



NATIONAL WILDLIFE FEDERATION®

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September 30, 2014

Mary Mahaffy
Science Coordinator
North Pacific Landscape Conservation Cooperative
510 Desmond Drive SE, Suite 102
Lacey, WA 98503-1263

RE: Final Report, U.S. FWS Agreement Number F12AC01035

Dear Ms. Mahaffy:

This report describes the completion of the objectives of the National Wildlife Federation's (NWF) work under U.S. FWS Agreement Number F12AC01035 (Agreement) – *Enhancing Outreach and Facilitating Climate-Smart Implementation of Strategic Science and Traditional Ecological Knowledge in the North Pacific Landscape Conservation Cooperative (NPLCC)*. This Agreement was initiated in January 2013 and was since amended under Modification No. 002 to include additional funding and a revised timeline. The completion date was June 30, 2014.

Summary of Significant Activities and Results

Under this Agreement, NWF assisted in the design of and developed content for the “NPLCC Interactive Climate Change Map” – an interactive web-based map of climate change impacts in the NPLCC region. The tool is intended to assist natural and cultural resource managers, conservation practitioners, researchers, and concerned citizens in understanding the science of climate change and visualizing the associated impacts on key resources in the NPLCC region. This project was implemented in response to the expressed desire among a range of stakeholders in the region for visualization tools to communicate climate change effects and examine vulnerable areas. While the final tool is being refined and finalized by U.S. Fish and Wildlife Service (FWS) and other partners, NWF accomplished all of the key deliverables under this grant. The primary task at hand was the development of content, which entailed the following activities:

- **Selection of categories and subregions.** Given the considerable range of climate change impacts underway and projected across the region’s diverse terrestrial, aquatic, and coastal and marine systems, it was decided early on to focus the entries on a few key categories under the timeframe of the project: glacier changes, changes in snowpack and streamflow, increased water temperature, changes in water quality, sea-level rise and coastal storms, and anadromous fish. The flexible nature of the map interface will allow for additional information to be added over time as warranted. The map itself was divided into 15 subregions, which are intended to be relevant at multiple ecological and jurisdictional scales (see Figure 2). Entries are also made to summarize impacts across the NPLCC region as a whole.
- **Development of a template for the content.** For each category (e.g., glacier changes), information was organized into three components: climate change impacts (including observed trends and

future projections); key risks and benefits for associated fish, wildlife and ecosystems; and information about relevant adaptation response strategies (including case examples within the respective subregion, where available). There is also a “science behind the impacts” summary for the broad categories.

- **Input of relevant information.** Content was largely drawn from two reports that were compiled by NWF under a separate agreement (U.S. FWS Agreement Number F11AP00032): *Climate Change Effects and Adaptation Approaches in Freshwater Aquatic and Riparian Ecosystems in the North Pacific Landscape Conservation Cooperative Region* (Tillmann and Siemann 2011a) and *Climate Change Effects and Adaptation Approaches in Marine and Coastal Ecosystems of the North Pacific Landscape Conservation Cooperative Region* (Tillmann and Siemann 2011b). The entries were also supplemented with information from more recent scientific literature, where available.

NWF worked closely with three partners to complete this work. To ensure the final product advances the NPLCC mission and goals and given this is a priority project of the NPLCC, NWF and the NPLCC worked closely on map design, content development, and implementation. NWF also collaborated with the map developer, EnviroIssues, on the visual display of map content and map navigation. Finally, NWF managed the development of additional map content by the U.S. FWS.

Problems, Delays, and Efforts to Resolve

The biggest challenge under this project was the loss of the primary staff person (Patricia Tillmann) involved in the development of the tool for NWF. While the project was ultimately completed on time by other NWF staff (Patty Glick), there was a bit of a “learning curve” to get up to speed on the process developed for summarizing the content and incorporating it into the map template. To assist in that process, Ms. Tillmann developed a highly-useful guidance document on the process for creating an entry (see Attachment A). Ultimately, this document should prove useful moving forward as the NPLCC works to populate the entries not covered under this project.

Conclusion

The interactive map is an accessible, informative, and visual venue for the interested non-scientist or resource manager to acquire a synthetic summary of how climate change is affecting or may affect fish, wildlife, and ecosystems in the NPLCC region. The map also provides information on what can be – and is being – done to address climate change impacts. The map is also unique to the region, as similar maps target larger geographies or different topics. Please see the Appendix on pages 3-8 for more detailed information on the project background and map structure. NWF appreciates the opportunity to contribute to this important work and thanks the NPLCC for its generous support.

Sincerely,

Patty Glick, Project Manager
Senior Climate Change Specialist
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APPENDIX. Background & Map Structure

I. Background

Interactive tools that visualize climate change impacts and build understanding of climate change science were requested by natural and cultural resource managers, conservation practitioners, and researchers working in the NPLCC region (Tillmann and Siemann 2012). Additional requests from these professionals include products that synthesize existing climate change-related information and improved communication with the public, decision makers, and among those working to address climate change in their conservation and sustainable management work. The interactive map responds to all of these requests.

Content for the interactive map was largely drawn and synthesized from two reports NWF produced on climate change effects and adaptation approaches in the region's freshwater ecosystems (Tillmann and Siemann 2011a) and coastal and marine ecosystems (Tillmann and Siemann 2011b). With this approach, the report's information can now "live" online and is more accessible and useful to a broader audience. As new peer-reviewed studies and agency literature are published on climate change effects in the region, the map can be updated easily to ensure the most relevant and recent information is available to the user. To our knowledge, this map is unique to the NPLCC region. While there are similar maps available, they are generally focused at a larger geographic scale or on different topics (e.g., [Climate HotMap](#), [EIS Mapper](#)).

II. NPLCC Interactive Climate Change Map: Structure

A. Overview

At the highest level, a user can navigate the map by the category of impact or by location (Figure 1). While the template shows the full range of categories that will ultimately be covered by the map, only entries for the following categories were populated under this project: glacier changes; changes in snowpack and streamflow; increased water temperature; changes in water quality; sea-level rise and coastal storms; and anadromous fish. Once a user selects a category of impact, they have three ways to access information on the impact, depending on their location of interest:

- *NPLCC-Wide Summary* is the "big picture" and synthesizes information on the impact across the entire NPLCC region. There is one of these entries per category of impact.
- *Ecoregional Summaries* synthesize information on the impact within a particular ecological and jurisdictional subregion of the NPLCC (Figure 2). Up to 16 entries are possible per category of impact, one for each subregion and one for the NPLCC region as a whole. If there is no information in a subregion, the subregion is not listed on the page for that particular category.
- *Specific Location Examples* synthesize information on a specific location within an ecoregion when two criteria are met. First, there is substantial information on the impact and location. Second, the location is of cultural, economic, recreational or other interest to the target audiences. The number of entries will vary by category of impact and may be zero.

Once a user selects a category of impact and location of interest, they are presented with their selected entry. Each entry provides information on the climate change impact (e.g., glacier changes), key risks and benefits for fish, wildlife, and ecosystems, and climate-smart response strategies and case studies (Figure 3). Every entry answers the questions "What are the historic, current, and potential future impacts of this category of impact? How will these changes affect fish, wildlife, and ecosystems in the NPLCC region? What can be done to prepare for the coming changes?" For example, Figure 4 illustrates the information

provided under “key risks and benefits for fish, wildlife, and ecosystems” section for glacier changes. Once a user has explored one entry, they can navigate to other entries using the navigation buttons. For users interested in a more in-depth look at the science, a complete source list is available. Users can also explore the various science, impacts, and adaptation options information for a particular category within one or more subregions (see Figure 5).

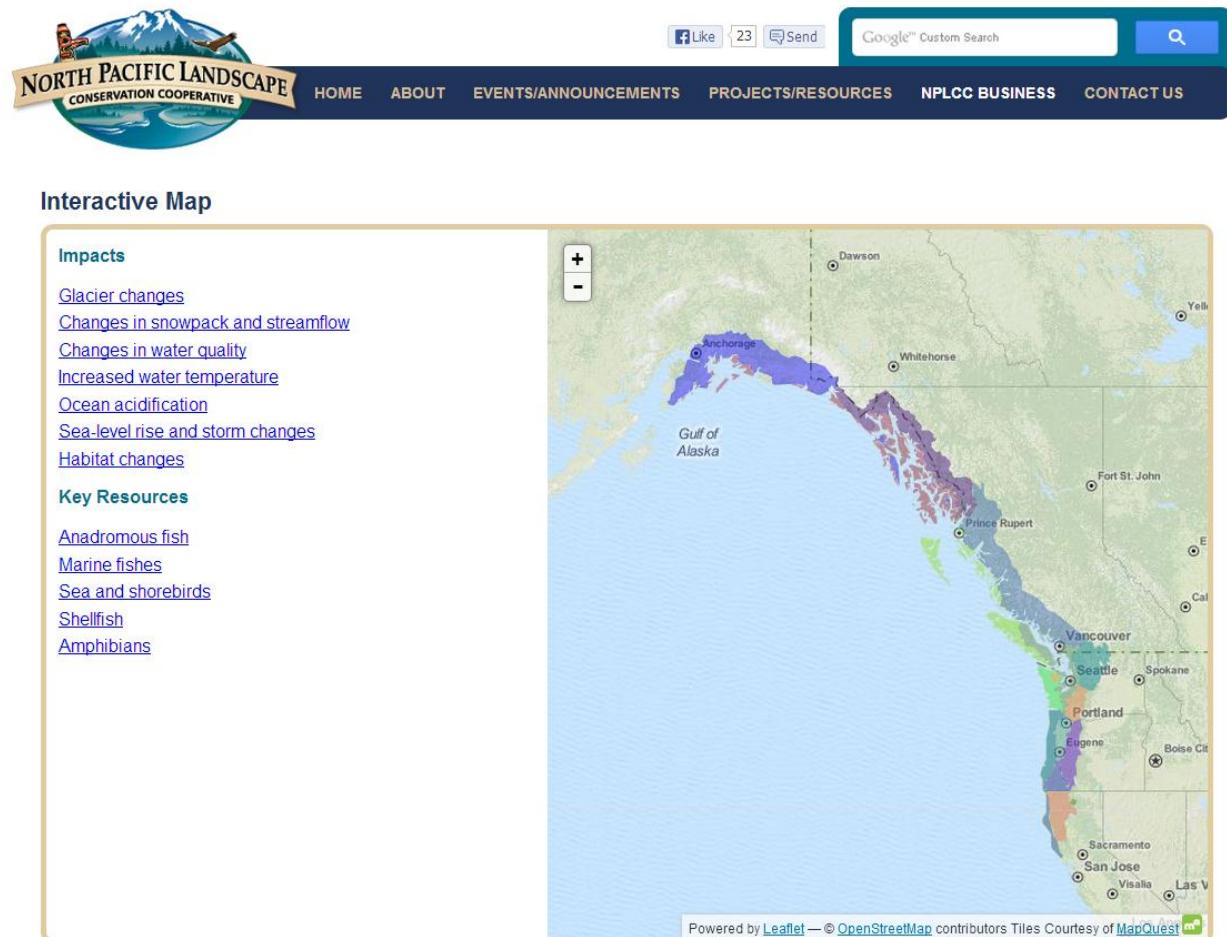


Figure 1. Screen capture of the NPLCC Interactive Climate Change Map homepage showing categories of impact (left) and the NPLCC region (right).

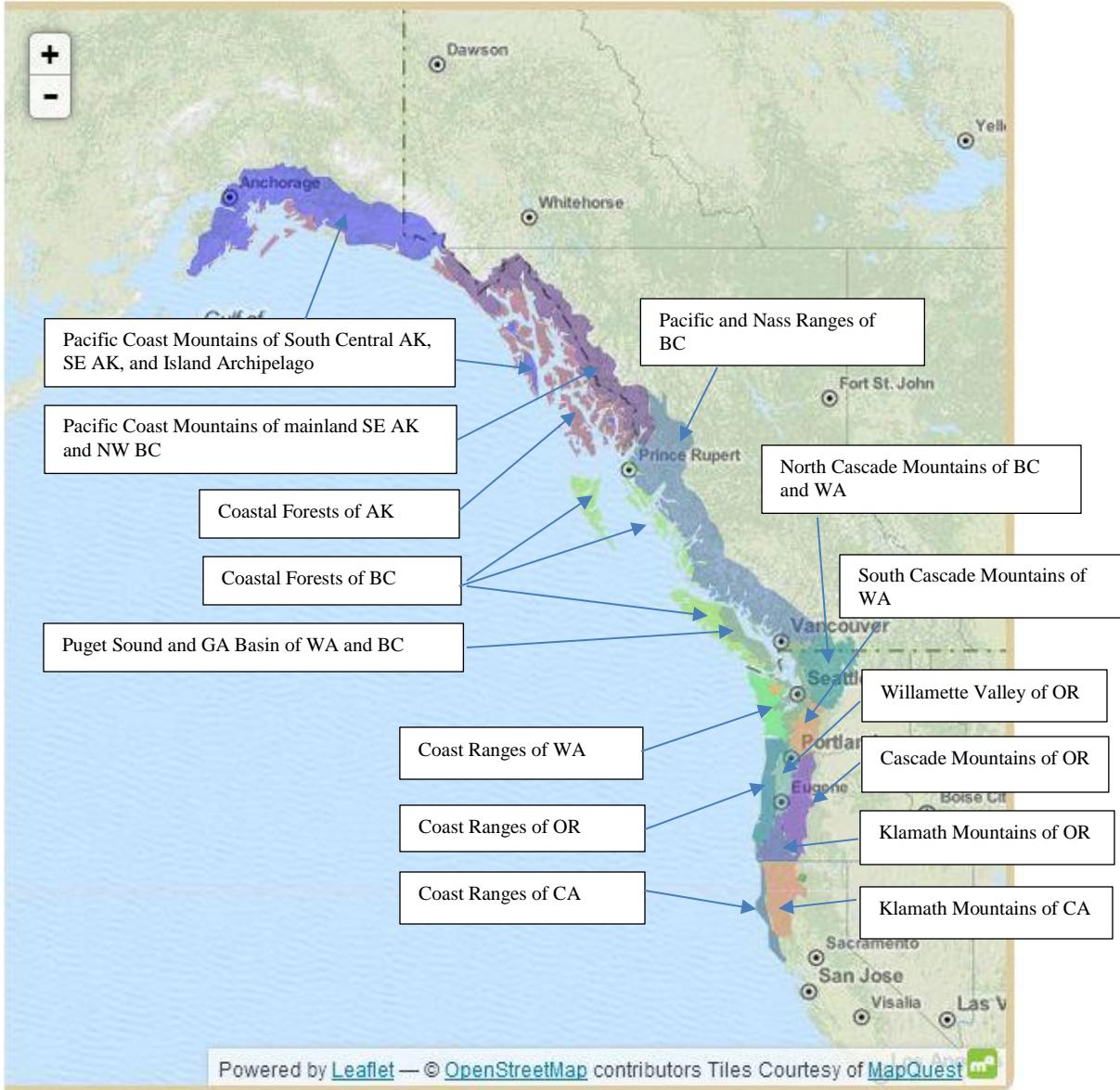


Figure 2. NPLCC region with biogeographic subregions identified.



Interactive Map

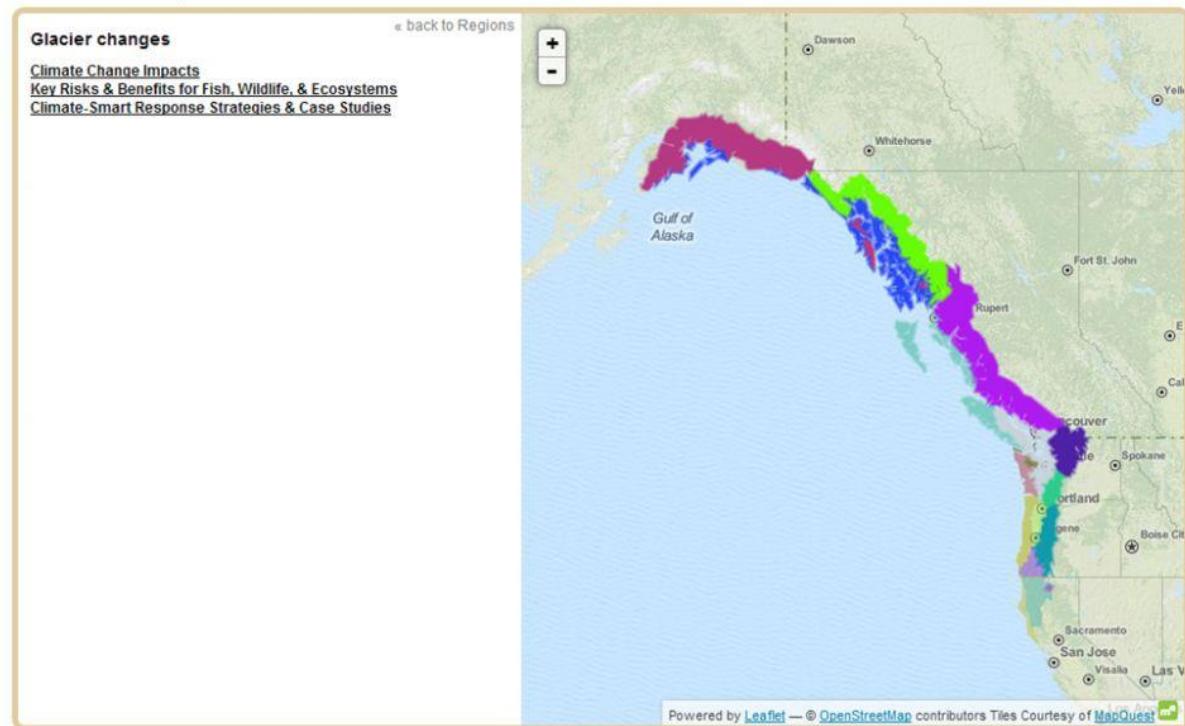


Figure 3. Screen capture showing the general outline of subjects in the glacier changes category.



Interactive Map

Glacier changes [« back to Regions](#)

Climate Change Impacts
Key Risks & Benefits for Fish, Wildlife, & Ecosystems

As glaciers recede, some species and habitats may benefit. Others may become more vulnerable. For example, vegetation may establish over time and provide wildlife a new home as glaciers recede and expose bare ground.

Glacier retreat and changes in ocean circulation will negatively affect the ability of Kittlitz's murrelet, a critically endangered diving bird dependent on Alaska's tidewater glacier ecosystems, to hunt and forage. Some studies suggest declines in glacier extent will result in less freshwater and nutrients (e.g., phosphorus, carbon) reaching Alaska's estuaries. Others find increased amounts of iron (needed for primary productivity) may be transported to the Gulf of Alaska.

Rapid melting of the region's high-elevation glaciers will increase summer streamflow in some locations in the near-term and may exacerbate flooding or alter sediment and nutrient transport. As glacier loss continues, less and less cold glacial water will supplement streams in the hot, dry summer, reducing a critical cold water source for salmon, trout, and other species.

[Climate-Smart Response Strategies & Case Studies](#)

Powered by Leaflet — © OpenStreetMap contributors Tiles Courtesy of MapQuest

Figure 4. Screen capture of information on the impacts of glacier changes on fish, wildlife, and ecosystems throughout the NPLCC region.



Interactive Map

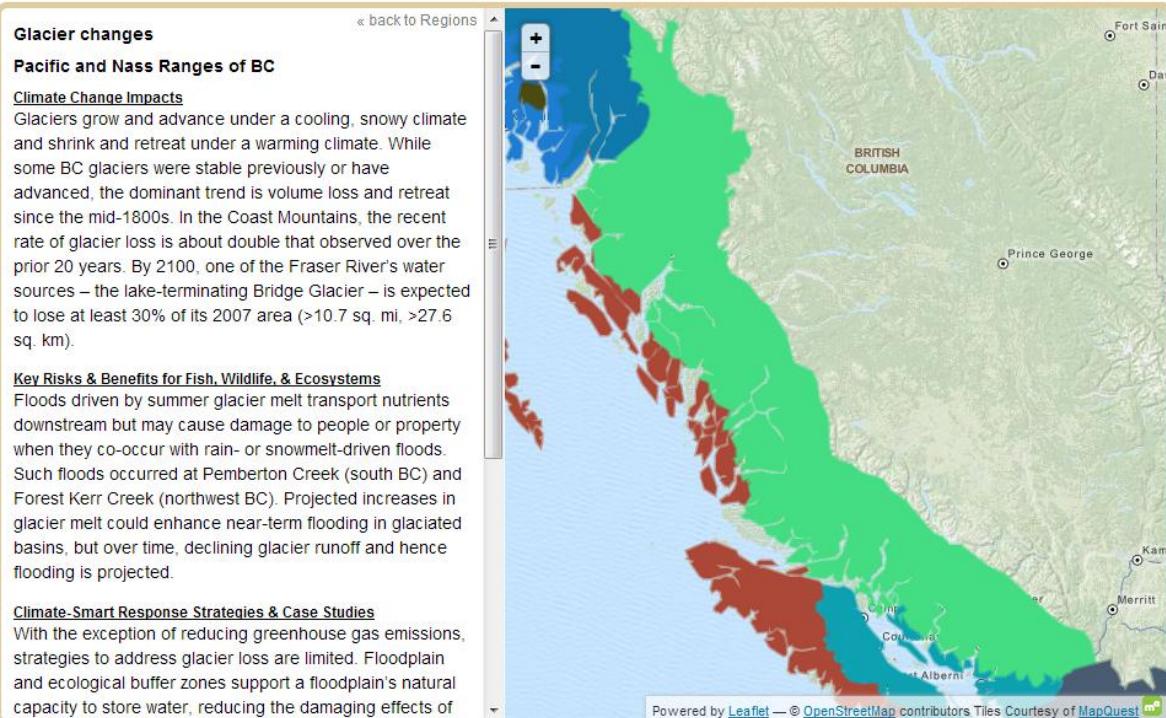


Figure 5. Screen capture of the specific information on glacier changes within the Pacific and Nass Ranges of BC.

References

- Tillmann, P. and D. Siemann. 2011a. Climate Change Effects and Adaptation Approaches in Freshwater Aquatic and Riparian Ecosystems of the North Pacific Landscape Conservation Cooperative. National Wildlife Federation, Seattle, WA.
- Tillman, P. and D. Siemann. 2011b. *Climate Change Effects and Adaptation Approaches in Marine and Coastal Ecosystems of the North Pacific Landscape Conservation Cooperative Region*. National Wildlife Federation, Seattle, WA.
- Tillmann, P. and D. Siemann. 2012. *Advancing Landscape-Scale Conservation: An Assessment of Climate Change-Related Challenges, Needs, and Opportunities for the North Pacific Landscape Conservation Cooperative*. National Wildlife Federation, Seattle, WA.

ATTACHMENT A

Process for creating an entry.

NWF used this process and provides it as an example for other content creators.

1. Read information in Chapter III on the Impact (e.g., increased water temperature).
2. Choose geography to begin writing on (e.g., southcentral and southeast Alaska). I'll call this an "Impact-Geography" pairing.
3. If needed, re-read information in Chapter III on relevant impact and chosen geography (e.g., observed trends and future projections for increased water temp in southcentral and southeast Alaska).
4. Where present, double-check larger geographies (e.g., global, western North America, etc.) for information pertinent to selected geography.
5. Distill key trends and projections for selected Impact-Geography combination.
6. Categorize the information by the ecoregion to which it applies. I'll call this an Impact-Geography-Ecoregion pairing. In southcentral and southeast Alaska, there are three ecoregions :
 - a. Coastal western hemlock-Sitka spruce forests of Alaska
 - b. Pacific Coast Mountains of southcentral Alaska and southeast Alaska island archipelago
 - c. Pacific Coast Mountains of mainland southeast Alaska and northwest B.C.
7. If it is not clear from the report which ecoregion the information belongs in, look at the footnote to identify the relevant citation, access the citation in Dropbox or by clicking on the hyperlink in the Bibliography (file: FW_bibliography or Marine_bibliography), and find the study area in the cited document.
 - a. Note: If the ecoregion is not apparent immediately (file: Map of NPLCC with map ecoregions labeled), I have found it easiest and quickest to plug the location (latitude and longitude or city, park, etc.) into Google Earth ([free online](#)) with the NPLCC ecoregions layer turned on (file: NPLCC_Ecoregions.kmz). Then, I can zoom in to see which ecoregion the study applies to. Sometimes, I have to Google the nearest town or city to a natural area or find coordinates for a natural area online.
 - i. Latitude and longitude has by far been the easiest and quickest way to assign an ecoregion to a study. If using latitude and longitude, make sure Google Earth is in the same units as those used in the study. This can be changed by going to Tools in the Toolbar, selecting Options, then in the 3D View tab, selecting the type of latitude and longitude needed from the Show Lat/Long section.
 - ii. Note: Google Earth is free to download. The NPLCC ecoregion layer is a file (title: NPLCC_Ecoregions.kmz). Double-click on the file and Google Earth will open automatically with the layer displayed. If you need the file, contact Tom Miewald (thomas_miewald@fws.gov).
8. Synthesize the available information for the selected Impact-Geography-Ecoregion pairing, referring back to the freshwater report and citations when needed to provide context or additional details. Aim for 80 words or less. However, this paragraph is often the longest of the three (up to 100 words).
 - a. **Important:** Include the sources used to create an entry in a source list at the end of the entry. It is critical we have a complete source list for those who want to learn more and to demonstrate that the entries synthesize published, peer-reviewed information. Please see the Boiler Plate Map Entry for an example of what the source list should look like. I have found it helpful to build the source list as I go, instead of at the end.
 - b. Note: If information is not available for a particular Impact-Geography-Ecoregion pairing, include information from a broader geography (e.g., Pacific Northwest, western North America). If information is not available for any part of an entry and a nearby location has information that is relevant for the location lacking information, use the

- information from the nearby location. Similarly, if two entries are very similar in their content, feel free to use the same one twice.
9. Scan the remaining chapters of the report for information on how the impacts described affect fish, wildlife, and ecosystems. Begin with chapters on species, then move to habitats and ecosystems.
 - a. Note: The goal is to focus on species impacts, but to include impacts to habitats and ecosystems of interest to target audiences. Also, keep in mind there is an Impact dedicated to Habitat Changes that will cover much of that information in detail.
 10. Repeat steps 3 through 8 to create the paragraph on key risks & benefits to fish, wildlife, and ecosystems.
 11. Scan the chapter on adaptation approaches for options that would ameliorate the risks described, take advantage of the benefits described, and work in the location under consideration. Be as specific as possible (see Boiler Plate Map Entry).
 12. Repeat step 8, synthesizing selected adaptation approaches.
 13. Search for case studies of adaptation that respond to the climate change impacts described. Ideally, they should be occurring in the location under consideration. Describe the case study in 10-15 words, including information on the location, actions taken, and goal of the work (e.g., Restoring Snohomish River Riparian Areas to Moderate Temperature and Flow). See the document Boiler Plate Map Entry for additional information.
 - a. Note: To find case studies, sources (listed from most to least useful) include cakex.org, DataBasin, Adaptation Clearinghouse (enter “case study” in search bar), and a general Google search.
 14. Edit, edit, edit! And peer-review! I take several passes through each entry, eliminating extraneous words, tightening up language, ensuring scientific accuracy, and getting the character count down to the desired number. After a couple passes, I send the entries for peer-review. During revisions, I do additional editing to prepare the final entries.
 - a. Note: It helps me to compose entries with page size A5 (5.83" x 8.27") in Calibri 10 point font because one page of this is approximately the amount of space available on the map that would not require the user to scroll down to get all the information.
 15. Once the entries are peer-reviewed, send to the NPLCC for their review. Once any revisions from the NPLCC are incorporated, the entries are final.
 16. If someone else is inputting entries into the map itself, this completes an entry! If you are inputting the entries into the map itself, steps 17-22 describe how to do so.
 17. Go to <http://www.northpacificlcc.org/Admin>. This is where we enter the information into the map itself. Enter user name and password to log into the system. If you do not have a user name and password, email Colin Davis at EnviroIssues (cdavis@enviroissues.com) to set one up.
 18. Click on “Map,” which is located just under the About tab.
 19. Navigate to the Impact-Geography-Ecoregion in which you would like to enter information.
 - a. **For the NPLCC-wide summary:** Select the Impact of interest, then select “edit NPLCC-wide summary.”
 - b. **For an ecoregion entry:** Select the Impact of interest, then select the ecoregion of interest from the list of Regions, then select “edit regional summary.”
 - c. **For a specific location entry:** Select the Impact of interest, then select the ecoregion of interest from the list of Regions, then select “Add New.”
 20. Paste information into the correct box. Ensure formatting is correct. For location-specific entries, be sure to include a title for the entry in the “Location Name.” box.
 21. Add citations to the ecoregion and specific location entries only. Click “Add a citation” at the bottom of the page. Select citation from the drop-down list. If a citation is not listed, add a new citation using the form. Contact Colin if you need assistance finding or using any of the forms.
 22. Save entry. At this point, the entry is visible on the map, go to <http://www.northpacificlcc.org/NPLCCBusiness/InteractiveMap> to view.

Characteristics of an entry. All entries must:

- Source the vast majority of information from the science compilation reports (pilot phase only). Rarely, I have needed to refer to studies not cited in the reports for reference.
- Focus on information pertinent to the Impact (e.g., increased water temperature) or Resource Affected. Where other Impacts are also critical to mention (e.g., low flows exacerbate summer stream temp increases), do so briefly. The other Impact (changes in snowpack and streamflow) will cover the flow changes specifically as well as reference the increased water temp briefly. For an example, see the entries on “Changes in snowpack and streamflow.”
 - Note: The report chapters that are included in a given Impact or Resource Affected are provided in a separate document (title: Source of information for each map category).
 - Note: If you would like to know how the list of Impacts and Resources Affected was generated, please see the document “NPLCC Interactive Map_Parsimonious Categories of Impact”
- Include only information pertinent to the geographic scale selected, either NPLCC-wide, a specific ecoregion, or in a specific location (i.e., be geo-referenced correctly). I described the process I have used to geo-reference information above.
- Focus on “what” is happening, not “why” it is happening. The “why” is provided in the Science Behind the Impacts, which leaves room to discuss the trends and projections that are the focus of these short entries.
 - For example, it makes sense to say “many rain-snow basins in the Washington Cascades are expected to transform to rain-dominant basins as more winter rain and less snow falls by 2100 (vs. 1980s),” but further explanation (e.g., of what a rain-snow or rain-dominant basin is) should be relegated to the Science Behind the Impacts.
- Strive to include both absolute and relative change in a value, as well as a complete date range for the study. Example: Glacier X is projected to retreat 25%, from 40 feet above its 1900 value to 50 feet above its 1900 value (from 12 m to 15 m) by 2100.
- Include both American and metric measurements, because the NPLCC region includes areas that use both systems. American units are listed first with metric units following or in parentheses.
- Aim to be concise syntheses of the information relevant to target audiences (see file: NPLCC Interactive Map_S-TEK Mtg_1.8.14) and written for a “middle-ground” audience (see document “ContentExamples_InteractiveMap_2013_0610”).
 - The target for NPLCC-wide entries is <3,000 characters (with spaces) and for other entries is <1,500 characters (with spaces, excluding source list; ~220-240 words).
 - However, topics with a lot of information (e.g., changes in snowpack and streamflow) may be longer (<2,000 characters, ~300 words).
- Be parsimonious, such that no extraneous information is included (see document, Boiler Plate Map Entry).
 - The information in the “key risks & benefits to fish, wildlife, & ecosystems” paragraph relates directly to the trends and projections covered in the “climate change impacts” paragraph and focuses on species and systems target audiences care about (and of course, in the pilot phase, that we have information for in the reports).
 - Similarly, the information in the “climate-smart response strategies & case studies” describes specific actions that can ameliorate the risks described, take advantage of the benefits described, and would work for the Impact and location covered by the entry.

For examples of entries, see those currently in the map (<http://www.northpacificlcc.org/NPLCCBusiness/InteractiveMap>) or the file of map entries, which includes the same information (file: Map entries_1.17.2014).

Other helpful documents, files, people, and resources referenced in this document.

Documents & Files (listed alphabetically)	Description
Boiler Plate Map Entry	One-page overview of which information goes in each paragraph of a map entry. Includes an example from the Impact, Glacier Changes.
ContentExamples_InteractiveMap_2013_0610	Three versions of a single entry, each targeting a different type of audience. We are writing for the “Middle-Ground Audience.”
FW_bibliography	Bibliography from the freshwater report, with hyperlinks to nearly all sources.
Map entries_1.17.2014	Document with the final entries for the Impacts, “Glacier Changes” and “Changes in Snowpack and Streamflow.” Use this or the map itself to see examples of what has already been done.
Map of NPLCC with map ecoregions labeled	Map showing ecoregions used for ecoregional entries.
Marine_bibliography	Bibliography from the marine report, with hyperlinks to nearly all sources.
NPLCC_Ecoregions.kmz	The file for Google Earth. When this layer is enabled (which it is automatically the first time you open it), you can use the Search box in Google Earth to enter a location and see which ecoregion it falls in. Once it Google Earth, the layer is called states_ecoreg_intersect.
NPLCC Interactive Map_Parsimonious Categories of Impact	A table showing how the Impacts and Resources Affected were selected. It shows how topics in the marine and freshwater reports were combined to give the Impacts/Resources Affected.
NPLCC Interactive Map_S-TEK Mtg_1.8.14	Presentation providing overview of map goals and structure.
Science Behind the Impacts	<1-page descriptions of why the Impacts covered in the map are happening. For example, the description for Glaciers covers the types of glaciers found in the NPLCC region and how glaciers respond to climate and climate change.
Source of information for each map category	A table showing where in the freshwater and marine reports to find information for a given Impact or Resource Affected on the map.
People & Other Resources	Description
Colin Davis, cDavis@enviroissues.com	Person to contact for questions or assistance with the technical aspects of the map (e.g., appearance, functionality), including how to input entries into the map itself.
Tom Miewald, thomas_miewald@fws.gov	Person to contact for the file of NPLCC ecoregions to use with Google Earth. The most recent file is called NPLCC_Ecoregions.kmz. When it loads in Google Earth, it is called states_ecoreg_intersect.
http://www.google.com/earth/	Link to download Google Earth for free.
http://www.northpacificlcc.org/NPLCBusiness/InteractiveMap	Homepage for the NPLCC Interactive Climate Map.
http://www.northpacificlcc.org/Admin	Admin page for the NPLCC Interactive Climate Map. Used to add entries to the map itself.