Willamette River Report Card 2015

Scores and scoring methodology

Prepared by Dr. Simon Costanzo, Dr. Heath Kelsey, and Tracey Saxby

Integration & Application Network

University of Maryland Center for Environmental Science

November 2015

Table of Contents

1 Overview

The Willamette River is a major tributary of the Columbia River, flowing northward in a wide river valley between the Cascade Range and the Coast Range in northwestern Oregon. The main stem is approximately 180 miles long, and produces more runoff per unit of land area than any other river in the United States due to the rain-laden weather systems moving eastward from the Pacific Ocean and colliding into the Coast Range and Cascade Range. The river valley is heavily populated, with 65% of Oregon's population, and 12 of its 15 largest cities. The watershed is mostly forested (68%), however agriculture dominates the fertile lands in the Willamette Valley (19%), while urban areas cover 5% of the land area. The Willamette River's tributaries are dammed in several places to provide hydroelectric power, flood protection, and water for irrigation. In addition to dams, the river has been highly modified along its length, losing more than 60% of the original floodplain forest that bordered the river in a wide band.

Seven of the 26 native fish species that commonly occur in the main stem Willamette River are listed as endangered, threatened, or sensitive by federal or state government, including spring Chinook salmon and winter steelhead. Significant threats to the condition and sustainability of the Willamette River's ecological health include pollution, loss of channel complexity, and development. In order to enhance understanding and management of these threats, the Meyer Memorial Trust has invited stakeholders from various agencies and organizations to help develop an Ecosystem Health Report Card for the Willamette River.

To further this effort, the Meyer Memorial Trust's Willamette River Initiative, in partnership with the Integration & Application Network from the University of Maryland Center for Environmental Science, brought together local and regional experts and stakeholders to develop ecosystem health indicators, thresholds, and a reporting framework for a Willamette River Report Card. Workshop participants represented the following organizations: University of Oregon, Oregon State University, Oregon Natural Resources Institute, Oregon Department of Fish and Wildlife, Oregon Department of Environmental Quality, Oregon Watershed Enhancement Board, Oregon Water Resources Department, Oregon Department of Agriculture, Oregon Department of Geology and Mineral Industries, National Oceanic and Atmospheric Administration Fisheries, U.S. Army Corps of Engineers, U.S. Geological Survey, Confederated Tribes of Grand Ronde, Confederated Tribes of the Warm Springs, City of Portland, City of Eugene, City of Albany, Clean Water Services, Eugene Water and Electric Board, City of Hillsboro, The Nature Conservancy Oregon, Willamette Partnership, and Bonneville Environmental Foundation.

The report card aims to capture a snapshot of the ecological health of the Willamette River based on pre-defined indicators and goals, to be able to track change over time in response to management actions and/or external pressures.

This report outlines the methodology employed to source chosen indicator data (Table 1-1) and calculate report card scores following technical stakeholder workshops held on September 23–25, 2014, and April 3, 2015 and subsequent reviews by technical stakeholders.

Participants at the September 2014 stakeholder workshop in Eugene, OR.

The Willamette River Report Card currently captures conditions along the main stem of the Willamette River from the confluence with the Columbia River in the north and south to Eugene, Oregon (0–229 km) (Figure 1-1). For the purposes of this report, the river was divided into three reporting reaches, herein referred to as:

- Lower Willamette River: 0 – 72 km
- Mid Willamette River: 73 – 150 km
- Upper Willamette River: 151 – 229 km

The process of calculating report card scores required collation and synthesis of multiple datasets and conversion of raw data into a percentage attainment of pre-defined goals. Reach scores were obtained by averaging, by reach, the indicator attainment scores within each value and category group shown in Table 1-2.

Grades are assigned + or - (e.g. B+ or B-) if attainment scores are within 5 points of the cutoff between grades. For example, 75% would equate to B+; whereas 65% would equate to a B-.

Table 1-1. *Willamette River Report Card indicators, indicator categories, values and scoring system.*

Indicators	Categories	Values	Scoring System
Native fish	Biodiversity	Fish and Wildlife	A: 80 to 100%
Non-native fish			
Juvenile chinook	Iconic native species		
Bald eagle			
Oregon water quality index	Clean water	Water Quality	B: 60 to <80%
Toxics			
Temperature			
Floodplain forest	Healthy riparian areas	Habitat	C: 40 to <60%
Channel complexity	In stream habitat		
Flow targets	Flow regime	Flow	D: 20 to <40%
Peak flows			
Tribal fisheries	Fishable	People and the River	
Fish consumption advisories			
Fecal bacteria	Swimmable		F: 0 to <20%
Harmful algal blooms			

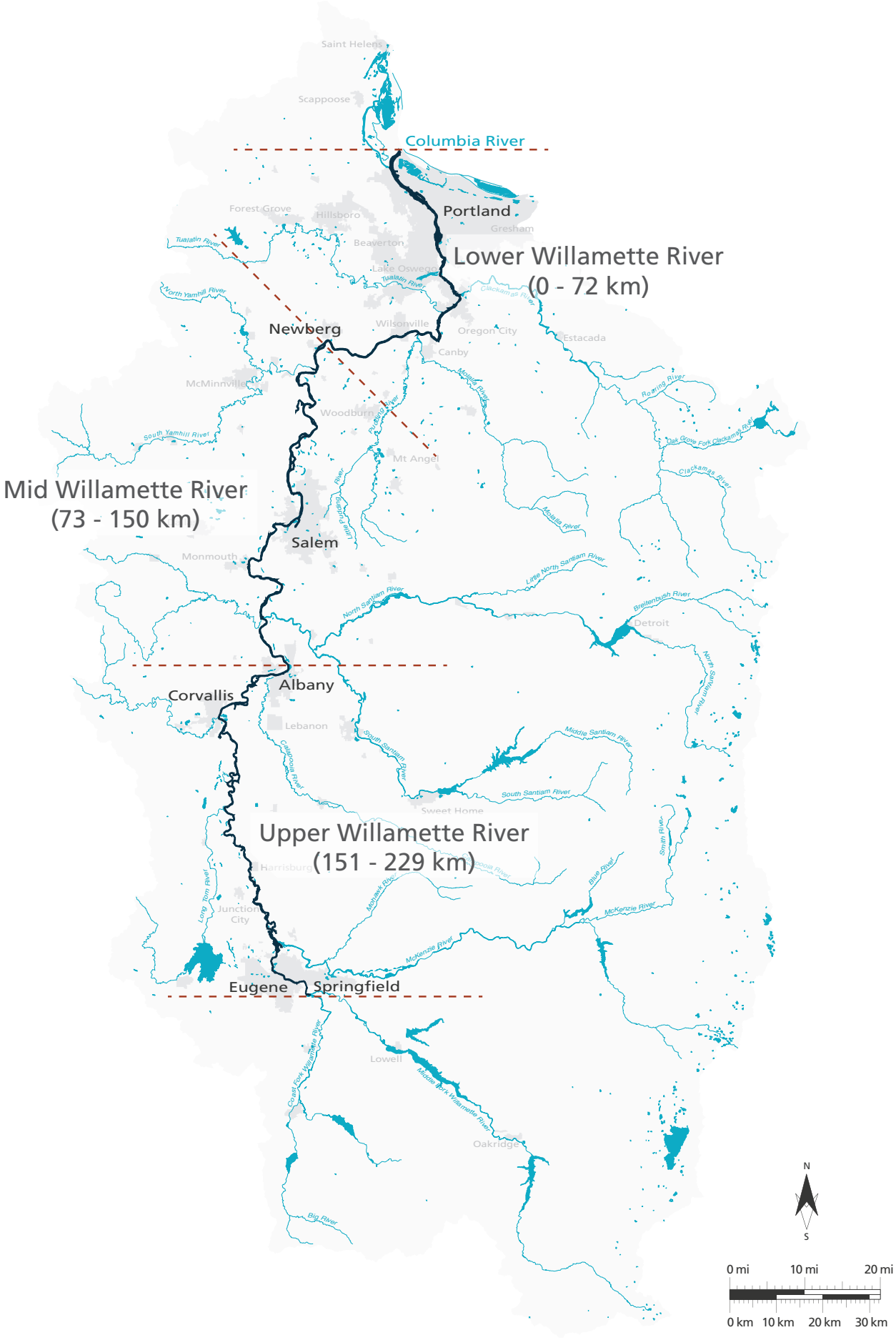


Figure 1-1. *The Willamette River and watershed with Lower, Mid, and Upper Willamette River Report Card regions.*

2 Category Fish and Wildlife

2.1 Value: Biodiversity

Indicator
Native Fish

Fish assemblages are an important component of aquatic ecosystems of the Willamette River. Fish assemblages are recognized as sensitive indicators of habitat degradation, environmental contamination, and overall ecosystem productivity. Of the 35 native fish species in the Willamette River basin, more than one-fifth (7 species) are listed by either the federal or state government as threatened, endangered, or sensitive.

Data source and expert advice

Data and expert advice were sourced from Professor Stan Gregory from the Department of Fisheries and Wildlife at Oregon State University.

Each data point consists of native species counts from four 200 m electrofishing runs by boat and four backpack electrofishing samples (from mainstem only; not including sloughs) within a 1 km slice of the Willamette River, as represented in the SLICES Framework[1] (see Appendix II).

Calculation method

Native fish species richness was calculated as the number of native species captured in a 1 km slice, as a ratio of the total number of native species captured in the respective report card region (Lower, Mid, Upper) (Figure 2-1). All ratios in a report card region were averaged and converted into a percentage score for that reach.

- A total of 32 data points (each representing one slice) from 2011 to 2013 were averaged for the Lower Willamette River.
- A total of 34 data points from 2011 to 2013 were averaged for the Mid Willamette River.
- A total of 44 data points from 2011 to 2013 were averaged for the Upper Willamette River.

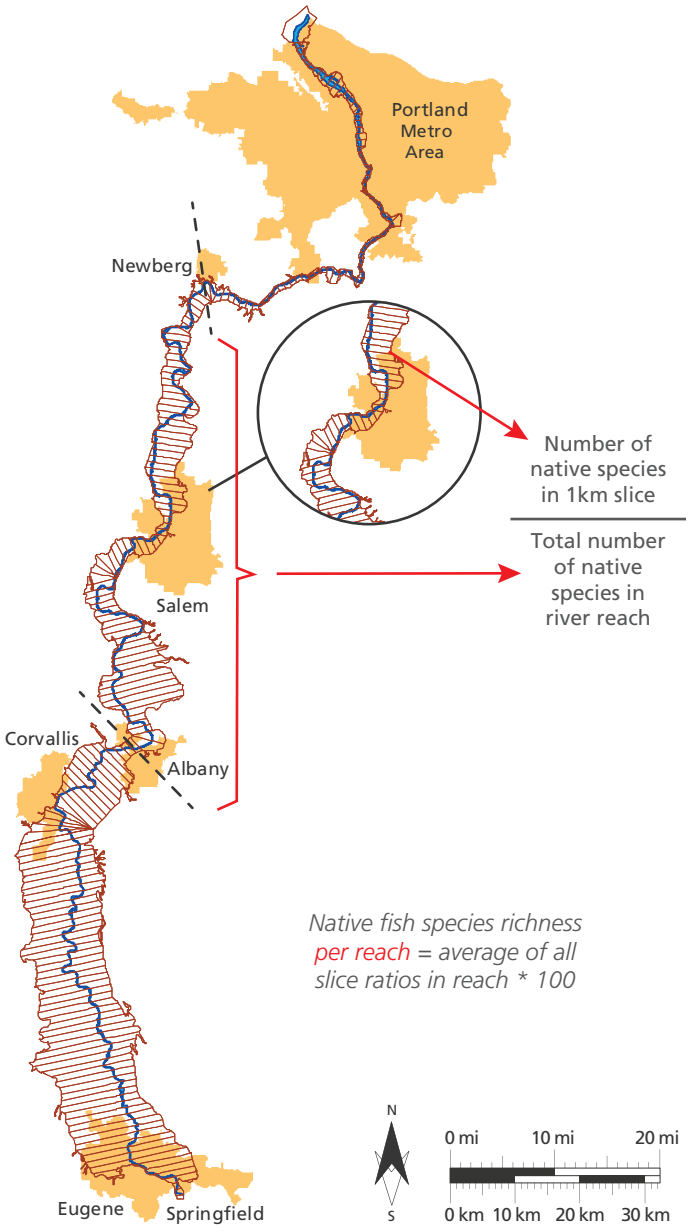


Figure 2-1. *Graphical representation of approach used to calculate the native fish species richness indicator.*

Result

- Lower Willamette River = 34%
- Mid Willamette River = 58%
- Upper Willamette River = 66%

1 http://ise.uoregon.edu/slices/main.html

Indicator
Non-native Fish

Non-native, invasive or introduced species can outcompete native fish species for food and habitat resulting in a loss of biodiversity, impacts to the food web and loss of economic income. The Willamette River Basin contains 32 non-native or introduced species. Almost half the total list of 67 native and non-native fish species in the Willamette River Basin is made up of non-native species.

Data source and expert advice

Data and expert advice were sourced from Professor Stan Gregory from the Department of Fisheries and Wildlife at Oregon State University. Data is based on native and non-native species counts from four 200 m boat electrofishing runs by boat and four backpack electrofishing samples (from main stem only; not including sloughs) within a 1 km slice of the Willamette River, as represented in the SLICES Framework[2] (see Appendix II).

Calculation method

The non-native fish indicator was calculated as a ratio of the total number of native and non-native species captured in the same 1 km river slice. The ratio of non-native to native species for all slices in each region (Lower, Mid, Upper) were averaged and then converted into a percentage. The greater percentage of non-native fish species represents a poorer score, hence values were subtracted from 100% for reporting purposes (Figure 2-2).

- A total of 32 data points (each representing one slice) from 2011 to 2013 were averaged for the Lower Willamette River. The average percentage of non-native fish species found for this report card region was 22%.
- A total of 34 data points from 2011 to 2013 were averaged for the Mid Willamette River. The average percentage of non-native fish species found for this report card region was 23%.
- A total of 44 data points from 2011 to 2013 were averaged for the Upper Willamette River. The average percentage of non-native fish species found for this report card region was 14%.

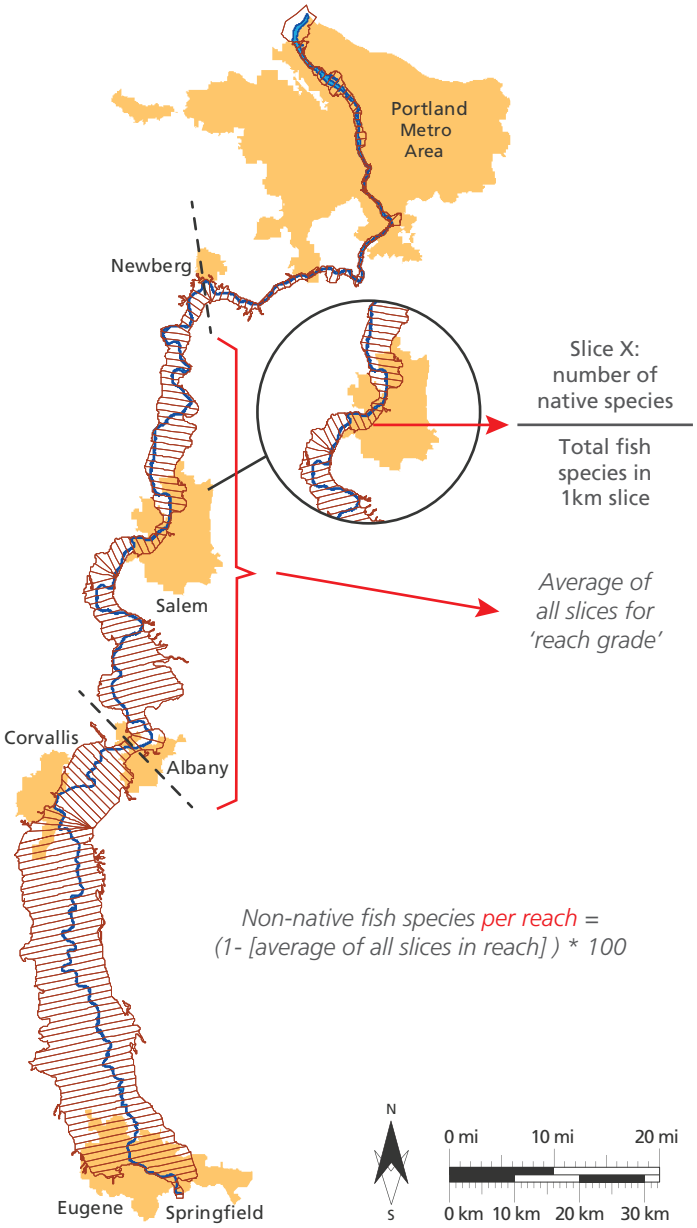


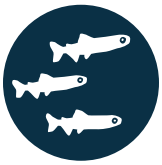
Figure 2-2. *Graphical representation of approach used to calculate the non-native fish species indicator.*

Result

- Lower Willamette River = 78%
- Mid Willamette River = 77%
- Upper Willamette River = 86%

2 http://ise.uoregon.edu/slices/main.html

2.2 Value: Iconic Native Species



Indicator
Juvenile Chinook

Spring Chinook (*Oncorhynchus tshawytscha*) are an iconic species in the Willamette River Basin and are listed as threatened under the U.S. Endangered Species Act. The loss of many miles of complex channels and floodplain habitat in the Willamette River, dams, which create barriers and alter flow downstream, and warmer water from loss of riparian shade and reduced snow pack, have impacted Chinook salmon migration, reproductive success, and juvenile rearing.

Data source and expert advice

Data and expert advice were sourced from Kelly Moore at the Oregon Department of Fisheries and Wildlife and Chris Prescott from the City of Portland's Science, Fish and Wildlife Program.

Juvenile spring Chinook salmon were counted per setting of a seine net at multiple locations along the main stem of the Willamette River. Seine nets are set in nearshore riffle/pool habitats typically used by migrating and rearing juveniles. Each capture event, or seine haul, samples about 200 square meters. Data were collected during the months of May, June, and July of 2013.

Calculation method

The score for juvenile Chinook is the percentage of seine nets cast that captured at least 20 juvenile Chinook.

- 5 of 181 seines in the Lower Willamette River had juvenile Chinook occupancy ≥ 20 in 2013.
- 19 of 22 seines in the Mid Willamette River had juvenile Chinook occupancy ≥ 20 in 2013.
- 24 of 37 seines in the Upper Willamette River had juvenile Chinook occupancy ≥ 20 in 2013.

Result

- Lower Willamette River = 3%
- Mid Willamette River = 86%
- Upper Willamette River = 65%

Indicator
Bald Eagle

Bald Eagle (*Haliaeetus leucocephalus*) are an iconic species not only in the Willamette River system but across the United States. Bald eagles are listed as a species of least concern by the Endangered Species Act and their population is rising throughout the U.S. as well as in the Willamette River Basin. Bald eagles have almost tripled in numbers in the southern portion of the Willamette Valley in the past nine years.

Data source and expert advice

Data and expert advice were sourced from Jimmy Kagan and Lindsey Wise at the Oregon Biodiversity Information Center, Institute for Natural Resources, at Portland State University.

Since nesting data are no longer being systematically collected due to the delisting of bald eagles in 2007, observations of groups of eagles during breeding season were used as an indicator of breeding activity. Non-wintering observations of bald eagles (sourced from *eBird*) over the last five years (2010–2014) were used to assess this species within each report card reach of the Willamette River. Areas occupied by groups of eagles over multiple years were weighted more heavily than those observed for only a single year.

Calculation method

The calculation method was based on the number of 1 km slices (as per the SLICES program) that contained one or more observations of groups of eagles (*eBird* count > 1) in non-winter months (March through October) in the past five years (Table 2-1). Scores ranging from 60-100 reflect the number of years of observations as per Table 2-2.

The equation on the following page was used to calculate scores per report card region of the Willamette River.

Result

- Lower Willamette River = 76%
- Mid Willamette River = 74%
- Upper Willamette River = 86%

3 www.ebird.org

$$\text{Reach Score} = \frac{(\#\text{slices with} \geq 3 \text{ obs.}* 100) + (\#\text{slices with } 2 \text{ obs.}* 80) + (\#\text{slices with } 1 \text{ obs.}* 60)}{\#\text{ Slices with observations } *100} = 100$$

Table 2-1. *Number of 1 km slices where groups of eagles were observed in non-winter months over past five years in the Willamette River. Source:* ebird.org.

Report Card region	Number of slices with ≥ three years of observations	Number of slices with two years of observations	Number of slices with one year of observations
Lower Willamette River	2	6	7
Mid Willamette River	5	3	10
Upper Willamette River	5	5	7

Table 2-2. *Scores assigned to the number of annual eagle observations.*

Number of observations in past five years per 1 km slice	Assigned score
Three or more annual observations	100
Two annual observations	80
One annual observation	60

3 Category Water Quality

3.1 Value: Clean Water

Indicator
Oregon Water Quality Index

Protecting the quality of water in the Willamette River benefits a multitude of uses such as drinking water, fish habitat, recreation and irrigation.

Data source and expert advice

Data and expert advice were sourced from Michael Mulvey from the Oregon Department of Environmental Quality (DEQ).

The Oregon Water Quality Index (OWQI) is a single number that integrates measurements of eight water quality parameters: temperature, dissolved oxygen, biochemical oxygen demand, pH, ammonia+nitrate nitrogen, total phosphorus, total solids, and *Escherichia coli* (*E. coli*) bacteria. (Note that temperature data used in the OWQI are based on a single measurement taken at the time the water chemistry sample is collected and are not the same as the continuously measured temperature data used in the report card temperature indicator described in Section 3.1.3.) The purpose of the OWQI is to provide a simple and concise method for expressing the overall ambient water quality of rivers for general recreational use, including fishing and swimming[4].

The OWQI is calculated in two steps by DEQ. The eight water quality parameters have different units of measurement, so each parameter's raw score must first be converted into a unitless sub-index value. These values range from 10 (worst) to 100 (ideal) depending on that parameter's contribution to water quality condition. The sub-indices for the individual parameters are then combined to give a single water quality index value ranging from 10 to 100. The formula used to combine sub-indices allows the most impacted parameter to impart the greatest influence on the water quality index. This method acknowledges that different water quality parameters will pose differing significance to overall water quality at different times and locations. The formula is sensitive to changing conditions and to significant impacts on water quality.

Calculation method

This report card used the three-year average of the seasonal mean minimum OWQI score (i.e. seasonal average poorest water quality score) for two seasons: low flow summer months (June through September), and higher flow fall, winter, spring (October through May). Samples were collected from a network of nine sites (Table 3-3) monitored approximately 18 times in water years 2012 to 2014 (October 1, 2011 to September 30, 2014). Averaging three years of OWQI scores reduces the variability that may be present in the annual site scores while still providing an overall assessment of water quality in recent years.

The OWQI score benchmarks (Table 3-1) required transformation into a range of 0-100% for compatibility with the report card scoring system as per the relationship depicted in Figure 3-1.

Conversions between the OWQI scoring benchmarks and the 0-100% report card grading system are shown in Table 3-2. The average OWQI score for each report card region (Lower, Mid, Upper) was transformed into the 0-100% report card score using the conversion equations outlined in Table 3-2. The three year OWQI site scores, report card grades, and report card region averages are presented in Table 3-3.

Result

- Lower Willamette River = 58%
- Mid Willamette River = 77%
- Upper Willamette River = 81%

4 www.deq.state.or.us/lab/wqm/wqimain.htm

Table 3-1. *Oregon water quality index benchmarks and descriptions.*

Condition	OWQI score benchmarks	Description
Very good	90-100	Expectation for healthy waters are almost always met.
Good	85-89	Expectation for healthy waters are frequently met.
Fair	80-84	Expectation for healthy waters are occasionally met.
Poor	60-79	Expectation for healthy waters are frequently not met.
Very poor	10-59	Expectation for healthy waters are rarely met.

Table 3-2. *OWQI scoring benchmark cut-offs and equations for conversion to report card scoring system.*

Condition	OWQI scoring benchmarks	Report card scoring system	Conversion/ Slope equation
Very good	90-100	>80-100%	y=2x-100
Good	85-89	>60-80%	y=4x-280
Fair	80-84	>40-60%	y=4x-280
Poor	60-79	>20-40%	y=x-40
Very poor	10-59	0-20%	y=0.4x-4

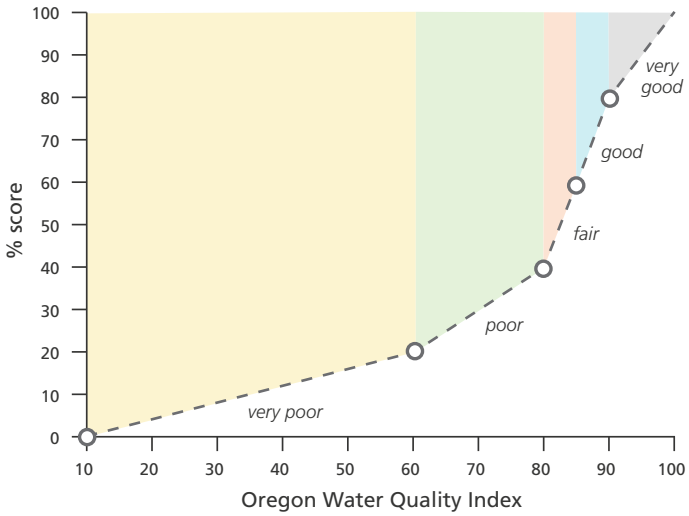


Figure 3-1. *Relationship between Oregon Water Quality Index and report card scoring system.*

Table 3-3. *Water quality monitoring stations and scores.*

Willamette Report Card region	DEQ station number	Station location	Three-year average OWQI score 2012-2014	Report Card score (%)	Average Report Card score (%)
Lower Willamette River	10332	Portland, St Johns Bridge	81	44%	58%
	10611	Portland, Hawthorne Bridge	83	53%	
	10339	Canby Ferry	89	77%	
Mid Willamette River	10344	Wheatland Ferry	89	75%	77%
	10555	Salem	90	79%	
Upper Willamette River	10350	Albany	88	75%	81%
	10352	Corvallis	90	80%	
	10355	Harrisburg	92	84%	
	10359	Springfield	93	85%	

Indicator
Toxics

Toxic pollutants have been identified in surface water, groundwater, sediments and fish in the Willamette River. These include legacy and emerging pollutants. Legacy pollutants typically refer to a group of chemicals now banned from use (at least in the U.S.), but due to their chemical persistence, remain in the environment and tend to accumulate in aquatic organisms. This broad group includes such familiar pollutants as chlorinated pesticides like DDT, polychlorinated biphenyls (PCBs), and dioxins and furans.

Data source and expert advice

Data and expert advice were sourced from Michael Mulvey at the Oregon Department of Environmental Quality (DEQ).

Three data sources, which are listed as footnotes to Table 3-5, were used in the toxics indicator:

- DEQ Toxics Monitoring Program. This is data source 'A' in Table 3-5. In 2008, the DEQ Laboratory implemented a statewide monitoring program to gather data about toxic substances in water, fish, and sediment samples. Seven of the toxics monitoring sites used in the statewide program are located within the area covered by the report card. (Table 3-4). These sites were sampled six times between 2008 and 2010. Water samples were analyzed for 164 contaminants, of which 31 were detected in the Willamette Basin and have either state criteria, recommended criteria, or a benchmark for rivers related to protecting aquatic life and human health. Data for combustion by-products, current use pesticides, and most priority pollutant metals come from this study. Mercury, PCBs, and legacy pesticides were not part of this study.
- DEQ Willamette Mercury Study 2010-2011. This is data source 'B' in Table 3-5. Mercury data used in the report card are from water samples collected four times at 16 sites in the Willamette Basin including eight sites on the Willamette River in 2010-2011 (Table 3-6). Water, sediment, and fish samples were also collected.
- Portland Harbor Remedial Investigation and Feasibility Study. This is data source 'C' in Table 3-5. The lower portion of the Willamette River in Portland was designated a Superfund site under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in 2000 because of heavily contaminated sediment from industrial pollution during the early 20th century. Contaminants of concern include PCBs, DDT, and other legacy contaminants, among many others. The Lower Willamette Group[5] conducted extensive water monitoring for a wide range of contaminants under varying flow conditions during 2004 to 2007 as part of a remediation investigation and feasibility study. The data include both transect samples collected during representative flow conditions as well as many other samples collected to map out the extent and severity of contamination. For the purposes of this report card, we used only transect sample data for DDT, DDD, DDE, PCBs, lindane, and dieldrin to determine the maximum contaminant level while we used all approximately 300 samples to determine percent of detection. Insufficient recent data were available to similarly assess the Mid and Upper Willamette River compared to the Lower Willamette River. As a result, the two upstream report card reaches receive an 'incomplete' sub score for these particular contaminants.

***Table 3-4.** DEQ Toxics monitoring stations in the Willamette River used for report card. Sample collection took place in 2008-2010.*

DEQ Station ID	Site name	Willamette River Report Card Region
10611	Willamette River at Hawthorne Bridge (Portland)	Lower
10339	Willamette River at Canby Ferry	Lower
10344	Willamette River at Wheatland Ferry	Mid
10555	Willamette River at Marion Street (Salem)	Mid
10350	Willamette River at Eastbound Hwy 20 bridge (Albany)	Upper
10352	Willamette River at Old Hwy 34 Bridge (Corvallis)	Upper
10355	Willamette River at Hwy 99E (Harrisburg)	Upper

5 www.lwgportlandharbor.org
www.portlandharborcag.info/node/68

Table 3-5. *List of toxic contaminants used in calculation of toxics indicator.*

Analyte (units)	Criterion/Benchmark *	Criterion/ Benchmark source	Data sources **
Combustion by-products (ng/L)			
Benzo(b)fluoranthene	1.3	**1**	A
Chrysene	1.3	**1**	A
Fluoranthene	14,000	**1**	A
Indeno(1,2,3-cd)pyrene	1.3	**1**	A
Pyrene	290,000	**1**	A
Current use pesticides (ng/L)			
Atrazine	1,000	**2**	A
Carbaryl	500	**3**	A
Carbofuran	750	**3**	A
Diuron	2,400	**4**	A
Hexazinone	7,000	**4**	A
Imidacloprid	1,050	**3**	A
Metolachlor	1,000	**3**	A
Metribuzin	8,700	**4**	A
Norflurazon	9,700	**4**	A
Oxamyl	27,000	**3**	A
Pentachlorophenol	150	**1**	A
Prometon	98,000	**4**	A
Propiconazole	21,000	**4**	A
Pyraclostrobin	1,500	**4**	A
Simazine	2,240	**4**	A
2,4-D	100	**1**	A
Dicamba	61	**4**	A
Triclopyr	100	**4**	A
Priority metals (µg/L) total recoverable			
Arsenic	2.1	**1**	A
Barium	1,000	**1**	A
Chromium	11	**5**	A
Copper	Based on water hardness	**6**	A
Iron	1000	**7**	A
Lead	Based on water hardness	**6**	A
Mercury	0.012	**6**	B
Nickel	Based on water hardness	**5**	A
Silver	Based on water hardness	**5**	A
Zinc	Based on water hardness	**5**	A
PCBs (ug/L) – Lower Willamette River only			
Total PCBs	0.0000064	**1**	C
Legacy pesticides and PCBs (ug/L) – Lower Willamette River only			
4,4 DDD	0.000031	**1**	C
4,4 DDE	0.000022	**1**	C
4,4 DDT	0.000022	**1**	C
Dieldrin	0.0000053	**1**	C
Lindane (gamma-Hexachlorocyclohexane, BHC gamma)	0.08	**3**	C

Criterion/Benchmark* (for Table 3-5)

1. Table 40 - Human Health Water Quality Criteria for Toxic Pollutants. www.deq.state.or.us/wq/standards/docs/tables303140.pdf.
2. Oregon and other Region 10 States are currently evaluating the EPA's recommended Atrazine benchmark of 1 ng/L. Until then, Oregon will continue to use 1,000 ng/L to evaluate Atrazine until a regionally uniform approach has been adopted.
3. EPA office of pesticide programs, invertebrate, chronic. www.epa.gov/oppefed1/ecorisk_ders/aquatic_life_benchmark.htm.
4. EPA office of pesticide programs, non vascular plants, acute. www.epa.gov/oppefed1/ecorisk_ders/aquatic_life_benchmark.htm.
5. EPA office of pesticide program, vascular plants, acute. www.epa.gov/oppefed1/ecorisk_ders/aquatic_life_benchmark.htm.
6. Table 30 - Aquatic Life Water Quality Criteria, Hardness based. www.deq.state.or.us/wq/standards/docs/tables303140.pdf.
7. Table 30 - Aquatic Life Water Quality Criteria, Chronic criterion. www.deq.state.or.us/wq/standards/docs/tables303140.pdf

Data Sources**

A: DEQ Toxics Monitoring Program, Willamette Basin, 2008-2010, see Table 3-3 for sites. www.deq.state.or.us/lab/wqm/toxics.htm.

B: DEQ Willamette Basin Mercury Study, 2010-2011, see Table 3-4 for sites.

C: Lower Willamette Group, August 29, 2011, Portland Harbor RI/FS Remedial Investigation Report, samples collected in 2004-2007, Transect water samples in high flow, low flow and storm influenced flow conditions. See Lower Willamette Group report for sites information. http://lwgportlandharbor.org/remedial/index.htm

***Table 3-6.** DEQ Mercury monitoring stations in the Willamette River used for the report card. Sample collection took place in 2010-2011.*

DEQ Station ID	Site name	Willamette River Report Card Region
10821	Willamette River at St. John's Bridge (Portland)	Lower
34198	Willamette River at Jon Storm Park boat dock (Oregon City)	Lower
10833	Willamette River 0.5 miles downstream of Tualatin River	Lower
26339	Willamette River upstream of Newberg Bridge at Rogers Landing	Mid
10344	Willamette River at Wheatland Ferry	Mid
31731	Willamette River at Wallace Marine Park boat ramp (Salem)	Mid
10355	Willamette River at Hwy 99E (Harrisburg)	Upper
29044	Willamette River at Greenway bike bridge (Eugene)	Upper

Calculation method

The toxics indicator is based on both the percentage of toxic contaminants (combustion by-products, current use pesticides, PCBs, legacy pesticides and metals) detected in the Willamette River and the relative level of toxicity of these contaminants based upon known criterion or benchmarks (referred to as the "impact value ratio"). The impact value ratio is the highest concentration of each contaminant detected in a report card reach divided by its respective human and aquatic health criterion or benchmark value. Therefore, if the concentration of a contaminant is greater than its respective criterion or benchmark, it will have an impact value ratio >1. Conversely, if a contaminant has a concentration less than its respective criterion or benchmark, it will have an impact ratio value of <1.

The adopted criterion or benchmark used to calculate the impact value ratio was either the lowest of the state numeric criterion, the EPA Office of Pesticides recommended benchmark, or other benchmark (outlined at the end of Table 3-5). A slightly different approach was required for scoring metals as they do also occur naturally in the environment in addition to what is a contributed by human activity. Hence for metals, only the percent of detections over their respective lowest criteria or benchmark within a report card region were used.

The frequency of detection and the Impact Value Ratios were sub scored as 1, 2, or 3; and 1, 2, 3 or 4 (respectively) using the scheme described in Figure 3-2. The toxics score is the sum of the two sub scores. A toxics score of 2 is "Very Good" and indicates that toxic contaminants are infrequently found, and only at low concentrations. A value of 7 is "Very Poor" and indicates that toxic contaminants are frequently found, and at high concentrations.

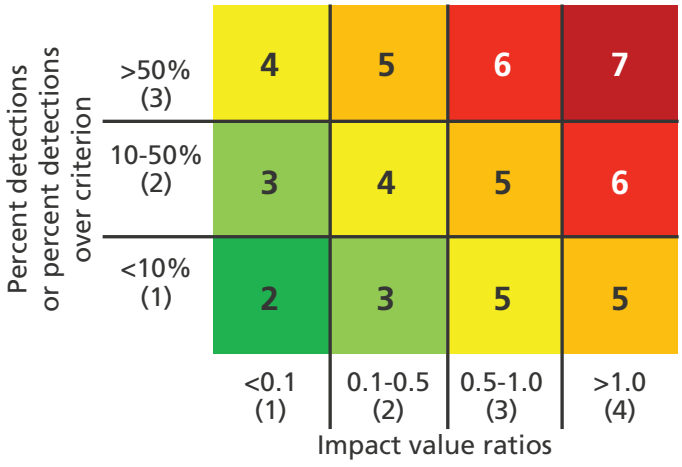


***Figure 3-2.** Toxics scoring matrix.*

Numeric toxics scores were converted to a 0 to 100% scale for compatibility with the report card scoring system as per the relationship depicted in Figure 3-3. Contaminant scores were averaged by category, and category scores averaged, to obtain the three report card reach scores. All contaminant scores were averaged for the Willamette River score.

Result

- Lower Willamette River = 48%
- Mid Willamette River = 83%*
- Upper Willamette River = 87%*

* Insufficient data for legacy pesticides and PCBs in the Mid and Upper Willamette River reaches.

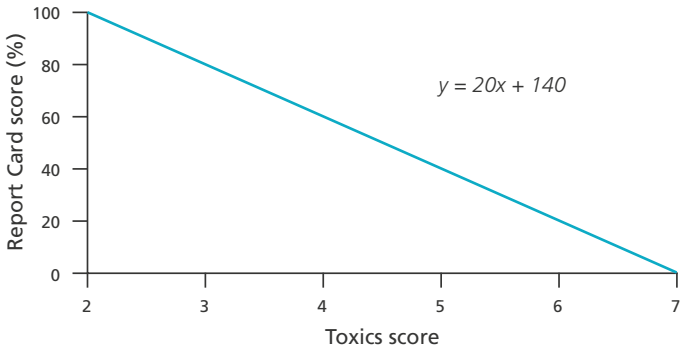


Figure 3-3. *Relationship between toxics indicator score and report card scoring system.*

Indicator
Temperature

Water temperature in the Willamette River Basin has been rising over the past decade due to drought, smaller snow pack, and changed flows. The trend of increased water temperature threatens species of fish in the basin such as Chinook salmon and steelhead trout.

Salmon and trout require water temperatures between 8 - 15°C for optimal survival and reproduction. As temperatures rise they are more susceptible to parasites and disease and spawning success declines. High temperatures in the Willamette led to fish die-offs in the Willamette in the summer of 2015.

Data source and expert advice

Expert advice was sourced from Michael Mulvey at the Oregon Department of Environmental Quality (DEQ), using data collected from U.S. Geological Survey (USGS) flow gage station data loggers recording temperature in 15 minute intervals. There are six stations on the Willamette River evaluated in this assessment:

- Lower Willamette River: USGS Station 14211720 (Willamette R. at Portland).
- Mid Willamette River: USGS Stations 14197900 (Willamette R. at Newberg); 14192015 (Willamette R. at Keizer).
- Upper Willamette River: USGS Stations 14174000 (Willamette R. at Albany), 14166000 (Willamette R. Harrisburg); 14158100 (Willamette R. at Owosso Bridge at Eugene).

Calculation method

Analysis of river temperature and the environmental implications was based on state temperature standards for the protection of threatened salmon and steelhead in the Willamette River. The 7-day average maximum temperature (7DAM) was calculated for the summer (June 21, 2014 to September 22, 2014—when water temperatures are the warmest for the year) and compared to the applicable water quality standard. The temperature criteria are different for the three major reaches of the main stem Willamette River. The standards for each reach depend upon the life histories of designated fish species at that location and time of year. The two most downstream stations in Portland and Newberg are designated as "salmon and steelhead migration corridors" with a 20°C 7DAM criterion and the other stations are located in "salmon and trout rearing and migration designated fish use areas" with an 18°C 7DAM criterion. As a

result, the metric for temperature in this report card is warmer in the lower river and less restrictive than the metric used for the middle and upper river.

The Oregon temperature standards are described in the Oregon Administrative Rules, OAR 340-041-0028[6]. The report card score is the percent of 7-day average maximum temperatures meeting the temperature standards for each reach during the summer (Figure 3-4).

Result

- Lower Willamette River = 22%
- Mid Willamette River = 17%
- Upper Willamette River = 23%

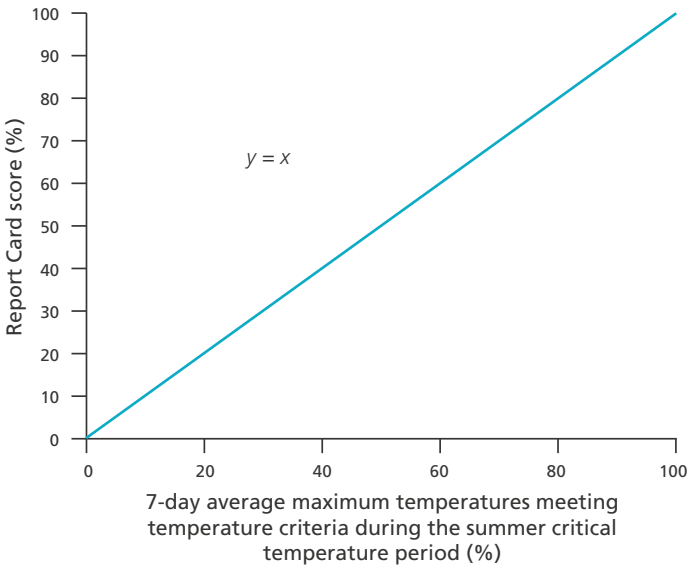


Figure 3-4. *Relationship between percent of 7DAM temperature meeting the criterion and report card scoring system.*

Table 3-7. *Temperature monitoring stations in the Willamette River and number of days the 7-day average maximum temperature (7DAM) criterion is exceeded during the summer of 2014. Percent of 7DAM meeting criteria based on 94 days from June 21 to September 22, 2014.*

Willamette Report Card region	USGS station number	Station location	Summer criterion °C 7DAM	Summer 7DAM meeting criterion	Report card region Average 7DAM meeting criterion	Percent of 7DAM meeting criterion	Report Card score (%)
Lower Willamette River	14211720	Portland	20	21	21	22%	22%
Mid Willamette River	14197900	Newberg	20	28	16	17%	17%
	14192015	Keizer	18	3			
Upper Willamette River	14174000	Albany	18	12	22	23%	23%
	14166000	Harrisburg	18	31			
	14158100	Eugene	18	23			

6 http://arcweb.sos.state.or.us/pages/rules/oars_300/oar_340/340_041.html

4 Category Habitat

4.1 Value: Healthy Riparian Areas

Indicator
Floodplain Forest

Floodplain forests are deciduous, bottomland forest communities that occupy low-lying lands subject to periodic flooding and sediment deposition. These riparian forests create habitat for hundreds of migratory land birds, absorb and filter floodwaters, and provide off-channel refuge for fish during high flows. The extent of floodplain forest throughout the Willamette River Basin has declined due to urban and agricultural development and reduced river flows.

Data source and expert advice

Data were sourced from the SLICES Framework[7,8], which uses distinct spatial units for tracking change in the Willamette River floodplain (see Appendix II). The first of these units are 1 km wide slices drawn at right angles to the floodplain (see Figure 2-1). The second of these units are 100 m subdivisions of the original 1 km slices, with ten 100 m slices in each 1 km slice[9].

Expert advice was sourced from Professor David Hulse from the University of Oregon.

Calculation method

The extent of floodplain forest was calculated as the area of 2010 floodplain forest within individual 100 m slices (slice numbers 101 – 22907 from the SLICES Framework) as a percentage of the 2050 Conservation Target for floodplain forest in respective slices[7]. The average of floodplain forest area in individual 100 m slices per report card region (Lower, Mid, Upper) was used as the report card score. A higher score indicates conditions that are closer to the 2050 Conservation Target.

The 2050 Conservation Targets for floodplain forest in each report card region of the Willamette River are:

- Lower Willamette River = 4,564 acres (slices 101 – 7210)
- Mid Willamette River = 29,812 acres (slices 7301 – 15010)
- Upper Willamette River = 25,265 acres (slices 15101 – 22907)

The last two digits in the four- or five-digit slice number represent the 100 m slice number (1–10) within the 1 km slice, which is represented by the first two or three digits. For example slice 101 is the first 100 m slice within the first 1 km slice of the Willamette River.

Result

- Lower Willamette River = 58%
- Mid Willamette River = 55%
- Upper Willamette River = 64%

7 http://ise.uoregon.edu/slices/main.html
8 Willamette River Basin:Trajectories of environmental and ecological change by The Pacific Northwest Ecosystem Research Consortium-1st OSU Press ed.p.cm.
9 http://ise.uoregon.edu/slices/data/metadata_s100fm_3.pdf

4.2 In-Stream Habitat

Indicator
Channel Complexity

The more complex a streams channel is (i.e. the existence of logs, many channels and pools, and a winding path), the better habitat it provides for fish and wildlife. Streams are often straightened and simplified when they become urbanized and this along with reduced peak flows often decreases channel complexity, as it has in the Willamette River Basin.

Data source and expert advice

Data were sourced from the SLICES Framework[10,11], which makes use of distinct spatial units for tracking change in the Willamette River floodplain (see Appendix II). The first of these units are 1 km long slices drawn at right angles to the floodplain. The second of these units are 100 m subdivisions of the original 1 km slices, with ten 100 m slices in each 1 km slice[12].

Expert advice was sourced from Professor David Hulse from the University of Oregon.

Calculation method

The channel complexity indicator was calculated as length of channel in 2010 of individual 100 m slices as a percentage of the 2050 Conservation Target channel length[11]. The average of channel complexity in individual 100 m slices per report card region (Lower, Mid, Upper) was used as the report card score. A higher score indicates conditions that are closer to the 2050 Conservation Target.

The 2050 Conservation Targets for channel length in each report card region of the Willamette River are:

- Lower Willamette River = 97,834 m (slices 101 – 7210)
- Mid Willamette River = 303,563 m (slices 7301 – 15010)
- Upper Willamette River = 376,918 m (slices 15101 – 22907)

The last two digits in the four- or five-digit slice number represent the 100 m slice number (1-10) within the 1 km slice, which is represented by the first two or three digits. For example, slice 101 is the first 100 m slice within the first 1 km slice of the Willamette River.

The Lower Willamette River was not evaluated for this indicator. The Lower Willamette represents a basaltic trench that has not historically displayed the extent of channel complexity found in the Mid and Upper reaches of the river. Hence the 2050 conservation target for channel complexity in this reach is almost the same as is currently found, which would result in a deceptively high score for this indicator in the lower river. As a result, the stakeholder advisory group felt this indicator should be designated "not applicable" in the lower Willamette.

Result

- Lower Willamette River = N/A
- Mid Willamette River = 76%
- Upper Willamette River = 80%

7 http://ise.uoregon.edu/slices/main.html
8 Willamette River Basin:Trajectories of environmental and ecological change by The Pacific Northwest Ecosystem Research Consortium-1st OSU Press ed.p.cm.
9 http://ise.uoregon.edu/slices/data/metadata_s100fm_3.pdf

5 Category Flows

5.1 Value: Flow Regime

Indicator
Flow Targets

Biological Opinion (BiOp) Flow Targets are river flow targets that if met would create the best conditions for salmon and trout recovery throughout the Willamette River System. These targets were part of salmon recovery recommendations outlined in a 2008 National Oceanic and Atmospheric Administration (NOAA) Fisheries report. BiOP flow targets support fish migration as well as reduce the likelihood of disease outbreaks.

Data source and expert advice

Daily mean stream flow data from the Willamette River at Salem (USGS station 14191000) were obtained from the USGS National Water Information System website[13]. Expert advice was sourced from Stewart Rounds at the Oregon Water Science Center (U.S. Geological Survey) and Stephanie Burchfield (NOAA Fisheries, West Coast Region, Willamette Branch).

This indicator quantifies compliance with minimum stream flow targets as specified by the NOAA Fisheries Willamette Biological Opinion (BiOp) (2008)[14] for spring Chinook and winter steelhead (Table 5-1). The BiOp spring stream flow targets were developed to support juvenile fish downstream migration and to reduce the likelihood of disease outbreaks, based on flow and temperature relationships. Compliance is calculated for the Willamette River at the City of Salem.

The U.S. Army Corps of Engineers (USACE) manages flow in the Willamette River via 13 dams and reservoirs that are located on major tributaries to the Willamette River. Water levels in these reservoirs are at their lowest November through February, creating storage space needed to hold water during heavy rains. The Corps begins filling the reservoirs in February, with the goal of having them full for other purposes by mid-May. Flood damage reduction remains the dams' highest priority use, but stored water supports other uses, such as irrigation, water quality, fish and wildlife, and recreation. The Corps must balance the risks associated with multiple uses of water for Willamette Basin flow and storage, including the needs of Endangered Species Act-listed species.

The BiOp permits the USACE to reduce flow targets in water years that are determined to be less than "abundant" or "adequate." The Corps conducts an annual assessment in May of the available water stored in the Willamette Project reservoirs, and if estimated May water storage is less than that observed during 75% of the years between 1936 and 2001, then lower stream flow targets are set for that year. When available water conditions in May are either "insufficient" or "deficit," then these stream flow targets are pro-rated downward based on the available water and further a "deficit flow threshold" level specified in the BiOp (Table 5-1 Column 3). A deficit designation occurs when the runoff season is so low that the projected system storage by mid-May is less than 900,000 acre-feet. Under these

Table 5-1. *BiOp stream flow targets for the Willamette River at Salem.*

Time period	Stream flow target at Salem (cubic feet per second, 7-day average*)	Deficit flow target at Salem (cubic feet per second, 7-day average*)
April 1-15	17,800	15,000
April 16-30	17,800	15,000
May 1-31	15,000	15,000
June 1-15	13,000	11,000
June 16-30	8,700	5,500

* The 7-day average is defined as an average of the mean daily stream flow in cubic feet per second over the prior 7-day period (i.e. the 7-day average on a particular date is defined as the average of the daily mean stream flow for that date and the previous 6 days).

13 http://waterdata.usgs.gov/or/nwis/dv?site_no=14191000

14 Endangered Species Act Section 7(a)(2). Consultation. Biological Opinion & Magnuson-Stevens Fishery Conservation & Management Act. Essential Fish Habitat Consultation. Consultation on the "Willamette River Basin Flood Control Project". NOAA's National Marine Fisheries Service. Northwest Region. NOAA Fisheries Log Number: FINWR12000/02117 Date Issued: July 11, 2008.

circumstances, it may not be possible to meet the biological or congressionally minimum flow objectives.

For the purpose of simplifying this analysis, the BiOp flow targets listed in Table 5-1 Column 2 were used for the report card calculation regardless of the water-availability assessment.

Calculation method

The biological stream flow indicator is the percentage of time that the 7-day average stream flow at Salem in April through June 2013 was at least equal to the BiOp stream flow target level shown in Table 5-1 Column 2. This percentage was applied to all report card regions because most of the stream flow in the lower river is controlled by stream flows at or upstream of Salem (and the BiOp is only calculated for Salem).

Result

- Lower Willamette River = 58%
- Mid Willamette River = 58%
- Upper Willamette River = 58%

***Table 5-2.** BiOp stream flow targets and number of 7-day average stream flows at Salem greater than or equal to stream flow targets for the Willamette River at Salem.*

Time period	Stream flow target at Salem (cubic feet per second, 7-day average*)	Number of 7-day average stream flows at Salem ≥ stream flow target
April 1-15	17,800	9/15 days
April 16-30	17,800	13/15 days
May 1-31	15,000	23/31 days
June 1-15	13,000	8/15 days
June 16-30	8,700	0/15 days
Total of 7-day average stream flows ≥ stream flow target		53/91 days = 58%

* The 7-day average is defined as an average of the mean daily stream flow in cubic feet per second over the prior 7-day period (i.e. the 7-day average on a particular date is defined as the average of the daily mean stream flow for that date and the previous 6 days).

Indicator
Peak Flows

The flow regime throughout the Willamette River system is disrupted by 13 dams built to mitigate and control downstream flooding by reducing the magnitude of peak flood flows. Reduction in the magnitude and frequency of peak flows has altered ecological communities and lead to a variety of negative geomorphological consequences in the Willamette River.

Data source and expert advice

Daily mean streamflow data for the Willamette River at Salem (USGS station 14191000) and Albany (USGS Station 14174000) were obtained from the USGS National Water Information System website[16]. Expert advice was sourced from Stewart Rounds at the Oregon Water Science Center (U.S. Geological Survey), Kristel Fesler (City of Hillsboro), and Leslie Bach (The Nature Conservancy).

This indicator assesses the annual variation of peak flow at Salem and Albany, in comparison to calculated naturalized flows that would have occurred at these sites without reservoir regulation or irrigation demands. These flows are referred to as No Regulation No Irrigation (NRNI) flows and data are available from the U.S. Army Corps of Engineers (USACE) upon request. Estimates for the years 1928–2008 can be found online[15].

Calculation method

The peak flows indicator was calculated for the period encompassing the 10 most recent years of NRNI information currently available (1999–2008). Actual maximum flow as a percentage of maximum NRNI flow was calculated for each year, and averaged across the 10 years (Table 5-3).

As the natural peak flow indicator is meant to be indicative of flow modifications caused by upstream dam operations, the Albany score was applied to the Upper Willamette River and the Salem score to the Mid and Lower Willamette River report card regions.

Result

- Lower Willamette River = 76%
- Mid Willamette River = 76%
- Upper Willamette River = 73%

15 www.bpa.gov/power/streamflow/default.aspx
16 http://waterdata.usgs.gov/or/nwis/dv?site_no=14191000 and http://waterdata.usgs.gov/or/nwis/dv?site_no=14174000, respectively.

Table 5-3. *Actual annual maximum flow, as a ratio of the annual maximum NRNI flow, averaged for 10 years (1999-2008) at Salem and Albany.*

	USGS Station (14191000) Salem – Lower and Mid Willamette River			USGS Station (14174000) Albany – Upper Willamette River		
Year	Annual maximum flow (cfs)	Annual maximum NRNI flow (cfs)	Ratio (Actual:NRNI)	Annual maximum flow (cfs)	Annual maximum NRNI flow (cfs)	Ratio (Actual:NRNI)
1999	122,000	151,730	0.80	71,200	87,383	0.81
2000	89,300	109,188	0.82	59,800	80,984	0.74
2001	85,800	109,196	0.79	49,700	65,787	0.76
2002	86,100	96,344	0.89	52,900	58,327	0.91
2003	92,300	137,246	0.67	58,900	93,900	0.63
2004	86,500	126,279	0.68	45,000	67,237	0.67
2005	118,000	188,705	0.63	66,000	120,284	0.55
2006	139,000	228,451	0.61	85,200	147,006	0.58
2007	89,500	116,043	0.77	59,600	76,832	0.78
2008	83,900	94,507	0.89	51,700	56,844	0.91
Average (score)			**0.76 (76%)**			**0.73 (73%)**

6 Category
People and the River

6.1 Value: Fishable

Indicator
Tribal Fisheries

Native American tribes such as the Confederated Tribes of Grand Ronde and the Confederated Tribes of Warm Springs have enjoyed fish and wildlife resources throughout the Willamette River Basin for centuries and continue to do so today in many capacities.

Data source and expert advice

Information on allowable fish catch in the Willamette River for lamprey, steelhead and Chinook was sourced from the 2014 Oregon Sport Fishing Regulations[17]. Expert advice were sourced from Lawrence Schwabe from the Confederated Tribes of Grand Ronde and Kelly Warren from the Confederated Tribes of the Warm Springs.

Calculation method

The tribal fisheries indicator is based on whether the wild harvest fisheries were allowed in each report card reach of the river in the latest year (2014). Scores were assigned as follows:

- Harvest (non-adipose fin-clipped) allowed all year = 100%
- Wild harvest (non-adipose fin-clipped) seasonally restricted = 80%
- Hatchery harvest (adipose fin-clipped) allowed all year = 60%
- Hatchery harvest (adipose fin-clipped) seasonally restricted = 40%
- No harvest allowed = 0%
- No harvest exists due to lack of natural suitable habitat = NA

Result

- Lower Willamette River = 67%
- Mid Willamette River = 60%
- Upper Willamette River = 60%

Table 6-1. *Wildlife harvest of lamprey, steelhead and/or Chinook results for 2014.*

Willamette River Report Card Region	Lamprey	Steelhead	Chinook	Average
Lower Willamette River	80%	60%	60%	**67%**
Mid Willamette River	NA	60%	60%	**60%**
Upper Willamette River	NA	60%	60%	**60%**

Indicator
Fish Consumption Advisories

Industrial contaminants such as Polychlorinated Biphenyls (PCB's) and mercury (Hg) are present in many of the rivers and ecosystems of the Pacific Northwest. These contaminants are harmful to humans when ingested and often make their way into human diets through the consumption of resident fish caught in contaminated rivers. The Oregon Health Authority has published advisories for maximum fish consumption throughout the Willamette River Basin, advising humans to restrict their consumption of certain resident species of fish such as carp, bass and catfish.

17 2014 Oregon Sport Fishing Regulations. www.dfw.state.or.us/fish/docs/2014/Oregon_Sport_Fishing_Regs_v12-31-13.pdf
18 http://public.health.oregon.gov/HealthyEnvironments/Recreation/FishConsumption/Pages/fishadvisories.aspx

Data source and expert advice

Information and expert advice on fish consumption advisories was sourced from David Farrer and Rebecca Hillwig at the Oregon Health Authority (OHA)[18].

Calculation method

The fish consumption advisory scores for resident fish species were based on: i) if an advisory was present for the Willamette River, and ii) if the advisory recommended a number of meals per month for non-vulnerable human populations by OHA.

The Willamette River, as of January 31, 2015, had two OHA advisories relevant to the report card region, as outlined in Table 6-2. These included an advisory for mercury (Hg) in resident fish for the entire reporting region; and an advisory for polychlorinated biphenyls, dioxins, and/or certain pesticides (referenced as PCBs) in resident fish for Portland Harbor in the Lower Willamette River.

The fish consumption advisory indicator used only the most stringent meals per month guideline given for each report card region of the river. Hence, in the Lower Willamette River, the PCB advisory (one meal per month) overrides the Hg advisory (four meals per month). The score for this indicator was calculated as the most stringent number of meals recommended per month as a percentage of 30 days (one month) as shown in Table 6-3. If no OHA advisories were present a score of 100% applied.

Result

- Lower Willamette River = 3%
- Mid Willamette River = 13%
- Upper Willamette River = 13%

Table 6-2. *Fish consumption advisories in the Willamette River and guidelines on the maximum number of meals per month[19].*

			Meals per month	
Waterbody	**Contaminant**	**Affected fish species**	**Vulnerable population***	**Non-vulnerable population**
Portland Harbor – Lower Willamette River (from Sauvie Island south to the Freemont Bridge)	PCBs	All resident fish; avoid eating carp, bass and catfish	0	1
Willamette River mainstem (from its mouth on the Columbia River southward to Eugene)	Hg	All resident fish	1	4

*Vulnerable population includes children under age 6, women of childbearing age and people with thyroid or immune system problems.

Table 6-3. *Fish consumption advisories, guidelines for the maximum number of meals per month, and the scores used in report card calculations.*

Willamette River Report Card Region	Fish consumption advisories	Meals per month guideline (most stringent)	Percentage of days in one month	Report card region score
Lower Willamette River	PCB and Hg	1	3.3%	3%
Mid Willamette River	Hg	4	13.3%	13%
Upper Willamette River	Hg	4	13.3%	13%

19 http://public.health.oregon.gov/HealthyEnvironments/Recreation/FishConsumption/Pages/fishadvisories.aspx#willamette

6.2 Value: Swimmable

Indicator

Fecal Bacteria (*Escherichia coli*)

Escherichia coli (*E. coli*) are bacteria that indicate fecal contamination and potential human health risks. *E. coli* present in the Willamette River indicate the presence of fecal matter from birds, rodents, pets, livestock, humans and other warm-blooded animals.

Data source and expert advice

E. coli bacteria data were sourced from the DEQ Ambient River Water Quality Monitoring Network. Expert advice was sourced from Michael Mulvey at the Oregon Department of Environmental Quality (DEQ).

DEQ samples the Ambient River Water Quality Network for *E. coli* approximately 6 times per year at 9 sites in the Willamette River (Table 6-4). Data are from water year 2014 (October 1, 2013 to September 30, 2014).

***Table 6-4.** Fecal bacteria monitoring stations in the Willamette River.*

Willamette River Report Card Region	DEQ site number	Site name
Lower Willamette River	10332	Portland, St Johns Bridge
	10611	Portland, Hawthorne Bridge
	10339	Canby Ferry
Mid Willamette River	10555	Wheatland Ferry
	10344	Salem
Upper Willamette River	10350	Albany
	10352	Corvallis
	10355	Harrisburg
	10359	Springfield

Calculation method

The fecal bacteria indicator score is the percent of *E. coli* samples that meet Oregon's criterion for safe water contact recreation, specifically 406 *E. coli* per 100 milliliters single sample[20].

Result

- Lower Willamette River = 90%
- Mid Willamette River = 100%
- Upper Willamette River = 100%

***Table 6-5.** Percent of samples passing the safe contact recreation criteria for E. coli in each report card region of the river in water year 2014 and associated report card scores.*

Willamette River Report Card Region	Percent passing safe contact recreation criterion	Report Card score
Lower Willamette River	90%	90%
Mid Willamette River	100%	100%
Upper Willamette River	100%	100%

Indicator

Harmful Algal Blooms

Algae are microscopic organisms that grow naturally in oceans and freshwaters. Under certain conditions, some algae can grow into a large visible mass called a bloom. Not all algal blooms are harmful, but some species of cyanobacteria can produce toxins that can cause serious illness or death in pets, livestock and wildlife. These toxins can also make people sick and in sensitive individuals also cause a rash or irritation.

Data source and expert advice

Data are from water year 2014 (October 1, 2013 to September 30, 2014). Rebecca Hillwig at the Oregon Health Authority provided expert advice.

Harmful algal bloom advisories are issued by the Oregon Health Authority (OHA)[21]. OHA collects and reviews information on harmful algal blooms and informs the public through the issuing and lifting of advisories when water sampling data warrants. OHA has criteria for recreational uses of water bodies based on the presence of algal species that may produce toxins. These criteria are based on three factors: visible scum, cell counts, and toxicity levels. Only a fraction of all water bodies in Oregon are monitored for harmful

20 Oregon Department of Environmental Quality: Division 041-Chapter 45-Water Quality Standards. Effective July 2nd, 2007. Specifically OAR 340-041-0009.

21 http://public.health.oregon.gov/HealthyEnvironments/Recreation/HarmfulAlgaeBlooms/Pages/index.aspx.

algal blooms (HABs) due to limited physical and monetary resources. OHA relies upon other agencies and partner organizations to perform algal toxin testing and report the results.

This indicator, like other indicators, is focused on the main stem of the Willamette River. Additional HAB advisories have occurred in the Willamette River's tributaries and dams/reservoirs that were not included in the analysis.

Calculation method

The harmful algal bloom indicator score is the percent of days per year with no OHA harmful algal bloom advisories posted.

Result

No HAB recreational advisories were issued in the Middle or Upper regions of the Willamette River. One advisory was issued in the Lower Willamette River region in the Portland metropolitan area between Ross Island and Sauvie Island. It lasted from September 16 until October 2, 2014.

- Lower Willamette River = 96%
- Mid Willamette River = 100%
- Upper Willamette River = 100%

Table 6-6. *Percent of days passing the safe contact recreation criteria for harmful algal blooms in each report card region of the river in water year 2014 and associated report card scores.*

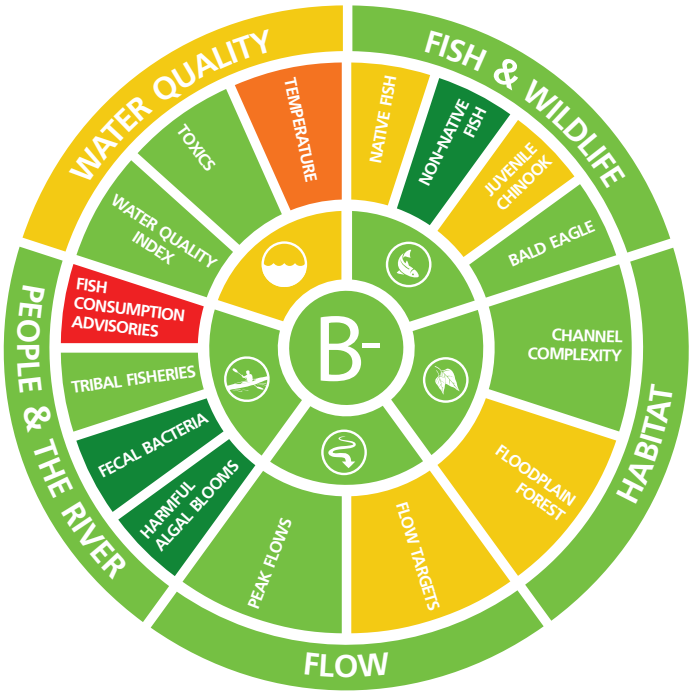
Willamette River Report Card Region	Percent passing safe contact recreation criterion	Report Card score
Lower Willamette River	96%	96%
Mid Willamette River	100%	100%
Upper Willamette River	100%	100%

7 Summary of Report Card scores and assigned grades

Overall Willamette River

Overall, the Willamette River scored a B-. The health of the river declines as it flows downstream, with both the upper and middle Willamette scoring a B and the lower Willamette scoring a C+. Key findings from this assessment of the Willamette River include:

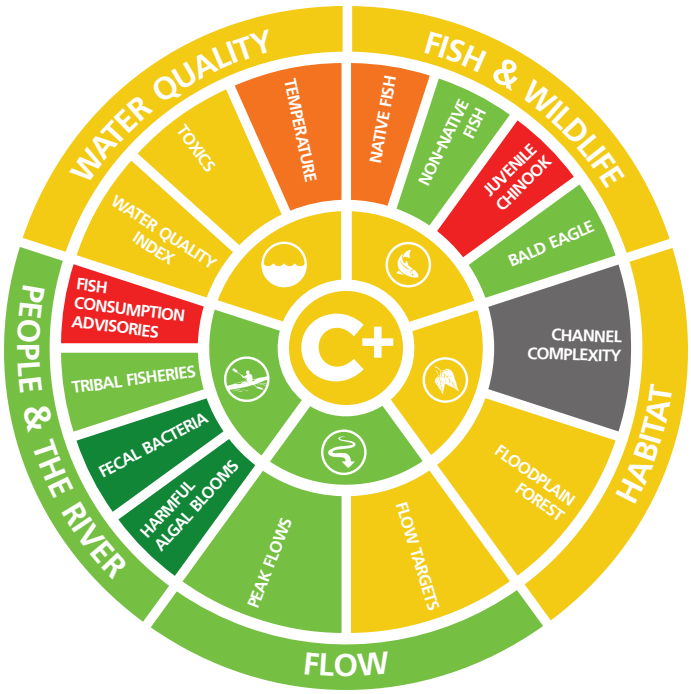
- The river is clean enough to swim in along its entire length.
- Bald eagle populations are doing well, and native fish species outnumber non-native species throughout the river.
- Water temperatures were elevated in all three river reaches, impacting the river's chemical and biological health.
- Toxics received very poor scores for PCBs and legacy pesticides in Portland Harbor.
- Some fish found in the Willamette are too contaminated to eat regularly.



Category	Value	Indicator	Indicator score (%)	Value score (%)	Category score (%)	Overalll Score (%)	Overall grade
Fish and Wildlife	Biodiversity	Native fish	53	66	66	65	B-
		Non-native fish	80				
	Iconic native species	Juvenile Chinook	51	65			
		Bald eagle	79				
Water Quality	Clean water	Oregon water quality index	72	55	55		
		Toxics	72				
		Temperature	21				
Habitat	Healthy riparian areas	Floodplain forest	59	59	69		
	In stream habitat	Channel complexity	78	78			
Hydrology and Flow	Flow regime	Flow targets	58	67	67		
		Peak flows	75				
People and the River	Fishable	Tribal fisheries	62	36	67		
		Fish consumption advisories	10				
	Swimmable	Fecal bacteria	97	98			
		Harmful algal blooms	99				

Lower Willamette River

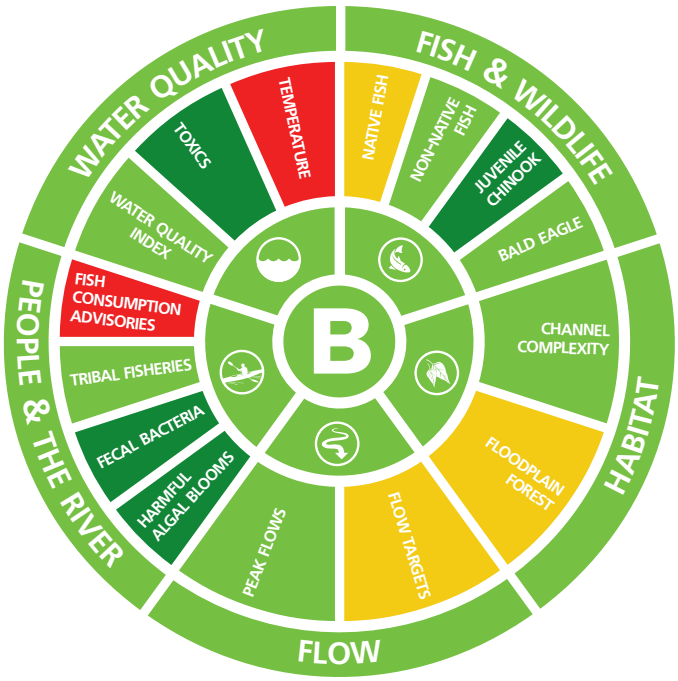
From Newberg north, farmland gradually shifts to suburbs, waterfront homes, and a string of small cities at the edge of the Portland metro area. Portland's vibrant mix of buildings and bridges gives way quickly to industrial and marine facilities in Portland Harbor. The lower Willamette has the poorest health of all three reaches, with a C+ grade. Key concerns are poor juvenile Chinook populations, fish consumption advisories, and poor water quality, including toxic contamination in the Portland Harbor Superfund site.



Category	Value	Indicator	Indicator score (%)	Value score (%)	Category score (%)	Reach score (%)	Reach grade
Fish and Wildlife	Biodiversity	Native Fish	34	56	48	56	C+
		Non-native Fish	78				
	Iconic native species	Juvenile Chinook	3	39			
		Bald Eagle	76				
Water Quality	Clean water	Oregon Water Quality Index	58	43	43		
		Toxics	48				
		Temperature	22				
Habitat	Healthy riparian areas	Floodplain Forest	58	58	58		
	In stream habitat	Channel Complexity					
Hydrology and Flow	Flow regime	Flow Targets	58	67	67		
		Peak Flows	76				
People and the River	Fishable	Tribal Fisheries	67	35	64		
		Fish Consumption Advisories	3				
	Swimmable	Fecal Bacteria	90	93			
		Harmful Algal Blooms	96				

Mid Willamette River

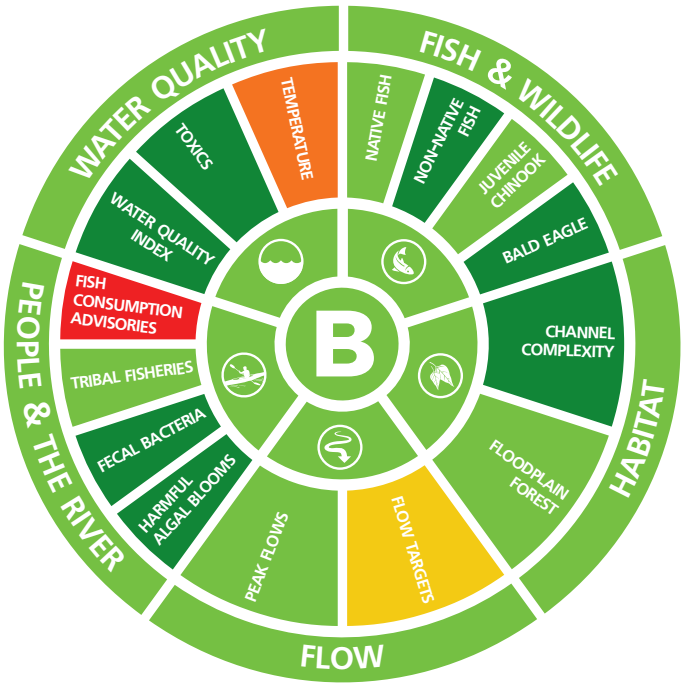
Between Albany and Newberg, the Willamette meanders through a mixed landscape of rich farmland, parks, natural areas, and small cities and towns. The middle Willamette has good overall ecosystem health, with a grade of B. Water quality is comparable to the upper Willamette, and the middle reach has the largest number of juvenile Chinook salmon compared to other reaches. Concerns include failing grades for water temperature and fish consumption advisories, and C scores for the diversity of native fish species and amount of floodplain forest.



Category	Value	Indicator	Indicator score (%)	Value score (%)	Category score (%)	Reach score (%)	Reach grade
Fish and Wildlife	Biodiversity	Native Fish	58	68	74	67	B
		Non-native Fish	77				
	Iconic native species	Juvenile Chinook	86	80			
		Bald Eagle	74				
Water Quality	Clean water	Oregon Water Quality Index	77	59	59		
		Toxics	83				
		Temperature	17				
Habitat	Healthy riparian areas	Floodplain Forest	55	55	66		
	In stream habitat	Channel Complexity	76	76			
Hydrology and Flow	Flow regime	Flow Targets	58	67	67		
		Peak Flows	76				
People and the River	Fishable	Tribal Fisheries	60	37	68		
		Fish Consumption Advisories	13				
	Swimmable	Fecal Bacteria	100	100			
		Harmful Algal Blooms	100				

Upper Willamette River

The upper Willamette stretches from Eugene to Albany. This reach holds some of the highest quality habitats in the basin, but also contains three of Oregon's ten largest cities—Eugene, Springfield, and Corvallis. With good water quality, diverse instream habitats, and strong fish and wildlife numbers, the upper Willamette scored a B. Key concerns include warm water temperatures and fish consumption advisories for resident fish.



Category	Value	Indicator	Indicator score (%)	Value score (%)	Category score (%)	Reach score (%)	Reach grade
Fish and Wildlife	Biodiversity	Native Fish	66	76	76	69	B
		Non-native Fish	86				
	Iconic native species	Juvenile Chinook	65	75			
		Bald Eagle	86				
Water Quality	Clean water	Oregon Water Quality Index	81	64	64		
		Toxics	87				
		Temperature	23				
Habitat	Healthy riparian areas	Floodplain Forest	64	64	72		
	In stream habitat	Channel Complexity	80	80			
Hydrology and Flow	Flow regime	Flow Targets	58	66	66		
		Peak Flows	73				
People and the River	Fishable	Tribal Fisheries	60	37	68		
		Fish Consumption Advisories	13				
	Swimmable	Fecal Bacteria	100	100			
		Harmful Algal Blooms	100				

8 Summary note

This report card is an attempt to provide a consistent and scientifically documented assessment of the mainstem Willamette River as a foundation for public education and community involvement. The Willamette River received an overall grade of B- based on the identified values, chosen indicators and best information available. It should be noted that many values of the river that are important to citizens may not currently be represented in the report card. In most cases, this is because monitoring data that cover the entire river were not available.

The most important outcome of the report is not the grade but rather the things we do in our communities to shape the future health of the Willamette River. It's going to take everyone working together to maintain and improve the river's health.

Appendix I

Proposed indicators that did not qualify

A number of indicators originally proposed to represent values of the Willamette River were not able to be included in this report card, due to a lack of current and/or available data. It is important to highlight these as potential future indicators.

Category	Value	Potential indicator	Indicator description	Reason not included
Fish and Wildlife	Biodiversity	Organisms at risk	Ratio of rare, threatened or endangered (RTE) vertebrate species to total vertebrate species along the Willamette River corridor. Data were from habitat suitability maps created by the Institute for Natural Resources.	Existing RTE maps were based on a set of models created using a 2008 vegetation map and forest structure models created with 2006 imagery. At the present time there are no resources available to update this dataset on a periodic basis. Therefore, there are no trends, and a questionable ability to detect change.
	Iconic species status	Northern red-legged frog	The northern red-legged frog (*Rana aurora*) and western pond turtle (*Actinemys marmorata*) were selected, in addition to the bald eagle, as iconic species at the September 2014 stakeholder workshop. Element Occurrence (EO) Ranks[22] for both species were investigated to assess estimated viability (probability of persistence) of this species within each reach of the Willamette River. Data were sourced from the Oregon Biodiversity Information Center, Institute for Natural Resources, at Portland State University.	The dataset used for this indicator had a mixture of observations from different locations in the Willamette River ranging from 1991-2007. There were insufficient observations (for the western pond turtle and none for the red-legged frog) over the last few years in the project area to provide confidence that reports reflected current status. Calculating the current status of this indicator for each reach of the river is not possible without resources to monitor these species.
		Western pond turtle		
Habitat	Healthy riparian areas	Area of 2 yr inundated floodplain	Maps are available showing areas of inundation associated with a regulated 2-year flood event. The indicator was calculated as the area of 2010 2-yr flood inundation of individual 100 m slices (slice number 101 – 22907 from the SLICES Framework[23,24]), as a percentage of the total 100 m slice area (representing the maximum floodplain area geomorphically possible).	It was agreed that this indicator did not reflect the health of the Willamette River, but is a good resource for identifying possible areas for floodplain or riparian restoration projects.

22 http://orbic.pdx.edu/rte-defs.html
23 http://ise.uoregon.edu/slices/main.html
24 Willamette River Basin:Trajectories of environmental and ecological change by The Pacific Northwest Ecosystem Research Consortium-1st OSU Press ed.p.cm.

Category	Value	Potential indicator	Indicator description	Reason not included
Hydrology and Flow	River dynamism	Aerial extent of bare gravel bars OR Streambank hardening	This indicator aimed to asses the presence/absence of bare gravel bars. Bare gravel bars are affected by bank stabilization, reduced sediment and wood inputs, and decreased peak flows. Fewer gravel bars have consequences for aquatic habitats and vegetation.	In order for this indicator to be used, data must first be analyzed from the SLICES Framework[25,26.]
People and the River	Protecting and restoring lands	Acreage of protected and restored lands on floodplain compared with 2050 Conservation Scenario targets	This indicator would assess the ratio of protected and/or restored land within the floodplain as a ratio of the 2050 conservation target for this land type.	Data must first be analyzed from the SLICES Framework[24,25.]
	Tourism and recreation	# boating days	These indicators could capture resident use of/connection to the river.	Consistent and river-wide information was not available.
		Park use days		

25 http://ise.uoregon.edu/slices/main.html
26 Willamette River Basin: Trajectories of environmental and ecological change by The Pacific Northwest Ecosystem Research Consortium-1st OSU Press ed.p.cm.

Appendix II

General description of SLICES

Four of the river health indicators used in the Willamette River Report Card (floodplain forests, channel complexity, non-native fish, and fish diversity) make reference to "the SLICES framework." The SLICES framework is a map and corresponding database originally developed as part of the Willamette Basin Atlas (2002) and expanded and refined through the joint efforts of the University of Oregon and Oregon State University. (http://ise.uoregon.edu/SLICES/Main.html).

The SLICES map results from dividing the Willamette River floodplain into 229 1-km "slices" drawn at right angles to the floodplain's center axis (see Figure 2-1). Each slice is further divided into 100 meter "sub-slices." All slices have a unique four or five digit numeric label based on their location in the floodplain, with the first 2-3 digits referring to the 1-km slice, and the last several digits referring to the 100 m sub-slices.

Information on key indicators of river and floodplain health is organized by individual slice. To date, this information includes complexity of the river channel and its habitats, number of native and non-native fish species, the extent of floodplain forest, the number and location of coldwater areas, and parts of the floodplain that may be inundated in a two-year regulated flood event. The report card relied on the SLICES framework to organize and compare, by reach, the average and target conditions for the native fish species diversity and non-native fish status indicators.

The Willamette Basin Atlas also describes three modeled scenarios of future land and water conditions in the basin. The purpose of the scenarios is to evaluate how different growth and development patterns could affect a variety of environmental and social conditions like water availability, agricultural crop yields, or wildlife habitat quality. Three alternative scenarios for the year 2050 were developed for the Atlas, one based on current natural resource policies and practices, one based on a loosening of current policies and practices, and one in which the conservation and restoration of ecological function would play a larger role. Scenario maps show where different conservation and development-related land uses might occur on the landscape under these varying assumptions. Overlaying the SLICES framework on the scenario maps allows quantification of desired endpoints for different indicators, and was used to generate report card targets for channel complexity and floodplain forests.

These organizations provided data used in the report card:

Document layout and design by: Jane Hawkey, Simon Costanzo, Brianne Walsh and Tracey Saxby