Where Road Projects Could Improve Oregon's Estuaries and Benefit Local Communities

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Executive Summary

Estuaries are some of the world's most productive and diverse ecosystems. Estuaries support salmon, steelhead, sturgeon, clams, oysters, crabs, birds and many other species we cherish. They also provide beauty, recreation and other significant benefits to people, so much so that estuaries are at the heart of most of Oregon's coastal communities.

Safe and reliable road systems are critical infrastructure for connecting people and helping communities and economies thrive. Unfortunately, the growth and development of coastal communities and their related road infrastructure has had unintended impacts to the health of our estuaries with consequences to people and nature.

Our challenge is to find ways to reduce the impacts roads have on estuaries while also improving the safety and health of coastal communities.

In 2017, thanks to guidance and funding from the Oregon Department of Transportation (ODOT), the Oregon Watershed Enhancement Board (OWEB) and Mintkeski Family Fund of the Oregon Community Foundation, The Nature Conservancy completed an analysis to better understand where roads are impacting the state's estuaries. We created an Impact Index to estimate the loss of hydrologic connectivity for 29 estuaries caused by roads. We then combined these data with ODOT road improvement priorities and three social and structural vulnerability measures to create a Composite Index identifying where road improvements might provide multiple benefits to nature and people.

State Highways impact 29 of Oregon's 46 estuaries. Over 372 road miles cross or run close to an estuary's boundary (44 highway miles and 328 county and local road miles). Eighteen miles of highway and 165 miles of county and local roads that cross estuaries are built on fill material (constructed on compacted soil, gravel or other materials that block the flow of water) rather than bridges or viaducts. These miles of roadway are likely to have the greatest impact on hydrologic connectivity and function. They are also the most vulnerable areas for failure in an earthquake, so improvements would benefit human safety and the coastal economies as well.

Seven estuaries in Oregon have Impact Indices indicating high or very high road impacts: Coos Bay, Tillamook Bay, Umpqua, Coquille, Siuslaw, Yaquina and Nehalem (Figure 1). The Composite Index identified Coos Bay, Umpqua and Tillamook Bay as estuaries where

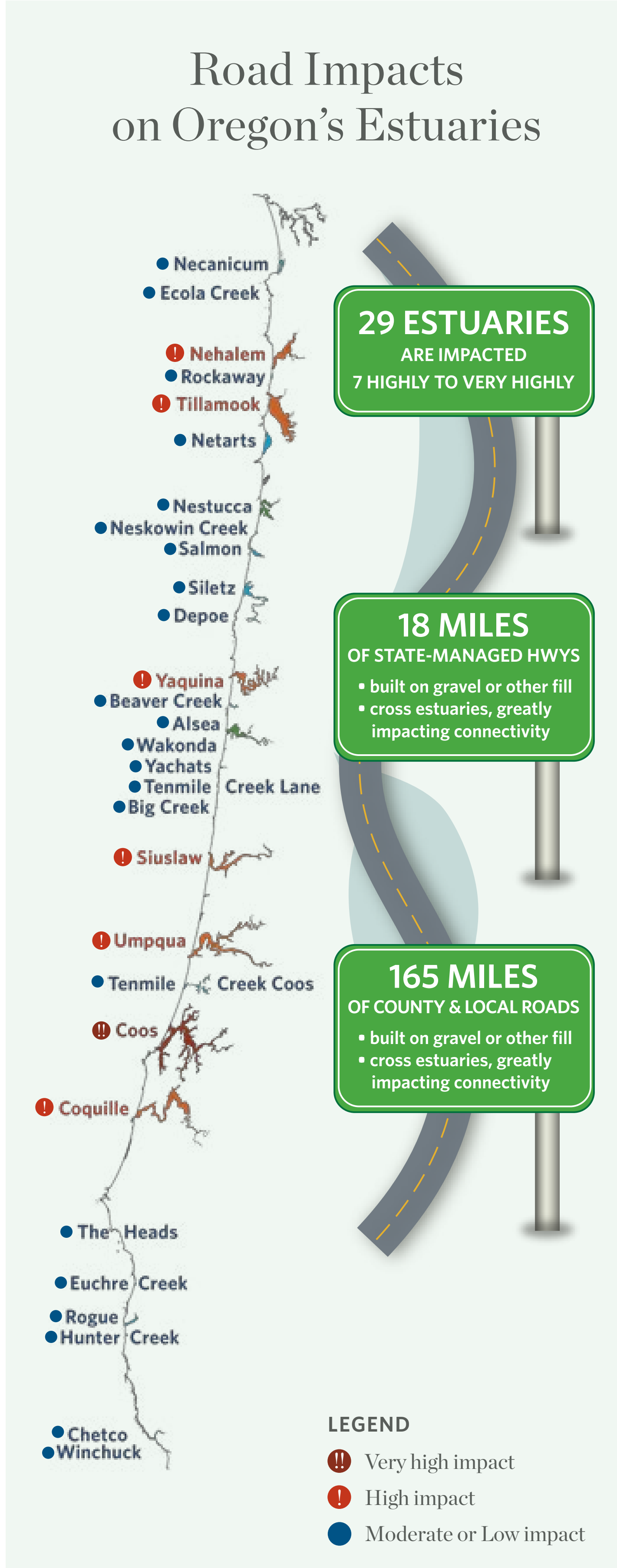

Figure 1. The estuaries most impacted by highways and other roads.

road improvements would have the most potential to improve hydrologic connectivity while also enhancing coastal communities' natural disaster escape routes and access. Locally reduced flood risk may also result where projects include restoration of floodplains.

Examples of road projects that can restore the health of estuaries and allow water to flow unimpeded, include viaducts, culverts and bridges. This report highlights that repairing road segments built on fill material could significantly improve connectivity.

These data can help identify where to allocate limited resources that will have the greatest return on investment for nature and people. The Nature Conservancy is interested in collaborating with coastal partners to increase awareness of roads' impacts on estuarine connectivity, and to develop integrated projects that achieve co-benefits for Oregon's roads, estuaries and coastal communities.

Figure 2. The benefits of estuaries. The mouth of the Salmon River forms a vital estuary that remains relatively connected to its tributaries and to the ocean. The Western Sandpiper and the native Olympia Oysters call Oregon's estuaries home.

Introduction

Estuaries occur at the coastal frontier where rivers, adjacent lands and the ocean merge. They are some of the world's most productive ecosystems and host a rich diversity of species, including crab and salmon, sandpipers and ospreys, pickleweed and salt grasses. Many juvenile fish and invertebrates grow up in the shelter of estuaries before traveling to the sea or freshwater habitats (Beck et al. 2001). Estuaries are critically important for salmon species. The "Final ESA Recovery Plan for Oregon Coast Coho Salmon" (NMFS 2016) identifies the decreasing size and connectivity of estuarine habitats as one of four Primary Limiting Factors impacting coho populations.

Humans depend on estuaries, too. Healthy estuaries support fish that benefit Oregon's fishing industry. Oregon's recreation and tourism industries profit from the beauty and biodiversity of the state's bays, inlets and salt marshes (Figure 2). Healthy estuaries protect coastal communities from storm surges, sea level rise and other natural disasters. Indeed, estuaries deliver some of the most valuable ecosystem services on the planet (Costanza et al. 1997).

Despite their importance, estuaries have been impacted by multiple stressors. Loss of hydrologic connectivity is one of the primary stressors to estuarine habitats (Aldous et al. 2008; Adamus et al. 2005; Richardson et al. 2003). Loss of connectivity can result from a variety of land use changes. Early settlers found the flat, fertile floodplains in estuaries were attractive places to establish their farms. The growth and development of coastal communities needed to support farming and fishing also impacted connectivity and the associated estuarine flows and functions (Heady et al. 2014). In addition, estuaries are downstream from every other point along a watershed, so they are affected by accumulated runoff and pollution.

WHAT IS HYDROLOGIC CONNECTIVITY?

As Pringle (2003, 2685) explains, hydrologic connectivity is "the water-mediated transfer of matter, energy and/or organisms within or between elements of the hydrologic cycle." It is the movement of water — as well as everything in the water — from one place to another. Human activity can negatively affect connectivity in obvious and not-so-obvious ways. It is easy to see how a dam hinders fish migration. What is less obvious is how the same dam prevents vital upstream nutrients from reaching coastal waters (Pringle 2003).

HOW DO ROADS AFFECT CONNECTIVITY?

Highways and roadways (hereafter referred to collectively as "roads") have the potential to restrict and even cut off natural freshwater and tidal channels, which are important to juvenile organisms such as salmon smolts that must acclimate to saltwater. Roads also limit the amount of key habitat available to plant and animal populations. Roads built on fill (compacted soil, gravel or other materials) within the estuary create more significant barriers to water and sediment flow than those suspended on bridges or viaducts.

DIFFERENT TYPES OF ESTUARIES IN OREGON

The mix of salt and fresh water in an estuary depends upon the flow of the river, strength of the tide, depth of the estuary and movement of sediment. These factors combine to result in different estuary types. The Oregon coast is host to 46 estuaries outside of the Columbia River (Figure 3), as defined by the Coastal and Marine Ecological Classification Standard (CMECS) (FGDC 2012).

Riverine estuaries, those dominated by river energy and inputs, are the most abundant type, numbering 39 (85 percent) out of the 46 estuaries. There are six lagoonal estuaries, dominated by wave energy with small riverine inputs, in Oregon and one embayment, deeper-water features that are dominated by tidal energy — Netarts Bay. The effects of roads on estuarine function may differ among these estuary types.

While Oregon enjoys the benefits of 46 estuaries, the remainder of this report focuses on the 29 estuaries that are impacted by state-managed highways.

Figure 3. The types of estuaries in Oregon—excluding the Columbia River.

The Challenge

Coastal communities have flourished for centuries as people have sought the abundant resources and breathtaking views of the Pacific Ocean and its estuaries and rivers. After World War I, Oregon's coastal highways and smaller roadways were built to increase emergency preparedness, like many across the country. These same roads were meant to attract more tourists and connect once-isolated fishing and logging villages that had previously been accessed only by ferries.

Today, roads affect every estuary in Oregon. They impede the natural tidal flows and movement of sediment. Fish species migrating from oceans to rivers have restricted access to the channels used to reach their breeding grounds. Juvenile marine species, which temporarily dwell in estuaries to grow large safe from ocean predators, and in some cases to acclimate to saltwater, must rely on disconnected, patchwork nurseries before returning to the ocean. In some cases, nutrients do not make it far enough downstream to nourish salt grasses and other estuarine plants. The loss of productive estuarine habitats also affects migratory birds along the Pacific flyway.

The stress roads place on Oregon's estuaries

Figure 4. A road on fill intersecting the Umpqua estuary.

Figure 5. A non-intersecting road adjacent to the Yaquina Estuary.

Figure 6. A road and culvert crossing a tributary of Coos Bay.

Figure 7. A road crossing a tidal channel in the Coos Bay estuary.

Despite these estuarine impacts, Oregonians need a safe and reliable transportation system that connects people and helps communities and economies thrive. According to the American Society of Civil Engineers' Infrastructure Report Card (ASCE 2017), 11 percent of Oregon's 73,544 miles of public roads are in poor condition, and 5.3 percent of bridges are structurally deficient. Of the 135 bridges on Highway 101, 56 are expected to collapse — and another 42 to be heavily damaged — in a Cascadia Subduction Zone event. A fault-line "event" would most likely be an earthquake and subsequent tsunami (Transportation Vision Panel ca. 2016).

What's more, driving on Oregon roads in need of repair costs each driver $285 per year (ASCE 2017). Fortunately, the state legislature recently approved a significant investment in transportation to help address these needs.

How do statewide partners effectively combine the need for a strong road infrastructure with the promotion of healthy estuaries? This study quantifies how roads impact Oregon's estuaries and where opportunities exist to address the needs of both. Where do the roads bisecting and running along estuaries reduce hydrologic connectivity? Where can transportation projects most efficiently meet the multiple needs of estuaries, road repairs and coastal communities? We offer some answers in this report.

With guidance and support from the Oregon Department of Transportation (ODOT), the Oregon Watershed Enhancement Board (OWEB) and Mintkeski Family Fund of the Oregon Community Foundation, we created an Impact Index to identify which of Oregon's estuaries have experienced the most hydrologic loss caused by roads (TNC 2017). The index is composed of multiple measures, including the number of interior and exterior roads impacting each estuary, the number of road miles affecting each estuary and the number of estuarine features crossed by roads (Figure 4 to Figure 7).

We also created a Composite Index to integrate current ODOT planning priorities and measures of coastal communities' social vulnerability with the ecologically focused Impact Index. (Details are provided in the next section.)

By aligning estuary, transportation and community vulnerabilities, we have highlighted areas where road projects have the potential to produce multiple benefits and attract diverse partnerships and funding sources.

An Integrated Approach

By focusing on a co-benefit approach, The Nature Conservancy has defined where opportunities exist to achieve win-win-win solutions (Figure 8). The indices we developed pinpoint locations where decision makers can achieve the greatest benefits by factoring estuarine and community considerations into transportation planning, such as the benefits attained by the Circle Creek Ranch restoration (see sidebar on next page) which illustrates how restoring floodplains can reduce flood risk for local communities.

This section of the report defines the two indices first. Then, it lists the indices for each estuary in a series of charts and maps.

WHAT IS THE IMPACT INDEX?

The Impact Index quantitatively identifies the estuaries that would benefit the most from road projects that help to restore estuarine connectivity.

CO-BENEFIT PROJECTS

Let's get going. Our data identify points of impact where we can protect estuaries and communities while completing high-priority road projects. We can build new partnerships and achieve multiple benefits.

Figure 8. The co-benefit approach.

The index is composed of measures that fall into three categories:

1. The length of roads impacting an estuary
   a. Miles of interior roads built on fill
   b. Miles of exterior roads
2. The number of roads
   a. Interior roads (on fill and bridges)
   b. Exterior roads (on fill and bridges)
3. The number of estuarine features crossed by roads
   a. Tributaries
   b. Tidal channels

Interior roads are those roads that cross an estuary. We defined "exterior roads" as those non-intersecting roads that are near both a dike and an estuary's boundary, meaning within 100 meters of both. We assigned twice the weight to interior roads as exterior roads when generating the Impact Index. The greater an estuary's index number, the less hydrologic connectivity there is. However, the Impact Index did not account for the number of human-made channels, like culverts, that allow water to flow under the roads built on fill. We did not have sufficient data to include this information, but these channels would affect the level of connectivity.

The resulting Impact Index for Coos Bay indicates that it has the highest number of road miles and crossings affecting it, which is likely correlated with high connectivity impacts. The indices of these six estuaries place them in the high-impact category: Tillamook Bay, Umpqua, Coquille, Siuslaw, Yaquina and Nehalem. Our study did not evaluate estuaries based on ecological value or health, although connectivity is one indicator of estuarine health.

WHAT IS THE COMPOSITE INDEX?

To determine an estuary's Composite Index, Nature Conservancy scientists combined the Impact Index with two other components relevant to road projects: ODOT priorities and the social and structural vulnerability of coastal communities. We looked for places where these factors overlapped.

ODOT PRIORITIES

We assessed ODOT priorities by asking ODOT district managers to share their maintenance hotspots (i.e. places where they have recurring maintenance issues) located in estuaries and by reviewing projects under

{ *Case Study* }

Circle Creek Ranch Restoration

Circle Creek is a 364-acre former ranch owned by the North Coast Land Conservancy. Historically, the Necanicum River flooded the portion of Highway 101 that runs adjacent to Circle Creek, causing a 70-mile detour between the cities of Seaside and Cannon Beach many times a year. Stakeholders from ODOT, Clatsop County and the affected cities formed a consortium to study ways to reduce flooding.

THE SOLUTION

The stakeholders determined that the most effective and least costly way to reduce highway flooding was to remove the river berm on Circle Creek property near Highway 101. A team removed the berm in 2013 and restored nearby forests, both of which improved floodplain connectivity.

THE RESULTS

An early flood season in September 2013 served as an immediate test of the restoration efforts (Figure 9). Highway 101 did not flood. Experts from the North Coast Land Conservancy measured a peak flood stage of 18.9 feet, which is 1.8 feet lower than what would have been expected before the project. They estimated the highway would have been flooded for 21 hours without the restoration.

(Collins et al. [ca. 2013].)

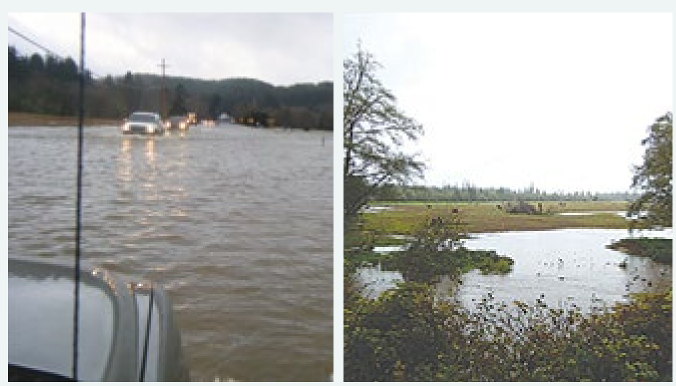

Figure 9. Restoration at Circle Creek Ranch. The left-hand photo shows flooding on Hwy. 101 —south of Seaside, Oregon—prior to the removal of berms along the Necanicum River. The photo on the right shows flooding in September 2013 after berms had been removed, allowing the floodwaters to access the floodplain at natural bank elevations. The floodplain was completely inundated but the highway was not.

the Statewide Transportation Improvement Program (STIP) (See Figure 10). At the time the data sets were compiled, the approved STIP projects spanned the years 2015 to 2018 and proposed projects spanned 2018 to 2021 (ODOT 2018).

Out of this group, The Nature Conservancy included in its data sets only those STIP projects that were in or adjacent to an estuary and that involved construction activities (e.g., culvert or bridge replacements rather than improvements unrelated to connectivity, such as paving or painting). Based on these criteria, 26 currently approved STIP projects were included in the Composite Index as well as 9 additional projects that have been proposed in the 2018-21 STIP.

VULNERABILITY OF COASTAL COMMUNITIES

Nature Conservancy scientists included three aspects of social and structural vulnerability in the Composite Index:

1. **TSUNAMI VULNERABILITY** – This aspect is defined by the concentrations of socially vulnerable populations living in areas near an estuary that could be inundated by a tsunami, as defined by Wood et al. (2010). We considered the estuary to have high tsunami vulnerability if Wood et al. gave 100 or more residents living in the tsunami-hazard zone a high social-vulnerability score.

2. **SEISMIC LIFELINE ROUTES** – These routes provide a secure network of streets, highways and bridges to help emergency services respond to a disaster, facilitate evacuation and ensure rapid recovery when a crisis subsides. The most vulnerable lifeline routes, classified as Tier 1 routes, include those in low-elevation areas adjacent to rivers and estuaries, which are subject to flooding (ODOT 2014). We included these routes in the index.

3. **INUNDATION RISK** – The Estuary Sea Level Rise Exposure Inventory (Sepanik et al. 2017) identified the assets and geographies most likely to be impacted by sea level rise in 21 of Oregon's estuaries; these features were incorporated into the Composite Index calculations. The inventory by Sepanik et al. did not include all the estuaries that are part of this assessment, but it did include the estuaries we rated as exposed to very high, high and moderate impacts (TNC 2017).

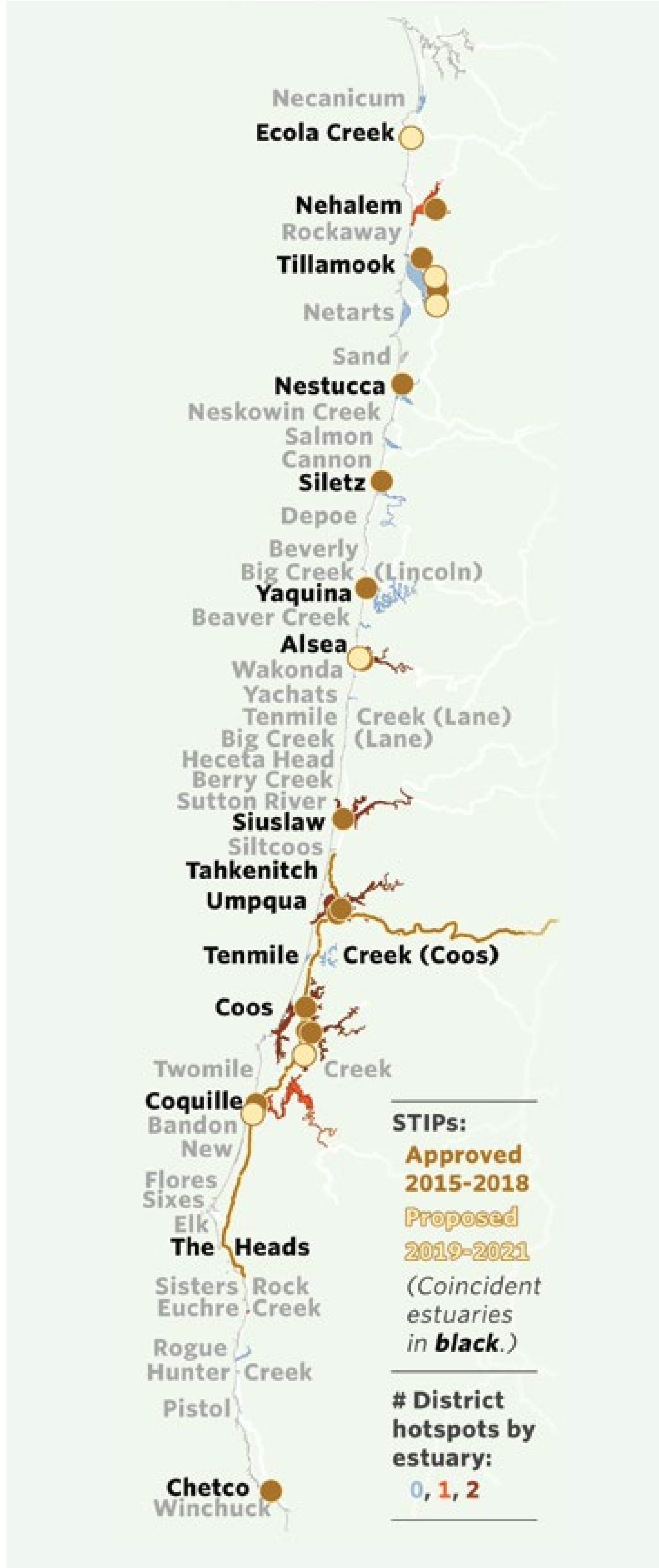

Figure 10. ODOT-identified maintenance hotspots and projects in the Statewide Transportation Improvement Program.

IMPACT INDICES FOR THE 29 ESTUARIES STUDIED

We calculated Impact Indices for each of Oregon's 29 estuaries affected by state-managed highways. Figure 11 shows the most impacted estuaries, with Coos Bay alone ranking in the very-high-impact category. These six estuaries are in the high-impact category: Tillamook Bay, Umpqua, Coquille, Siuslaw, Yaquina and Nehalem.

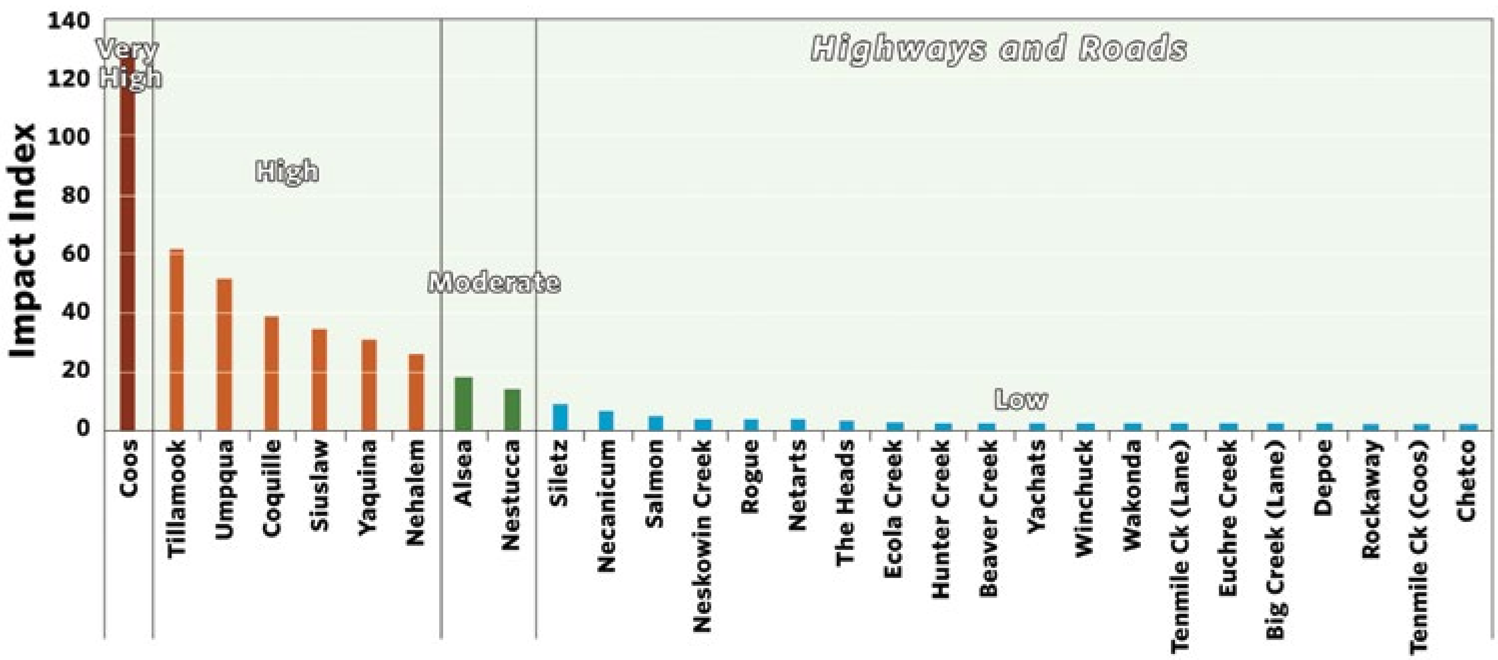

Figure 11. The Impact Index for each estuary when assessing the combined impact from state-managed highways and both county and local roads. Impact index was binned using the Jenk's Natural Breaks classification method, which identifies class breaks that minimize within-class variance and maximize between-class variance.

Oregon can achieve significant benefits by improving 183 miles of road built on fill material

Our analysis identified 372 miles of roads that have some impact on estuary connectivity and function along the Oregon Coast. Tackling hundreds of miles of transportation improvements would be overwhelming, that's why a thoughtful prioritization is important to focus limited resources in the places that have the most impact for people and these important ecosystems. Places where roads are built on fill material across estuaries may offer some of the best opportunities to produce significant benefits for estuary function. On state-managed highways, there are just 18 miles that are built on fill across estuaries, while the number for county and local roads is 165 miles. Rivers and tidal waters are severely restricted by these stretches of road. In places with bridges or viaducts the flow is more natural. Additionally, fixing these areas would be highly beneficial to communities, since roads on fill may be more susceptible to liquefaction during earthquakes.

We can further narrow the focus by concentrating on those places where the greatest impediments — roads built on fill — intersect with estuaries that have the highest Impact Indices: Coos Bay, Tillamook Bay and the Umpqua Estuary (Figures 12-14). This results in a focus on 10 highway miles and 96 miles of county and local road. Improving the connectivity of those road miles could achieve significant benefits for both estuaries and communities. In general, the state highways are the lifelines for coastal communities both along the coast and to other parts of the state so from a community vulnerability and benefit perspective, they are especially important.

IMPACT POINTS FOR THE THREE MOST AFFECTED ESTUARIES

The following maps (Figure 12 to Figure 14; much of the information in these figures will not be readable if printed in black and white) show the estuary-road impact points for the three most impacted estuaries: Coos Bay, Tillamook Bay and the Umpqua Estuary. Nature Conservancy scientists mapped four types of impact points: interior road length, exterior road length, tributaries crossed and tidal channels crossed. The maps allow transportation planners to zero in on the most significant road-related losses of hydrologic connectivity.

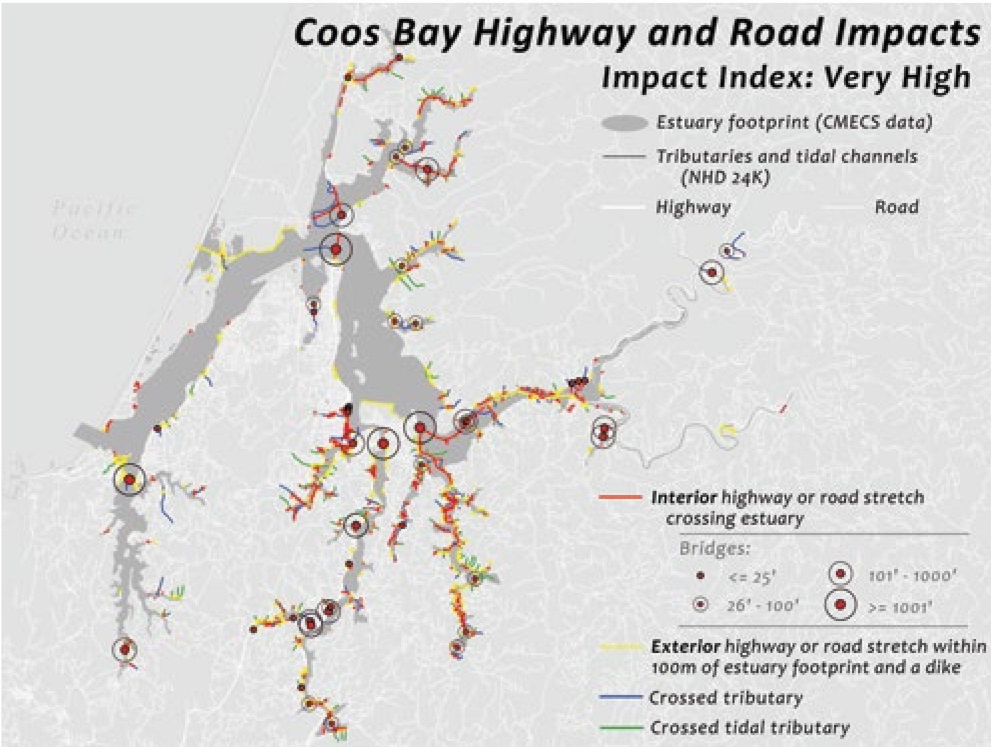

Figure 12. A map of the impact points across Coos Bay; the combined impacts from state-managed highways as well as county and local roads.

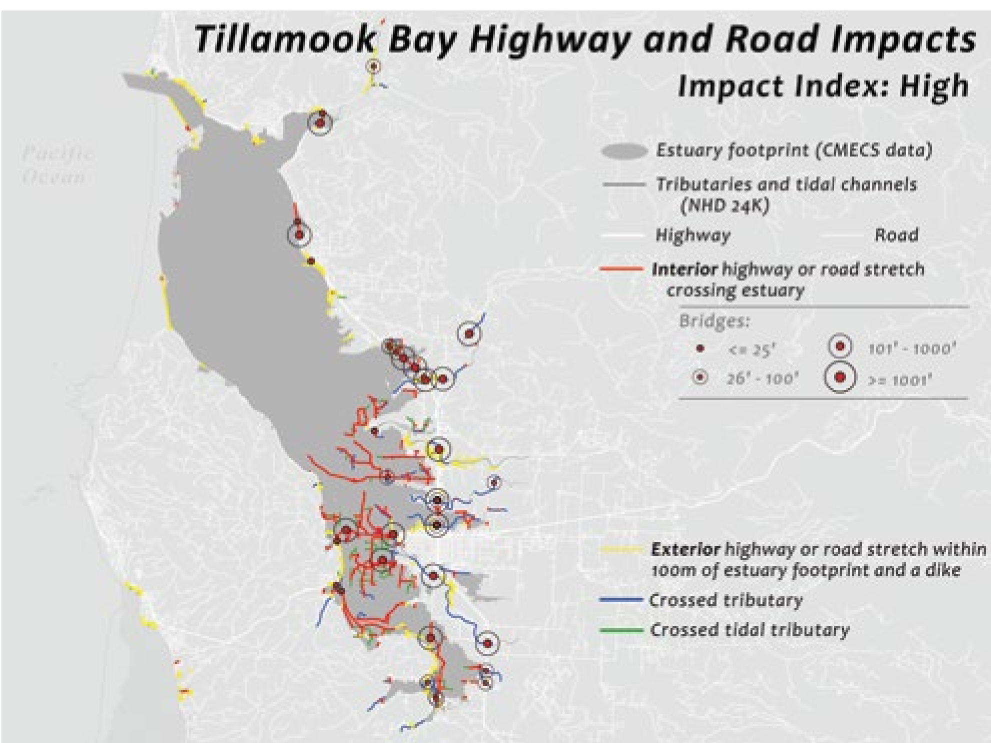

Figure 13. A map of the impact points across Tillamook Bay; the combined impacts from state-managed highways and county and local roads.

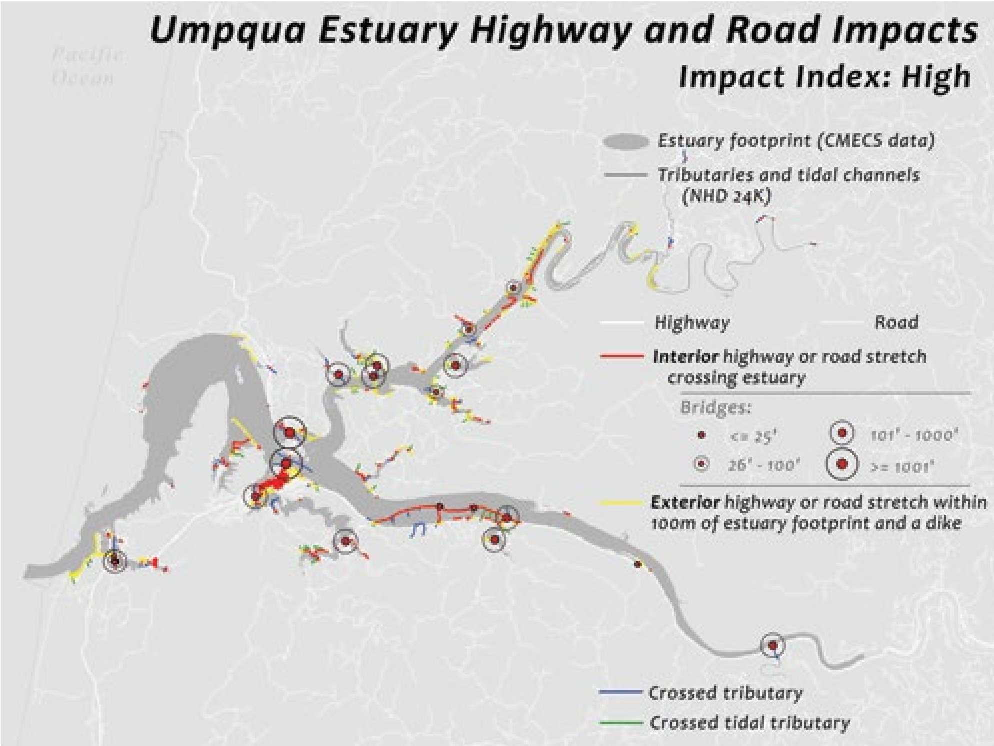

Figure 14. A map of the impact points across the Umpqua Estuary; the combined impacts from state-managed highways and county and local roads.

COMPOSITE INDICES FOR THE 29 ESTUARIES AFFECTED BY STATE-MANAGED HIGHWAYS

The previous charts and maps focused on the Impact Index. Figure 15 focuses on the Composite Index. Shown in the right-most column, the Composite Indices categorize the 29 estuaries based on a combination of their:

- Impact Indices,
- collocated transportation priorities and
- neighboring social and structural vulnerabilities.

When evaluating ODOT priorities alone, Coos Bay and the Umpqua and Alsea estuaries are at the top of the list. Coos Bay and the Necanicum and Salmon estuaries top the list when aspects of vulnerability are the sole criteria under consideration.

Rating estuaries

RANK	IMPACT INDEX: HIGHWAYS AND ROADS	ODOT PRIORITIES	VULNERABILITY	COMPOSITE INDEX USING IMPACT INDEX BASED ON HIGHWAYS AND ROADS
1	COOS !!	COOS !!	COOS !!	COOS !!
2	TILLAMOOK !	UMPQUA !	NECANICUM	UMPQUA !
3	UMPQUA !	ALSEA	SALMON	TILLAMOOK !
4	COQUILLE !	COQUILLE !	TILLAMOOK !	ALSEA
5	SIUSLAW !	TILLAMOOK !	NESTUCCA	NECANICUM
6	YAQUINA !	TENMILE CREEK (COOS)	ALSEA	NESTUCCA
7	NEHALEM !	SIUSLAW !	THE HEADS ★★	SALMON
8	ALSEA	EUCHRE CREEK	NETARTS	COQUILLE !
9	NESTUCCA	ECOLA CREEK	UMPQUA !	NETARTS
10	SILETZ	NEHALEM	NESKOWIN CREEK	THE HEADS ★★
11	NECANICUM	CHETCO	DEPOE	SIUSLAW !
12	SALMON	SILETZ	SIUSLAW !	NEHALEM !
13	NESKOWIN CREEK	NESTUCCA	SILETZ	YAQUINA !
14	ROGUE	YAQUINA !	TENMILE CREEK (LANE)	TENMILE CREEK (COOS)
15	NETARTS	| BEAVER CREEK	YAQUINA !	NESKOWIN CREEK
16	THE HEADS ★★	| BIG CREEK	NEHALEM !	DEPOE
17	ECOLA CREEK	| DEPOE	HUNTER CREEK	EUCHRE CREEK
18	HUNTER CREEK	| THE HEAD S ★★	EUCHRE CREEK	ECOLA CREEK
19	BEAVER CREEK	| HUNTER CREEK	WINCHUCK CREEK	SILETZ
20	YACHATS	| NECANICUM	COQUILLE !	TENMILE CREEK (LANE)
21	WINCHUCK	| NESKOWIN CREEK	ECOLA CREEK	CHETCO
22	WAKONDA ★★	| NETARTS	TENMILE CREEK (COOS)	HUNTER CREEK
23	TENMILE CREEK (LANE)	| ROCKAWAY ★★	ROGUE	WINCHUCK
24	EUCHRE CREEK	| ROGUE	WAKONDA ★★	ROGUE
25	BIG CREEK	| SALMON	YACHATS	WAKONDA ★★
26	| CHETCO	| TENMILE CREEK (LANE)	ROCKAWAY ★★	YACHATS
27	| DEPOE	| WAKONDA ★★	BEAVER CREEK	ROCKAWAY ★★
28	| ROCKAWAY ★★	| WINCHUCK	CHETCO	BEAVER CREEK
29	| TENMILE CREEK (COOS)	| YACHATS	BIG CREEK	BIG CREEK

LEGEND

!! Very high impact

! High impact

● Moderate or Low impact

| Estuaries tied at upper-most such rank

★★ Estuary named after local beach, rather than by the Oregon Continually Updated Shoreline Product, 2014 (Oregon Coastal Management Program)

Figure 15. Rating estuaries by Impact Indices, ODOT priorities, community vulnerabilities and Composite Indices.

Desired Outcomes

Co-benefit projects seek integrated solutions that improve roads, protect estuaries and mitigate the risks natural disasters and other emergencies pose to coastal communities. This report gives statewide partners — transportation, environmental and community stakeholders alike — the data necessary to identify locations where multiple objectives can be achieved. Now is the time to focus on where road projects can improve estuaries and more.

GOOD PLACES TO START

The Impact and Composite indices show that Coos Bay, Tillamook Bay and the Umpqua Estuary may offer excellent opportunities to reduce the stress roads place on estuaries, improve safety and improve the emergency-response capabilities of coastal communities. A variety of stakeholders can rally around common projects. Even if their initial motivations differ, partners can develop strong projects together, ones that attract diverse funding sources and get the most out of limited time and budgets.

While the sheer number of county and local road miles impacting estuaries may offer more opportunities to find suitable co-benefit projects, the relatively small number of highway miles (18) built on fill across Oregon's estuaries offer hope that significant gains could be had by altering just a few miles of highway. Additionally, two of our vulnerability criteria (sea-level rise and lifeline corridors) are specific to State-managed highways , which provide key linkages for coastal communities, so addressing those sections are especially important.

The maps in Figure 12 to Figure 14 offer insights into the estuaries that are ripe for future dialogue and exploration. Figures 16 and 17 show examples of road sections that have minimal impact on the associated estuaries. The Case Study in Figure 18 illustrates a potential pilot project for this approach, but also highlights the issue of competing or adjacent land uses that will need to be considered as potential projects are explored. Additional, finer-scale work will be needed to determine the specific project sites and design solutions that can best accrue benefits for the interested parties.

What good projects look like

Figure 16. The Alsea Bay bridge places little impact on the estuary's connectivity.

Figure 17. This photo of the Sixes River estuary shows a good example of how roads can avoid heavily impacting connectivity.

Roads (shown in the foreground of this photo) were constructed upland from the estuary. The ocean's flow is not restricted by infrastructure.

WHAT WE CAN ACHIEVE TOGETHER

The Nature Conservancy is committed to working with and sharing this information. At hand is quantified data that define and prioritize where Oregon's roads impact the hydrologic connectivity of estuaries.

Together, the Conservancy and other coastal partners can build on this study and refine the sites where present and future road upgrades or repairs have the greatest potential to restore connectivity. The Nature Conservancy urges consideration of nature-based solutions to meet our infrastructure needs and challenges. Investments in natural infrastructure can provide multiple economic, environmental and social benefits to communities that need functioning infrastructure and a healthy environment. We can identify how these same projects can make local communities more resilient. We can increase highway safety, create more secure natural-disaster escape routes, mitigate the risks from floods and improve access to coastal areas for tourism and other industries.

To focus on achieving these multiple benefits, transportation, environmental and community partners alike can collaborate on these next steps:

1. Increase awareness of road impacts on the hydrologic connectivity in Oregon's estuaries.
2. Ensure diverse partners work together to identify and implement one or more pilot projects in the most impacted estuaries. Document results and lessons learned to help inform future activities of this type.
3. Integrate this work with the Statewide Transportation Improvement Program (STIP) to get a clearer picture of where priority road projects overlap with estuaries' needs. Members of the public can get involved in this process by watching Oregon Transportation Commission meetings online, signing up for ODOT's STIP email updates, participating in meetings and discussions of advisory committees, and providing comments to the Commission on STIP development. (Visit www.oregon.gov/ODOT/STIP for details.)
4. Identify and test new road designs that allow for greater estuary connectivity while providing safe transportation corridors.
5. Increase funding for infrastructure improvements that achieve multiple benefits.

{ *Case Study* }

Multiple benefits from restoring Highway 38

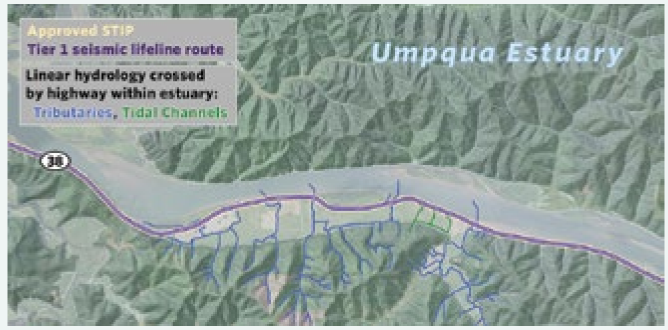

Figure 18. A map of the stretch of Highway 38 where restoration could help the Umpqua Estuary and attain multiple other benefits.

Stakeholders have the potential to attain multiple benefits by improving a stretch of Highway 38 where it crosses the highly impacted Umpqua Estuary. ODOT has already identified the road segment as needing repair, and this Tier 1 seismic lifeline route is vulnerable to sea level rise. If designed with multiple benefits in mind, transportation repairs can restore the estuary's connectivity while improving road safety and emergency response. However, the BLM's Dean Creek Elk Viewing Area is also located in this area and there are local concerns that estuary restoration may impact the elk. This will need to be explored more fully as design solutions are considered.

Figure 19. Flooding on Oregon Highway 42 South.

It's not often that opportunities exist that have the potential to yield so many tangible and diverse benefits. We want to improve our roads, so they remain safe and reliable for Oregon's citizens. We must enhance emergency-response routes, so communities are protected. And we want to restore Oregon's estuaries, so plants, animals and habitats flourish as nature intended. Together, we can do all this and more.

IF YOU ARE INTERESTED in participating in any of these next steps, please contact:

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www.Nature.org/Oregon

Figure 20. Thumbs up for co-benefit estuary restoration!

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