

OPPORTUNITY ASSESSMENT FOR TARGETED BMPS IN PUGET SOUND

A technical report of The Nature Conservancy to the Puget Sound Natural Resources Alliance, March 2016

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PURPOSE

This regional assessment is intended to provide the RCPP steering committee with the foundational information needed to inform decisions and provide transparency in directing future funding. This high level information is not intended to be prescriptive. For example, it cannot tell you exactly which BMP's would be most effective on which parcels. Instead, this readily available coarse scale information is most useful in guiding decisions about where to direct further planning efforts in specific watersheds and in some cases, sub-watersheds.

METHODOLOGY

This spatial assessment utilizes overlays of geographic data inputs from various sources which are indicators of agricultural prominence, habitat value to species, water quality, and future pressures to salmon and shellfish. Three sets of results are presented depicting relative need of inland subregions for water quality improvement by BMPs: salmon freshwater habitat, marine shellfish habitat, and an overall combination of those two.

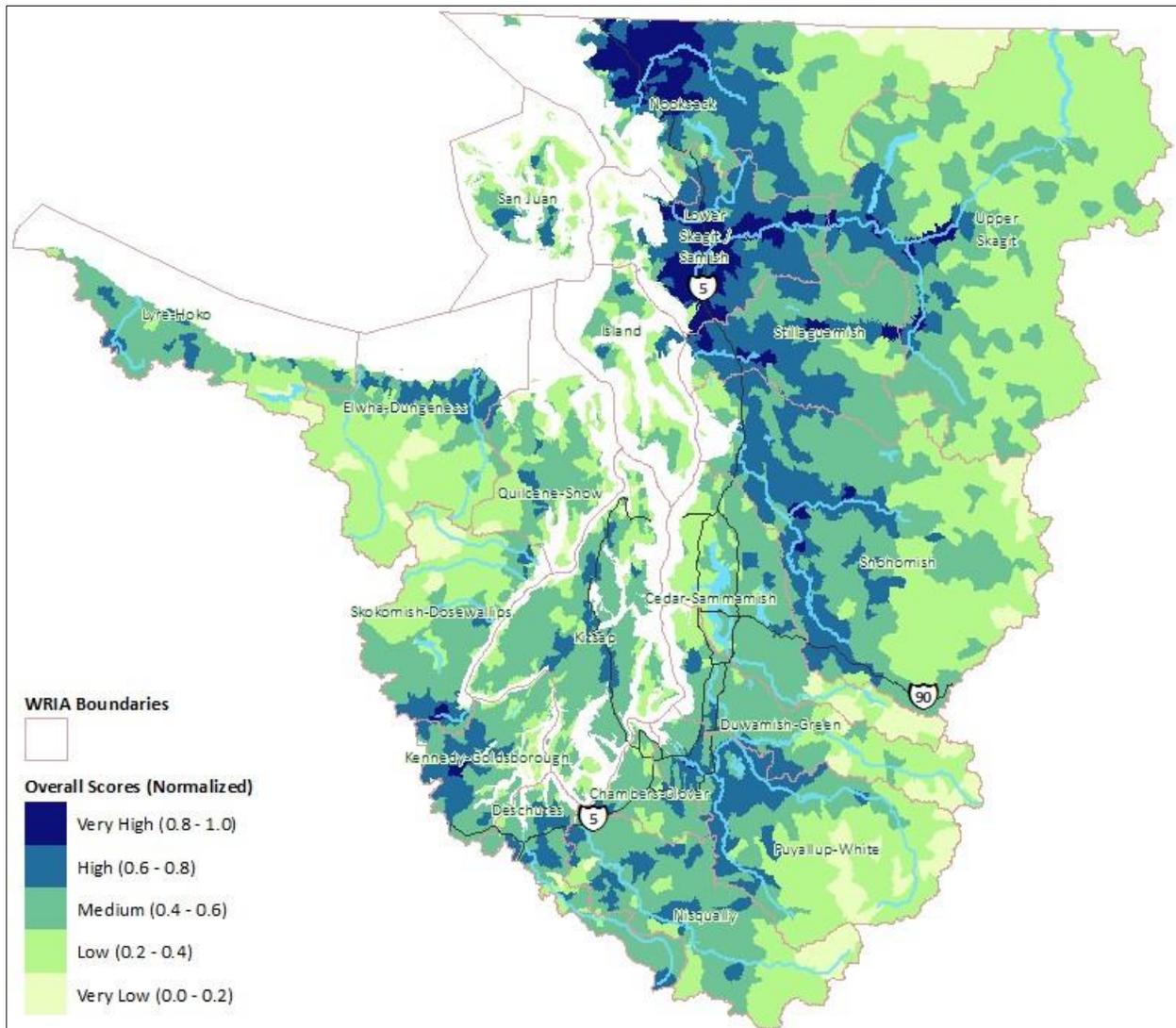
Each indicator is summarized per analysis unit (AU) developed for the WECY Watershed Characterization (Stanley et al. 2011, upd. 2015). Most indicators are used for both the salmon and shellfish scores, but some are specific to one of the two priorities. The AUs are 2,977 sub-basins ranging in size from 80 acres to 13,157 acres with a mean area of 2,927 acres. For this assessment, the summarized values are calculated or assigned values ranging from 0 to 1, where 0 equals the lowest assessment value and 1 equals the highest assessment value possible for any given indicator. This standardizes the inputs for final analysis. For each AU, the mean of values from overlapping indicators is calculated and then normalized by the greatest of those mean values to determine the final scores.

This method is meant to be simple from a spatial analysis perspective. The difficult portion of this assessment is determining the indicator inputs and how to transform their summarized values into the 0-to-1 value range so that a single data input contains values of relative weight to each of the other indicators. These decisions are generally subjective; however, inclusion of the WECY Watershed Characterization data, which are already scored on a 0-to-1 basis for each AU, does provide baselines for considering one indicator score relative to another.

PRIORITIES

Results describe priority areas implementing BMPs to improve water quality for salmon freshwater habitat, marine shellfish habitat, and an overall combination of those two.

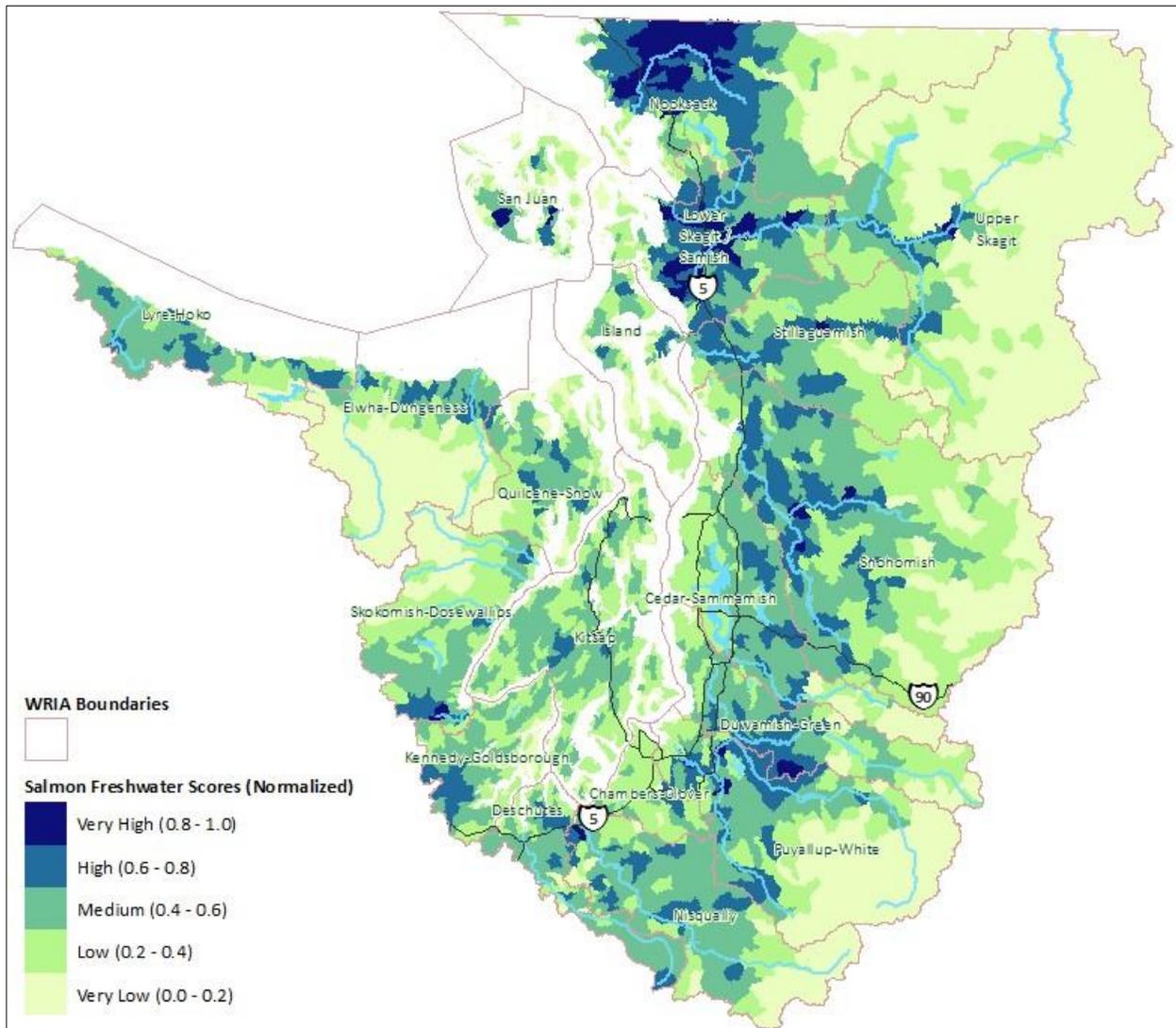
OVERALL PRIORITY AREAS FOR BMPs



Input Indicators:

- Proportion of analysis unit (AU) that is agriculture in prime farmland
- Area of agriculture in prime farmland
- Salmonid freshwater habitat value
- Nutrient degradation of water quality
- Sediment degradation of water quality
- Pathogen degradation of water quality
- Watersheds directly upstream of shellfish habitat
- Potential that Shellfish Areas directly downstream of the Watershed are impacted by Agriculture
- Proportion of Stream Projected to Change to Unsuitable Temperature for Salmonids (approx. 2000 - 2040)
- Projected Increase in Peak Flows of 2-Year Events from Climate Change (1980s - 2040s) – This indicator is not used in some areas due to lack of data
- Projected New Development Pressure (approx. 2000 - 2060)

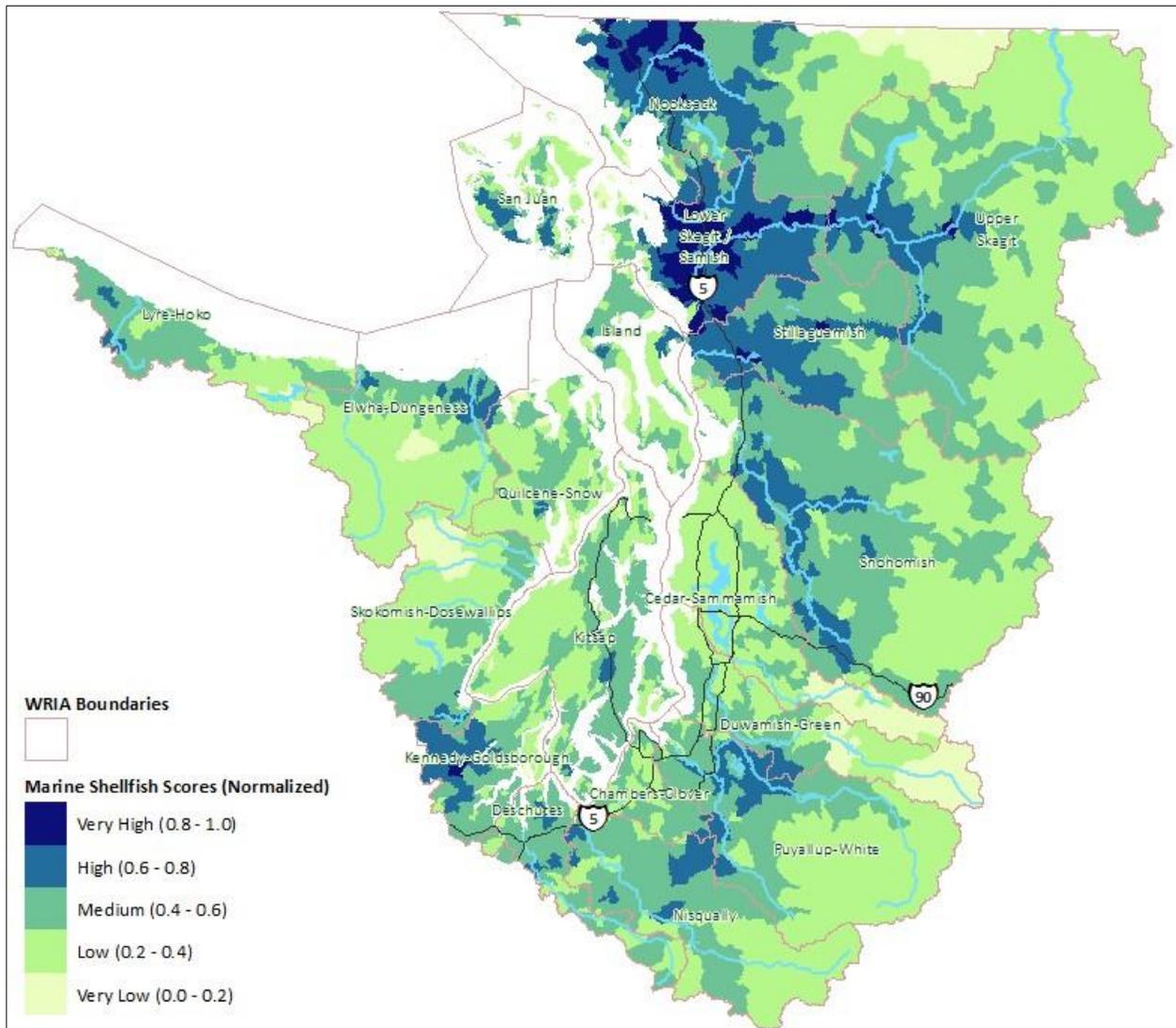
SALMONID PRIORITY AREAS FOR BMPS



Input Indicators:

- Proportion of analysis unit (AU) that is agriculture in prime farmland
- Area of agriculture in prime farmland
- Salmonid freshwater habitat value
- Nutrient degradation of water quality
- Sediment degradation of water quality
- Proportion of Stream Projected to Change to Unsuitable Temperature for Salmonids (approx. 2000 - 2040)
- Projected New Development Pressure (approx. 2000 - 2060)

SHELLFISH PRIORITY AREAS FOR BMPs

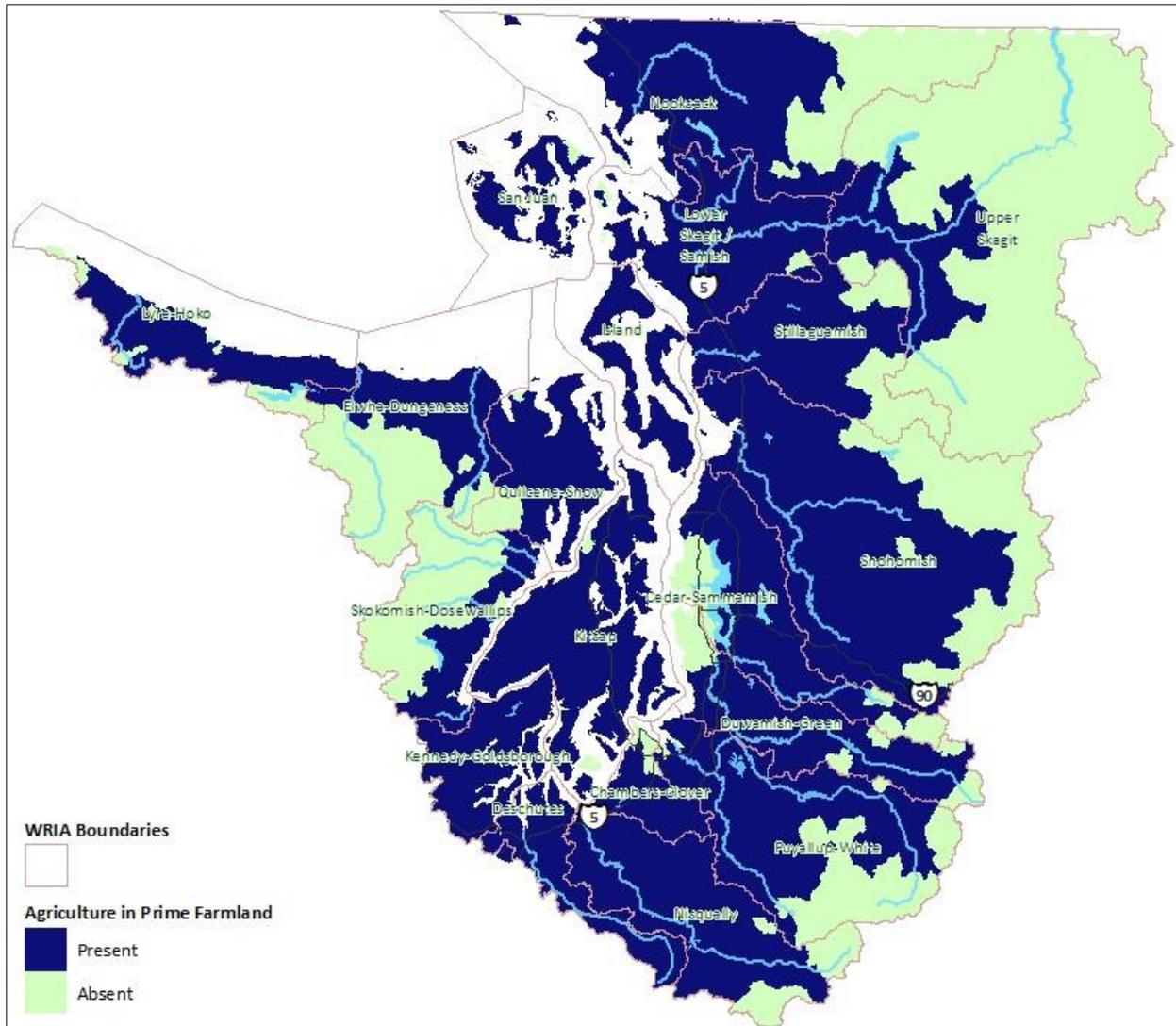


- Proportion of analysis unit (AU) that is agriculture in prime farmland
- Area of agriculture in prime farmland
- Sediment degradation of water quality
- Pathogen degradation of water quality
- Watersheds directly upstream of shellfish habitat
- Potential that Shellfish Areas directly downstream of the Watershed are impacted by Agriculture
- Projected Increase in Peak Flows of 2-Year Events from Climate Change (1980s - 2040s) – This indicator is not used in some areas due to lack of data
- Projected New Development Pressure (approx. 2000 - 2060)

OPTIONAL MASK

AGRICULTURE IN PRIME FARMLAND

Source: Derived from USDA, NASS 2011-2015; USDA NRCS 2014.

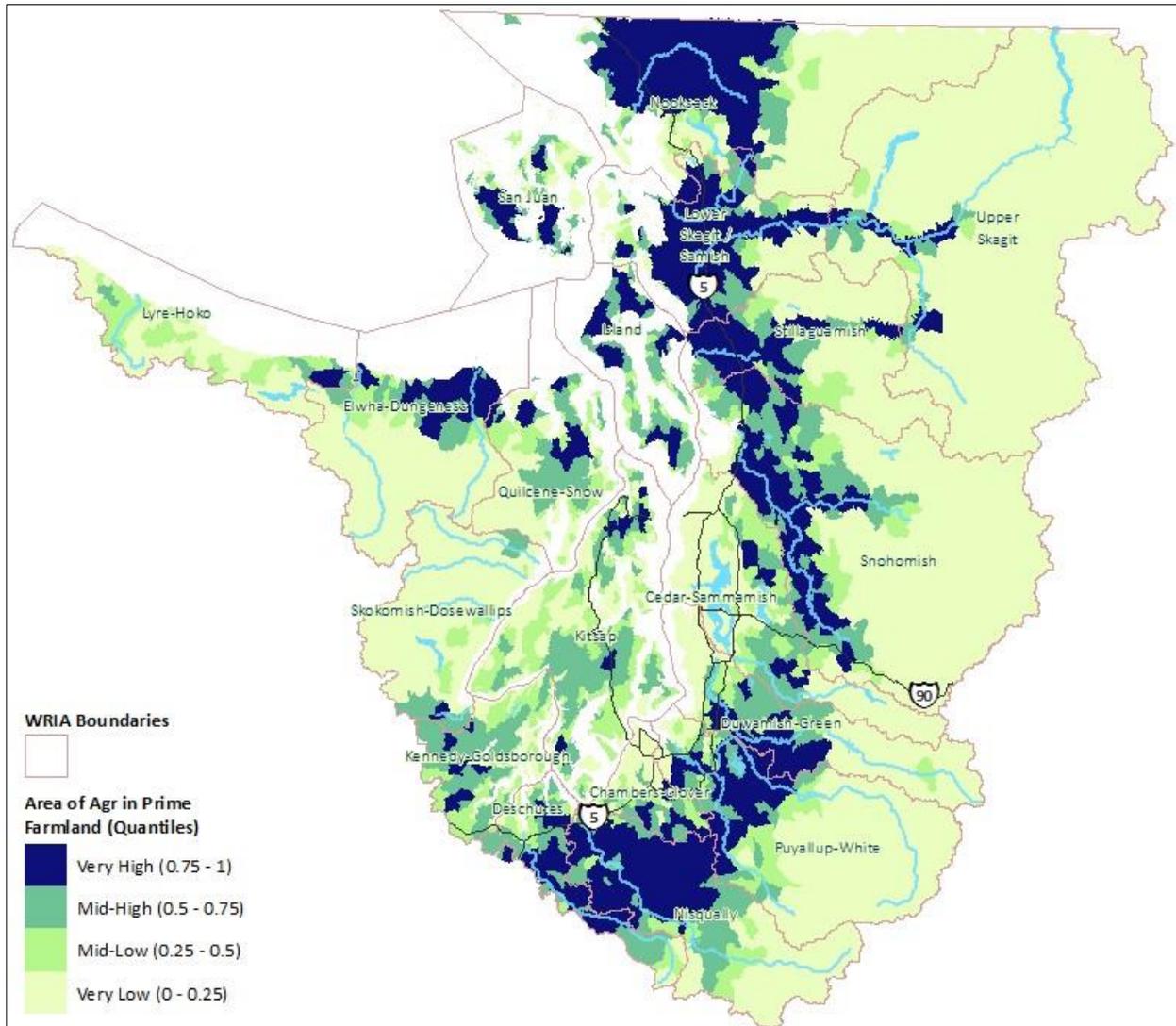


The purpose of the mask is to simply show whether an area does or does not contain agriculture with the purpose of quickly excluding subregions of very little agriculture from consideration in this project. The values Presence and Absence are defined by whether or not the AU contains any amount of agriculture existing in prime farmland. This mask is not used during the actual scoring of AUs and is merely to assist viewing of the results. Agriculture data are created from the satellite-derived 30-meter resolution USDA Cropland Data Layer (USDA, NASS 2011-2015), years 2010 through 2014. Before combination, annual inputs are reclassified to include values of agriculture or non-agriculture, where agriculture includes both cropland and grass/pasture land cover categories. To combine the five annual datasets, the most commonly-occurring input value is returned (agriculture or non-agriculture) at each cell location. Prime Farmland is a field (column) in the Soil Survey Geographic (SSURGO) soils database (USDA NRCS 2014), but a subset was used for this assessment where all “Prime Farmland” types are included except “Prime farmland if subsoiled, completely removing the root inhibiting soil layer.”

INDICATORS

AREA OF AGRICULTURE IN PRIME FARMLAND

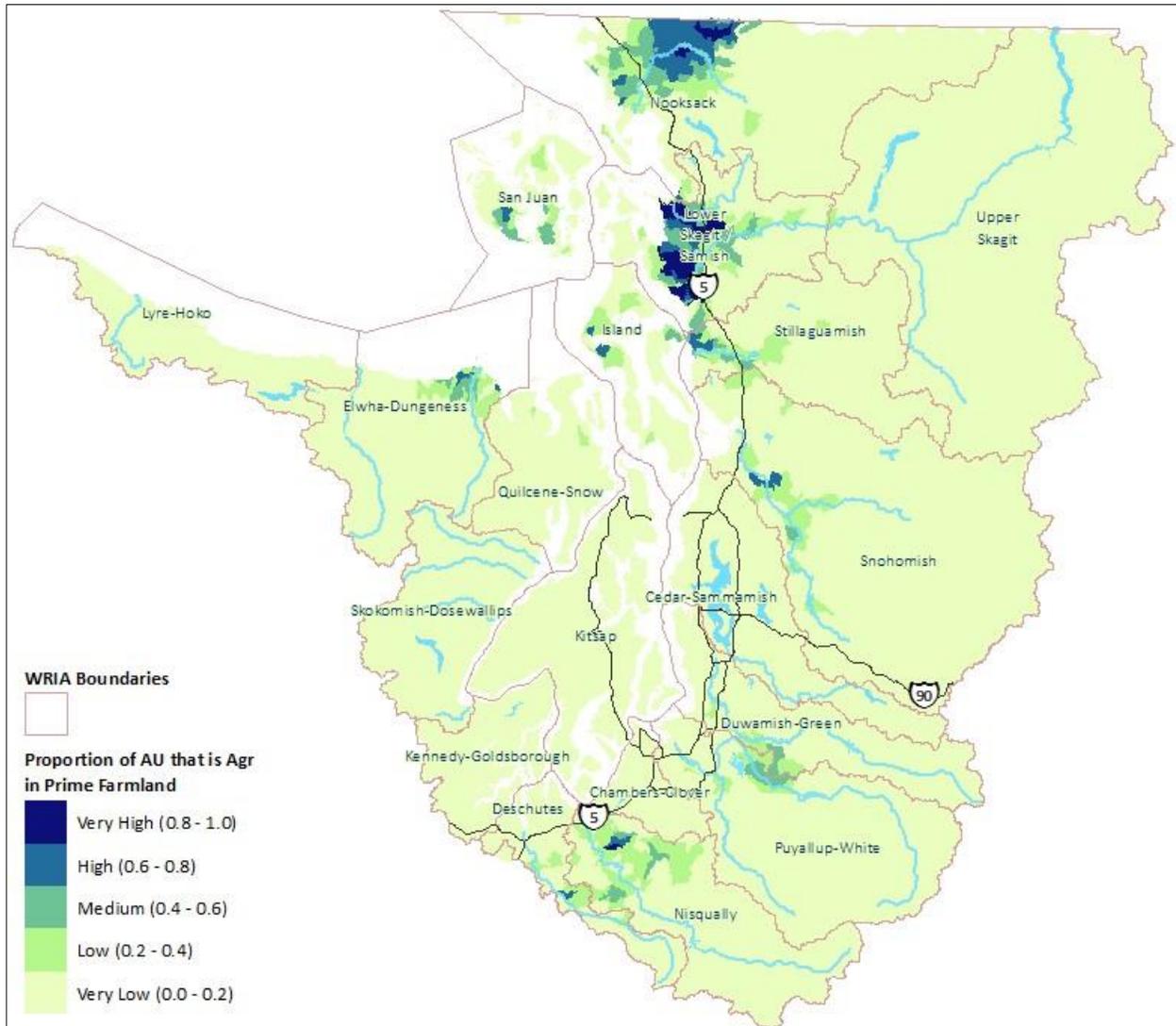
Source: Derived from USDA, NASS 2011-2015; USDA NRCS 2014.



This indicator differentiates AUs by farmland area to describe prevalence of agriculture relative to all other AUs across the Puget Sound. Area values were normalized by the value from the AU with maximum agriculture area. However, when these results are viewed by equal intervals, they over-emphasize a few AUs with extremely large amounts of agriculture and group most of the AUs into low value categories. To address this, quintiles are used to better distinguish the AUs, and the scores given to the quintiles are not linear. Rather, they are a simple additive curve, where the lowest quintile is valued at 0, next is 0.1, then 0.3, 0.6, and 1. This technique is more inclusive than more linear approaches to categorizing area. For more information, see the Optional Mask of Agriculture in Prime Farmland on page 8.

PROPORTION OF ANALYSIS UNIT THAT IS AGRICULTURE IN PRIME FARMLAND

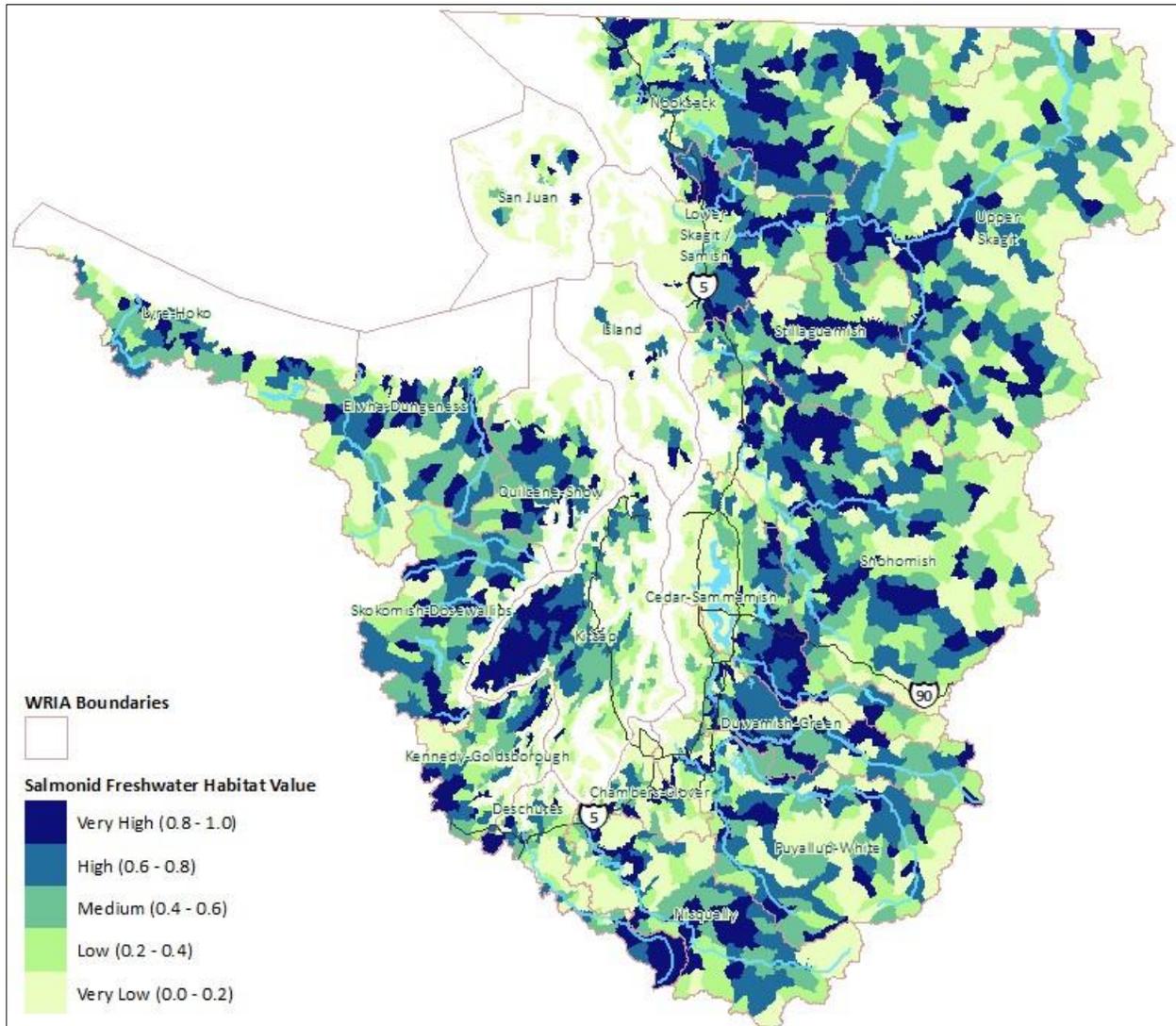
Source: Derived from USDA, NASS 2011-2015; NRCS SSURGO 2014.



Proportion of agriculture in prime farmland indicates relative prevalence of agriculture within the AU. The purpose of this indicator is to highlight those AUs possibly most influenced by the prevalence of agriculture and to ensure that the indicator of “Area of Agriculture in Prime Farmland” does not over-weight large AUs. For more information, see the Optional Mask of Agriculture in Prime Farmland on page 8.

IMPORTANCE TO SALMONID HABITAT

Source: Wilhere et al. 2013.

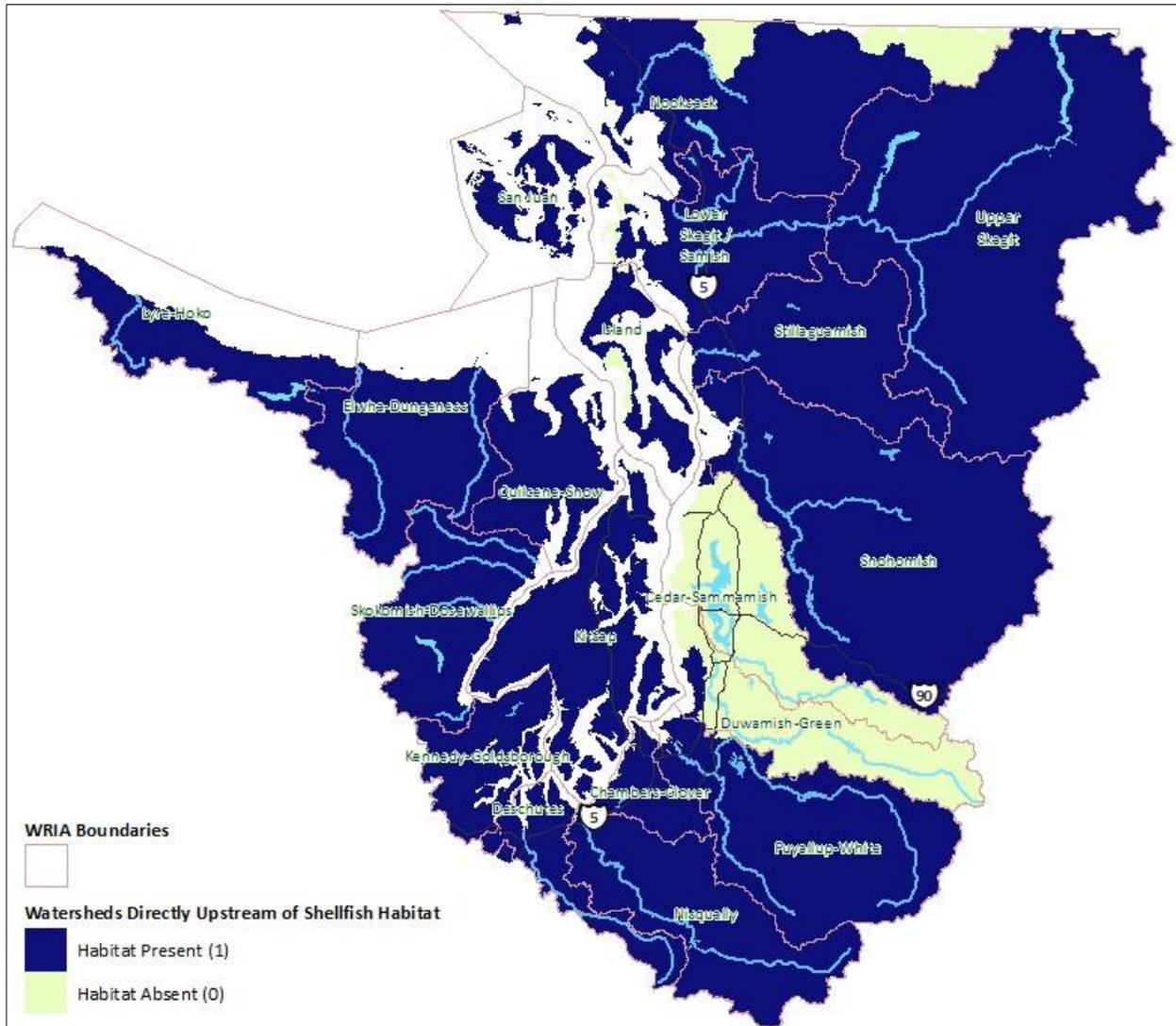


This indicator was developed for the Freshwater Habitat Assessment of the WECY's Watershed Characterization project and was not altered for this assessment. It represents Habitat Value calculated as a Watershed Habitat Index integrating Reach Intrinsic Potential, Ecological Integrity, and Fish Presence Category as well as Fish Status. Fish Status refers to both Federal Endangered Species Act species and WDFW's Salmonid Stock Inventory. Results were normalized within WRIAs, so while one WRIA may have more ESA species presence than another for example, the scores reflect value of the ESA species within the WRIA and high and low index values are distributed across the region. In one respect, this is a drawback to this assessment because it does not indicate which watersheds are higher value than another. In another respect, this is an advantage because it may highlight human values (i.e. local significance) and potential adaptation areas if one fishery location were to fail.

For more information on WECY's methods, see: page 149 of the 2013 final Habitat Assessments report: ftp://www.ecy.wa.gov/gis_a/inlandWaters/ps_project/Docs/Watershed_Characterization_WDFW_Report_Final_Dec2013.pdf

SHELLFISH HABITAT PRESENCE

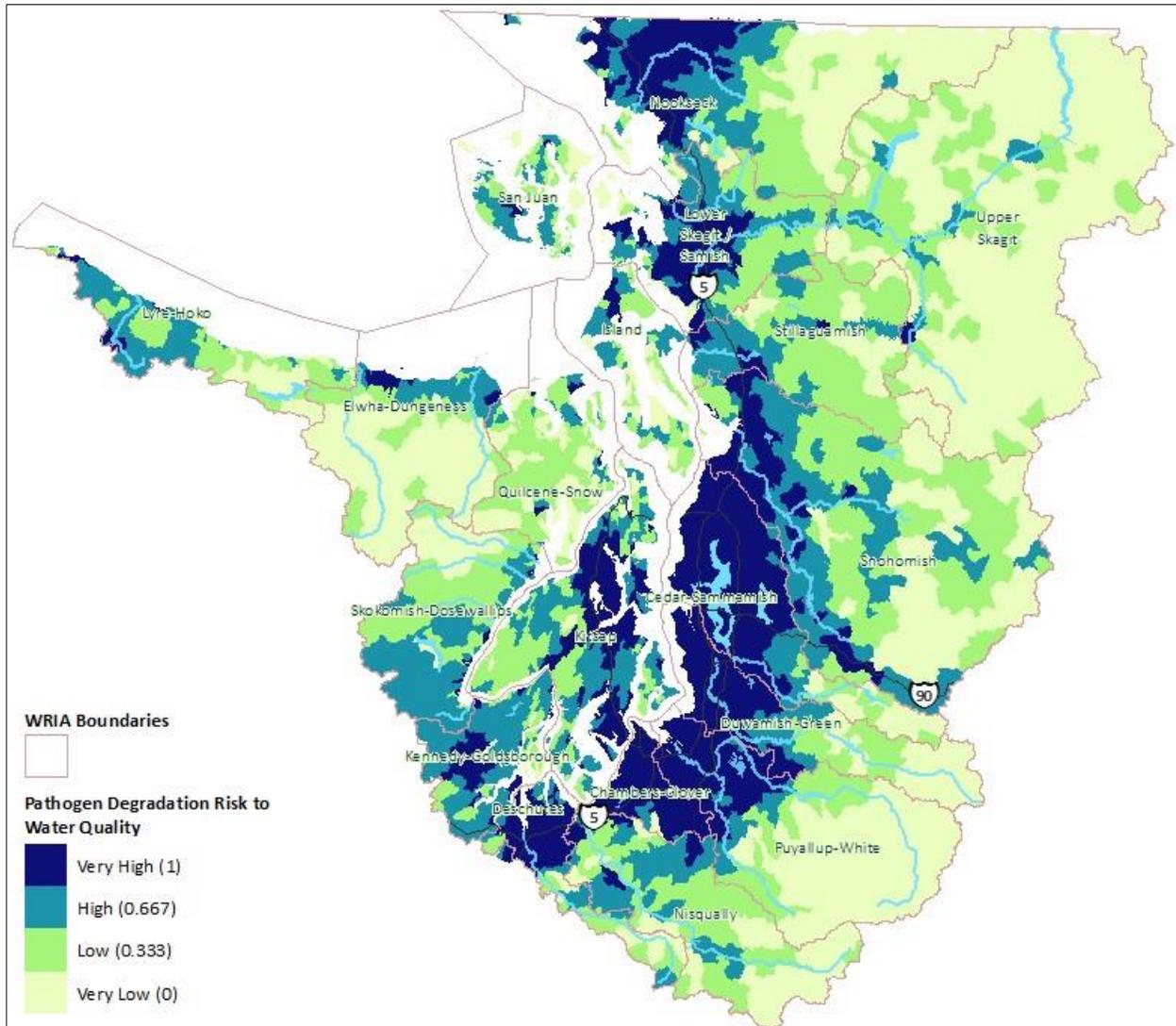
Source: Derived from WDOH 2014; WDOH 2015a; WDOH 2015b.



This indicator highlights those AUs in watersheds which drain directly to the Shellfish Biotoxin Closure Zones(WDOH 2014) that contain shellfish habitat. These Zones are defined in metadata as “areas of marine waters that are managed distinctly for shellfish biotoxin closures.” In this assessment, shellfish habitat is Shellfish Growing Areas(WDOH 2015a) and Recreational Shellfish Harvest Beaches(WDOH 2015b). The particular growing areas included those of class: 'Approved', 'Conditional', 'Prohibited', and 'Restricted'. The particular recreational beaches included those of status: 'Open', 'Conditionally Open', and 'Closed'. Direct drainage is calculated by selecting all AUs within 50-meters of a closure zone that contains any amount of habitat. The 50-meter distance was used to capture AUs with boundaries that may not well-align spatially with the habitat polygons and lines data. Once selected, all AUs upstream of the selected nearshore AUs were included regardless of distance from the shore. The goal of this indicator is to be over inclusive of potential upstream agriculture with the assumption that other indicators will better pinpoint AUs of concern. Similarly, AUs with habitat deemed Absent are not filtered out of the Shellfish Priority scores and may still be high priority if determined so by other indicators.

PATHOGEN DEGRADATION

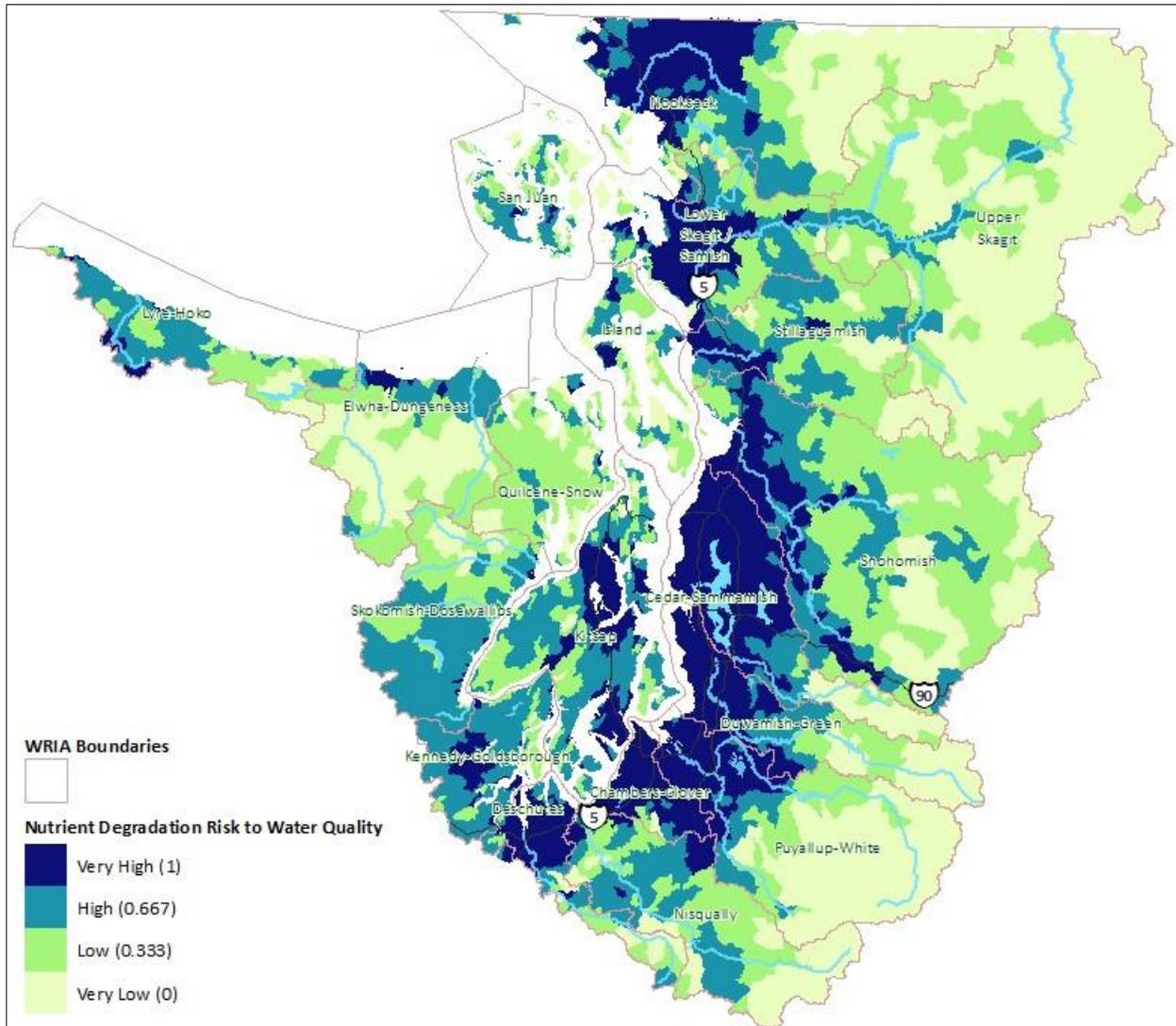
Source: Stanley et al. 2011 (updated 2015).



The purpose of this indicator is to describe the degree to which an Analysis Unit is degraded by pathogen loading which have potential to pollute shellfish habitat downstream. Pathogen sources are defined by land use/land cover type, such as agriculture, high urban development, forest type, etc., and do not include pollution point-sources. This indicator was developed by WECY for the Water Quality Assessment of the Watershed Characterization project using a model called N-SPECT and was not altered for this assessment. (For more information about the N-SPECT model and how the degradation results were produced, see item A in the Notes portion below in this document.)

NUTRIENT DEGRADATION

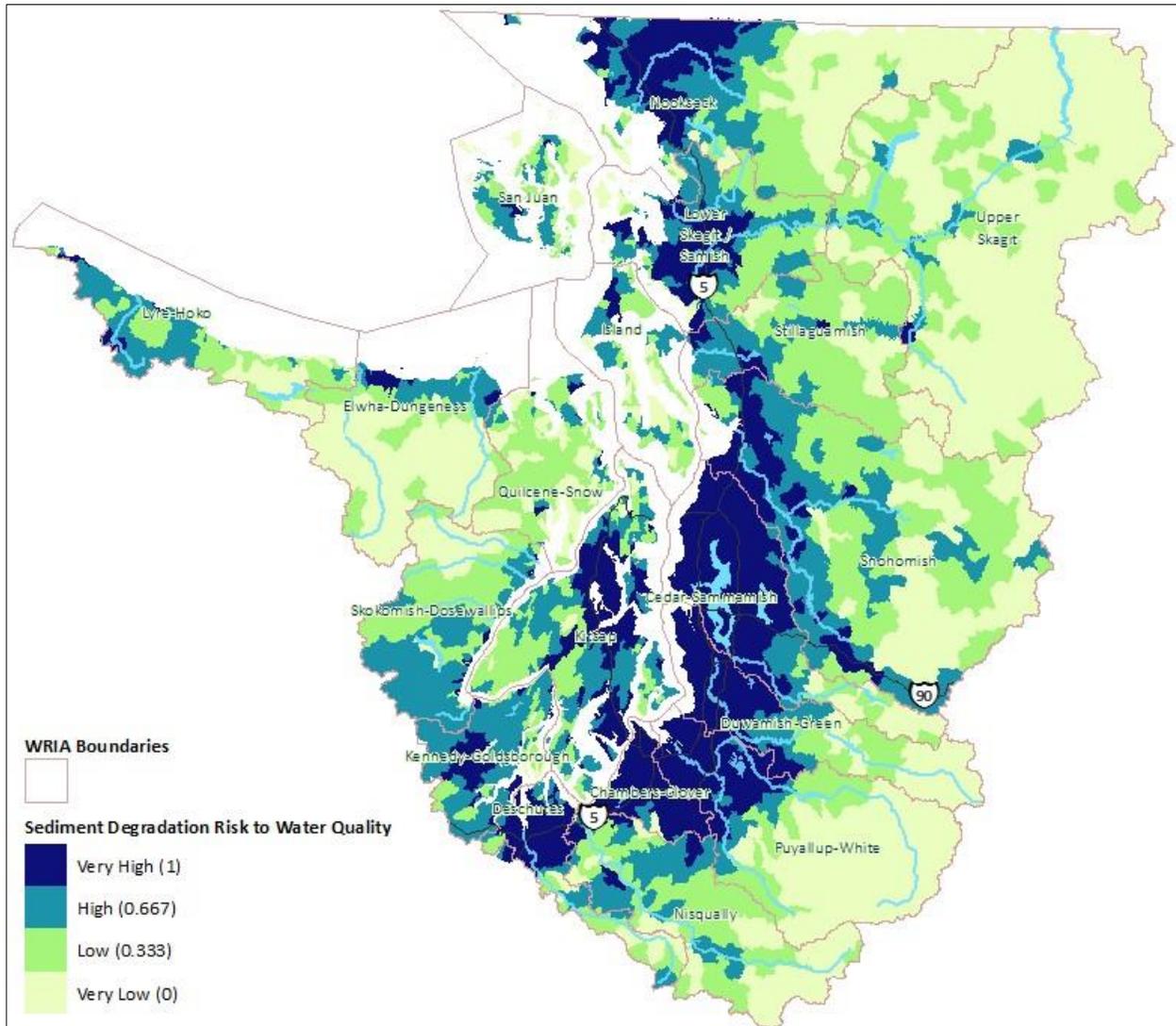
Source: Stanley et al. 2011 (updated 2015).



The purpose of this indicator is to describe the degree to which each analysis unit is degraded by nutrient loading (i.e. nitrogen and phosphorus) which has potential to cause excess eutrophication in salmon habitat locally or downstream. Nutrient sources are defined by land use/land cover type, such as agriculture, high urban development, forest type, etc., and do not include pollution point-sources. This indicator was developed by WECY for the Water Quality Assessment of the Watershed Characterization project using a model called N-SPECT. Input values were not altered; however, two inputs were combined to produce this indicator: the results of the nitrogen and phosphorous degradation models. The combination method simply assigned the output as the higher degradation value of each AU for either the nitrogen or phosphorus data. For more information about the N-SPECT model and how the degradation results were produced, see item A in the Notes portion below in this document.)

SEDIMENT DEGRADATION

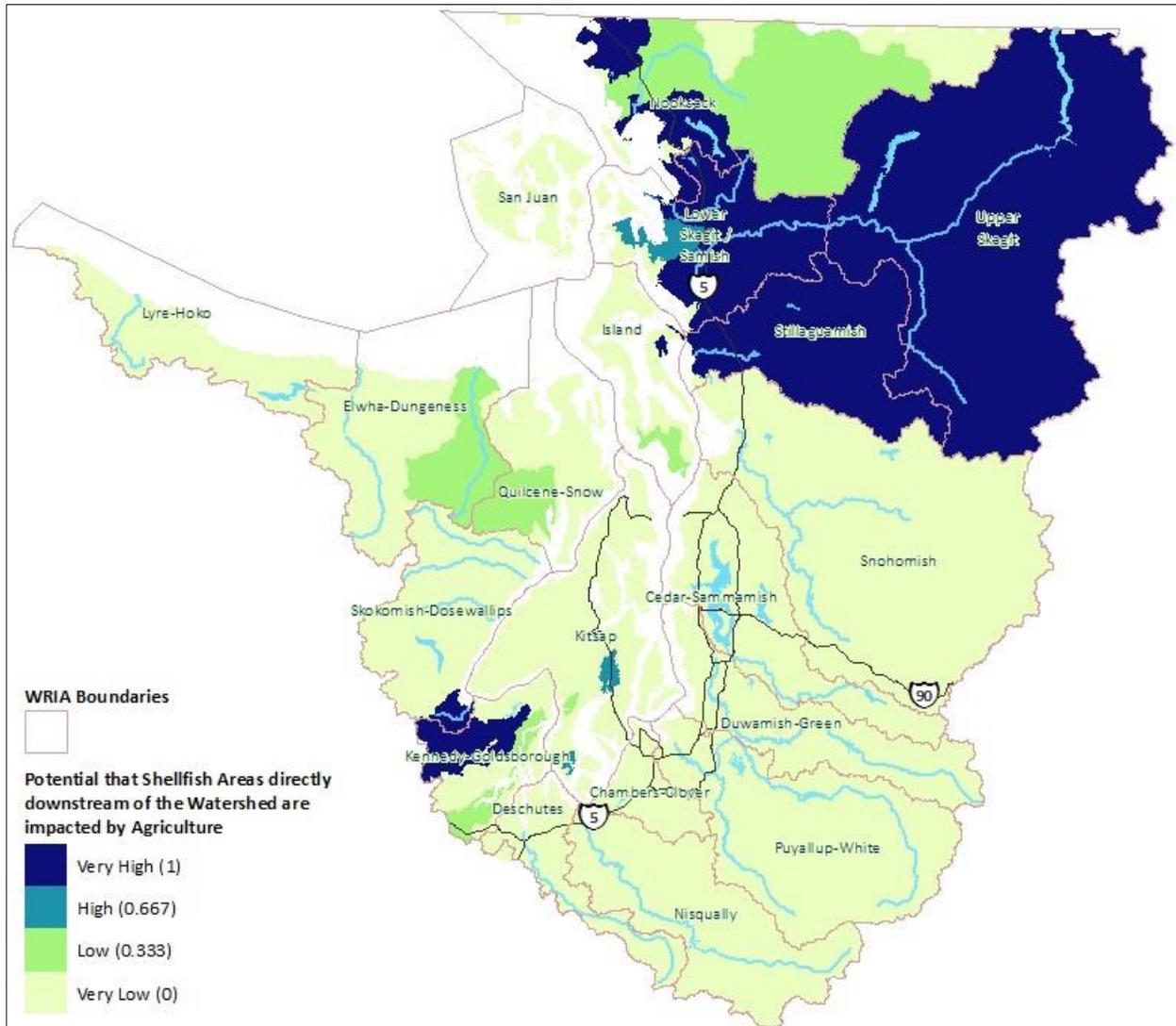
Source: Stanley et al. 2011 (updated 2015).



The purpose of this indicator is to describe the degree an Analysis Unit is degraded by sediment loading which has potential to bury shellfish habitat downstream and cause temperature increases and hypoxia in salmon habitat. Sediments also act as vehicles transporting pathogens in flowing water. Sediment sources are defined by land use/land cover type, such as agriculture, high urban development, forest type, etc., and do not include pollution point-sources. This indicator was developed by WECY for the Water Quality Assessment of the Watershed Characterization project using a model called N-SPECT and was not altered for this assessment. (For more information about the N-SPECT model and how the degradation results were produced, see item A in the Notes portion below in this document.)

SHELLFISH GROWING AREAS POTENTIALLY IMPACTED BY UPSTREAM AGRICULTURE

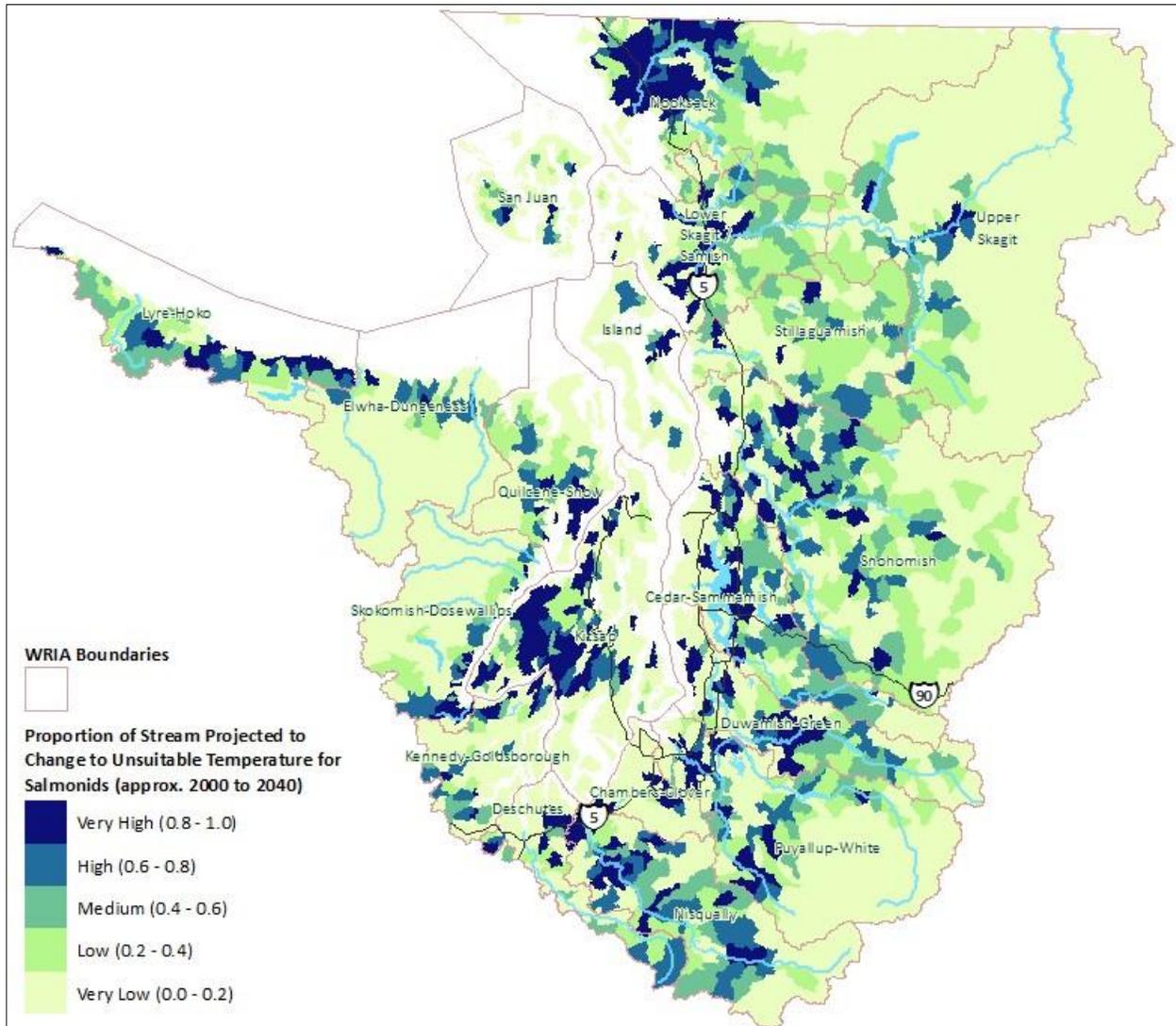
Source: Derived from Berbells 2016; WDOH 2014.



The purpose of this indicator is to portray the relative importance that agriculture within an entire watershed has for impacting water quality of shellfish growing areas. The original data were provided to The Nature Conservancy as point data of particular shellfish areas and describing their potential pollution risk from agriculture. The Nature Conservancy assigned scores to Shellfish Biotoxin Closure Zones polygons (WDOH 2014) matching the scores of the point located in them and next assigned those same scores to the entire watersheds draining directly into those closure zones. Zones with no points were assigned scores of zero(0), and the others were assigned scores of 0.333, 0.667, and 1 respectively for “Low/Mixed”, “Moderate”, and “High” risk point scores. (Thanks in particular to Scott Berbells of the Washington Department of Health (WDOH) for providing the point data and correspondences.)

CLIMATE CHANGE AND WATER TEMPERATURES FOR SALMONIDS

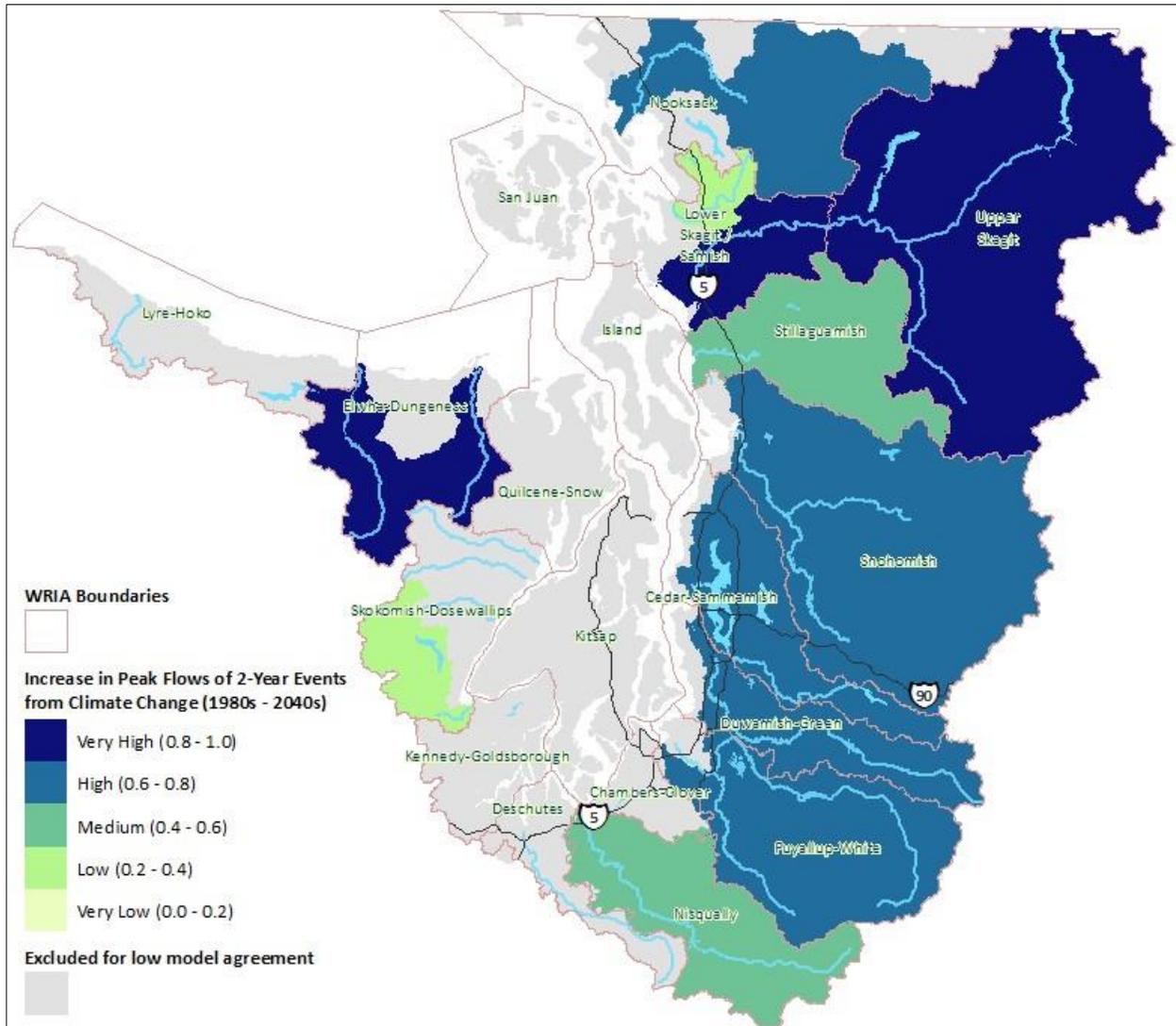
Source: Derived from Isaak et al. 2011; Payne 2011.



The purpose of this indicator is to highlight risk to salmon habitat from warming waters due to climate change. Areas projected to experience changes to water temperature amounting to unsuitable temperatures for salmonid core summer habitat. Suitability for salmonids is defined by the WECY "Different Aquatic Life Uses and Their Associated Numeric Criteria" in the agency's Surface Water Quality Standards and in an agency report (Payne 2011). Key summer temperature thresholds for salmonids are maximum 13 degC for spawning/incubation and maximum 16 degC for core usage. This assessment considers temperatures suitable if below 16 degC and unsuitable if above. A stream segment is considered at risk if its temperature is projected to change from suitable to unsuitable with climate change by around 2040. The score is the proportion of the length of stream segments within an AU that are projected to change to unsuitable during the time period. Areas of current unsuitability are not considered changing to unsuitable and thus are not considered at risk here. Input data are the NorWeST Stream Temperature dataset of modeled stream temperature historically and projected (Isaak et al. 2011). (For more information about NorWeST, see item B in the Notes portion of this document.)

CLIMATE CHANGE AND FLOODING RISK TO SHELLFISH

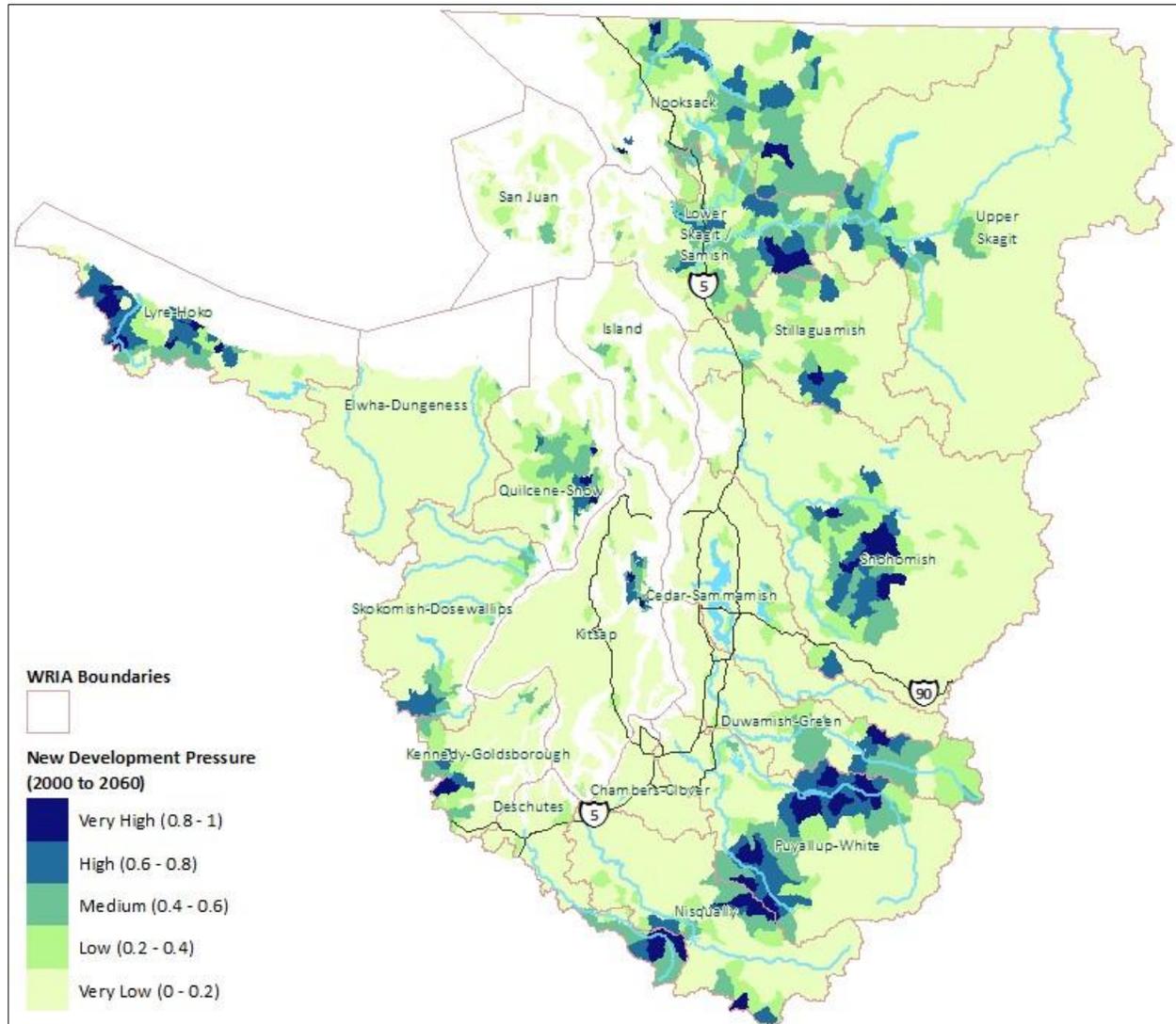
Source: Derived from Hamlet et al. 2013.



The purpose of this indicator is to highlight risk of increased flooding which could potentially mean increased risk of pollution events impacting shellfish downstream. The model results provide projections of increase in peak flows of 2-year flood events from the 1980s to the 2040s by watershed. Although flood events impacting water quality for shellfish typically occur at a much greater frequency than two year events, these projections are likely indicative of the relative increase in more frequent flood events. Results are aggregations at the mouth of the watersheds and should not be assumed uniform among sub-basins within a watershed. These results do not account for regulation. For example, dam effects are not accounted for in the Skagit River Watershed.) (Thanks in particular to Guillaume Mauger of UW's Climate Impacts Group (CIG) for providing the data and correspondences.)

NEW DEVELOPMENT PRESSURE (2000 – 2060)

Source: Derived from Bolte and Vache 2010.



The purpose of this indicator is to highlight areas likely to add new development (re: conversion to urban or agriculture land cover/land use) and thus increase risk to water quality from development over the period 2000 to 2060. Input data are the base year (2000) and projected year 2060 results of the PSNERP land cover change analysis (Bolte and Vache 2010). This is calculated as a difference in proportions of developed lands within an AU and is not a calculation of proportional change in developed area of the AU. In other words, it provides a score of how much more of the AU is projected to be developed rather than how much more development is projected to occur. Proportional change is not being used because it could over-emphasize AUs which may have very little development currently thus any percent (or proportional) increase in development would be very high relative to other AUs which may have more initially existing development. (An example is provided in item C of the Notes portion of this document below.) This difference is normalized across all AU values by the value of the AU with highest difference to stretch from 0 to 1.

SUPPLEMENTAL INFORMATION:

These maps are meant to be used at supplemental information to the assessment. These data were not integrated into the assessment for various reasons described, and they may be best used to further understand the results of the assessment or how an AU may be further assessed for at the local level.

PUGET SOUND CHINOOK SALMON POPULATION RECOVERY APPROACH (PRA)

Source: Tynan et al. 2010

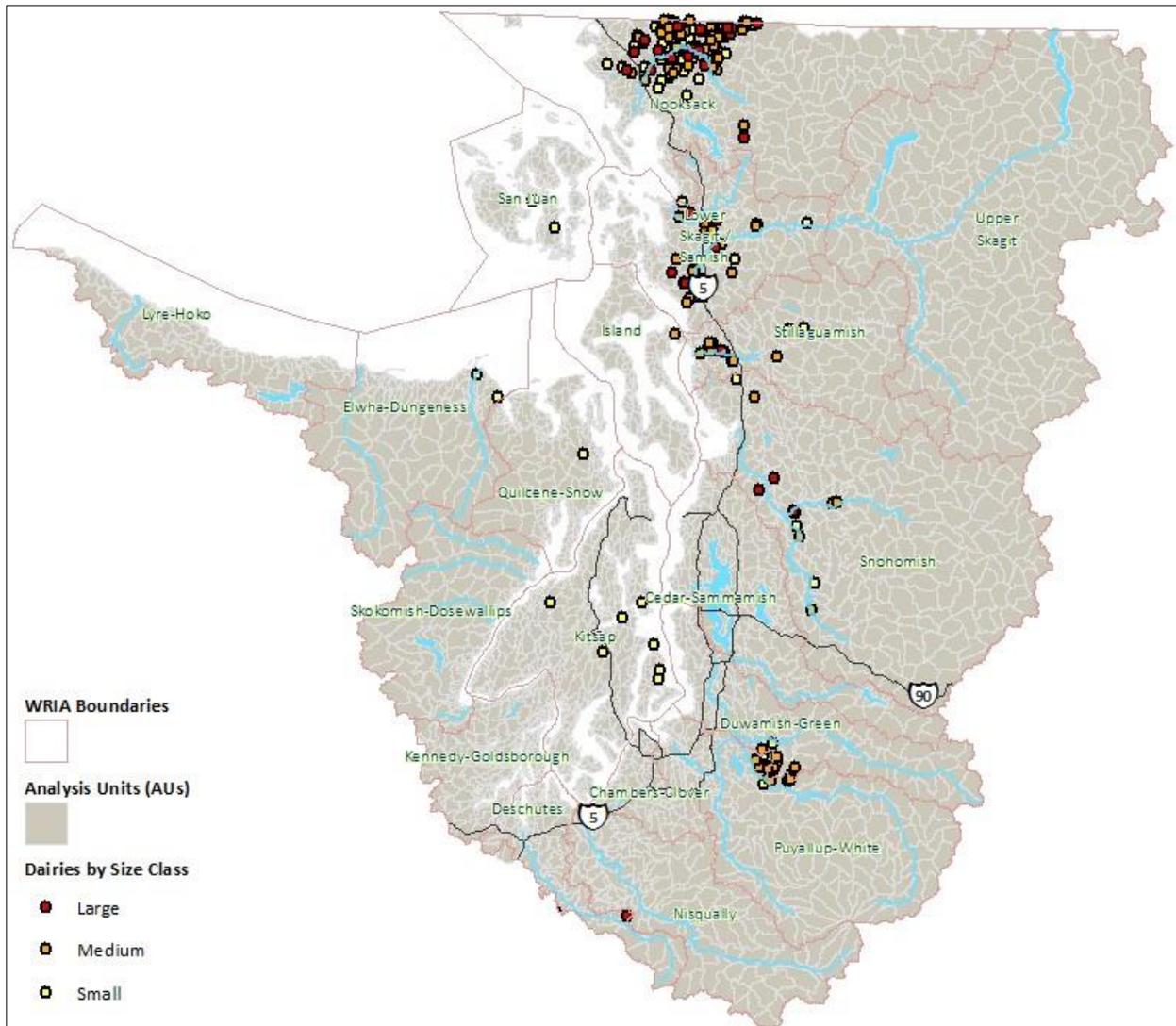
Table 5. NMFS Northwest Region assignments regarding the value of individual Puget Sound Chinook salmon populations within each biogeographical region to the recovery and delisting of the ESU.

Biogeographical Region	Population	PRA Tier Assignment
Strait of Georgia	North Fork Nooksack	1
	South Fork Nooksack	1
Whidbey Basin	Upper Skagit	1
	Lower Skagit	1
	Upper Sauk (early run)	1
	Lower Sauk	1
	Suiattle (early run)	1
	Cascade (early run)	1
	North Fork Stillaguamish	2
	South Fork Stillaguamish	2
	Skykomish	2
	Snoqualmie	3
	Sammamish	3
Central/South Sound	Cedar	3
	Green/Duwamish	2
	Puyallup	3
	White	1
	Nisqually	1
	Skokomish	1
Hood Canal	Mid-Hood Canal	1
Strait of Juan de Fuca	Elwha	1
	Dungeness	1

Information presented in the PRA was not included as an indicator in this assessment but may be helpful in considering next steps and further prioritization distinguishing major drainage basins. For more detailed description of the PRA, see http://wdfw.wa.gov/about/advisory/pshaac/documents/ps_chin_pra-draft.pdf. The PRA may be controversial among some stakeholders, so special consideration may be warranted in the use of the Tier Assignments.

DAIRIES

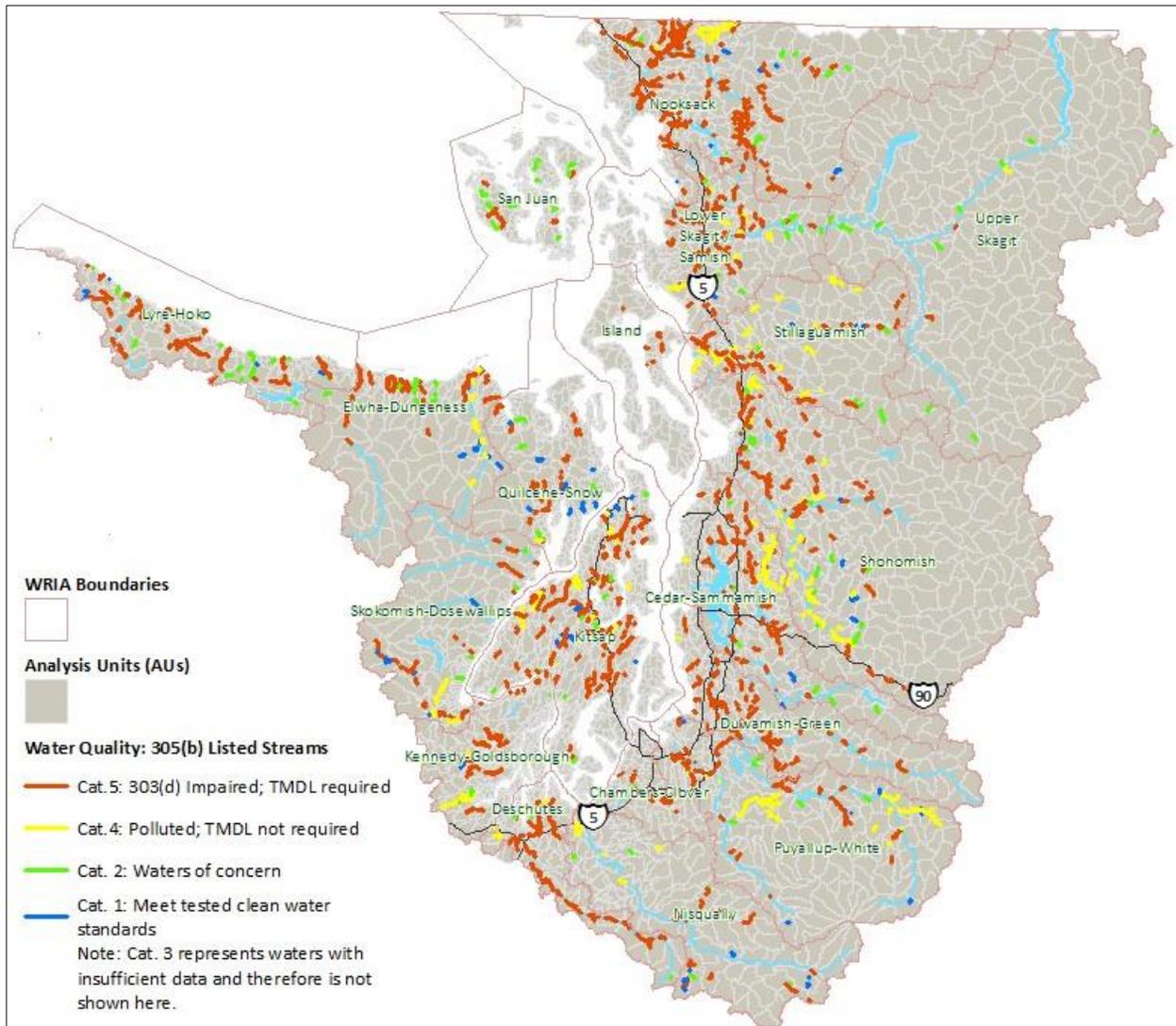
Source: WSDA 2014



Dairy data were not included as an indicator for priority scores, but it may be useful for visual checks to help explain results of the assessment or bring attention to potential gaps. The decision to not use these data as an indicator was made in conversation between Jamie Robertson of The Nature Conservancy and Leif Fixen of American Farmland Trust on February 3, 2016. AFT explained that the dairy size classes and head counts were not correlated with rates of pollution or runoff and therefore should not be used in a scoring system. Furthermore, the dairy data do not account for transported manure to croplands and other uses and therefore would over-weight AUs with dairies compared to AUs without them. Dairy information may be more useful for further more localized investigation of AUs for targeting BMPs after the AUs have been prioritized.

305(b) WATER QUALITY

Source: WECY 2013



The 305(b) and 303(d) Water Quality data were not included as an indicator because they are not spatially comprehensive enough to be adequate for summary by AU across the Puget Sound region. Many AUs contain streams not assessed adequately under the WECY Water Quality monitoring program thereby leaving gaps of unknown water quality. Furthermore, other indicators should capture the majority of the water quality issues related to agriculture. The 305(b) and 303(d) Water Quality information will be useful for further more localized investigation of AUs for targeting BMPs after the AUs have been prioritized. For example, they may be used for determining problem catchments, setting local goals (e.g. TMDLs), and monitoring outcomes. (For information about the data displayed in this map, see item D in the Notes portion of this document.)

NOTES

A. Regarding the Watershed Characterization's Degradation Submodels for Pathogens, Nutrients, and Sediments:

From Stanley et al. (2011):

“**N-SPECT**: The ‘Nonpoint-Source Pollution and Erosion Comparison Tool,’ developed and supported by the National Oceanographic and Atmospheric Administration (NOAA). N-SPECT is GIS-based model that uses pollutant export coefficients to quantify the relationship between land use/land cover and pollutant amounts. It is most useful in planning-level assessments such as the Characterization, providing estimates of the change in pollutant amount in response to a change in land use/land cover (see also <http://www.csc.noaa.gov/digitalcoast/tools/nspect>).” (p.7)

“The **degradation submodel**, in contrast to the water-flow model, evaluates the watershed in its “altered” state by use of a numerical model, N-SPECT (the “Nonpoint-Source Pollution and Erosion Comparison Tool”), to assess the degree of existing degradation to sediment processes based on compiled GIS land-use data together with a compilation of “typical” contaminant loadings for various land uses. N-SPECT uses pollutant export coefficients to quantify the relationship between land use/land cover and pollutant amounts, and it is applied pixel-by-pixel across the entire Puget Sound basin. For use within the Characterization framework these results are summed by AU, , but the raw results [are calculated] on a pixel-by-pixel (i.e., 30x30 meter).” (p.46)

B. Regarding the Climate Change and Freshwater Temperatures indicator:

The 16degC is the threshold for core summer habitat (i.e. for spawning, emergence, rearing, and adult holding) and not necessarily an impediment to migration. Also, it should be noted that ECY's 16C threshold is actually for a 7-day average of daily maximum temperatures. The NorWeST scenario represents the mean temperature across the month of August. These two temporal units obviously are not aligned, and the fact that NorWeST uses mean temperature and not 7-day mean max temp means the method used in this assessment very likely under-estimates the amount and extent of streams which have unsuitable temperatures currently and in the future. Despite this, the indexed scoring system likely captures amount of change in one AU relative to others (higher vs lower risk locations), which is the intent of the indicators.

The two NorWeST data inputs used here are S1_93_11 and S30_2040D. The former is the “Scenario 1, modeled stream temperature from 1993-2011.” The latter is the “Future scenario based on global climate model ensemble averages that represent the A1B warming trajectory for 2040s (2030-2059). Future stream deltas within a processing unit were based on similar projected changes in August air temperature and stream discharge, but also accounted for differential warming of streams by using historical temperatures to scale temperature increases so that cold streams warm less than warm streams” (from metadata).

C. Regarding New Development Pressure:

Here is an example to further explain the methods used to develop this indicator. If only 1% of the AU is currently developed and increases to only 3% in the future, that is still a 200% increase in developed area. Likewise, an AU that is currently 50% developed may increase to 75% developed, which is only a 50% increase in developed area. The difference in proportional looks at the difference between the two current and future percentages of developed area, so the first example would be a difference of 2% and the second example a difference of 25%, which are more indicative of added risk.

D. Regarding 305(b) Water Quality:

A single stream segment in the 305(b) Water Quality data may contain multiple often varying water quality scores for whichever pollutant is tested at that location. Therefore, to achieve a single score for the map displayed here, the score of highest impairment value was used for a stream segment. For more information about WECY's Water Quality Assessment and detailed descriptions of the assessment categories, see <http://www.ecy.wa.gov/programs/wq/303d/WQAssessmentCats.html>.

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