Potential Research Directions for HCP Amphibians

The Independent Research and Science Team (IRST) reviewed the amphibian research questions identified by the Adaptive Management Program Committee (AMPC) and summarized in the IRST Scoping Document *Amphibian Literature Review*. This document outlines potential research directions that could address those questions and support evaluation of relevant Biological Goals and Objectives (BGOs) in the Private Forest Accord Habitat Conservation Plan. These options are not mutually exclusive, and many of the research directions described below are interconnected. Future RFPs could incorporate elements from multiple options depending on the scope and priorities identified by AMPC. The options presented here are intended to illustrate potential approaches and to support preliminary discussion and feedback; they do not represent the final set of research directions that would appear in a formal scoping proposal, which would also include estimated costs for each option.

Table 1. AMPC questions relevant to amphibians and scope of the IRST Amphibian Literature Review.

AMPC Question	Question Description	Addressed in Review
Question 1	For each of the covered amphibian species, what is the distribution (including population diversity) within Oregon, and what factors (e.g., stream gradient, stream size, fish presence/absence, slope, aspect, temperature, seasonality, micro-habitat conditions) determine this distribution at a smaller spatial scale (e.g., watershed)?	Yes
Question 2	What is the population trend of the Columbia and Southern torrent salamanders over time on lands subject to the Forest Practices Act (FPA) rules? This question is informed by the following overarching biological goal as stated in the draft PFA HCP: "Forest practices that support the survival and recovery of the covered species by providing clean, cool, connected, and complex habitats."	Yes
Question 3	The following sub-questions are informed by direction from the PFA Report to "…better understand how riparian and unstable slope protections of at least the current and proposed rules for private forestland impact persistence of populations."	Not yet addressed
Question 3.1	How do rules for no-harvest RMAs affect Columbia and Southern torrent salamanders' habitat? BGO from Draft PFA HCP: Goal 2: Shade and watershed processes controlling stream temperature provide cool water compatible with the needs of the covered species. Objective 2.2 – No-harvest RMAs maintain stream shade sufficient to support desired cool water temperatures for covered amphibians. The most recent version of the BGOs is in the Dec. 2022 draft HCP. The BGOs will be finalized within the HCP due Dec. 31, 2027. Private Forest Accord Report, p. 121.	Not yet addressed
Question 3.2	How do rules for Type N streams affect Columbia and Southern torrent salamanders' habitat? BGO from Draft PFA HCP: Goal 3: Stream network connectivity satisfies freshwater habitat needs for covered species. Objective 3.3 – Timber harvest maintains stream-associated connectivity in riparian areas along non-fish streams sufficient to support covered amphibians.	Not yet addressed
Question 3.3	How do rules for steep/unstable slope protections affect Columbia and Southern torrent salamanders' habitat? BGO from Draft PFA HCP: Goal 4: Riparian areas function to support complex habitats for the covered species. Objective 4.3 – Designated Debris Flow Traversal Areas function to deliver large wood to fish-bearing streams. Objective 4.4 – Forest practices maintain stream-associated wetlands and stream-adjacent seep and spring habitat for amphibians.	Not yet addressed

AMPC Question 1 Research Options– Distribution, Habitat Associations, and Population Diversity

AMPC Question 1 focuses on improving understanding of the geographic distribution, habitat associations, and population diversity of the five focal amphibian species: coastal giant salamander (*Dicamptodon tenebrosus*), Cope's giant salamander (*D. copei*), southern torrent salamander (*Rhyacotriton variegatus*), Columbia torrent salamander (*R. kezeri*), and coastal tailed frog (*Ascaphus truei*).

The amphibian literature review conducted for the IRST indicates that several aspects of the ecology and distribution of these species are relatively well established. Broad geographic ranges for all five species are reasonably well characterized across Oregon and the Pacific Northwest, and available studies consistently document strong associations with cold, perennial headwater streams, seeps, springs, and shaded riparian environments. Habitat relationships at reach and microhabitat scales are also relatively well described, including associations with coarse substrates, cold water temperatures, and forested stream channels. Across studies, local abundance commonly varies widely among streams and watersheds, reflecting the spatial heterogeneity typical of headwater amphibian populations, as well as limits in sampling. Genetic studies further indicate that populations are often structured across landscapes and that dispersal is limited for several taxa, particularly torrent salamanders and Cope's giant salamander, consistent with restricted movement along headwater stream networks.

At the same time, the literature highlights several important uncertainties. Historical survey effort has been uneven and largely opportunistic, leaving gaps in coverage across portions of Oregon and limiting understanding of watershed-scale distribution and occupancy patterns. Range-wide population size, demographic rates, and long-term population trends remain largely unknown for all five species. Much of the available information is derived from short-term reach-scale surveys that rely on presence or relative abundance data and often do not account for imperfect detection, which can complicate interpretation of species–habitat relationships and population patterns. Demographic processes such as adult survival, recruitment, and population turnover are poorly quantified, particularly for later life stages. In addition, although genetic studies demonstrate population structure across portions of species' ranges, Oregon-specific patterns of genetic diversity and connectivity remain unevenly resolved, limiting inference about exchange among watersheds.

Addressing this question could involve compiling and synthesizing existing data, conducting targeted field surveys to refine species ranges, and evaluating habitat associations that influence amphibian occurrence across spatial scales. The options below outline several potential approaches that could contribute to improving understanding of amphibian distribution, habitat associations, and population diversity across the ranges of these species.

Research Topic Q1-A - Range and Distribution Data

Option Q1-A1 – Targeted Sampling to Refine Species Range Limits

Sampling could be directed toward areas near the edges of known species ranges or regions with historically limited survey coverage. For example, targeted surveys could improve understanding of the geographic range limits of species such as coastal giant salamander (*Dicamptodon tenebrosus*), Cope's giant salamander (*D. copei*), and coastal tailed frog (*Ascaphus truei*), particularly near the eastern margins of their distributions

in Oregon east of the Cascade crest. Similar approaches could also be applied in other areas where distribution gaps or uncertain range boundaries occur.

By focusing effort in locations where uncertainty is highest, this option could help refine range boundaries, clarify distribution gaps, and improve understanding of environmental gradients where species presence changes across the landscape. Results could improve confidence in statewide distribution information while limiting field effort to specific areas of uncertainty rather than conducting broader surveys across entire species ranges.

Option Q1-A2 – No Action Alternative: Rely on Existing Range Maps and Distribution Information
Under this option, no additional synthesis or field sampling would be conducted to update statewide amphibian distributions. Existing range maps and distribution information derived from previously published studies, agency records, museum collections, and other commonly used data sources would continue to serve as the primary reference for species distributions within Oregon.

Current range maps and occurrence records compiled from the scientific literature, agency databases, and biodiversity data systems provide a general representation of the geographic distribution of the five focal species across Oregon. These sources collectively describe the broad spatial extent of each species and are commonly used to inform planning, research, and management activities. However, relying solely on existing information would not improve resolution of uncertain range boundaries or address gaps in distribution data in areas where survey effort has historically been limited.

Maintaining the status quo would avoid additional research costs and reflect the current level of available information for these species. Under this approach, existing datasets and range maps could continue to be consulted as needed for planning or evaluation purposes, but no new effort would be undertaken to systematically compile, synthesize, or update statewide distribution information.

Research Topic Q1-B – Watershed-Scale Occurrence

Research Topics Q1-B and Q1-C are closely linked because occurrence data collected through watershed-scale sampling may provide the basis for evaluating habitat associations in Q1-C. Amphibian occurrence could be evaluated at multiple spatial scales, including site or stream-reach scale (individual survey locations), subwatershed or watershed scale (broader landscape units encompassing multiple streams), or through a combination of scales within a hierarchical framework.

Watershed-scale sampling could help evaluate how amphibian occurrence varies across landscapes and environmental gradients, including variation in hydrology, stream network structure, temperature regimes, and forest conditions. Such approaches may require substantial field effort; previous work suggests that crews sampling approximately 25–35 subwatersheds per field season may require on the order of $125,000–$150,000 depending on survey methods (*not a formal budget estimate*). Analyses based on occurrence or occupancy data are likely to be more feasible than attempts to estimate abundance. Another decision point for AMPC is whether watershed-scale occurrence sampling and subsequent habitat analyses would be conducted for all five focal species or a subset, as this choice may influence sampling design and feasibility of the options described below.

Option Q1-B1 – Watershed-Scale Sampling of Amphibian Occurrence
Under this option, amphibian occurrence would be evaluated through systematic sampling across watersheds where species are expected to occur. Sampling could be designed to evaluate patterns of species

occurrence within stream networks and among watersheds across portions of the species' ranges in Oregon. Sampling frameworks would likely vary depending on the species selected for study.

This approach could help clarify how consistently species occur within headwater stream networks and how occurrence patterns vary among watersheds. Sampling across multiple watersheds could also provide information on the spatial distribution of species within stream networks and the extent to which occupied streams occur within broader watershed contexts. Results from watershed-scale sampling could improve understanding of spatial patterns of amphibian occurrence while providing a framework for evaluating species presence across stream networks.

Option Q1-B2 – Sampling a Representative Subset of Watersheds

Under this option, sampling would focus on a representative subset of watersheds selected to capture variation in geography, environmental conditions, and forest management history across the ranges of the focal species.

By concentrating effort in fewer watersheds, this approach could allow more intensive sampling within each watershed and more detailed evaluation of how amphibians occur within stream networks at a local scale. Sampling across a representative set of watersheds could still provide insight into broader patterns of occurrence while reducing the overall spatial extent of field effort. This approach may provide a balance between spatial coverage and sampling intensity, allowing evaluation of watershed-scale occurrence patterns while maintaining a manageable level of field effort.

Research Topic Q1-C - Habitat Associations Influencing Amphibian Occurrence

Research Topics Q1-B and Q1-C are closely linked because information on amphibian occurrence collected through watershed- or site-scale sampling can be used to evaluate habitat relationships. While Q1-B focuses on documenting patterns of species occurrence within stream networks and across watersheds, Q1-C focuses on identifying environmental factors associated with those occurrence patterns.

Habitat associations could be evaluated at multiple spatial scales, including local stream-reach conditions or broader watershed and landscape contexts. Analyses would then evaluate statistical relationships between amphibian occurrence and environmental variables.

Option Q1-C1 – Landscape-Scale Habitat Associations

Under this option, relationships between amphibian occurrence and environmental conditions would be evaluated using landscape-scale variables derived primarily from remotely sensed or GIS-based datasets. Analyses would focus on how broader landscape characteristics influence patterns of species occurrence at watershed or sub-watershed scales.

Potential landscape variables include:

- Forest cover by forest
- Underlying geology or rock type
- Slope direction (aspect)
- Slope steepness
- High Landslide Hazard Locations (HLHL)

Option Q1-C2 – Local Habitat Associations
Under this option, relationships between amphibian occurrence and environmental conditions would be evaluated using habitat variables measured at local stream or site scales. Analyses would focus on how conditions within individual stream reaches influence amphibian occurrence.

Potential habitat variables include:

- Stream gradient
- Stream size
- Fish presence or absence
- Slope and aspect
- Water temperature
- Seasonal hydrology
- Microhabitat features such as substrate and cover

Option Q1-C3 – Combined Landscape and Local Habitat Associations
Under this option, relationships between amphibian occurrence and environmental conditions would be evaluated using a combination of landscape-scale and local habitat variables. Analyses could evaluate how factors operating at multiple spatial scales influence amphibian occurrence and how local habitat conditions interact with broader watershed or landscape characteristics. Habitat associations could be evaluated at multiple spatial scales, including the stream reach and watershed.

Research Topic Q1-D – Population Diversity and Demography

Understanding population diversity and demographic characteristics may help clarify how amphibian populations are structured across their ranges in Oregon and how populations differ in genetic composition or demographic traits. Approaches under this topic could help identify distinct populations and evaluate patterns of connectivity or differentiation among them.

Option Q1-D1 – Genetic Diversity and Population Structure
Under this option, genetic data would be used to evaluate population structure and genetic diversity across portions of the species' ranges. Genetic analyses could help identify genetically distinct populations, evaluate levels of genetic variation, and assess connectivity among populations.

Evaluating genetic diversity and population structure would require collection of genetic material from multiple locations. This could involve environmental DNA (eDNA) sampling from water or collection of tissue samples from individual animals obtained through capture methods (e.g., tail clips, toe clips, or swabs). The level of field effort and logistical complexity would vary depending on the sampling approach used, with individual-based sampling typically requiring more intensive field effort and animal handling than eDNA-based approaches.

Option Q1-D2 – Demographic and Life-History Studies
Under this option, demographic information would be collected to evaluate population characteristics and potential differences among populations. This could include estimating age classes, sex ratios, reproductive condition, or body condition. Such studies would require more intensive sampling and handling of individuals than occupancy surveys and would likely focus on selected watersheds where populations can be sampled repeatedly.

AMPC Question 2 Research Options – Population Trends for Torrent Salamanders

AMPC Question 2 focuses on evaluating population trends for Columbia torrent salamanders (*Rhyacotriton kezeri*) and southern torrent salamanders (*R. variegatus*) on lands subject to Forest Practices Act (FPA) rules. Existing studies of torrent salamanders in Oregon and the Pacific Northwest provide information on habitat associations, distribution patterns, and local abundance, but relatively little information is available on long-term population trends. Most surveys have been conducted as short-term studies at individual stream reaches and have not been designed to evaluate population change through time. As a result, the direction and magnitude of population trends remain uncertain for both species across much of their ranges.

Evaluating population trends would require repeated sampling at the same locations over multiple years using study designs that account for imperfect detection. Monitoring programs must also balance the need for sufficient temporal replication to detect trends with spatial coverage across watersheds. The options below outline potential approaches for establishing monitoring networks that could support evaluation of torrent salamander population trends over time.

Research Topic Q2-A – Long-term monitoring networks

Option Q2-A1 – Establish a New Monitoring Network Using Data from This Study as a Baseline

This option would use data collected during the initial study as a baseline for long-term monitoring. A subset of watersheds where torrent salamanders are known or expected to occur would be selected for repeated sampling. Monitoring could occur for 5–10 years following baseline surveys to evaluate potential population trends. A nested sampling design could be used to balance trend detection and spatial coverage. For example:

- Core monitoring sites sampled annually to detect population trends
- Additional rotating sites sampled once every 3–5 years to track broader changes in distribution

This approach would provide a strong framework for evaluating population trends while also improving understanding of torrent salamander distribution across watersheds. Detecting trends in amphibian populations typically requires repeated sampling over multiple years, and monitoring designs that combine annually revisited sites with rotating survey locations can improve both statistical power to detect trends and spatial coverage.

Option Q2-A2 – Expand Monitoring Using Existing Datasets as a Baseline

This option would compile pre-PFA datasets (e.g., OSU/NCASI studies and other research efforts) and use those data as a starting point for expanded monitoring across the known range of torrent salamanders in Oregon. Monitoring could expand the geographic scope of existing sampling while maintaining consistency with earlier survey methods. Sampling could occur at intervals such as:

- Annual or biennial surveys at core monitoring locations
- Rotating surveys across a broader set of sites

This approach would build on existing work while extending monitoring across a larger portion of the species' range. An important early step would be identifying where prior or ongoing sampling occurred and determining which studies used methods suitable for long-term monitoring and detection-corrected analyses.