2015 Chehalis Egg Mass Surveys in Off-Channel Habitat

2nd Progress Report (November 30, 2015)

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EXECUTIVE SUMMARY

Introduction

This report summarizes results from the 2015 off-channel stillwater-breeding amphibian egg mass surveys in the mainstem Chehalis floodplain. The work is part of the larger effort addressing off-channel habitats and contributes directly and indirectly to the Chehalis Aquatic Species Restoration Plan (ASRP). The goals of the surveys are to:

- Identify stillwater-breeding amphibian and non-amphibian aquatic species occupancy patterns in off-channel habitat in the Chehalis floodplain.
- Support occupancy modeling characterizing the distribution of ASRP target species in the Chehalis floodplain.
- Support development of a Project level Environmental Impact Statement (PEIS) for reducing flood impacts in the Chehalis Basin.
- Support inundation modeling intended to evaluate potential changes in off-channel habitats as a consequence of flood control alternatives.
- Inform and prioritize restoration efforts in the basin

This study looks at 6 of the 9 ASRP non-salmonid target species known to occur in Chehalis Basin off-channel habitats:

- American beaver (*Castor canadensis*).
- Northern red-legged frog (*Rana aurora*).
- Olympic mudminnow (*Novumbra hubbsi*).
- Oregon spotted frog (*Rana pretiosa*).
- Western pond turtle (*Actinemys marmorata*).
- Western toad (*Anaxyrus boreas*).

This work was conducted on the land of, and with the permission of, almost 50 landowners within the basin – 6 public and 48 private entities.

Methods

Surveys were completed between February 19 and May 28, 2015, using a visual encounter method involving a slow walk in shallow aquatic habitats (<1 m deep). This method is the gold standard for detecting amphibians because their egg masses are non-mobile and easily identifiable down to the species level. Survey timing encompasses the egg-laying interval for early breeders such as the northern red-legged frog and late season breeders like the western toad. Visual encounter surveys were supplemented with systematic dipnet surveys to enable identifying the presence of non-egg amphibian life stages and fishes. We sampled 49 distinct off-channel habitats distributed across the length of the Chehalis floodplain from above the proposed dam

footprint at Pe Ell to the Highway 101 bridge in Aberdeen, with each site surveyed three times with intervals of at least 10 days between sampling events.

Results and Conclusions

We recorded American beaver, six stillwater-breeding amphibian species and selected life stages of at least 17 fish species during the 2015 surveys. Three of the species recorded, the American beaver, northern red-legged frog, and Olympic mudminnow are ASRP target species. However, we did not find the three remaining ASRP non-salmonid target species - the Oregon spotted frog, western pond turtle, and western toad.

All ASRP non-salmonid target species appear relatively widespread and were detected at 18 to 43 sites of the 49 possible sites. However both the beaver and Olympic mudminnow appeared to decline in occupancy as one moved upstream. Because beavers are largely nocturnal and our surveys were conducted during the day, there is some uncertainty regarding the presence of beaver. However, confidence in the pattern for northern red-legged frog and Olympic mudminnow is high due the documented effectiveness of the sampling methods on the two species.

The remaining non-target amphibians appear to be moderately widespread to widespread and were detected at 17 to 42 of the 49 sites sampled. Occupancy patterns for both the long-toed salamander (25 of 49 sites) and rough-skinned newt (17 of 49 sites) were likely underestimated because the year's dry conditions resulted in missing the early-shifted breeding period for the salamander and likely limited detection for the newt. All fishes except the Olympic mudminnow (23 of 49 sites) and three-spined stickleback (27 of 49 sites) were irregularly detected. While the data should not be used to infer patterns about distribution for these fish, their general lack of detection in off-channel habitats at the upper and lower ends of the floodplain may be a pattern. For the three ASRP non-salmonid targets that were not detected, it is possible that the species may yet be found, but that they are likely to be infrequent.

Next Steps

The work described here represents one-third of the work that will occur during the 2015 to 2017 biennium. The remaining effort will determine whether or not the patterns observed to date are generally consistent across sampling years. While additional beaver and fish-competent sampling is needed to more fully understand the pattern for these species, some of this gap will be addressed by both the extensive and intensive off-channel floodplain sampling efforts.

Because the extensive sampling program is a summer effort (May-September), visual encounter/dipnet sampling cannot capture the seasonal use of off-channel habitat by faster moving fishes such as coho. As a result, we propose to add electroshock sampling to the egg mass survey effort to ensure that the juveniles of faster-moving fishes like coho are effectively detected in 2016 and 2017. We also intend to analyze egg mass data for association patterns for all amphibians except the long-toed salamander and rough-skinned newt, along with the potential association patterns for the Olympic mudminnow and three-spined stickleback. We anticipate exploring coarse-level abundance information from the systematic dipnet surveys for discernable patterns. Incorporation of the egg mass survey data into preliminary modeling will occur

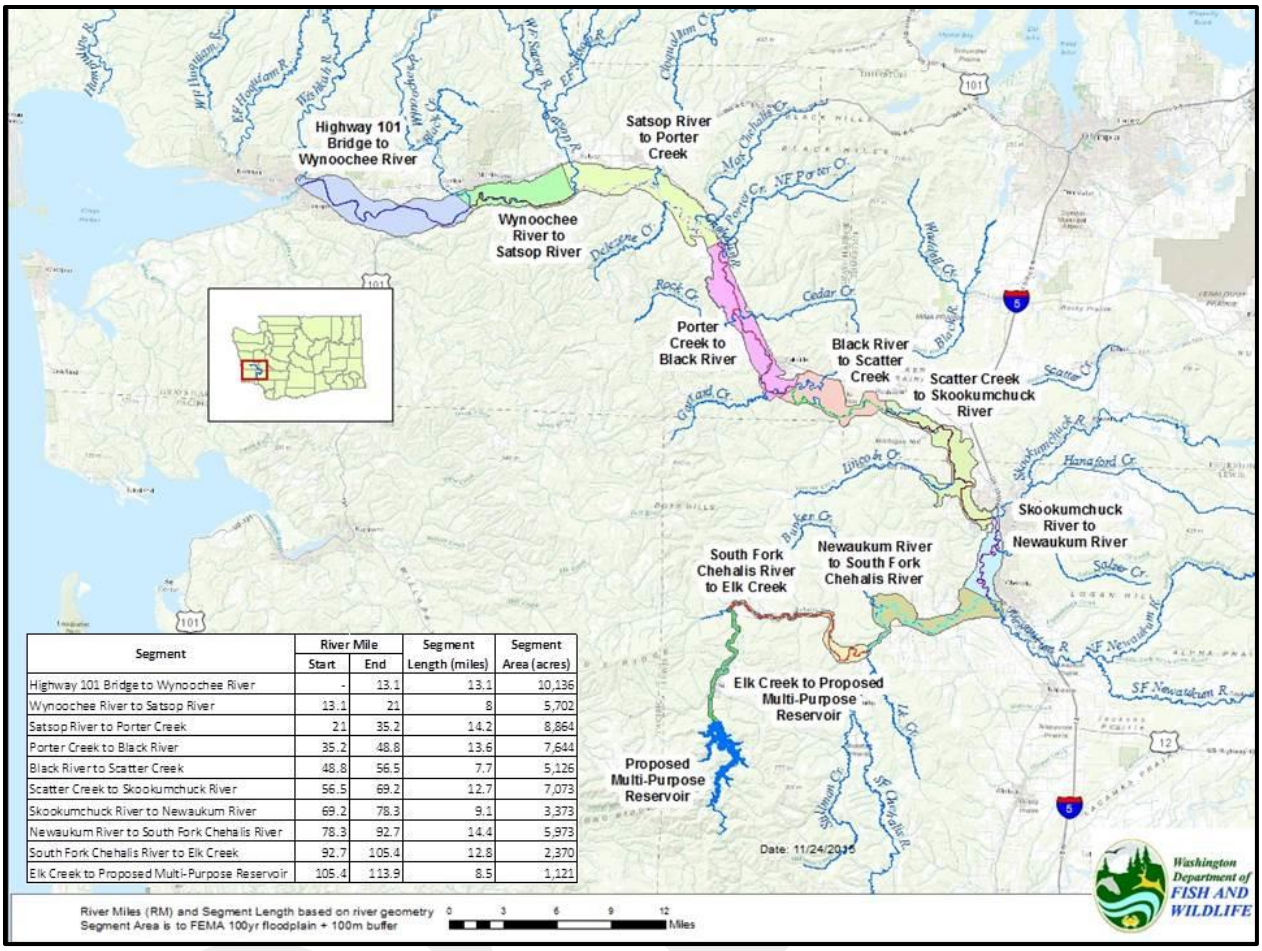
over the fall and winter of 2016, with the data available to inform preliminarily restoration priorities.

PROGRESS REPORT

Site Selection

We chose sites from a 324-site pool of off-channel habitats spanning the entire floodplain of Chehalis mainstem from the proposed dam location (just above Pe Ell) to the 101 bridge in Aberdeen. This pool of sites was developed in GIS from the 2011 NAIP aerial photograph taken in late summer. We defined the mainstem floodplain footprint as the FEMA-specified 100-year flood line plus an additional 100 meters drawn perpendicular to that line. The inundation pattern during late summer conditions, as reflected in the aerial photographs, do not necessarily reflect inundation conditions during late winter-spring period of these surveys, so we also cross-checked aerial photographs against field conditions early during our survey interval; this effort captured a few additional sites. Further, we also intentionally captured seven sites lapping the margin of the floodplain footprint in part because of our inability to obtain permission for access from a few landowners in the upper floodplain, where off-channel habitats are few. The latter modifications increased the size of the site selection pool to 332.

We stratified our selection of sites across 10 segments of the Chehalis mainstem partitioned primarily on the entry of major tributaries (**Figure 1**). Our sampling effort is distributed over three years, so Table 1 shows the number of originally available (i.e., that based on 2011 NAIP aerial photograph) contrasted to the number of sites targeted for random selection over the three-years, the number of sites targeted for sampling in 2015, and the number of sites actually sampled in 2015. One focus of this effort was to inform evaluation of proposed dam alternatives. As effects of those alternatives are expected to be most evident in mainstem river segments nearest the proposed dam, and off-channel habitats in mainstem river segments nearest the proposed dam were few, we intentionally sampled more sites in segments nearest the proposed dam. Specifically, we selected all the sites in the two mainstem river segments nearest the dam and 50% of the sites available in the mainstem segment that was the third nearest the dam. In the remaining seven further downstream segments, we selected sites in proportion to the numbers available such that about 36% of all sites from all segments (including the three nearest the dam) would be sampled over the three years of study. Beyond the emphasis on more sampling nearer the dam, we randomized site selection within each segment. We did this with the realization that it was unrealistic to expect to obtain permission for access from every landowner; the randomization allowed us to be able to select the next site(s) in the randomized sequence within any particular segment if selected permissions for access were refused. This enabled us to reach our target numbers.



Segment	River Mile		Segment Length (miles)	Segment Area (acres)
	Start	End		
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 1. Chehalis River mainstem segments used to stratify sampling of off-channel habitats. The inset describes the start and end points (by river mile (RM), length (in miles based on measurement along the mainstem) and area (in acres) for the 10 segments (each with a unique color on the map).

Sampling

We conducted surveys of each site with a minimum of two people. Surveys were visual encounter and also involved dipnet sampling; we obtained 50 dipnets samples at each wetland. We conducted the surveys at water depths of up to 1 m (3 ft), the focal footprint. We were able to walk into most sites, but used inflatable kayaks to facilitate access to and enable effective survey of some sites. We surveyed 100% of the focal (wetted) footprint of all sites except one; we surveyed about 80% of the exception because the co-owning landowner of this unit disallowed permission to access the rest of this site. We recorded the identity and life stage of all species encountered. We photographed at least one individual of all amphibians or fishes using a photo box with a scale to enable estimating animal size. We also recorded the sign of some species, like beaver, and also made a determination of the freshness of that sign to suggest whether or not occupancy was recent.

Results

The aforementioned selection pattern resulted in our surveying three to eight sites across each of the 10 river segments in 2015 (see "Completed in 2015" column in **Table 1**) and sites surveyed closely matched the 2015 target (compare "2015 Target" and "Completed in 2015" columns in **Table 1**). The sole under target exception was the Newaukum River to South Fork Chehalis River segment, which was one site short of its target. Two other segments, Elk Creek to Proposed Dam and Porter Creek to Black River, each had one site above their target number. Site sampled in remaining seven segments matched their target numbers.

Table 1. Site Numbers Summary by Chehalis Mainstem Floodplain Segment for Sites Sampled during the Egg mass-based Off-Channel Sampling. River segments are displayed in an upstream sequence. The "Available" column were the number of sites obtained from the original GIS exercise; the "3-year Target" column is the number of sites that we anticipate sampling over the three study years; the "2015 Target" is the number of sites that should be sampled in 2015; and the "Completed in 2015" column is the number of sites that were actually sampled in 2015.

River Segment		Available	3-year Target	2015 Target	Completed in 2015
1	Hyw 101 Bridge to Wynoochee River	18	6	2	2
2	Wynoochee River to Satsop River	31	10	3	3
3	Satsop River to Porter Creek	74	24	8	8
4	Porter Creek to Black River	64	21	7	8
5	Black River to Scatter Creek	21	8	3	3
6	Scatter Creek to Skookumchuck River	51	17	6	6
7	Skookumchuck River to Newaukum River	24	8	3	3
8	Newaukum River to South Fork Chehalis River	30	15	5	4
9	South Fork Chehalis to Elk Creek	8	8	8	8
10	Elk Creek to Proposed Dam	3	3	3	4
Totals		**324**	**120**	**48**	**49**

We recorded three of the nine ASRP non-salmonid target species across the 49 off-channel habitats sampled: American beaver (*Castor canadensis*), Northern red-legged frog (*Rana aurora*), and Olympic mudminnow (*Novumbra hubbsi*). At least one of these three ASRP non-salmonid target species was detected at 94% (46 of 49) these off-channel habitats (**Table 2**). The three remaining possible ASRP non-salmonid target species that might be found, Oregon spotted frog (*Rana pretiosa*), Western pond turtle (*Actinemys marmorata*), and Western toad (*Anaxyrus boreas*), were not recorded in any off-channel habitats sampled.

Table 2. Species Detection of ASRP Target Species and Non-ASRP Target Amphibians based on Numbers of Sites per Segment during Amphibian Egg Mass based Off-Channel Surveys, February-May 2015. River segments are displayed in an upstream sequence. Detection data on fishes other than Olympic mudminnow are in Tables 3 and 4. The totals in the columns labeled "Totals Sites with ASRP Targets" and "Total Sites

with Amphibians" do not equal the sums of their dependent columns because more than one species often occurred at different sites.

River Segment		Sites	ASRP Target Species			Total Sites with ASRP Targets	Non-ASRP Target Amphibians					Total Sites with Amphibians
			American beaver	Northern red-legged frog	Olympic mudminnow		Northwestern salamander	Long-toed salamander	Pacific treefrog	Rough-skinned newt	American Bullfrog	
1	Hyw 101 Bridge to Wynoochee River	2	0	2	2	2	2	1	1	1	0	2
2	Wynoochee River to Satsop River	3	2	3	3	3	3	1	2	1	3	3
3	Satsop River to Porter Creek	8	3	6	8	8	7	0	6	3	7	8
4	Porter Creek to Black River	8	6	8	6	8	7	5	7	3	7	8
5	Black River to Scatter Creek	3	2	3	1	3	3	0	3	1	3	3
6	Scatter Creek to Skookumchuck River	6	0	6	2*	6	4	5	6	1	5	6
7	Skookumchuck River to Newaukum River	3	2	1	0	2	2	1	1	0	2	2
8	Newaukum River to South Fork Chehalis River	4	0	4	2	4	4	3	4	1	3	4
9	South Fork Chehalis to Elk Creek	8	2	6	1	6	6	6	8	2	1	8
10	Elk Creek to Proposed Dam	4	1	4	0	4	4	3	4	4	1*	4
Totals		**49**	**18**	**43**	**25**	**46**	**42**	**25**	**42**	**17**	**31**	**48**

*An asterisk indicates that the species in one site in the indicated cell represents a sighting unverified by a photograph or other direct evidence.

Northern red-legged frogs were the most frequently detected ASRP target species (**Table 2**). They were found in every floodplain segment, and recorded at 88% of sites (43 of the 49 sites). On average, Northern red-legged frogs were detected at 88% of sites per segment (range: 33-100%), and were not found at 100% of sites in only three segments (**Table 2**).

In contrast, American beaver and Olympic mudminnow were each recorded in roughly half or fewer of off-channel habitats sampled (**Table 2)**; Beaver at 37% of sites (18 of

49) and Olympic mudminnow at 51% of sites (25 of 49). For both species, over 70% of the sites in which they were recorded were downstream of Scatter Creek; and both species were unrecorded two river segments upstream of Scatter Creek. The latter were different segments for each species (see **Table 2**).

We also recorded five non-ASRP target amphibian species: four native (Northwestern salamander [*Ambystoma gracile*], Long-toed salamander [*Ambystoma macrodactylum*], Pacific treefrog [*Pseudacris regilla*], and Rough-skinned newt [*Taricha granulosa*]) and one exotic species (American bullfrog [*Lithobates catesbeianus*]). Northwestern salamander and Pacific treefrog were widespread in a manner near parallel to the Northern red-legged frog, both were recorded in all 10 river segments and both were recorded at 86% (42 of 49) sites, though the precise sites at which both species were recorded was not a exact match. In contrast, Long-toed salamander and Rough-skinned newt were recorded at roughly half or fewer of the sites; 51% (25 of 49) for the Long-toed salamander and 35% (17 of 49) for the Rough-skinned newt. Long-toed salamander had distributional pattern somewhat inverse to Beaver and Olympic Mudminnow, being recorded in over 70% of the sites in which it was found upstream of Scatter Creek. American bullfrog was also widespread, being recorded at 63% of sites (31 of 49). Bullfrogs were recorded less frequently above the South Fork of the Chehalis River and below the Wynoochee River. Overall, at least one species of amphibian was recorded at nearly every (98% [48 of 49]) off-channel habitat sampled (**Table 2**).

Besides Olympic mudminnow, we also recorded at least 17 fish species during the 2015 off-channel egg mass surveys. At least 10 of those fish species were native (**Table 3**) and at least seven were not native (**Table 4**). Of those species, only Three-spined stickleback (*Gasterosteus aculeatus*) was recorded with any frequency; we recorded sticklebacks in all river segments except the upstream-most two and at 55% (27 of 49) of sites. The Three-spined stickleback has a distributional pattern rather parallel to the Olympic Mudminnow in that it appears to occupy disproportionately fewer sites in the upstream portion of the floodplain. Besides Olympic mudminnow and Three-spined stickleback, the egg mass surveys recorded no other fish species, native or non-native, at more than 10 sites (20% of 49 sites). However, the two categories of fishes found at 10 sites, unidentified sculpins (*Cottus* spp.) and unidentified sunfishes (*Lepomis* spp.), not only have a strong likelihood of representing more than one species, but may be juveniles of species already quantified. The next most frequently recorded

Table 3. Detection of Native Fish Species based on Numbers of Sites per Segment during Amphibian Egg Mass based Off-Channel Surveys, February-May 2015. River segments are displayed in an upstream sequence. Olympic Mudminnow data are provided in **Table 2** and Non-native fish species detection data are provided in **Table 4**. Unidentified lamprey and sculpin detections may represent more than one species; fin clips from unidentified sculpin detections are currently being processed to determine species identities. The "Total Sites with Native Fishes column includes Olympic mudminnow (data from **Table 2**) and the totals do not equal the sum of their dependent columns because more than one species often occurred at different sites.

River Segment		Sites	Chinook salmon	Coho Salmon	Largescale Sucker	Northern Pikeminnow	Prickly Sculpin	Redside Shiner	Speckled Dace	Three-spined Stickleback	Unidentified Lamprey	Unidentified Sculpin	Total Sites with Native Fishes
1	Hyw 101 Bridge to Wynoochee River	2	0	0	0	0	0	0	0	2	0	0	2
2	Wynoochee River to Satsop River	3	0	1	0	1	0	0	0	3	0	1	3
3	Satsop River to Porter Creek	8	0	0	0	1	2	0	1	7	0	4	8
4	Porter Creek to Black River	8	0	2	0	2	0	1	2	5	0	1	6
5	Black River to Scatter Creek	3	0	0	0	0	0	1	0	2	0	0	2
6	Scatter Creek to Skookumchuck River	6	1	1	0	2	1	1	2	3	1	1	3
7	Skookumchuck River to Newaukum River	3	0	0	1	2	1	0	1	1	0	2	3
8	Newaukum River to South Fork Chehalis River	4	0	0	0	1	0	0	0	4	0	0	4
9	South Fork Chehalis to Elk Creek	8	0	0	0	0	0	0	0	0	0	1	1
10	Elk Creek to Proposed Dam	4	0	0	0	0	0	0	0	0	0	0	0
Totals		**49**	**1**	**4**	**1**	**9**	**4**	**3**	**6**	**27**	**1**	**10**	**32**

Table 4. Detection of Non-Native Fish Species based on Numbers of Sites per Segment during Amphibian Egg Mass based Off-Channel Surveys, February-May 2015. River segments are displayed in an upstream sequence. Olympic Mudminnow data are provided in **Table 2** and Native fish species data are provided in **Table 3**. Unknown sunfish detections may represent more than one species; fin clips from unknown sunfish detections are currently being processed to determine species identities.

River Segment		Sites	Bluegill	Brown Bullhead	Goldfish	Largemouth Bass	Pumpkinseed	Rock Bass	Yellow Perch	Unidentified Sunfish	Total Sites with Non-native Fishes
1	Hyw 101 Bridge to Wynoochee River	2	0	0	0	0	0	0	0	0	0
2	Wynoochee River to Satsop River	3	0	0	0	0	0	0	0	1	1
3	Satsop River to Porter Creek	8	1	1	0	1	1	0	1	4	5
4	Porter Creek to Black River	8	0	0	0	1	0	1	1	2	3
5	Black River to Scatter Creek	3	0	0	0	0	0	0	0	0	0
6	Scatter Creek to Skookumchuck River	6	2	0	0	0	0	1	1	1	3
7	Skookumchuck River to Newaukum River	3	0	0	0	0	0	0	0	1	1
8	Newaukum River to South Fork Chehalis River	4	0	0	1	0	0	1	0	1	1
9	South Fork Chehalis to Elk Creek	8	1	0	0	0	0	1	0	0	1
10	Elk Creek to Proposed Dam	4	0	0	0	0	0	0	0	0	0
Totals		**49**	**4**	**1**	**1**	**2**	**1**	**4**	**3**	**10**	**15**

species where no ambiguity exists about species identity was the Northern Pikeminnow (*Ptychocheilus oregonensis*), which was recorded at nine sites (18% of 49 sites). After the Northern Pikeminnow, all other fishes species, native or non-native, were recorded at six (12% of 49 sites) or fewer sites. Overall, during egg mass surveys, at least one native fish species was recorded at 32 sites (65% of 49 sites; **Table 3**) and at least one non-native fish species was recorded at 15 sites (31% of 49 sites; **Table 4**).

Discussion

The 2015 egg mass surveys represent about a third of the planned effort for this particular study in the Chehalis, so patterns obtained from these surveys should be viewed as preliminary. Assessment to date is based on naïve occupancy patterns, the dataset is not quite large enough to integrate into modeling efforts, and selected statistical analysis await the larger dataset. Nonetheless, selected patterns appear to be emerging, which are:

1) Northern red-legged frogs, Northwestern salamanders, and Pacific treefrogs make widespread use of Chehalis floodplain off-channel habitats for reproduction and rearing, and the exotic American bullfrogs also makes relatively widespread use of those habitats for parallel reasons. We expect naïve (unmanipulated) data (that presented here) to somewhat underestimate the off-channel habitat use for all four of these species because despite being a rigorous approach, the three-pass VES/dipnet sampling system may miss populations occurring at very low densities. We also anticipate that American bullfrog presence may also be underestimated if this species either did not successfully reproduce or its reproductive output failed (complete mortality of pre-metamorphic life stages), because post-metamorphic American bullfrogs are less frequently surface active during the late winter-early spring interval we conducted egg mass surveys. Projected modeling will provide meaningful (confidence interval-bounded) occupancy estimates for these taxa in off-channel habitats and enable deducing patterns from habitat co-variates that can estimate limiting factors and inform restoration options. The late spring and summer-based extensive sampling effort in off-channel habitats (in a companion report) will help gauge how much post-metamorphic bullfrogs may have been missed during the egg mass survey interval.
2) Our inability to detect Western Toad in Chehalis mainstem floodplain off-channel habitats was unexpected. Western toads are well known to favor stillwater habitats for breeding (Jones et al. 2005), so this pattern suggests that in their current state, floodplain off-channel habitats are somehow unsuitable for Western Toad. Unsuitability could be related to lack of breeding habitat (western toads deposit eggs in unvegetated shallow water), exotics disfavoring toad presence, or another unidentified factor or combination of factors. The remaining two years of egg mass survey effort in off-channel habitats will enable identifying whether lack of Western toads in off-channel habitats is a real pattern, and if it is, analysis of off-channel

habitat co-variates can suggest the basis of unsuitability. Lastly, given our frequent encounters of breeding Western Toad in the Chehalis mainstem after the water levels dropped seasonally in both 2014 and 2015 using VES/dipnet sampling, the lack of Western toad in floodplain off-channel habitats is unlikely to result from a sampling issue.

3) Olympic mudminnow and American beaver were recorded more frequently in the lower Chehalis River below Scatter Creek. This may reflect the greater extent of off-channel habitat in the lower river. We caution, however, that our diurnal VES/dipnet sampling system was not designed to detect typically nocturnal beaver and we expect to integrate several other datasets to develop a more complete picture of beaver distribution in the floodplain. Still, though we recognize that our diurnal VES/dipnet sampling system is biased against detecting typically nocturnal beaver, we do not expect that bias to change as a function of floodplain location; hence, we expect the pattern of more beaver in the lower floodplain to hold up regardless of what other data sources are added. Similar to the amphibian species discussed in #1 above, we expect that three-pass VES/dipnet sampling system may miss Olympic mudminnow populations occurring at very low densities. We expect that the alternative (trapping) sampling systems implemented during the extensive summer sampling program will help gauge where Olympic mudminnow may have been missed.

4) Long-toed salamander seems to be less frequent in floodplain off-channel habitats as one moves downstream. Whether this reflects a real pattern or a seasonal sampling issue is unclear. With regard to the latter, the Long-toed salamander is the earliest breeder among native stillwater-breeding amphibians, typically reproducing in the late December-February interval in lowland western Washington (Jones et al. 2005). Drought years shift breeding timing to earlier in that interval, and since egg mass surveys in floodplain off-channel began in late February, we may have missed most of its reproductive period. However, Long-toed salamanders are also known to be intolerant of predatory fishes, especially exotic species, which seem more frequent in the lower Chehalis. Site-specific patterns of co-occurrence between exotic predators and Long-toed salamanders will clarify this possibility, and an earlier start to the egg mass-focused sampling of off-channel habitats in 2016 and 2017 that includes some sites sampled in 2015 will determine whether the .

5) American bullfrog was not recorded in off-channel habitats above the South Fork of the Chehalis and below the Wynoochee River, but whether bullfrogs really become less frequent at the tails of the floodplain is uncertain. In both cases, it may reflect a lack of suitable habitat for bullfrogs, but the alternative (trapping) sampling systems implemented during the extensive summer sampling program will determine whether or not this pattern holds up.

6) The Rough-skinned newt was least widespread of all native stillwater amphibian species recorded based on egg mass survey data. This pattern seemingly contradicts information that newts are active diurnally more than other native amphibians and rank among the more common amphibian species in the Pacific Northwest (Jones et al. 2005). However, we depended on detecting newts by encountering their larval, juvenile and adult life stages because newts lay single eggs in dense aquatic vegetation that present an excessively high search time cost to detect them. Further, non-egg newt life stages typically favor warmer water, and hence, are generally less active during the time interval egg mass surveys were conducted, which could have contributed to missing newts at some sites. However, larval newts are also highly vulnerable to fish predation, especially exotics, so newt detection may have been influence by the presence of predatory exotic fishes. Bias in detection as a function of the early season egg mass survey interval can be assessed by comparison to the late spring and summer trapping-based extensive surveys of off-channel habitats; bias due to predatory exotic fishes can be assessed by examining the same data for the suite of exotic predatory fishes that may be present.
7) Olympic mudminnow and Three-spined stickleback were the only two fish species detected in a substantial proportion of off-channel habitats. This may reflect the ease with which they can be captured with dipnet sampling because the most other fish sampled except for sculpins represent faster-swimming species. We intend to address some of this bias via comparison to the extensive off-channel sampling effort at the same sites. However, for fast-swimming fishes like Coho salmon, which may only appear in off-channel habitats during the season that laps the egg mass survey season, a different sampling approach will have to be coupled to the egg mass survey interval to effectively detect them. For this reason, we are recommending adding backpack electroshocking sampling to the egg mass survey effort in 2016 and 2017.

We should also note that genetic verification of species identities for the sculpins and sunfishes will likely change the picture fish species assemblage as well as selected analyses. Genetic verification is currently underway. Lastly, we incorrectly gauged that the sole lamprey obtained during egg mass surveys, a larval form (ammocoete), could confidently be identified to species in the field. However, no tissue was collected from this animal, so no alternative opportunity existed to verify its identity. A tissue sample will be obtained for all future captures of species of lamprey.

Literature Cited

Jones, L.L.C., W.P. Leonard, and D.H. Olson (editors). 2005. Amphibians of the Pacific Northwest. Seattle Audubon Society, Seattle, Washington. 227 pp.