition was focused in (a) flow-protected, off-channel habitats that later appeared instream (within the main channel) with hydrograph drops; or (b) if instream, on shallow marginal shelves that generally have lower velocities ($\bar{x}$ = 0.03-0.04 cm/sec) than elsewhere in the main channel (cf. Vadas and Orth 1998). This oviposition pattern likely reflects selection of sites that avoids flow-induced sweeping of the toad's unattached eggs and/or weakly swimming, hatchling larvae into unsuitable habitats (Carey et al. 2005).

Western toad breeding is more extensive in the proposed dam and reservoir footprint than either up or downstream of this footprint. This difference was most marked in the two years where it was compared (2014 and 2016) between the footprint and downstream. This may reflect juxtaposition of high-quality breeding and upland rearing habitat within the proposed footprint of the dam reservoir, and a potential contrast between a managed timber landscape (potentially higher quality uplands for Western toad) and an agricultural landscape (potentially of lesser quality). This possibility and the alternative hypothesis of a potential geomorphic or hydrologic limiting factor (see above) underscore the need for landscape-level habitat modeling, to more rigorously understand what controls habitat utilization patterns of Western toads.

Previous work attempting to predict changes in aquatic-vertebrate habitat across flows using PHABSIM needs discussion in the context of our habitat data for Western toads. The PHABSIM algorithm uses a three-variable suite (depth, flow, and substrate or cover) upon which to base its predictions (Vadas and Weigmann 1993, Beecher et al. 2016); often avoiding instream-associated, off-channel habitats as at the upper Chehalis River site (Caldwell et al. 2004, personal observation). However, much of the Western toad oviposition sites (well over 50%, based on our data) are outside the main channel, occurring in essentially zero-flow, off-channel habitat that becomes isolated at lower flows. Second, our data imply that Western toads show no substrate selection at oviposition sites. Hence, one might use PHABSIM to predict changes in Western toad habitat in the flow stream, but it would essentially reflect a two-variable (depth/flow) exercise with a little variation from substrate/cover conditions. Nevertheless, the third habitat variable could instead reflect the relative suitability of main- and off-channel habitats, similar to what has been attempted for young coho salmon (Reeves et al. 1989). Another important habitat variable for instream-flow and riparian analyses is water temperature (Vadas and Weigmann 1993, Hendrick and Monahan 2003, Beecher et al. 2016), which is relevant to Western toads.

A significant species assemblage also uses the habitats in which Western toads breed. Among the more important are (a) Coho salmon fry and (of lesser abundance) lamprey ammocoetes (larvae) that overlap in their rearing habitat; and Pacific treefrogs that partially overlap in breeding habitat. However, at least eight other native fish species and some other amphibians may at least occasionally use Western toad breeding and rearing habitat associated with the stream network.[33] We incidentally sampled several of these amphibian species during our own surveys (see the appendices).

EVALUATION OF ALTERNATIVES LINKED TO FLOOD REDUCTION: The almost exclusive breeding of Western toad in instream habitats in the Chehalis Basin coupled with the most concentrated instream breeding occurring in the proposed footprint of alternative dam and reservoir options is a concern because the preferred flood-control alternative is some form of dam (CBS – ASEP 2014, WDRC 2014). This represents a concern because an extensive literature exists describing a broad range negative effects and few positive effects on biota that has led to broadening efforts at dam breaching in the Pacific Northwest and elsewhere (Stanford et al. 1996, Loomis 1998, Lovett 2014, Quiñones et al. 2015, O'Connor et al. 2015, Warrick et al. 2015). For this reason, we use the aforementioned patterns of Western toad distribution and life history in the Chehalis Basin help inform the alternatives proposed for flood reduction in the PEIS (cf. CBS – ASEP 2014, WDRC 2014; Allegro 2016) and added hybrid dam alternative proposed in the most recent Chehalis Basin Strategy (CBS 2017). We briefly comment on the anticipated Western toad response to each alternative.

No Action: We might expect the no-action alternative to maintain the status quo, that is, the current distribution and population structure of Western toads in the Chehalis Basin. However, two caveats alter this view, i.e., effects resulting from climate change and lack of understanding of dynamics linked to the historic timeline. Each deserves brief comment. Three predictions of climate change in western Washington might affect Western toads. These are increases in: 1) rainfall, 2) seasonal precipitation variability, and 3) frequency of extreme events resulting from rainfall (Mote and Salathé 2009). In concert, these predictions can increase flow variability and/or exacerbate extreme flow levels (Milly et al. 2008, Salathé et al. 2014). Over the long-term, this might cause a decline in survival of the pre-metamorphic (embryonic and tadpole) life stages of Western toads, given unfavorable flow regimes during oviposition and rearing. We would expect the magnitude of this pattern to increase progressively over time unless human efforts ultimately change the climate change trajectory dramatically. However, increased thermal variability and exacerbated temperature extremes in streams from climate change (Milly et al. 2008), might partially counteract such population declines because Western toads are warm-adapted (Carey et al. 2005).

Lack of understanding of dynamics linked to the historic timeline relates to the fact that the large-magnitude, wet-season freshets of 2007-2009 (WDRC 2014) moved large amounts of

[33] In contrast, more floodplain-oriented fish like Olympic mudminnows (*Novumbra hubbsi*) are more often associated with Threespine stickleback, juvenile Coho salmon, and Reticulate sculpin (*Cottus perplexus*) in the Chehalis River basin and elsewhere in western Washington (Beecher and Fernau 1983; Mongillo and Hallock 1995, 1999), i.e., farther downstream where other (non-toad) amphibians (including native ranids and American bullfrogs) are found with these fishes (Henning 2004; Henning and Schirato 2006).

wood and rock (Nelson and Dubé 2016) that scoured many areas of the upper Chehalis River mainstem to bedrock (Robert Bilby, Andrew Kroll, personal communication). This condition may have increased available habitat for Western toad oviposition, resulting in the high breeding site and egg-mass density indices one currently observes in that area. If this were the case, we would expect available oviposition and rearing habitat to decline somewhat over time as riparian vegetation develops and succession proceeds. This pattern would continue until the next large magnitude freshet, which should result in another scouring event that resets succession. Though this would likely be a fluctuating pattern over time, we expect the magnitude of that fluctuation to increase under an unaltered climate change trajectory. This might slowly degrade Western toad populations over time if riparian disturbances become excessively frequent or intense.

Restorative Flood Protection (RFP) Alternative: This alternative, which focuses on floodplain restoration, should increase available oviposition and rearing habitat many-fold initially, due to the broad-based creation of habitat. However, this alternative might settle into a longer-term, dynamic equilibrium between the creation and loss of oviposition and rearing habitat. What is uncertain is how climate change might alter the path of this dynamic equilibrium.

This alternative involve riparian tree plantings, so one should consider the planning of those plantings for Western toad oviposition habitat. Riparian tree plantings are frequently part of solutions to shade aquatic habitat for salmon life stages, so a balance between riparian plantings to shade habitat for salmon life stages and open unshaded areas for toad oviposition and rearing habitat must be considered.

Flood Retention Only (FRO) Dam: Instream habitat would be eliminated when dam closure pools a freshet. If that occurs during the Western toad-breeding season, larval recruitment might be eliminated. If dam closure occurs outside of the breeding period, its effects depend on other habitat changes that affect Western toad breeding and rearing. Those patterns are uncertain in part because the suitability of instream habitat in the temporary reservoir pool is uncertain, because (a) of the unpredictability of substrate deposition patterns (but see below) and (b) details of riparian management in the footprint where woody vegetation has been removed have not been developed. Nevertheless, increased fines sedimentation is likely throughout the footprint (Allegro 2016; Dubé 2016). In addition, the temporary reservoir pool of the FRO could be attractive for breeding if it creates a shallow, insolated habitat structure long enough to attract Western toads, particularly at its upstream end where we expect fines deposition to be important (cf. Dubé 2016). That possibility is good because Western toads are particularly successful exploiters of new, early-successional habitats (see above). However, the FRO pool management plan involves draining the reservoir pool within a few weeks (at the most) of the filling period, so it is likely that the entire oviposition or early rearing complement would be at risk of stranding.

Superimposing climate change effects on the anticipated responses of Western toads to the FRO adds further uncertainty, but positive responses seem unlikely, except perhaps for a temporary, warmer tailwater (cf. Carey et al. 2005). Because warmer, more pool-oriented conditions farther downstream in the Chehalis River (Phinney et al. 1975, AQ et al. 2012) may not be conducive to Western toads (see above), a warmer FRO reservoir with riparian deforestation (Ferguson et al. 2017) might actually affect toads via anticipated habitat changes in this footprint. Because Western toad populations exist in the Chehalis mainstem and its tributaries upstream of that footprint, this reservoir could isolate upstream populations from those further downstream, perhaps reducing the latter's population viability (including emigration [cf. Carey et al. 2005]) to further restrict the toad's mainstem distribution.

Flow Reduction Flow Augmentation (FRFA) Dam: Instream breeding habitat in the proposed dam/reservoir footprint would likely be eliminated, as a large, deep, stillwater pool would replace instream habitat. Some possibility exists that the FRFA could add stillwater breeding habitat, as Western toads are known to breed in permanent reservoirs (Nussbaum et al. 1983, Wente et al. 2005; Joanne Schuett-Hames, personal communication). However, this addition or its extent is uncertain because the magnitude and timing of water level fluctuations resulting from the combination of dam operations and reservoir filling/emptying patterns.[34] If substantial water fluctuations (>6 inches [15 cm]) occur immediately post-breeding, Western toad eggs and embryos could (a) die from stranding with a water level drop, or (b) show impaired development or greater mortality from excessive water depth, where water temperature may be colder.

The FRFA alternative would also reduce or eliminate suitable breeding habitat for Western toads for some unspecified distance downstream if cooler water outflow below the dam is maintained by water withdrawals from the hypolimnion (CBS – ASEP 2014). Cooler water delivered prior to breeding could delay (Carey et al. 2005) or deter breeding altogether, and cooler water during breeding could impair Western toad development, thus increasing mortality. The magnitude of this effect, especially downstream, is dependent on how cool the released water may be, its volume, and its timing. Similarly, the FRFA alternative would reduce or eliminate suitable habitat for Western toad for some unspecified distance downstream if discharge from the dam is maintained at a level somewhat higher than what is seasonally typical. Western toads normally lay unattached eggs in strings (Nussbaum et al 1983) and do not tolerate flow except at lower levels.[35] Hence, unless reproduction shifted mostly to floodplain wetlands, even a relatively small increase in flow level may prevent breeding or move

[34] Notably, the Western toad population farther north in Lake Cushman reservoir is subjected to daily fluctuations under 1 m during non-winter seasons (Joanne Schuett-Hames and Peggy Miller, personal communication). However, western toad embryonic survival and early larval rearing under those conditions has not been evaluated.

[35] Precise threshold flows and water velocities that deter Western toads oviposition is unknown, but are thought to be somewhat higher than water velocities measured at main channel oviposition sites in this study, and somewhat lower than random points at which no Western toad oviposition was found (see **Figures 7** and **8**).

eggs or embryos into shaded habitats that are unsuitable for development. Because dam releases for temperature reduction would invariably involve an increase in flow, the effects of flow and temperature are confounded. Lastly, even if Western toads could undergo such a behavioral shift to floodplain wetlands, floodplain wetlands are extremely limited in the upstream mainstem floodplain, so lack of proximate suitable Western toad breeding habitat may prevent colonization success with such a shift.

Similar to the FRO, superimposing climate change effects on the anticipated responses of Western toads to the FRFA adds further uncertainty, but positive responses seem unlikely. Also similar to the FRO, presence of the FRFA footprint would result in some degree of isolation of the upstream populations from those further downstream. The FRFA has a permanent reservoir, so population isolation may be more likely than with the FRO alternative.

If one considers alternatives in the context of an unaltered climate-change trajectory, all alternatives except the RFP are likely to have negative effects on Western toad. Indeed, we expect that the no-action option would ultimately exhibit negative effects given climate change. Regardless, the dam alternatives are more likely to have negative effects, particularly for the FRFA, but uncertainty exists even for that assessment. Either dam alternative could contribute to the loss of a significant proportion of Western toad populations in the lowland Chehalis Basin, as no significant breeding of Western toad occurs downstream of the upper river and larger tributaries that are often in the proposed dam and reservoir footprint.

Hybrid Dam Alternative (FRX): The FRX alternative proposed in the most recent Chehalis Basin Strategy (CBS 2017) allows a shift from an FRO dam to an FRFA over time. In other words, the initial dam built would be an FRO expect that the dam would have a larger footprint to ultimate accommodate a switch to the FRFA structure. Since this alternative simply represents a temporal shift between the two, we anticipate that Western toad response would reflect a sequential pattern as has already been described for FRO and then for FRFA (see above summaries for details).

The effects of urban development merit comment because the urbanized area of the Chehalis Basin is still limited and below that identified elsewhere as showing potentially negative effects on amphibians (cf. May 2009). In particular, development of the Chehalis floodplain involves only about 3.6% of its area (Pierce et al. 2017). Urban stream studies show negative impacts beginning at 10-15% urbanization, though amphibian-specific effects may become evident at ~8% development (Riley et al. 2005). We simply point out that if these percentages reflect general threshold effects across different landscapes, opportunities are still likely to minimize negative effects on amphibians (like Western toad) in the Chehalis Basin via careful design in the ASRP.

We will focus effort in the future field seasons on reducing uncertainty about the effects of these PEIS alternatives for Western toad. We will be do this by:

1) Identifying the precise upper limits of instream breeding for Western toads in Chehalis River tributaries where they have been found (primarily in Olympic tributaries);
2) Sampling remaining gaps in the downstream mainstem Chehalis, to verify the lack of Western toad breeding in these reaches. This might require sampling earlier in the spring than for upstream sites, as Western toad oviposition occurs relatively early at lower elevations elsewhere in the western USA (Carey et al. 2005). Nevertheless, because adults (especially males) often show site fidelity, their presence may indicate nearby oviposition sites (Carey et al. 2005; Appendix III);
3) Sample larger tributaries downstream of the reservoir that are have not been sampled to date;
4) Modeling habitat factors that most affect breeding and rearing habitat quality evaluated through variation in instream breeding densities; and
5) Reducing uncertainty about the effects of FRFA and FRO dam alternatives on Western toads. This can be done by refining understanding of dam operations (especially water release patterns and reservoir stage variation under different scenarios) and reservoir sedimentation patterns for both alternatives, detailing what constitutes riparian management (especially for the FRO alternative), and developing a better understanding of complicating factors like landslide induction (for both alternatives [Ferguson et al. 2017]). These uncertainty-reducing efforts may not represent immediate next steps, but they should be addressed with the advance to the project-specific flood control alternative chosen.

To date, habitat restoration for instream breeding Western toads has yet to be attempted; and available data make it unclear what restoration options are actually possible. Specifically, if we find upland habitat along the large-riverine Chehalis mainstem to be limiting because of lesser suitability, restoration improving its suitability to Western toads may be possible. On the other hand, if hydrological or geomorphic factors limit Western toads in the middle/lower mainstem, that restoration approach may not be available. What hydrologic, geomorphic, and/or biotic factors (e.g., predation and fungal disease [Carey et al. 2005; Reaser and Blaustein 2005]) may be limiting need elucidation to determine what alternative restoration options may be possible. Further, whether mitigation for Western toads within the reservoir is even possible under the FRFA or FRO alternatives is uncertain. Next steps presented above would inform the viability of any restoration or mitigation options. If that conclusion is affirmative, it would reveal which habitat features could be manipulated to restore Western toads and their associated fauna. If floodplain backwaters are too shaded (cold) for Western toad breeding (op. cit., Cavallo 1997, Frissell and Cavallo 1997), then partial timber harvest there could potentially enhance toad populations.

Lastly, if the Olympic and upper Chehalis River mainstem units of Western toads are revealed to be geographically disjunct, genetic analysis needs to address potential differences that may need protection and consideration under the ASRP.

Acknowledgements – The State of Washington Chehalis Initiative provided funding for this work. Weyerhaeuser and Panesko Tree Farms provided site access. Sarah Ashworth, Bonnie Blessing, Keith Brady, Angela Brear, Sarah Coven, Kaysie Cox, Sebastian Ford, Caitlin Harris, Chris Holcomb, Lameace Kalisz, Jacob Layman, Noel LeRoy, Stephanie Lewis, Caitlin McIntyre, Tara Newman, Sandy Patnode-Parrish, Kelly Perry, Kara Randall, Hope Rieden, Claire Satterwhite, David Snyder, Noll Steinweg, Larissa Swanson, Nick Wegener, Kerri Wheeler, and Kevin Young helped collect these data.

LITERATURE CITED

Allegro, J., ed. 2016. *WDFW Chehalis Basin Strategy Draft PEIS comments*. Washington Department of Fish and Wildlife, Habitat Program. Olympia, WA. 56 pp.

AQ (Anchor QEA), Watershed GeoDynamics, and Normandeau Associates, Inc. 2012. *Chehalis River flood storage dam: Fish Population Impact Study (final report)*. Prepared for the Lewis County Board of County Commissioners, Chehalis River Basin Flood Authority. Chehalis, WA. 88 pp. + app.

Beecher, H., B. Caldwell, and J. Pacheco, eds. 2016. *Instream flow study guidelines: technical and habitat-suitability issues (open-file report)*. Washington Department of Fish and Wildlife and Washington Department of Ecology 04(11-07):84 pp.

Beecher, H.A., and R.F. Fernau. 1983. Fishes of oxbow lakes of Washington. *Northwest Science* 57(2):125-131.

Caldwell, B., J. Pacheco, H. Beecher, T. Hegy, and R. Vadas. 2004. *Chehalis River Basin, WRIAs 22 and 23: Fish habitat analysis using the Instream Flow Incremental Methodology*. Washington Department of Ecology and Washington Department of Fish and Wildlife, Open File Technical Report 04(11-006): 99 pp.

Carey, C., P.S. Corn, M.S. Jones, L.J. Livo, E. Muths, and C.W. Loeffler. 2005. Factors limiting the recovery of boreal toads (*Bufo b. boreas*). Pages 222-236 *in* M. Lannoo (editor). *Amphibian declines: the conservation status of United States species*. University of California Press. Oakland, CA.

Carpenter, C.C. 1953. A ecological survey of the herpetofauna of the Grand Teton – Jackson Hole Area of Wyoming. *Copeia* 1953(3):170-174.

Cavallo, B.J. 1997. *Floodplain habitat heterogeneity and the distribution, abundance, and behavior of fishes and amphibians in the Middle Fork Flathead River basin, Montana*.

Master of Science Thesis, Department of Biological Sciences, University of Montana. 133 pp. [Spring]

CBS - ASEP (Chehalis Basin Strategy - Aquatic Species Enhancement Plan). 2014. *Chehalis Basin Strategy: Reducing Flood Damage and Enhancing Aquatic Species: Effects of Flood Reduction Alternatives and Climate Change on Aquatic Species*. Report prepared for the Chehalis Work Group. ES 1-19 + 126 pp + [29 August]

Chamberlin, T., and D. Humphries (editors). 1977. *Aquatic system inventory and analysis*. British Columbia Ministry of Environment, Resource Analysis Branch. Victoria, BC, Canada. 39 pp. + app.

Crisafulli, C.M., L.S. Trippe, C.P. Hawkins, and J.A. MacMahon. 2005. Amphibian responses to the 1980 eruption of Mount St. Helens, Pp. 183-197. *In*: Dale, V.H., F.J. Swanson, and C.M. Crisafulli (editors), *Ecological Responses to the 1980 Eruption of Mount St. Helens*, Springer, New York, New York, USA.

Conner, J.E., J.J. Duda, and G.E. Grant. 2015. 1000 dams down and counting. Science 348(6234):496-497.

Davis, T.M. 2002. *Research priorities for the management of the Western Toad, Bufo boreas, in British Columbia*. Wildlife Working Report No. WR-106:1-23.

Dubé, K.V. 2016. *Effects of FRO facility reservoir on geomorphology and aquatic species habitat in reservoir area (draft memorandum, July 13)*. Prepared by Anchor QEA and ICF International. Seattle and Olympia, WA. 13 pp.

Ferguson, J., N. Kendall, and R. Vadas, Jr. 2017. *Literature review of the potential changes in aquatic and terrestrial systems associated with a seasonal flood retention only reservoir in the upper Chehalis Basin (March 8 memorandum)*. Prepared by Anchor QEA and Washington Department of Fish and Wildlife. Olympia, WA. 37 pp.

Frissell, C.A., and B.J. Cavallo. 1997. Aquatic habitats used by larval western toads, (*Bufo boreas*), on an intermontane river floodplain and some landscape conservation implications. *Supplement to Bulletin of Ecological Society of America* 78(4):91. [Abstract]

Hamer, M., A. Annanie, J. Evenson, I. Keren, and M. Hayes. 2017. *Waterfowl and waterbird abundance and utilization of aquatic off-channel habitats in the Chehalis floodplain*. Washington Department of Fish and Wildlife, Wildlife and Habitat Programs. Olympia, WA. 46 pp.

Hendrick, R., and J. Monahan. 2003. *An assessment of water temperatures of the Entiat River, Washington using the Stream Network Temperature Model (SNTEMP)*. Washington Department of Ecology and the Entiat WRIA Planning Unit. Yakima and Entiat, WA. 85 pp.

Henning, J. 2004. An evaluation of fish and amphibian use of restored and natural floodplain wetlands. Washington Department of Fish and Wildlife. Olympia, WA. 81 pp.

Henning, J.A., and G. Schirato. 2006. Amphibian use of Chehalis River floodplain wetlands. Northwestern Naturalist 87(3): 209-214.

Karlstrom, E.L. 1986. Amphibian recovery in the North Fork Toutle River debris avalanche area of Mount St. Helens, Pp. 334–344. In: Keller, S.A.C. (editor), Mount St. Helens: Five years later. Eastern Washington University Press, Cheney.

Loomis, J.B. 1998. Estimating the public's values for instream flow: economic techniques and dollar values. *Journal of the American Water Resources Association* 34(5):1007-1014.

Lovett, R.A. 2014. Dam removals: Rivers on the run. *Nature* 511(7511):521–523

Maxell, B.A. 2000. *Management of Montana's amphibians: A review of factors that may present a risk to population viability and accounts on the identification, distribution, taxonomy, habitat use, natural history and the status conservation of individuals species*. Report to USFS Region 1, Order Number 43-0343-0-0224. University of Montana, Wildlife Biology Program. Missoula, Montana. 161 pp.

May, C. 2009. *Watershed processes and aquatic resources: a literature review*. Prepared for the Washington Department of Fish and Wildlife. Seattle, Washington. 70 pp.

McCafferty, W.P., and A. Provonsha. 1981. *Aquatic entomology: the fishermen's and ecologists' illustrated guide to insects and their relatives*. 1st edition, Jones & Bartlett, Boston, Massachusetts. 448 pp.

McGee, M., and D. Keinath. 2004. *Species assessment for boreal toad* (*Bufo boreas boreas*) *in Wyoming*. Report prepared for United States Department of the Interior, Bureau of Land Management, Wyoming State Office, Cheyenne, Wyoming. 86 pp.

McPhail, J.D. 1967. Distribution of freshwater fishes in western Washington. *Northwest Science* 41(1):1-11.

Metter, D.E. 1961. Water levels as an environmental factor in the breeding season of *Bufo boreas boreas* (Baird and Girard). *Copeia* 1961(4):488.

Milly, P.C.D., J. Betancourt, M. Falkenmark, R.M. Hirsch, Z.W. Kundzewicz, D.P. Lettenmaier, and R.J. Stouffer. 2008. Stationarity is dead: whither water management? *Science* 319:573-574.

Mongillo, P.E., and M. Hallock. 1995. *Resident nongame fish investigations: 1993-1994 report*. Washington Department of Fish and Wildlife, Fish Management Program, Inland Fish Division Annual Report 95(04): 36 pp.

Mongillo, P.E., and M. Hallock. 1999. *Washington state status report for the Olympic mudminnow*. Washington Department of Fish and Wildlife, Fish Program, Freshwater Division. Olympia, WA. 36 pp.

Mote, P.W., and E.P. Salathé. 2009. Future climate in the Pacific Northwest. Chapter 1 in The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, Climate Impacts Group, University of Washington, Seattle, Washington.

Nelson, A., and K. Dubé. 2015. Channel response to an extreme flood and sediment pulse in a mixed bedrock and gravel-bed river. *Earth Surface Processes and Landforms* 41(2):178-195.

Nussbaum, R.A., E.D. Brodie, Jr., and R.M. Storm. 1983. *Amphibians and reptiles of the Pacific Northwest*. University Press of Idaho, Moscow, Idaho, USA. 353 pp.

O'Connor, J.E., J.J. Duda, and G.E. Grant. 2015. 1000 dams down and counting: dam removals are reconnecting rivers in the United States. *Science* 348(6234):496-497.

Pearl, C.A., and J. Bowerman. 2006. Observations of rapid colonization of constructed ponds by western toads (*Bufo boreas*) in Oregon, USA. *Western North American Naturalist* 66(3):397-401.

Pierce, K., Jr., M.P. Hayes, J.A. Miller, K.R. Sampson, A.C. Agun, and J.A. Tyson. 2017. *Changes in the Chehalis floodplain – 1938-2013*. Washington Department of Fish and Wildlife, Habitat Program, Final Report for Work Group Distributions. 124 pp.

Phinney, L.A., P. Bucknell, and R.W. Williams. 1975. *A catalog of Washington streams and salmon utilization. Volume 2: coastal region*. Washington Department of Fisheries. Olympia, WA. Variable p.

Quiñones, R.M., T.E. Grantham, B.N. Harvey, J.D. Kiernan, M. Klasson, A.P. Wintzer, and P.B. Moyle. 2015. Dam removal and anadromous salmonid (*Oncorhynchus* spp.) conservation in California. *Reviews in Fish Biology and Fisheries* 25(1):195–215.

Reaser, J.K., and A. Blaustein. 2005. Repercussions of global change. Pages 60-63 *in* M. Lannoo (editor). Amphibian declines: the conservation status of United States species. University of California Press. Oakland, CA.

Reeves, G.H., F.H. Everest, and T.E. Nickelson. 1989. Identification of physical habitats limiting the production of coho salmon in western Oregon and Washington. U.S. Forest Service, Pacific Northwest Research Station, General Technical Report PNW-245: 18 pp.

Riley, S.P.D., G.T. Busteed, L.B. Kats, T.L. Vandergon, L.F.S. Lee, R.G. Dagit, J.L. Kerby, R.N. Fisher, and R.M. Sauvajot. 2005. Effects of urbanization on the distribution and abundance of amphibians and invasive species in southern California streams. *Conservation Biology* 19(6):1894-1907.

Salathé, E.P., A.F. Hamlet, C.F. Mass, S.-Y. Lee, M. Stumbaugh, and R. Steed. 2014. Estimates of twenty-first-century flood risk in the Pacific Northwest based on regional climate model simulations. *Journal of Hydrometerology* 15:1881-1889.

Stanford, J.A., J.V. Ward, W.J. Liss, C.A. Frissell, R.N. Williams, J.A. Lichatowich, and C.C. Coutant. 1996. A general protocol for restoration of regulated rivers. *Regulated Rivers: Research and Management* 12:391-413.

Vadas, R.L. Jr. 1992. Seasonal habitat use, species associations, and community structure of forage fishes in Goose Creek, northern Virginia. II. Mesohabitat patterns. *Journal of Freshwater Ecology* 7(2):149-164.

Vadas, R.L. Jr., and D.J. Orth. 1998. Use of physical variables to discriminate visually determined mesohabitat types in North American streams. *Rivers* 6(3):143-159.

Vadas, R.L. Jr., and D.L. Weigmann. 1993. The concept of instream flow and its relevance to drought management in the James River basin. *Virginia Water Resources Research Center Bulletin* 178:1-78.

Warrick, J.A., J.A. Bountry, A.E. East, C.S. Magirl, T.J. Randle, G. Gelfenbaum, A.C. Ritchie, G.R. Pess, V. Leung, and J.J. Duda. 2015. Large-scale dam removal on the Elwha River, Washington, USA: source-to-sink sediment budget and synthesis. *Geomorphology* 246:729–750.

Wente, W., M.J. Adams, and C.A. Pearl. 2005. Evidence of decline for *Bufo boreas* and *Rana luteiventris* in and around the northern Great Basin. *Alytes* 22(3/4):95-108.

WDRC (William D. Ruckelshaus Center). 2014. *Chehalis Basin strategy: Governor's 2014 recommendation report*. Prepared for the Chehalis Basin Work Group. Pullman and Seattle, WA. 28 pp.

Appendices

These appendices provide year-specific information on the instream surveys.

Appendix I

In 2014, we conducted all surveys in the Chehalis mainstem headwaters above RM 94 (RKm 151.0). We recorded 162 locations with Western toad breeding (egg masses, mixed aggregated hatchling tadpoles and egg masses, or aggregated hatchling tadpoles) or evidence of recent breeding (aggregated toadlets) (**Appendix Figure 1** and **Appendix Table 1**). Forty-four of these locations had only egg masses, 98 had a mixture of aggregated hatchling tadpoles and egg masses, 9 had exclusively aggregated hatchling tadpoles, and 11 had exclusively aggregated toadlets. We recorded 4, 130, and 28 of these locations, respectively, which were below, within, and above the footprint.

At these 162 locations collectively, we estimated a minimum of 261 egg masses; we judged 44 of these egg masses to be recently deposited (within 48 hr). We also estimated another 197 egg masses from aggregated tadpole groups, 9 from mixed egg masses and aggregated tadpole groups, and 11 from aggregated toadlet groups (**Appendix Table 1**). We recorded a minimum of 9, 223, and 28 of these early life stage groups, respectively, below, within, or above the footprint. We observed aggregated toadlet groups only in later July: we estimated that the 11 aggregated toadlet groups collectively represented 9,440 toadlets. Ten of these groups, which we collectively estimated at 9,365 toadlets, were upstream of the footprint; the remaining toadlet group, consisting of 75 individuals, was within the footprint.

During the 2014 instream surveys, we also recorded numerous Pacific treefrogs in early life stages (egg packets)[36] at 33 sites, 14 of which were sites where Western toad breeding had been recorded (**Appendix Figure 2**). One of those sites was below the proposed reservoir footprint, 29 were within the footprint, and three were above the footprint. We also observed 256 post-metamorphic Pacific treefrogs (juveniles and adults) at seven sites. Most post-metamorphic Pacific treefrog observations (n = 250 or 97.7%) came from one site upstream of the proposed reservoir footprint. We made the remaining six observations across six sites within the proposed reservoir footprint. Hence, the footprint serves as important habitat for at least two ranid species.

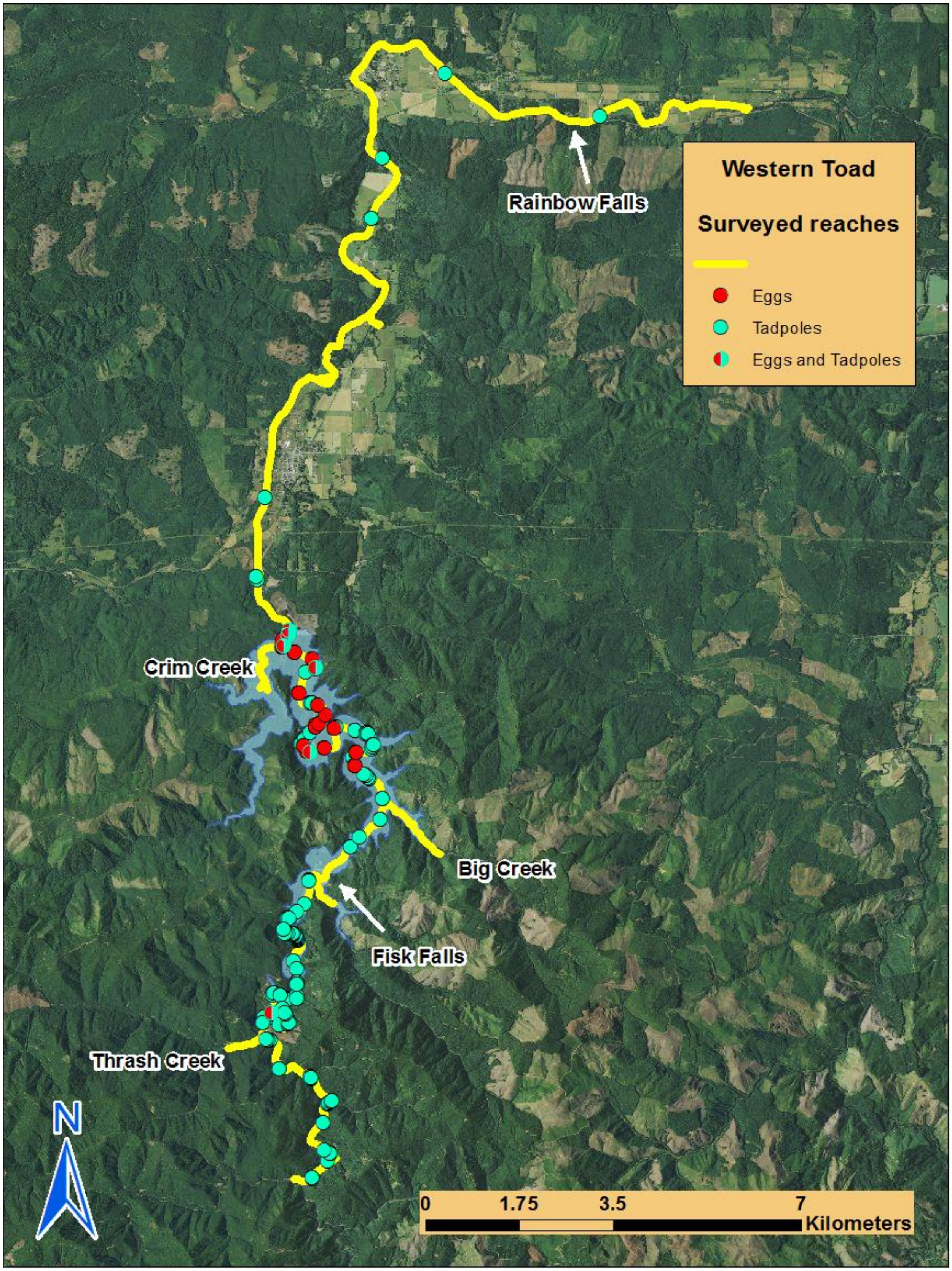
Besides Western toads and Pacific treefrogs, we incidentally recorded six more amphibian species during instream surveys (**Appendix Table 2**). We recorded them all at five or fewer sites. The incidental species for which we have the most observations was the Columbia torrent salamander. We found 28 such salamanders at three geographically separated sites, two of which were within the footprint of the proposed dam. One of the footprint sites, which had two

[36] Pacific treefrogs, unlike Western toads, deposit eggs into separate packets (rather than a single mass] and/or their tadpoles are aggregated in small groups (rather than in large groups numbering in the thousands).

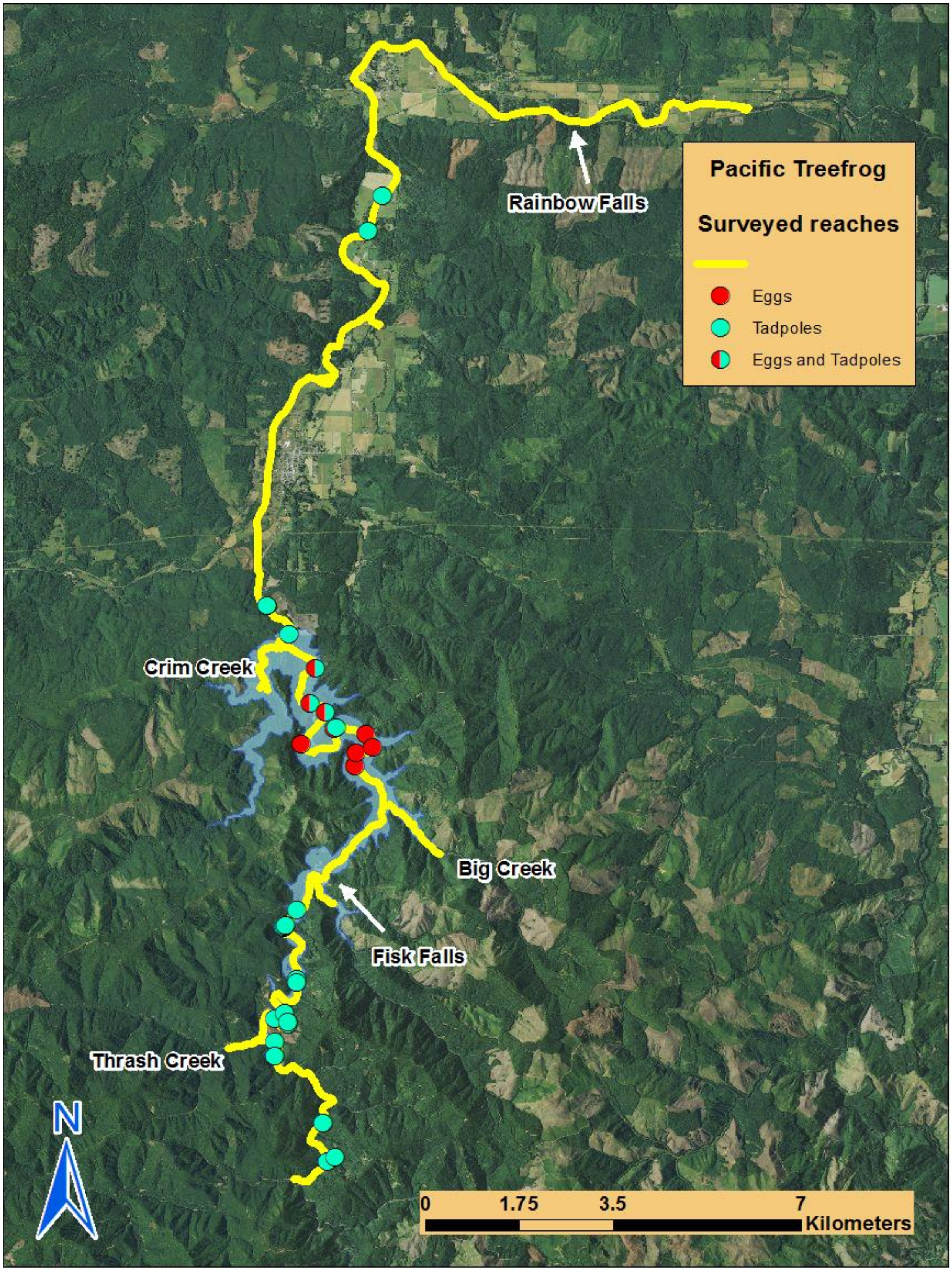
small seeps within a meter of each other along Crim Creek, had 26 of 27 individuals. We found the remaining individual at one location upstream from the proposed reservoir footprint. We also observed Roughskin newt, Northern red-legged frog, Dunn's salamander, Western red-backed salamander, and Coastal tailed frog.

We also regularly observed at least five fish species in side pools during 2014 surveys. Most common were juvenile speckled dace and Coho salmon fry, which we observed in several of the same side pools in which Western toads had bred. We also occasionally observed unidentified species of fishes, including larval lamprey (ammocoetes) and individual sculpins.

Appendix Figure 1. 2014 Instream survey reaches and breeding locations of Western Toads.



Appendix Figure 2. 2014 Instream survey reaches and breeding locations of Pacific Treefrogs.



Appendix Table 2. Incidental amphibian species observed during 2014 instream surveys. Subtotals or totals for sites may be less than summed site sums for species across habitat categories, as one or more species may have occurred at the same site.

Species		**Numbers of *Sites* and *Individuals (Ind)* observed**							
Standard English Name	Scientific Name	Below footprint		In footprint		Above footprint		**Totals**	
		Sites	*Ind*	*Sites*	*Ind*	*Sites*	*Ind*	*Sites*	*Ind*
Terrestrial Amphibians									
Dunn's salamander	*Plethodon dunni*	0	0	0	0	1	2	**1**	**2**
Western red-backed salamander	*Plethodon vehiculum*	0	0	2	2	0	0	**2**	**2**
Subtotals		**0**	**0**	**2**	**2**	**1**	**2**	**3**	**4**
Stillwater-breeding Amphibians									
Northern red-legged frog	*Rana aurora*	2	4	3	3	0	0	**5**	**7**
Roughskin newt	*Taricha granulosa*	1	4	3	6	0	0	**4**	**10**
Subtotals		**3**	**8**	**6**	**9**	**0**	**0**	**9**	**17**
Stream-breeding Amphibians									
Coastal tailed frog	*Ascaphus truei*	0	0	1	1	0	0	**1**	**1**
Columbia torrent salamander	*Rhyacotriton kezeri*	0	0	2	27	1	1	**4**	**28**
Subtotals		**0**	**0**	**3**	**28**	**1**	**1**	**5**	**29**
Overall Totals		**3**	**8**	**11**	**39**	**2**	**4**	**16**	**50**

Appendix II

In 2015, we observed only one site with Western toad breeding over the 34.2 RM (54.9 RKm) reach surveyed (**Figure 3**). We recorded only one egg mass at this site, which was located along the east bank of the Satsop River 0.4 RM [0.6 RKm] downstream of the Highway 12 bridge. We recorded no Western toad breeding activity on the Newaukum and Skookumchuck Rivers and the 15.6 RM (25 RKm) of the upper Chehalis mainstem surveyed. A portion of the Chehalis River mainstem segment from the South Fork Chehalis River to Elk Creek, surveyed on July 1, also did not reveal any evidence of Western toad breeding activity. However, reaches both downstream and upstream of that mainstem segment had some Western toad breeding activity in 2014 and 2016 (**Figure 3**).

Appendix III

During instream surveys in 2016, we recorded evidence of Western toad breeding (egg masses, mixed aggregated hatchling tadpoles and egg masses, or aggregated hatchling tadpoles/toadlets) at 56 locations (**Appendix Figures 3** and **4**). Eighteen of these locations had only egg masses, 13 had a mix of aggregated hatchling tadpoles and egg masses, 24 had only aggregated hatchling tadpoles, and one site had a mix of aggregated tadpoles and metamorphosing toadlets. We recorded 24, 18, and 14 of these locations, respectively, below, within, and above the footprint (**Appendix Table 3**).

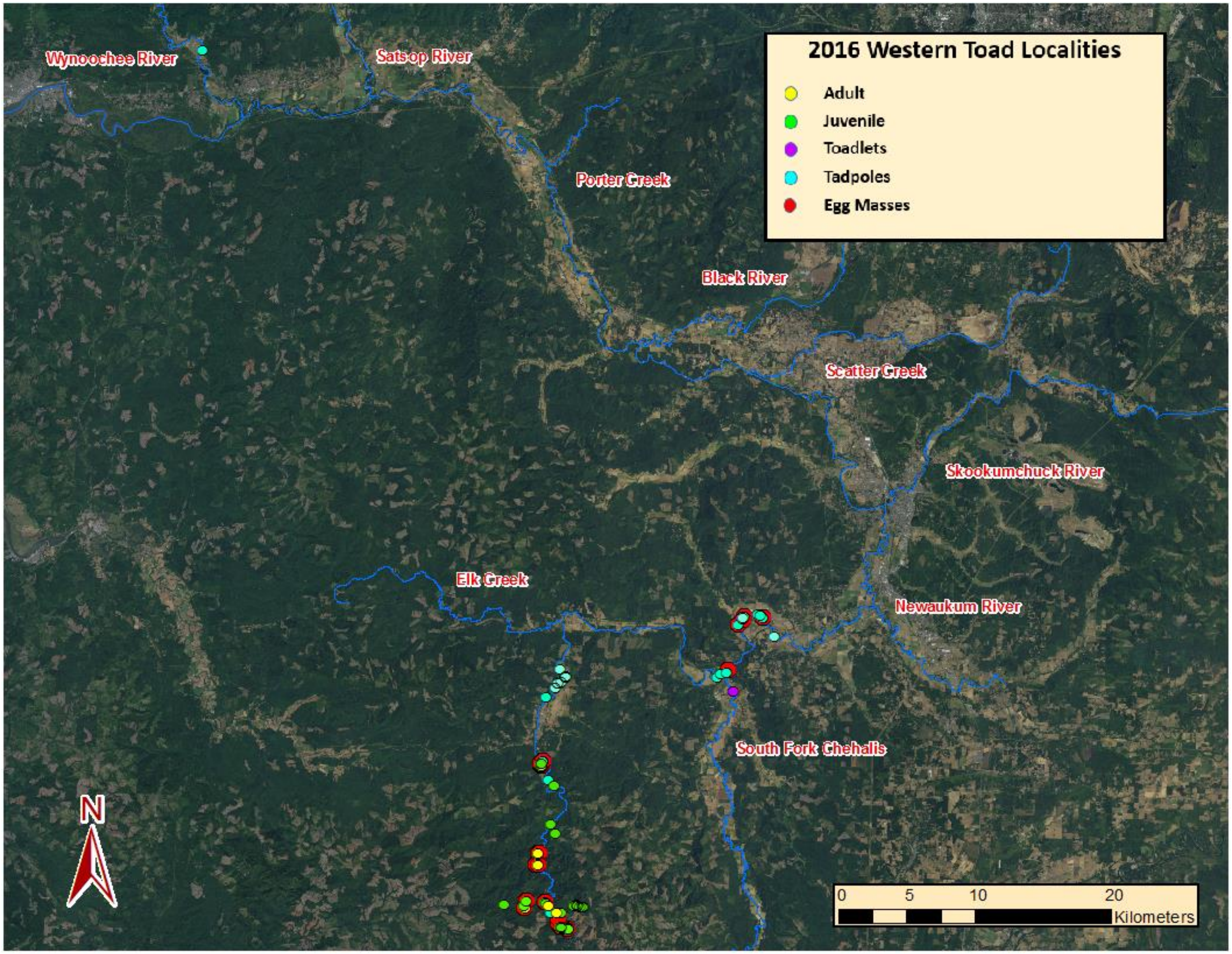
At these 56 locations collectively, we conservatively estimated a minimum of 98 egg masses, 25 of which were recently laid. We also estimated another 29 egg masses based on aggregated tadpole groups, 44 based on mixed egg masses and aggregated tadpole groups (**Appendix Table 3**). We recorded 33, 50, and 15 of these groupings, respectively, below, within, and above the footprint (**Appendix Table 3**). We found 125 toadlets at one location in the South Fork Chehalis River on 6 June; tadpole estimates for all reaches combined exceeded 900,000 animals. All post-metamorphic toads (n = 30) observed were upstream of the proposed dam site in the mainstem. Counts of adults (5 in the inundation pool, 3 upstream) and juveniles (4 in the inundation pool, 21 upstream tributaries); of these, 12 were associated with a breeding site. This is indicative of some site fidelity.

Besides Western toads, we also incidentally observed six more amphibian species during the 2016 instream surveys (**Appendix Table 4**). The incidental species for which we have the most observations (n = 103) was the American bullfrog, seen at 13 locations. The Roughskin newt was next most often encountered (n = 38), seen at 12 sites. All incidental observations of bullfrogs and newts were from below the proposed reservoir footprint, evidence of limited upstream dispersal by the former, exotic species. Less frequently, we recorded Northern red-legged frogs, Coastal tailed frogs, giant salamanders, and Pacific treefrogs. All observations of Coastal tailed frogs and giant salamanders were in tributaries above the proposed reservoir footprint. Four of the Pacific treefrog observations were egg masses found within the same breeding pools as Western toads.

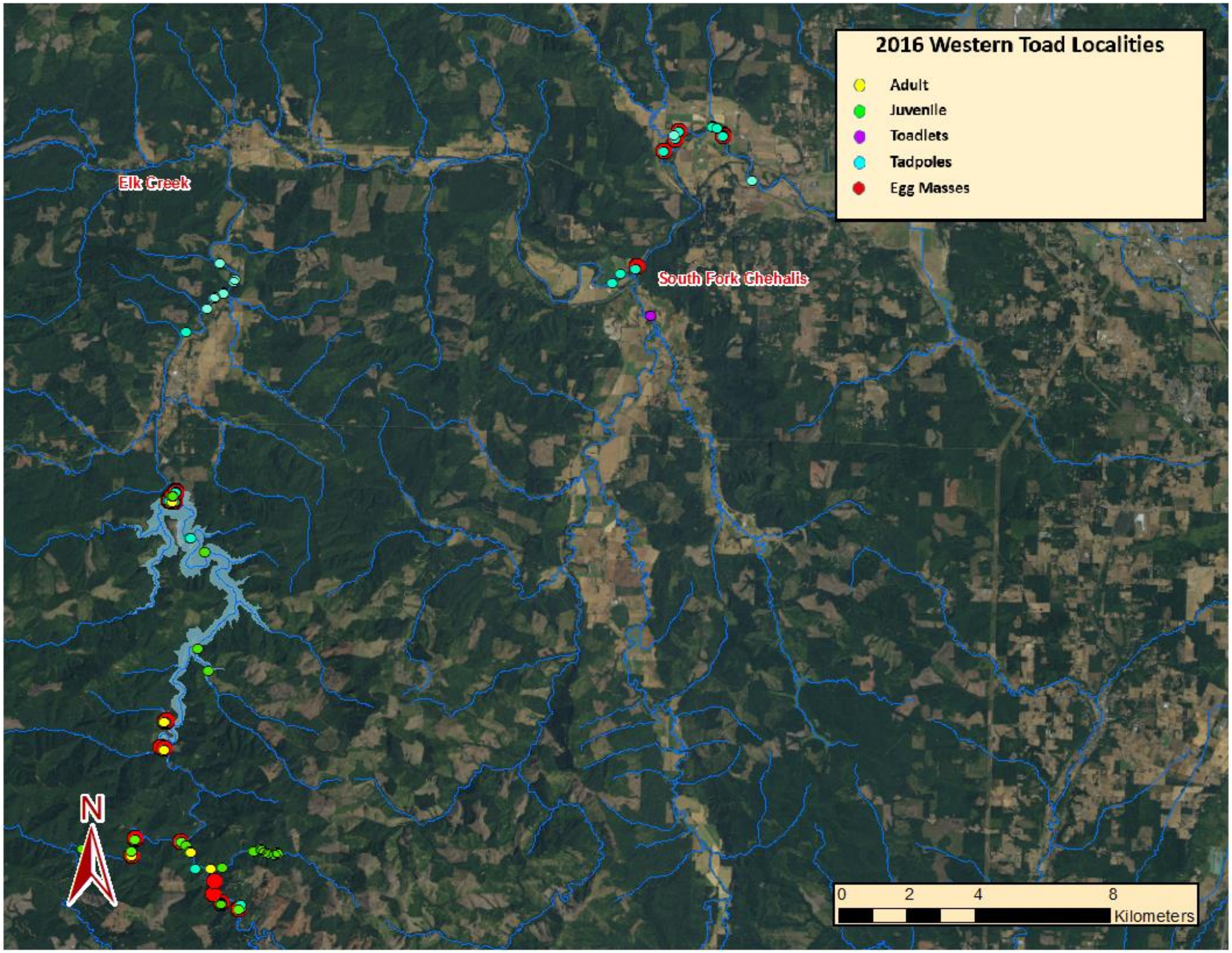
We regularly observed at least one fish species, Coho salmon (as fry) in side pools during instream surveys in 2016. Coho fry were recorded in several of the same side pools in which Western toads had reproduced (n = 20). Though these pools were most often connected to the mainstem Chehalis River, we did see Coho fry in five pools that were now disconnected from the river. We also observed lamprey or lamprey redds at 12 separate locations; at six locations, we determined the lamprey to be Pacific lamprey. At the remaining six locations, we could not identify the larval lamprey recorded. We also observed Northern pikeminnow, Cutthroat trout, Largescale sucker, Redside shiner, Rock bass, Speckled dace, Threespine stickleback, and an unidentified species of sculpin in these same breeding pools. We observed the only exotic fish, Rock bass, exclusively in the mainstem (Elk Creek to South Fork reach) downstream of the footprint.

We also incidentally recorded Beaver or their sign (n = 29); all Beaver records were downstream of the proposed dam/reservoir footprint, both within the mainstem and tributaries.

Appendix Figure 3. 2016 instream survey map for Western toads by life stage.



Appendix Figure 4. 2016 map of Western toads locations upstream of the Newaukum River by life stage.



Appendix Table 3. Numbers and density indices of Western toad breeding locations and egg mass estimates below, within, and above the proposed reservoir footprint in 2016.

Location Relative to Proposed Reservoir Footprint	Breeding Category	Number	Distance		Density Index	
			RM	RKm	n/RM	n/RKm
Below	Breeding Locations	23	70.9	114.1	0.32	0.20
	Egg Mass Estimate	28			0.39	0.26
Within	Breeding locations	17	3.2	5.1	5.31	3.33
	Egg Mass Estimate	46			14.38	9.02
Above	Breeding locations	14	10.8	17.4	1.30	0.81
	Egg Mass Estimate	15			1.39	0.86

Appendix Table 4. Incidental amphibian species observed during 2016 instream surveys. Subtotals or totals for sites may be less than summed site sums for species across habitat categories because one or more species may have occurred at the same site.

Species		Numbers of Observations				
Standard English Name	Scientific Name	Position Relative to Proposed Reservoir				Totals
		Below		Within	Above	
		mainstem	tributaries	mainstem	tributaries	
Stillwater-breeding Amphibians						
Northern red-legged frog	*Rana aurora*	4	2	1	3	**10**
Roughskin newt	*Taricha granulosa*	31	7			**38**
Pacific treefrog	*Pseudacris regilla*	10		4		**14**
American bullfrog	*Lithobates catesbeianus*	101	2			**103**
	Subtotals	**146**	**11**	**1**	**3**	**161**
Stream-breeding Amphibians						
Coastal tailed frog	*Ascaphus truei*				10	**10**
Giant salamanders	*Dicamptodon spp.*				2	**2**
	Subtotals					**12**
	Grand total	**146**	**11**	**1**	**3**	**173**

Appendix IV

In 2017, we recorded evidence of Western toad breeding (egg masses and/or aggregated hatchling tadpoles) at 60 locations (**Appendix Figure 5**); we recorded one location incidentally below Highway 8 on the Satsop River). Eight of these locations had only egg masses, 4 had mixed aggregated hatchling tadpoles and egg masses, and 48 had exclusively aggregated hatchling tadpoles. All 60 of these locations were located below the footprint (**Appendix Table 5**).

At the 59 locations recorded during our standard surveys, we conservatively estimated a minimum of 78 egg masses, 23 of which had not hatched yet. We also estimated another 46 egg masses based on aggregated tadpole groups and nine more based on mixed egg masses and aggregated tadpole groups (**Appendix Table 5**). We did not find any toadlet groups in 2017, but tadpole estimates for all reaches combined exceeded 400,000 animals, with the vast majority (390,000) being from the Wynoochee River. All post-metamorphic toads (n = 10) observed were on the Wynoochee River, where eight adults and one juvenile were associated with a breeding site (**Appendix Figure 5**); the last individual was elsewhere. We surveyed significantly more of the Wynoochee River than the South Fork Chehalis (45.4 RM vs 24.2 RM), but the density index for both breeding locations and egg masses also revealed higher abundance in the Wynoochee River (**Appendix Table 5**).

In 2017, we found Western toad breeding at 59 sites spanning 70.3 RM (113.2 river kilometers [RKm]) that was surveyed on (a) two major tributaries to the Chehalis (Wynoochee [45.4 RM] and South Fork Chehalis Rivers [24.2 RM]) and (b) one mainstem Chehalis site near its confluence with the South Fork. However, breeding sites were not uniformly distributed. In particular, we found 57 of those sites on the Wynoochee River (1.3 Western toad breeding sites (BrS) per RM (= 0.5 BrS/RKm)), one location on the South Fork Chehalis (0.04 BrS/RM = 0.06/RKm), and one on the mainstem Chehalis at its confluence with the South Fork (1.42 BrS/RM = 1.00 /RKm) (**Appendix Figure 5, Appendix Table 5**).

Besides Western toads, we also incidentally observed four more amphibian species during the 2017 instream surveys. Roughskin newt (n = 5), Northern red-legged frogs (n = 3), American bullfrog tadpoles (n = 2), and Pacific treefrogs (n = 103), of which all were egg masses, were found on both tributaries.

At least one species of salmon fry was regularly observed in side pools during instream surveys in 2017 (n = 41 or 70% of Western toad breeding sites). We positively identified Coho salmon in eight of those locations, and we did not handle the fry at remaining locations, which prevented confident identification. Almost half (n = 18) of these pools were disconnected from the river at the time of surveys in June. In a few breeding pool locations, we also observed Largescale sucker, Speckled dace, Threespine stickleback, and unidentified species of sculpin.

In addition, we also recorded incidental observations not associated with the Western toad breeding sites. On both tributary rivers, we recorded Beaver or their sign (n = 10) and adult Largescale suckers (n = 12), whereas larval lamprey was recorded in the Wynoochee River.

Appendix Table 5. Numbers and density indices of Western toad breeding locations and egg mass estimates below the proposed reservoir footprint in 2017 on the Wynoochee and South Fork Chehalis Rivers. We recorded one additional breeding location and egg mass just below the confluence of the South Fork on the mainstem Chehalis River.

Location	Breeding Category	Number	Density Index	
			n/RM	n/RKm
Wynoochee River	Breeding Locations	57	1.26	0.51
	Egg Mass Estimate	76	1.77	1.04
South Fork Chehalis River	Breeding Locations	1	0.04	0.06
	Egg Mass Estimate	1	0.04	0.06

Appendix Figure 5. 2017 instream survey map for Western toads by life stage.