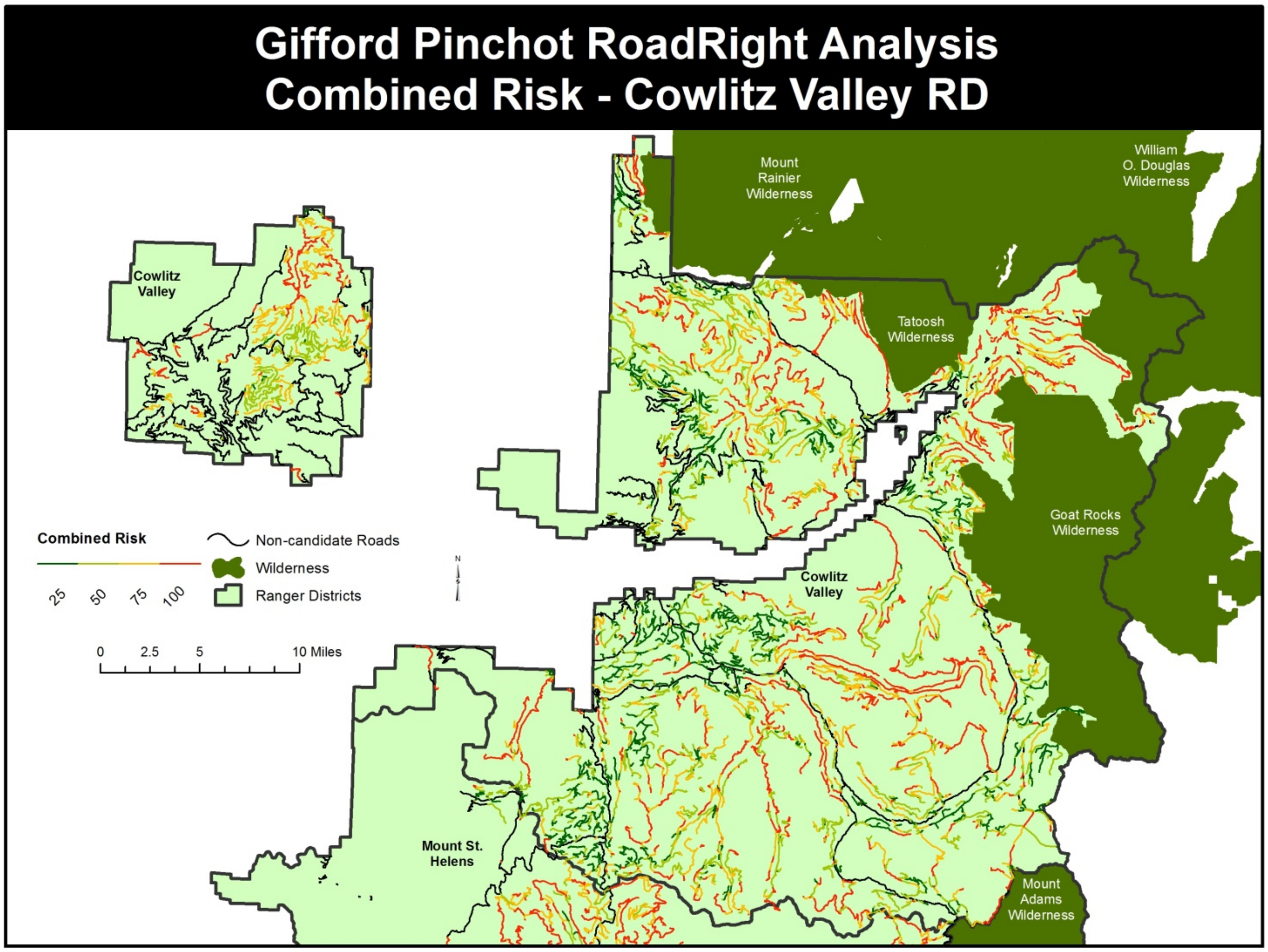
RoadRight Spatial Analysis Report

Gifford Pinchot Task Force



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www.gptaskforce.org

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Background and Objectives

In an effort to add valuable ecological data to the Travel Analysis planning process of the Gifford Pinchot National Forest, we have undertaken the task of overseeing the completion of a forest-wide GIS roads analysis, integrating the results of this analysis into a report and related tables, and transferring this information to the Forest Service for incorporation into the planning process. Based on variables such as slope, habitat overlap, area designations, stream intersections, and sedimentation, this analysis highlights which roads are likely to have the greatest impacts on the National Forest. The results can serve as a filter to help the agency in determining priority roads for repair, closing, or decommissioning.

The GIS analysis employed the use of the RoadRight model, which is a decision support system that uses social and ecological criteria to prioritize opportunities for road restoration in national forests. It is intended to be science-based, simple, transparent, flexible, and scalable. In 2013, we contracted Bird's Eye GIS to run the RoadRight model to capture and document this important perspective on the road network of the Gifford Pinchot National Forest.

The objective of this summary and analysis is to increase the usefulness of the RoadRight analysis by: 1) summarizing the data and making its integration into planning simpler and more applicable; 2) interpreting the results so we are understanding and transferring them in a way that aligns with how the planning process will be carried out; 3) creating priority ranking lists with and without the use of the isolation index to see impact without roadless considerations; and 4) creating maps that clearly show impact and subsequent recommendations for distinct categories.

About RoadRight

RoadRight is a project of an open-source scientific community called The Landscape Collaborative and it was built with ArcGIS ModelBuilder application using Python programming language. RoadRight runs within ArcGIS and has been released as open-access software to be used and improved upon by organizations and agencies working in restoration. This decision support system uses a hierarchical, multi-criteria framework to identify roads that are at highest risk of causing environmental damage and should, therefore, be the highest priorities for repair (if essential) or to decommission (if unneeded). Figure 1 shows the hierarchical framework upon which the model is built.

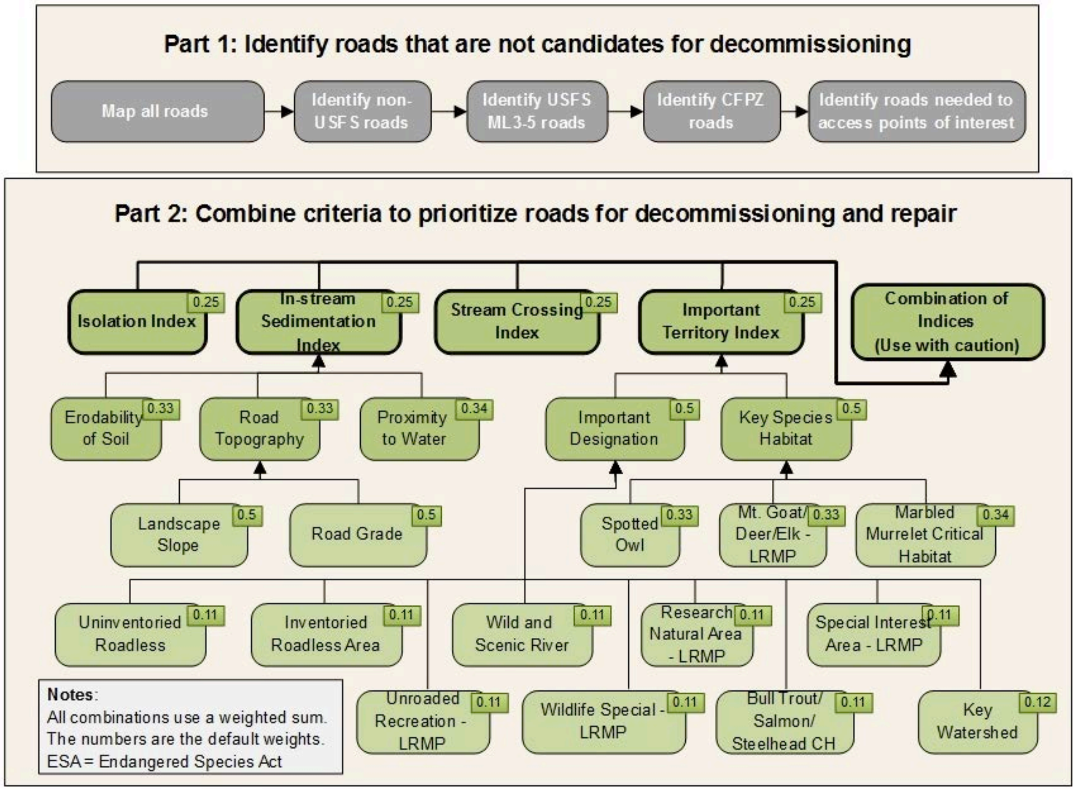


Figure 1. Hierarchical framework for the RoadRight analysis.

Below is functional detail about RoadRight mechanics to help in understanding the input parameters and scope of this work.

> In Part 1 of RoadRight—the social analysis—all roads are classified as candidates for either decommissioning or repair based on several social criteria that indicate whether the road is essential, such as if the road leads to any developed point of interest or is necessary to protect human communities from wildfire. After separating roads into two categories—those that are necessary in a minimum road system and those that are candidates for decommissioning—an analysis will be conducted to identify potential ecological risks to determine which roads are highest priority for action—either decommissioning or repair.
>
> Part 2 of the decision support system—the ecological analysis—considers the potential environmental impact of each road. RoadRight considers 18 input criteria (such as road grade, number of stream crossings, whether a road passes through critical endangered species habitat, etc.) to rank each road for its potential to cause environmental damage (i.e., its level of risk). Each of these criteria can be weighted as a reflection of its importance to the user. Note that the spatial data are not meant to describe or predict the actual condition of the road. The purpose of the decision support system is to rank roads based on their potential to cause environmental damage.
>
> The ecological analysis is divided into four sections (see Figure 1) that measure environmental risk via four indices: isolation, in-stream sedimentation, stream crossing, and important territory. The objectives achieved by repairing or decommissioning these roads are to 1) improve the spatial configuration of the road system for wildlife and people (isolation index); 2) reduce soil erosion and in-stream sedimentation (in-stream sedimentation index); 3) increase stream connectivity (stream crossing index); and 4) reduce impacts to important conservation areas and critical wildlife habitat (important territory index). Through these four paths one can prioritize road decommissioning and repair to accomplish a large number of broader ecological goals: creating more and larger roadless areas for wide-ranging, area-sensitive species; creating larger natural-sound areas for people and wildlife; zoning the forest to ease conflict between primitive and motorized recreation; creating more barrier-free corridors for terrestrial wildlife to migrate, disperse, or move in response to climate change; reducing fragmentation of wildlife habitat; decreasing in-

stream sedimentation to improve water quality and aquatic species' habitat; decreasing barriers to fish passage; and achieving target road densities for a given area or species.

High-risk roads that are deemed essential in Part 1 are prioritized for repair, and high-risk roads that are deemed non-essential in Part 1 are prioritized for decommissioning. Figure 1 is a diagram of the RoadRight Decision Support System with all of its input criteria.

In RoadRight the road system and all input data are converted into GIS grids (rasters) with 30 m cell resolution. Each 30-meter-square road cell is assigned an output value for each of the 18 ecological criteria. Each road segment (its entire length) is then assigned the mean value of all the corresponding cells for each criterion. The mean value for each criterion is then normalized, so that the highest-value road on the landscape (for that criterion) receives a value of 1, and the lowest value is no lower than 0. The criterion can then be weighted and combined with other criteria.

Output attribute tables contain the relative value of each road segment, for each of the above criteria. Hence, if a road has a high score in the "in-stream sedimentation index," it is expected to make a large contribution to stream sedimentation, and hence be a good candidate, for this criterion, for decommissioning or emergency repair. All four indices are combined in an overall prioritization score and placed into the combined attribute column. Note: often one criterion will be negatively correlated with another, thus obscuring risks in each category. Use this overall score with caution.

-From RoadRight User Guide version: 2.2

Creation of Tables and Ranking of Roads

In order to examine the impact and the ranked risk of roads, we have organized the results by the four primary categories of impact and have also organized according to combined risk. Excel files of these ranked lists have been sent electronically to the Forest Service for integration into the Travel Analysis process. These tables have been set up with the same naming conventions as those used by the Forest Service, so incorporation into the Travel Analysis planning process should be straightforward. Results for individual roads in question can be looked up quickly with all respective data in subsequent columns. We recommend weighing the analysis results with information on access needs, as well as road and culvert condition, and using the ordering of the RoadRight ranking lists as a prioritization measure for repair, closing, or decommissioning.

Below, we have ranked the first 50 roads to offer a quick look at the highest priority roads, according to each category (Table 1). It is important to note that the first step in the RoadRight analysis has already removed roads that were deemed as necessary for the minimum road system. These include roads that intersect an in-holding or a community fire planning zone, maintenance level 3 to 5 roads, or roads that access developed sites such as: ranger stations; developed campgrounds; active mines or quarries; boat launches; snowmobile and ORV staging areas; hiking, biking, cross-country skiing, and equestrian trailheads; research stations; interpretive trails and kiosks; developed fishing access sites; downhill ski resorts; fire lookouts; private in-holdings; recreation sites; historic buildings; picnic areas; parking lots; public utility stations; and developed scenic viewpoints.

Table 1. Top 50 roads highlighted by the five weighting parameters. *Use the combined risk index in combination with others.

	In-stream sediment index		Stream crossing index		Important territory index		Isolation index		Combined risk index*	
Rank	Rd ID	Name	Rd ID	Name	Rd ID	Name	Rd ID	Name	Rd ID	Name
1	7713686	Tri 501	2516026	1027a	2212044		4109605	Ed-10	8410039	Granite lake
2	2560000	Paradise cutoff	2900100		2212061	Tri 601	2329022	Chain of lakes	4107000	Copper cr.
3	2586000	Muddy pine	5600059		8600110		5995000	Lake west	5270042	Voodoo
4	7708000	Iron crk butte	9091071		2551630		2325078	Tri 508	5940042	Helen creek
5	2911000	Jumbo crk	7400000	Nisqually loop	5270000	Butter creek	2904000	Lambert creek	9091071	
6	2600000	Ryan lake	4107000	Copper cr.	8000717	Ed-10	4100502	Bluff mt	7700000	Greenhorn crk
7	2562530	Smith	2900692	Tri407	4109600	Ed-10	3000650	Ed-10	2200000	North fork cispus
8	2562540	Bean cr	3050611	Ed-10	6808011	Carson r	6808011	Carson r	5270000	Butter creek
9	5270042	Voodoo	2800021		2208000	Elkridge	4720049	North	2810051	W yellowjacket
10	2801080		2517678	Tri 303	9341120	Snag	9900000	Spirit lk-iron cr	5600059	
11	2608000	Red springs	6513000	Wildcat	8000011		4100559	Mowitch	2400785	
12	2810042		2300500	N84j	8031739	Ed-10	2810104		2801080	
13	8800783	Ed-10	2200000	North fork cispus	6600723	Ed-10	4600079	Lava basin	2900115	Langille creek
14	2900115	Langille creek	2505016	Huffaker a	4200000	E.fork lewis r	3062000	Ninemile creek	2551638	
15	4109000	Silverstar	6030080		2212000	Bubble gum pass	8100830	Climber's bivouac	7800000	Timonium
16	6800000	Cedar crk	2160000	Walupt lake	3300620	Ed-10	5603042	1020	4200000	E.fork lewis r
17	8511018		2810035	Fish 6	4107507	Copper cr	2329116	Tri 703	2608000	Red springs
18	4109600	Ed-10	2900697	Tri 502	6800580	N408e beaver dam	6403229	Fillet ts	4400000	Carlton creek
19	9085020		4830016	Hager 2-2	2200068	Fish 2	2329078	Horseshoe lk cg	2900697	Tri 502
20	8410039	Granite lake	8500111	Tri 101	2904000	Lambert creek	6052000	S0 butte	4610000	Purcell creek
21	4200680	Ed-10	2100097	Avalanche	6801071		2608016	1109	5270066	Range
22	2020000	Smith vally	7007000	Tumble cr	5940042	Helen creek	2515042	Benham creek	2900000	Mc coy crk
23	5300000	Jakes ridge	7700000	Greenhorn crk	8410039	Granite lake	2329000	Midway loop	5940000	Middle deer
24	7800000	Timonium	2325000	Summit prairie cr	6600030	N604j black	7800064		2020000	Smith vally
25	1831708	Ed-10	8410039	Granite lake	2200000	North fork cispus	4100406	3 corner rock	6513000	Wildcat
26	7007000	Tumble cr	2801080		1800121	N502a s fk berry creek	4400071	Carl	9085020	
27	2300304	123a	8500131		1800781	Ed-10	8300450	Cone	4109000	Silverstar
28	2516026	1027a	8871030	N845c upper poison	1800729	Ed-10	1284000	Yellowjacket	7400000	Nisqually loop
29	2100097	Avalanche	2505022	Huffaker b	1800736	Ed-10	6808018		8871030	N845c upper poison
30	5500052	Dry hill	2100278	Tri 606	6600730	Ed-10	6400210	Ed-10	9310000	Single tree
31	2010000	Dry creek pass	7700092	W greenhorn	1266069	Mine 4	2130039	Ridge	8871000	N845 middle
32	2810051	W yellowjacket	2600170	Norway pass trailhead	5500128		3000669	Ed-10	6808011	Carson r
33	5250019	Low skate 4	2400785		1831716	Ed-10	2900626	Tri508	8841000	
34	4107507	Copper cr	8800000	N88 trout lk cr	1831712	Ed-10	1262000	Latch	2904000	Lambert creek
35	7812044	Tri 606	9308000	Pepper cr rdg	1266000	Lake creek	3000667		8031020	N716
36	2900100		2510000	Lower iron cr	1800011	Blc r of w	2160047	Guard station	2750000	Goat creek
37	5500695		8800120	N88c flat	6600020	Shingle mtn	5110162	Kamloops ts	9312000	Cussed hollow
38	4610000	Purcell creek	8200000	Bird creek mdws.	6600044	N44c west cabbage	5270042	Voodoo	4200640	Ed-10
39	8800707		2517035	Cow	1800186	Ed-10 768, changed on wasp ts	4200510		2911000	Jumbo crk
40	2573000	Eastside	2505000	Huffaker	1800783	Ed-10	5700320	North	6800000	Cedar crk
41	4610056	Lost creek	2515043	Jasper	1800080	N443 old burn	8061000	N81b morrison camp	2212000	Bubble gum pass
42	4730042	Able	8620000	Mann butte	1800040	N431 moss cr cg	6300030	Davis mountain	9343000	Quartz cr
43	5301607	Ed-10	2575200		1800712	Ed-10	8123070	Goat marsh pit	2562530	Smith
44	8500130		5301000	Big rock creek	6600717	Ed-10	5270000	Butter creek	8600141	N549 berry cr ridge
45	2586270		7812044	Tri 606	1800763		9328220		2900692	Tri407
46	5500108	Upper camp cr	2150040	Berry patch	1840702	Ed-10	2600170	Norway pass trailhead	6500606	Ed-10
47	8200732	Ed-10	8871000	N845 middle	6700148		1284016	White one	2900100	
48	3800000	Pelvyer	8322700		2300566		6320037	Boomer	8322700	
49	3700000	Canyon creek	8031020	N716	9075000	N935 quartz cr r	6403216	Siouxon peak	6802000	
50	4900017	Bridge	3241000	N87 l r bridge	4109000	Silverstar	6600716	Ed-10	2010000	Dry creek pass

Combined risk as a sole measure has drawbacks that need to be considered before interpreting the results. One being that a certain weighting value might negatively correlate with another, thereby masking affect levels. For example, if a particular road has significant in-stream sedimentation and high stream crossing rankings yet low ranking for the isolation and important territory indices, it will likely not rank high in the combined risk index. Due to this, combined risk should be used in addition to, rather than instead of, the individual measures. Moreover, since the combined weight brings in isolation, it might alter risk ranking in ways that do not most appropriately speak to the ecological components of watersheds and wildlife or particular planning needs of the agency. By looking at the ranking for each value on its own as well, we are more readily able to see priority in terms of the management focus areas that are most likely to coincide with the work of the National Forest. Isolation and combined risk are, however, important values to consider and should be incorporated into the Travel Analysis planning process. Independent recommendations that can be drawn from isolation measures add value to terrestrial habitat enhancement efforts, as well as efforts to create larger, more functional, and more connected roadless areas. This offers both recreational and ecological benefits. Roads ranked high in combined risk are causing negative effects in numerous ways, and measures of their need and value should take this into consideration.

Functional detail on the indices used for ranking roads is explained above in the excerpt from the RoadRight User Guide summary, but further methodological description is needed to more fully understand the results and interpretation.

Isolation Index – The isolation index weighs the impact of individual road segments on the roadless quality of the landscape by measuring the density of neighboring roads at three radii: 300 meters, 900 meters, and 3,000 meters, and then combining the results in a weighted total. The final road values are normalized on a scale between 1 and 0 reflecting their degree of isolation. Values of 0 represent the most clustered roads and values of 1 represent the most isolated roads.

Important Territory Index – The important territory designation measures the existence of road segments in montane meadow zones, meadow management zones, inventoried roadless areas, wild and scenic rivers, research natural areas, special interest areas, non-motorized areas, critical aquatic refuges, and key watersheds. The assumption is that if a road crosses many of these designations, it is a higher priority for closing or decommissioning.

Key Species Index – For the key species index, road cells that are within an important species habitat layer are given a value of 1 and all other cells are assigned a value of 0. The results are then summed and normalized. The assumption is that if a road crosses a lot of these habitats, it is a higher priority for closing or decommissioning.

In-Stream Sedimentation Index – This measure takes into account four physical factors that influence in-stream sedimentation. Road grade and the landscape slope that the road cuts across are equally weighted to create a road topography input. Road topography is then combined with the proximity to water and the erodability of the soil (based on soil KW factor). Results of the combination are normalized and averaged. A normalized value between 0 and 1 is calculated for each cell representing a road. The cell values that correspond to a road segment are then averaged.

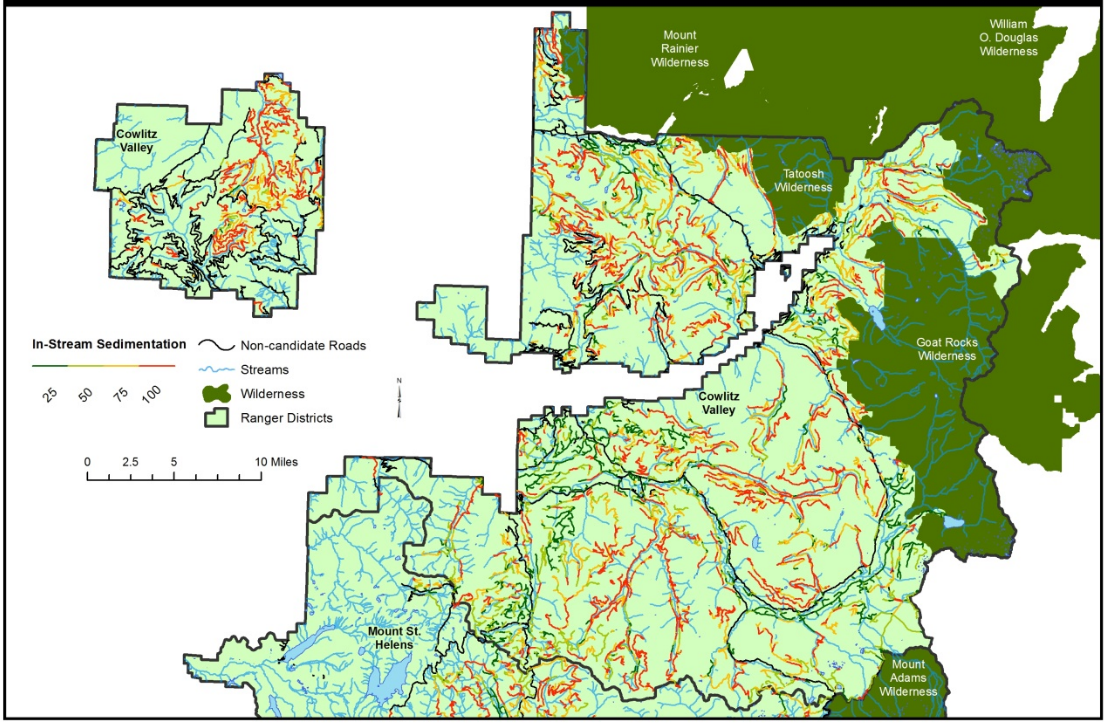
Stream Crossing Index – The stream crossing index assigns all road cells a value of 0 unless they cross a stream, in which case they are assigned a value of 1. Layers are summarized by road segment to generate the number of stream crossings per unit distance of road, and the results are normalized. The assumption is that roads that cross waterways can have culverts that can fail or crossings that can block fish passage, and are therefore a higher priority for decommissioning.

Map Representations

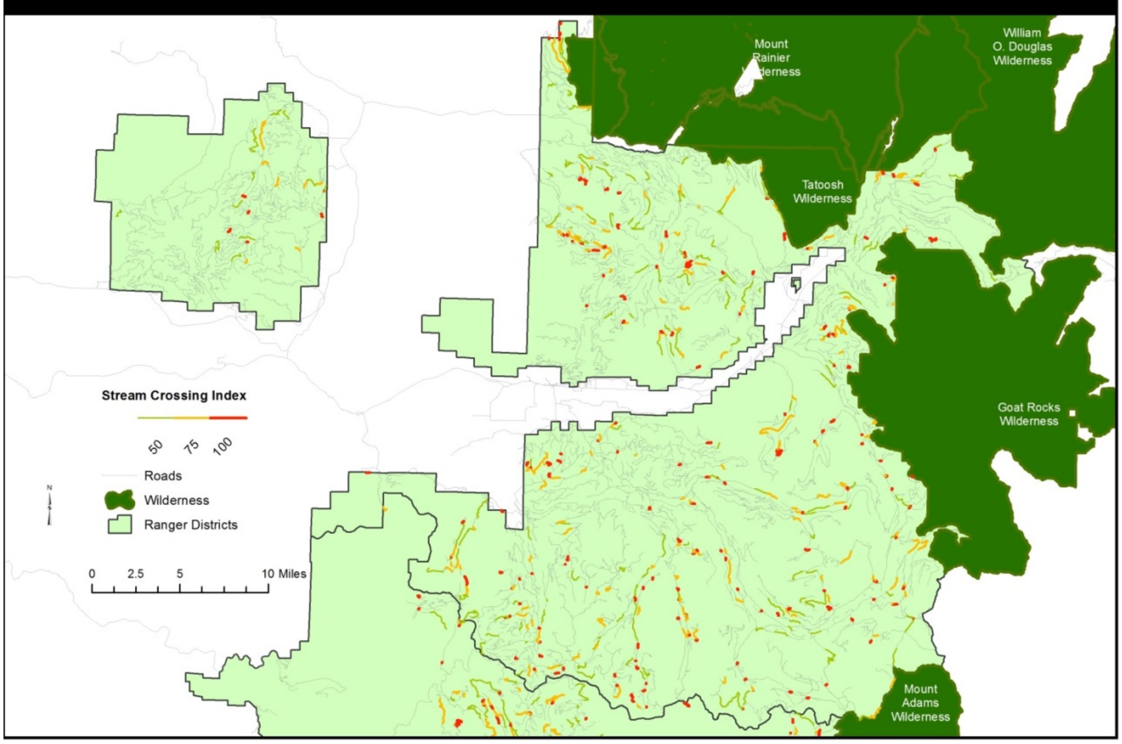
Spatial representations offer a different and equally important view of the results. To more clearly understand the location and spatial patterning of risk, we have created a series of maps that show ranks according to the same five categories through which the tables were organized: in-stream sedimentation index, stream crossing index, important territory index, isolation index, and combined risk. In addition, for a more detailed understanding of the spatial patterning of affect, we have included maps showing key species rankings, road segment relationships to bull trout/steelhead/salmon critical habitat, and road segment relationships to inventoried roadless areas. Appendix A contains this group of maps, and for each category, there is a map of the northern part of the GPNF (Cowlitz Valley Ranger District) and one of the south (Mount St. Helens and Mount Adams Ranger Districts).

Appendix A.

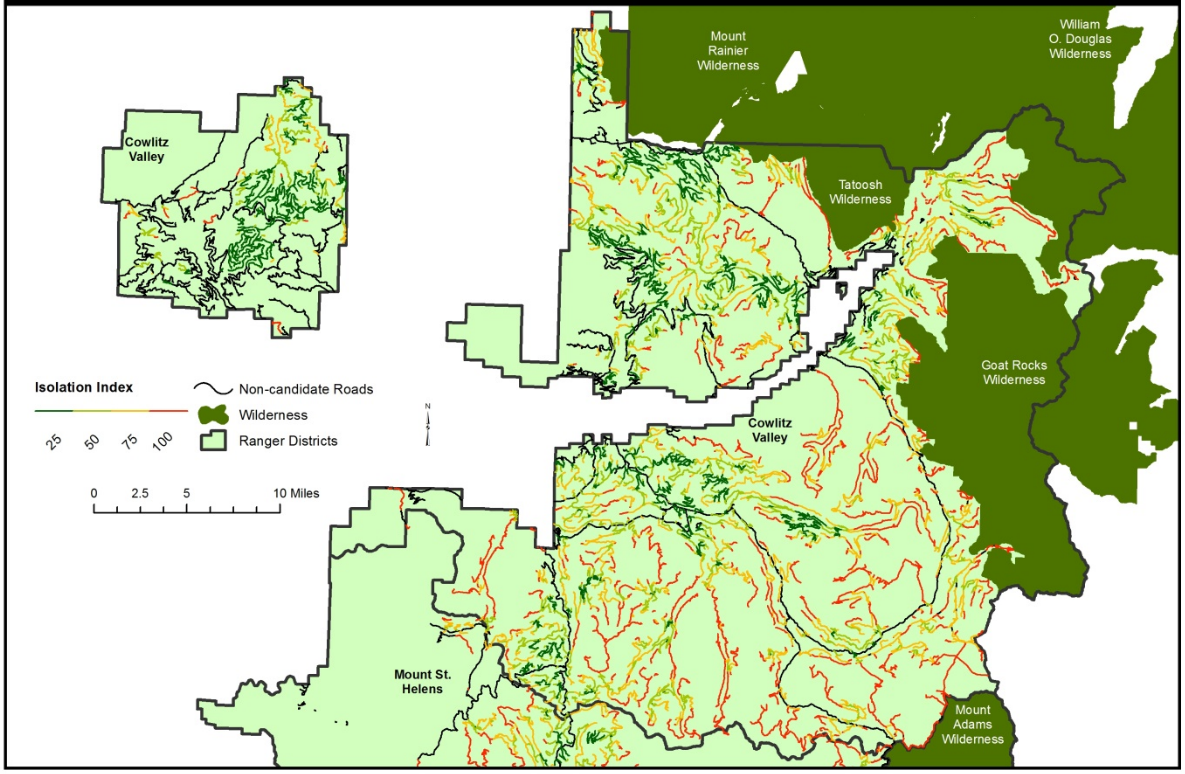
Gifford Pinchot RoadRight Analysis
In-Stream Sedimentation Index - Cowlitz Valley RD



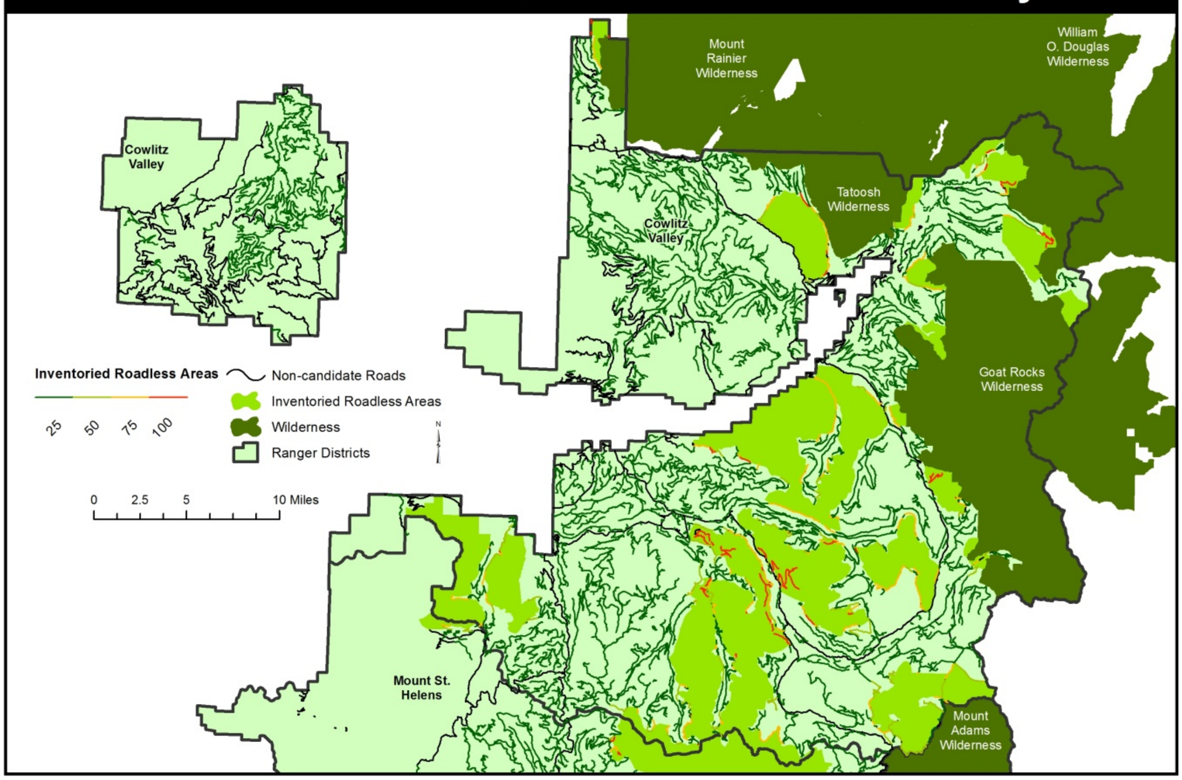
Gifford Pinchot RoadRight Analysis
Stream Crossing Index (50, 75, and 100) - Cowlitz Valley RD



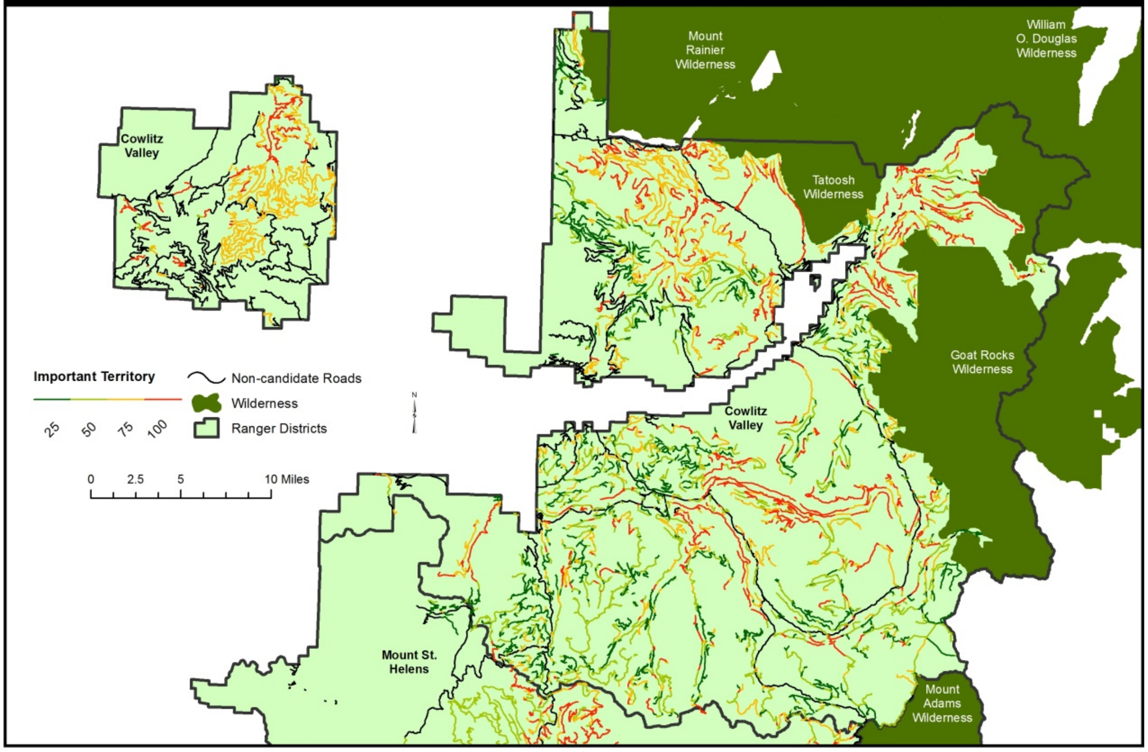
Gifford Pinchot Road Right Analysis
Isolation Index - Cowlitz Valley RD



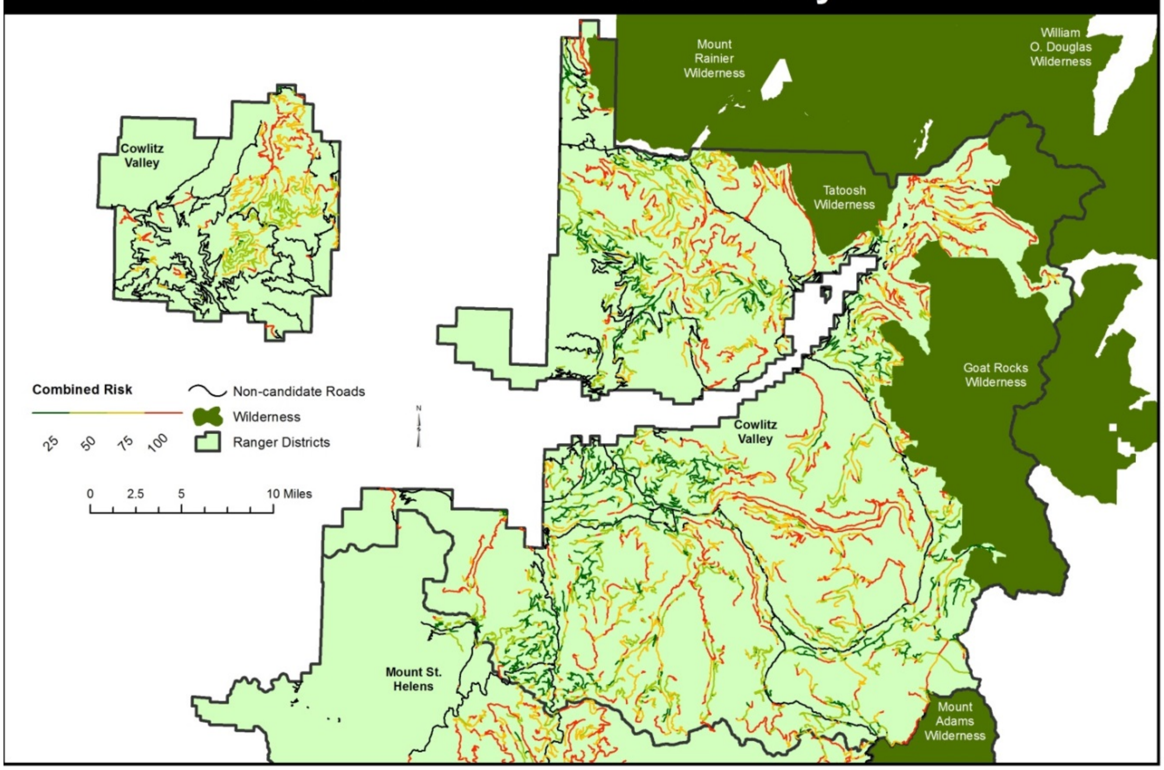
Gifford Pinchot Road Right Analysis
Inventoried Roadless Areas - Cowlitz Valley RD



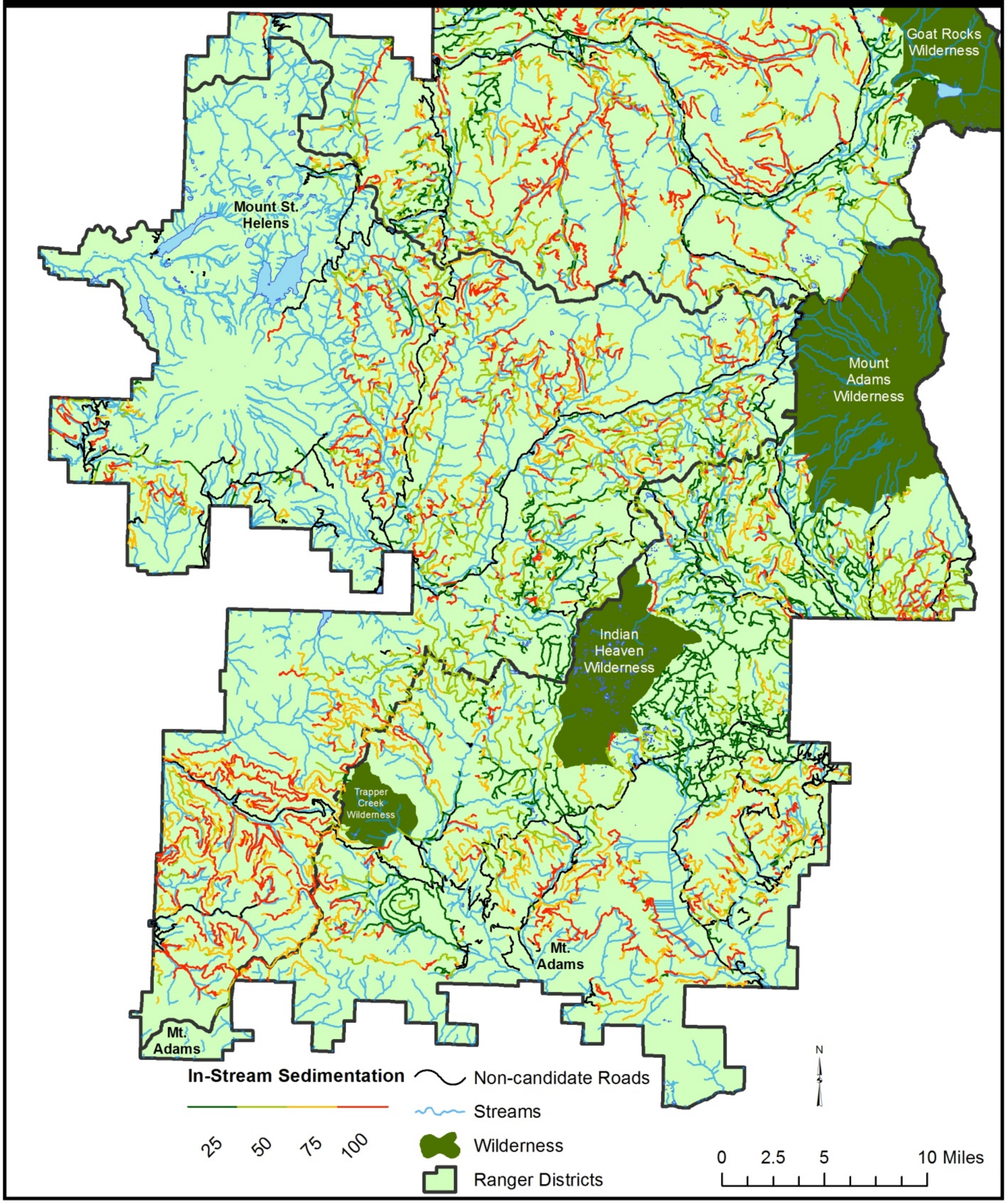
Gifford Pinchot RoadRight Analysis
Important Territory Index - Cowlitz Valley RD



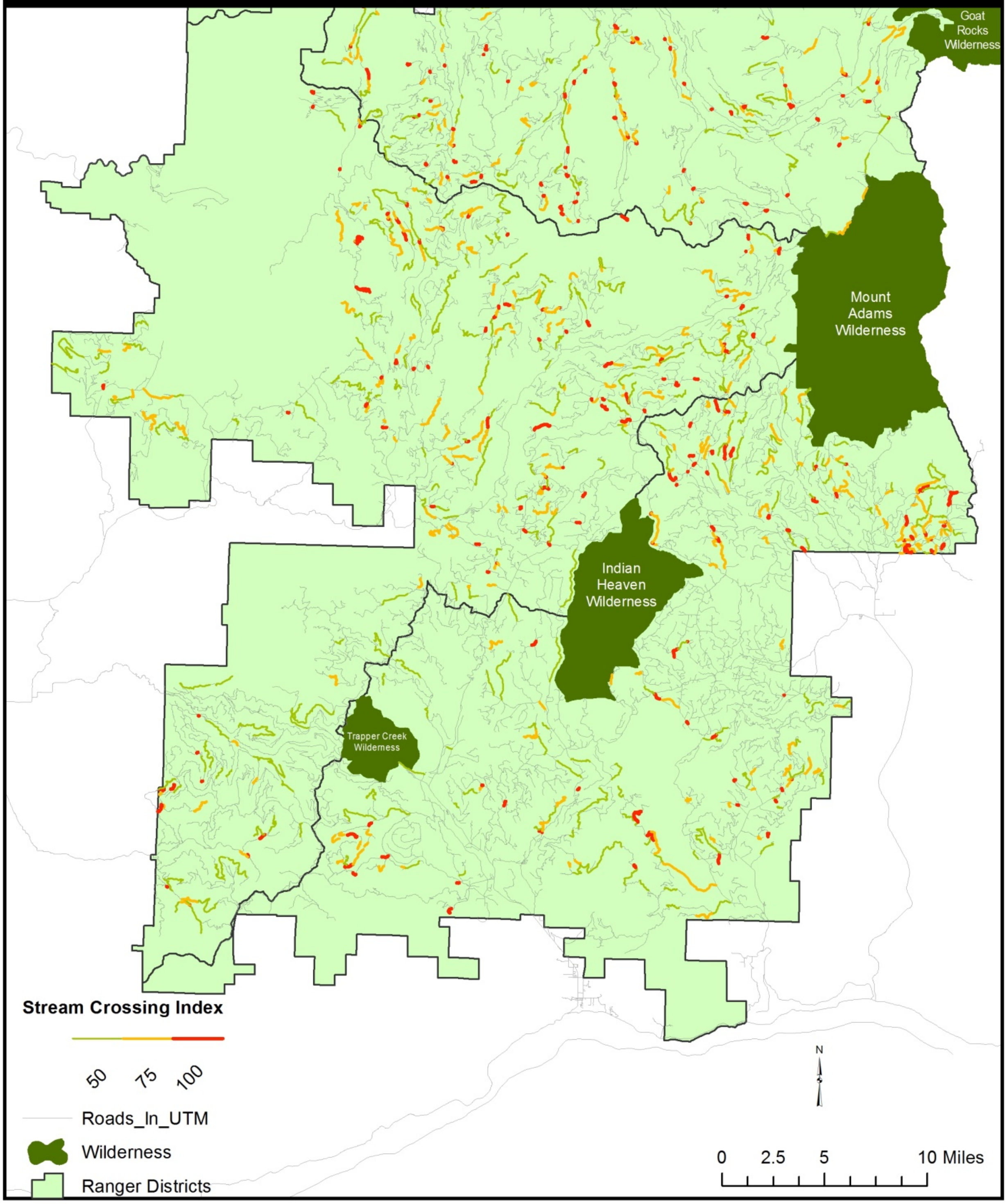
Gifford Pinchot RoadRight Analysis
Combined Risk - Cowlitz Valley RD

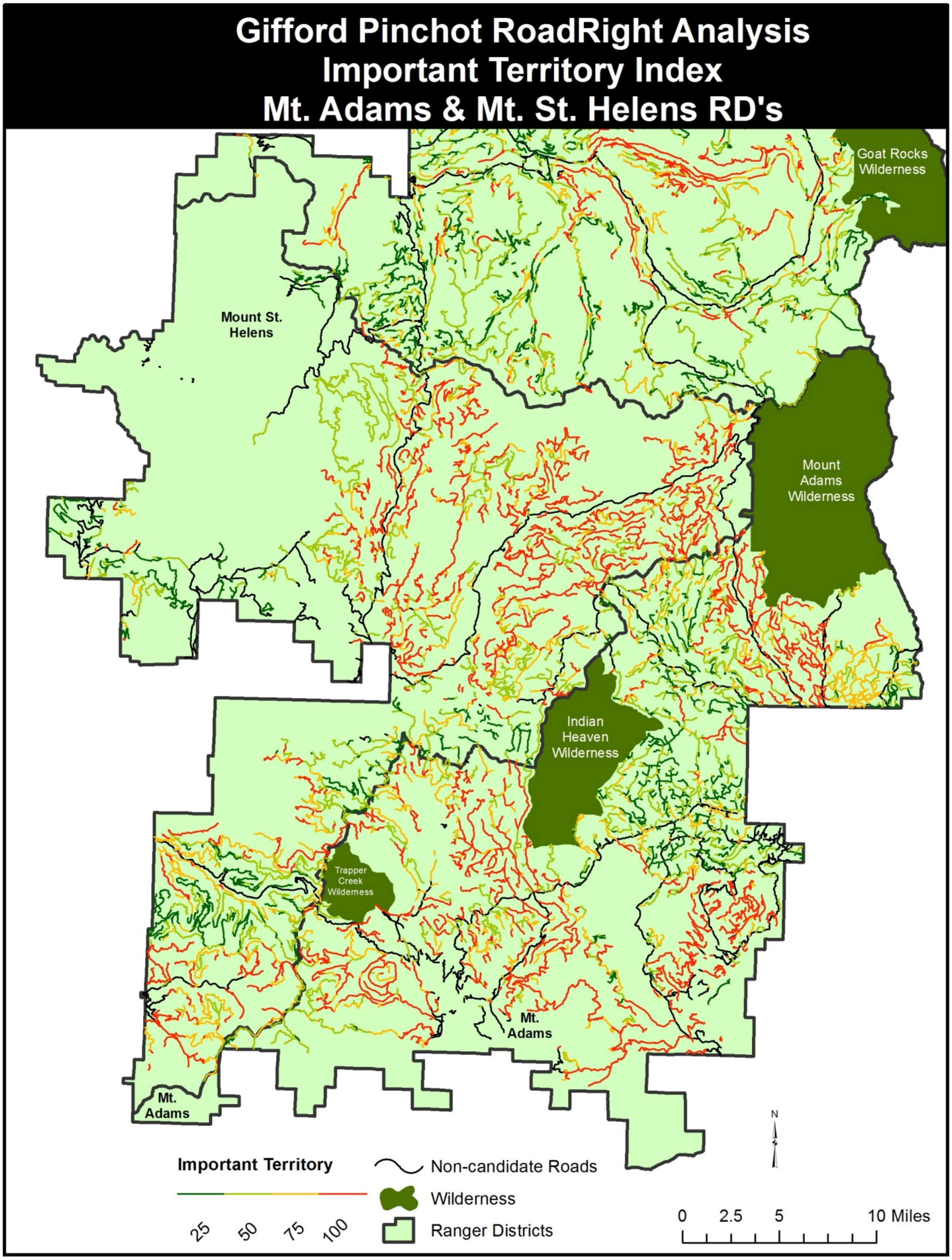


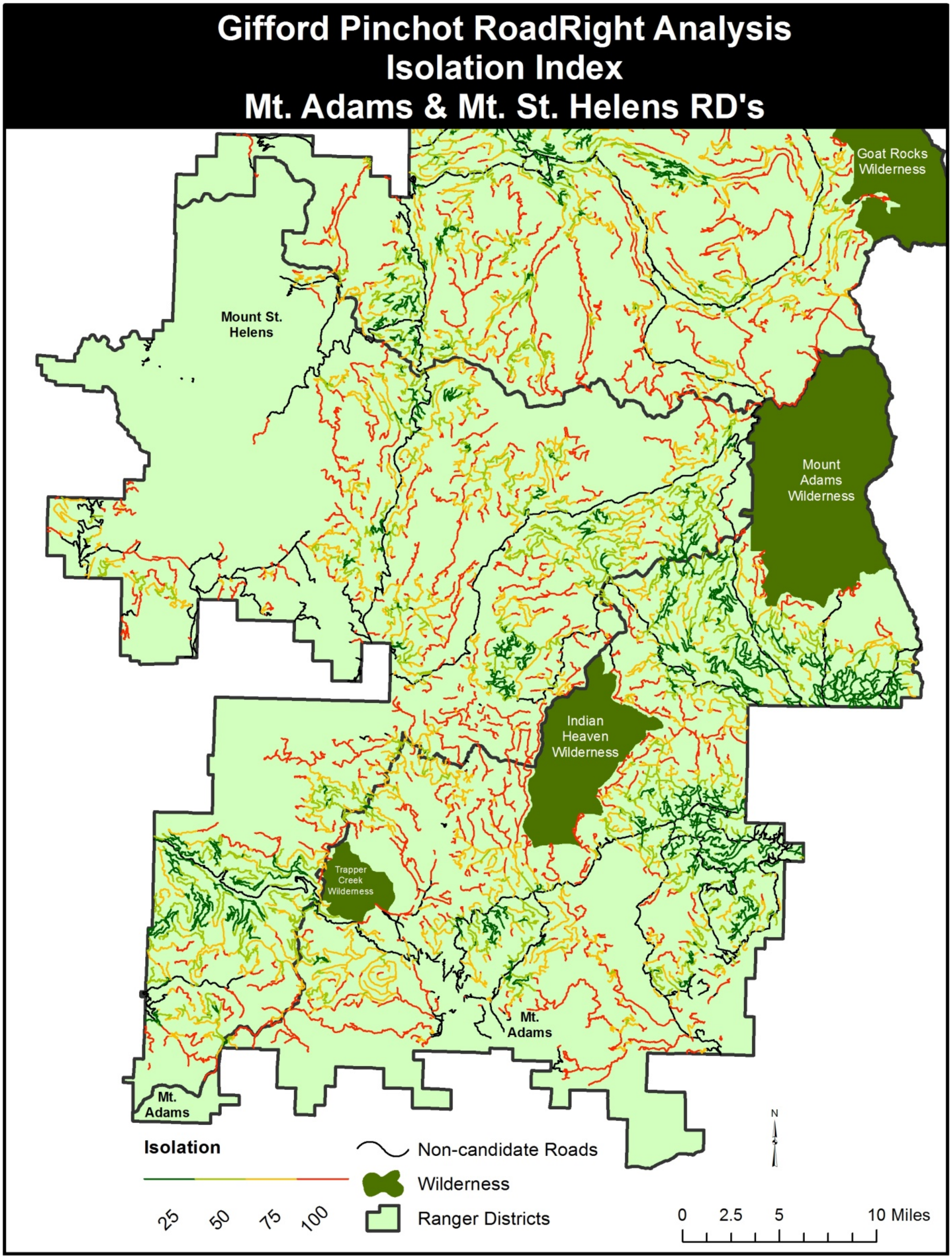
Gifford Pinchot RoadRight Analysis
In-Stream Sedimentation Index
Mt. Adams & Mt. St. Helens RD's



Gifford Pinchot RoadRight Analysis
Stream Crossing Index (50, 75, and 100)
Mt. Adams & Mt. St. Helens RD's




Gifford Pinchot RoadRight Analysis
Important Territory Index
Mt. Adams & Mt. St. Helens RD's
Goat Rocks Wilderness
Mount St. Helens
Mount Adams Wilderness
Indian Heaven Wilderness
Trapper Creek Wilderness
Mt. Adams
Mt. Adams
N
Important Territory
25
50
75
100
Non-candidate Roads
Wilderness
Ranger Districts
0
2.5
5
10 Miles


Gifford Pinchot RoadRight Analysis
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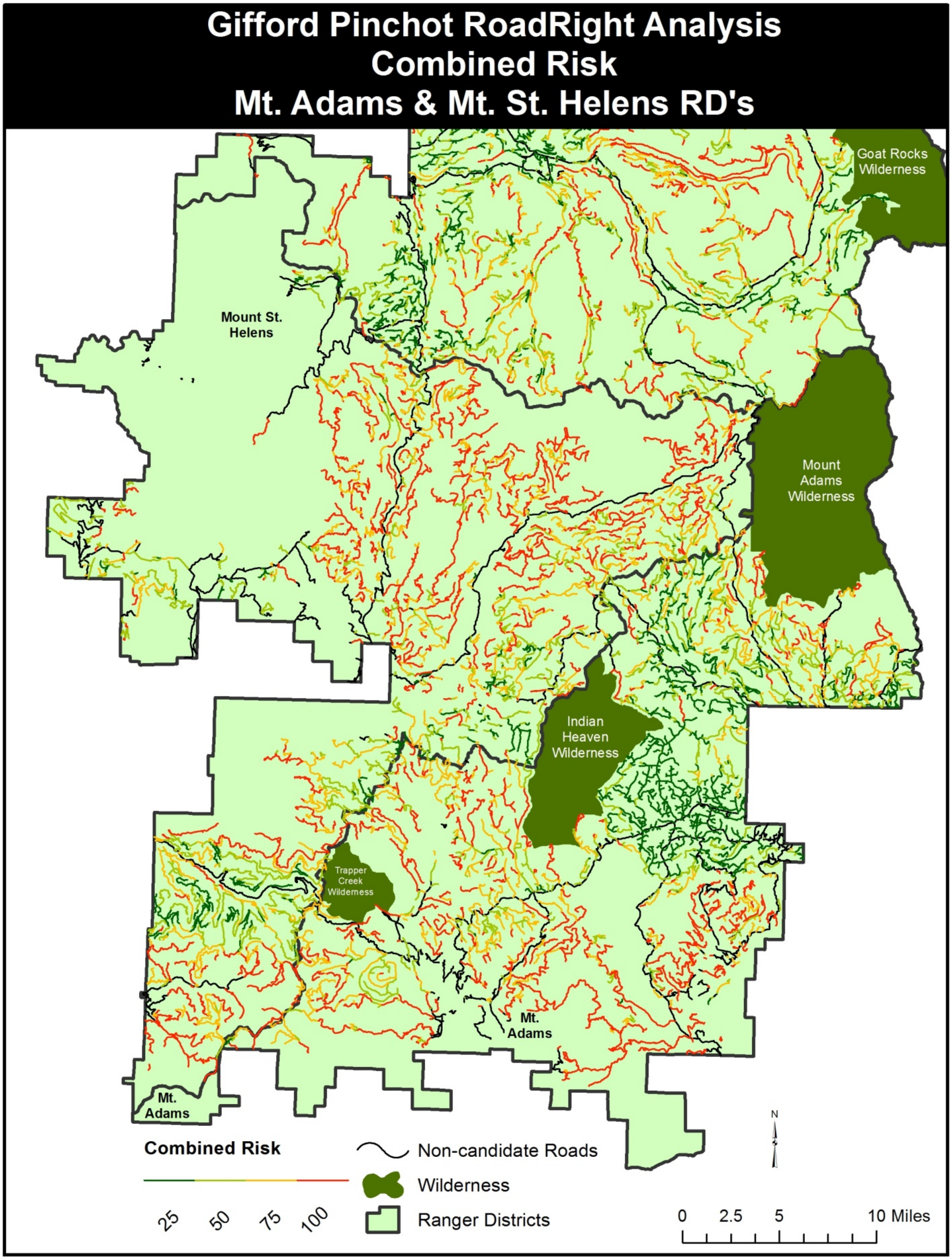
Mt. Adams
Mt. Adams
Isolation
25
50
75
100
Non-candidate Roads
Wilderness
Ranger Districts
N
0
2.5
5
10 Miles


Gifford Pinchot RoadRight Analysis
Combined Risk
Mt. Adams & Mt. St. Helens RD's
Goat Rocks Wilderness
Mount St. Helens
Mount Adams Wilderness
Indian Heaven Wilderness
Trapper Creek Wilderness
Mt. Adams
Mt. Adams
Combined Risk
25
50
75
100
Non-candidate Roads
Wilderness
Ranger Districts
N
0
2.5
5
10 Miles