FINAL NPLCC PROGRESS REPORT

Integrating Climate Change into Washington's State Wildlife Action Plan Revision

NPLCC Agreement #: F15AC00149

Washington Department of Fish and Wildlife

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Lead project staff:

Lynn Helbrecht, WDFW

Jessi Kershner, EcoAdapt

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Introduction

This document serves as WDFW's final progress report for the project listed above – "Integrating Climate Change into Washington's State Wildlife Action Plan Revision". We have organized this report according the topics listed on the NPLCC Progress Reporting guide.

1. Administrative Information

Project Title	Integrating Climate Change into Washington's State Wildlife Action Plan Revision
Project Manager	Lynn Helbrecht, Climate Change Coordinator, WDFW
Address	PO Box 3143, Olympia, WA 98504-3143
Email	lynn.helbrecht@dfw.wa.gov
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2. Public Summary

The Washington Department of Fish and Wildlife recently completed a project to help the agency understand how climate change may further impact species already at risk from existing threats. We collected information for 268 animals and over 80 habitat types to determine which are most likely to be affected by climate change and why. To make this determination, we ranked the degree to which a species or habitat has a built in sensitivity to certain climatic factors - for example, bull trout cannot survive in waters above a certain temperature and so has a *high* sensitivity to *water temperature*. We also considered the degree of climatic change expected within each species' known range, also referred to as *exposure*. For example, in the instance of the bull trout, we evaluated the projected increase in water temperatures in streams across its range as a measure of its *exposure* to climate change. Finally, we assessed the availability and quality of reference data available as we made our determinations. In some cases, very limited information exists, while for others we found multiple sources of high quality data.

Our findings resulted in a preliminary 'climate watch" list, consisting of 35 species which ranked high for their vulnerability to climate change – meaning that they ranked high in both sensitivity and exposure to climate change. We only included animals on this list for which we found multiple, high quality references. This project also developed a framework for managers to apply climate information in their work to develop species management or recovery plans. Particularly for species ranking high in climate vulnerability, managers can now be explicit about how and why climate change may exacerbate existing stressors or pose new ones, and how management could be altered to better prepare for climate change.

3. Executive Summary

A recently completed project led by the Washington Department of Fish and Wildlife (WDFW) resulted in the integration of climate change into the 10-year revision of the Washington State Wildlife Action Plan (SWAP). All 50 states are required to update their SWAP at least every 10 years in order to qualify for certain kinds of funding for fish and wildlife conservation. Washington's update was due in 2015. Required elements of the SWAPs include a determination of species which are of greatest conservation need, known in the SWAP as "SGCN". For all SGCN identified, the SWAP requires a description of important habitats, identification of the key stressors affecting that species and its habitats, and the management actions needed to improve its conservation status. The comprehensive scope of the SWAP makes it an ideal opportunity to address climate considerations throughout the plan. WDFW was fortunate to partner with the NPLCC and a team from EcoAdapt, capably lead by lead scientist Dr. Jessi Kershner to develop and conduct this project. The primary audience for the project was WDFW, since the SWAP is produced and owned by the agency. However, we aimed to design the products so that they would be useful to other organizations interested in the conservation of fish, wildlife and their habitats in Washington.

The project consisted of four major tasks: (1) conduct a vulnerability assessment for all SGCN and ecological systems of concern, (2), integrate the findings from the vulnerability assessment into the SWAP, (3) develop a framework for applying information on climate vulnerability to evaluate management actions for SGCN, and finally, (4) conduct workshops and outreach on the project to staff and conservation partners.

Methodology

Task 1, conducting a vulnerability assessment, was the heart of this project and the most significant task in terms of workload and complexity. This task consisted of developing and populating a database for information regarding the climate vulnerability of 268 species of greatest conservation need and 80 ecological systems. We developed a spreadsheet and populated it with the following information for our selected SGCN and ecological systems.

1. Narrative description of species/ecological system sensitivity to climate change, and an assigned rank of 1-5 (numbers corresponding to ranks of low, low-moderate, moderate, moderate-high, high).
2. Assessment of confidence for the species/ecological system sensitivity rank, on a scale of 1-3 (low, medium or high, depending on the number and quality of references).
3. A list of the key exposure factors, and a rank for the exposure vulnerability, from 1-5 (low, low-moderate, moderate, moderate-high, high), for species and ecological systems of concern.
4. Assessment of confidence for the species/ecological system exposure rank, on a scale of 1-3 (low, medium, high, depending on the availability of projected future climate information, as well as spatially explicit range or habitat extent).
5. A list of references for each entry.

We clarified our definitions for the following terms: *sensitivity*, defined as a measure of whether and how a resource is likely to be affected by a given change in climatic factors, *exposure* - a measure of how much of a change in climate or climate-driven factors a resource is likely to experience, *vulnerability* - the degree to which a habitat or species is susceptible to, and unable to cope with adverse impacts of climate change, and *confidence* – a measure to reflect the sureness assessors had in a given sensitivity or exposure ranking.

To determine vulnerability to climate change, we evaluated sensitivity and exposure for each species or habitat, assessed confidence for each sensitivity and exposure evaluation, and scored overall vulnerability and confidence for a species or habitat. Each evaluation of sensitivity includes assigned rankings as well as short summaries describing key information from the scientific literature. The aim of the summaries that accompany rankings is to make the rationales and assumptions underlying the rankings and confidences assigned transparent. Each evaluation of exposure includes assigned rankings as well as a bulleted list of the key climate exposure factors for a given species or habitat. This list of exposure factors, along with the spatial location of a resource, was used to guide the literature review for future climate projections in order to assess the likelihood that these climatic factors would increase significantly within the next 20-40 years.

Based on the literature review, one of five rankings (High-5, Moderate-High-4, Moderate-3, Low-Moderate-2, or Low-1) was assigned each to sensitivity and exposure for a given species or habitat. Assigned rankings for sensitivity and exposure were then averaged to generate an overall vulnerability score for that particular species or habitat.

Sensitivity and exposure evaluations were also assigned one of three confidence rankings (High-3, Moderate-2, or Low-1); confidence reflects the sureness assessors had in a given sensitivity or exposure ranking and was based on the extent and quality of reference material. Confidence rankings for sensitivity *and* exposure were also averaged (mean) to generate an overall confidence score.

Results

Our results were summarized in narrative form in the SWAP, and included summaries for each taxa group – mammals, birds, reptiles and amphibians, fishes and invertebrates. In general we found that species with higher vulnerability rankings were often dependent on particularly vulnerable habitats, such white tailed ptarmigan, which is closely tied to high alpine environments. Other indicators of vulnerability were those species which occupied narrow thermal niches, such as certain salmonids or invertebrates, or had other specific habitat needs, such as shrub steppe obligates, or wolverines which are dependent on a persistent spring snowpack. In other cases, as with several bat species, reptiles and many invertebrates, we found a lack of information which limited our ability to assess a vulnerability rank with confidence. It should be noted that there was a limited timeframe to conduct this assessment, and that we expect to be able to improve some of these rankings over time.

We integrated these results throughout the SWAP. This included fact sheets developed for each species, habitat evaluations and to some extent, the discussion of management priorities needed to improve conservation status.

While the vulnerability assessment provided an important and critical foundation for understanding climate impacts to species, it was in some sense an interim product. Our overarching goal was to identify how we could apply what we learned from the vulnerability assessment to our management priorities. Should our proposed management actions or priorities change? For example, in some cases, climate change might exacerbate existing stressors for a particular species, and if so, should efforts to address those stressors increase in priority? Or perhaps climate change will introduce a new stressor which could affect a species conservation status and future management options. And for others, addressing existing, non-climate stressors such as development and habitat fragmentation may continue to be the most significant actions we can take. The sheer number of SGCN (268) prompted us to develop a framework and train staff in how to apply it to management priorities rather than attempt to conduct this analysis for all SGCN and Habitats of Greatest Conservation Need as identified through the SWAP.

This framework proposes a methodology for using the vulnerability assessment results to evaluate how climate change will impact the stressors already identified through the SWAP, and concurrently, how the identified management actions might help to mitigate the climate threat to a particular species. This approach is designed to evaluate the threat of climate change alongside existing threats, and help us to identify “climate informed” management options.

Next Steps

The final phase of this project was a series of workshops conducted for staff to introduce them to the results of the vulnerability assessment and the use of the framework. The workshops were well received and provided helpful feedback about opportunities to continue to improve the tool and our methodology. Our next steps, assuming sufficient resources and funding availability, include continuing to strengthen the data in the vulnerability assessment, packaging or grouping results in ways that could be helpful to advance conservation initiatives, and exploring ways to share our results with organizations conducting similar projects in our region. We are interested in finding ways to leverage this work with other organizations, and aligning work products as much as possible.

4. Background, Purpose and Objectives

The overarching goal for this project was to integrate climate change impacts and implications into major components of the Washington State Wildlife Action Plan (SWAP) Revision. All 50 states are required to update their SWAP every 10 years in order to qualify for certain kinds of funding for fish and wildlife conservation. Washington's update was due in 2015. Required elements of the SWAPs include a determination of species which are of greatest conservation need, known in the SWAP as "SGCN". For all SGCN identified, the SWAP requires a description of important habitats, identification of the key stressors affecting that species and its habitats, and the management actions needed to improve its conservation status. The comprehensive scope of the SWAP makes it an ideal opportunity to build in climate considerations throughout the plan. WDFW was fortunate to partner with the NPLCC and a team from EcoAdapt, capably lead by lead scientist Dr. Jessi Kershner to develop and conduct this project.

Original tasks

We originally laid out three major tasks aimed at integrating climate change into our SWAP, and subsequently added two additional ones:
<u>Task 1</u>: Integrate climate change into species specific information.
<u>Task 2:</u> Integrate climate change into habitat descriptions and assessments
<u>Task 3</u>: Summarize methodology and findings
<u>Task 4</u>: Evaluate stressors for highly vulnerable species and identify climate-related management actions.
<u>Task 5:</u> Host a workshop to introduce methodology and findings and gather feedback from agency experts and other conservation partners.

What we learned along the way

We modified these original tasks as the project progressed, in response to feedback from the cross agency steering committee guiding the development of the SWAP. This group raised concerns about the workload impacts on staff in terms of the timeframe and volume of material we were potentially asking them to review. We also made some changes to ensure that the products we developed would be useful and relevant not only for the purposes of the SWAP, but also to other programs at WDFW and our external conservation partners. The evolution of our concept and project design was particularly informed by the following observations during our process.

1. **<u>We recognized the need for a complete vulnerability assessment for all SGCN</u>**
   Soon after the project began we recognized the need to systematically evaluate all SGCN for climate sensitivity and exposure, using a consistent methodology that was embraced and vetted by WDFW. We had originally thought to focus only on highly vulnerable species, and to identify these species by extracting existing data as developed by the PNW Climate Sensitivity Database and other sources. However, we found that existing data contained information for only a subset of the species we needed to evaluate, and that the quality of information varied considerably.

   Task 1 thus evolved to create a complete climate vulnerability database for all 268 SGCN. While this task consumed the bulk of our time and resources during the first phase of the project, it has become clear that it filled a gap. The database has become an indispensable resource and served as a critical foundation for integrating climate change into the SWAP and more broadly, providing "at your fingertips" information about climate impacts on species to staff across the agency.

2. **<u>Selecting ecological systems as the classification for habitat</u>**
   The SWAP development team ultimately selected ecological systems (part of the National Vegetation Classification hierarchy) as the classification scheme for defining key habitats for SGCN. Task 2 thus

evolved to assessing climate vulnerability first for the 33 ecological systems of concern (as defined by the SWAP), and then expanded to include 80 of the most prevalent ecological systems in Washington.

3. **A new framework was needed for integrating climate into the discussion of management actions**
While we had originally intended to identify climate change related management actions in the SWAP for all species, our team recommended that we approach this task more strategically. There was some concern that we could over-emphasize the risk posed by climate change relative to other stressors. We wanted to approach this task thoughtfully, and develop a framework that encouraged evaluating existing risks and actions with a climate lens, and could help to highlight when additional action to address the added risk of climate change might be warranted. Task 3 focused then on developing a framework for conducting this analysis and on training staff how to use it appropriately. The SWAP climate vulnerability database provides the source information needed to apply the "climate lens".

Modified Tasks

Based on the lessons learned as described above, we modified our tasks as follows:

Task 1: Conduct a vulnerability assessment.

Research existing data sources in order to develop baseline information on climate vulnerability for all 268 SGCN and 33 ecological systems of concern (as well as an additional 57 ecological systems). Part of this task included assembling the data in a format which could be easily accessed and updated by WDFW staff and others.

Task 2: Integrate the results of the vulnerability assessment throughout the SWAP.

This included integrating climate into species and habitat fact sheets, as well as presentation of detailed climate vulnerability information for those species on the climate watch list. It also includes preparation of a chapter dedicated to describing the methodology and results of the vulnerability assessment, and an appendix to the SWAP with detailed information and references.

Task 3: Develop a framework for strategically applying climate vulnerability information to the identification and prioritization of management actions.

This task included incorporating input from WDFW biologists and developing a framework for using the data in the climate vulnerability database to create "climate informed" management actions for SGCN. The primary purpose is to assess how climate vulnerability might impact existing stressors and management actions, and when modifications or additions might be warranted.

Task 4: Conduct outreach and workshops

The primary purpose of the workshops was to train WDFW staff and other conservation partners on the methodology used to develop the vulnerability assessment in order that they could vet, update and improve the data over time. We also wanted to train staff in using the framework we developed for applying a climate lens to the management actions identified for SGCN as part of the SWAP.

Primary audience

The primary audience for this project was WDFW, since the SWAP is produced and owned by the agency. However, we aimed to design the products so that they would be of benefit and useful to other organizations interested in the conservation of fish, wildlife and their habitats in Washington.

5. Methods, Organization and Approach

Task 1: Conduct a Vulnerability Assessment

This task consisted of developing and populating a database for information regarding the climate vulnerability of 268 species of greatest conservation need and 80 ecological systems. We developed a spreadsheet and populated it with the following information for all SGCN and ecological systems. Each component is described in detail below.

- Narrative description of species/ecological system sensitivity to climate change, and a rank of 1-5.
- Assessment of confidence for the species/ecological system sensitivity rank, on a scale of 1-3
- A list of the key exposure factors, and a rank for the exposure vulnerability, from 1-5, for species and ecological systems of concern.
- Assessment of confidence for the species/ecological system exposure rank, on a scale of 1-3
- A list of references for each entry.

Vulnerability Assessment Methodology

To determine vulnerability to climate change, we evaluated sensitivity and exposure for each species or habitat, assessed confidence for each sensitivity and exposure evaluation, and scored overall vulnerability and confidence for a species or habitat. Note that the SWAP uses ecological systems to describe habitat types, and ecological systems of concern indicate those systems most imperiled. The terms habitats and ecological systems are used interchangeably in the SWAP, and in this final report.

Each evaluation of sensitivity includes assigned rankings as well as short summaries describing key information from the scientific literature. The aim of the summaries that accompany rankings is to make the rationales and assumptions underlying the rankings transparent. Each evaluation of exposure includes assigned rankings as well as a bulleted list of the key climate exposure factors for a given species or habitat. This list of exposure factors, along with the spatial location of a resource, was used to guide the literature review for future climate projections in order to assess the likelihood that these climatic factors would increase significantly within the next 20-40 years.

Based on the literature review, one of five rankings (High-5, Moderate-High-4, Moderate-3, Low-Moderate-2, or Low-1) was assigned each to sensitivity and exposure for a given species or habitat. Assigned rankings for sensitivity and exposure were then averaged to generate an overall vulnerability score for that particular species or habitat:

Defining Terms

Sensitivity: A measure of whether and how a resource is likely to be affected by a given change in climatic factors.

Exposure: A measure of how much of a change in climate or climate-driven factors a resource is likely to experience.

Vulnerability: The degree to which a habitat or species is susceptible to, and unable to cope with adverse impacts of climate change.

Confidence: For the purposes of this study, confidence reflects the sureness assessors had in a given sensitivity or exposure ranking.

Sensitivity and exposure evaluations were also assigned one of three confidence rankings (High-3, Moderate-2, or Low-1); confidence reflects the sureness assessors had in a given sensitivity or exposure ranking and was based on the extent and quality of reference material. Confidence rankings for sensitivity *and* exposure were also averaged (mean) to generate an overall confidence score.

Species Sensitivity

Species sensitivity to climatic factors may be direct (e.g., physiological) or indirect (e.g., ecological relationships). Sensitivity to climatic factors includes consideration of direct climate (i.e., temperature, precipitation) or climate-driven changes (e.g., pH, oxygen) or disturbance regimes (e.g., fire, flooding, extreme events). Physiological sensitivity refers to a species' physiological ability to tolerate changes that are higher or lower than the range of variability that they currently experience. Species that are able to tolerate a wide range of climatic factors may be considered less sensitive. The sensitivity of a species also depends on the sensitivity of its ecological relationships (e.g., habitat needs, diseases, predator-prey dynamics, foraging, pollination, competition). More generalist species (e.g., few to no dependencies on specific habitats, prey or forage species, etc.) are likely less sensitive to climate change effects, whereas specialist species that are dependent on specific habitats, prey or forage are likely more sensitive, particularly if those relationships are likely to be affected by climate change. For example, climate-driven changes in Clark's Nutcracker distribution or behavior could have a significant impact on whitebark pine regeneration, as this species is dependent on the Clark's Nutcracker for seed dispersal. Ecological relationships significantly affected by small changes in climatic factors likely confer a higher sensitivity to a species.

Evaluations of sensitivity for species considered the following factors:

- Physiology (e.g., limits to heat tolerance)
- Phenology dependencies (the timing of ecological events e.g., the availability of prey or forage species relative to migration timing)
- Other ecological relationships (e.g., competition, predator-prey dynamics)

Species sensitivity rankings were assigned as follows:

- Low: Unlikely to be affected by a given change in climatic factors. The species exhibits little to no physiological or phenological sensitivity to climatic factors. The species is more of a generalist with few to no dependencies (e.g., on specific habitat types, prey or forage species). For those dependencies that do exist, they are unlikely to be sensitive to climate change.
- Low-Moderate: May be somewhat affected by a given change in climatic factors but to a low degree. The species may exhibit some slight sensitivity to climatic factors in terms of physiology, phenology, and/or ecological relationships (e.g., habitat needs, forage or prey).
- Moderate: Likely to be noticeably but not significantly affected by a given change in climatic factors. The species exhibits a fair amount of sensitivity to climatic factors in terms of physiology, phenology, and/or ecological relationships.
- Moderate-High: Likely to be significantly affected by a given change in climatic factors. The species exhibits more significant sensitivity to climatic factors in terms of physiology, phenology, and/or ecological relationships.
- High: Likely to be substantially affected by a given change in climatic factors, with major implications for species long-term persistence. The species exhibits substantial physiological sensitivity to climatic factors AND/OR the species is more of a specialist with critical dependencies (e.g., on specific habitat types, prey or forage species) that are likely to be significantly affected by climate change.

Habitat Sensitivity

Habitat sensitivity to climatic factors includes consideration of whether the habitat occurs in a relatively narrow climatic zone, and/or whether it experiences large changes in structure or composition in response to relatively small changes in climatic factors. Sensitivity to climatic factors includes consideration of direct climate (i.e., temperature, precipitation) or climate-driven changes (e.g., pH, snowpack) or disturbance regimes (e.g., fire, flooding, insect and disease outbreaks, wind). More sensitive habitats are likely those that occur within a narrow climatic zone and/or experience large changes in composition or structure in response to small changes in climatic factors. Similarly, habitats may be at greater risk of decline, or elimination even, in response to small alterations in disturbance regimes. For example, altered fire regimes in grassland habitats may increase invasion rates and abundance of non-native annual grasses and weed species that out-compete native grasses.

Habitat sensitivity rankings were assigned as follows:

- Low: Unlikely to be affected by a given change in climatic factors. The habitat exhibits little to no change in structure or composition in response to changes in climatic factors or disturbance regimes, and/or does not occur in a relatively narrow climatic zone.
- Low-Moderate: May be somewhat affected by a given change in climatic factors but to a low degree. The habitat may exhibit some slight sensitivity to climatic factors in terms of changes in structure or composition.
- Moderate: Likely to be noticeably but not significantly affected by a given change in climatic factors. The habitat exhibits a fair amount of sensitivity to climatic factors in terms of changes in structure or composition, and/or may inhabit a somewhat narrow climatic zone, increasing its potential susceptibility to climate changes.
- Moderate-High: Likely to be significantly affected by a given change in climatic factors. The habitat exhibits more significant sensitivity to climatic factors in terms of changes in structure or composition, and/or occurs in a narrow climatic zone likely to be significantly affected by climate change.
- High: Likely to be substantially affected by a given change in climatic factors, with major implications for long-term persistence. The habitat exhibits substantial change in structure or composition in response to changes in climatic factors or disturbance regimes, and/or occurs in a narrow climatic zone likely to be eliminated or experience substantial declines due to climate change.

Assessing Exposure for Species and Habitats

An exposure evaluation for habitats or species includes considering exposure to climate changes (e.g., temperature and precipitation) as well as climate-driven changes and disturbance regimes (e.g., water chemistry, altered fire regimes, altered flow regimes). In particular, to what degree is the habitat or species likely to be exposed to and affected by a given change? As part of this evaluation, it is important to consider both the magnitude and rate of projected future change. In general, exposure for a given species or habitat was evaluated using downscaled climate projections (tables, narratives, figures) from various synthesis reports on climate change projections and impacts for the Pacific Northwest region, which included the following:

- Climate Impacts Group. 2009. The Washington Climate Change Impacts Assessment, M. McGuire Elsner, J. Littell, and L. Whitely Binder (eds). Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Oceans, University of Washington, Seattle, Washington.
- Gregg, R. M., K. M. Feifel, J. M. Kershner, and J. L. Hitt. 2012. The State of Climate Change Adaptation in the Great Lakes Region. EcoAdapt, Bainbridge Island, WA.
- Gregg, R.M., L.J. Hansen, K.M. Feifel, J.L. Hitt, J.M. Kershner, A. Score, and J.R. Hoffman. 2011. The State of Marine and Coastal Adaptation in North America: A Synthesis of Emerging Ideas. EcoAdapt, Bainbridge Island, WA.
- Mote, P., A. K. Snover, S. Capalbo, S. D. Eigenbrode, P. Glick, J. Littell, R. Raymondi, and S. Reeder. 2014: Ch. 21: Northwest. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 487-513. doi:10.7930/J04Q7RWX.
- Snover, A.K, G.S. Mauger, L.C. Whitely Binder, M. Krosby, and I. Tohver. 2013. Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers. State of

Knowledge Report prepared for the Washington State Department of Ecology. Climate Impacts Group, University of Washington, Seattle.

- State of Washington Department of Ecology. 2012. Preparing for a Changing Climate: Washington States Integrated Climate Response Strategy. Publication No. 12-01-004. Olympia, WA.
- Tillman, P. and Glick, P. 2013. Climate Change Effects and Adaptation Approaches for Terrestrial Ecosystems, Habitats, and Species: A Compilation of the Scientific Literature for the North Pacific Landscape Conservation Cooperative Region. National Wildlife Federation. Available at: http://www.nwf.org/~/media/PDFs/Global-Warming/2014/Terrestrial-Report/CC-and-Terrestrial-Systems_Final-Report_NPLCC-NWF_online-size.pdf
- Tillman, P. and Siemann, D. 2011. Climate Change Effects and Adaptation Approaches in Freshwater Aquatic and Riparian Ecosystems in the North Pacific Landscape Conservation Cooperative Region: A Compilation of Scientific Literature. National Wildlife Federation. Available at: http://www.nwf.org/~/media/PDFs/Global-Warming/2014/Freshwater-Report/NPLCC_Freshwater_Climate-Effects_Final.pdf
- Tillman, P. and Siemann, D. 2011. Climate Change Effects and Adaptation Approaches in Marine and Coastal Ecosystems of the North Pacific Landscape Conservation Cooperative Region: A Compilation of Scientific Literature. National Wildlife Federation. Available at: http://www.nwf.org/~/media/PDFs/Global-Warming/2014/Marine-Report/NPLCC_Marine_Climate-Effects_Final.pdf
- Washington Wildlife Habitat Connectivity Working Group (WHCWG). 2010. Washington Connected Landscapes Project: Statewide Analysis. Washington Departments of Fish and Wildlife, and Transportation, Olympia, WA.

Exposure rankings were assigned as follows:

- Low: Unlikely to be exposed to and affected by a given change in climatic factors.
- Low-Moderate: May be somewhat exposed to and affected by a given change in climatic factors but to a low degree.
- Moderate: Likely to be noticeably but not significantly exposed to and affected by a given change in climatic factors.
- Moderate-High: Likely to be significantly exposed to and affected by a given change in climatic factors.
- High: Likely to be substantially exposed to and affected by a given change in climatic factors, with major implications for long-term persistence.

<u>Overall Vulnerability</u>

In this particular context, vulnerability was evaluated by considering the sensitivity and exposure of the habitat or species to climatic factors. Vulnerability rankings were assigned as follows:

- Low: A combination of low or low-moderate sensitivity and exposure to climate change. Score range: 1-1.8
- Low-Moderate: A combination of low to moderate sensitivity and exposure to climate change. Score range: 1.81-2.6
- Moderate: Moderate sensitivity and exposure to climate change or some combination of high and low sensitivity and exposure. Score range: 2.61-3.4
- Moderate-High: A combination of moderate to high sensitivity and exposure to climate change. Score range: 3.41-4.2
- High: A combination of moderate-high or high sensitivity and exposure to climate change. Score range: 4.21-5

<u>Assessing Confidence</u>

Confidence can be defined as “the subjective assessment that any ranking will prove correct” (Schneider et al. 2007). Sensitivity and exposure evaluations were assigned one of three confidence rankings (High-3, Moderate-2, or Low-1). These approximate confidence levels were based on Manomet Center for Conservation Sciences (2012), which collapsed the 5-category scale developed by Moss and Schneider (2000) for the IPCC Third Assessment Report into a 3-category scale to avoid implying a greater level of certainty precision. Confidence rankings for sensitivity and exposure were averaged (mean) to generate an overall confidence score.

Confidence rankings were assigned as follows:
- Low: Little to no information exists in the scientific literature and/or information is characterized by high uncertainty.
- Moderate: Some (e.g., 1-3 scientific or gray literature reports or papers) exist for the sensitivity or exposure factors identified although there may be some uncertainty and/or conflicting information.
- High: Multiple (>3) scientific or gray literature sources exist for each sensitivity or exposure factor identified with less uncertainty.

Task 2: Integrate vulnerability assessment findings into the SWAP

Section 6 of this report, “Results” (p.17), includes a table which summarizes how and where in the SWAP we included climate change information. In addition to integrating climate throughout the report, we also added a new chapter, chapter 5 which focused exlusively on climate change. Here we presented a summary of expected climatic changes in the state and introduced the methodology for the vulnerability assessment. We also used this chapter to present highlights of the vulnerability assessment findings and include summarized results for the list of 33 species we placed on our “climate watch list” - those we considered highly vulnerable and for which we had a high degree of confidence.

Task 3: Develop a framework for applying climate vulnerability to the identification and prioritization of management actions.

Section 6 of this report also includes the framework that we developed to help staff evaluate how climate risks might affect existing stressors and management actions. Our overarching goal for this task, and the project overall, was to include sufficient climate information in the SWAP so as to be able to consider and evaluate the risks of climate change alongside existing stressors, and to be able to determine, if, when and how to change our management approach in order to effectively respond. However, with a scope that included 80 ecological systems and 268 SGCN, combined with a short timeline for completing the SWAP, we recognized that this evaluation will be an ongoing effort. We aimed to create the tools and integrate into management actions as opportunities and need arise.

Task 4: Conduct outreach and workshops

For this task we hosted three invitational workshops, and a webinar open to a broad audience. The webinar was oriented more as an introduction to the products of the vulnerability assessment, whereas the workshops were designed as a training session to ensure staff understood the methodology and appropriate uses of the information.

The workshops had two major objectives:
1. Train staff on the methodology used for the vulnerability assessment in order that they could understand how to evaluate the data and edit as needed. We also wanted them to be able to understand the appropriate uses of the data; for example, to inform management decisions or contribute to other documents and publications on species status and/or recovery needs.
2. Introduce a framework to allow staff to explore in a structured way how to evaluate the relative risk of climate change alongside existing stressors. We wanted to use the information developed for the SWAP on species stressors and management actions needed, and demonstrate how to apply a climate lens (using the vulnerability assessment products) to inform management.

Number and types of workshops

We held two workshops for WDFW staff and other conservation partners (staff from the NPLCC and our Department of Natural Resources participated). One was held on February 11th, 2016 as a full day workshop, and the second was a half day workshop held on February 12th, 2016 designed for managers. We also held a half day workshop on June 15th, 2016 for USFWS staff in the Washington Field Office. A sample agenda for the workshops can be found in Attachment 1.

6. Project Results

Task 1: Conduct a Vulnerability Assessment

As mentioned in the previous section, this task consisted of developing a baseline database to collect information regarding the climate vulnerability of 268 species of greatest conservation need and 80 ecological systems. To accomplish this task we designed a spreadsheet and populated it with the following information for all SGCN and ecological systems:

- Narrative description of species/ecological system sensitivity to climate change, and a rank of 1-5.
- Assessment of confidence for the species/ecological system sensitivity rank.
- A list of the key exposure factors, and a rank for the exposure vulnerability, from 1-5, for species and ecological systems of concern.
- Assessment of confidence for the species/ecological system exposure rank
- A list of references for each entry.

Example of spreadsheet

Below is a screen shot of the spreadsheet in order to illustrate how the information is organized. Separate tabs are available for each taxa group; mammals, birds, amphibians, reptiles and invertebrates. The entire spreadsheet is available as Attachment 2 of this report.

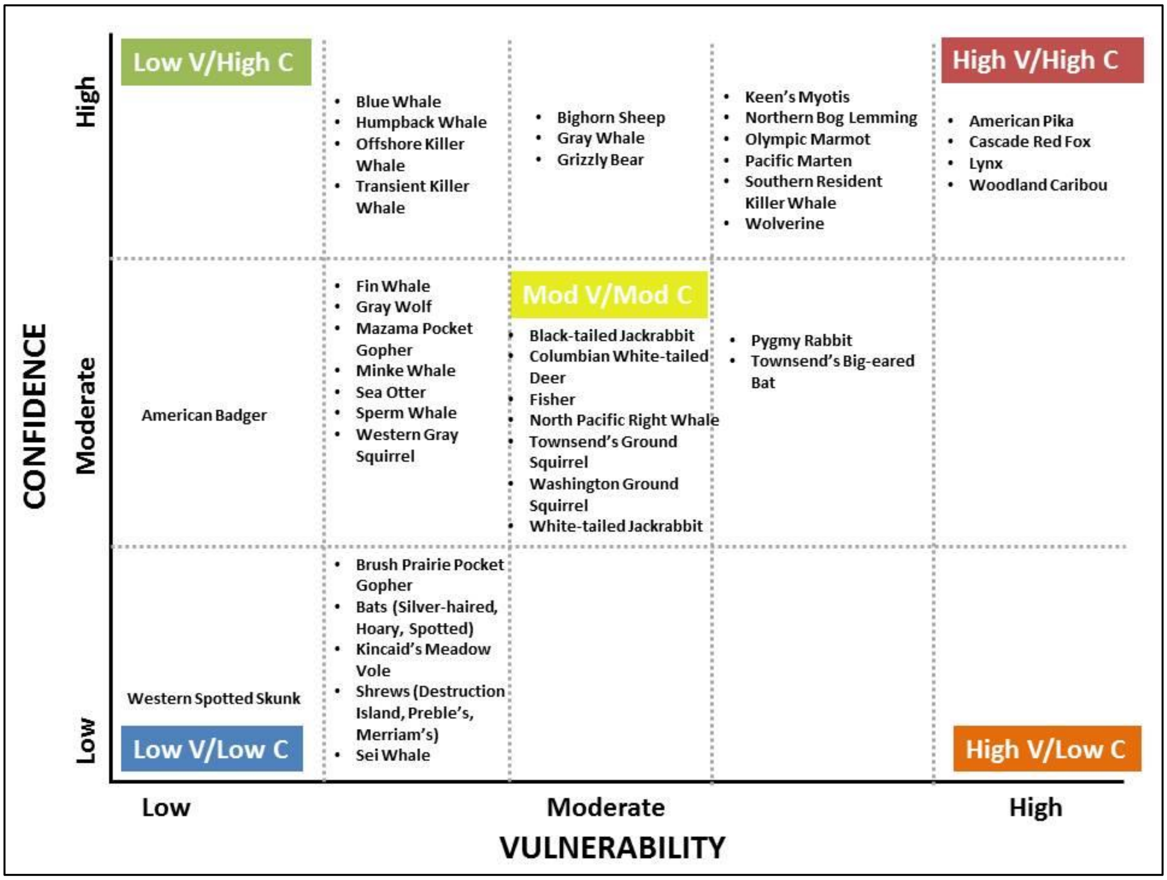
Common Name	Scientific Name	Vulnerability Ranking	Overall Confidence	Sensitivity Ranking	Confidence in Sensitivity Rank	Exposure Ranking	Confidence in Exposure Rank	Description of Sensitivity	Description of Exposure	References
Beller's ground beetle	Agonum belleri	Mod-High	Mod	Mod	Mod	Mod-High	Mod	Beller's ground beetles inhabit sphagnum bogs or sphagnum moss in other wet areas (e.g., near springs), preferring the wettest sites available. This species' sensitivity to climate change will largely be driven by shifts in habitat availability. Reduced water availability and quality (i.e., due to precipitation shifts, reduced snowpack, earlier snowmelt) can affect bog water levels, seasonal bog duration, and rates of succession to meadow or other adjacent vegetation, potentially reducing or degrading habitat for this beetle. This species is likely sensitive to both bog drying and prolonged inundation from flooding.	> Changes in precipitation (snow and rain) > Increased amount and/or duration of flooding > Drought	1) LaBonte, J. R. (1995). Possible threatened or endangered terrestrial predaceous Coleoptera of the Columbia River Basin. Report prepared for the Bureau of Land Management/US Forest Service, Eastside Ecosystem Management Project. 2) Foltz, S. (2009). Species Fact Sheet: Agonum belleri. Xerces Society for Invertebrate Conservation. 3) Hamer Environmental. (2003). Analysis Species Assessment: Beller's Ground Beetle (Agonum belleri). Final Report prepared for Puget Sound Energy. FERC Project No. 2150. 4 pp.
Columbia River tiger beetle	Cicindela columbica	Mod	Mod	Mod	Mod	Mod	Mod	The Columbia River tiger beetle occupies stable river sandbars and riparian sand dunes. They are likely sensitive to flooding, soil moisture, and temperature. Soil moisture and temperature may affect larval development, as larvae grow and molt in sand/soil burrows that draw moisture from adjacent rivers/streams.	> Increased amount and/or duration of flooding	1) LaBonte, J. R. (1995). Possible threatened or endangered terrestrial predaceous Coleoptera of the Columbia River Basin. Report prepared for the Bureau of Land Management/US Forest Service, Eastside Ecosystem Management Project. 2) The Xerces Society for Invertebrate Conservation, http://www.xerces.org/columbia-river-tiger-
Hatch's click beetle	Eanus hatchii	Mod-High	Low	Mod	Low	Mod-High	Mod	Hatch's click beetles occupy low elevation sphagnum bogs, and their climate sensitivity is likely driven by changes in habitat availability. Reduced water availability and quality (i.e., due to precipitation shifts, reduced snowpack, earlier snowmelt) can affect bog water levels and seasonal bog duration, potentially altering habitat extent.	> Changes in precipitation (snow and rain) > Increased amount and/or duration of flooding > Drought > Increased	1) The Xerces Society for Invertebrate Conservation, http://www.xerces.org/eanus-hatchi/ 2) Hamer Environmental. (2003). Analysis Species Assessment: Hatch's Click Beetle (Eanus hatchi). Final Report prepared for Puget Sound Energy. FERC Project No. 2150. 4 pp. 3) Foltz, S. (2009). Species Fact Sheet: Eanus hatchii. USDA Forest Service.

Summaries of Vulnerability Assessment Results for SGCN, by Taxa Group

Following is an excerpt from Chapter 5 in the SWAP. Here we provided summaries of the vulnerability assessment results for each taxa group: mammals, birds, amphibians, reptiles, fishes and invertebrates. These summaries also include a graphic which compares the vulnerability ranking on the x-axis, and the confidence ranking on the y-axis. This figure allows a more nuanced view of vulnerability, and can help to illustrate appropriate management options. For example, feasible adaptation approaches might depending on location within the figure, as described below.

- **Low Vulnerability**
  Focus on reducing current stressors as these likely represent a greater threat to these species. For species with low confidence, managers could consider gathering and integrating additional data to refine vulnerability information and improve confidence.
- **Moderate Vulnerability**
  Focus on identifying possible interactions between climate and non-climate stressors, as non-climate stressors may have the potential to exacerbate climate impacts. Other options include reducing current stressors, enhancing knowledge to refine vulnerability information and improve confidence evaluation (e.g., for low or moderate confidence), or increasing or enhancing monitoring to include evaluation of climate stressors.
- **High Vulnerability**
  Focus on reducing climate stressors as these likely represent a significant threat to these habitats. Additionally, those habitats with low or moderate confidence could be prioritized for monitoring to determine if and when impacts occur. High vulnerability and high confidence habitats may also provide an opportunity to review and modify actions for reducing non-climate stressors so that they help to ameliorate the effects of climate change.

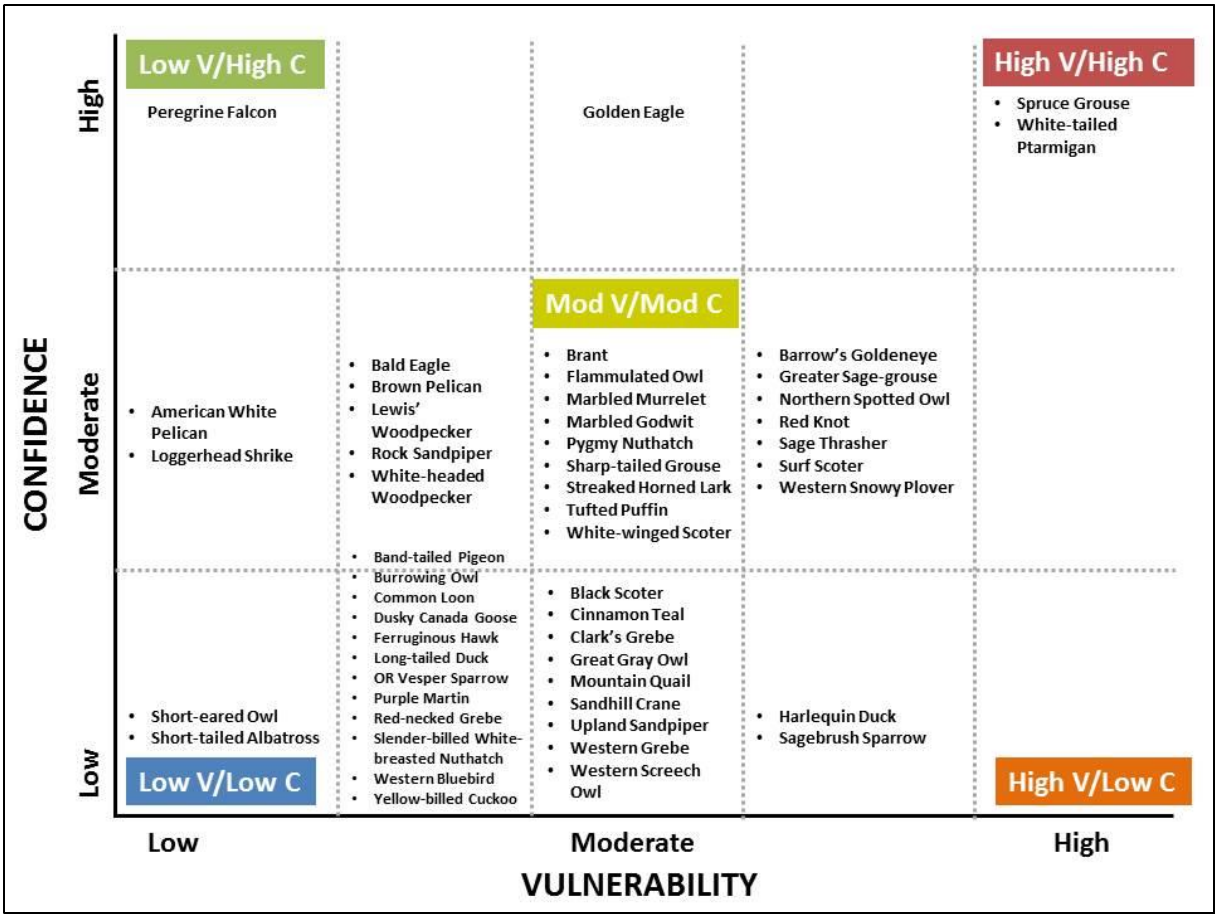
SGCN Mammals- **Vulnerability (V) and Confidence (C)**



Mammals

Species with higher vulnerability, such as American Pika, Olympic Marmot, Wolverine, Lynx, Cascade Red Fox, and Pacific Marten occupy higher elevation habitats such as alpine and subalpine forests, meadows, and parklands and are sensitive to warming temperatures and reduced snowpack. Species evaluated with moderate-high or high vulnerability but only moderate confidence included Pygmy Rabbit and Townsend's Big-eared Bat – we will aim to add to our references and improve these rankings as we can. Hoary, Spotted, and Silver-haired Bats all had a lower overall vulnerability ranking as they tend to occupy a range of habitats and/or exhibit a generalist diet. Many marine mammals including Blue, Fin, Humpback, Sperm, Minke, and Sei Whales; Transient/Offshore Killer Whales, and Sea Otters were evaluated as having low-moderate overall vulnerability. Sensitivity for many of these marine mammals was primarily driven by prey availability, although many species (e.g., Sea Otters, Sei, Minke, Fin Whales) are able to switch prey species, lowering overall sensitivity. A number of small mammal species had little to no information on climate sensitivity including the Brush Prairie Pocket Gopher, Destruction Island Shrew, Kincaid's Meadow Vole, Mazama Pocket Gopher, Preble's Shrew, and Western Spotted Skunk. We intend to build this data as information becomes available.

SGCN Birds – Vulnerability (V) and Confidence (C)

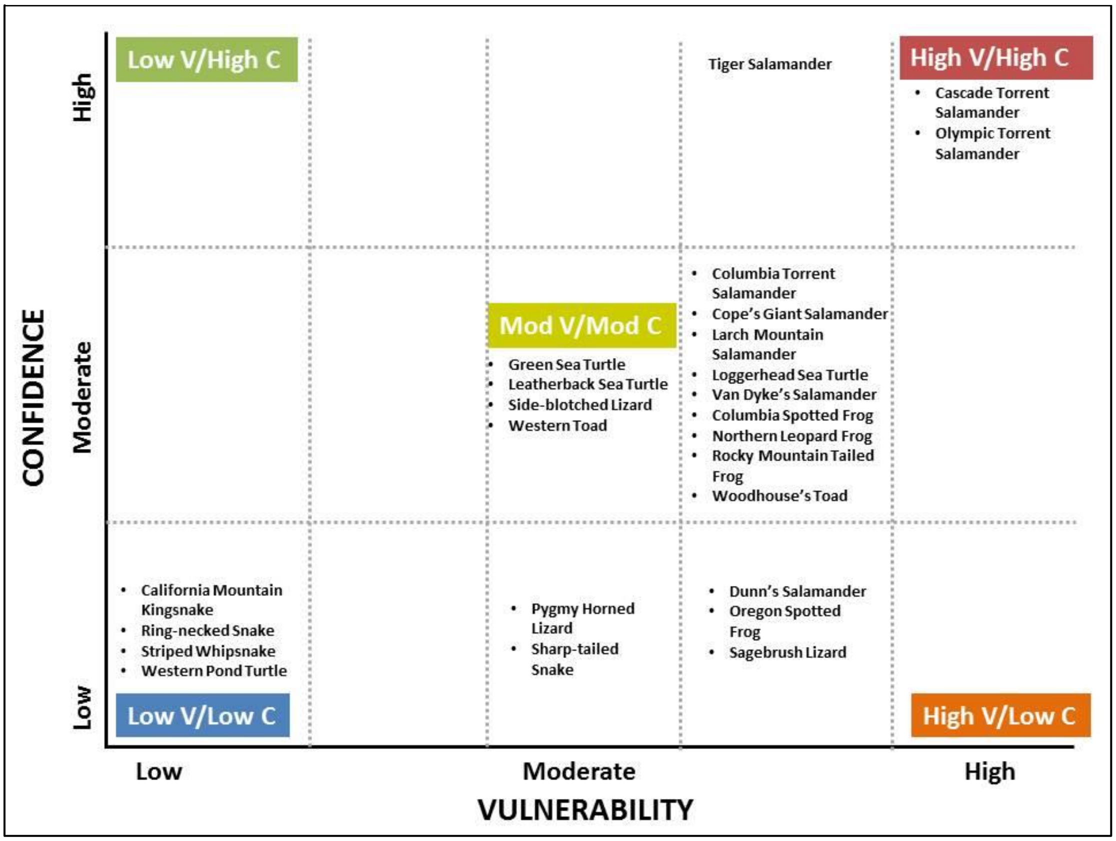


Birds

Species evaluated with moderate-high or high vulnerability but low or moderate confidence included Barrow's Goldeneye, Harlequin Duck, Greater Sage-grouse, Northern Spotted owl, Red Knot, Sage Thrasher, Sagebrush Sparrow, Surf Scoter, and Western Snowy Plover. Birds utilizing higher elevation habitats (e.g., White-tailed Ptarmigan and Spruce Grouse) as well as sagebrush-obligate species such as Greater Sage-grouse, Sage Thrasher, and Sagebrush Sparrow exhibit high sensitivity due to potential climate impacts on habitats (e.g., higher elevation habitats have higher vulnerability to warming temperatures and reduced snowpack while sagebrush habitats have higher vulnerability to altered fire regimes and invasive weeds). The sagebrush-obligates are not on the climate watch list because of a lower confidence level in exposure - the rate and timing of climate changes to the species range.

Coastal species such as Red Knot, Surf Scoter, and Western Snowy Plover exhibit high vulnerability due to sea level rise impacts on nesting and/or foraging habitat, as well as climate-driven changes in phenology resulting in timing mismatches with prey availability. Many species evaluated as having low or low-moderate overall vulnerability are considered generalist species or are highly adaptable (e.g., occur within a range of habitats, including human-altered landscapes); e.g., Bald Eagle, American White and Brown Pelicans, Dusky Canada Goose, Loggerhead Shrike, and Peregrine Falcon.

SGCN Reptiles and Amphibians *– Vulnerability (V) and Confidence (C)*

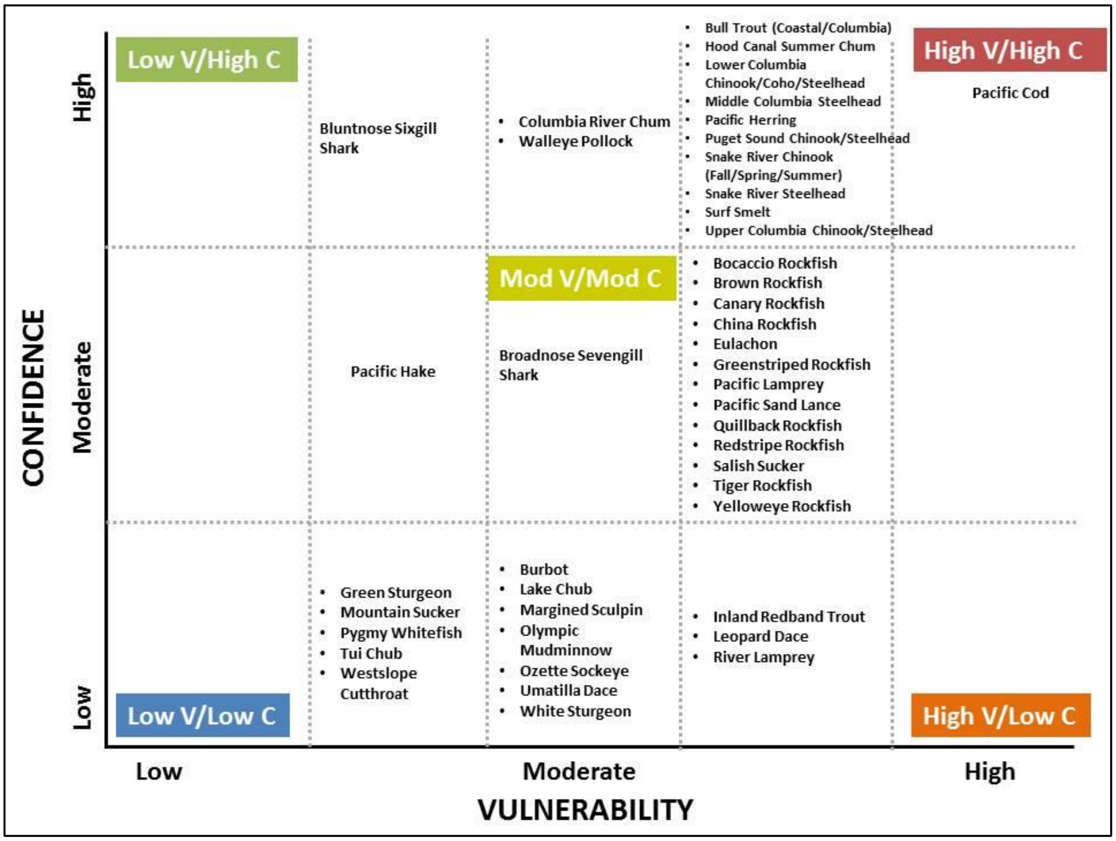


Reptiles and Amphibians

All salamanders were evaluated as having moderate-high or high sensitivity to climate change due to physiological sensitivity to heat and desiccation and/or their dependence on specific habitats that are sensitive to changes in water supply (e.g., decreased precipitation or snowpack) that dry or reduce available habitat and/or shifts from snow to rain that lead to erosion and scouring of habitats. Cascade Torrent, Columbia Torrent, Olympic Torrent and Cope's Giant Salamanders exhibit greater vulnerability due to their association with headwater habitats that are sensitive to rain-on-snow events. Species evaluated with moderate-high or high vulnerability but low or moderate confidence included: Columbia Spotted Frog, Columbia Torrent Salamander, Cope's Giant Salamander, Dunn's Salamander, Larch Mountain Salamander, Northern Leopard Frog, Oregon Spotted Frog, Rocky Mountain Tailed Frog, Van Dyke's Salamander, Western Toad, and Woodhouse's Toad. The low confidence ranking was largely due to lack of information.

No reptiles were evaluated as having moderate-high or high vulnerability *and* high confidence. Species evaluated with moderate-high or high vulnerability but low or moderate confidence included: Loggerhead Sea Turtle and Sagebrush Lizard. The Green Sea Turtle, Loggerhead Sea Turtle, and Leatherback Sea Turtle exhibit moderate or moderate-high sensitivity to climate change (e.g., increased ocean temperatures, declines in pH) however, exposure is thought to be moderate in this region. Side-blotched and Pygmy Horned Lizard both exhibit moderate vulnerability primarily due to their association with shrub-steppe habitats that are sensitive to altered fire regimes and invasive weeds that degrade or eliminate habitat. Overall, there is a lack of information regarding sensitivity of all snake species evaluated, which led to low or moderate vulnerability rankings.

SGCN Fishes – Vulnerability (V) and Confidence (C)

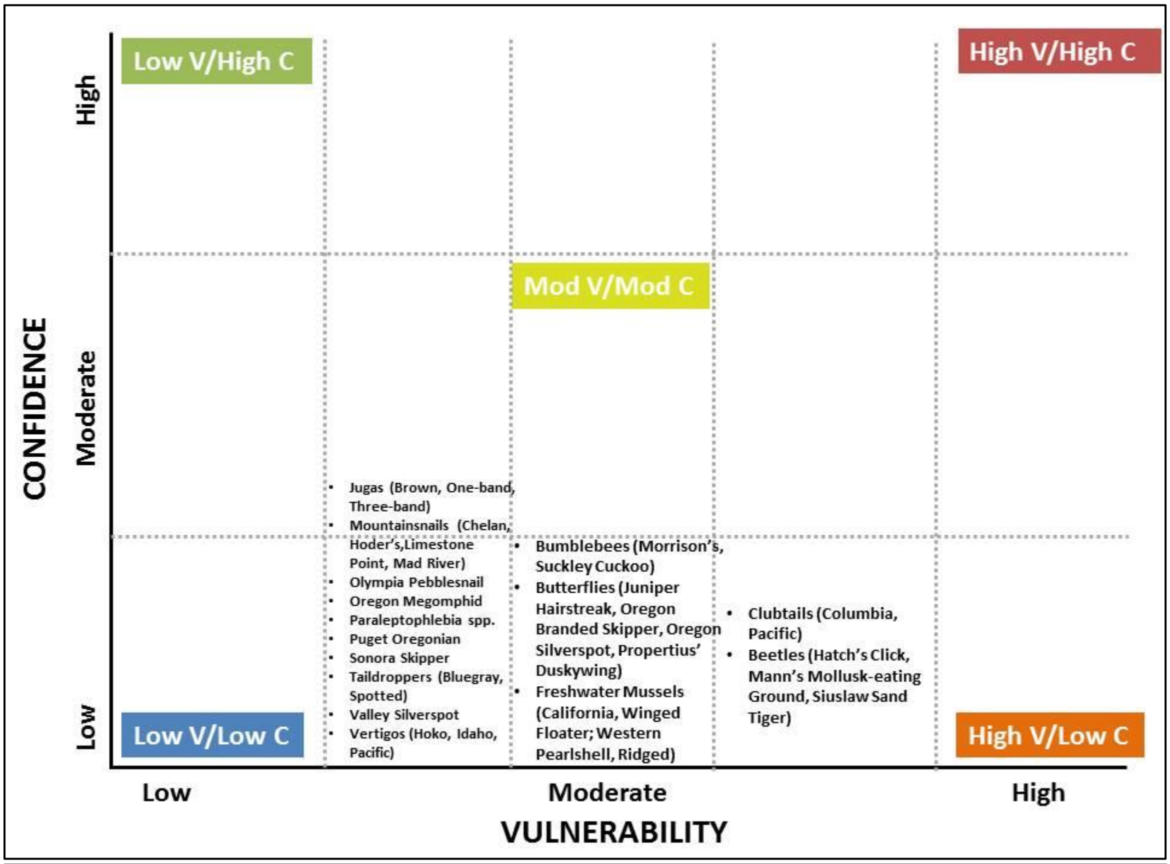


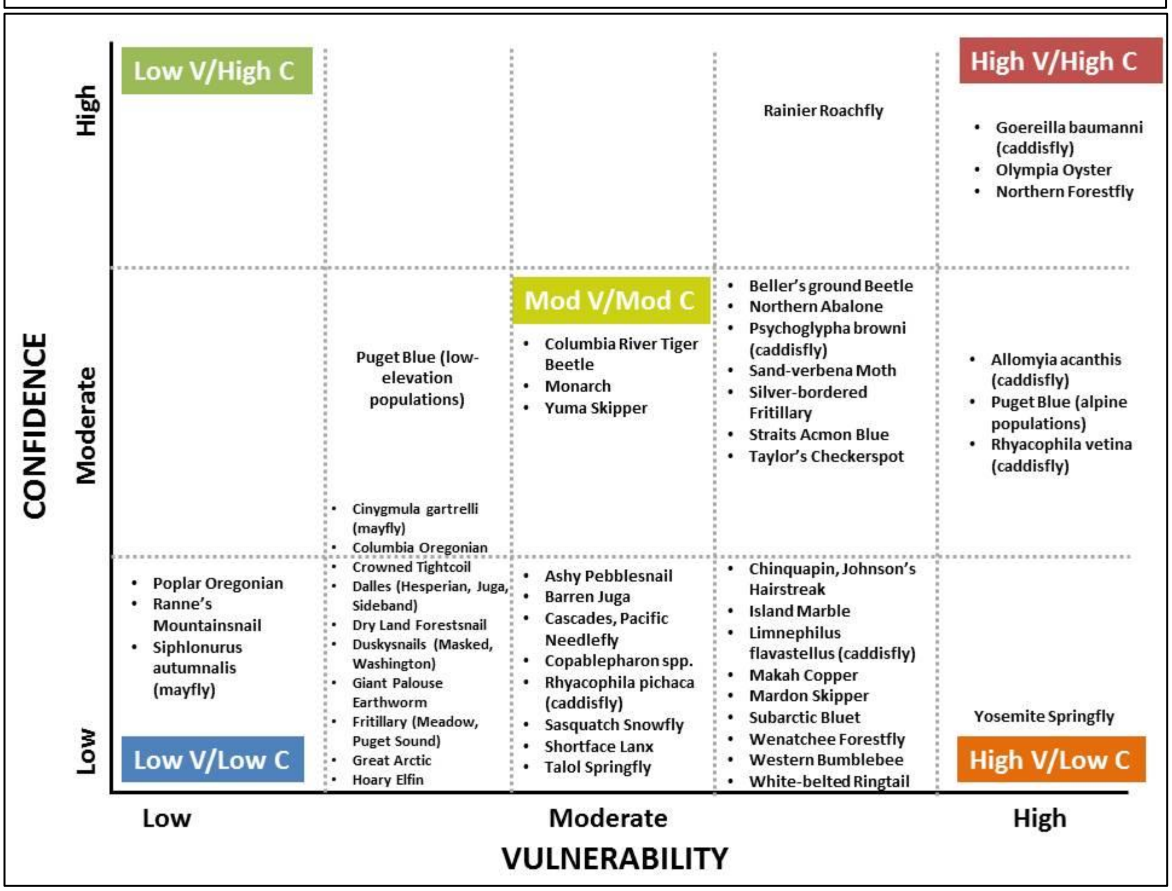
Fishes

Pacific Cod, Pacific Herring, and Surf Smelt sll received moderate-high or high vulnerability and high confidence scores – Pacific Cod and Pacific Herring primarily because of warming sea surface or ocean temperatures that can affect prey availability and/or spawning and recruitment, and Surf Smelt because of potential reductions in beach spawning habitat due to sea level rise. Species evaluated with moderate-high or high vulnerability but low or moderate confidence included: Bocaccio, Brown, Canary, China, Copper, Greenstriped, Quillback, Redstripe, Tiger and Yelloweye Rockfishes; Eulachon; Inland Redband Trout; Leopard Dace; Pacific Lamprey; Pacific Sand Lance; River Lamprey; and Salish Sucker.

In general, rockfish species were evaluated as having moderate sensitivity to climate change due to potential impacts to their prey base and habitat requirements. Key exposure factors for Washington including increased ocean temperatures, declines in pH, sea level rise, and decreased oxygen contributed to an overall moderate-high vulnerability evaluation. While Bull Trout (Coastal and Mid-Columbia) received moderate-high vulnerability rankings, some of the literature suggests that future exposure to warmer temperatures, lower flows, and higher flows may be moderate within current distributions. Chinook, Coho, and Steelhead of the Lower and Upper Columbia and Snake River received moderate-high vulnerability rankings due to higher sensitivities and projected future exposure to warmer water temperatures and lower low flows. Puget Sound Chinook and Steelhead received moderate-high vulnerability rankings due to moderate future exposure to warmer water temperatures and lower summer flows but higher exposure to increased high flow events.

SGCN Invertebrates *– Vulnerability (V) and Confidence (C)*





Invertebrates
Species evaluated with moderate-high or high vulnerability but low or moderate confidence included: Beller's Ground Beetle, Butterflies (see list below), Caddisflies (Limnephilus flavastellus, Psychoglypha browni), Northern Abalone, Sand-verbena Moth, Subarctic Bluet, Wenatchee Forestfly, Western Bumblebee, and White-belted Ringtail. Butterfly species such as Chinquapin and Johhson's Hairstreak, Island Marble, Mardon Skipper, and Taylor's Checkerspot exhibit both direct (e.g., activity and emergence are influenced by temperature) and indirect sensitivity to climate (i.e., due to habitat specialization). Similar to butterflies, dragonfly species exhibit moderate-high to high direct and indirect sensitivity to climate change; temperature is known to influence the phenology, development, and behavior of dragonflies while altered flow regimes and reduced water supply may degrade aquatic habitat.

Several species of caddisflies including Allomyia acanthis, Goereilla baumanni, Limnephilus flavastellus, and Psychoglypha browni received moderate-high vulnerability rankings, primarily due to climate impacts on specialized habitat requirements (e.g., cold water streams). Marine invertebrate species including the Northern Abalone and Olympia Oyster received moderate-high or high vulnerability rankings due to high sensitivity and exposure to declines in pH. All snail species were evaluated as having low or low-moderate sensitivity to climate change, although these rankings could change as more information becomes available. Similarly, a number of invertebrate species had little to no information on climate sensitivity including Cryptomastix mullani hemphilli, Leschi's Millipede, Mission Creek Oregonian, Nimapuna Tigersnail, and the Salmon River Pebblesnail.

Summaries of Vulnerability Assessment Results for Habitats
The SWAP uses two vegetation levels as described in the National Vegetation Classification System; vegetation formations, and ecological systems. These two vegetation levels provide for a general (formation level) to a more specific (ecological system level) assessment of habitat needs for multiple SGCN. We included a general assessment of climate vulnerability for each of the 18 major formations occurring in Washington, as summarized below. For the SWAP, we assessed the 30 ecological systems of concern (those considered most in conservation need). After completion of the SWAP we completed additional vulnerability assessments for the remaining 50 most prevalent ecological systems in the state.

The complete descriptions of these assessments can be found in Chapter 5 of the SWAP, as well as in Attachment 3 to this report. Similar to the figures provided above to summarize climate vulnerability for SGCN, we have included a figure which contrasts confidence and vulnerability for the 30 ecological systems of concern included in the SWAP.

Climate Vulnerability for Vegetation Formations

Climate Change Vulnerability Summaries for Washington Vegetation Formations

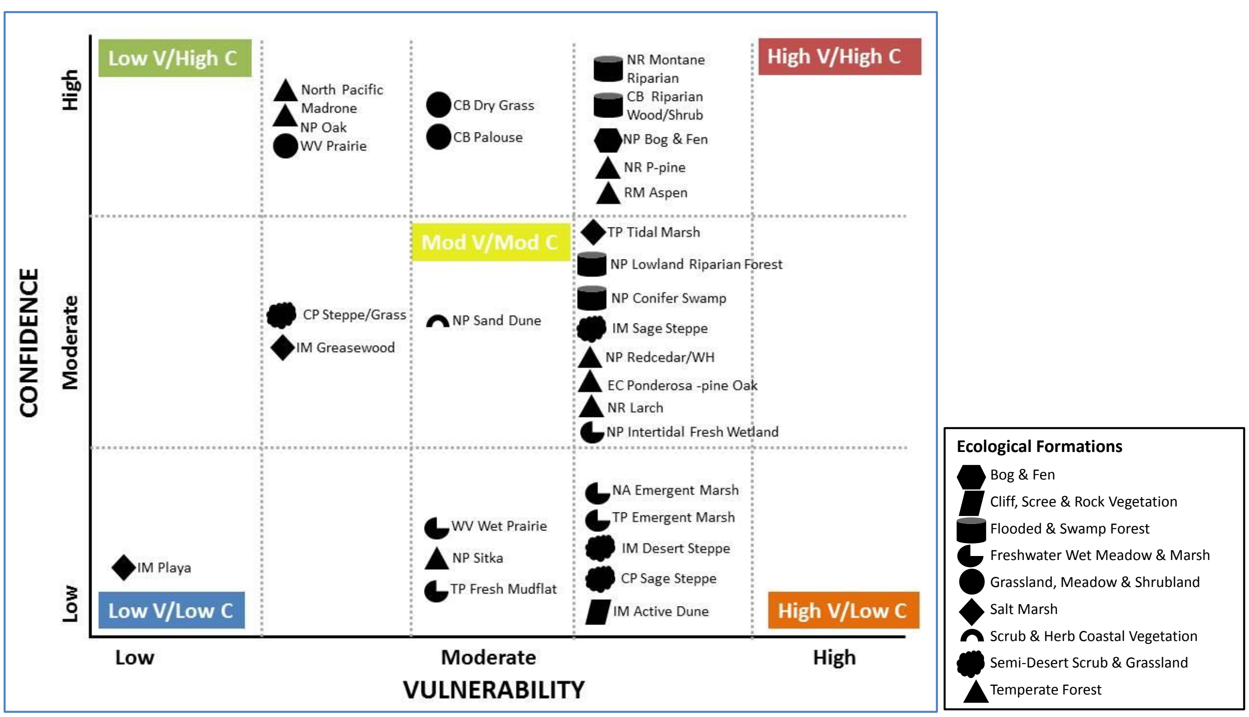
FORMATION	DESCRIPTION OF VULNERABILITY
Alpine Scrub, Meadow & Grassland	Climate change, which may result in reduced snowpack and encroachment by trees and shrubs is considered a major stressor.
Barren	Climate change is a significant stressor for the Alpine Ice Field ecological system (decline of glaciers and reduction in snowpack) and unconsolidated shore in coastal areas (sea level rise, shoreline armoring limiting the flow of sediment).
Bog & Fen	Climate changes such as decreased precipitation, reduced snowpack, or prolonged drought that reduce water availability and recharge may lead to range contraction and/or habitat conversion, increased invasion of dry-adapted species, or tree encroachment in bog and fen habitats. Shifts from snow to rain that enhances winter/spring flood risk may increase erosion of moist peat and topsoil, reduce opportunities for recharge, and/or lead to drying of habitats.

FORMATION	DESCRIPTION OF VULNERABILITY
Cliff, Scree & Rock Vegetation	Climate change could alter species composition of this system possibly by allowing more vascular plant species to establish as well as a shift in species composition. Inter-mountain basins active and stabilized dune habitats are highly dynamic by nature, with varying vulnerabilities to climate changes such as increased temperatures and moisture stress. High moisture years enhance dune stabilization by limiting sand movement and/or favoring invasive vegetation establishment (e.g., cheatgrass) and dominance, whereas warmer, drier years enhance dune erosion and movement, facilitating habitat diversity and/or the establishment of new habitat areas.
Flooded & Swamp Forest	Flooded and swamp forests are generally adapted to high moisture levels, making them vulnerable to projected climate changes in hydrology and fluvial processes from precipitation shifts, reduced snowpack and earlier snowmelt, drought, and altered flow regimes. Declining summer and spring stream flows, particularly when combined with drought, could reduce available water for riparian communities, affecting seedling germination and adult survival and potentially contributing to shifts to more xeric and drought-adapted vegetation. Increasing winter flood frequency and volume may also affect vegetation composition, potentially selecting for hardwoods, smaller trees, and younger age classes. Alteration of seasonal and annual flooding regimes will likely alter vegetation establishment, succession, and composition. Drought periods may exacerbate fire risk.
Freshwater Aquatic Vegetation, Wet Meadow & Marsh	Climate changes such as drought, increasing temperatures, and changes in precipitation type, timing, and amount that alter hydrologic regimes and rates of evaporation and recharge may have significant impacts in wetland habitats. For example, these climate changes could lead to wetland drying, shifts in species assemblages (native and non-native), habitat conversion, and/or decreased quality and quantity of habitat available for aquatic biota. Changes in winter precipitation type and timing, as well as earlier runoff, could positively (e.g., create side channels or additional habitat) or negatively (e.g., reduced opportunities for water storage and recharge, increased erosion) impact these habitats. Intertidal freshwater wetlands are also vulnerable to rising sea levels and intrusion of brackish water that can lead to vegetation changes, increased eutrophication, and expansion of invasive plant species.
Grassland, Meadow & Shrubland	In general, prairies and grasslands are well-adapted to warm and dry conditions and periodic soil drought, and projected future increases in temperature and/or drought for the region are unlikely to disadvantage (and may benefit) these systems. Grasslands may be somewhat sensitive to altered wildfire regimes, particularly increased fire frequency or severity that could limit native species regeneration or increase invasion rates and abundance of non-native annual grasses and weeds. However, increases in wildfire may also benefit grasslands and savannas by preventing conifer encroachment. Conifer encroachment associated with warmer temperatures likely represents the greatest stressor for alpine and subalpine meadows, shrublands, and grasslands.
Open Water	Climate changes such as reduced glacial and snowpack runoff as well as more frequent, intense, and longer-lasting droughts may affect replenishment of open water systems. Increased water temperatures and changes in precipitation type, timing, and amount that lead to altered flow regimes and/or shifts in water supply represent important climatic stressors for open water. Warming water temperatures may cause shifts in species distribution, phenology, and life histories. Changes in precipitation type, timing, and amount may affect habitat complexity, quality, and quantity; reduce connectivity of aquatic habitats; modify food web structure or productivity; or cause range contraction or loss of local species.
Salt Marsh	Climate changes that lead to changes in water levels may impact inter-mountain basin playa, alkaline closed depressions and greasewood flats. Changes in precipitation may lead to fluctuations in salinity levels (e.g., increased salinity with decreased precipitation), which could lead to shifts in vegetation composition. Increases in runoff that increase nutrient levels in basin playas and alkaline closed depressions could also threaten vegetation. Projected sea level rise represents a key climate stressor for tidal salt and brackish marshes, as it could lead to submergence of habitats and declines in vegetation unless they are able to migrate inwards through sediment accretion.

FORMATION	DESCRIPTION OF VULNERABILITY
Scrub & Herb Coastal Vegetation	Sea level rise, increased coastal erosion, and increased storminess and wave action represent significant climate stressors. Projected sea level rise could cause erosion and/or landward shift of dunes and cliffs. Similarly, greater wave and wind action from storms could cause increased disturbance and erosion of cliffs, dunes, and dune vegetation. Climate induced-changes or declines in dune vegetation that help stabilize and protect dunes could make dune habitat more vulnerable to disturbances from increased erosion, waves, and winds.
Semi-Desert Scrub & Grassland	Climate changes including shifts in precipitation, drought, and altered fire regimes may affect plant composition, density, and distribution in semi-desert scrub and grassland habitats. Precipitation likely influences plant composition, growth, and recruitment, and drought negatively affects seedling survival in sagebrush systems, reduces shrub cover, and elevates herbaceous diversity and cover. Increasing fire frequencies and/or intensities will likely negatively affect sagebrush and shrub habitats, and may favor grassland expansion. However, fire also favors cheatgrass and other non-native annual establishment, which can alter ecosystem function.
Temperate Forest	Increasing temperatures, decreased moisture availability, and altered fire regimes represent the most significant climate stressors to temperate forests. Altered fire regimes appear to be the greatest threat, particularly given fire suppression practices of the past century that have led to the invasion of shade-tolerant and fire-intolerant species and/or altered forest structure and composition (i.e., increased stand density, smaller diameter trees. Warmer temperatures and decreased moisture availability may increase insect outbreaks in some temperate forests. In general, North Pacific temperate forests likely exhibit less vulnerability to climate change than temperate forests of the East Cascades and Rocky Mountains.

Ecological Systems of Concern at highest risk from climate change

This figure summarizes the vulnerability and confidence ranks for all of the ecological systems of concern – the symbols indicate the formation in which the ecological system is found. Note that the list below represents only a partial list of the ecological systems of concern currently found in Washington.



Climate Watch List
Finally, below is a list of those SGCN which we ranked high or moderate-high in regards to climate vulnerability, and with a high degree of confidence. This list is intended to be used to indicate when climate change must be considered when developing management or recovery plans.

Preliminary Climate Watch List – SGCN with moderate-high or high vulnerability and high confidence

MAMMALS	American Pika Cascade Red Fox Keen's Myotis Killer Whale Lynx Northern Bog Lemming Olympic Marmot Pacific Marten Wolverine Woodland Caribou
BIRDS	Spruce Grouse White-tailed Ptarmigan
AMPHIBIANS	Cascade Torrent Salamander Olympic Torrent Salamander Tiger Salamander
FISHES	Bull Trout Coastal Recovery Unit Bull Trout Mid-Columbia Recovery Unit Hood Canal Summer Chum ESU Lower Columbia Chinook ESU Lower Columbia Coho ESU Lower Columbia Steelhead DPS Middle Columbia Steelhead DPS Pacific Cod (Salish Sea Population) Pacific Herring Puget Sound Chinook ESU Puget Sound Steelhead DPS Snake River Chinook – Spring/summer ESU Snake River Basin Steelhead DPS Surf Smelt Upper Columbia Spring Chinook ESU Upper Columbia Steelhead DPS
INVERTEBRATES	Caddisfly ((Goereilla baumanni) Northern Forestfly Rainier Roachfly Olympia Oyster

Where to find the spreadsheets
The SGCN climate vulnerability spreadsheet is available as Attachment 2, and the Ecological system is available as Attachment 3 to this report. WDFW staff have been working on vetting the data in the SGCN spreadsheets, and the version attached reflects current edits. We are still working on securing the resources for staff in the Washington Natural Heritage Program to review and vet the data and rankings in the Ecological System Climate Vulnerability Spreadsheet.

Task 2: Integrate Vulnerability Assessment Findings into the SWAP

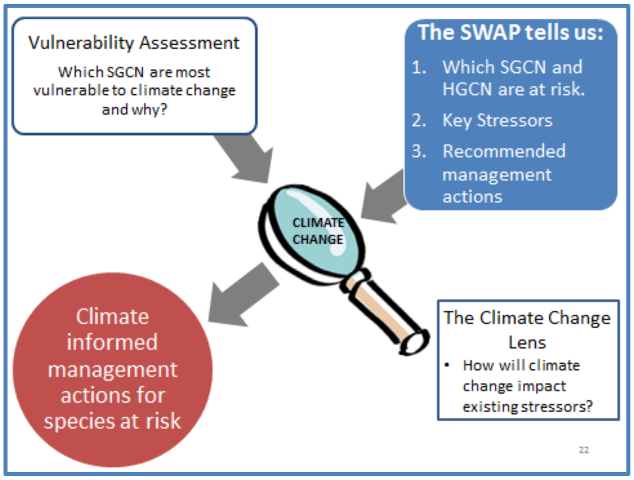
The full SWAP is accessible here. This link allows a reader to navigate directly to a chapter of interest, and within chapters, to navigate directly to areas of interest as highlighted on the table of contents.

The following table summarizes where and how climate change was addressed in the SWAP.

How climate was integrated into the SWAP document
Chapter 2 - *Overview of challenges and strategies for conserving biodiversity*
The impacts of climate change on species and habitats in Washington, and corresponding implications for how we manage those species is introduced and briefly discussed in the context of major statewide conservation problems and issues. (Chapter 2, Section 2-2).
Chapter 3 – *Species of Greatest Conservation Need*
This chapter discusses the methodology used to select species of greatest conservation need. We included a brief summary of our methodology for assessing the climate vulnerability for all SGCN, and also how we determined those species on our climate watch list. This chapter also includes a summary of the conservation status of all 268 SGCN, and we including the climate vulnerability rank in this summary. (Chapter 3, Table 3-3 in the SWAP)
Chapter 4 – *Habitats of Greatest Conservation Need*
Chapter 4 introduces the use of the Natural Vegetation Classification System as a classification scheme for key habitats, and discusses key stressors by formation, and for ecological systems of concern. This chapter highlights which ecological systems of concern ranked high in terms of climate vulnerability (Chapter 4, Table 4-1), and climate change is included and described in the list of stressors for these ecological systems, which number approximately 30. *Note that after the completion of the SWAP itself the remainder of the significant ecological systems occurring in Washington were also assessed for climate vulnerability.*
Chapter 5 – *Climate Change Vulnerability of Species and Habitats in Washington*
Chapter 5 details the methodology used to conduct the vulnerability assessment, and highlights key themes and findings by major taxa group (amphibians, reptiles, birds, mammals, fish and invertebrates). Chapter 5 also includes a narrative summary description of projected climate change impacts on fish and wildlife habitats in Washington, for the 2040s and also for the 2080s. It also provides the spreadsheet information detail for the 33 “climate watch” species, those which ranked highest in terms of vulnerability to climate change and also in terms of confidence – a rank which reflects the number and quality of reference sources.
Appendix A - *Species fact sheets*
This appendix includes a fact sheet for each SGCN. The climate change vulnerability assessment results are included on each fact sheet, and for highly vulnerable species we have included climate change as a stressor in the list of key stressors and management actions.
Appendix C - *Climate Change Supporting Information*
Appendix C includes a full summary of projected climatic changes for Washington, and the vulnerability assessment results for all SGCN, excluding references (which can be found in Appendix E of the SWAP).
Appendix E – *References*
The entire set of references used for the climate vulnerability assessment for all SGCN and ecological systems of concern can be found in Appendix E, which includes all references from all chapters of the SWAP. The references specifically used for climate change are indicated as such.

Task 3: Develop a framework for applying climate vulnerability to the identification and prioritization of management actions.

Working with our partners at EcoAdapt, we developed a framework for staff to easily integrate, or "overlay" the climate information with information already developed in the SWAP regarding stressors and management actions for SGCN. The following graphic illustrates the concept in using the climate vulnerability assessment as a "lens" by which to develop "climate informed" management actions for SGCN.



The framework is designed to use the fact sheets developed for each SGCN, found in Appendix A of the SWAP. The first page of these fact sheets describes the nature of the conservation concern, in narrative summary fashion, as well as life history needs and major habitat types. The second page lists key stressors and the management actions needed to help address them. Here is where our framework proposes to overlay climate vulnerability information. We extract from the SGCN climate vulnerability spreadsheet the key climatic exposure factors, and then evaluate whether and how those climatic factors will exacerbate the existing stressors, and whether and how the management action could be amended to address the added climate stress.

7. Findings and Conclusions

This project fulfilled our goals for integrating climate change into the 10-year Revision of the State Wildlife Action Plan. The products we developed provided a systematic approach to collect information about climate change, in ways that will help us to evaluate the added risk it poses to species and habitats of conservation concern. But perhaps more fundamentally, it has helped WDFW to build a foundation for understanding and clarifying how climate change may affect our work, and provided us an important tool for addressing potential impacts. The staff who have been introduced to the tool are very appreciative of the way it is organized and the ability to quickly access basic information about climate sensitivity and exposure, as well as relevant references. This format makes it well suited for updating as new information becomes available, and improving the product over time.

8. Recommendations for Future Work

The scope and timeframe of this project did not allow as much review and vetting of the SGCN and ecological system databases as we would have liked. The more review we can provide, the stronger and more reliable this tool becomes. We also see opportunities for different ways to package the results, and, opportunities to better harmonize the results of this project with those of other organizations in Washington doing similar projects. A list of additional tasks that could increase the effectiveness of this product follow:

1. **Coordinate with Climate Science providers and tribes and other organizations engaged in climate vulnerability assessments to share information about content and methodology.**
   There is a need to harmonize assessments occurring with similar targets and goals and/or geographies. With limited resources, there is a tremendous opportunity to leverage our respective work and investments by building on existing products whenever possible rather than creating new.

2. **Improving the useability of existing products.**
   A. Re-examine SGCN vulnerability data for those with low confidence scores to see if additional data can be found. Vet ecological systems with Washington Natural Heritage Program
   These two tasks will help to improve the credibility and usability of the product over time.

   B. Add transparency for exposure factors for SGCN.
   This is an improvement suggested at the February workshops, and was completed for the ecological systems component. We need to do this for the SGCN in order to ensure consistency across all Vulnerability Assessment products and improve usability. This task would explain how each of the exposure factors were weighted in the evaluation and ranking.

   C. Refine SGCN narratives and rankings by cross-walking with the ecological systems data.
   This task allows us to enrich the SGCN vulnerability narratives, improve rankings and ensure consistency across all Vulnerability Assessment products.

3. **Working with mangers to integrate the vulnerability assessment products into management frameworks.**
   A. Explore the connection/linkages between the ecological system vulnerability assessment products and the SGCN rankings and narratives.
      - Identify patterns across the landscape and potentially identify regional priorities.
      - Identify “themes” or groups of actions that may address climate risks from groups of species (and/or by habitat type).
      - Task would consist of analysis and pre-work by staff and then workshops with partners to vet and further the work.

   B. Re-assess priority management options for 20-25 priority species (what constitutes *priority* to be determined).
      - Revise proposed management actions using a climate lens – apply findings from the vulnerability assessments
      - Create “climate informed” fact sheets for each species. This task would include analysis and pre-work by WDFW and project staff and further development through workshops with partners.

9. Management Applications and Products

The vulnerability assessment development for this project has already been used by biologists in writing status and recovery planning documents for several species. Workshops included interactive sessions at which participants explored other uses, such as providing technical assistance to land use planners, forest landowners or others regarding the management of priority habitats and species. We are currently working with the managers of the Priority Habitats and Species program at WDFW to explore how climate vulnerability information could be integrated in a more formal way as part of consultations provided as a part of that program.

10. Publications and Outreach

Outreach for the State Wildlife Action Plan

The draft SWAP was completed and available for public review in August of 2015. This draft included Chapter 5, which described our approach to integrate climate change into the document, as well as highlighting key findings, and also Appendix C, which described in full the climate vulnerability data for the 33 climate watch species. A news release from WDFW announced the availability of this document for review by any interested parties. A webinar highlighting the contents of the SWAP, including climate change, was delivered on three occasions to interested parties (twice on August 20th and once on August 21st).

Outreach and Workshops on the Climate Vulnerability Assessment

We also conducted a webinar for WDFW staff and others (Washington Department of Natural Resources and the Washington Recreation and Conservation Office staff) on January 19th, describing the methodology and introducing the draft final vulnerability assessment product. A full day followup workshop was held on February 11th in Olympia, and approximately 25 staff attended, including staff from WDFW, the NPLCC, and the Washington Natural Heritage Program. The purpose of this workshop was to fully explain the methodology of the vulnerability assessment and instruct staff on how to add or correct information if needed. We also delved deeper into how to use these products to inform management options and approaches. An additional workshop was tailored for staff from the Washington Field Office of USFWS on June 15th, 2016.

Other outreach presentations on the project include:

- A 30-minute presentation as part of a session at the National Natural Areas Conference, held on October 17-18, 2016 in Davis, California.
- Presentation to the Washington State Interagency Climate Adaptation Network at its Fall, 2016 meeting.
- Presentation to the Washington Fish and Wildlife Commission meeting on January 20th, 2016.

11. Signature:

Lynn Helbrecht
Climate Change Coordinator
Washington Department of Fish and Wildlife

WDFW Climate Change Vulnerability Assessment Workshop
Draft Agenda

Thursday, February 11, 2016
Natural Resources Building – Room 175AB
10:00-4:00

Workshop Objectives:

1. Review the methodology for conducting a vulnerability assessment for species and ecological systems, and introduce the resulting WDFW tool.
2. Evaluate climate vulnerability assessment results for selected species and identify potential improvements.
3. Collaboratively review proposed management actions for species with high vulnerability. Identify those actions that may help to avoid and/or minimize vulnerabilities, and identify additional actions if needed.
4. Review and discuss opportunities for how to use this information in our work.

Time	Agenda Item	Presenter(s)
10:00	**Welcome and Introductions** • **Agenda Review** • **Opening Remarks** Review State Wildlife Action Plan and vulnerability assessment project goals and outcomes.	Lynn Helbrecht Jessi Kershner, EcoAdapt **All Participants**
10:20	**Vulnerability Assessment Process and Results** • Review vulnerability assessment methodology and findings • Introduce vulnerability assessment tool • Questions, comments, and discussion *Objective: Provide participants with background information and understanding of the vulnerability assessment process.*	Jessi Kershner, EcoAdapt **All Participants**
11:15	**Small Groups: Review Vulnerability Assessment Findings** Part One • Review sensitivity information for selected species taxa • Discuss sensitivity information – can confidence be improved for any of the species? Is there key information missing? *Objectives: Review species sensitivity information. Discuss ways in which confidence could be improved including new information and references.*	**All Participants**
12:00	**Review Species Vulnerability Assessment Findings, Report-Back**	**Small Group Reporters**

Time	Agenda Item	Presenter(s)
	• Report-outs and plenary discussion *Objective: Breakout groups report back to share thoughts (e.g., challenges, guidance needed, etc.) on revising sensitivity information with all participants.*	**All Participants**
12:15	**Break for lunch** (available for purchase in cafeteria or bring your own)	
1:00	**Small Group Activity: Review Species Vulnerability Assessment Findings, continued** Part Two • Review climate exposure information for selected species taxa • Re-evaluate climate exposure for a small suite of species using new species range maps + climate exposure maps *Objectives: Review species exposure information. Discuss ways in which confidence could be improved including new information and references.*	**All Participants**
1:45	**Review Species Vulnerability Assessment Findings, Report-Back** • Report-outs and plenary discussion *Objective: Breakout groups report back to share thoughts (e.g., challenges, guidance needed, etc.) on revising sensitivity and exposure information with all participants.*	**Small Group Reporters** **All Participants**
2:00	**Opportunities (and limitations) for Using Climate Vulnerability Data in Our Work Activities** • Identify specific activities in which you could use information in the tool (for example – grant applications, restoration project design, land use planning consultations, etc.) • Discuss any limitations or suggestions for improving usability	**All Participants**
2:30	**BREAK**	
2:45	**Small Group Activity: Evaluating Management Actions for High Vulnerability-High Confidence SGCN** • Review management actions currently proposed for high vulnerability-high confidence SGCN • Identify which vulnerabilities current actions are addressing • Discuss additional actions to implement that may help avoid and/or minimize climate vulnerabilities for these species	**All Participants**

Time	Agenda Item	Presenter(s)
	Objectives: Review current management actions for highly vulnerable SGCN. Highlight those vulnerability factors that management actions can/cannot control.	
3:30	**Small Group Activity: Evaluating Management Actions for High Vulnerability-High Confidence SGCN** • Report-outs and plenary discussion	**Small Group Reporters**
3:50	**Next Steps and Wrap up**	Lynn Helbrecht
4:00	**ADJOURN**	

EXERCISE #1: Evaluate Climate Exposure Information

1. Review climate exposure information for species in your taxa (see list given to table). As a group, re-evaluate overall climate exposure by comparing new species range maps with climate exposure maps; also re-evaluate confidence to determine if ranking can be improved (Moderate: spatial info for some climate factors but not all; High: spatial info available for most/all climate factors).

Species	Existing Overall Exposure Ranking & Confidence	Key Climate Exposure Factors (use spreadsheet to identify exposure factors)	Using Climate Maps + Species Range Maps, Consider Whether Overall Exposure Ranking and/or Confidence Should be Revised. Write Suggested Changes Below. (Consider ranking each exposure factor individually as it may help to discern differences)
Dragon	*Exposure: Moderate-High* *Confidence: Moderate*	• *Altered fire regimes* • *Changes in precipitation* • *Increased temperatures*	*Altered fire regimes: M-H exposure, H confidence* *Changes in precip: M exposure, M confidence* *Increased temp: M-H exposure, H, Confidence* *Overall rankings: Keep M-H exposure but increase to H confidence*

EXERCISE #2: Evaluating Management Actions with a Climate Lens

SPRUCE GROUSE (Falcipennis canadensis)

Conservation Status and Concern

Although a gamebird, the indirect effects of climate change including disease of trees and wildfire, the direct effects of certain timber harvest practices, and the uncertainty about taxonomy mean that Spruce Grouse conservation status is unclear.

Federal Status	State Status	PHS	Global Ranking	State Ranking	Population size/trend	Climate Vulnerability
None	None	No	G5	S4	Declining	High

Biology and Life History

Spruce Grouse dwell mostly in trees from late autumn through early spring and on the ground from late spring through early autumn. Both males and females are territorial during the spring. Females generally produce a clutch of five to six eggs. Nest and brood success are usually not very high, but are compensated for with relatively high adult survival.

Photo: M. Schroeder

Distribution and Abundance

These grouse are distributed throughout the boreal forest of Canada and Alaska and small portions of other northern states. Most evidence suggests that this grouse consists of types that are genetically, phenotypically, and behaviorally distinct, and taxonomic reclassification may occur at some point in the future. In Washington, they are primarily found on the east slope of the Cascades from the U.S.-Canada border south to Yakima County and in Okanogan, Ferry, Stevens, and Pend Oreille Counties. Cascade populations are believed to be relatively sparse and discontinuous while populations in the Okanogan highlands have historically been abundant and continuous. Spruce Grouse have declined in many portions of northern Washington due to wildfires between 1994 and 2014. The Washington population is approximately 5,000 individuals.

Habitat

Spruce Grouse depend on conifer forests, especially fire-adapted lodgepole pine, but also spruce and fir. Greatest densities appear to be in young successional stands of dense lodgepole pine, with a well-developed middle and understory of spruce, fir, and/or deciduous shrubs. Populations close to the crest of the Cascades live in habitats with greater tree diversity, but these populations are poorly understood. Grouse forage in winter primarily on lodgepole pine needles, and secondarily on spruce needles. Nesting and brood-rearing females often use small riparian meadows and forest openings. Spruce Grouse living in fragmented habitats have lower survival.

References

Boag, D. A., and M. A. Schroeder. 1991. Spruce grouse (Falcipennis canadensis). Birds of North America 5: 1-28.

Boag, D. A., and M. A. Schroeder. 1987. Population fluctuations in spruce grouse: what determines their numbers in spring? Canadian Journal of Zoology 65:2430-2435.

Spruce Grouse: Conservation Threats and Actions

			Climate vulnerabilities addressed			
	STRESSOR DESCRIPTION	**ACTION NEEDED**				
1	Increased fire size resulting from beetle infestations	Fire management				
2	Salvage harvest in areas impacted by beetle infestations	Develop and implement best management practices				
3	Beetle infestations due to climate temperature change killing lodgepole pine, spruce and fir	Forest management				
4	Lack of population data poses risk of over-harvesting	Monitor annual harvest				

NOTE: Numbers are for reference only and do not reflect priority.

Climate Change Analysis

- Please describe how the management actions affect the climate vulnerabilities listed in the table. Do they have a direct impact, an indirect impact or no impact?

- Could the action be modified in some way to increase the degree to which it could help to enhance opportunities for adaptation? If so, how?

- Are any new actions needed to address this species' vulnerability to climate change?