

**Independent  
Multidisciplinary  
Science Team  
(IMST)**



**State of Oregon**

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June 13, 2012

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Oregon House Co-Speaker  
State Capital Building  
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The Honorable Bruce Hanna  
Oregon House Co-Speaker  
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Dear Sirs,

We are pleased to enclose the Independent Multidisciplinary Science Team's (IMST) technical report titled *Urban and Rural-Residential Area Land Uses in Oregon: A Synthesis of an IMST Technical Workshop on Watershed Functions and Salmonid Recovery*. This workshop, held in June 2011, was designed to supplement the IMST's 2010 technical report on urban and rural-residential land uses in Oregon. The 2010 report was focused on evaluating the best available science and how actions in urban and rural-residential areas could contribute to salmonid recovery and watershed health. For the workshop, the IMST invited professionals from municipalities, counties, and non-governmental groups to share their experiences and perspectives on managing aquatic and watershed resources in urban and rural-residential areas. The workshop report reflects the participants' experiences and professional opinions, not the IMST's, regarding restoration and management priorities and research needs.

The IMST hopes that this report and the IMST's 2010 report, *Urban and Rural-residential Land Uses: Their Role in Watershed Health and the Rehabilitation of Oregon's Wild Salmonids*, will be useful to the State as it reviews and revises the Oregon Plan for Salmon and Watersheds in the coming year.

Sincerely,

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IMST Co-Chair

Nancy Molina  
IMST Co-Chair

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# Urban and Rural-Residential Area Land Uses in Oregon: A Synthesis of an IMST Technical Workshop on Watershed Functions and Salmonid Recovery

IMST Technical Report 2012-1

Released June, 13 2012



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**Independent Multidisciplinary Science Team**  
Oregon Plan for Salmon and Watersheds  
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## **Report Preparation**

The synthesis was prepared by Kathy Maas-Hebner (Oregon State University and Lead IMST Technical Support) and the members of the IMST, Alan Yeakley, Nancy Molina, Carl Schreck, Bob Hughes, Clint Shock, and Vic Kaczynski). The draft report was reviewed by participants and comments were incorporated as appropriate. The final draft was unanimously adopted at the May 31, 2012 IMST public meeting.

# EXECUTIVE SUMMARY

This report is the result of a technical workshop for resource managers and practitioners operating in Oregon's urban and rural-residential lands. Participants represented a variety of geographic areas in Oregon, spanning from Florence to Ontario west to east and from Portland to Josephine County north to south. The workshop sought to gauge practitioners' responses to key findings from IMST's 2010 report titled *Urban and Rural-residential Land Uses: Their role in Watershed Health and the Rehabilitation of Oregon's Wild Salmonids*<sup>1</sup> (from here on out referred to as the Urban Report). The Urban Report provided a comprehensive review of how human activities in urban and rural-residential areas can alter aquatic ecosystems and resulting implications for salmonid recovery, with a geographic focus on the state of Oregon. The workshop findings are intended to improve understanding of the technical and political issues regarding plans for minimizing development impacts on aquatic ecosystems.

Participants were asked to address the following objectives:

1. Better determine the steps environmental managers are already taking, that may or may not have been covered in the 2010 Urban Report.
2. Determine what monitoring and research needs may have been missed in the 2010 Urban Report and prioritize research and monitoring needs in urban native fish ecology and rehabilitation.
3. Identify and prioritize actions that could enhance or rehabilitate native fish habitat and populations in urban environments.

By gaining perspectives from resource managers and practitioners in the technical workshop, this report seeks to ground and to augment the findings of the Urban Report. This report should be of use to future planning and management efforts that seek to minimize development impacts on aquatic ecosystems. It should be of value both for local resource management efforts (e.g. for a given municipality or non-profit organization for a given stream) and for statewide planning and resource management approaches (e.g. for updates to the Oregon Plan for Salmon and Watersheds and for planning and management efforts by state level agencies).

## **Objective 1: Further management activities and lessons learned**

Workshop participants were asked to provide information on further management activities not adequately addressed in the Urban Report. Participants also provided examples of successful programs, mixed outcomes and lessons learned.

### *Activities Inadequately Covered in the Urban Report*

Some of the examples cited by workshop participants of further actions, programs and policies included the Oregon Rapid Assessment Protocol, ODFW's Wildlife Conservation Strategy, and ODEQ's toxics water quality standard. Participants desired further discussion regarding improvements in urban storm water collection and treatment, including underground injection control (UIC) systems. Participants felt that the impact of road networks and infrastructure

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<sup>1</sup><http://www.fsl.orst.edu/imst/reports/urban.html>.

needed more treatment in the Urban Report, citing examples spanning state (e.g., Section 401 water quality certifications from ODEQ), federal (e.g., compliance with the federal ESA requirements), and local levels (e.g., Portland's Tabor to the River green infrastructure project). Participants felt that more emphasis was needed on other areas including: integration across disciplines and institutions, stream mitigation, statewide planning goals, in-channel removal and fill impacts, integrated resource strategies, public education and outreach, hydrological connections, low impact development (LID), saltwater marshes, and rural-residential development.

### Successful Programs

Participants identified several successful programs. Successes included examples of collaboration across boundaries (e.g., the Association of Clean Water Agencies) and examples of partnerships (e.g., West Eugene Wetland Program). Other successes included leveraging funds to expand benefits, outreach, and education (e.g., community involvement in Prineville's stormwater management plan). Incentive programs were seen by participants as effective, for example stormwater rebates to residents for tree planting and downspout disconnection in Portland and differential fees for water uses in Florence. Other successful programs cited by workshop participants included encouragement of green infrastructure in several cities, stewardship programs, use of restoration and rehabilitation techniques, and the streamlining of permit processes.

### Programs with Mixed Outcomes

Several rehabilitation techniques were seen by workshop participants as having mixed results, including projects to mitigate stream temperature, by vegetation planting, gravel augmentation, and erosion control. Other programs with mixed results included ODEQ's TMDL program, which previously addressed diffuse drivers of water quality inadequately (although ODEQ is addressing that with a new watershed-based approach). Further examples of programs with mixed results included mitigation approaches and stormwater permitting programs (particularly Phase II stormwater communities). Participants also cited problems in programs regarding invasive species control, beaver management, underground injection control (UIC) systems, statewide environmental education programs, and floodplain and coastal area management. Further problem areas included a lack of statewide riparian ordinances, a lack of review for Goal 5 compliance, and a lack of brownfield redevelopment. Participants viewed program failures as stemming from funding shortfalls for effectiveness monitoring, education, and outreach. Another area of concern included data gaps, incompatibility of data, and inadequate methods standardization.

### Lessons Learned

Workshop participants cited a number of critical lessons learned. Their observations included the need for public support for successful watershed and stream rehabilitation projects, as well as the need for maintaining green infrastructure. Participants cited the need to understand watershed conditions prior to project implementation, and difficulties in gaining public support for

conservation land acquisition and lifecycle responsibilities for appliances and pharmaceuticals<sup>2</sup>. Participants discussed the important role of groups and consortia in facilitating disciplinary and institutional crossover successfully in ecosystem management. They further mentioned that rehabilitation approaches should not be a “one size fits all.” They suggested that major problems should not be viewed as obstacles but rather as stimuli for increased collaboration.

## **Objective 2: Prioritizing further monitoring and research needs**

Workshop participants were asked to provide information on further monitoring and research needs that were not adequately addressed in the Urban Report. Participants also provided their views of the most pressing monitoring and research needs, based on their own experiences in the agencies or organizations in which they work.

### *Monitoring and Research Inadequately Covered in the Urban Report*

Participants identified several water quality issues as needing further research, including atmospheric deposition sources, effects of underlying substrate, modification of traditional stormwater engineering approaches, bacterial contamination, oceanic and estuary dynamics, and the effectiveness of retrofitting stormwater systems, particularly in older urban areas. Participants would like more information on the effectiveness of land acquisitions on cost-benefit analyses concerning environmental protection and LID techniques. Participants sought further knowledge on piscivore predation rates on native salmonids and on how salmonid rehabilitation efforts affect other sensitive wildlife and plant species.

Beyond addressing biophysical unknowns, participants also cited the need for more socioeconomic research and monitoring. They saw the need for further economic and social analyses to determine environmental preferences and behaviors among the public. They also cited the need for research on the functional nature of urban natural areas in the landscape and how to better manage environmental amenities inside and outside urban growth boundaries. They also desired more information on alternative future scenarios, on the effectiveness of natural system-based strategies, on pre-settlement hydrologic estimation, and on the long-term effectiveness of BMPs.

### *Pressing Monitoring and Research Needs*

Workshop participants identified a number of critical areas for more monitoring and research. They cited the need for more investigation into climate change, low impact development (LID), regulation effectiveness, toxic chemicals, rehabilitation effectiveness, groundwater, transportation networks, and data standardization and availability. Climate change needs included more weather and discharge stations, a better understanding of plant species responses, and the effect climate change may have on water availability. Regarding LID, participants would like more research and monitoring concerning LID effectiveness for both water quantity and quality concerns, as well as how effective are LID structures at larger spatial extents. They further discussed toxic chemicals research needs, including a mismatch between laboratory and field methods, a lack of analysis of synergistic effects, the effectiveness of native plants as

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<sup>2</sup> Lifecycle responsibility means taking responsibility for a product from the time of purchase through disposal and recycling of the product.

bioaccumulators, and the effects of application of sewage sludge. They cited several gaps in knowledge about groundwater (e.g., withdrawals and contaminants), as well as the need for knowledge on the effects of transportation networks on aquatic ecosystems.

### Monitoring Priorities

Participants prioritized toxic substance monitoring, monitoring that will inform adaptive management, disparate data management, reducing uncertainty in monitoring and system dynamics, and the need to tailor priorities to the specific concerns of a given community. Similar to the findings of the Urban Report, toxic substance monitoring and management were cited as pressing priorities, including use of a wider variety of test organisms and more systematic evaluation of toxic chemical in the environment. Participants also listed key factors affecting monitoring priorities, ranging from funding and political will to the need for partnerships with researchers and the public. Participants felt that monitoring and research data need to be readily accessible and widely disseminated beyond agency practitioners, and thus available to citizens groups.

### **Objective 3: Priority actions to rehabilitate urban aquatic ecosystems**

Workshop participants were asked to provide information on further actions needed to rehabilitate fish habitat and populations in urban areas. Participants also developed a list of priority actions.

### Further Actions Needed

Participants identified actions needing increased attention, including stormwater management and erosion control; improvements to riparian, terrestrial and aquatic habitats; effectiveness monitoring; water quality and toxic substance monitoring; and public education regarding natural resources. Actions identified in the area of stormwater management and erosion control included increasing tree canopy, minimizing future impervious surfaces, increasing local capacity to manage surface stormwater, enhancing regulations and incentives, and developing ordinances and regulations to better control erosion. Participants identified actions in the area of habitat rehabilitation including creation of state-wide riparian and floodplain management policies, providing better incentives for riparian buffer protection and enhancement, increasing stream day-lighting and re-meandering, increasing attention on noise and light pollution abatement, creating state-wide assessments and mitigation of hotspots for air temperature, categorizing of areas by ecological sensitivity prior to development, increased focus on off-channel salmonid rearing habitat, and managing invasive species. Monitoring actions should include both effectiveness monitoring and establishment of monitoring networks. In addition to monitoring toxic substances in the environment, there is a need for source control to remediation and rehabilitation of contaminated sites. Participants also highlighted actions in the realm of public education and enhancement of local resources such as improved citizen monitoring networks and more diverse public-private partnerships.

### Priority Actions

Each of the three focus groups in the workshop was asked to develop a list of its priority actions. Actions that were emphasized or at least mentioned by all groups included:

- Development of state-wide land use policies that emphasize landscape ecology attributes such as habitat and connectivity, and discourage development in sensitive areas such as floodplains.
- Increased attention to stormwater mitigation strategies included LID implementation and monitoring, and mitigation of impervious surface encroachment particularly in sensitive ecological areas.
- A comprehensive, state-wide toxic substance reduction strategy led by ODEQ that addresses land, air and water pollutants.
- Assistance from state agencies to develop standards and standard assessment tools that can benefit municipalities of all sizes and resource bases.
- Cultivation of sustainable and reliable funding sources that allow for increased implementation of rehabilitation projects and monitoring.

Participants also identified other high priority items, including the establishment of statewide and local guidance for development, provision of incentives in the private sector to enhance rehabilitation and mitigation actions, determination of water storage needs in light of climate change, and planning strategies that incorporate uplands to oceans.



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## LIST OF ACRONYMS

BMPs	best management practices
DLCD	Department of Land Conservation and Development
DSL	Department of State Lands
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
GIS	geographic information system
IMST	Independent Multidisciplinary Science Team
LID	Low Impact Development
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
OSU	Oregon State University
OWEB	Oregon Watershed Enhancement Board
OWRD	Oregon Water Resources Department
STEP	Salmon and Trout Enhancement Program
SWAT	Stormwater Action Team
TMDL	total maximum daily load
UIC	underground injection control
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency

# INTRODUCTION

On June 21-22, 2011, the Independent Multidisciplinary Science Team (IMST) hosted a technical workshop for local and regional natural resource managers and practitioners in urban and rural-residential land uses. The purpose of the workshop was to discuss management and rehabilitation actions in developed areas that could improve watershed functions, aquatic habitats, and salmonid populations.

This workshop was designed to follow up and expand on key findings from IMST's 2010 report titled *Urban and Rural-residential Land Uses: Their role in Watershed Health and the Rehabilitation of Oregon's Wild Salmonids*<sup>3</sup> (hereafter referred to as the Urban Report). The Urban Report was primarily based on scientific research and technical documents. The findings from the workshop are intended to help the State of Oregon and local governments better understand the technical issues regarding, and impediments to implementing, plans for minimizing development impacts on water quality, watershed hydrology, and aquatic ecosystems.

Workshop invitees, representing municipal, county, and state agencies, non-governmental organizations, and universities, were selected to reflect experience in managing, monitoring, and/or rehabilitating salmonid and aquatic habitats in urban and rural-residential areas. Invitees were also chosen to represent the varied geographic areas in Oregon. Twenty-three professionals participated in the workshop (Appendix A) and another seven who were not able to attend provided additional information (Appendix A). Participants were asked to address three objectives and a subset of questions (Appendix B). The objectives were:

**Objective 1.** Better determine the steps environmental managers are already taking, that may or may not have been covered in the 2010 Urban Report.

**Objective 2.** Determine what monitoring and research needs may have been missed in the 2010 Urban Report and prioritize research and monitoring needs in urban native fish ecology and rehabilitation.

**Objective 3.** Identify and prioritize actions that could enhance or rehabilitate native fish habitat and populations in urban environments.

Prior to the workshop, all invited participants received a questionnaire to determine what types of water quality, watershed condition, and/or salmonid habitat management and rehabilitation they are involved in; what technical, scientific, and policy information guides their actions; and what further information or steps need to be taken to better manage resources. Seventeen responses were received (of a total of 84 sent) and summarized (Appendix C).

## Report Methods and Format

This report is a synthesis of the workshop deliberations and pre-workshop survey. When applicable, information from survey responses was used to better describe programs or examples

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<sup>3</sup> Independent Multidisciplinary Science Team (2010) *Urban and Rural-residential Land Uses: Their Roles in Watershed Health and the Recovery of Oregon's Wild Salmonids*. Technical Report 2010-1. Oregon Plan for Salmon and Watersheds, Oregon Watershed Enhancement Board. Salem, Oregon. <http://www.fsl.orst.edu/imst/reports/urban.html>.

mentioned during the workshop. IMST members used their own notes to check the accuracy of the synthesis. Except to provide clarification or context, additional or supplemental information was not incorporated. As a result, some sections appear incomplete or vary in the level of detail.

This synthesis reflects the collection of ideas and concepts discussed during the workshop. It does not necessarily reflect the opinions of the IMST or any individual workshop participant or their employer. This report does not include formal recommendations by the IMST to any Oregon Plan partner requiring responses as directed by Oregon Revised Statute 541.409. The mention of trade names or other products does not constitute endorsement or recommendation for use.

### **Intended Applications for This Report**

The immediate goal of this workshop report is to gain perspectives from resource managers and practitioners from across Oregon, and thus both to ground and to augment the findings of the Urban Report. This report should be of use to future planning and management efforts that seek to minimize development impacts on aquatic ecosystems. It should be of value both for local resource management efforts (e.g. for a given municipality or non-profit organization for a given stream) and for statewide planning and resource management approaches (e.g. for updates to the Oregon Plan for Salmon and Watersheds and for planning and management efforts by state level agencies). After being published on the IMST www site, this report will be available for any state agency, municipality, academic researcher, or non-profit organization to use in helping to structure urban aquatic ecosystem science and management proposals and approaches.

## **OBJECTIVE 1. Better determine the steps environmental managers are already taking, that may or may not have been covered in the Urban Report.**

### **1.1) The Urban Report covered a variety of activities that local, regional, and state agencies and non-profit organizations are conducting to enhance watershed healthy. What further management activities are taking place that were not covered in the Urban Report?**

Participants identified several specific actions, programs, and policies that should have been included the Urban Report, as well as areas that needed more emphasis. These are summarized below. Because not all participants were familiar with the content of the full IMST report, when an item was mentioned as missing but was actually in the report, we listed it as needing more emphasis. These topics may be considered in future IMST work on urban and rural-residential areas.

#### *Actions, Programs, and Policies Not Included, Should be Discussed*

- Oregon Rapid Wetland Assessment Protocol<sup>4</sup>. The protocol (a DSL product) is a tool to identify wetland functions and socio-ecological values. The protocol is used by DSL to evaluate proposed impacts to wetlands, explore avoidance and minimization of impacts on highest functioning wetlands and apply a watershed-based approach for replacement of lost functions. The State's ability to track gains and losses of wetland resources has significantly improved and the information now can be shared with OWEB and the Oregon Explorer databases. DSL is working with the US EPA and USACE on a similar assessment approach for streams.
- ODFW's Wildlife Conservation Strategy<sup>5</sup>. The strategy is being implemented by the State and several municipalities.
- ODEQ's toxics water quality standard<sup>6</sup>. The human health toxic pollutants water quality standard was adopted by the Oregon Environmental Quality Commission on June 16, 2011. The new standard is designed to protect human health, fish, and water supplies by preventing or reducing pollutants in waterways.
- Retrofits. Participants felt a discussion on retrofitting developed areas is needed alongside the Urban Report's discussion of off-setting impacts from new development. Some participants felt that the best chances for mitigation of urban impacts on watersheds are in redevelopment of older developed areas, or areas that have been severely degraded by

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<sup>4</sup> [http://www.oregon.gov/DSL/WETLAND/or\\_wet\\_prot.shtml](http://www.oregon.gov/DSL/WETLAND/or_wet_prot.shtml). Accessed on Aug. 8, 2011.

<sup>5</sup> [http://www.dfw.state.or.us/conservationstrategy/read\\_the\\_strategy.asp](http://www.dfw.state.or.us/conservationstrategy/read_the_strategy.asp). Accessed on Aug. 8, 2011.

<sup>6</sup> <http://www.deq.state.or.us/wq/standards/humanhealthrule.htm>. Accessed on Aug. 8, 2011.

natural or human-caused events. Participants noted that ODEQ is spearheading the retrofitting of stormwater collection and treatment systems in existing developed areas to alleviate hydrologic and water quality problems. Most areas that could benefit from retrofitting were developed before federal MS4 (municipal separate storm sewer system) regulations were established and implemented.

- Underground injection control (UIC) systems. UICs are used in some regions to manage stormwater; however, their use may not be effective or appropriate in all areas of Oregon because of the underlying geology. The City of Prineville has eliminated the use of UICs in favor of diverting stormwater to swales.
- Roads. Except as a fish passage issue and a source of pollutants, the impacts of road networks and associated infrastructures on aquatic ecosystems were not discussed in the Urban Report (also see bullet on hydrological connectivity under the next subsection). The Urban Report did not discuss actions or policies of the State to minimize the impact of roads on aquatic ecosystems. For example:
  - ODOT requires that maintained highways and facilities are covered by NPDES permits.
  - Projects that require a Clean Water Act Section 404 permit must also receive Section 401 water quality certification from ODEQ.
  - ODOT projects that affect listed threatened or endangered species must meet federal Endangered Species Act requirements.
  - The 2009 Oregon Jobs and Transportation Act<sup>7</sup> directed ODOT to develop environmental performance standards that will apply to state highway projects and local agency projects funded by ODOT. In response to the Act, ODOT is developing environmental performance standards for work in both aquatic and upland sites, roadside development<sup>8</sup>, erosion, sediment, and pollution control.

In 2006, ODOT established the Stormwater Action Team<sup>9</sup> (SWAT), which developed stormwater management criteria for highway projects. The SWAT defined project elements that indicate when stormwater management is needed, delineated contributing areas subject to stormwater management regarding the water quality and flow control design stormwater systems, and identified the most effective BMPs to be used. The SWAT work has been incorporated into NMFS's programmatic Biological Opinion,

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<sup>7</sup> [http://www.oregon.gov/ODOT/JTA\\_overview.shtml](http://www.oregon.gov/ODOT/JTA_overview.shtml). Accessed Aug. 12, 2011.

<sup>8</sup> "The roadside is the area outside the traveled way. This applies to all lands managed by ODOT and may extend to elements outside the right-of-way boundaries. Examples include, but are not limited to, unpaved median strips and auxiliary facilities such as rest areas, roadside parks, viewpoints, heritage markers, pedestrian and bicycle facilities, wetlands and their associated buffer areas, stormwater treatment facilities, park and ride lots, and quarries and pit sites." (ODOT. 2006. Roadside Development Design Manual, Salem, OR. Page 1).

<sup>9</sup> The SWAT is comprised of personnel from ODOT, state regulatory and natural resource agencies, and the Federal Highway Administration.

Standard Local Operating Procedures for the Environment IV (SLOPES IV), and is the basis for the agency's stormwater environmental performance standard.

- Other specific programs mentioned:
  - *City of Portland's fish passage program.*
  - *ODFW's Salmon and Trout Enhancement Program (STEP)*<sup>10</sup>. STEP is a volunteer program designed to increase native salmonids, and is used in schools as a natural resource education tool. Local municipalities are actively working with STEP volunteers to bolster recovery efforts (e.g., City of Florence has small STEP hatchery near the water treatment plant; STEP uses existing weirs).
  - *City of Portland's Tabor to the River Program*<sup>11</sup>. The program integrates sewers, bioswales in rights-of-way, private stormwater retrofits, tree planting, and watershed partnerships for community action to improve the City's sewer system reliability and stormwater management.
  - Local surface and groundwater monitoring programs (e.g., City of Florence).

#### Actions, Programs, and Policies that Needed More Emphasis

- Integration across disciplines. Participants stated that more integration across disciplines is needed. Increased involvement of other interests (e.g., transportation, trails, recreation) is needed to better manage urban/rural-residential impacts on watershed hydrology and aquatic ecosystems. It is important to identify collaborative opportunities and to identify conflicts and synergies between professionals (e.g., transportation vs. environmental professionals). Regular collaboration among various agencies and groups can also improve the prioritization of management/restoration efforts and outreach opportunities.
- Stream mitigation. The Urban Report includes a general discussion of mitigation banks, but stream mitigation was not specifically discussed. Over the next two years DSL will develop a stream mitigation framework. It will incorporate frameworks already used by USEPA, USACE, DSL, and the Willamette Partnership for wetlands. The framework will apply to all types of mitigation, including permittee-responsible and agency-managed mitigation banks. The overall goal is to have a framework that facilitates a function-based watershed approach to stream mitigation. The State does have a stream mitigation program with stream credits for sale in some ecosystem marketplaces. The City of Salem has trial sites for stream mitigation using functional assessments. Salem's mitigation bank is mostly used internally so it is not competing with private mitigation banks, but might sell credits to public agencies in the future.

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<sup>10</sup> <http://www.dfw.state.or.us/fish/STEP/>. Accessed April 11, 2011.

<sup>11</sup> <http://www.portlandonline.com/bes/tabortoriver>. Accessed April 10, 2012.

- Statewide Planning Goals. The Urban Report includes a short discussion of Oregon's Statewide Planning Goals (coordinated by DLCD) and the potential effects of Ballot Measures 37 and 49 on those Goals. Some workshop participants expressed concern that the State no longer requires riparian inventories and program updates under Goal 5 (natural resources, scenic and historic areas, and open spaces). They felt that by not requiring updates to Goal 5 programs, the State lost an important motivator for many municipalities. Other planning goals not well-covered in the Urban Report were Goals 16 (estuarine resources), 17 (coastal shorelands), 18 (beaches and dunes), and 19 (ocean resources).
- Removal/Fill. The Urban report included brief discussions of in-channel removal/fill related to dredging navigable channels and in-stream aggregate mining. Other aspects of removal/fill (both permitted and non-permitted activities) and potential impacts on aquatic ecosystems were not included.
- OWRD's Integrated Water Resource Strategy<sup>12</sup>. The draft Strategy was mentioned in the 2010 Urban Report; since then OWRD has done a considerable amount of work on the draft strategy that deserves additional discussion.
- Public Education and Outreach. Participants identified several significant public education and outreach programs and projects that weren't included in the Urban Report. It was felt that education can often work better than regulation, can increase citizen involvement, and foster citizen stewards. Examples included:
  - Support organized within the Prineville community for riparian management in Ochoco Creek and the reintroduction of steelhead;
  - Public participation in making changes to the City of Prineville's wastewater treatment plant to increase instream flow; and
  - Siuslaw Estuary Partnership student workshops and field education for 3<sup>rd</sup> and 8<sup>th</sup> grade classes. Programs include the salmon life cycle and the impacts human communities can have on salmon.

Participants identified several areas that need to be addressed better by outreach programs including:

- describing the positive impacts habitat restoration efforts can have on jobs and local economies; and
  - promoting and explaining the overall value of trees along urban streams and to local communities.
- Hydrological Connections. Some participants indicated that more emphasis was needed on how hydrological alterations can negatively affect restoration or other activities in

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<sup>12</sup> [http://www.wrd.state.or.us/OWRD/LAW/Integrated\\_Water\\_Supply\\_Strategy.shtml](http://www.wrd.state.or.us/OWRD/LAW/Integrated_Water_Supply_Strategy.shtml). Accessed on Aug. 8, 2011.



urban areas (e.g., damage to riparian plantings by flooding or scouring). One example not considered in the Urban Report is the potential alteration of subsurface flows caused by underground infrastructures related to wastewater systems or roads with gravel underlays; such structures can result in dewatering of perched wetlands.

- Low Impact Development (LID). While the Urban Report did discuss LID and some of the key practices, it did not address potential cumulative effects at the watershed level or how LID systems affect pollutants. There appeared to be some disagreement among participants regarding the adequacy of research available on LID, especially at larger scales. Some participants felt the use of LID could have been emphasized more in the Urban Report as an approach to protect streams before they are degraded in areas of new development, particularly in smaller communities and cities.
- Rural-residential development. Participants felt that the nature of rural-residential development was not described well in the Urban Report. Rural-residential developments may have issues in common with urban areas, but impacts on aquatic ecosystems and the approaches required for rehabilitation can vary significantly. Some examples of issues that may need special consideration in rural areas are:
  - septic systems in different geological substrates,
  - wetland and saltwater marshes in coastal areas,
  - estuarine habitat projects,
  - fire protection at wildland-residential interfaces,
  - forest land conversion to rural-residential development, and
  - acquisitions and conservation easements.
- Saltwater marshes. Wetlands play different roles in different areas and saltwater marshes and their role in salmon rehabilitation were not well-addressed in the Urban Report.

**1.2) In your experience, what management activities have proven to be most successful? What are some examples of success? And, what are some examples of failures and lessons learned?**

Each workshop group of participants identified which actions, programs, and policies that they felt were successful, had mixed results, or failed. Lessons learned encompassed both failures and successes. Participants noted that success or failure of actions, programs, or policies may be site and situation specific. Failure was not necessarily seen as a bad thing by participants. Often a failed project provided lessons on what not to do again.

***Successful Actions, Programs, and Policies***

- Collaboration across boundaries. Many local municipalities and regional jurisdictions are working to increase collaboration between agencies and local organizations. The current economic downturn appears to have led to increased collaboration. Collaborative efforts vary by locale, and can be difficult to create and maintain because of the number of jurisdictions present (i.e., local, county, state, federal). Professional organizations, such as the Association of Clean Water Agencies, can facilitate resource sharing. Several positive aspects of collaboration that were identified by participants included:
  - reduced redundancy;
  - better prioritization of resources and projects;
  - more efficient use of limited funds;
  - larger cities/communities sharing resources and information with smaller cities/communities;
  - sharing equipment or resource professionals;
  - trading work with other agencies; and
  - reducing overall costs.
- Partnerships. Several formal partnerships were identified as successful:
  - *West Eugene Wetland Program* – a non-profit, state and federal partnership with private land developers to restore wetlands.
  - *Siuslaw Estuary Partnership* – a non-profit collaborative effort by the City of Florence and federal, state, local, and tribal entities to protect and restore the lower Siuslaw River watershed.
  - *Nehalem River TMDL* – a partnership of diverse groups working together to help the Nehalem River (the largest river in Tillamook County) meet recreational water quality TMDLs for the first time in six years.

- *Crooked River* – goals for wetland mitigation by ODOT along the Crooked River were broadened to include salmon re-introduction in a collaborative effort with DSL, Crooked River Watershed Council, ODFW, USACE, and the City of Prineville.
- *Crystal Springs Restoration Partnership* – a partnership involved with restoring Portland’s Crystal Springs Creek has significantly shortened the estimated timeframe for restoration.
- *OWEB Special Investment Partnerships*. The program has been successful in bringing different groups together to implement projects.
- Leveraging funding to expand benefits. Many regional and local agencies have found ways to use funds from populated areas in less-densely populated areas in the same watershed. Washington County developed a method for drawing utility district boundaries based on flood control regulation, which factors in both population location and physical watershed boundaries. The resulting framework of service areas allows funds to be used in both urban areas, and upland areas (such as dairies or farmlands) that affect water quality. The City of Portland also uses the watershed for drawing utility boundaries, facilitating the use of revenues on water quality impact areas outside the urban footprint.
- Outreach and Education. Some education and outreach programs were identified as successful by participants. Adequate funding and staffing resources were commonly listed as critical to developing effective outreach programs. Participants agreed that in order for outreach to be successful it has to occur early in the decision-making process, represent information in a straight forward manner, and not set false expectations. Good documentation of successes is useful in gaining public acceptance of actions and policies needed to protect salmon and watersheds. Participants noted that when the public is given adequate information on issues and the implications of actions, they feel included in accomplishing environmental restoration goals. Likewise, allowing citizens to become active participants in decision-making before actions are taken leads to more support. Examples of results from successful outreach and education efforts included:
  - Passage of the statewide Ballot Measure 76 in 2010, providing continued lottery funds for restoration grants through OWEB, was accomplished through outreach efforts.
  - The Urban Ecosystem Research Consortium<sup>13</sup> has created a successful network for professionals collecting and using ecological data in the Portland, Oregon/Vancouver, Washington area.

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<sup>13</sup> <http://www.uerportland.org/>. Accessed Aug. 9, 2011.

- Outreach to the local community and schools were included in the development of the City of Prineville’s stormwater management plan. This resulted in the engagement of a high school natural resources class, in which students were paid to conduct water quality sampling. Enthusiasm for the project spread from the students to the parents, and on to the broader community.
- Incentives. Participants felt that a generally successful approach was providing property owners with monetary incentives to improve conditions on their property. Regulations and awards can also be used as incentives. Incentives were seen as a way to increase public awareness and lead to a change in behavior. Examples included;
  - Planting large trees on private property resulted in a \$20 rebate on the property owner’s stormwater bill in Portland, Oregon.
  - Incentives and education were used to garner broad support for disconnecting downspouts from the stormwater system in Portland.
  - The city of Florence has successfully used differential fees for water uses. The City charges more for water used for irrigating lawns and non-native vegetation than it does for watering native vegetation.
- Encouraging green infrastructure. Participants indicated that green infrastructure was often less expensive than traditional engineered approaches. Examples included:
  - Under the advice of City of Prineville personnel, the Iron Horse development used less costly retention ponds instead of expensive underground injection control (UIC) systems to manage stormwater.
  - In Prineville, commercial developers were persuaded to use bioswales instead of raised planters, integrating landscaping and stormwater control requirements.
  - Portland’s Tabor to the River Program installs bioswales instead of traditional pipes to control stormwater on public property and encourages the use of rain gardens, tree plantings, and downspout disconnection on private property.
  - Metro’s Title 13 – Nature in Neighborhoods requires local jurisdictions to identify and, where feasible, remove barriers to nature-friendly development practices.
- Use of the Oregon Explorer<sup>14</sup>. Along with other tools being used (e.g., GIS, tree canopy change over time), the City of Salem can make recommendations to the city council and the public based on city data and other data available from Oregon Explorer.
- ODEQ Pesticide Stewardship Program. Amazon Creek (City of Eugene, Lane County) in the Long Tom Watershed was the first urban stream site included in the program. Amazon Creek encompasses both urban and agricultural land uses. The program is

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<sup>14</sup> The Oregon Explorer is a web-based natural resources library that integrates data from state and federal agencies, local NGO’s, municipalities, and university researchers. ( <http://oregonexplorer.info/> accessed January, 17, 2012).

designed to increase the involvement of agricultural chemical suppliers, forest landowners, and municipalities in reducing the impacts of pesticide use on water quality. Amazon Creek monitoring is conducted by the Long Tom Watershed Council and ODEQ conduct the analysis.

- DEQ's toxics water quality standard. The adoption of a new human health toxic pollutants water quality standard by the Oregon Environmental Quality Commission in 2011 is seen as a positive step toward addressing concerns about health risks to humans through consumption of water and fish. Exposure to toxic chemicals is a particular concern in Oregon tribal communities where large quantities of fish are consumed.
- ODOT's bridge permit program. The bridge permit program brings multiple agencies together to identify environmental goals to serve as the starting point for new projects.
- Specific restoration/rehabilitation techniques. Participants identified the following habitat restoration and rehabilitation measures that were considered successful, at least to some degree:
  - *Off-channel habitat restoration*. In the Portland region, restored sites are seeing increased use by salmonids.
  - *Fish barrier removal*. Removing fish passage barriers like dams and culverts was seen as successful, but participants felt that terrestrial wildlife passage should be included in the assessments. Also, culvert regulations should focus on both fish passage and hydrology; in some cases retrofits designed solely for fish passage have not adequately handle sediments, instream wood, and floodwaters.
  - *Land acquisitions*. Acquisitions can be very effective and are becoming more common with passage of local and regional bond measures.
  - *Bank modification*. Re-grading streambanks to allow for more natural flood cycles is seen as a way to enhance the diversity of habitats and floodplain functions.
  - *Native vegetation*. The City of Florence has a successful program for maintaining native riparian vegetation. Vegetation clearing permit requirements encourage developers to protect native vegetation when clearing, and to favor native vegetation in landscape plantings.
- Low Impact Development (LID). LID in new developments and reconstruction (retrofits) was seen as successful. Green roofs were seen as working well to retard stormwater runoff.
- Puget Sound Salmon Recovery Plan<sup>15</sup> process. The overall plan rolled multiple watershed plans into one master plan. Salmon recovery efforts are now aligned with utility districts.

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<sup>15</sup> <http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Recovery-Plan.cfm>. Accessed Aug. 15, 2011.

- Streamlining permit processes. The City of Portland streamlined permits for city projects by bringing multiple state and federal agencies together. Efficiency increased significantly. Timelines for attaining permits has decreased 200% and costs related to attaining project permits have also decreased.

### ***Mixed Results Actions, Programs, and Policies***

- Funding. Funding for watershed councils is limited and funds granted through OWEB often do not include money for staffing, reducing the capabilities of individual watershed councils. Funding for education and outreach is lacking at the federal and state levels, leaving local groups to try to fill the gaps. More money is also needed for voluntary programs on private lands. OWEB funding is not focused on urban areas. OWEB needs to invest effort in determining watershed improvement priorities.
- Data availability and use. Several participants expressed concern about data availability and being able to use data to leverage actions. Concerns included:
  - Data sets that cannot be combined or compared have proliferated. This is inefficient (in terms of cost-effectiveness) and reduces the amount of information that can be gleaned from multiple data sets. More integrated data collection strategies need to be developed so that costs are reduced and the usefulness of the data is increased.
  - The data that are collected need to be more comprehensive in scope, and more focused on ecological endpoints or indicators that can be used in adaptive management.
- Specific rehabilitation techniques. Several techniques used for watershed or aquatic habitat rehabilitation had mixed results, according to participants. In general, in-stream projects implemented without first assessing watershed fluvial processes resulting in marginal improvements. Techniques mentioned by participants included:
  - *Shade and stream temperature.* Planting trees in riparian areas to reduce stream temperatures in urban areas was seen as successful by some participants, but was questioned by others. Most research on shading effects on stream temperatures has been done in forested systems, and participants disagreed on whether the results can be appropriately extrapolated to urban areas. Some participants felt the efficacy of shading is over-emphasized.
  - *Gravel augmentation.* Gravel augmentation of streambeds in the Clackamas River did not have the intended affect of significantly lowering stream temperature, but did help provide more refugia for fish.
  - *Erosion control.* In general, surface erosion control was seen as successful in keeping material out of waterways in urban environments; however, rip-rapping banks was noted as often causing downstream erosion problems.

- ODEQ's TMDL Program. Participants felt that various aspects of ODEQ's TMDL program have produced mixed results. The program does not enable all the water quality drivers in a watershed to be addressed. The overall efficiency of the program needs to be improved and more enforcement against offenders is needed. More data are needed on sources of pollutants and toxic substances present in waterways. More BMPs are needed for bacterial pollutants (wildlife sources of bacteria in particular are not well addressed). Air quality impacts on water quality (e.g., atmospheric deposition of mercury) also need to be incorporated into TMDLs.

ODEQ is taking a new watershed approach<sup>16</sup> in order to improve prioritization of environmental issues and incorporation of stakeholder concerns. Unlike the traditional TMDL process, the new approach takes into account overall watershed environmental status and trends, and does not focus solely on Clean Water Act 303(d) listed streams.

- Mitigation. Participants felt developers should have more flexibility in using off-site vs. on-site mitigations, or in mixing the two. On-site mitigation can be problematic where there are legal or physical challenges. Industry and environment professionals seem to prefer off-site mitigation, but the effectiveness in terms of ecological services provided may not be comparable to the project site.
- Stormwater Permitting Program. The program works well for Phase I communities but is weaker in Phase II communities<sup>17</sup>. Many smaller communities are not even required to have stormwater management plans because they are not part of the Phase II program. Many smaller communities that are part of the Phase II program may not have adequate stormwater management plans in place. The plans are rarely holistic or fully implemented. There needs to be better coordination of stormwater plans across jurisdictions. Stormwater quality (not just the conveyance of water off site) needs to be addressed in the permitting program.

### ***Failed Actions, Programs, and Policies***

- Statewide Planning Goal 5 and riparian ordinances. Participants felt that local riparian ordinances and Goal 5 are not being enforced, and many communities are not in compliance. Political and development interests were identified as key reasons for ordinances not being effectively implemented. Participants suggested that Goal 5 needed to be clarified, implemented, and periodically reviewed by DLCD, and a statewide riparian standard was needed across all land uses and regions.

Public support is critical, but difficult to gain, for managing private property along waterways under Goal 5. The City of Portland's city-wide stream initiatives attempted to protect riparian areas with environmental overlay zoning. Efforts failed because of citizen

<sup>16</sup> <http://www.deq.state.or.us/wq/standards/docs/toxics/humanhealth/rulemaking/TMDLIMD.pdf>. Accessed Aug. 15, 2011.

<sup>17</sup> The Phase I program requires NPDES permits for large municipalities that have populations of 100,000 or more. The Phase II program extends permit requirements to smaller communities (<100,000 residents) that fall under the US Census Bureau's definition of an urbanized area, referred to as small *municipal separate storm sewer systems* (MS4s).

backlash. Portland now has an updated natural resource inventory showing the location of significant riparian corridors and wildlife habitat, and describing the functions and attributes of these resource areas. This information is informing policy discussions relating to resource management along the Willamette River and other areas of Portland. Regulating development on private property continues to be challenging.

- Brownfield redevelopment. Brownfields (underused or abandoned industrial and commercial sites contaminated by hazardous materials) can have a high value for redevelopment (for example, along riverfronts), but the cleanup costs can be prohibitive. The potential liability of the developer can also prevent redevelopment. New development of previously undeveloped lands is often less expensive. New partnerships and incentives may be needed to make brownfield redevelopment more appealing to developers.
- Ballard project. The City of Seattle (Washington) installed low infiltration bioswales in the Ballard neighborhood. The bioswales accumulated standing water during the winter months, leading to community outrage and political backlash. Real estate agents also saw the open water in bioswales as objectionable. More community education was needed for citizens to understand the value of bioswales, and how stormwater runoff affects salmon.
- Invasive species control. In general, attempts to manage and control invasive species were seen as not successful by participants. Plants have been generally more problematic than animals in Oregon so far, but this could change over time.
- General rehabilitation activities. Some aspects were seen as problematic:
  - *Project maintenance*. Funding and resources are often not available to maintain restoration and enhancement projects after initial implementation.
  - *Baseline monitoring*. Baseline monitoring (pre-project implementation) is often not funded. It is not seen as a priority for restoration, but is necessary to assess project outcomes.
  - *Effectiveness monitoring*. Many practitioners do not have the ability or capability to conduct effectiveness monitoring because of funding and staffing issues.
  - *Data availability and use*. Available data are often not being used. Data can sit in boxes or files, unanalyzed, and unavailable for use by others.
  - *Lack of Consistency*. Overall there is a lack of consistency among monitoring designs, methods, and indicators.
- Beaver management. There is a general failure to properly address potential flooding issues, ownership/property issues, and hydrological benefits in beaver management plans. For example, riparian plantings can attract beavers, causing unanticipated flooding.
- Underground injection control (UIC) systems. The success of UICs varies according to underlying geology (i.e., porous sandstone vs. non-porous basalt), and they may not be equally effective in all regions of Oregon. In Prineville, developers paid to build high end UICs, but the City of Prineville has had to fill in several because they weren't functioning properly and installed more traditional stormwater discharge systems instead.



- Statewide Environmental Education. Participants felt that students are not developing adequate environmental literacy in school. They felt that the lack of required environmental education in K-12 schools is a major shortcoming. It was noted that Oregon does have an environmental literacy program but it is not required, funded or implemented.
- Policy failures. Participants identified several areas where policies or the lack thereof impede good management of watersheds and aquatic resources. These included:
  - no state level comprehensive environmental protection act;
  - no consistent statewide riparian and floodplain policy addressing all land uses;
  - no effective riparian buffer protection legislation;
  - no policy level priority to protect uplands and headwater areas as part of riparian restoration actions;
  - lack of public involvement in decisions, which can lead to weakened support and political backlash (e.g., Lane County’s McKenzie River floodplain/channel migration zone);
  - inadequate protection of instream water rights and in-stream uses;
  - greenway goals can be difficult to implement in urban areas that are already urbanized (i.e., have installations of hard surfaces such as buildings and roads);
  - lack of regulation for new chemicals and pollutants released into the aquatic environment; and
  - monitoring data are often not being used to inform policy decisions.
- Floodplain and coastal area management. Development is encouraged in high risk areas like floodplains and coastal areas through programs such as federal floodplain insurance. Older properties often receive grandfathered allowances to use erosion control measures (for example, rip-rapping) that can cause erosion problems on other properties and have negative effects on aquatic habitats. Model floodplain ordinances developed by FEMA and other entities that are not compliant with the federal ESA could leave local municipalities vulnerable to third party litigation. Participants felt that 100 and 500 year floodplains should be considered in floodplain management programs. The State needs more acceptance of moving redevelopment away from riparian corridors. FEMA money could be used to relocate structures out of floodplains after flood damage has occurred.

### ***Lessons Learned***

- Public support is critical to the overall success of projects and policies aimed at improving watershed and aquatic ecosystem conditions in urban areas. Crises motivate people, but managers and practitioners should not wait for a “train wreck” before taking action.
  - Agencies and local jurisdictions need to make an investment in public education and involvement.

- Rehabilitation and restoration projects need to have clearly established goals and thresholds for success. These need to be documented and shared with the public.
- Opportunities (like citizen advisory committees) need to be created for public participation.
- Governing bodies need to address public comments in a transparent manner in revised project plans; to fail to do so weakens public confidence in the process, and support for projects.
- Long-term maintenance of LID installations needs to be taken into account, particularly where there is a lack of funds for maintenance. Sites chosen for LID should be as easy to maintain as possible.
- Practitioners need to understand larger-scale watershed functions and conditions before projects are implemented. Offsite conditions can affect project outcomes.
- Conservation land acquisitions around urban growth boundaries can be difficult. Creative clauses in acquisitions, such as allowing owners to occupy structures or farm the land until their deaths, have been demonstrated to be successful incentives for land owners to agree to offers to acquire their lands.
- “Lifecycle” responsibility<sup>18</sup> for appliances and pharmaceutical products are good ideas to minimize unwanted items and chemicals ending up urban waterways.
- Opportunities for multidisciplinary groups to meet are needed. Convening science groups or teams to review and inform policy is a positive step to improving management of aquatic resources. Groups such as the Urban Ecosystem Research Consortium allow for the disciplinary crossover crucial for managing ecosystems.
  - Managers need to foster understanding of the direct links between incremental actions of daily life and larger environmental problems.
  - Education is critical for both the public and elected officials. Because elected office holders turn over regularly, environmental education must be a continuous process.
- Agency managers and practitioners at all levels need continuous education to ensure high quality projects. Agencies also need to create better, consistent standards that apply to all rehabilitation projects. Public agencies should lead by example and do projects correctly and efficiently, not just cheaply.
- Big problems should not be viewed as obstacles but as reasons to collaborate. In spite of regulatory gridlock that sometimes makes it difficult for agencies to collaborate, they need to agree on issues and processes to solve problems.
- Regional and statewide policies cannot be “one size fits all”. There is a high variability of environmental conditions across the State. What works well in one area may not work well in another (e.g., standard stormwater discharges vs. UICs).

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<sup>18</sup> Lifecycle responsibility means taking responsibility for a product from the time of purchase through disposal and recycling of the product.

## **OBJECTIVE 2. Determine what monitoring and research needs may have been missed in the Urban Report and prioritize research and monitoring needs in urban native fish ecology and rehabilitation.**

### **2.1) After review of the chapter entitled Science Question 4 of the Urban Report, are there some other monitoring and research needs not included in the chapter? What are some additional monitoring and research needs?**

Science Question 4 of the Urban Report (Appendix D) summarized research and monitoring needs that the IMST felt warranted greater attention from Oregon Plan for Salmon and Watershed partners. In general, these research and monitoring needs included: better research and evaluation of the effectiveness of policy and management practices in urban and rural-residential areas to improve and better protect aquatic resources; a better understanding of how toxic chemicals affect the aquatic environment; determination of the effectiveness of rehabilitation/restoration strategies for salmonid habitat and populations in urban and rural-residential areas; and a better understanding of how to more effectively communicate and engage the public to increase their awareness of watershed functions and health of aquatic ecosystems.

The following research and monitoring needs were identified by one or more of the workgroups at the 2011 workshop. Several (e.g., toxic pollutants, climate change) are also listed in the next section, concerning the most pressing issues identified by participants. These are not listed in order of importance.

- General water quality issues (toxic pollutants are listed in the next section under most pressing issues):
  - Examine the sources and root causes of water pollutant impacts, particularly atmospheric deposition. Air pollutants need to be monitored and managed with more emphasis on how they affect water quality.
  - Determine how the quality of water from stormwater treatment systems is affected by underlying substrates (i.e., sand, clay, etc.).
  - Determine how traditional stormwater engineering solutions can be modified under various environmental conditions?
  - What are the impacts of bacterial contamination on salmonids and aquatic ecosystems? There is a need to sort out whether bacteriological impacts on salmonids are primarily related to reduced-levels of dissolved oxygen or to toxic substances.
  - What is the relative importance of the various stressors in urban waterways and which ones need to be addressed first (e.g., toxic chemicals vs. dissolved oxygen)?

- How can one separate the ocean upwelling and estuary impacts on water temperature, salinity, and dissolved oxygen, in monitoring results from developed sites in coastal areas?
- How can urban stormwater systems be retrofitted to improve water quality? The National Co-Op Highway Project at University of Texas that retrofitted urban stormwater systems to remove metals was brought up as an example of an approach that can be used.
- Will retrofitting older urban areas result in water quality improvements?
- More economic and social analyses are needed to determine what people value and what policies and strategies work best in communities for improving water quality and for enhancing and protecting terrestrial and aquatic habitats. For example, Reed College (Portland, Oregon) is doing research on the correlation between greenspaces and home values in Portland<sup>19</sup>. More research in this area is needed for other Oregon urban areas.
- More research is needed on the functional nature (e.g., ecosystem attributes, importance to key species) of urban natural areas within the landscape. Should cities adjust their urban growth boundaries to increase natural spaces within them versus protecting lands outside those boundaries? What social and education services do natural areas provide city dwellers? How can these needs be determined and translated into targeted acreage and placement of natural space? Local and regional agencies need to conduct buildable lands surveys to determine where natural space is needed the most.
- How effective are land acquisitions as a tool? Are acquisitions an effective investment for municipalities? How do managers make informed choices between restoring a site and acquiring a new one? How can connectivity corridors be factored in?
- More cost-benefit analyses are needed on environmental protection and LID techniques, and the information needs to be made more accessible. It is assumed that new infrastructure is often cheaper when LID is used instead of traditional development methods. How do cities determine the services green infrastructure is providing to residents?
- Need more alternative futures analysis (e.g., OSU's model ENVISION<sup>20</sup>) and consider cities systematically in the analyses that assess varying potential urban growth patterns and how they affect watersheds and aquatic resources.
- There is a need to determine how and when more natural system-based strategies can be used in place of traditional or highly-engineered solutions (e.g., wastewater treatment lagoons vs. mechanical treatment).

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<sup>19</sup> Netusil NR (2005) The effect of environmental zoning and amenities on property values: Portland, Oregon. *Land Economics*. 81: 227246.

<sup>20</sup> <http://envision.bioe.orst.edu/> . Accessed on Sept. 7, 2011.

- How is pre-development hydrology defined? Is it immediately prior to development? 50 years ago? 100 or 200 years ago?
- Follow up studies are needed to show how BMPs work over decadal scales, not just one or two years after implementation. There is a need for more long-term ecological research sites in urban areas.
- How do urban areas affect native and non-native piscivore predation rates on native salmonids? How can predation rates increased by the urban environment be reduced?
- How do salmonid rehabilitation efforts affect other sensitive wildlife species and plant species? How can restoration plans be modified to benefit more species? How can wildlife connectivity corridors be incorporated into rehabilitation efforts? A suggestion was made that better synthesis of information should be made more accessible to decision makers to help show how an action to improve salmonid habitat (e.g., 500 ft. intact riparian buffers) could benefit other species of concern. The information could help demonstrate the environmental benefits of regulations.
- How does the trend of higher house square footage coupled with a decreasing number of dwellers in individual households affect impervious surfaces? How does the current trend in some areas of more people renting apartments instead of buying houses affect impervious surfaces? How do both of these trends affect aquatic habitat?
- How will rehabilitation and other efforts (e.g., LID) in urban areas located lower in the watershed affect or be affected by upstream efforts?
- How do invasive species (by species, abundance, distribution, associations) affect riparian functions? How effective are management efforts at controlling or minimizing impacts on invaded sites and preventing species from spreading into new areas?

**2.2) In your experience, which research and monitoring needs either listed in Science Question 4 or added in item 2.1 above are most pressing? What are some specific examples of information gaps that need to be addressed?**

All three workshop groups mentioned funding as one of the most pressing research and monitoring needs. All agreed funding for monitoring and disseminating results is inadequate. There was also a call for more applied research in general. In addition to funding, the topics below were identified by one or more of the work groups as their most pressing issues.

*Climate Change*

Participants expressed concern that public acceptance of climate change is eroding with time, and ways are needed to get citizens and policy makers to address a problem they may not feel is problem. Some also perceived a feeling of helplessness among the general public about the ability of individuals or small groups to positively affect climate change impacts. Some participants felt that there is a large emotional component to the public's response to climate change, and ways are needed to address the issue beyond simply providing scientific information. Agencies need ways to personalize information that will move people to modify behaviors before a crisis occurs. The specific areas of climate change research that participants identified as pressing were:

- More weather stations are needed to monitor long-term changes and they need to cover more ecophysiological gradients (e.g., Cascade crest to coast).
- Regional and local climate change models are needed. Current climate change modeling is mostly done at coarse scales, leaving managers in need of more local information from "high resolution" modeling. The following questions need to be addressed: How will climate change affect stream temperature, water budgets, and hydrological regimes? How will climate change affect vegetation? How will climate and vegetation changes affect stormwater runoff and sediment processes? How will groundwater availability and recharge be affected? What are the implications of climate change on urban aquatic and riparian ecosystems and hydrology?
- Given climate change, are practitioners planting the right plant species? Will streams go dry regardless of the efforts we are taking? Are there climate change driven disconnections that may occur between plants and pollinators? Practitioners need to know the implications of life cycle interactions under dynamic climatic conditions.
- How will climate change affect water availability and how can managers plan for adequate stormwater retention systems?

### ***Low Impact Development (LID)***

Can LID actually produce the intended results? Some participants felt that LID is primarily designed to address water quantity, with less emphasis on water quality. Research, modeling, and futuring analyses are needed to determine how much LID is needed in urban and rural-residential areas to make a positive change in watershed hydrology and water quality. How effective are LID strategies at a regional scale? Can LID strategies be used to improve water quality, capture carbon, improve air quality, and generally meet multiple objectives? Could LID structures eventually create toxic sites, with accumulations of toxic substances in soil, plants, or mulch? Overall, what is the general maintenance cycle for LID structures?

### ***Regulation Effectiveness***

Participants identified a need for research on how to increase the effectiveness of regulations and management strategies in protecting water quality, aquatic resources, and watershed functions. Several participants noted that the State of Oregon lacks a consistent, enforceable statewide riparian policy. For example, the Oregon Forest Practices Act contains policies (coordinated by the Oregon Department of Forestry) for managing riparian areas on forest lands, but for other types of land uses, such policies may be inconsistent, ineffective, or non-existent. Furthermore, regulations tend to focus on stream and riparian conditions with little attention to impacts from adjacent uplands.

Participants felt that the full spectrum of regulations should be evaluated (e.g., via sociopolitical research) to determine where gaps, inconsistencies, and contradictions exist. This would likely lead to sweeping (not incremental) changes. Regulations and management strategies need to consider the entire landscape using land use and zoning as fundamental units. The application of policies across the landscape should not be fragmented by differing agency mandates or limits of authority. Regulations should be redesigned to be comprehensive and statewide, to cover a long time period (e.g., for the next 100 years), and to anticipate land use changes. The State needs regional prioritizations that go beyond individual agency or municipality jurisdictions.

### ***Toxic Chemicals***

Toxic chemicals, including those in pharmaceuticals and personal care products, are increasing in number and variety and are entering aquatic environments. More research is needed on the types of toxic chemicals, the sources of toxic pollutants, and their fate in the ecosystem (i.e., water column, sediments, aquatic organisms), especially those that are bioaccumulated. The top priority toxic chemicals for monitoring need to be determined. Prevention and removal methods need to be developed. Additional comments from participants were:

- Current laboratory methods do not consistently reflect field conditions for toxic substances in streams and stormwater. For example, dissolved copper measured in the lab may not be ionically equivalent to copper found in streams. In addition, lab tests for individual compounds do not reflect synergistic effects of multiple compounds in the environment.
- What bioaccumulators (e.g., native plants) could be used to mitigate for dissolved copper? What is their effectiveness?
- What are the full effects of application of sewage sludge, especially with regard to the persistence and bioaccumulation of toxic chemicals?
- What are the direct and indirect connections between atmospheric deposition and water pollution?

### ***Restoration/rehabilitation Effectiveness***

Systematic effectiveness monitoring is severely lacking. It is critical to determine whether actions being taken are improving conditions, and how effective restoration and rehabilitation practices can actually be. It is also necessary to determine how much of an activity has to be implemented to positively affect environmental conditions. Specific questions from participants included: What measureable changes in water quality and stormwater runoff can be shown for retrofitted urban areas? Can existing urban areas be retrofitted to increase salmonid populations?

### ***Groundwater***

Several significant knowledge gaps about groundwater exist. For example, there is poor understanding of the effects of numerous unpermitted rural wells on groundwater systems. In coastal areas where saltwater intrusion is an issue, managers lack information on how wells and withdrawals affect groundwater resources. Additional questions include:

- How do withdrawals affect groundwater quantity and quality?
- How does surface water affect groundwater in the various geological regions of Oregon?
- How effective is groundwater mitigation and recharge in various regions?
- What is the fate and transport of contamination in stormwater that is injected into groundwater (i.e., UICs)?

### ***Transportation Networks***

Oregon needs better information on the cumulative impacts of transportation infrastructure (e.g., fish/wildlife passage, distribution of stressors). There is a need to identify roads that are



contributing the most to stream and river degradation, prioritize corrective measures, and determine which roads could be decommissioned.

### ***Data and Information Availability***

Participants identified lack of access to and sharing of data and related information concerning environmental conditions and restoration projects as key issues that need further attention. Much information is being collected, but it is not shared among agencies, locally or across geographical areas. A centralized data exchange for environmental and restoration data in the Pacific Northwest is needed. Several databases do exist but they are often narrowly focused (e.g., STORET<sup>21</sup>, ODEQ's LASAR database<sup>22</sup>, OWEB's Oregon Watershed Restoration Inventory<sup>23</sup>, International Stormwater BMP Database<sup>24</sup>, StreamNet<sup>25</sup>, Center for Watershed Protection<sup>26</sup>). Practitioners noted the need for knowledge of the specific links between diverse land uses within a watershed, and knowledge related to land uses and environmental conditions.

Participants felt monitoring and research data need to be readily accessible and widely disseminated beyond agency practitioners. The databases need to be framed in a way that is compelling and understandable to the public. More resources need to be invested in communicating monitoring results on 'hot button' issues, those that people will respond to. Practitioners need to be able to synthesize monitoring data into a 'story' that the public and policy makers can easily relate to. Practitioners, managers, and policy makers also need to engage the public by sharing and explaining monitoring information that is applicable to their neighborhoods and back yards. OWEB and NGOs can provide education assistance and access to technical information, tools, and perhaps help develop incentives for taking action. Demonstration sites can help make the information and the need for improvements more tangible. Managers and practitioners need to understand community values and priorities in order to effectively share information.

Participants felt that practitioners, managers and decision-makers need more help in interpreting the outputs of models, especially in the area of applying information at the appropriate scale and geographic area. In addition, data are needed at the appropriate level of resolution for the questions being asked.

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<sup>21</sup> <http://www.epa.gov/storet/>. Accessed Sept. 7, 2011.

<sup>22</sup> <http://deq12.deq.state.or.us/lasar2/>. Accessed Sept. 7, 2011.

<sup>23</sup> <http://www.oregon.gov/OWEB/MONITOR/OWRI.shtml>. Accessed Sept. 7, 2011.

<sup>24</sup> <http://www.bmpdatabase.org/>. Accessed Sept. 7, 2011.

<sup>25</sup> <http://www.streamnet.org/>. Accessed Sept. 7, 2011.

<sup>26</sup> <http://www.cwp.org/>. Accessed Sept. 7, 2011.

**2.3) How do you prioritize current monitoring activities? What factors influence your priorities? How do you prioritize information gaps that might be addressed by further monitoring? How do you prioritize information gaps that might be address by original scientific research (either in your jurisdictions or more generally)?**

Time constraints prevented most of the work groups from discussing these sub-questions in depth. Below is a brief outline of the priorities mentioned and the key factors that affect monitoring priorities.

- Toxic chemical monitoring needs to be a much higher priority in Oregon. We need to look at a wide array of toxic chemicals and measure impacts across various spatial and temporal scales to determine which chemicals have the most impact on the environment. A wider variety of test organisms and toxic chemicals should be evaluated. Because toxic chemicals are expensive to monitor and test for, it would be helpful to identify more easily measured surrogate chemicals. It may be possible to monitor at smaller scales or to systematically monitor in an upstream direction in order to identify key sources of toxic pollutants.
- Need to prioritize monitoring that will really inform adaptive management. Consensus on monitoring priorities should be built across disciplines and agencies. Some agencies are better positioned to monitor certain parameters or indicators. Regulations can help set relevant monitoring priorities. It is necessary to include mandates for monitoring within regulations to ensure that adequate monitoring occurs. The usefulness of data being collected should be regularly evaluated.
- Developing methods to bring disparate data together should be a priority.
- Need to evaluate the amount of natural and assessment uncertainty in system dynamics and the potential for us to influence the systems.
- Every community and every neighborhood is different. Determining what a community values will help in setting priorities. Investing in education and communication will help turn awareness into community action.

#### KEY FACTORS AFFECTING MONITORING PRIORITIES

Participants identified several key factors that affect their abilities to conduct monitoring. These were:

- money
- timelines
- political will
- public support and engagement
- staffing
- cost of effective research/monitoring
- funding source requirements
- partnerships (agencies, universities, public)
- regulations

- issues that directly impact human health and safety
- tasks that are feasible or information gaps that can be readily addressed; difficult and/or long-term tasks may be put at lower priority levels
- access to existing data (e.g., high-resolution remote-sensing data)
- site access, both private and public lands, can affect selection and randomization of monitoring sites

## **OBJECTIVE 3. Identify and prioritize actions that could enhance or rehabilitate native fish habitat and populations in urban environments.**

### **3.1) The Urban Report suggested a variety of actions that environmental managers could take that would enhance or rehabilitate native fish habitat and populations in urban environments. What further management actions would you like to see implemented?**

Workgroup participants listed many actions they felt were needed. These are grouped into broad, non-prioritized categories below. After the general discussion each group determined its top priorities, and these are listed by workgroup in Section 3.2. An overarching theme was the need for regional approaches to managing aquatic resources, stormwater, and water quality that both integrates federal, state, county, and local policies and regulations and is tailored to the specific ecological, geological, hydrological, and social issues of each particular area. The following actions were recommended by workshop participants:

#### Stormwater Management and Erosion

- Increase tree canopy area to help reduce runoff.
- Minimize future impervious surfaces and reduce existing impervious surfaces.
- Increase local capacity to manage surface stormwater (e.g., create rights-of-way wide enough for natural management of stormwater).
- Develop better stormwater management (particularly LID) for all sizes of communities.
  - Address and treat first and second flushes for pollutants.
  - Re-engineer stormwater systems to include water treatment.
- Enhance regulations and incentives for LID for all new developments and for redevelopments.
  - Retrofits need incentives, including market-driven incentives.
  - Different incentives and approaches are needed for rural-residential areas than for large metropolitan areas.
- Develop ordinances and regulations to control erosion at the local level for small lots and developments less than one (1) acre in size.
  - State agencies, NGOs, or larger municipalities could provide technical assistance and resources for smaller communities for permitting and LID strategies.

## Condition of Riparian Areas, Floodplains, and Aquatic and Terrestrial Habitats

- Create a comprehensive state-wide riparian and floodplain policy that includes rules, protocols, and enforcement for all land uses.
  - Integrate current rules, policies, and management plans to provide better protection for aquatic resources, floodplains, and riparian areas. For example, integrate Statewide Planning Goal 6 (air, water and land resource quality) with Goal 5 (natural resources, scenic and historical areas, and open spaces).
  - Take advantage of opportunities to move built structures and infrastructure out of floodplains.
- Investigate incentives for riparian buffers and enhancements.
  - High quality habitat should be better protected through conservation easements or acquisitions.
  - Use land acquisitions to increase the number of riparian corridors in urban reserves.
- Increase stream day-lighting and re-meandering, where appropriate.
- Give more attention to the effects of noise and light pollution on wildlife, and develop effective methods to mitigate or abate harmful impacts.
- Promote state-wide assessments of urban and rural-residential ‘hot spots’ for ambient air temperature, and provide incentives for mitigation (e.g., increase albedo<sup>27</sup> or reflection, increase tree plantings).
- Categorize areas as ecologically healthy, sensitive, or degraded before development is planned or approved to help minimize negative impacts on watershed functions and aquatic resources. It is better to protect rather than rehabilitate key areas.
- Put more focus on maintaining and creating off-channel salmonid rearing habitat.
  - Too much focus is on dams and not enough on channel complexity and wetlands.
  - Breach levees and dikes where appropriate and remove concrete reinforced channelization structures to create off-channel habitat.
- Improve invasive species management in urban and rural-residential areas.
  - Increase regulations, enforcement, and incentives for preventing invasions and controlling population expansions.

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<sup>27</sup> Albedo is the proportion of the incident light or radiation reflected by a surface.

## Monitoring

- Conduct more effectiveness monitoring (including pre-treatment measurements and baseline conditions) of rehabilitation projects and actions. Some of the parameters recommended by workshop participants include toxic airborne compounds, albedo, water quality, and environmental stressors.
- Develop and maintain well-distributed networks for monitoring, including more stream gauges, water quality stations, weather stations, and fish tag sensing networks that can provide more locally relevant data and detect statistically significant trends.

## Water Quality, Toxic Chemicals, and Other Pollutants

- Create a dedicated funding source for water quality improvements, including those targeted at non-point source pollutants. Provide funding for adequate staffing, monitoring, and research.
- Provide more funding and staffing for ODEQ to be able to conduct full watershed analyses. Determine how ODEQ can increase post-TMDL water quality monitoring in the absence of adequate funding for state and local jurisdictions.
- Improve stormwater and wastewater treatment to help meet in-stream water quality standards by removing bacteria (particularly from domestic and wild animal waste sources and septic tanks), toxic chemicals, and other pollutants. Determine how wastewater effluent can be re-used (e.g., for irrigation). Put treated water back into stream systems as quickly as possible.
- Increase monitoring and participation in clean marina programs.
  - More pump-out facilities are needed at boat launches, boat check stations, and refueling stations.
  - Sewage from boats is not well addressed. Participants noted that many live-aboard boats and houseboats are still dumping sewage into rivers despite initiatives like Oregon State Marine Board's Clean Marinas Program<sup>28</sup>.
- Increase monitoring of air toxic chemicals and enforcement of regulations. Increase attention to the effects of atmospheric deposition on water quality.
- Brownfields and other legacy pollution sources (e.g., superfund sites, closed landfills) need to be cleaned up and be more heavily regulated to minimize impacts on aquatic ecosystems.

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<sup>28</sup> [http://www.boatoregon.com/OSMB/Clean/clean\\_marina.shtml](http://www.boatoregon.com/OSMB/Clean/clean_marina.shtml). Accessed Sept. 8, 2011.

- Determine where brownfields fit into policy and regulatory oversight so that they are more effectively managed. Determine whether they come under Statewide Planning Goal 9 (economic development) or under ODEQ's jurisdiction.
- ODEQ has identified broad classes of pollutants for a statewide comprehensive toxic reduction strategy. Other local and state agencies need to assist ODEQ with implementation (e.g., city road herbicide management). In general, toxic substances need to be reduced.
- Increase regulation and guidelines for how hazardous waste can be stored and what waste can be disposed of in landfills.
  - Ensure proper disposal of street sweepings and contaminated bioswale vegetation.
  - Expand household hazardous waste round-ups and include items such as electronic waste and pharmaceuticals along with hazardous chemicals like pesticides.
- Ban copper from use in vehicle brake linings.
- Identify and address sources of salmonid pre-spawning mortality related to water pollution.
- Identify septic systems in urban and rural-residential areas that do not operate correctly.
  - ODEQ should create an easily accessible statewide database of septic systems and their status (e.g., age, type, location, known working condition).
  - Provide adequate funding and resources to enforce compliance with regulations and to mitigate for contamination caused by failed systems.
  - Establish loans and grants to help homeowners fix failing systems.
- Expand market-based trading for ecosystem services. Participants indicated there are 12 utilities in Oregon that are interested in water quality credit trading but only one, Clean Water Services, is currently allowed to do so. Allocate more resources to help ODEQ promote increased trading by utilities and other entities.
- Streamline ODEQ's permitting process for stormwater and wastewater treatment plants.

#### Public Education and Local/Regional Resources

- Identify and fund small model/demonstration watersheds and sites in urban and rural-residential areas for restoration/rehabilitation projects, LID, and retrofits. Provide interpretative signs to promote action and educate the public.
- Increase education on proper application of household pesticides and how to reduce their use in the home and yard.

- Explore public and business consumption patterns that could lead to reducing a community's ecological footprint. Provide incentives to promote environmentally beneficial behaviors (e.g., disconnecting downspouts or paying actual costs for utilities and other resources).
- Improve citizen education and outreach programs to foster engagement in restoration and protection of aquatic and riparian resources.
- Create and promote more diverse partnerships between agencies, educational institutions, non-profit organizations, businesses, and stakeholder groups.
- Provide resources for rural landowners to find funding sources and information to implement restoration on their property.
- Provide coordinators for schools and youth groups to increase environmental literacy and exposure to the outdoor environment and ecosystems. Develop curriculum requirements and educational materials. Develop partnerships among schools, local NGOs, youth groups, agencies, and universities to provide resources and knowledge.
- Hire trained, salmon-knowledgeable staff in agencies and allow them to work with other local governments and groups to provide technical services and relay information about how management and policies affect aquatic resources.



### **3.2) Given the variety of suggested actions, both by the Urban Report and additional ones from item 3.1 above, how would you prioritize them?**

Each group was asked to identify the top seven actions from their discussions for Section 3.1; that could be used as recommendations to the State of Oregon or to various local, regional, and state agencies. The priorities were not listed in order of importance. The groups used different formats to list their priorities, and they have been preserved here. These priorities are presented verbatim from each group.

#### **Group A.**

##### *Physical Aquatic Habitat*

- Policy
  - Develop plans, implementing tools, and funding sources at local and state levels that address ecological connectivity, habitat corridors, cumulative effects, anchor [critically important] habitats, incentives, and means to adapt to climate change.
  - Ecological connectivity<sup>29</sup> should be an explicit goal and state and local land use and infrastructure planning. Ecological connectivity should be treated equally with transportation and other infrastructure connectivity issues.
- Actions
  - All state agencies should review, report, and adapt policies, and tools (e.g., incentives and regulations) to improve habitat connectivity in urban and rural residential areas. The Oregon Plan Core Team is a good body to begin and oversee the process. State agencies should review and report to the Governor on how they intend to integrate ensuing recommendations into their operations and policies.
  - Continue development of stream and wetland functional assessments and implement their use. Use consistent language and methods across the state and among agencies. Explore how tool relates to urban and rural-residential stream restoration. Calibrate the assessments by land use potentials and determine what is reasonable and prudent for streams and wetlands in urban and rural-residential areas.
  - Research and Monitoring
    - Investigate links between improvements to streams/watersheds for salmonids and how these benefit other species.
    - Craft ecosystem-based management standards and practices.

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<sup>29</sup> Stream and riparian corridors provide the majority of ecological connection between terrestrial and aquatic habitats.

### *Built Environment and Land use*

- Policy
  - How do you enforce or encourage retrofitting built-out environments?
  - Need to establish statewide and local triggers and guidance for redevelopment (e.g., in Lake Oswego its set at 6,000 sq. ft. while others like in Portland its much lower, 500 sq. ft).
- Actions
  - Develop options, approaches, and tools for managing effective impervious areas at the watershed scale including but not limited to identifying targets and limits for effective impervious area.
- Research and Monitoring
  - Compile data on protection policies in each city across the state:
    - to inform state regulatory assessment/permitting, and
    - to facilitate technical assistance.
  - Identify an array of tools for reducing impervious areas through property taxes and/or incentives
  - Develop tools (e.g., OSU's model ENVISION) and pilot projects on how to set effective impervious surface limits at the watershed scale.
  - What objectives are LID strategies meetings and how can the strategies be improved to more effectively meet the objectives (e.g., carbon sequestration, habitat, urban heat island effect, normalizing hydrology)?

### *Stormwater, Groundwater, and Hydrology*

- Integrate policies and agency actions to consider stormwater, groundwater, and hydrology as a fully connected water system, not as three separate systems.
- Need to determine water storage needs in light of climate change. Some areas may need more impoundments to collect and store water as precipitation patterns change with the climate. Need to balance water storage and need for connected streams.
- Direct water resource reporting strategies to incorporate and balance ecological and economic needs.
- Better marine planning is needed to increase connectivity between hydrological and spatial systems.

### **Group B.**

- Reduce development in floodplains and work to achieve functional riparian areas. Restore floodplain acquisitions to functioning condition.

- Develop all-encompassing watershed plans to guide/inform other management actions (e.g., transportation, land use planning). Incorporate more, better-coordinated public education and outreach into the plans. Develop coordinated and integrated monitoring as part of the plans and projects, not as stand-alone pieces. Include stormwater drainage retrofits into the plans. Restructure policies and permit processes so that they are integrated and can be used to track portions of these plans.
- Conduct a pilot program to review and “reset” landscape policies and regulations.
- Encourage and enable the standardization and sharing of monitoring data (e.g., design specification, methods, and data). Integrate monitoring directly into projects and restoration plans.
- Establish alternative funding sources that are sustainable. Recognize the greater context (e.g., ocean, upstream) in determining what actions will result in the biggest impact for the money.

### **Group C.**

1. Develop better stormwater management guidelines for communities of all sizes. Good examples include LID requirements, regulations and incentives, adequate treatment of first and second flush runoff, erosion control ordinances for developments smaller than 1 acre, and increase technical and financial assistance for municipalities.
2. Implement ore monitoring, specifically baseline, pre- & post-project effectiveness, TMDL implementations, air and water toxics [toxic chemicals], and environmental stressors.
3. ODEQ should partner with other agencies to develop and implement a comprehensive statewide toxics [toxic chemical] reduction strategy for land, air, and water pollutants.
4. Foster diverse partnerships and collaborations in all actions/programs. Good examples include citizen education, outreach, and engagement with agencies, academics, non-profit organizations, businesses, and stakeholder groups.
5. Fund a “model urban and rural-residential watershed program’ to identify successful restoration/rehabilitation/enhancement projects and actions that can be shared with the public. Good examples should highlight positive effects of projects and actions including LID and retrofits. Model watersheds should incorporate interpretive signage and point to other case studies and research opportunities.
6. Create a dedicated, reliable funding source for water quality improvement including non-point source pollution. Funding should address staffing needs, monitoring, project maintenance, and research.
7. Create statewide riparian and floodplain regulations and incentives for all land uses

# APPENDICES

## ***Appendix A. Workshop Participants and Other Contributors***

### **Workshop Participants**

Sandra Belson, City of Florence, Siuslaw Estuary Partnership  
Jerry Brummer, City of Prineville  
Doug Drake, Oregon DEQ  
Patricia Farrell, City of Salem  
William Fletcher, ODOT Geo/Environmental Section  
Lori Hennings, Metro  
Teresa Huntsinger, Oregon Environmental Council  
Roberta Jortner, Portland Bureau of Planning and Sustainability  
Kevin Kilduff, City of Portland Rivers Office  
Eric Klann, City of Prineville  
Kristen Larson, Long Tom Watershed Council  
Torrey Lindbo, City of Gresham  
Kaitlin Lovell, City of Portland Bureau of Environmental Services  
Anne Nelson, City of Portland Bureau of Environmental Services  
Anita Panko, City of Salem  
Lisa Phipps, Tillamook Estuaries Partnership  
Bruce Roll, Clean Water Services  
Julie Ryden, Oregon State University  
Jason Schmidt, Long Tom Watershed Council  
Candace Stoughton, E. Multnomah Soil & Water Conservation District  
Trevor Taylor, City of Eugene, Parks and Open Space Division  
Lori Warner-Dickason, Oregon Department of State Lands  
Donald Yon, Oregon DEQ, Water Quality Division

**Other Contributors** (Contributors provided information but were not able to attend the workshop)

Jim Hossley, City of Coos Bay  
Chuck Mickelson, City of Ontario  
Josh Seeds, Oregon DEQ  
Greg Sieglitz, OWEB  
Adam Stebbins, Benton County  
David Wechner, Josephine County  
Eric Wold, City of Eugene

### **Facilitators**

Rick Bastasch  
Paul Hoobyar  
Marcia Sinclair

### **Note Takers**

Alex Desrochers  
Mat Dorfman  
Gunnar Johnson

## ***Appendix B. Workshop Objectives and Questions***

### **Workgroup Session #1: 10:00-12:30 questions**

**Objective 1.** Better determine the steps environmental managers are already taking, that may or may not have been covered in the Urban Report.

- 1) The Urban Report covered a variety of activities that local, regional and state agencies and non-profit organizations are conducting to enhance watershed health. What further management activities are taking place that were not covered in the Urban Report?
- 2) In your experience, what management activities have proven to be most successful? What are some examples of success? And, what are some examples of failures and lessons learned?

### **Workgroup Session #2: 1:15-3:45 questions**

**Objective 2.** Determine what monitoring and research needs may have been missed in the Urban Report and prioritize research and monitoring needs in urban native fish ecology and rehabilitation.

- 3) After a review of the chapter entitled Science Question 4 of the Urban Report, are there other monitoring and research needs not included in the chapter? What are some additional monitoring and research needs?
- 4) In your experience, which research and monitoring needs either listed in Science Question 4 or added in item 3 above are most pressing? What are some specific examples of information gaps that need to be addressed?
- 5) How do you prioritize current monitoring activities? What factors influence your priorities? How do you prioritize information gaps that might be addressed by further monitoring? How do you prioritize information gaps that might be addressed by original scientific research (either in your jurisdiction or more generally)?

### **Workgroup Session #3: 9:00-11:30 questions**

**Objective 3.** Identify and prioritize actions that could enhance or rehabilitate native fish habitat and populations in urban environments.

- 6) The Urban Report suggested a variety of actions that environmental managers could take that would enhance or rehabilitate native fish habitat and populations in urban environments. What further management actions would you like to see attempted?
- 7) Given the variety of suggested actions, both by the Urban Report and additional ones from item 6 above, how would you prioritize them?

## **Appendix C. Pre-workshop Survey Summary**

**Background Information** (This information will be used to help categorize the responses by region and population size. No names will be included with summarized information.)

**Name:**

**Agency/Organization:**

**City on un-incorporated area(s) dealt with:**

**County:**

Do you have staff that currently addresses water quality (including but not limited to stormwater, wastewater, septic systems), watershed condition, and/or aquatic habitat management in urban or rural-residential areas? **Yes No**

If no, do you contract this work out to another agency or organization? **Yes No**

Are native salmon and/ or trout populations of concern in the land area that your organization or agency manages? **Yes No**

Besides salmonids, are there other aquatic or riparian species or habitats that are of concern in your land management area? **Yes No**

If so, please list the key species or habitats.

### **Questions:**

**1) Is your agency or organization currently involved in water quality (including but not limited to stormwater, wastewater, septic systems), watershed condition, and/or aquatic habitat management in urban or rural-residential areas? **Yes No****

If so, briefly list the science, policies, and other information that guide your activities.

How does your group prioritize the activities?

**2) What water quality (including but not limited to stormwater, wastewater, septic systems), watershed condition, and/or salmonid habitat management and rehabilitation activities is your group involved with?**

What further technical or scientific information or tools does you group need to help plan, implement, and determine the outcome of these efforts?

What are your main sources for technical or scientific information or tools?

**3) What further steps do you feel need be taken to enhance or rehabilitate water quality, watershed condition, and aquatic organisms and their habitats and organisms urbanizing and developing environments?**

## **State Level Management**

**Responses received from agencies and NGOs:** Six responses were received from three state agencies and one response from one NGO.

### **Science Guidance:**

- Best available science (literature, monitoring, agency reports, International Stormwater BMP Database, etc.)
- Watershed assessments
- Reports from universities, federal agencies, and natural resource organizations

### **Policy and other guidance:**

- US Clean Water Act; TMDLs, NPDES permits, ESA guidelines, NMFS Programmatic Biological Opinion SLOPES IV
- Economic and political considerations can affect what is done.
- Local policies and priorities
- State policies
- OWEB Board priorities and OWEB strategic plan
- Model stormwater policies in the City of Portland, Gresham, and Clean Water Services.

### **Prioritizations (examples given):**

- Resources are determined by federal money and appropriations from the state legislature and Governor. Priorities are based on what the agency is required to do, what will gain the most benefit from the effort, and where the greatest needs are.
- OWEB Board and staff have struggled with prioritizing work in urban areas and to some extent in rural-residential. Making decisions about which projects and investments have a high likelihood of yielding watershed improvement dividends is a challenge.
- Look at relative contributions of priority pollutants and sensitive beneficial uses. Temperature, nutrients, sediment, and toxic chemicals are priorities.
- Stormwater and watershed activities are tied to transportation projects
- Based on needs that are currently not being met.
- Ability to secure grant funding.

### **Water Quality (including but not limited to stormwater, waste water, septic systems), watershed condition, and/or salmonid habitat management and rehabilitation the group or entity is involved with:**

- State level regulation of water quality. Oversees county and city plans. Prepares TMDLs for water quality restoration. Monitoring and reducing toxics are a priority.
- Restoring riparian conditions and functions as well as all forms of run-off from various land uses.
- Provide funds, information, and guidance for restoration and prioritization done by other entities.



- Provide funding for activities across multiple land uses designed to assess, protect, restore, rehabilitate, monitor, and educate the public on aspects of water quality. Less funding is directed specifically at stormwater and wastewater but related work does occur and the interface is closing.
- Offer “Stormwater Solutions” LID workshops in communities outside of Portland. Currently working on some for central Oregon.
- Provide pollution prevention programs and policy change, especially for toxics.
- Fish passage projects associated with transportation projects.
- Riparian and stream channel enhancements tied to transportation project mitigation; ODOT has its own wetland mitigation bank.

**What further technical or scientific information is needed:**

- More resources (staff and funding) to increase the amount of monitoring, data analysis and reporting, watershed assessments, and restoration planning
- Greater understanding of pollution sources, pathways, and effects including how pollutants interact with ecosystem processes.
- Better understanding of the relationships between BMPs, restoration projects, and the cumulative effects these have at watershed scales in improving water quality.
- Long-term performance of water quality BMPs, long-term maintenance requirements of BMPs
- Modeling to determine the magnitude of highway contribution to water quality problems in various watersheds in the state (tied to TMDLs)
- A better interface between urban and rural-residential data, drivers, and needs with the more “natural” land cover environments.
- A large amount of compliance monitoring is being done on habitat mitigation but there is little or no consolidated examination of the information that would produce better guidance for implementation.
- More implementation monitoring.
- Practical means to prevent or remove pollutants.
- Means to prioritize restoration and increase effectiveness. A way to develop priorities that span various land covers so that urban and rural-residential areas are not viewed as separate and distinct land uses.
- More cost comparisons (with and without ecosystems benefits factored in) including maintenance costs of LID vs. conventional stormwater. This type of information is very motivating for local governments, developers, and engineers.
- Technical and financial assistance to provide support to both the regulated and non-regulated communities. Increase in staff and funding to provide the support.

**Main sources for technical and scientific information or tools:**

- Scientific and technical literature

- State and federal agencies and their reports (e.g., USEPA, NOAA, DEQ, OWEB ).
- Conferences and technical seminars, trade journals
- Any and all water quality data that can be gathered; GIS mapping and modeling of impacts and preferred strategies to address water quality problems; electronic information systems
- Universities and natural resources protection organization reports
- Voluntary programs, plans, and projects, particularly implementation and effectiveness monitoring
- Local organizations and experts for area specific issues

**What further steps are needed to enhance or rehabilitate water quality, watershed condition, and aquatic organisms and their habitats in urbanizing and developing environments?**

- Switch chemicals in personal care products, cleaning products, etc. to natural alternatives that degrade quickly.
- Reduce pharmaceutical consumption to reasonable levels and to educate the public to prevent dumping of old medications into sewage systems.
- Require new or re-development to use LID techniques. Make it a priority that new development is done in a way that protects watersheds. Would require additional regulation.
- Retrofit established developments. Create incentives to retrofit these areas which would require new funding sources.
- Daylight buried streams; restore urban, suburban, and rural-residential watersheds.
- Statewide riparian policy that includes protection and restoration of streams in urban and rural-residential areas.
- Riparian buffers adequate to protect streams for temperature increases and run-off of stormwater.
- Stormwater initiatives to protect water quality and restore natural hydrological regimes. Nonpoint pollution control improvements – better regulatory structures, more education, and incentives (e.g., encourage LID, less impervious area, reduce toxic run-off)
- Promote ecological literacy in the population. Creating political will requires public education and awareness, backed by solid science.
- Develop more user friendly and less technical tools and materials to inform a broader audience. This can help watershed practitioners with other sectors.
- Reduce pesticide use.
- Better establish the connection between stormwater impacts and salmonids.
- While transportation project by project water quality mitigation is necessary to prevent further degradation, watershed level efforts that address specific problems are needed.

## County & Regional Level Management

**Responses received from agencies and NGOs:** Responses were received from two counties and three regional government agencies.

**Science Guidance:** None listed in the responses.

**Policy Guidance:**

- Required to meet all applicable local (e.g., wastewater, stormwater, and land use requirements), state (e.g., TMDLs, DLCDC Statewide Planning Goals 5, 6, and 7) and federal (e.g., Clean Water Act) regulations
- Regional ordinances and development codes
- Healthy Streams Plan (Tualatin River Watershed)

**Prioritizations:**

- Combination of regional, sub-regional, and site-specific planning
- Annual budget and investment
- Partially guided by partners' needs
- Sub-basin planning that includes prioritization of projects based on relative benefit and feasibility
- Opportunistic

**Water Quality (including but not limited to stormwater, waste water, septic systems), watershed condition, and/or salmonid habitat management and rehabilitation:**

- Review development within riparian corridor setback areas which includes potential impacts to vegetation.
- Act as technical advisors, partners or conveners with other agencies. Local jurisdictions generally deal with wastewater and septic issues.
- Restoration/rehabilitation including stream preservation, river flow restoration, tree planting, stormwater outfalls, and culvert retrofits.
- Policies and programs including stormwater regulations, sensitive areas and vegetated corridors regulations, operation and maintenance of the stormwater system, inspection and code enforcement, incentives, and public education and awareness.

**What further technical or scientific information is needed:**

- More specific information about climate change (e.g., are the correct plant species being planted in the right places).
- Need more staff resources for monitoring restoration success.
- Need more baseline monitoring data before restoration work is done (e.g., several years water temperature data prior to implementing riparian plantings).
- Metric development for a wide variety of projects which will indicate success or failure of projects on a local and regional scale from an ecological standpoint.

- Tool(s) for determining the costs and benefits of various best management practices (e.g., street cleaning vs. stream restoration or advanced wastewater treatment vs. riparian retention).

**Main sources for technical and scientific information or tools:**

- State and federal agencies and their reports
- Partner organizations (not specified)
- Scientific literature
- GIS analysis
- Internal and externally available data
- Technical books and manuals other Willamette Valley managers have written
- Statewide Wildlife Conservation Strategy (ODFW)
- Urban Ecosystem Research Consortium

**What further steps are needed to enhance or rehabilitate water quality, watershed condition, and aquatic organisms and their habitats in urbanizing and developing environments?**

- Regional restoration priorities are needed.
- More knowledge on how climate change may affect hydrology and the potential impacts on a variety of activities (e.g., transportation infrastructure planning and associated fish and wildlife connectivity, recommendations for local jurisdictions' water detention facility requirements).
- Research on the effectiveness of current water quality and watershed improvement policies (e.g., riparian buffers) is an urgent concern at city and county levels.
- More public education is needed.
- More effective communication and assistance tools for private landowners because that is where the majority of habitat is located in urban areas.
- Better coordination between local, state, and federal agencies. This would help to alleviate loss of resources with funding reductions. Continue and expand leveraging of resources and talent among interested agencies and partners.
- More ongoing discussion and regulatory flexibility to do the right thing for the watershed. For example, should we spend millions of dollars on high energy-use infrastructure at a wastewater treatment plant for fractional improvements in water quality or can we get better improvement in overall watershed health through instream or riparian restoration higher in the watershed?
- Develop long-term maintenance standards, life cycle costs, and funding mechanisms for green infrastructure.
- Better engage the agricultural industry as important contributors to watershed health.

## Local Level Management

**Responses received from cities:** Responses were received from seven cities.

**Science Guidance:** none were identified except in one response:

- Volunteer Water Quality Monitoring Sample and Analysis Plan
- North Florence Dunal Aquifer Study, June 1982

**Policy and other guidance:**

- City specific plans
- ESA
- Clean Water Act; 303(d) list; TMDLs; 404 permits (wetlands, riparian mitigation/management); NPDES permits; MS4 permits; USEPA and Dept. of Health Services regulations for water treatment plant to deliver potable water.
- Internal agency stormwater planning and policy
- Municipal wastewater collection and treatment plant management and permit policies
- Stormwater management within UGB; DEQ required stormwater sampling

**Prioritizations:**

- Must meet all regulatory and permit requirements to ensure compliance
- City specific plans (e.g., Portland Watershed Management Plan) and City Council goals
- Water quality (e.g., Florence has Oregon's only EPA-designated sole source aquifer)
- Forecasting needs to upgrade, repair, and maintain components of wastewater treatment and collection system. Similarly, stormwater systems planning.
- Tiered systems (e.g., after meeting permit requirements then city owned properties with easy remedy or on the Capital Improvement Program list, followed by willing landowners/ watershed council driven, and finally outreach-generated projects).
- Modeling and cost-benefit analysis
- Ability to provide multi-benefits with other city capital projects

**Water Quality (including but not limited to stormwater, waste water, septic systems), watershed condition, and/or salmonid habitat management and rehabilitation:**

- Wastewater management
- Stormwater management
- Surface and groundwater quality monitoring
- Riparian, wetland, and/or estuary habitat restoration and management
- Trash removal from streams
- Pharmaceutical and hazardous waste collections
- Removal of noxious weeds
- Erosion control along major rivers within city
- Provide funding and support of watershed councils
- Culvert/barrier removals; fish ladders & screens on operational facilities

- Collaborative efforts (e.g., Siuslaw Estuary Partnership; Siuslaw watershed council; STEP-Salmon and Trout Enhancement Program)
- Public education and stewardship activities (including workshops and field explorations for school children and adults, and removal of noxious weeds)

**What further technical or scientific information is needed:**

- Climate change information and potential implications (e.g., there is a high uncertainty in projecting future changes in runoff, water quality, and urban water demand; a lack of research on long-term water temperature trends in undisturbed watersheds; what extent will climate change influence estuarine water temperature and dissolved oxygen; how will climate change affect groundwater; monitor indicators of climate change;)
- Statistical software for identifying trends and training for software(Salem)
- Modeling to track historical patterns and predict future conditions.
- Collaborative modeling that crosses jurisdictional boundaries
- Better system of project implementation based on cost/benefits/ needs assessment
- Weather stations from the mountain crest to the coast
- Research on areas where there are currently large data gaps in OWEB restoration priorities (e.g., Siuslaw River)
- An “all encompassing” plan for what the watershed should be
- Don’t really need technical or scientific information. We need funding to implement monitoring of project outcomes.

**Main sources for technical and scientific information or tools:**

- Primary scientific literature; local, regional, and international research
- Bulletins and trade journals
- Professionals, state and federal agency staff, and hiring competent city staff
- Internet resources including literature reviews and searches for scientific documents
- Consultants in planning, hydrogeology, stormwater engineering, and wetlands
- 19-member Siuslaw Estuary Partnership Interdisciplinary Team representing federal, state, tribal, and local organizations and agencies
- Scientific organizations such as the Ecological Society of America, Society of Conservation Biology, Society of Ecological Restoration (City of Eugene)

**What further steps are needed to enhance or rehabilitate water quality, watershed condition, and aquatic organisms and their habitats in urbanizing and developing environments?**

- Comprehensive education for planning bodies.
- Tighter requirements for stormwater management.
- A better system of project prioritization based on cost/benefits/needs assessment.
- Use the precautionary principle as related to water quality and climate change.
- Protect riparian areas from development (waterside ‘buffers’ or ‘set backs’).

- Broader focus (ridge top to ridge top) not just in-stream or riparian influences.
- Better watershed-wide approach that incorporates multiple jurisdictions/agencies & stake holders.
- Continue public education efforts to remind citizens what activities they are engaged in that might degrade the health of water quality and what that means to them.
- Funding for side channel and floodplain restoration.
- Ongoing surface and groundwater monitoring.
- Funding for continuation of stewardship activities including established interagency/inter organizational partnerships.
- Funding to create city natural resource programs with trained specialists on staff.
- Incentives for riparian area reforestation.
- Combinations of incentives and regulations for ‘green infrastructure’ and LID techniques, including bioswales, rain gardens, green roofs, etc.
- The community must decide what is important to them and what they want the watershed to be. Are we concentrating on one species or the watershed in general?
- The regulatory system is burdensome. It is difficult to deal with naturally occurring elements in drinking water standards (e.g., arsenic in eastern Oregon). When the new allowed levels for arsenic are adopted by DEQ, the city of Ontario will be forced to go through an expensive variance process which will result in no improvement to water quality.
- Cities are willing to invest in technology/treatment processes that result in water quality improvement. Cities object to burdensome regulations that have no benefit to the environment.
- Stiff penalties and enforcement for illegal discharges.

***Appendix D. Urban Report Science Question 4: What are the major research and monitoring needs for urban and rural-residential landscapes?***



#### **Science Question 4: What are the major research and monitoring needs for urban and rural-residential landscapes?**

There are many research and monitoring needs directly related to urban and rural-residential areas, some of which overlap with the research and monitoring needs for other land use types (e.g., Wenger *et al.* 2009). Given the marked effects developed areas can have on surface and ground waters, the continued expansion of development in Oregon, the proportion of the human population residing in these areas, and the limited amount of research and monitoring conducted on them, IMST believes that the following research and monitoring needs warrant greater attention from Oregon Plan partners.

#### **Section 11.0: Research and Monitoring Needs**

The needs IMST has identified in this section range in scale from basic research and monitoring needed on statewide variation in urban effects to more focused studies on specific parameters and structures (e.g. low impact development effectiveness, identification and removal of fish passage barriers). ***These needs are not listed in priority order.*** Overall, the effectiveness of policy and management practices needs more research and evaluation. A great challenge lies in the understanding of how toxic chemicals affect the aquatic environment and how effective rehabilitation strategies for salmonid habitat and salmonid populations are in urban and rural-residential watersheds, riparian areas, streams, floodplains, rivers, wetlands, and lakes. A better understanding of how to effectively communicate and engage the public to increase their awareness and knowledge of watershed health and salmonid recovery is crucial to successful implementation of the Oregon Plan in urban and rural-residential areas.

The IMST recognizes that various entities at the federal, state, or local levels may be engaged in addressing some of these needs listed below in ways we were not aware of during the development of this report. This possible lack of knowledge in itself, however, illustrates the communication problem we have in a state as large and varied as Oregon. Given that agencies in various municipalities and counties in Oregon (e.g. City of Portland, Clean Water Services in Washington County) are actively working to address many of these needs, the IMST spells out this list in hopes that it will generate discussion and coordinated responses throughout the State. Ideally individual entities would work together to share experiences, data, and create emergent knowledge regarding the research, monitoring, and management needs listed below as well as a “toolkit” of cost-effective remedies to be shared throughout Oregon.

The IMST further recognizes that this list of research needs is not complete. Other areas needing further research include, but are not limited to, processes of urban impacts that are unique to estuaries, knowledge regarding air quality relationships with water quality, and better knowledge of socio-ecological dynamics (see also Wenger *et al.* 2009 for other urban-related research needs developed for the US). It is the nature of science to raise additional questions in the process of answering others. The potential for unknowns expands significantly given the complexity of dealing concurrently with numerous aspects of biology, human systems, and their interactive effects. The high likelihood that the landscape is also going to change through time because of demographic pressures, economic growth, and climate change further expands the difficulty of anticipating information gaps for the future.

#### ***Section 11.1: Needs Related to General Effects of Urban Development***

**Evaluate the major factors that impair aquatic ecosystems and limit salmonid populations in urban and rural-residential areas.** This information could be used to set priorities for addressing the sources of such impairments, whether future, contemporary or historical. In Section 8 we summarized research that reported on the variability in biological indices measured in aquatic ecosystems affected by development. These results suggest that multiple factors associated with development alter the composition of aquatic communities. This research need incorporates three sub-components.

- 1) **Assess how effective impervious area (including its proximity and connectivity to streams), landscape development indices (e.g., Brown & Vivas 2005; McMahon & Cuffney 2000), and measures of traffic or road density affect aquatic ecosystem responses to varying degrees.** By determining the major landscape sources of ecological variability, it may be possible to determine how to minimize the effects of current and future development on aquatic ecosystems.
- 2) **Insure that research on water quality (e.g., toxic chemicals) is integrated into other inter-related landscape-level factors that affect entire aquatic ecosystems (i.e., from headwaters to estuaries and near-shore marine environments) and salmonid recovery.** In general, there has been a recent tendency by aquatic scientists to focus attention on the physical and hydrological stressors of aquatic ecosystems. This is a natural consequence of largely ignoring such physical and hydrological stressors during the 1970s, but such swings in attention ignore the need to consider all the multiple stressors outlined in Figure 2-1. For example, how land use affects toxic chemicals may be just as important as how it affects hydrology, and mitigating one stressor without attending to the others means that aquatic ecosystems will remain impaired.
- 3) **Consider large-scale, long-term changes and anticipate at least 50–100 years of future human population and economic growth in salmonid-supporting watersheds, through the use of futuring and systematic analyses.** Current conditions and short-term, site-scale changes are often considered in risk assessments, but increasingly landscape ecologists are emphasizing temporally and spatially greater perspectives and long-term systematic changes (e.g., Parmesan & Yohe 2003; Baker *et al.* 2004; Steel *et al.* 2010b). Such perspectives often reveal fundamentally different risks than those evident from short-term, site-scale studies. For example, how predicted climate and land use changes will affect future hydrologic regimes and water quantity in basins affected by development needs more research, but cannot be addressed with short-term, reach-scale studies.

### *Section 11.2: Needs Related to Variation in Effects of Development across Oregon*

**Assess how the effects of development on aquatic ecosystems vary across Oregon regions (e.g., Coast, Valley, Central, East).** The IMST found very few published studies reporting on the effects of urban and rural-residential areas on aquatic biota and their habitats throughout Oregon's varied environments. Most assessments were limited to the Willamette Valley and therefore may be unrepresentative of urbanization effects in other ecoregions (e.g., in more arid regions or in estuaries). By using a scientifically rigorous sampling design (such as a probability-based design using consistent physical, chemical, and biological indicators and sampling

methods, see IMST 2009) with stream sites distributed throughout Oregon's urban and rural residential areas, the State would be able to assess the degree to which those land uses alter aquatic ecosystems. That is, given such a probability-based design, one can assess the proportions and extents of stream length that are meeting desired conditions, and relate those to the stressors associated with those conditions. Such a survey would help establish management and rehabilitation priorities by clarifying the magnitude and effects of stressors. Lacking such a survey, Oregon can only guess about the effects of urban and rural-residential development on stream ecosystems (e.g., Oregon Progress Board 2000). This need incorporates two sub-components.

- 1) **Assess the proportion of urban and rural-residential stream length that is 303(d) listed, the proportions of those with TMDLs, and the proportions of the streams with reduced biological condition that are not listed.** Waterways with 303(d) listings and TMDLs offer insights into the more extreme parts of the water quality picture, but may ignore flow, passage, and habitat structure for salmonids. A more thorough consideration of the effectiveness of water quality standards goes beyond water chemistry and sediment analysis and would include an assessment of biological condition and the role of multiple stressors. However, 303(d) listings depend on sampling (with sometimes either frequency or spatial limitations), and not all urban/rural-residential streams have been rigorously sampled. A state-wide assessment of the proportion of stream lengths that merit 303(d) listing in urban and rural-residential areas would indicate which streams, rivers, or estuaries warrant more water quality monitoring and assessment.
- 2) **Assess the current capacity of Oregon streams and rivers within urban growth boundaries to support salmonids (in terms of parameters such as physical habitat, seasonal flows, storm flows, water temperature, dissolved oxygen, fine sediments, and biota).** A probability-based survey such as that described earlier could be used to assess the proportion of urban and rural-residential streams that support, or that has the potential to support, viable salmonid populations. By sampling in both summer and winter, the State could determine the proportion of stream miles in developed or developing areas that support or could support salmonid spawning, rearing, or both. Recent research in Oregon agricultural streams in the Willamette Valley indicates that intermittent streams may support spawning and rearing of native fish (Colvin *et al.* 2009). Some small urban streams in western Oregon also support small salmonid populations (Friesen & Ward 1996; Hughes *et al.* 1998; Waite *et al.* 2008), but the distributions and sizes of such populations have not been rigorously evaluated.

### *Section 11.3: Needs Related to Stormwater Runoff*

**Determine the adequacy of methods currently implemented in Oregon for alleviating or mitigating the adverse effect of stormwater runoff (e.g., by increasing on-site retention) in both urban and rural-residential areas.** Impervious surfaces such as roofs, roads, and parking areas rapidly deliver stormwater runoff to streams rather than allowing precipitation to infiltrate

into the soil (Section 4.11 of this report). Low impact development methods have the goal of increasing on-site water retention that may better mimic natural hydrologic and vegetation patterns (Section 9.23 of this report). It would be useful for the State of Oregon to determine where and how often low impact development methods are implemented in Oregon's urban and rural-residential areas and their overall effectiveness in protecting Oregon's aquatic ecosystems. This need incorporates two sub-components.

- 1) **Assess the degree to which current technical methods that have been shown to be effective in increasing on-site water retention have been implemented by local development codes.** The implementation frequency of flow retention methods can likely be assessed by surveys of households and of city planning departments. A second tier of assessment could use field studies of paired sites to evaluate the effectiveness of such retention measures on local flow regimes.
- 2) **If methods increasing on-site water retention are not effective, or are not consistently implemented by local governments and residents, determine why.** Assuming that many urban and rural-residential properties lack flow retention measures, city planner and household surveys could indicate possible reasons. The reasons may include current and historical lack of awareness of the importance of storm flow retention for protecting natural stream structure and function, the initial economic costs of such measures, the notion that such features are not attractive, uncertainty concerning the cost-effectiveness of alternative retention methods, or the contrasting values of citizens (e.g., Lakoff 2002; Graham *et al.* 2009; Steel *et al.* 2010a)

#### *Section 11.4: Needs Related to Groundwater*

**Assess future groundwater hydrologic responses to population pressures and the extent of groundwater contamination in Oregon's urban and rural-residential areas.** Better knowledge of both groundwater hydrology and groundwater quality is needed. Further knowledge is needed concerning how groundwater quality, location and supply could be affected as population and economic pressures on groundwater increase. Knowledge needed includes better understanding of the connections between urban surface and groundwater hydrology, the effect of groundwater withdrawals on groundwater supply, and the current and potential effects of groundwater contamination from waste discharges and land use.

Toxic chemical mixtures from urban and rural-residential areas may leach into groundwater and the degree to which this happens and the potential consequences for aquatic ecosystems are unknown (see Section 11.6 for more needs related to toxic chemicals). The use of low impact development techniques to increase stormwater detention and soil infiltration (as well as the potential to inject surface water into dry wells which were not addressed in this report) create the potential for increased groundwater contamination depending on the sources of the runoff. Further, there is a need to assess the extent to which present and historical landfill, industrial, and commercial facilities leach toxic chemicals into groundwater.

### *Section 11.5: Needs Related to Fish Passage Barriers*

**Determine the extent and number of physical fish passage barriers in urban and rural-residential areas, especially concerning prioritization of removal.** Removal of fish passage barriers has been found to be an effective stream rehabilitation technique because barrier removal opens up habitat otherwise inaccessible to migratory fishes. Oregon Department of Transportation and the Oregon Department of Fish and Wildlife both have databases with information on fish passage barriers. Better integration of information on all existing barriers is needed in terms of how they are distributed and how they may be prioritized for removal.

### *Section 11.6: Needs Related to Toxic Chemicals*

**Determine the effects of, and possible treatment/remediation/elimination methods for, urban toxic substances and mixtures of toxic substances.** Our current understanding of the role of the many varied toxic chemicals prevalent in urban and rural-residential areas is poor and needs much work. Generally, much needs to be learned both regarding conveyance systems of toxic chemicals in urban watersheds and regarding the aquatic chemistry and biological response of aquatic organisms to the cumulative and interactive effects of toxic chemicals. The known and potential ways in which toxic mixtures may impair aquatic ecosystems is summarized in Section 7.6 of this report; however, the individual and cumulative effects of toxic chemicals remain an area of major scientific uncertainty. Sewage and stormwater treatment systems already in use in Oregon and elsewhere do not remove many of the toxic chemicals of concern before treated water is discharged into the environment. The Oregon Department of Environmental Quality considers this issue a major concern because deleterious effects on aquatic organisms are often apparent despite sub-toxic concentrations of individual chemicals. Also, little is known how differences in water quality parameters, such as pH, hardness, and temperature, alter the cumulative chemical interactions and their effects on biota. This need incorporates 6 sub-components.

- 1) **Determine how, when, where, and how often to screen for and identify levels of contaminants and mixtures in aquatic ecosystems affected by urban and rural-residential developments.** Chemicals and their breakdown products are released to the environment on a daily basis from urban and rural-residential areas. These releases create a difficult and expensive monitoring challenge.
- 2) **Evaluate the ecologically relevant and chronic toxicities of a wide range of chemicals on salmonids, and compare those toxicities with those that may occur at the concentrations found in the aquatic environment.** If chronic toxicities (i.e., long-term toxicity of a substance in small, repeated doses) are known for pesticides, pharmaceuticals and personal care products, and other commonly used products, they can be compared against concentrations found in urban water bodies. It is likely that toxicities of many of these chemicals, are unknown, and even more likely that the toxicities of mixtures are unknown. Given the large number of potentially toxic chemicals determining those present in low concentrations but with high frequency would be a priority over those that occur infrequently. Higher priority chemicals could then be

evaluated for their endocrinological effects on salmonid physiology and potential consequences at the population level.

- 3) **Assess the degree to which cumulative and synergistic effects of commonly-occurring chemicals prevalent in urban areas alter salmonid behavior, reproduction, and mortality.** A combination of whole effluent chronic toxicity and early developmental tests can be used to evaluate salmonid growth, feeding, predator avoidance, parasite/disease loads, endocrine disrupting potential, and hormones. Acute tests will likely focus on juvenile salmonid mortality rates (USEPA 2002a).
- 4) **Assess the degree to which cumulative and synergistic effects of commonly-occurring urban chemicals alter salmonid-supporting food webs.** Research insights in this area may be best attained through use of experimental streams or model ecosystems (with underlying assumptions clearly identified) because of the complexity of potential interactions among predators, prey, and the food base (e.g., Warren & Davis 1971; Belanger 1997).
- 5) **Conduct research on the relative technical and economic feasibility of removing endocrine disrupting chemicals and other toxic chemicals from the waste stream through sewage and stormwater treatment and/or prohibitions on product sales.** Endocrine disrupters are viewed by some as a fundamental threat to the health and sustainability of salmonids and other aquatic vertebrates because they occur throughout our environment. Endocrine disrupters can affect vertebrate endocrine systems at very low doses. These effects can extend to vertebrate embryological development, juvenile development, general health (including immune system dysfunction and increased vulnerability to cancer) and reproductive fitness (either directly or indirectly) (e.g., Colborn *et al.* 1993, 1996; Hayes *et al.* 2006; Colborn 2009). Assays have been, and continue to be, developed for impairment of physiological systems by endocrine disrupting compounds; given the risks of these chemicals and the extent of their occurrence, however, it would be wise to consider ways of substantially reducing their presence in the environment as well as in salmonids.
- 6) **Determine the best available strategies for keeping toxic chemical from pesticides, herbicides, personal care products, pharmaceuticals, metals, and other anthropogenic-derived products out of surface and ground waters.** Given their widespread occurrence and the potential for toxic substances to impair salmonid and human health at extremely low concentrations, it is advisable that Oregon agencies review methods for eliminating these chemicals from use and waste streams. Research and monitoring resources might best be focused on the effectiveness of cost-effective and scalable (i.e., from reach to basin-level) strategies to control and mitigate toxic contamination. A more thorough assessment of effectiveness would go beyond chemical analyses to include the perspective of biological condition.

## Section 11.7: Needs Related to the Evaluation of Effectiveness of Policies and Regulations

**Determine the strengths and areas for improvement of measures currently implemented in Oregon to avoid, remedy or mitigate the impact of urban and rural-residential development in headwaters, wetlands, riparian areas, floodplains, and key salmonid-watersheds.** The State of Oregon leads the nation in comprehensive land use planning; however, as described in Section 9.0 of this report, much more can be done, especially regarding sensitive aquatic environments and the watersheds that dominate and buffer the flow regimes of urban streams. A review of current county and municipal land use plans and regulations could indicate the degree to which current laws, regulations and programs adequately remedy or mitigate the adverse impacts of development on watersheds and aquatic ecosystems (e.g., Ozawa & Yeakley 2007). This need incorporates four sub-components.

- 1) **Assess whether or not planning measures for protecting streams, wetlands, riparian areas, floodplains, and other sensitive areas are effective.** If current laws are written such that they could provide adequate protection to aquatic ecosystems, then the implementation consistency of protective measures can be assessed by studying the land use plans of local governments and completed projects to determine how frequently sensitive systems are protected. Assessment of these systems could be evaluated through remote sensing and field surveys.
- 2) **If planning measures are failing to mitigate or remedy the adverse effects of development or are inconsistently implemented, determine why.** If sensitive areas (e.g., water bodies, riparian areas, and unstable lands) within urban growth boundaries are not protected or incompletely protected, a survey of county and urban planners could indicate possible reasons. It also appears prudent to assess the long-term ecological effects and monetary costs associated with the implementation and lack of implementation of these measures. In other words, the effects of a “lack of action” may lead to long-term future costs that greatly outweigh costs associated with implementation of mitigation or remedial actions in the first place (NRC 1992; 2002).
- 3) **Assess the most cost-effective low impact development (LID) practices.** Research is needed to determine the effectiveness of major LID techniques for normalizing hydrological regimes and removing toxic chemicals from runoff. Washington State has eastside and west-side best management practices, reflecting the differing hydrologic regimes east and west of the Cascades. Evaluations would include the degree to which LID increases runoff retention and improves fish physical, chemical and biological habitat and fish species and assemblage condition. It also would be useful to study whether LID can improve stream physical, chemical, and biological conditions relative to preexisting conditions (Brown *et al.* 2009).
- 4) **Determine how much low impact development (LID) is required in a developed watershed to protect aquatic ecosystems or to improve the condition of already affected streams, rivers and estuaries.** Evaluations are needed concerning whether LID

structures in new developments regulated by the NPDES permitting system are sufficient for controlling stormwater and water pollution. Also in need of evaluation are the specific water quality parameters improved by specific forms of LID structures. If sufficient, strategies for integrating LID into existing development need to be determined. It would also be useful to consider assessing LID at site, development, and watershed scales. Here again, a more thorough evaluation of the effectiveness of practices would be evaluated from the perspective of the biological condition of receiving streams.

### *Section 11.8: Needs Related to Rehabilitation*

**Assess the effectiveness of efforts to rehabilitate streams in urban and rural-residential areas.** A number of projects have been funded to rehabilitate urban streams in Oregon; however to our knowledge, none have been evaluated for their effectiveness in supporting salmonids (Section 10.0 of this report). This need incorporates three sub-components.

- 1) **Assess the effects of urban and rural-residential rehabilitation projects in Oregon on salmonids, aquatic assemblages, and aquatic physical and chemical habitat.** Depending on the number of projects and available funds, project effectiveness could be assessed through a census or survey of sites using a consistent site-scale design and a consistent set of indicators. Incorporating basin coordinators, municipalities and volunteer groups, as well as state and federal agencies, in this monitoring will increase the likelihood of successful salmonid rehabilitation.
- 2) **Evaluate the current technical and implementation processes and estimated costs of removing fish barriers.** Because urban areas are often located downstream of salmonid spawning and rearing streams and because urban areas typically have many barriers (e.g. barriers where roads cross streams), removing these barriers can be an effective way of reducing the effects of developed areas on salmonid production.
- 3) **Assess the ecological and economic costs and benefits that would likely result from rehabilitation efforts directed toward recovering salmonids in developed areas. Evaluate project costs and benefits for households as well as municipalities.** The cost to taxpayers and utility ratepayers is a frequent reason cited for resisting salmonid conservation and water quality improvement. But to IMST's knowledge there has been no rigorous evaluation of those costs, of the costs of incomplete and uncoordinated attempts to comply with state land use and federal ESA and CWA regulations, or of the ancillary benefits to other users and uses if naturally sustainable salmonid populations were attained.

### *Section 11.9: Needs Related to Communication and Citizen Science*

**Determine how to communicate science information more widely and effectively to the broadest possible audience via formats that go well beyond technical journal articles.** Citizen science spans a large spectrum, from individual citizens to non-governmental environmental research and management entities (e.g. non-profit organizations and watershed councils). Citizen groups offer the potential to extend the scope of environmental research and to produce a public that is more cognizant of environmental issues. New cross-discipline



partnerships (e.g., social scientists, communication scientists, graphic artists, and print and electronic media journalists) are needed to expand the overall effectiveness and social context of citizen science efforts.

**Intra- and inter-disciplinary communication on all research gaps is needed.** It is critical that government bodies at all levels, including university and agency researchers, work together to ask, evaluate, and answer questions concerning watershed health and the rehabilitation of wild salmonids. While investigator independence and creativity will always be essential to conducting scientific studies, communication and transferability of study outcomes are enhanced by consistency of terminology, methods and indicators. Without consistent and spatially extensive study designs, sampling methods and indicators, the State of Oregon can invest considerable human and fiscal resources and learn little that can be inferred beyond each separate study. If some standardization of experimental designs, methods, and indicators are used by potential investigators and shared through common databases, much more can be learned for the same fiscal and human investments in our common future (e.g. Stranko *et al.* 2005; Paulsen *et al.* 2008; Brown *et al.* 2009; Mulvey *et al.* 2009). In other words, just as spatial and temporal fragmentation limit species richness, fragmented information and management practices limit knowledge and effectiveness.