# A Comparison of the Old and New: A Case Study for Rebuilding the Nationwide Rivers Inventory

University of Washington

Department of Geography

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Capstone Report

Scott Schlueter, Neil Shetty, and Emily Zvolanek

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# Recommended Course of Action

Our sponsor at the National Park Service (NPS) tasked our group with devising a new methodology for updating the Nationwide Rivers Inventory (NRI). We used a pilot study area of one state, Oregon, but the eventual goal is to update the NRI for all states. Our recommended course of action is for NPS to examine our designed methodology for effectiveness in providing a landscape-level, or phase-one, assessment of new potentially eligible river segments for fish, recreation, and/or scenic outstandingly remarkable values. We also recommend for NPS to use the public-facing web application our group designed to promote stewardship of river systems and gather crowd-sourced information from citizens familiar with river segments. Furthermore, we recommend that larger-scale, more detailed analyses, perhaps involving ground-truthing and site visits, are conducted before any river segments are officially recommended for National Rivers Inventory status.

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# Introduction

The Nationwide Rivers Inventory (NRI) was created as a pipeline for designating wild and scenic rivers (WSR); therefore one must understand WSRs in order to understand the NRI. A river becomes a WSR via Congressional designation and must be free-flowing and contain at least one outstandingly remarkable value. The Wild and Scenic Rivers Act was enacted in 1968 to protect exemplary waterways "for the benefit and enjoyment of present and future generations," (Interagency Wild & Scenic Rivers Coordinating Council 1968). Conceptualized in the 1970s and completed in the early 1980s, the Nationwide Rivers Inventory was created to identify those rivers which may eventually be eligible for wild and scenic river designation (National Park Service 2011).

There are two main criteria for establishing eligibility as a National Rivers Inventory segment: the river segment must be free flowing and contain at least one outstandingly remarkable value (ORV). According to the National Park Service, "the eligibility analysis consists of an examination of the river's hydrology, including any man-made alterations, and an inventory of its natural, cultural, and recreational resources. There are a variety of methods to determine whether certain resources are so unique, rare or exemplary as to make them outstandingly remarkable," (NPS, National Center for Recreation and Conservation 2011). There are nine different ORV classifications, but they all must be river-related. That is, an outstandingly remarkable value must be located in the river or on its shorelands, contribute greatly to the functioning of the river ecosystem, or owe its existence to the presence of the river (NPS, National Center for Recreation and Conservation 2011).

The nine possible outstandingly remarkable values are as follows: scenery, recreation, geology, fish, wildlife, prehistory, history, cultural, and other values. A river with the scenery ORV has notable visual features due to landform, vegetation, water, color, and other factors. In order for a river segment to receive the recreation classification, it must have recreational opportunities that would attract people beyond the local scale. Recreational activities could include fishing, boating, hiking, camping, sightseeing, and observing wildlife. A river segment could be eligible for geology ORV classification if it contains a geologic feature, process, or phenomenon that is rare to the region. The fish ORV is a protective classification, and therefore is concerned with presence of wild stocks or federal and state listed threatened, endangered, or sensitive species. The wildlife ORV is similar to the fish ORV in that it is meant to be protective, and applies to terrestrial or aquatic wildlife species instead of fish species. A river may be considered to have a prehistory outstandingly remarkable value if there is evidence of use by and significance to Native Americans. The history ORV is applied to river segments that are associated with an important person, cultural activity, or significant event, such as a site on the National Register of Historic Places. The cultural ORV applies to rivers that contain archaeological sites, traditional practices such as subsistence fishing, or other anthropological characteristics. The other ORV category is a catch-all for other similar values, such as botany or paleontology, that may not fall directly into one of the other eight categories (NPS, National Center for Recreation and Conservation 2011).

The first NRI was completed in 1982, with the intention of yearly updates. The most recent national update was in 1993, to celebrate the twenty-fifth anniversary of the National Wild and Scenic

Rivers Act (National Park Service 2011). The National Park Service decided it was high-time to update the Nationwide Rivers Inventory, and asked us to design a methodology that would allow for a nationwide update. It was decided early on during the scoping process that analyzing all nine outstandingly remarkable values would not be feasible within the span of ten weeks, so we decided to devise a new NRI methodology for the most populous ORVs in the 1995 Oregon NRI data. Based on a quick analysis of river miles, we decided to focus on the scenery, recreation, and fish ORVs. The following report details the steps taken to design our new methodology for updating the Nationwide Rivers Inventory.

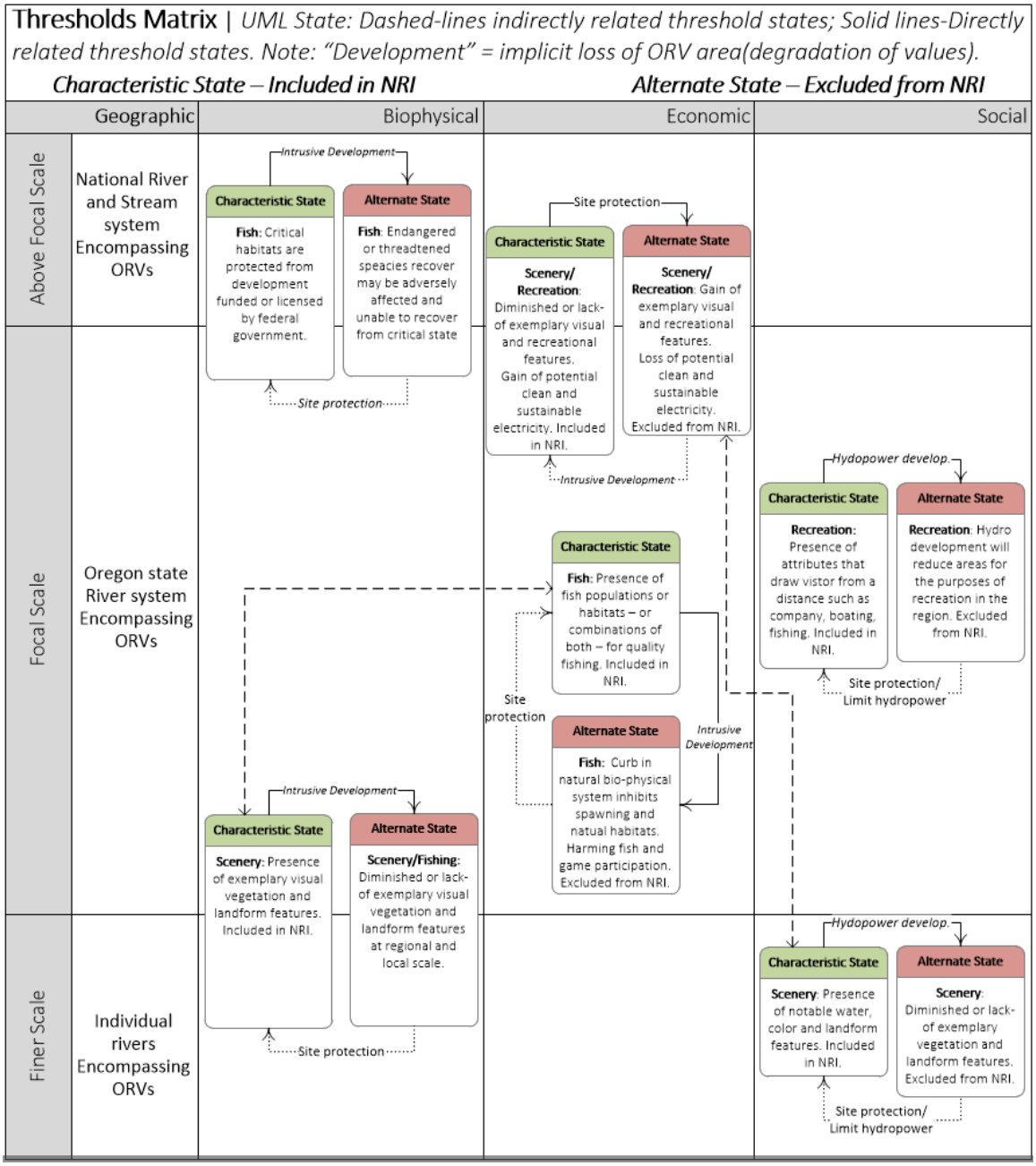
# Design and Methods

The primary task of this project was to design a method to systematically identify stream reaches throughout the state of Oregon for inclusion to the Nationwide Rivers Inventory - and eventually, so it may be refined and applied to a national scale. Before we could start to identify and gather data that would be used as representations of outstandingly remarkable values, we had to investigate the system relative to the scope of our area of study. Social-Ecological Systems (SES) table was generated which examines the interactions of Biophysical, Economic and Social states Outstandingly Remarkable values would have on the system at scales at, above, and below the system. Figure 1 depicts the SES table seen below. Likely ideal conditions for rivers to be included in the NRI are explained, as well as the likely key factors that would aid in contributing to that ideal state.

**Figure 1**. Social-Ecological Systems Table, Showing Ideal States, at Various Scales Related to ORV Representations of the Oregon NHD River System.

| Social-Ecological Systems Table \| Goal: Identification and Sustainable management of Wild and Scenic Rivers. Discover new methods to identify rivers which qualify for inclusion in the Nationwide Rivers Inventory – with subsequent inclusion to the National Wild and Scenic Rivers database. **An Ideal State with Identification/Inclusion to NRI:** | | | | |
|---|---|---|---|---|
| | Geographic | Biophysical | Economic | Social |
| Above Focal Scale (National Focus effects) | National River and Stream system Encompassing Outstanding Remarkable Values. | Help promote sustainable river ecosystems nationwide(Key Factor: Low prox to negative developments, high prox. to ORVs). | All Federal Agencies must provide additional resources into and consult with NPS if a development project will adversely affect river system included in NRI(Key Factor: Rivers close to development and existing ORVs) | Outdoor and recreational users of the system will provide social and personal value based on land ownership.(Key Factor: Quality of national parks and River system) |
| Focal Scale(System) | Oregon state River system Encompassing Outstanding Remarkable Values. | Sustainable management of rivers in via NPS oversight(NRI)(Key Factors: Fish ORV(critical habitat)). | Help maintain protection and sustainable management of individual river biophysical ecosystem services (Key Factors: All considered ORVs) | Community values: recreation v. development(hydropower) v. ecosystem services (viewshed) in Oregon.(Key Factors: Recreational or Scenic ORVs). |
| Finer Scale | Individual rivers Encompassing Outstanding Remarkable Values. | Protection and sustainable management of individual river biophysical ecosystem services | Management of Individual River segments (Key Factor: Value of clean hydropower v. tourism income from scenic ORVs ) | Grassroots for public and private values at higher scales. (Key Factor: Input from public for ORV consideration). |

**Figure 2.** Thresholds Matrix Displaying the Interactions at the Various Scales of ORVs on the Oregon NHD River System.



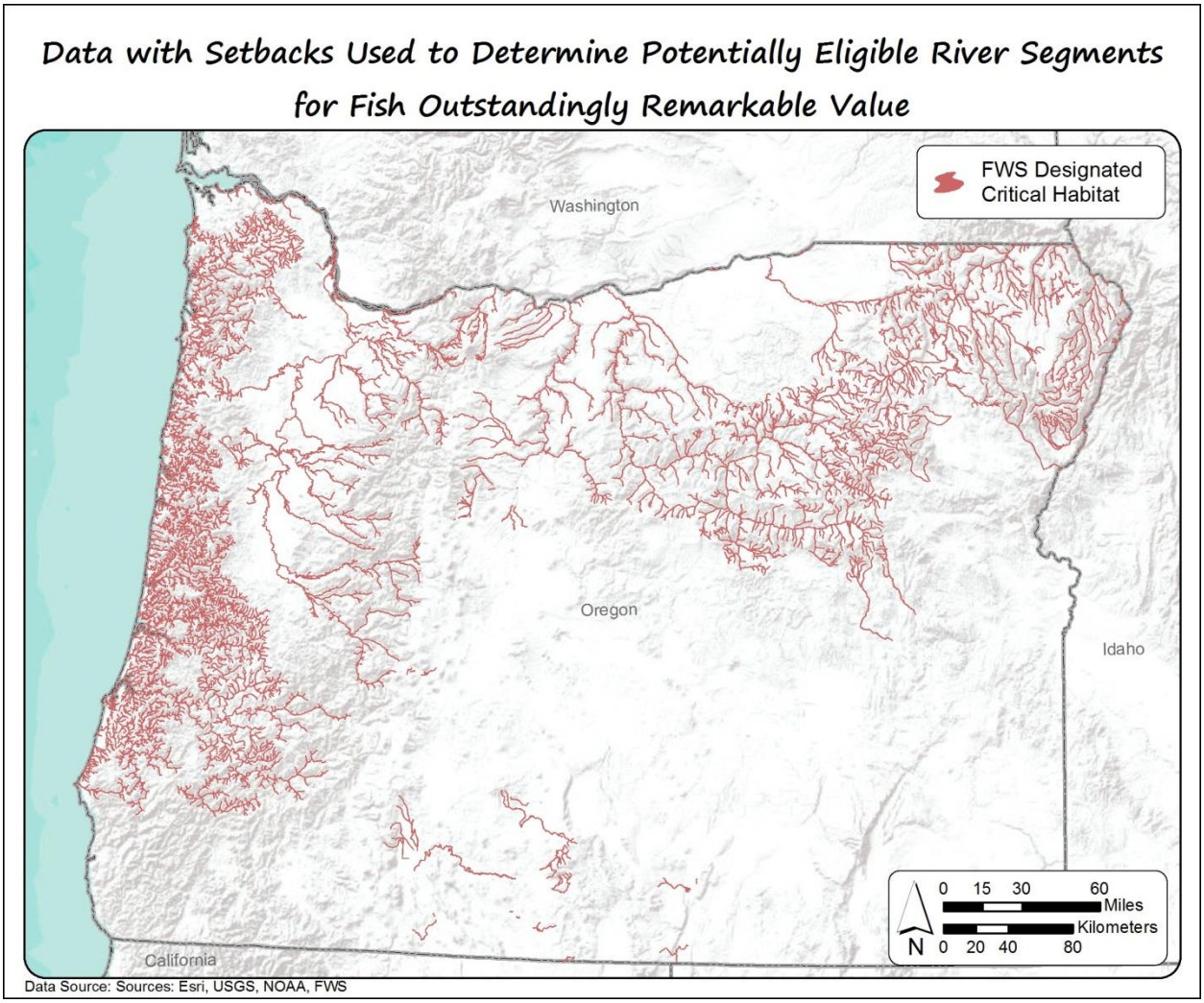

Though a computational agent based model was not being used for this project, a Thresholds Matrix (as shown in Figure 2) helps any future development understand what variables may unravel a system's ideal, i.e. sustainable, state. The group found that most of the thresholds boil down to different aspects of human development. Construction of a hydropower dam, urban development, changes in climate from emissions/pollution, and the presence of intrusive development near an ORV will typically degrade its quantifiable or intrinsic values that the NRI is trying to capture. It is because of

these variables why the group chose of the ORV elements – which will be discussed later – which help prevent the swelling of intrusive development that would degrade river ORVs.

At a core of any of the human development thresholds, however, it was discussed and assumed for this project that all development is viewed in a negative light. We are aware that some developments may narrowly aid the system by producing clean energy from hydroelectric power stations, or parks along the riverside for greater recreational benefits. As mentioned earlier, the intrusive development thresholds typically will damage the ideal characteristic states within the system.

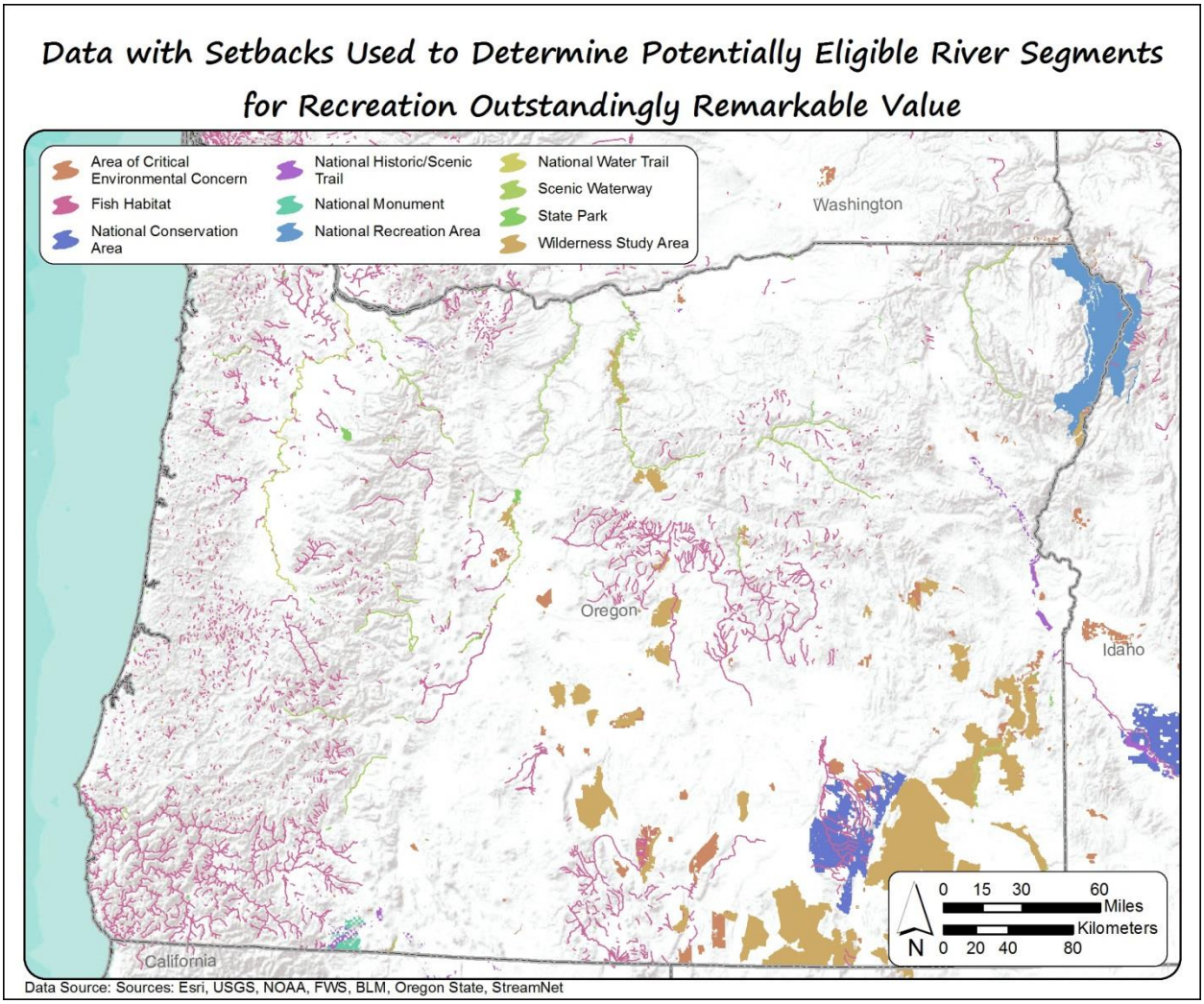
In order to develop spatial representations of our three selected ORVs, the group had to research and gather the elements (individual feature classes) of each, which will be merged together to generate the final representation of the ORVs. For the fish habitat ORV, the designated critical habitat provided by the US Fish and Wildlife Service allowed us to develop an extensive ORV representation that helps us identify areas (river segments) that contain features essential for the conservation of a threatened or endangered species. Please see Figure 3 for the locations of critical habitat within Oregon. The NPS has indicated that these river segments will be included in the NRI because of the protection of a river segment included in the NRI will contribute to the recovery of any particular species' habitat.

**Figure 3.** Designated Critical Habitat Data Used to Determine River Segments with Fish ORV Characteristics.



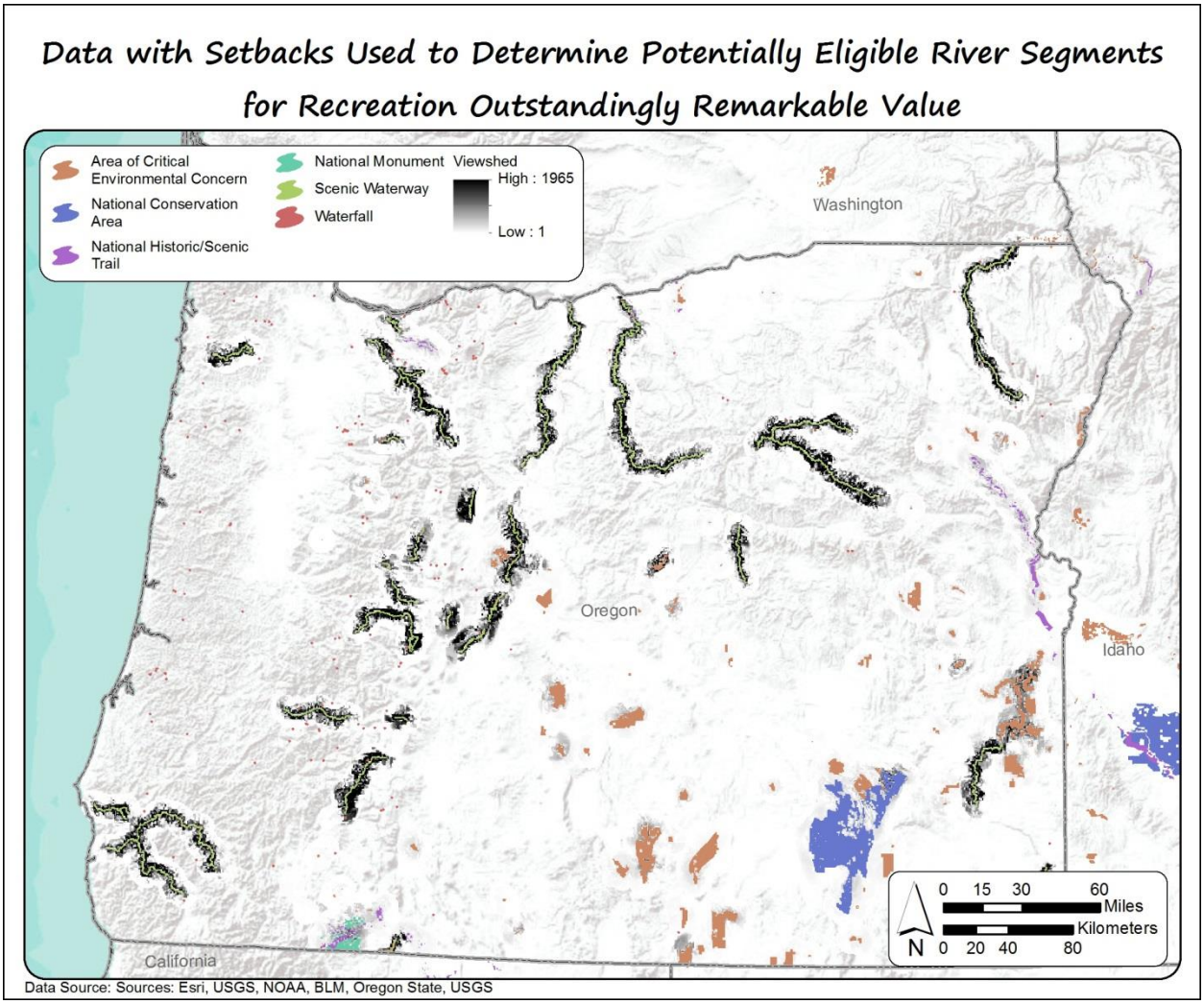

The recreation ORV incudes all areas we were able to find that contribute to a river's ability to draw visitors from a distance (non- local residence) to participate in a river's recreational services (sightseeing, wildlife observation, camping, photography, hiking, fishing and boating). The elements that the group was able to procure for this ORV's services were Historic and Scenic Trails, Scenic waterways, National Monuments, Scenic Waterways, Conservation Areas, Areas of Critical of Environmental Concern (ACEC), American Whitewater locations, and Wilderness study areas. For detailed information about data sources used in this pilot study, please see Appendix A. We imagine that this particular ORV will benefit the most from the external feedback from the public. Though this list covers all federally designated areas where recreational services are represented, many unofficial locations for these services likely exist elsewhere. Third party input will help make this ORV more comprehensive for river inclusion to the NRI. Data elements used to determine recreation ORVs can be seen in Figure 4.

**Figure 4**. Data Sources Used to Determine River Segments with Recreation ORV Characteristics.




The scenic ORV includes spatial representations of areas that contain of landform, vegetation, water, or color factors with exemplary features or attractions. Areas where seasonal variations in vegetation, scale of cultural modifications, and the length of time negative intrusions are also considered. Though many of the Scenery ORV elements are included in the recreation ORV (i.e. recreational sightseeing), this ORV considers the landform and which features are actually viewed from the river segments. As a result, topological errors (intersects) with the ORVs and stream geometries themselves are not the only valid scenic elements. To achieve a more accurate representation of all the scenic ORV elements, a viewshed analysis on the scenic locations was performed. With the Scenic locations identified as "observer" points, the viewshed analysis identifies all areas where the observers can be seen from according to the provided DEM. River segments that fall within a visual range and line of sight of positive viewshed output the 500 meters resolution output raster were included as having scenic ORV. The scenic elements used in this analysis can be seen in Figure 5.

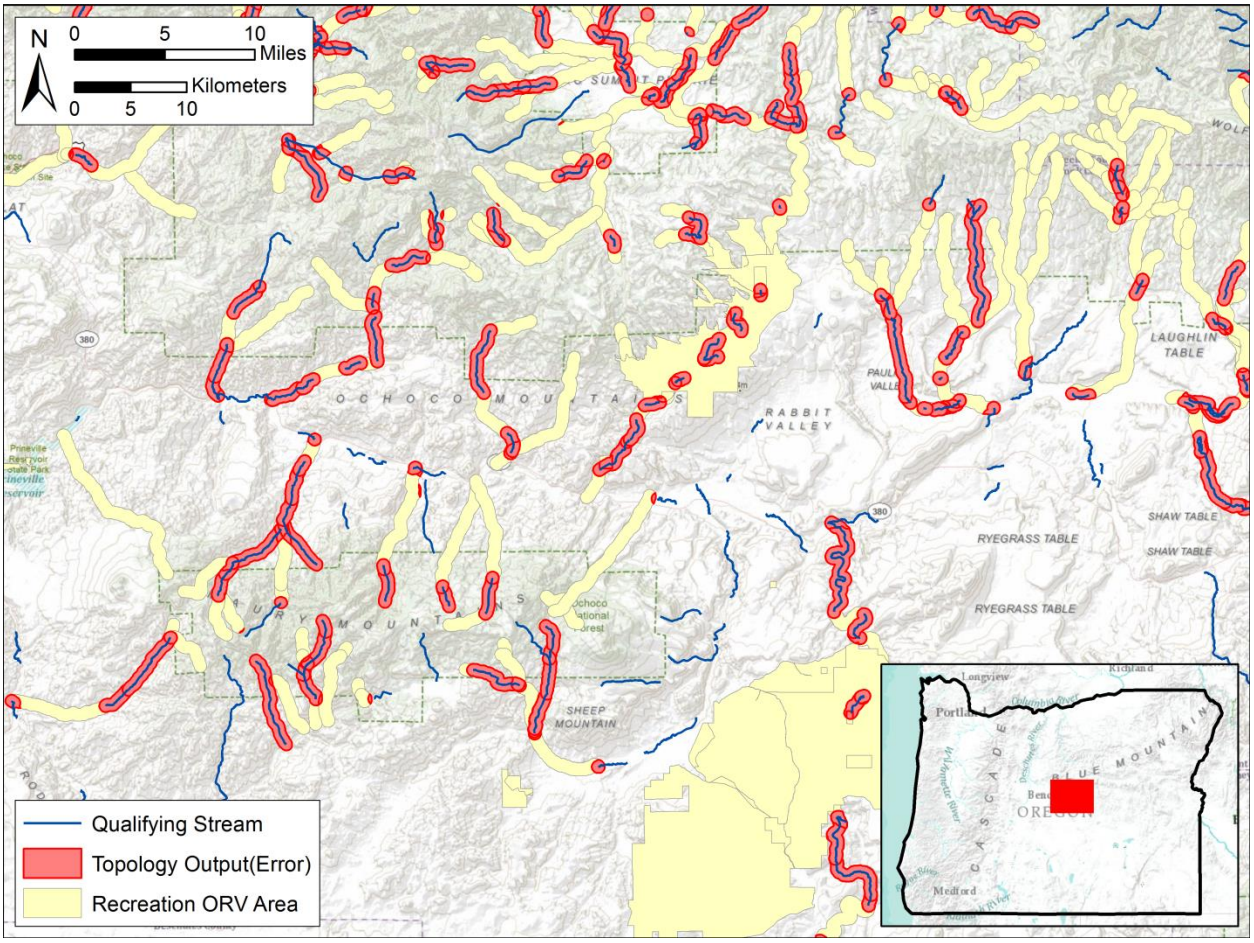
**Figure 5.** Data Sources Used to Determine River Segments with Scenic ORV Characteristics.




Once all ORVs elements are merged into their respective ORV classes, the topology analysis is performed to discover which available NHD stream features intersect with which ORV. The spatial representations of each ORV are set to 'Must not Overlap With' any river segment. The generated topology is validated and the 'errors' are output in the geodatabase. Though our analysis directly uses the output of the topology as the rivers that will be included into the NRI, a useful feature of the topology errors output dataset that will be used is the retained feature class id. This will allow us to work with attributes of the former river features for pop-up displays in the final web-mapping applications.

A preliminary example where only recreations ORVs were examined by the topology analysis can be seen on the map in Figure 6 below. The final analysis has similar output styles but with a thorough representation of the spatial and fish ORV datasets. Details of the methodology can be found in Appendix B.

**Figure 6.** Recreation ORV Topology Errors Example.




The National Parks Service wanted two web maps. One web map is to help facilitate easy comparison between the current NRI and the new NRI and a second web map to try to spur public engagement. The creation of the first web map was done using the ESRI JavaScript API. ESRI provides a large selection of hosted templates that allow for the easy creation of powerful and targeted web apps. The original thought was to use the Swipe map which allows the user to see all of one map, all of another map, or half and half of the same extent. The problem with this map was that it was not easy to spot check the map as the user would have to swipe left and right multiple times to check out the differences between the current and new NRI. After testing our data with the swipe map it became very apparent that it was not the right tool for the job, the story telling template was then tested and ultimately chosen because it did exactly what the NPS asked for. The story telling template allowed for two maps to be viewed side by side where the web app would synchronize both scale and location so when the user panned on one map it would automatically move to the same extent in the other. The result was web app that allowed for fast and easy comparison of both NRI datasets.

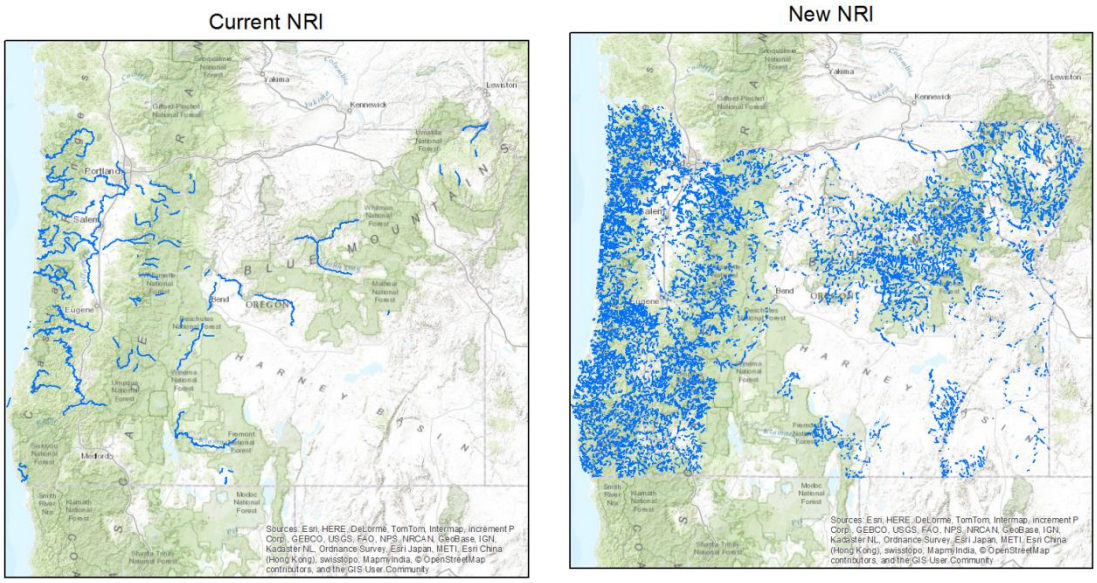
The public facing web map was created using underlying ESRI technology to deliver the data over the internet and the Geocortex HTML 5 viewer to create the public facing map. The goal of the public facing map was to help the public find different segments of river with outstandingly remarkable

values and give them a way to submit feedback to the National Parks Service. A self-populating google form was created and built into the web map to allow for easy feedback submitting. The main reason Geocortex was chosen over using solely ESRI technology was because the National Parks Service already is a Geocortex customer and uses the technology heavily. Geocortex allows for the fast creation of powerful web maps that would require heavy custom JavaScript development to achieve a similar product. One of the main concerns that the National Parks Service had of our work was their limitation in human power and ability to maintain complex solutions. The NPS is already stretched to the max and cannot absorb new responsibilities and work created by us so the goal of creating this map was to make something that was simple, effective, and ultimately very easy to maintain and implement. By leveraging their own technology and infrastructure to deploy the public facing map we reduce the need to have personnel learn new technologies and make it even easier to maintain our final solution. After the creation of both the internal and external map a technical document was made with detailed instructions on how to deploy either map so should the maps need to be moved to a different GIS system in the future there would be instructions on how to do so. The technical documentation can be found in Appendix C.

# Results

The current NRI for the state of Oregon consists of 140 segments that span roughly 826 miles. In contrast, the new NRI created using the methodology outlined in this paper created a total of 12,031 river segments with one or more outstandingly remarkable values that span a total of 16348 miles. Figure 7 displays a side by side comparison of the current and new NRI.

**Figure 7.** The Original 1995 Nationwide Rivers Inventory Compared (left) Compared to the New NRI Analysis (right).

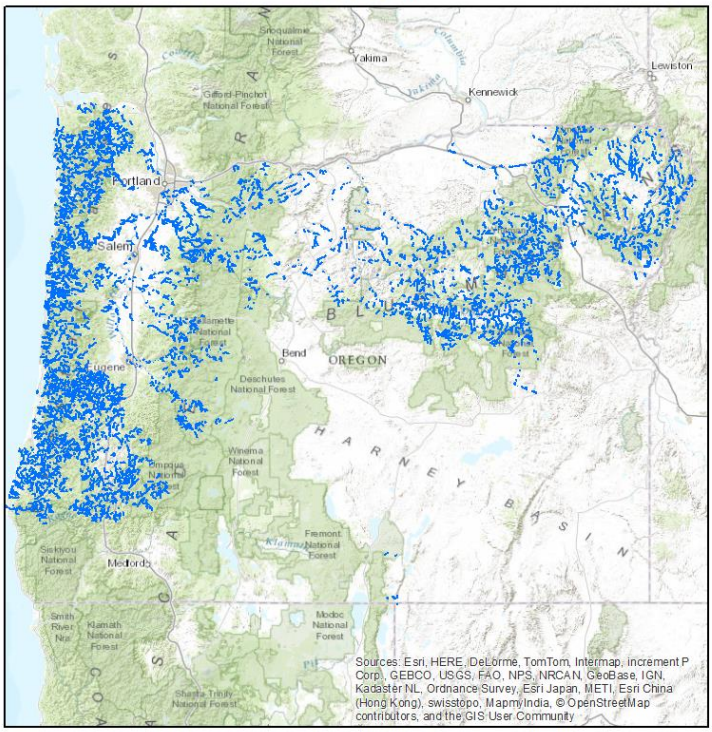



The biggest difference is that there are a lot more sections of river that could be added into the NRI and that many of these sections are a lot smaller in length than the current NRI. In the current NRI the average length of a river section is 5.9 miles while in the new NRI it is only 1.3 miles.

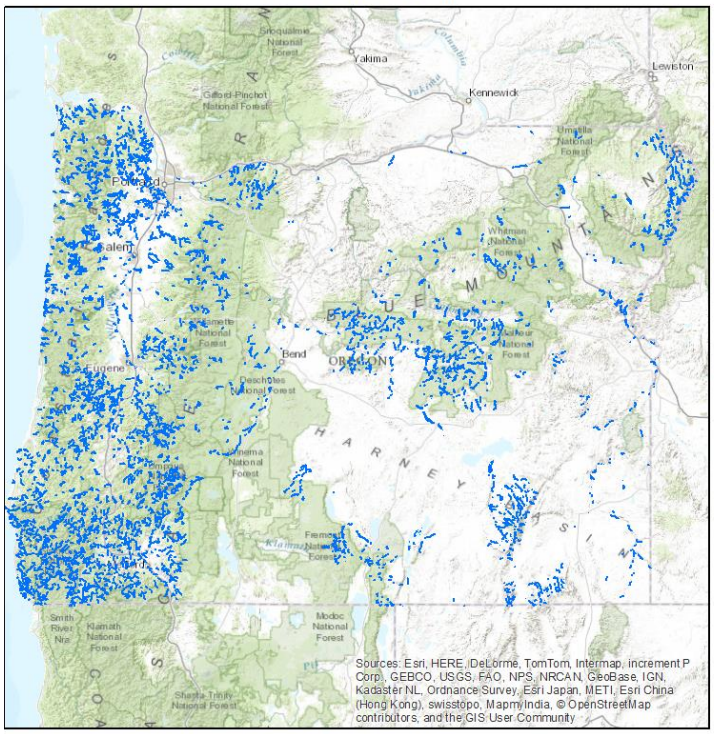
Fish outstandingly remarkable value is the most populous value by far with a total of 7,215 river segments which span for 10,175 miles. The second most populous outstandingly remarkable value is recreation with 6,718 segments which span for 8,966 miles. Lastly, the scenic remarkable value has a total of 3,572 river segments which span for 4,723 miles. Of the 12,031 river segments created using the new methodology about 60% of those segments only have one outstandingly remarkable value. This means that the other 40% have either two or more outstandingly remarkable values. Maps displaying each individual outstandingly remarkable value are shown in Figure 8.

**Figure 8**. Results from the Fish, Recreation, and Scenic ORV Analyses.

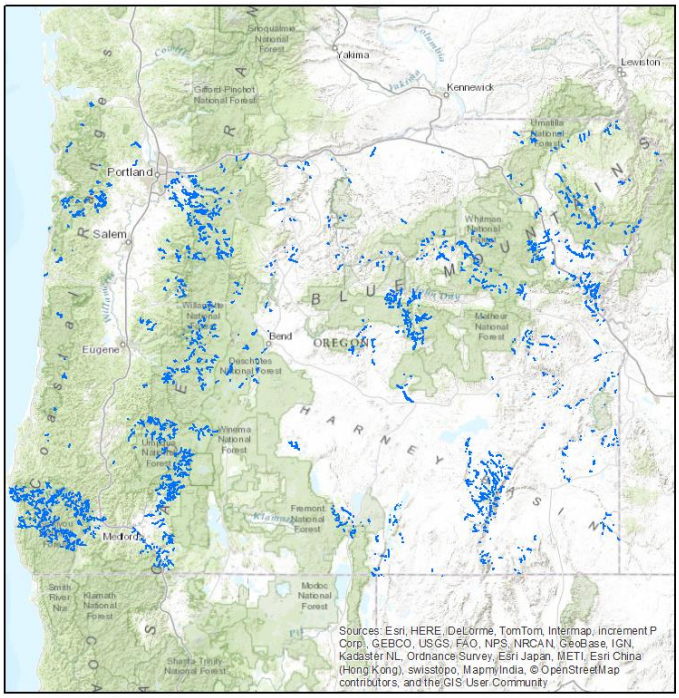
Fish NRI




Recreation NRI




Scenic NRI



The fish outstandingly remarkable value is by far the densest and can be found heavily on the west coast near the Pacific Ocean and in the mid-east portion of the state. In contrast the scenic outstandingly remarkable value is scant on the west coast of the state and is found primarily in the southern part of the state with river segments scattered all over the state. The recreation outstandingly has a similar distribution as the fishing outstandingly remarkable value except it is less dense along the west coast and has some segments in the Harney Basin.

# Discussion

At first, a visual comparison of the 1995 Oregon Nationwide Rivers Inventory to the results found in this pilot study may seem alarming. Significantly more river segments and mileage could now potentially be eligible for NRI status, as emphasized in Figure 9 and Figure 10, which display the change in mileage and percent change in river segments from the 1995 NRI to the results from this pilot study. For example, Figure 11 compares the original 1995 river segments with fish outstandingly remarkable value to the potentially eligible river segments determined by this analysis. It also displays our base set of potentially eligible streams, that is, those stream segments classified as perennial in the NHDPlus data and not adjacent to a dam with hydropower capabilities or taller than 50 feet. Returning to the source data provides answers to questions that may arise looking at the map. According to the U.S. Fish & Wildlife Service, only two fish species with available geospatial data had critical habitat designated before 1995: Warner Sucker and Borax Lake Chub (U.S. Fish & Wildlife Service n.d.). Many threatened and endangered species did not have land designated as critical habitat until much later. Bull Trout, for example, was not presented in the Federal Register until October 18, 2010, and Chum Salmon and Chinook Salmon were not designated in the Federal Register until February 16, 2000 (U.S. Fish & Wildlife Service n.d.).

**Figure 9.** Miles of Recreation, Scenic, and Fish Outstandingly Remarkable Value River Segments from the Original 1995 Data Compared to the 2014 Analysis.

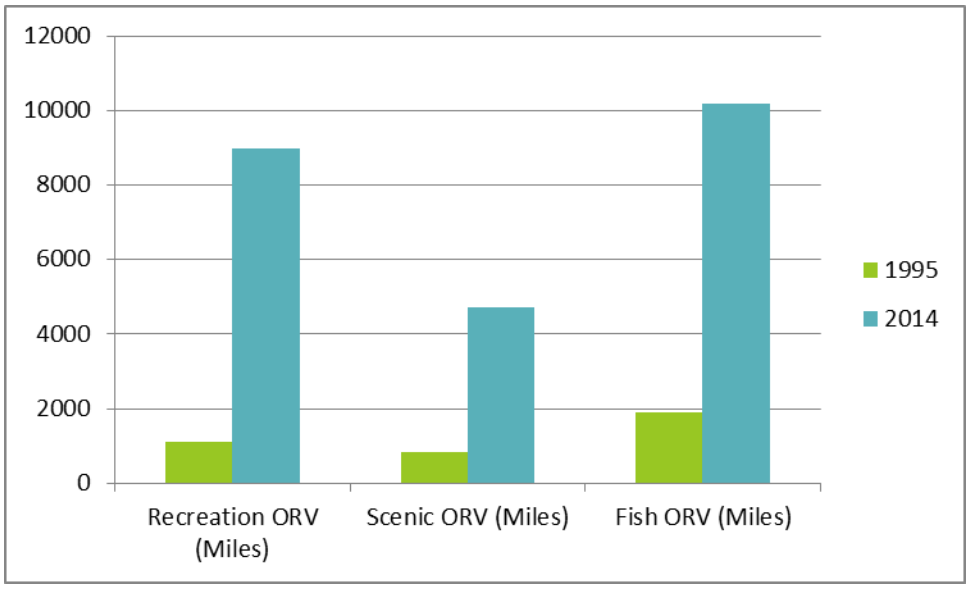
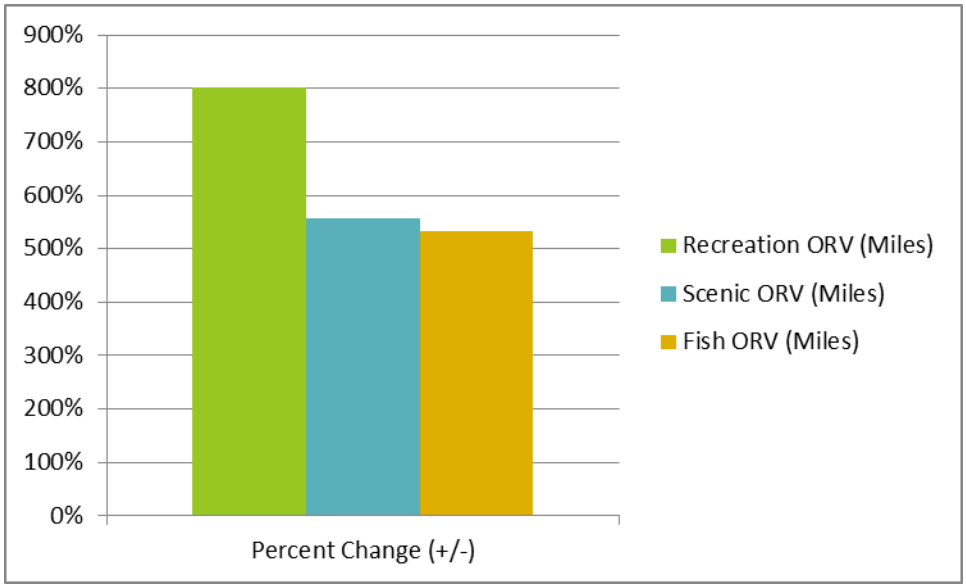


**Figure 10.** Percent Change in ORV River Segments from the Original Data to the 2014 Analysis.




The differences between the old and new NRI results for recreation and scenic ORVs can most likely be explained by time and improvements in technology. The Nationwide Rivers Inventory was conceptualized in the mid-1970s by the director of the Bureau of Reclamation and completed in August 1982 (National Park Service 2011). The methodology devised for this pilot study, using detailed nationwide data and relying on quality geospatial information, would not have been possible in the early 1980s. Analysts used 1:500,000 USGS topographic maps to identify river segments and field verified rivers of interest with video-taped aerial flyovers (National Park Service 2011). Digitalization of conservation and geospatial information has resulted in a much more efficient process. The difference between the 1995 Oregon NRI river segments and the 2014 river segments for recreation can be seen in Figure 12; Figure 13 shows the river segments for the scenic outstandingly remarkable value. A number of river segments contained qualities for multiple outstandingly remarkable values. Figure 14 shows those river segments that contain elements of fish, recreation, and scenic ORVs. Figure 15 displays all NRI river segments from the 1995 Oregon data compared to the NRI results found in this pilot study.

**Figure 11.** A Comparison of the 1995 NRI Fish ORV River Segments to the 2014 Analysis Results.

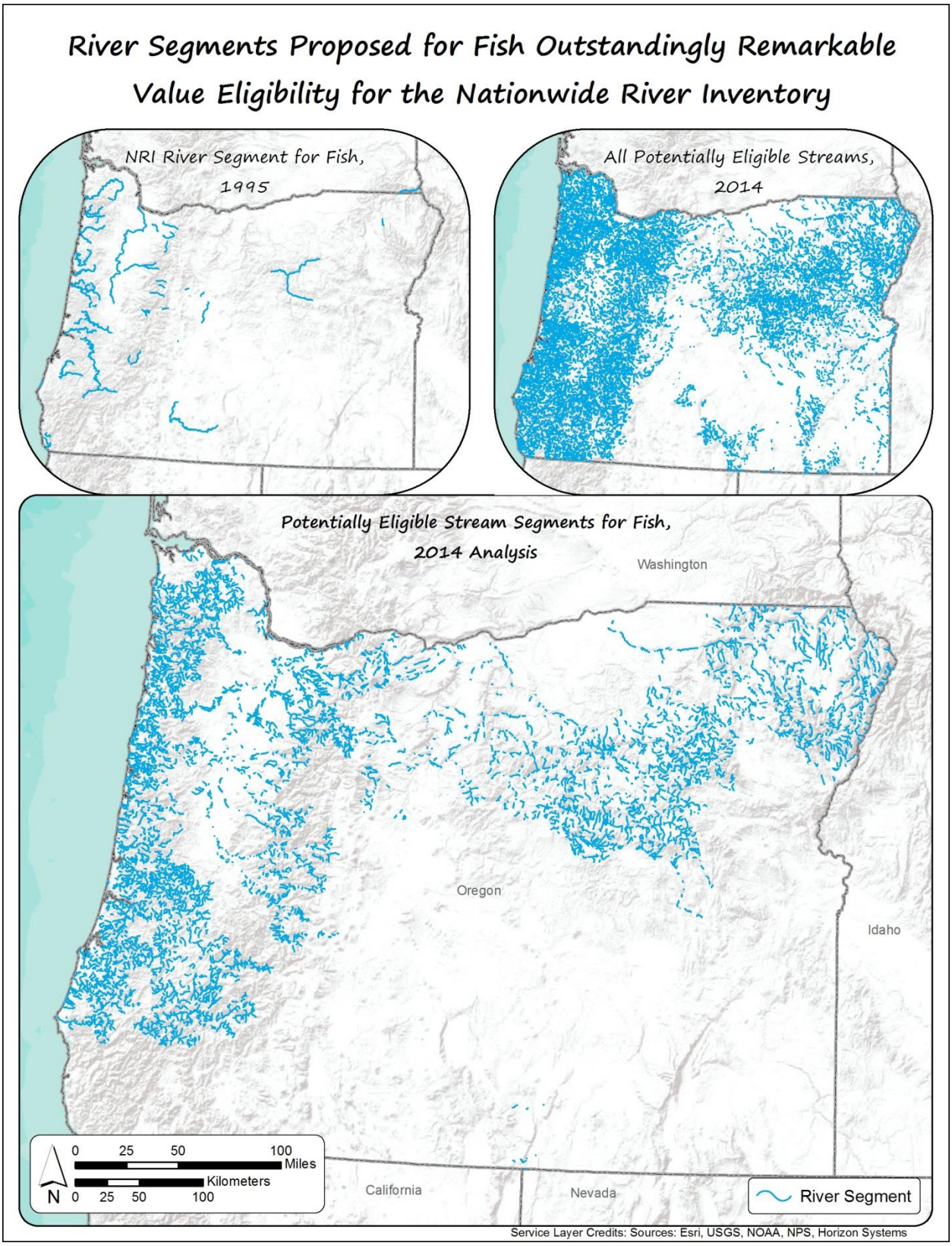


**Figure 12.** A Comparison of the 1995 NRI Recreation ORV River Segments to the 2014 Analysis Results.

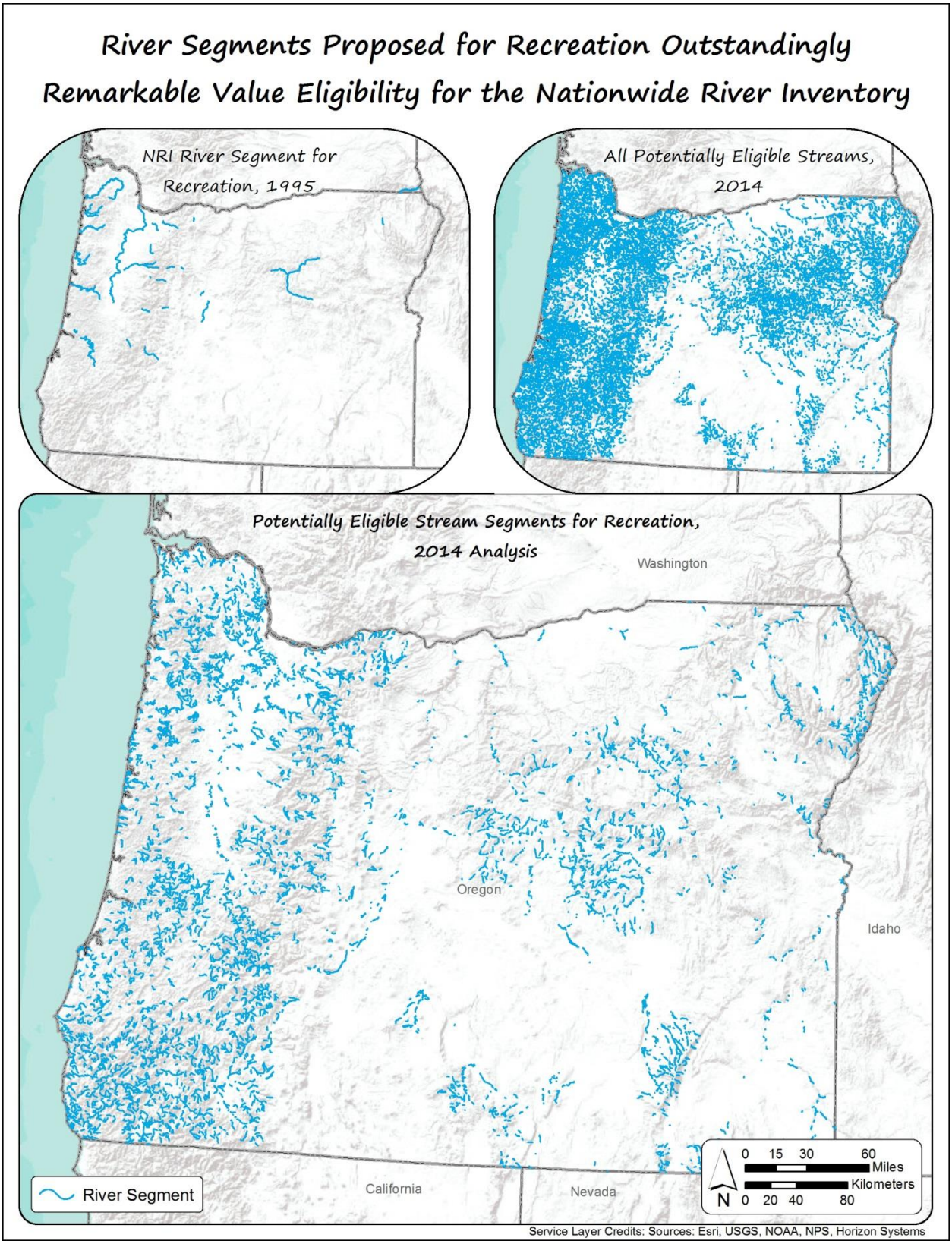


**Figure 13**. A Comparison of the 1995 NRI Scenic ORV River Segments to the 2014 Analysis Results.

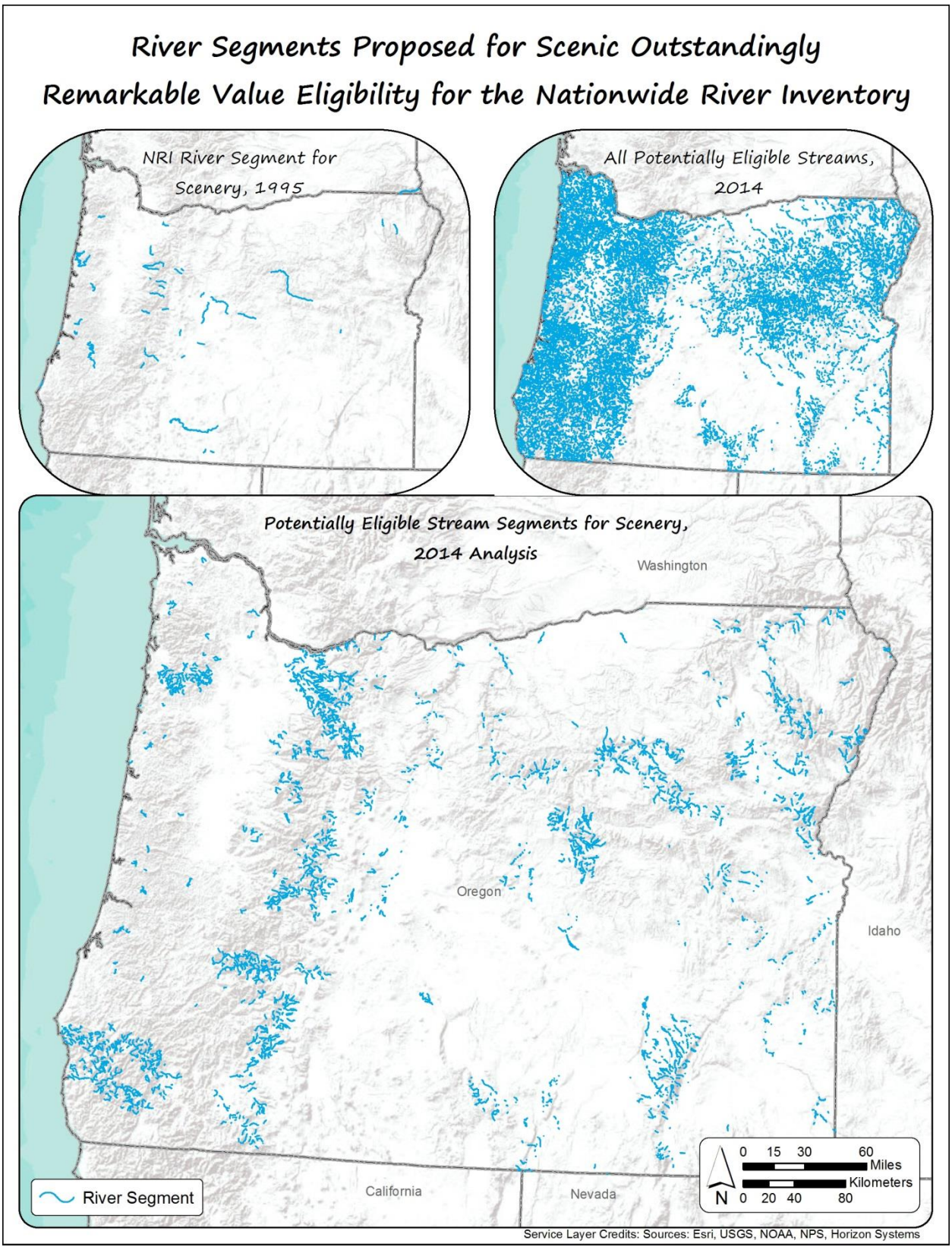


**Figure 14.** River Segments that have all Three Fish, Recreation, and Scenic Qualities.

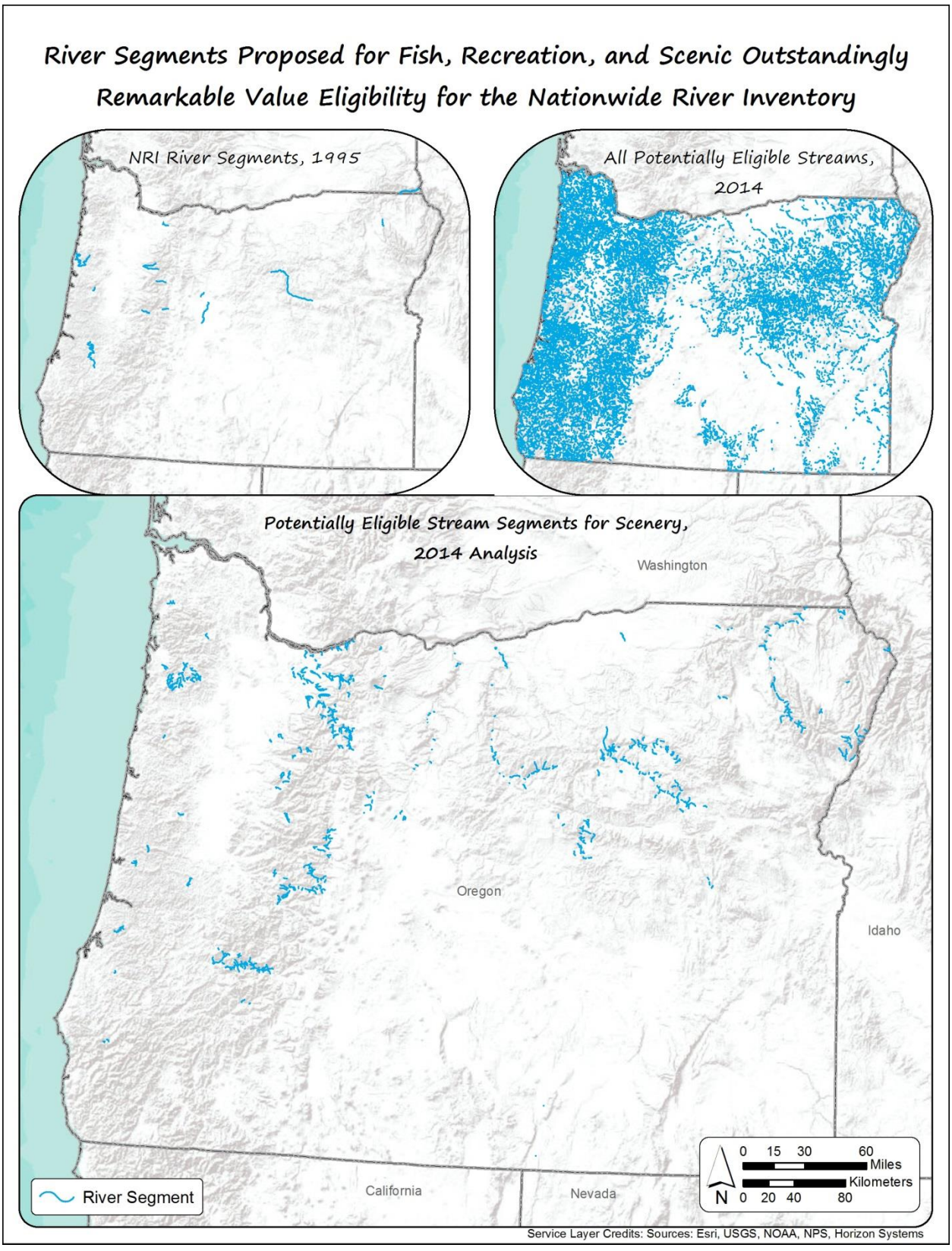
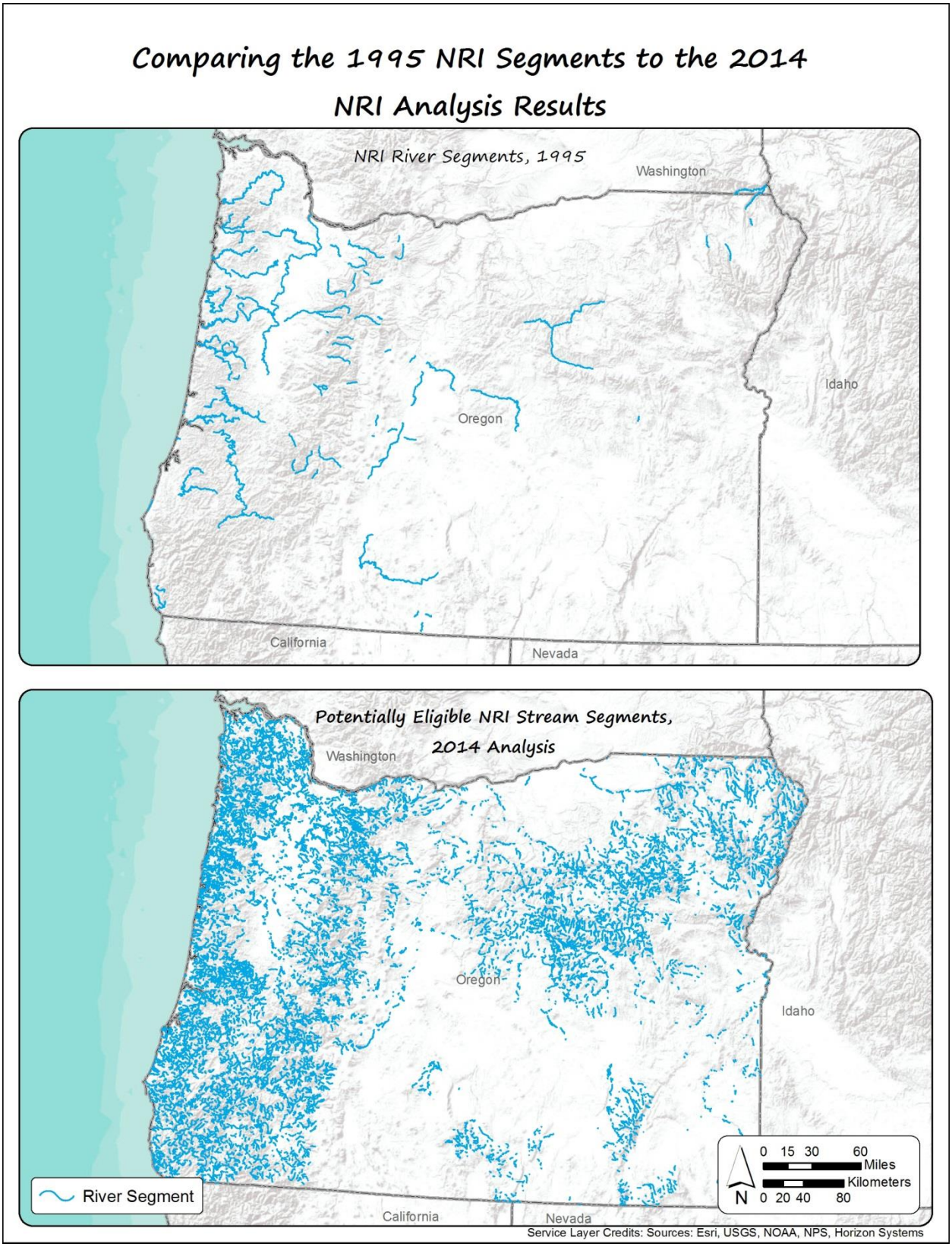


**Figure 15.** Comparing All 1995 NRI Segments to All 2014 NRI Analysis Results.



The National Park Service sponsors expressed several deliverables they wished to see as a part of this project. One of them was a tabular comparison of 1995 NRI rivers with the segments found in this pilot study, along with the visual comparison. Table 1 below displays the various named rivers and overlapping miles between the original and new NRI studies.

**Table 1.** Length of River Segments that Overlap Between Original Published NRI and New NRI Analysis.

| Matching Stream Name | Number of New NRI Segments | Overlapping Miles |
|---|---|---|
| **Alsea River** | 14 | 231.1851 |
| **Antelope Creek** | 10 | 24.4334 |
| **Bear Creek** | 90 | 387.9580 |
| **Boulder Creek** | 90 | 254.4772 |
| **Breitenbush River** | 7 | 71.5104 |
| **Canton Creek** | 12 | 125.7959 |
| **Chetco River** | 22 | 240.9776 |
| **Clackamas River** | 33 | 480.4448 |
| **Cow Creek** | 51 | 1358.2418 |
| **Crabtree Creek** | 7 | 12.1657 |
| **Crescent Creek** | 7 | 49.9372 |
| **Crooked River** | 12 | 851.5741 |
| **Deschutes River** | 25 | 784.2515 |
| **Drift Creek** | 17 | 178.5012 |
| **Eagle Creek** | 45 | 329.7078 |
| **Fall Creek** | 34 | 397.1363 |
| **Fall River** | 2 | 22.9144 |
| **Fish Creek** | 25 | 142.8976 |

| Matching Stream Name | Number of New NRI Segments | Overlapping Miles |
|---|---|---|
| **Grande Ronde River** | 46 | 1801.2920 |
| **Jack Creek** | 5 | 25.7648 |
| **John Day River** | 105 | 8587.0891 |
| **Joseph Creek** | 8 | 287.7033 |
| **Kilchis River** | 7 | 112.6417 |
| **Little Deschutes River** | 33 | 2051.0008 |
| **Little Luckiamute River** | 8 | 215.1085 |
| **Little Nestucca River** | 13 | 257.2689 |
| **Little North Santiam River** | 10 | 173.5752 |
| **Lobster Creek** | 10 | 165.1034 |
| **Lostine River** | 17 | 233.4761 |
| **Luckiamute River** | 21 | 1288.6494 |
| **Malheur River** | 31 | 130.4753 |
| **Marten Creek** | 2 | 14.3118 |
| **McKenzie River** | 18 | 213.5628 |
| **Miller Creek** | 9 | 54.7736 |
| **Minam River** | 23 | 211.3760 |
| **Molalla River** | 32 | 431.7348 |
| **Nehalem River** | 56 | 6938.5240 |
| **Nestucca River** | 21 | 159.8632 |
| **New River** | 3 | 23.0482 |
| **Opal Creek** | 4 | 15.4211 |

| Matching Stream Name | Number of New NRI Segments | Overlapping Miles |
|---|---|---|
| **Paulina Creek** | 10 | 84.3817 |
| **Quartzville Creek** | 5 | 40.1859 |
| **Sandy River** | 14 | 161.6488 |
| **Sevenmile Creek** | 2 | 11.0046 |
| **Sharps Creek** | 4 | 44.5754 |
| **Siletz River** | 20 | 1337.2698 |
| **Siuslaw River** | 35 | 539.9202 |
| **Smith River** | 35 | 583.8788 |
| **Steamboat Creek** | 8 | 23.2102 |
| **Tenmile Creek** | 11 | 6.1430 |
| **Trask River** | 8 | 151.5648 |
| **Tualatin River** | 17 | 1366.9725 |
| **Walker Creek** | 11 | 31.9101 |
| **Whittaker Creek** | 3 | 18.1681 |
| **Willamette River** | 4 | 676.8300 |
| **Wilson River** | 18 | 543.0200 |
| **Yaquina River** | 21 | 1129.6398 |

Our National Park Service sponsors are particularly concerned about potential new hydropower development in the pilot study area and nationwide, and how that could impact stream quality. A second deliverable they requested was an examination of hydropower in two capacities. The first was examining the 2014 report about the potential of new stream-reach development (NSD) on over three million US streams published by the Department of Energy (DOE) Water Power Program, in conjunction with Oak Ridge National Laboratory (ORNL). Initially, the results seem quite alarming for the Pacific Northwest region, as that region had the highest potential for hydropower development. In total, the report projected that undeveloped NSD capacity is 84.7 GW, and undeveloped NSD generation is 460

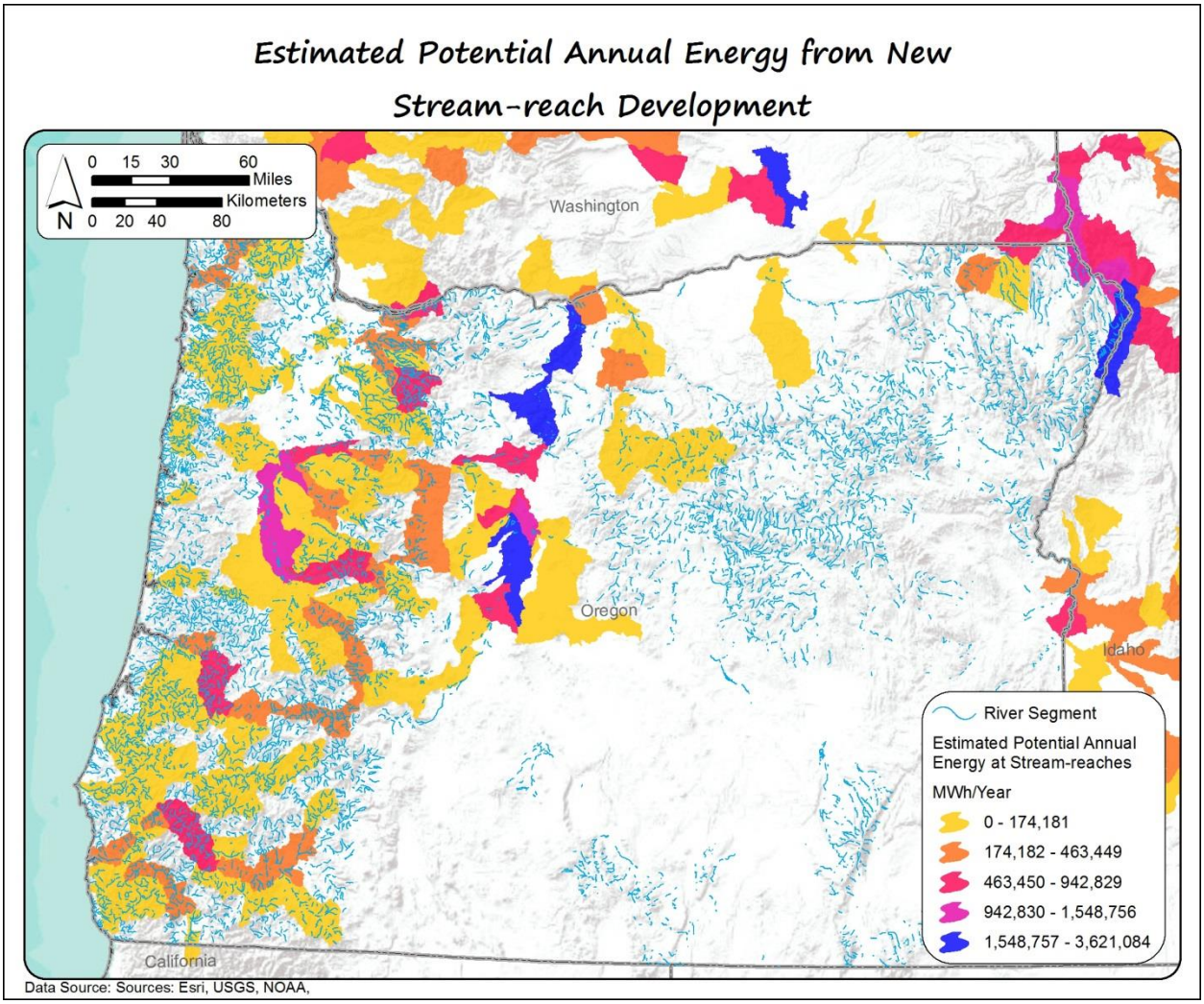
TWh/year. The report projected NSD capacity for the Pacific Northwest region is 25.2 GW and the generation is 149 million MWh/year (Kao 2014). The report differentiates between larger (>1 MW) and smaller (<1 MW) capacity stream-reaches. In the Pacific Northwest Region, undeveloped NSD capacity in larger stream-reaches is projected to be 15,997 MW with a potential generation of 96,756,000 MWh of generation. Smaller stream reaches have a projected NSD capacity of 9,228 MW with a projected capacity of 52,244,000. This is about 76% of existing conventional hydropower nameplate capacity (Kao 2014). The highest hydropower potential for an individual state is in our pilot state, Oregon. Oregon has an undeveloped NSD potential capacity of 8.9 MW and potential generation of 53.4 MWh/year from hydropower.

Examining these numbers alone can be startling to those concerned with altering the water systems. ORNL and DOE did not simply look at potential; they also identified a number of environmental, social, and cultural factors. They did not specify mitigation measures for any of these factors, but did identify how their presence could affect development. After excluding stream-reaches in close proximity to national parks, wild and scenic rivers, and wilderness areas, Oregon is projected to have a potential NSD capacity of 4.5 MW and potential generation of 25 million MWh/year. The Pacific Northwest Region has a projected capacity of 17 MW and generation of nearly 98 million MWh/year (Kao 2014).

Following through on hydropower development in the Pacific Northwest could have potentially serious impacts to wildlife and recreation. For example, twenty-eight species have designated critical habitat in the Pacific Northwest. Eighty-three percent of stream-reaches with hydropower potential intersect at least one critical habitat and ninety-nine percent intersect protected lands (Kao 2014). There are 1,595 boat ramps, 1,157 freshwater fishing access areas, 550 waterfalls, and 867 recreational boating river sections (Kao 2014). Hydropower development could definitely impact the three outstandingly remarkable values studied in this pilot project if mitigation measures are not enacted. Figure 16 shows the NRI results from this pilot study with the potential annual energy projected by ORNL.

Our NPS sponsors expressed interest in a second hydropower issue, as well. The Northwest Power and Conservation Council (formerly the Pacific Northwest Electric Power and Conservation Planning Council) created a list of Protected Areas in 1988, and updated most recently in 1992. According to the Council, these areas should be protected from hydroelectric development because the risks of loss to fish and wildlife were deemed irreversible (StreamNet n.d.). Given that the data were available in the form of a 30,000+ record access database or as a web map, but the raw geospatial data were not readily available, this comparison was left for future work.

**Figure 16**. 2014 NRI Results with the DOE ORNL Report Potential Annual Energy.




Our sponsors also expressed interest in how the new Nationwide Rivers Inventory results would relate to designated wild and scenic rivers. We found 152 named rivers from the NRI results that overlapped wild and scenic rivers. Figure 17 below shows the overlap between the NRI results and Wild and Scenic Rivers. Table 2 that follows lists the named stream segments that overlapped established wild and scenic rivers and the mileage of overlap.

**Figure 17.** Pilot Study NRI Results and Wild and Scenic Rivers.

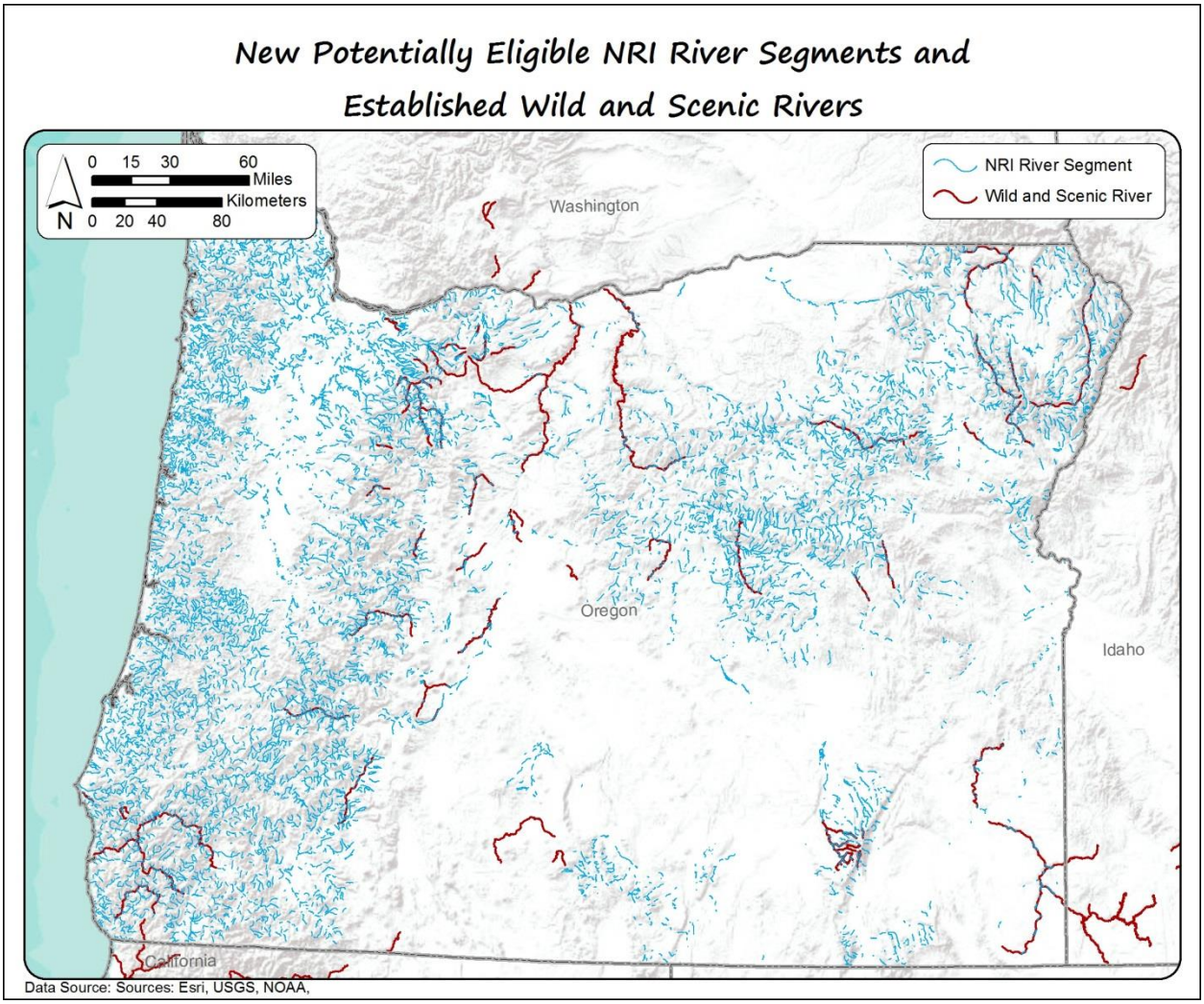



**Table 2.** NRI Named Streams that Overlap Established Wild and Scenic Rivers.

| Stream Name | Overlap Mileage |
|---|---|
| **Ankle Creek** | 1.66 |
| **Backout Creek** | 1.62 |
| **Bakeoven Creek** | 0.62 |
| **Baldy Creek** | 1.19 |
| **Basin Creek** | 3.15 |
| **Big Creek** | 3.75 |

| Stream Name | Overlap Mileage |
|---|---|
| **Bighorn Creek** | 1.62 |
| **Blue Creek** | 1.93 |
| **Bogus Creek** | 1.48 |
| **Boulder Creek** | 0.73 |
| **Bowman Creek** | 0.95 |
| **Box Canyon Creek** | 1.83 |
| **Bridge Creek** | 2.53 |
| **Brokencot Creek** | 2.10 |
| **Bunker Creek** | 2.17 |
| **Burnt Creek** | 2.04 |
| **Calico Creek** | 1.94 |
| **Caribou Creek** | 0.54 |
| **Carter Creek** | 4.30 |
| **Cayuse Creek** | 1.24 |
| **Chalk Creek** | 4.79 |
| **Cheeney Creek** | 0.08 |
| **Chetco River** | 12.48 |
| **China Cap Creek** | 1.58 |
| **Christy Creek** | 1.00 |
| **Clackamas River** | 28.43 |
| **Cliff Creek** | 4.16 |
| **Collawash River** | 7.88 |
| **Copper Creek** | 1.67 |

| Stream Name | Overlap Mileage |
|---|---|
| **Corral Creek** | 1.27 |
| **Cougar Creek** | 1.16 |
| **Courtney Creek** | 3.05 |
| **Cove Creek** | 1.02 |
| **Crescent Creek** | 6.98 |
| **Cub Creek** | 5.89 |
| **Culvert Creek** | 1.98 |
| **Dartmouth Creek** | 1.10 |
| **Deep Creek** | 0.71 |
| **Deschutes River** | 13.61 |
| **Dinner Creek** | 1.54 |
| **Dixie Creek** | 2.78 |
| **Donner und Blitzen River** | 6.71 |
| **Dunno Creek** | 1.02 |
| **Dutch Flat Creek** | 4.16 |
| **Eagle Creek** | 15.30 |
| **East Fork Collawash River** | 1.60 |
| **East Fork Hood River** | 4.75 |
| **Elk River** | 6.55 |
| **Elkhorn Creek** | 1.36 |
| **Ellis Creek** | 1.83 |
| **Fall Creek** | 3.51 |
| **Fifteenmile Creek** | 4.17 |

| Stream Name | Overlap Mileage |
|---|---|
| **Fish Creek** | 8.86 |
| **Fisher Creek** | 4.90 |
| **Glade Creek** | 2.86 |
| **Gowing Creek** | 1.68 |
| **Grande Ronde River** | 10.98 |
| **Granite Creek** | 2.84 |
| **Grizzly Creek** | 1.41 |
| **Grouse Creek** | 2.96 |
| **Horseshoe Creek** | 2.78 |
| **Hunter Creek** | 1.88 |
| **Illinois River** | 14.74 |
| **Imnaha River** | 15.22 |
| **Jack Creek** | 2.87 |
| **Jack Davis Creek** | 1.43 |
| **Jazz Creek** | 2.56 |
| **John Day River** | 22.48 |
| **Jones Creek** | 0.71 |
| **Joseph Creek** | 4.62 |
| **Junction Creek** | 1.26 |
| **Kink Creek** | 4.31 |
| **Labrador Creek** | 2.01 |
| **Lackey Creek** | 1.61 |
| **Lake Creek** | 4.44 |

| Stream Name | Overlap Mileage |
|---|---|
| **Little Blitzen River** | 9.72 |
| **Little Boulder Creek** | 1.64 |
| **Little Deschutes River** | 19.23 |
| **Little Pot Creek** | 2.91 |
| **Long Creek** | 1.28 |
| **Lostine River** | 2.57 |
| **Lunch Creek** | 1.57 |
| **Major Creek** | 1.30 |
| **Malheur River** | 2.14 |
| **Maple Creek** | 1.13 |
| **Martin Creek** | 2.90 |
| **McKenzie River** | 4.91 |
| **McKinley Creek** | 3.81 |
| **Meadow Creek** | 5.67 |
| **Meadows Creek** | 3.67 |
| **Memaloose Creek** | 0.80 |
| **Metolius River** | 6.54 |
| **Middle Fork Hood River** | 1.18 |
| **Minam River** | 13.08 |
| **Montgomery Creek** | 1.58 |
| **Mud Creek** | 2.12 |
| **Muddy Creek** | 0.97 |
| **Myers Creek** | 0.77 |

| Stream Name | Overlap Mileage |
|---|---|
| **North Fork Crooked River** | 6.48 |
| **North Fork Elk River** | 1.35 |
| **North Fork John Day River** | 14.78 |
| **North Fork Malheur River** | 3.95 |
| **North Fork Middle Fork Willamette River** | 12.52 |
| **North Fork Owyhee River** | 2.81 |
| **North Umpqua River** | 11.73 |
| **Oliver Creek** | 4.36 |
| **Onion Creek** | 0.99 |
| **Owyhee River** | 26.59 |
| **Park Creek** | 1.50 |
| **Peat Creek** | 0.65 |
| **Powder River** | 6.95 |
| **Puzzle Creek** | 1.86 |
| **Quartzville Creek** | 3.03 |
| **Raspberry Creek** | 1.19 |
| **Roaring River** | 2.55 |
| **Robinhood Creek** | 1.68 |
| **Rock Creek** | 0.82 |
| **Rogue River** | 17.31 |
| **Rum Creek** | 0.50 |
| **Russ Creek** | 1.07 |
| **Salmon River** | 4.54 |

| Stream Name | Overlap Mileage |
|---|---|
| **Sandy River** | 1.63 |
| **Second Creek** | 1.49 |
| **Shasta Costa Creek** | 0.42 |
| **Sheep Creek** | 4.15 |
| **Skookum Creek** | 3.72 |
| **Slick Ear Creek** | 2.09 |
| **Slide Creek** | 1.30 |
| **Sluice Creek** | 1.96 |
| **Snailback Creek** | 2.75 |
| **Soldier Creek** | 1.27 |
| **South Ankle Creek** | 1.00 |
| **South Fork Clackamas River** | 3.24 |
| **South Fork John Day River** | 8.18 |
| **South Fork Roaring River** | 2.94 |
| **Splintercat Creek** | 1.60 |
| **Squaw Creek** | 2.63 |
| **Summit Creek** | 0.32 |
| **Swamp Creek** | 0.55 |
| **Tate Creek** | 2.22 |
| **Third Creek** | 1.38 |
| **Three Lynx Creek** | 2.13 |
| **Trail Creek** | 2.60 |
| **Tulley Creek** | 1.43 |

| Stream Name | Overlap Mileage |
|---|---|
| **Tweed Creek** | 1.59 |
| **Wallowa River** | 5.06 |
| **Wenaha River** | 6.86 |
| **West Little Owyhee River** | 12.48 |
| **White River** | 1.46 |
| **Wildhorse Creek** | 2.11 |
| **Wind Creek** | 0.39 |
| **Zigzag River** | 1.80 |

# Business Case and Implementation Plan

Like all simulations and analyses of social ecological systems, a proper business function that meets the needs of a particular business case for proper implementation is essential. Defining project goals, preventing mission creep, and identifying roles are keys to such proper business function's success and would be ideal for this particular project on the Nationwide Rivers Inventory project.

Although different levels of expertise are required for this particular project, each person would likely be involved at each step of the process, and at the very least, decisions at each step of the process. For this purpose, a similar structure to the Agent Based Modeling and Simulation - Generalist Modeling (North 2007) structure would be an ideal approach to the business process. All the project tasks are spread over several people but still require each of them to have at least some involvement in each task. Though the skillset of each person involved may differ, the tasks for the project are so dependent on one another that each decision in the process requires input from everyone. Thus, there will be a true understanding of how the model and simulation works for everyone involved.

For the Nationwide Rivers Inventory project group, every one of all skillsets collaborates on each task to ensure that subsequent tasks had everything required in order to move forward. A diagram of the business case and implementation plan is shown in Figure 18.

- **Conceptualization**: All personnel involved in the NRI project are involved in the conceptual design of the model. The project manager (in this case, the sponsor) provides whatever information they can and makes themselves fully available for further input. A discussion of the business needs of the model is paramount at this stage. *Group Result*: A decision is made the project will attempt to update the Nationwide Rivers Inventory for WSR designation.

- **Scoping**: Analysts, Molders, Managers and Developers investigate the realistic goals of the project. Through the conceptualization, everyone involved expresses what their idea of a realistic goal for the project should be. *Group Result*: The state of Oregon was chosen as the geographic scope and three of the ORVs were chosen to be investigated. Oregon has the most comprehensive "old" NRI dataset which may be easily modeled after.

- **Roles and Tasks**: All group members will be involved in data identification and gathering. *Group Result*: Several data sources were discovered for use in the modeling of the outstandingly remarkable values. Topology and viewshed analyses decide on the best methods of identifying Rivers that have an ORV.

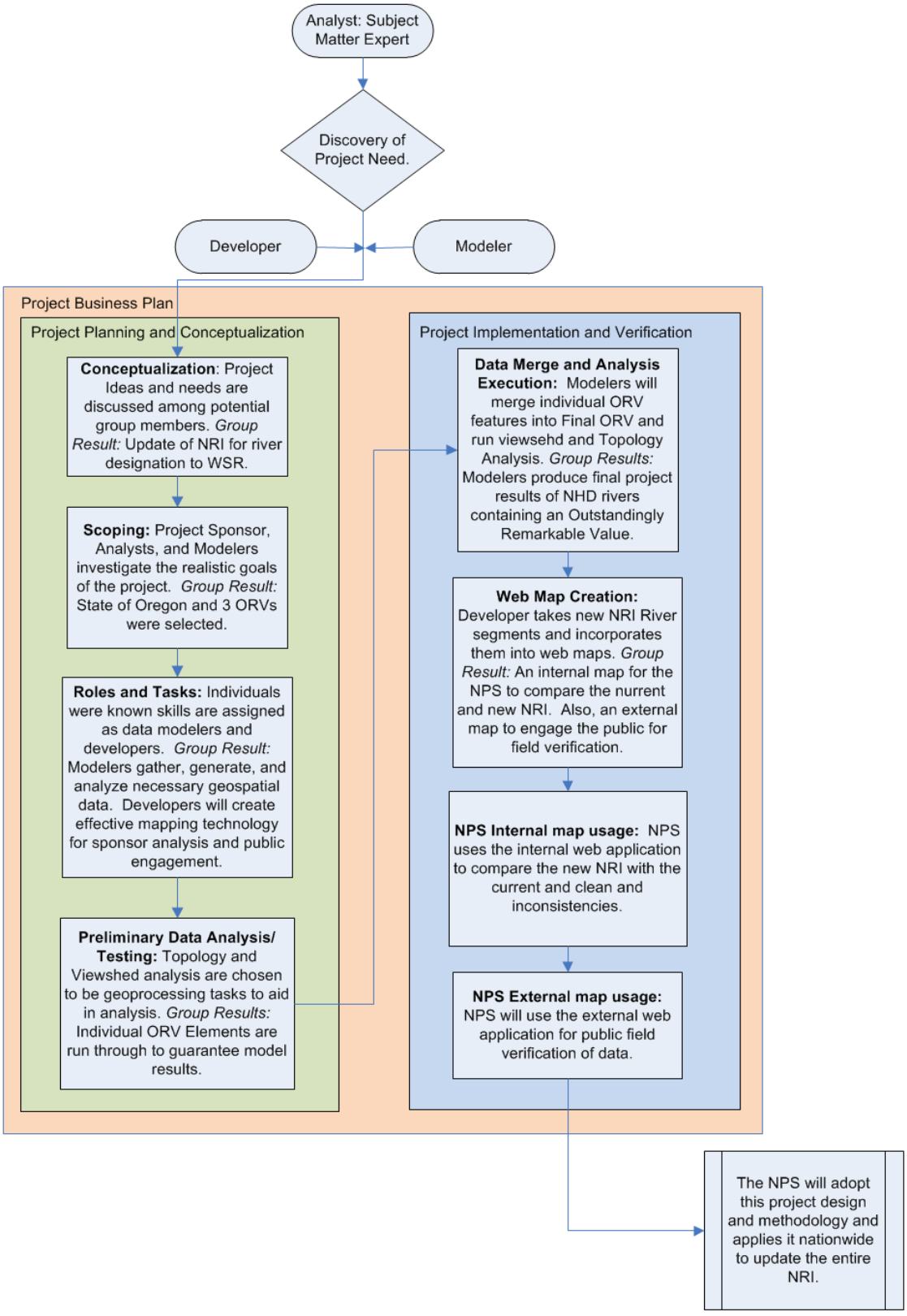
- **Initial Analysis Testing**: Group attempts to investigate the preliminary topology analysis for identification of Rivers that contain an ORV. *Group Result*: Initial testing of analysis is successful but not comprehensive (only one ORV will be tested; ensuring analysis works as intended.) enough for declaration of final output.

The National Parks Service needed a new way to view the data once the initial analysis testing was complete. A web map was created and designed to be simple but highly powerful by allowing for side by side comparison of the current and new NRI data. The web map was created and included an automatic synchronization and location feature so that when NPS staff was inspecting one area the adjacent map would be in the exact same spot, allowing for staff to focus on the important parts of the data and not having to worry about if the maps are in the proper extent.

Along with the new Nationwide Rivers Inventory, the National Parks Service wanted to create a way for the public to consume the new data along with trying to engage the public in a way that would be productive without creating too much extra work on their end. This web map was created in conjunction with a simple google form which allows the public to view a river segment, see which outstandingly remarkable values it has, and if they want leave feedback via the google form. The web map is built using HTML 5 so it is platform and device agnostic and be accessed anywhere internet is available.

To make sure the deployment of both web maps was easy and effortless for the National Parks Service a technical guide was made. The guide goes in great depth with step by step details on how to deploy both maps and all the underlying technology needed. The design of the guide is to make sure if someone needs to make tweaks or move the technology to another system it should allow them to understand all the interconnected GIS parts and the ways to tweak or move the system.

**Figure 18.** Business Case Diagram.



# References


Interagency Wild & Scenic Rivers Coordinating Council. "Wild and Scenic Rivers Act." October 2, 1968.

Kao, Shih-Chieh, et al. *New Stream-reach Development: A Comprehensive Assessment of Hydropower Energy Potential in the United States.* Oak Ridge: Oak Ridge National Laboratory, 2014.

National Park Service. *Nationwide Rivers Inventory.* 08 19, 2011. http://www.nps.gov/ncrc/programs/rtca/nri/hist.html#creation (accessed August 21, 2014).

North, M.J. and Macal, C.M. *Managing Business Complexity: Discovering Strategic Solutions with Agent-Based Modeling and Simulation.* Oxford: Oxford University Press, 2007.

NPS, National Center for Recreation and Conservation. *Eligibility Descriptions.* 8 19, 2011. http://www.nps.gov/ncrc/programs/rtca/nri/eligb.html (accessed July 15, 2014).

StreamNet. *Protected Areas.* n.d. http://www.streamnet.org/protectedareas.html (accessed July 30, 2014).

U.S. Fish & Wildlife Service. *Critical Habitat Portal.* n.d. http://ecos.fws.gov/crithab/ (accessed July 29, 2014).

# Appendix A: Data Sources

The following section details the data sources that were used and considered in this pilot study to design a methodology for updating the Nationwide Rivers Inventory.

Rivers

- NHD*Plus Version 2* – river segments
    - The National Hydrography Dataset (NHD) *Plus Version 2* data were used as the base stream data. The dataset is freely and publicly available for the entire United States. Originally produced by the United States Geological Survey (USGS), NHD*Plus* is now compiled and hosted by Horizon Systems and available for download here: http://www.horizon-systems.com/NHDPlus/NHDPlusV2_17.php. For the NRI analysis the flowline data were queried to include only perennial streams and to exclude river segments that were adjacent to any dams with hydropower capabilities or dams that are taller than 50 feet.
- 2012 National Anthropogenic Barrier Dataset (NABD) – dams
    - The National Anthropogenic Barrier Dataset was used to identify dams in the pilot study area to query river segments. The dataset was compiled by Michigan State University and is distributed by USGS on their National Fish Habitat website. The data are available for download here: http://ecosystems.usgs.gov/fishhabitat/viewdataset.jsp?sbid=512cf142e4b0855fde669828.
- Oregon NRI dataset
    - The Nationwide Rivers Inventory data for Oregon was suggested by National Park Service sponsors for this study. The 1995 data were used for comparison to analysis results. The data are available for download here: http://www.nps.gov/ncrc/programs/rtca/nri/index.html.
- Designated Wild and Scenic Rivers
    - Designated wild and scenic river data were used for comparison to analysis results. They are available at the national level, were obtained from Rivers.gov, and can be downloaded here: http://www.rivers.gov/mapping-gis.php. Detailed information about Oregon wild and scenic rivers can be found here: http://www.rivers.gov/oregon.php.

Fish ORV

- US Fish & Wildlife Service Designated Critical Habitat
    - Line and polygon data of fish species with designated critical habitat were downloaded for the fish outstandingly remarkable value. FWS designated critical habitat is available nationwide and is compiled and maintained by US Fish and Wildlife Service. Data for Oregon and other states is available here: http://ecos.fws.gov/wildfishsurvey/database/nwfhs/. Fish species with spatial data included in this analysis are: Borax Lake chub, Oregon chub, Chinook salmon, Chum salmon, Coho salmon, Steelhead, Lost River sucker, Short-nosed sucker, Warner sucker, and Bull trout.

Recreation ORV

- Generalized Fish Distribution
    - Fish habitat (not designated critical habitat) geospatial data were obtained for the recreation ORV analysis because fishing is a qualifying recreational activity for NRI status. Data were downloaded from StreamNet, as linked to by the Oregon Department of Fish and Wildlife: http://www.streamnet.org/mapping_apps.cfm.
- Oregon Scenic Waterways
    - Oregon State Scenic Waterways were obtained after a suggestion from our sponsors. The dataset was sent from David Quillin of the Oregon Parks & Recreation Department after contacting their website.
- Oregon State Parks
    - Oregon state parks were downloaded from the Oregon state government website (http://www.oregon.gov/DAS/CIO/GEO/pages/alphalist.aspx), as state parks offer numerous recreational activities that qualify for NRI status.
- National Water Trails System
    - Geospatial data for national water trails were obtained internally by our NPS sponsor after we learned about them in our data search. We decided to include them because they were designated in part to increase access to outdoor recreation. More information about the National Water Trails System can be found here: http://www.nps.gov/WaterTrails/.
- Areas of Critical Environmental Concern
    - Areas of Critical Environmental Concern (ACEC) are maintained by the Bureau of Land Management (BLM). An ACEC is designated to protect public lands with important

historic or scenic values, fish or wildlife resources, or to protect others from natural hazards. More information about ACECs can be found here http://www.geocommunicator.gov/GeoComm/metadata/acec/acec_desig_poly.htm or here http://www.blm.gov/ut/st/en/fo/st__george/blm_special_areas/areas_of_critical.html. Data can be downloaded here: http://www.geocommunicator.gov/shapefilesall/ACEC/ACEC.zip.

- National Historic and Scenic Trails
    - National Scenic and Historic Trails were included in the ORV analysis because they are part of BLM's National Conservation Lands. Historic trails have cultural significance and follow a historic trail or route of travel, such as the Pony Express or Oregon Trails. Scenic trails provide recreational opportunity as they pass through areas with scenic, historical, natural, or cultural qualities. Information about trails can be found here: http://www.blm.gov/wo/st/en/prog/blm_special_areas/NLCS/Trails.html. Trails data can be downloaded here: http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS__REALTY__AND_RESOURCE_PROTECTION_/energy/geothermal_eis/gis_data.Par.43235.File.dat/NFS_Lands_Trails.zip.
- National Conservation Areas
    - National Conservation Areas (NCAs) were included in the ORV analysis because they are part of BLM's National Conservation Lands. They are designated by Congress to conserve, protect, manage, and enhance public lands for the use and enjoyment of present and future generations. NCAs are designated as such if they have exceptional ecological, historical, recreational, cultural, or scientific values. More information about NCAs is found here: http://www.blm.gov/wo/st/en/prog/blm_special_areas/NLCS/National_Conservation_Areas.html. Geospatial data can be downloaded here: http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS__REALTY__AND_RESOURCE_PROTECTION_/energy/geothermal_eis/gis_data.Par.89466.File.dat/Public_Lands_NCAs.zip.
- National Recreation Areas
    - Geospatial data for National Recreation Areas (NRAs) are maintained by the Forest Service, but were downloaded from the BLM: http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS__REALTY__AND_RESOURCE_PROTECTION_/energy/geothermal_eis/gis_data.Par.93860.File.dat/NFS_Lands_NRAs.zip. They were included in the ORV analysis because the areas support and allow a number of NRI qualifying recreational activities.

- National Monuments
    - National Monuments were included in the ORV analysis because they are part of BLM's National Conservation Lands. They are established to protect exceptional natural or historic features and landscapes. More information about national monuments can be found here http://www.blm.gov/wo/st/en/prog/blm_special_areas/NLCS/monuments.html and geospatial data can be downloaded here http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS__REALTY__AND_RESOURCE_PROTECTION_/energy/geothermal_eis/gis_data.Par.94527.File.dat/Public_Lands_NMs.zip.
- Wilderness Study Areas
    - Wilderness Study Areas (WSAs) were included in the ORV analysis because they are part of the BLM's National Conservation Lands. They generally are primitive and unaffected by human development. They can also have scenic, ecological, historical, or other special qualities. Information about WSAs can be found here http://www.blm.gov/wo/st/en/prog/blm_special_areas/NLCS/wilderness_study_areas.html. Data can be downloaded at various BLM State Office websites; Oregon data can be downloaded here: http://www.blm.gov/or/gis/data.php.
- Desirable Whitewater Rivers
    - At the request of our sponsors, we downloaded the KML River List from American Whitewater from https://www.americanwhitewater.org/content/River/state-summary/state/OR/, was whitewater rafting is a popular recreational activity in the Pacific Northwest. Nationwide data are also available.
- Waterfalls
    - Waterfall points in the state of Seattle were obtained from Geology.com (http://geology.com/waterfalls/oregon.shtml) at the behest of our sponsor. Latitude and longitude for points were collected from the site and converted to spatial data for the ORV analysis. Nationwide data are also available.

Scenic ORV

- 30 meter Digital Elevation Models
    - Thirty meter digital elevation model rasters for Oregon were downloaded from the Natural Resources Conservation Service (NRCS) Geospatial Data Gateway here: http://datagateway.nrcs.usda.gov/GDGOrder.aspx. They were merged together and used in the viewshed analysis for the scenic ORV.

- Areas of Critical Environmental Concern
    - Please see description in the Recreation ORV section.
- National Monuments
    - Please see description in the Recreation ORV section.
- National Scenic and Historic Trails
    - Please see description in the Recreation ORV section.
- Scenic Waterways
    - Please see description in the Recreation ORV section.
- Waterfalls
    - Please see description in the Recreation ORV section.

Comparison Data

- Areas to be Protected from Hydropower Development
    - This Access database of areas to be protected from hydropower development was developed for the Northwest Power and Conservation Council and is hosted by StreamNet. It was downloaded for comparison to the NRI analysis results. The Access database is available here: http://www.streamnet.org/ProtectedAreas.html and the online web application is available here: http://map.streamnet.org/website/protectedquery/viewer.htm.
- National Hydropower Asset Assessment Program New Stream-Reach Development
    - The companion data to the report, *New Stream-reach Development: A Comprehensive Assessment of Hydropower Energy Potential in the United States*, compiled by Oak Ridge National Laboratory, is available for download here: http://nhaap.ornl.gov/nsd/region17. The dataset was used to compare areas of high hydropower potential with the NRI analysis results.

Data Considered but Not Used

- Oregon: National Fish Habitat Assessment Program 2010 Habitat Condition Index Scores and Disturbances
    - The Habitat Condition Index dataset is a nationwide dataset distributed on the USGS National Fish Habitat site and compiled by Michigan State University. It examined a number of data sources that represent human disturbances on landscape for how they

would affect fish habitat, resulting in a final index score. The data for Oregon are available for download here: http://ecosystems.usgs.gov/fishhabitat/viewdataset.jsp?sbid=50ef06bfe4b0dd1508a1e104. We could not decide where to incorporate this dataset and so therefore did not use it, but data quality was not an issue. We considered using the attribute with the number of road crossings in each local catchment, but the number was fairly steady throughout the study area, and would not have added much value to the analysis. We believe the data could be applicable in additional ORV studies.

- Official Recognized Zones of Pacific Marine and Estuarine Fish Habitat Partnership, 2013
    - The Official Recognized Zones of the Pacific Marine and Estuarine Fish Habitat Partnership are also available on the USGS National Fish Habitat website here:http://ecosystems.usgs.gov/fishhabitat/viewdataset.jsp?sbid=5343f5dce4b0cafa1c3dd7ec. We decided against this dataset because it did not add particular value to the NRI analysis; data quality was not an issue.
- National Wild Fish Health Survey Database (NWFHSDb)
    - The National Wild Fish Health Survey Database is hosted and maintained by FWS; the searchable web application is available here: http://ecos.fws.gov/wildfishsurvey/database/nwfhs/. The web application provides detailed descriptions of nationwide locations where various fish species were tested for pathogens and the results of these tests. The data were not used because we were unsure of how to incorporate the point data into the fish ORV analysis. Data quality was not an issue.

# Appendix B: Technical Guide for Deploying Nationwide River Inventory Analysis

In order to properly model the chosen Outstandingly Remarkable Values in Oregon, one must generate or download the most up-to-date versions of the ORV elements to a designated file geodatabase. For the purposes of this project, each feature element was stored in an appropriate feature dataset (i.e. American whitewater, and fishing are stored in the Recreational feature dataset, while waterfalls and National monuments were stored in the Scenic feature dataset).

Within each dataset, the elements of each ORV are merged into a single feature class using the Merge geoprocessing tool provided by ESRI. The output of the merge spatially represents areas that have that specific ORV. It is recommended that the user "clean up" the merge output attribute table since all the attributes of all the elements will be retained in the merge output. The user should then give all the elements usable names that represent the ORV element which will makes concatenating their representations easier.

The scenic ORV requires a little more than just merging the spatial representations of the elements. Since scenic ORVs can be seen from far away, the viewshed analysis must be performed on the merged scenic ORV. Using the viewshed geoprocessing tool, a 30 meter DEM bare earth raster was used in conjunction with the observer points (Scenic ORVs) to determine areas that have visible line of sight of Scenic ORVs. This output, as well as the representations of Scenic ORVs were merged one step further into the final Scenic ORV.

Now that all the ORVs are created, they should be copied to a new feature dataset called Analysis, as well as a polygon representation of the possible stream segments – this is where the topology analysis will be performed. Create a new topology and select "Must not overlap with" Stream segments for each of the ORV feature classes. Once validated, the error output from the analysis can be spatially joined to the existing NHD polylines, which now represent the rivers of the new Nationwide Rivers Inventory.

# Appendix C: Technical Guide for Deploying Nationwide River Inventory Online Maps

This guide is intended to help anyone who wished to deploy two specific online maps designed for the National Park Service's Nationwide River Inventory (NRI). The first online map is an internal map designed to give NPS staff an easy way to compare and contrast the difference between the current Nationwide River Inventory and the new Nationwide River Inventory created using a new methodology designed by Emily Zvolanek and Scott Schlueter. This guide will go over the necessary steps to implement both maps up and running. The following is a list of required or optional technology needed:

- ArcGIS Server at 10.1 or above (required)
- ArcDesktop and Catalog at 10.1 or above (required)
- ArcSDE at 10 or above (optional)
- An organizational account to ArcGIS online (required)
- Geocortex Essentials Software with HTML 5 viewer (required)

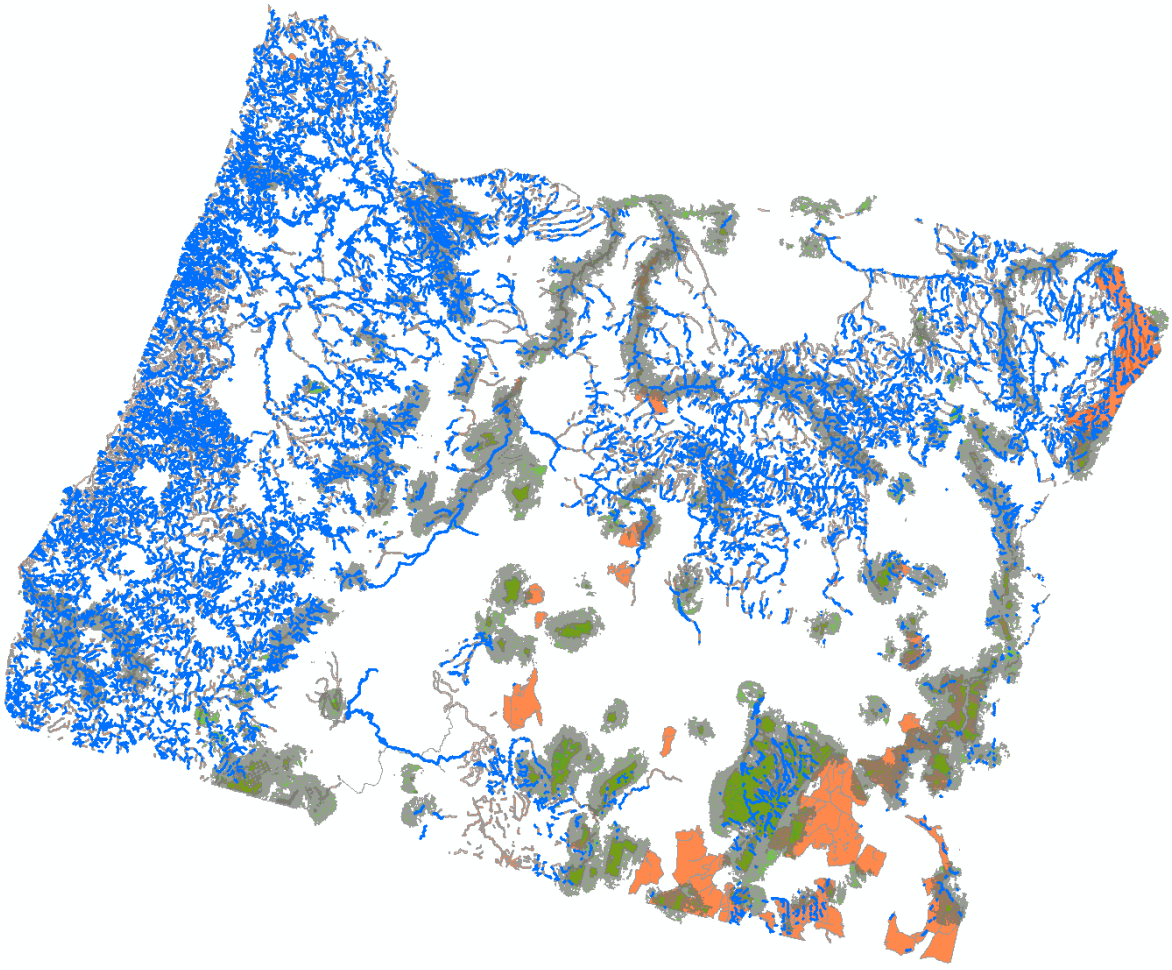
Attached with this technical guide should be a zip file that contains a file geodatabase and an ArcGIS MXD. The file geodatabase contains the following data:

- originalNRI
    - This feature class is the original nationwide rivers inventory dataset.
- newNRI
    - This feature class is the new nationwide rivers inventory created using the new methodology
- FishORV
    - This is a feature class that shows all the areas considered for the Fish Outstandingly Remarkable Value
- RecORV
    - This feature class shows all the areas considered for the Recreation Outstandingly Remarkable Value
- ScenicORV
    - This feature class shows all the areas considered for the Scenic Outstandingly Remarkable Value

- XXNRI
    - Where XX is some combination of Fish, Recreation, or Scenic. This was done to split out the new NRI into smaller components for two reasons. One was to make it very easy to identify which segment of river belonged to which ORV(s). The second reason was to increase performance in the online maps. By breaking up one giant feature class into a bunch of smaller feature classes drawing performance was increased.

All of the feature classes mentioned above are used in the MXD that the web service is based off of except for newNRI which is the equivalent of all the XXNRI feature classes turned on at once. This feature class is kept with the file geodatabase just so the original will be with the data.

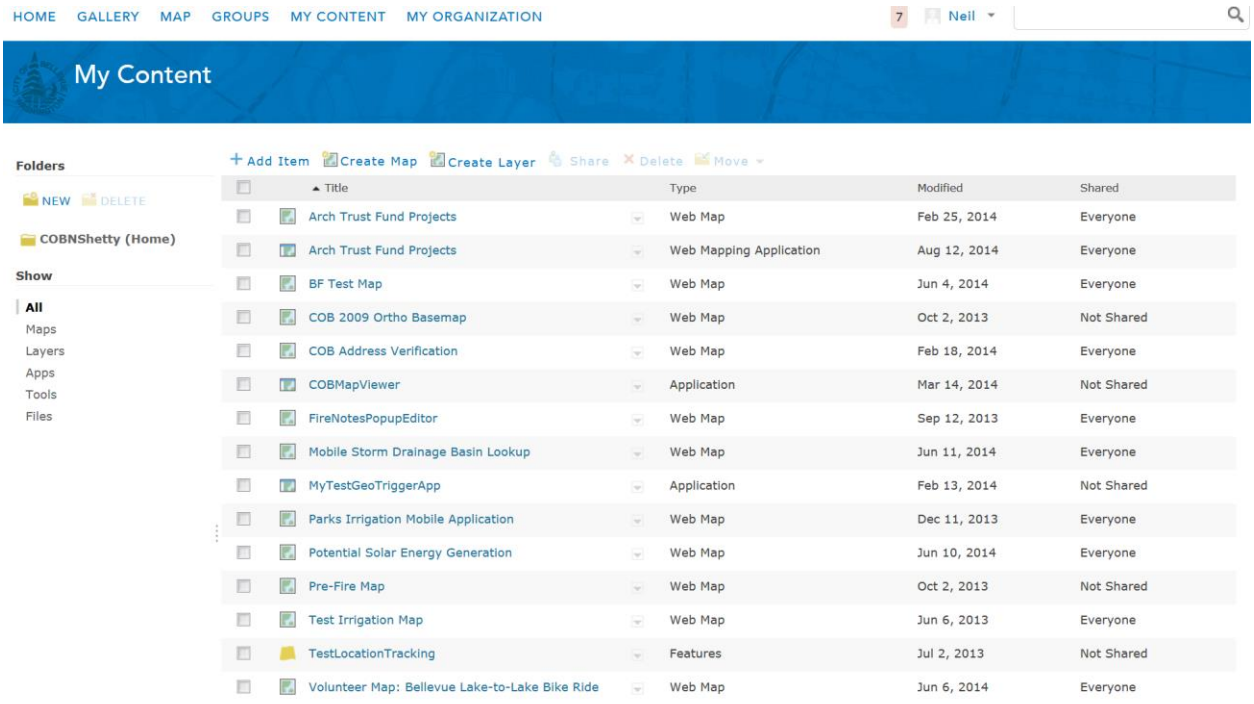
Once you have all the technology stated and the zip file with the file geodatabase and mxd unzipped on a computer with ArcDesktop and access to the ArcGIS server that will be used to host the data open up the NRIMXD and make sure everything is drawing correctly. It should look like the image below:



If you have no broken data sources and everything looks correct there are two ways you can proceed. The first more preferable approach will be to move all the data in the MXD from the file geodatabase into ArcSDE. To do this, open up ArcCatalog and import the data into the Database of choice. Once this has been completed right click the NRIMXD and change the data source from the file geodatabase to ArcSDE. The second and less desirable option would be to publish the MXD directly to ArcServer. If this approach is done the data will be copied to the server directly. The issue with this approach is that every time you make changes to the data the MXD must be republished. This is not an issue if you publish the web service with an MXD pointing to ArcSDE. When publishing the MXD please accept all the defaults and click the publish button in the top right corner. If you need help publishing a web service please read the technical documentation found here. Once the MXD has been published double check it is on the web by going to your ArcServer's REST end point and viewing the new service using the JavaScript map built into ArcServer. After the service has been checked and confirmed the internal comparison map can be created.

**Creating the Internal Comparison Map**

Creating the internal comparison map requires that the Nationwide Rivers Inventory map service already be up and running. If the map service is not running please refer to the previous part of this guide to publish it. Once the map service is up and running log into your ArcGIS Online organizational account and go to "My Content".



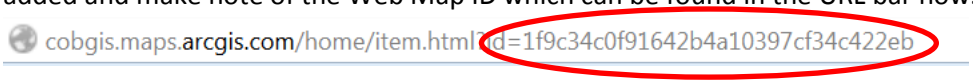

In this menu click the "Create Map" button at the top. This will open up a new ArcGIS Online web map that can be customized. On this map you will see a button that says "Add" click on this button and then "Add Layer from Web". This will open a prompt asking you for a URL. The first map we will be creating is a map that shows the current nationwide rivers inventory so we will add the current NRI data first. If

you have kept the same structure as the MXD given with this documentation the URL should look like this:

http://<ArcGIS Server Name>/arcgis/rest/services/<folder where web service is>/NRI/MapServer/0

The 0 at the end is the individual layer originalNRI which is also the first layer in the MXD. If the layer was moved at all then the number will be different. By going to the NRI web service you can click on the individual layers and get each unique URL. Once the originalNRI URL is found copy it and paste it into the "Add Layer from Web" prompt. It should resolve and add the layer to the map. Once this is done clean up the name so it only says "Original NRI" and configure the pop-up so that it uses the name of the river segment as the heading. Once this has been done save the map as "Current Nationwide Rivers Inventory" and then close out and create a new map.

The second web map will have all the new NRI data created using the new methodology. Add all the new NRI data sets in the same fashion as the current NRI web map. There should be no extra configuration needed. Save the map as New Nationwide Rivers Inventory once all the data has been added and make note of the Web Map ID which can be found in the URL bar now.




The long set of numbers and letters on the right side of the id= is the web map ID. Copy and paste it somewhere as it will be needed later. Also before closing this map make sure to click the "Share" button and share it with your organization.

Once both maps have been created go back to the Current Nationwide Rivers Inventory map and click the "Share" button. Once shared with the organization the button at the bottom that says "Make a Web Application" should be selectable, click this button. Once clicked a new menu about what types of web applications can be made from the various templates ESRI hosts. You are looking for the "Storytelling Compare" map that is currently on the third page as of writing this guide. Click the publish button and give it a title like "Comparison between Current and New Nationwide Rivers Inventory" and click the save and publish button. This will then open the new web application and requires some configuration. The first thing to do is add a title which should be the same as the title you provided before (the first title is what it will be called in my content). The second thing to do is to add the second web map ID to the "Add Web maps" box. Add a comma after the first web map and then add the ID you saved previously. Once this is done the web map application should only show two boxes, one showing the original NRI and one showing the new NRI. Once this is done click save and then done. After this the comparison web app should be complete. Open up the web app from my content and check it out. If you see both sets of data and the maps move synchronously then everything was done correctly. Share the URL with whoever would find it useful!

**Creating the Public Facing Geocortex Map**

The public facing map using Geocortex does not have to be done after the internal map but can be done once the NRI web service has been created. To create the map, login to the Geocortex Essentials Manager and follow the "Create New Site" wizard. The URL of the whole map service should

be used when asked for it (no /Number at the end) and the basemap used should be the ESRI world topographic map which has a URL of http://services.arcgisonline.com/ArcGIS/rest/services/World_Topo_Map/MapServer. Once the basic map is set up go to the "map" section of the site and set the full and initial extent to the following "-13798891.937356725, 5537888.543215529,-13564077.386464674, 5733567.335625571". This will center the map right around Portland, Oregon and areas to the south. This is a good starting spot because it includes some of Oregon's biggest cities while limiting the initial load of data. Once this is done certain site configurations need to be done. What needs to be done is in list form below. Before doing anything if you have never configured a Geocortex website you must know that every change on each page must first have the changes applied, and then have the site saved. It is always a two part process to save and if both parts aren't done the changes won't be saved.

1. Go to the map service added and change the display name to "National Park Service"
2. Go to the originalNRI data layer and do the following
    a. Change display name to Current Nationwide Rivers Inventory
    b. Have the Feature Label be the token for the river name
    c. Have the feature description be the token for the river description
    d. Turn on Map tips and turn off visible
3. Go to the newNRI data layer and do the following
    a. Change the display name to "New Nationwide Rivers Inventory"
    b. For each sub layer in this group do the following
        i. Make sure it is visible and uncheck "Include in Layer List"
        ii. Make the Feature Label the token for the River Name
        iii. In the feature description make sure it says "X / X / X River Segment" where X represents the ORV the layer displays. For a river segment that has both scenic and recreation ORVs the first line would say "Scenic / Recreational River Segment"
        iv. In the second line of the feature description copy and paste the URL INTO THE TEXT BOX, NOT INTO THE TEXT EDITOR. This is an important distinction because if you paste the URL into the text editor it will turn the URL into a bunch of HTML and the link won't work.
            1. <a href="https://docs.google.com/forms/d/1iRxC4mkxB4YSJYjNqhxEoJ4MGJSvkehexr3C2F2eQJU/viewform?entry.1035440962={GNIS_NAME}&a

mp;entry.807961942" target="_blank">Submit Feedback About River </a>

2. You can see {GNIS_NAME} is the name token for each river segment. If it's different for new data for some reason please replace the token.

v. This link will open a Google Form with a few questions for the public to answer about the river segment and the outstandingly remarkable value. The google account that all the forms are submitted to is the following

1. Google Account: NPSNRIORV@gmail.com
2. Password: npsORV2014
3. Name on account: First Name=National Parks Last Name=Service
4. Birthday on account: August 1st, 1982. The day the original NRI was completed

vi. Lastly make sure "Show Map Tips" is checked

4. Go to the Fish ORV polygon and do the following configurations
   a. Change the feature label to Fish Area: {fish name token}
   b. Enable map tips and disable visible
5. For the Scenic and Recreation Areas polygons do the following configurations
   a. Change the feature label to be X Area where X represents the ORV being configured
   b. Change the feature description to say the following
      i. Shared Outstandingly Remarkable Values: {Recreation} where the token represents the attribute that shows all the shared ORV data.
6. Once these configurations have been done go to the viewer menu item and create a new HTML 5 viewer. The following configurations need to be made to the HTML 5 viewer.
   a. First the viewer needs to be branded in some way, two things need to happen. The badge that opens up with the viewer needs to be configured to use the National Parks Service logo and the banner at the top of the viewer needs to use the National Parks Service Logo.
   b. The viewer needs to have the toolbar completely removed by the toolbar menu item and clicking the remove toolbar button. This is done because the map is fairly simple and all necessary commands can be accessed from the "I want to" menu.

c. The home panel needs to be filled with something useful. It should give a basic rundown of how to interact with the map and its general purpose. Currently this is what is in the home panel but at any point can be updated:

7. Welcome to the National Parks Service Nationwide Rivers Inventory Map

    i. This map is designed to show you different river segments that have outstandingly remarkable values. These values can be anything from white river for aquatic sports to waterfalls to look at! By browsing the map like you would any other online map you can find different areas which may be great for your unique need. If you find that a river is represented accurately or is totally wrong feel free to submit feedback on it by clicking on the segment of river and clicking the "Submit Feedback" URL.

b. Once these configurations have been made the map should be ready to use. Open it up using the viewer link and check it out. If all the data loads and you can submit a form for feedback everything has been configured correctly and the map is ready.

c. Someone from your IT department will probably want to make the URL nicer by giving the map its own unique domain or using a link shortener.

If both maps have been implemented then all the work has been done and ready for consumption! Should you have any issues with deployment please feel free to email Neil Shetty at nshetty@uw.edu.