Unlocking the Socioeconomic Value of Oregon's Tidal Wetlands

A Comprehensive Guide to Valuing Tidal Wetland Ecosystem Services Through a Socioeconomic Lens

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This guide is based on a study conducted during my master's research, titled *The Socio-Economic Impacts of the Southern Flow Corridor Restoration Project: Tillamook Bay, Oregon,* by Graham Shaw and Dr. Steven Dundas. The methods and processes used in that study form the foundation of this guide, which expands and elaborates on those approaches. This report is intended as an informative guide, however some of the topics discussed have been simplified or generalized for clarity and readability. Please be aware that some biological processes and valuation methods may be more complex than portrayed in this document.

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Introduction

Tidal wetlands, nestled along the rugged Oregon coastline, play a crucial role in supporting biodiversity and providing a myriad of ecosystem services vital to both ecological health and human well-being. As environmental awareness deepens, there is a growing recognition of the need to quantify and understand the value of these wetlands to inform sustainable natural resource management practices. The purpose of this guide is to provide land use planners, natural resource managers, finance experts, and policy makers with tools to assess and quantify the ecosystem services offered by tidal wetlands in Oregon, with the goal of creating a comprehensive valuation framework that can inform critical decisions for their region.

This guide is, in part, a response to requests for authors of the *Socio-Economic Impacts of the Southern Flow Corridor Restoration Project: Tillamook Bay, Oregon* to describe the methods used in their study for replication elsewhere. The guide is organized into six key sections, each addressing a critical aspect of the valuation process. The initial section explains the nature and significance of tidal wetlands, establishing a foundation for understanding why these ecosystems are indispensable. Following this, the guide directs readers through the process of setting goals for the valuation analysis, emphasizing the need for a nuanced and holistic approach that aligns with the unique needs of the team conducting the analysis.

Recognizing the importance of collaboration and inclusive decision-making, the guide then delves into a step-by-step process for identifying and engaging with co-managers, stakeholders, Tribal Nations, and other parties of interest. This collaborative effort ensures that diverse perspectives contribute to a comprehensive valuation that reflects the multitude of ways in which tidal wetlands impact nearby communities.

To facilitate an efficient valuation process, this guide provides insights into identifying and selecting ecosystem services provided by tidal wetlands. This section aims to streamline the valuation process by providing four clear steps for identifying key services that provide significant benefits to communities.

Finally, this guide offers an overview of various ecosystem service valuation methodologies. By presenting a diverse array of approaches, from market-based to non-market valuation methods, the report equips decision-makers, project managers, and community members with the tools needed to assess the value of tidal wetlands comprehensively.

As we embark on this journey of understanding and valuing the ecosystem services of tidal wetlands in Oregon, it is our hope that the insights gained will catalyze informed decision-making, contributing to the sustainable management and preservation of these vital ecosystems for generations to come.

Section 1

Oregon's Tidal Wetlands

Across the country tidal wetlands are vital and productive ecosystems. Tidal wetlands not only provide habitat for endangered and valuable species such as salmon, but also provide useful services, such as flood mitigation and maintaining water quality. In Oregon, tidal wetlands provide numerous services which benefit coastal communities, counties, and the state as a whole. This section provides an overview of tidal wetlands in Oregon including a summary of the benefits and services they provide.

What are Tidal Wetlands?

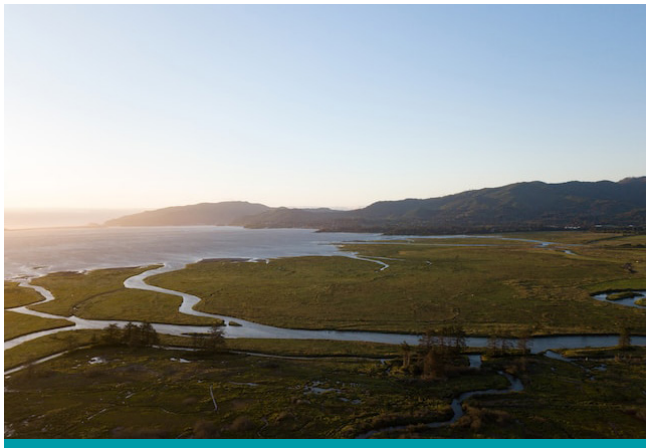
The term tidal wetland covers a lot of ground, literally and figuratively. Oregon has an estimated total of 17,300 acres of tidal wetlands along its coast, not including the Columbia River (Brophy, 2019a). That's around the same size as the city of Medford, OR! Tidal wetlands are defined as wetlands that are inundated by the tides at least once a year (Adamus, 2006) and in general, tidal wetlands form where rivers meet the ocean, however they can also extend miles upriver within the **tidal reach**.

Along the coast, tidal wetlands generally form within **estuaries**. Estuaries can form in bays, such as in Tillamook or Yaquina Bays, or in places where the river runs into the sea such as in the Columbia or Rogue Rivers. All a tidal wetland needs to form is low lying land that is affected by the tides.

Tidal wetlands fall into several major classes, including tidal flats, seagrass beds, tidal marsh, and tidal swamp. However, tidal marsh and tidal swamp are the most commonly affected by human activities, so they are often the target of restoration and conservation actions. These two wetland types have unique physical, chemical, and biological characteristics which produce complex valuable services or benefits unique to that class of habitat.

Tidal Reach

A section of river that is influenced by the tides. Some rivers are called tidal rivers as the whole river is considered to be tidally influenced. This does not mean the whole river is salty. In fact, salt water may not intrude very far upriver if at all. However, the tidal influence can reach many miles upriver (Hoitink & Jay, 2016). The mighty Columbia River has a tidal reach of 143 miles inland (Christy, 2017).



Estuary

"An estuary is a partially enclosed body of water or wetland that periodically receives freshwater and seawater inputs and extends from its connection to the ocean to the limit of tidal influence, defined by salinity gradients or tidal inundation" (Wolanski, 2007; Pritchard, 1967) Estuaries are important habitats because their location allows them to receive nutrients from both the river and the ocean. The surplus of nutrients allows for a rich diversity of plants and animals to thrive in a relatively small area.

Tidal Marsh

Tidal marshes (also called tidal emergent wetlands) form in low lying lands which can be saline, brackish, or fresh (Figure 1). They are formed when a tidal flat accumulates enough sediment and organic material to allow salt-tolerant plants to take root and grow. Tidal channels also develop as the soil builds up, creating complex marine and shoreline habitats (Cornu, 2005). Tidal marshes with the lowest elevation, called low marshes (Figure 2), usually have the most saltwater inundation. This leads to dominance by highly salt-tolerant vegetation. As elevation increases, the frequency and duration of saltwater inundation tends to decrease, allowing less salt-tolerant vegetation to become dominant. This creates high marshes (Figure 2), which nurture a more diverse mix of grasses, sedges, rushes, and broadleaf plants (Brophy, 2019a).

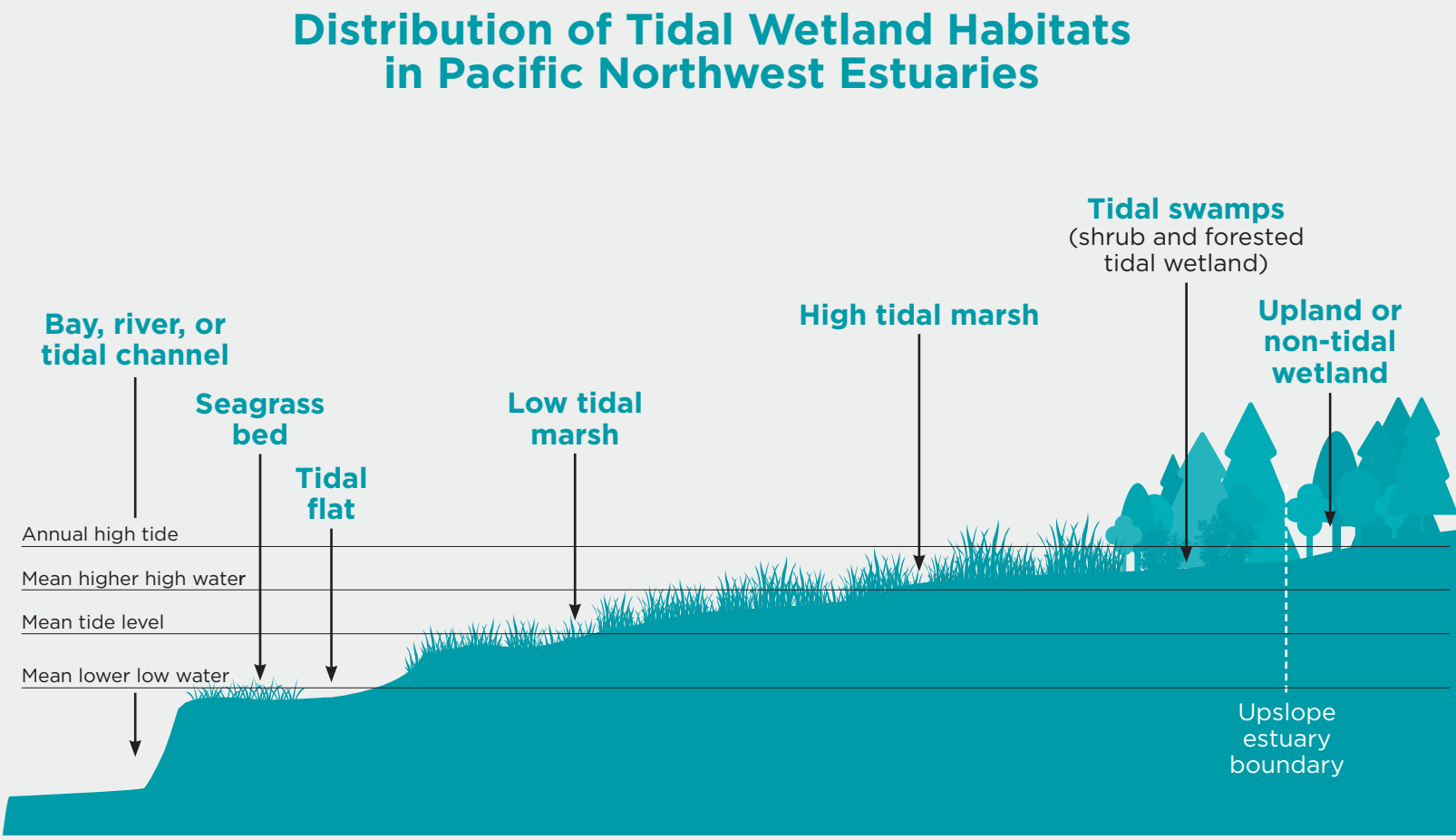


Figure 1: Schematic diagram of the distribution of PNW tidal wetland habitats relative to elevation and tides (not to scale). Original diagram by Laura Brophy (used by permission); Bonneville Environmental Foundation.

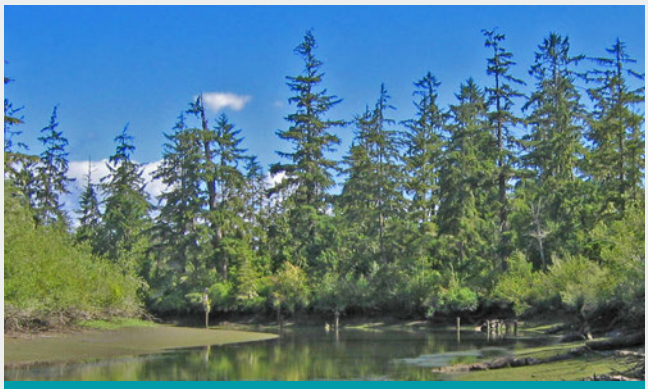
Tidal swamps are tidal wetlands that are dominated by woody plants (shrubs or trees) (Figure 2). They usually occur higher up in elevation (Figure 1) or further inland within the tidal reach compared to tidal marshes and as a result can range from brackish to freshwater (Brophy, 2019a). Shrub lands and forests are the two classes of vegetation in Oregon's tidal swamps. Shrub species that are often dominant within Oregon's scrub-shrub tidal swamps include black twinberry, Pacific crabapple, and Hooker's willow. The most dominant tree in coastal tidal forests is Sitka spruce, which is somewhat salt-tolerant and can grow in brackish waters. However, there are many other tree species that can dominate tidal forests such as Oregon ash, cottonwoods, western red cedar, and red alder (Pojar et. al, 2016).

Tidal Marsh Habitat

Low (Saline) Tidal Marsh

High (Brackish) Tidal Marsh

Tidal Swamp Habitat



Forested Tidal Swamp

Scrub-Shrub Tidal Swamp

Figure 2: *Images of 4 sub-classes of tidal wetlands around Oregon. Tidal Forest is defined as a tidal swamp with more than 10% tree cover. A scrub-shrub wetland has less than 10% tree cover. Photos © Laura S. Brophy, CC BY SA*

Historical, Current, and Future Extent

Oregon has 23 major estuaries along its coastline (Figure 3) in addition to the Columbia (Brophy, 2019b). According to a report by Laura Brophy from 2019, which analyzed 15 estuaries comprising 96.5% of the coast's historical tidal wetland area, Oregon historically had an estimated 38,000 acres of tidal wetlands prior to the arrival of European colonizers—more than twice their current area. For reference, the historical area of tidal wetlands is almost three times the surface area of Crater Lake! Of the total 38,000 acres, around 58% was tidal swamp, with tidal marsh making up the rest, showing that tidal swamps with their trees and shrubs made up a slight majority of Oregon's tidal wetlands pre-colonial contact.

Historically, the Columbia River estuary contained an estimated 87,000 acres of tidal wetland habitat which consisted of 55% tidal marsh and 45% tidal swamp (Marcoe and Pilson, 2013). The historical presence of both tidal marsh and swamp shows that like the coastal tidal wetlands, the Columbia River's wetlands were diverse and abundant.

Unfortunately, Oregon's tidal wetlands are currently not as widespread or diverse as they used to be. Efforts by Euro-American settlers to create more land and control flooding through diking and damming caused significant losses in tidal wetland habitat (Figure 4). While creating usable land, the process of diking disrupts natural water flows, blocks salmon and other fish movement, and removes vegetation that provides vital habitat and ecosystem services. In turn, these alterations caused tidal wetlands to change from tidal swamp to marsh or vice versa or become eliminated entirely.

In fact, through residential, commercial, agricultural, and industrial development Oregon has lost 58% of the tidal wetlands along its coast (Brophy, 2019). Breaking down the habitat loss in coastal tidal wetlands by tidal swamp or marsh reveals that the losses are not equal between the two habitat types. In a stark transformation, tidal swamp habitat along the coast has lost 95% of its historical extent since white settlers arrival. Tidal marshes are faring a little better, only losing 59% of its historical extent.

The loss of tidal wetlands is equally bleak within the Columbia River. An estimated 44-67% of historical tidal wetlands within the lower Columbia (below Bonneville Dam) have been lost (Marcoe and Pilson, 2017). Breaking down the lost area by tidal wetland subclass reveals both

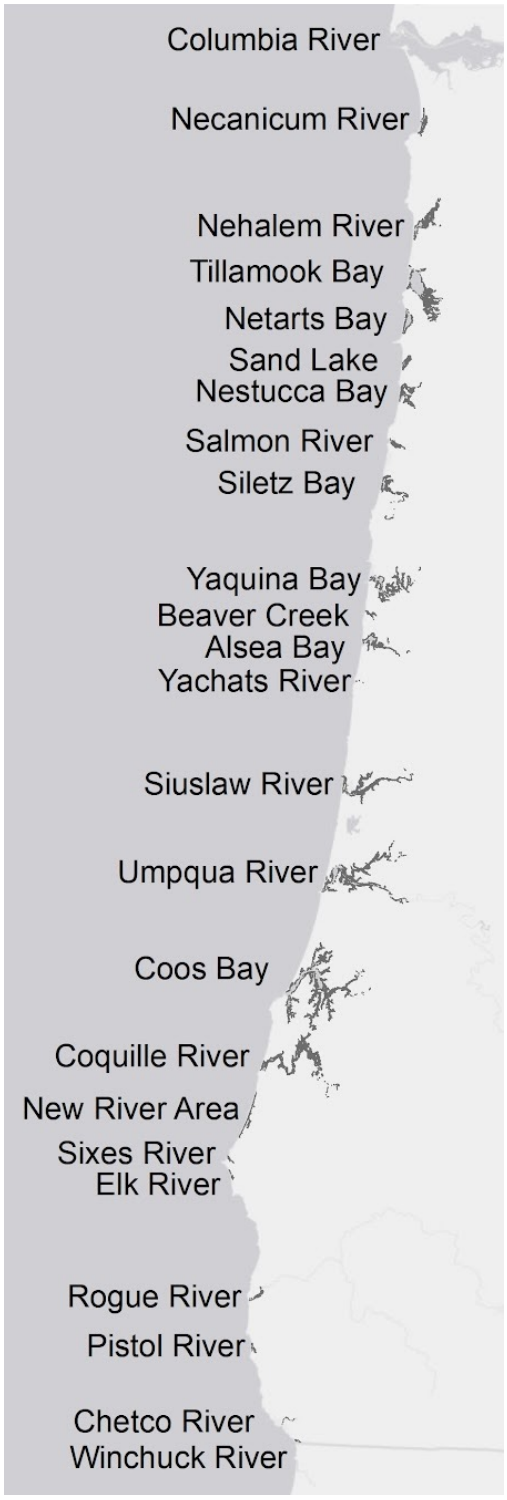


Figure 3: *Map of 23* major estuaries in Oregon. (*sources differ on whether there are 22 or 23 major estuaries). Source Brophy, 2019b*

tidal marsh and swamp have lost roughly 69% of their historical area. In addition to diking to create farmland, the construction of Bonneville Dam also likely caused the shrinking of Columbia River wetlands (Cannon, 2015).

The results of damming and diking paint a sorry picture of the current state of Oregon's tidal wetlands. However, despite the significant losses of tidal wetland habitat, there is some good news. The Brophy 2019 report noted restoration of around 1,700 acres of tidal wetlands along the Oregon coast (Brophy, 2019a). In the time since the report, local leaders, non-profits, and state and federal agencies have collaborated on the Southern Flow Corridor restoration project, which restored an additional 442 acres of tidal wetlands in Tillamook Oregon (Janousek et al, 2021). Moreover, around 4,300 acres of tidal wetlands have formed naturally through sediment accumulation at the mouth of rivers and streams (Brophy, 2019a). Most of the restored and naturally forming tidal wetlands are tidal marsh, with very few areas of tidal swamps developing (Brophy, 2019a). The natural development of tidal wetlands combined with the success of the tidal wetland restoration projects demonstrates that it is possible for tidal wetlands to make a comeback. They just might need a little help along the way.

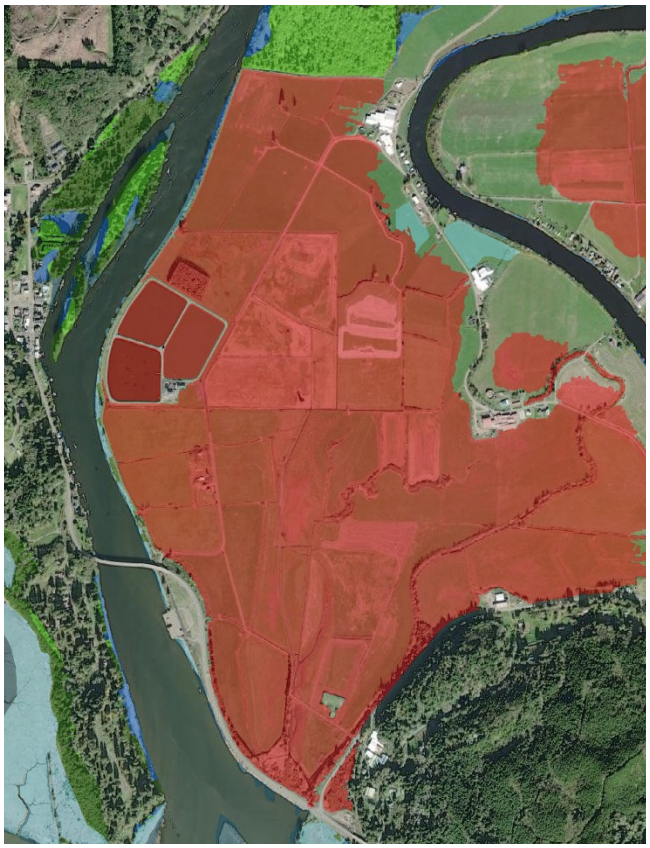


Figure 4: *Example of how tidal wetlands were diked to form farmland. This is an arial image of the Nehalem River, just to the northeast of Nehalem Bay. The red shaded area was once tidal wetland but has since been diked and is now mostly farmland. Source: Brophy 2019c.*

Tidal Wetlands in Public Policy and Natural Resources Management

In 1977, in response to a new federal law called the Coastal Zone Management Act (CZMA) of 1972, Oregon legislators included tidal wetlands as a priority in the state's Land Use Planning Program and as a central tenet of the Oregon Coastal Management Program. This program was created under the CZMA to work with the federal government to responsibly manage critically important coastal areas like estuaries. Land Use Planning Goal 16, Estuarine Resources, aims "…to recognize and protect the unique environmental, economic and social values of each estuary and associated wetlands; and to protect, maintain, where appropriate develop, and where appropriate restore the long term environmental, economic and social values, diversity and benefits of Oregon's estuaries." (Oregon Land Conservation and Development Department, 1977). Goal 16 helped state agencies determine and align priorities for managing coastal resources such as emphasizing habitat restoration over non-water dependent industrial development.

Many other governmental and non-governmental groups, including universities and non-profits, are raising awareness about the importance of tidal wetlands. Furthermore, coastal Tribal Nations have worked to sustain estuarine health since time immemorial and continue to speak to the critical importance of the areas for culture, life, and ecosystem function.

Future Threats

While momentum to preserve and restore tidal wetlands might be increasing, there is another large threat to them outside of historic land use decisions and developments: climate change. Climate change will likely have many impacts on Oregon's tidal wetlands including sea level rise, ocean acidification, increasing average water temperatures, and altered precipitation cycles (Oregon Department of Fish and Wildlife, 2012). Each of these factors would negatively impact tidal wetlands in unique ways, but sea level rise is one of the most concerning. Researchers expect climate change to cause sea levels along the coast to rise (Olmeta Schult et al, 2023), flooding tidal wetlands on the coast and up rivers as the ocean advances (Figure 5). If sea levels rise between 63-142 cm (24-56 in) over the next century, Oregon could completely lose many of its coastal tidal wetlands, based on analysis of several tidal marshes in Siletz Bay, Coos Bay, and Bandon (Thorne et al, 2018). Additionally, Oregon's steep topography makes it difficult for tidal wetlands to migrate inland (Brophy and Ewald, 2017; Thorne et al, 2018). Even minimal sea level rise will reduce the total area, diversity, and distribution of tidal wetlands (Thorne et al, 2018). If sea levels rise 142 cm (56 in) the available area for tidal marsh and swamp to migrate to along the Oregon coast (at appropriate elevations) is estimated to be about 21% smaller than their current area. If sea levels rise 350 cm (138 in) the available area is estimated to be 60% less than their current area (Brophy and Ewald, 2017). With seas rising on one side and communities and infrastructure encroaching on the other, tidal wetlands could be squeezed out of existence.

However, again there is a glimmer of hope. The exact rate of sea level rise varies along the coastline. Interestingly, this is because sections of Oregon's coastline are rising as well. The tectonic plate that the Oregon coast rests atop is slowly shifting unevenly upward (Oregon Department of Fish and Wildlife, 2012; Verdonck, 2006). As a result, there are areas along the coastline where the rising land is expected to keep pace with or potentially exceed the rising sea, sparing tidal wetlands within those areas (Verdonck, 2006). Furthermore, even in areas where the uplift from the tectonic plate is not enough to equal that of the rising ocean, there are some wetlands that could still stay above water by trapping and building up soil through a process called accretion. If the wetland can build up enough soil each year to keep itself above the rising ocean, then the wetland is likely to survive. For example, the Southern Flow Corridor tidal wetland in Tillamook Bay is accreting an average of 10.3 mm of soil per year, so it might have the potential to survive the projected 4 mm of annual local sea level rise, assuming the accretion rate stays the same (Brophy et al, 2018; Mazzotti et al, 2008; Peck, 2017). Since sea level rise is a major threat to Oregon's tidal wetlands it is critical to start planning now for how communities can work with, benefit from, and protect their local tidal wetlands (Oregon Department of Fish and Wildlife, 2012). If planned carefully, tidal wetlands could help us fight climate change, instead of becoming a casualty of it.

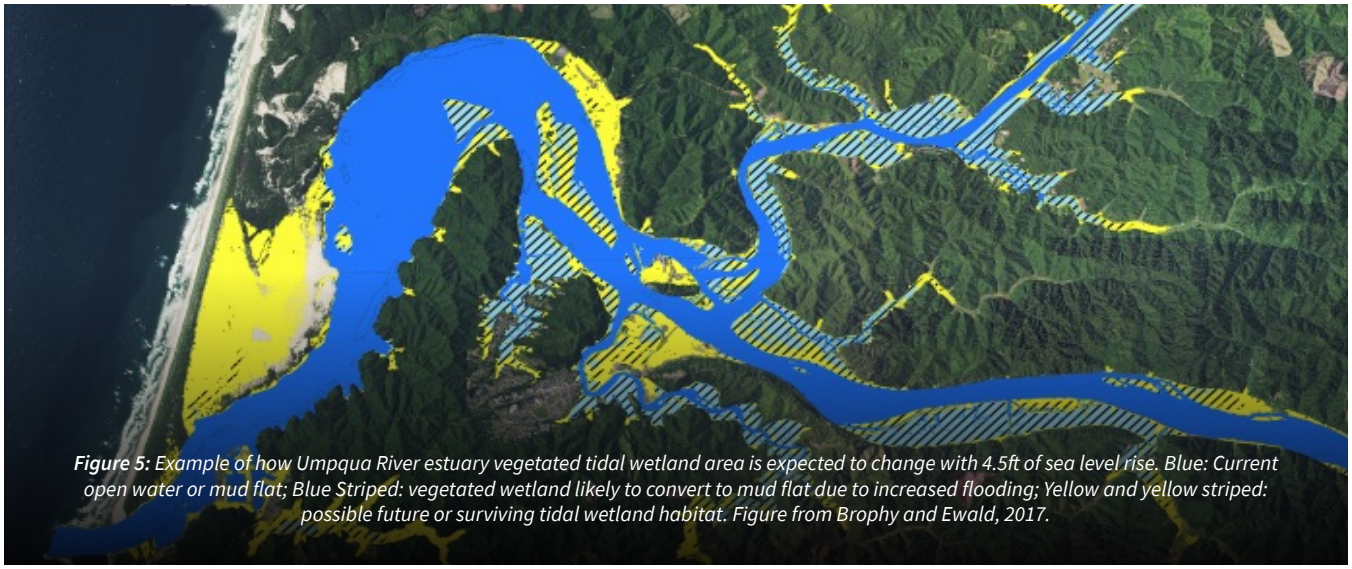


Figure 5: *Example of how Umpqua River estuary vegetated tidal wetland area is expected to change with 4.5ft of sea level rise. Blue: Current open water or mud flat; Blue Striped: vegetated wetland likely to convert to mud flat due to increased flooding; Yellow and yellow striped: possible future or surviving tidal wetland habitat. Figure from Brophy and Ewald, 2017.*

Ecosystem Services of Tidal Wetlands

Now that we've discussed what Oregon's tidal wetlands are and how they're doing, let's talk about why they're so great. Tidal wetlands produce numerous ecosystem services to local and regional communities. Ecosystem services are functions provided by the environmental that benefit people economically, culturally, recreationally, and physically (Marcot et al, 2023). These services include water filtration, flood control, carbon storage, recreational opportunities, and plant and animal habitats that support commercial and recreational activities.

Tidal wetlands provide these services through a combination of their topography, vegetation, and the natural processes that take place within them. For example, they can help protect communities from storm surges and floods by providing an open area for the deluge of water to spread out into and slow down (Reed et al, 2018). Also a study found that tidal wetland vegetation can significantly reduce wave energy strength across a range of geographic and hydrodynamic settings, helping to protect communities from storms (Shepard et al, 2011). Tidal wetlands can also remove high levels of nitrogen through absorption by plant and alga photosynthesis (Korol & Noe, 2020). Excessive levels of nitrogen can cause potentially toxic algae blooms and areas of low oxygen, causing aquatic organisms to suffocate.

Tidal marshes and swamps are also a great home for salmon and other fish species, as the tidal channels provide productive habitat for hunting and shelter (Rountree and Able, 2006). Additionally, these wetlands and swamps are great places for juvenile salmon to take shelter while they acclimate to saltwater as part of their life cycle. Tidal wetlands within estuaries often have salinity gradients within their tidal channels which allow fish to gradually become accustomed to the increased salt levels while still being able to hunt for food and find shelter.

Furthermore, Sitka spruce and other large trees help to form a complex multilayered habitat from deep channels to high tree crowns. This rich environment is used by many aquatic species like, salmon, other fish, insects, and amphibians, while scrub and forested ground is prime habitat for many birds and mammals including eagles, minks, bats, and bobcats (Frenkel et al, 1981; Batzer and Baldwin, 2012). Finally, the dense vegetation in both tidal marsh and swamp helps to trap and accumulate sediment. The accumulated sediment can contain high levels of carbon and nutrients that contribute to the food webs for many species while sequestering carbon. Refer to the following page, for a more comprehensive look at the services that tidal wetlands can provide.

Flood Control

Tidal wetlands help with flood control by providing a large area for flood waters to slow down and spread out into (Reed et al, 2018). This feature of tidal wetlands can help decrease the duration and severity of a flood potentially saving the community significant amounts of money on repair costs.

It was found that the Southern Flow Corridor tidal wetland in Tillamook Oregon, decreased flood levels on 4,800 acres of the surrounding area (Collins, 2018). Another study found that a restored tidal wetland decreased flood damage to the local community by 22% (Narayan et al, 2017).

Food Production

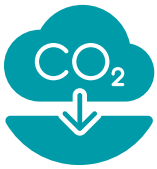
Juvenile salmon and Dungeness Crab use estuarine tidal wetlands for shelter and to find food before they head further out into the ocean (Armstrong et al, 2003; Fisher & Velasquez, 2008; Hoobyar, 2007). Shellfish beds also commonly form in tidal wetlands (Nelson, 2007). While the shellfish within the tidal wetlands may not be the most accessible, it is likely that their progeny float out of the wetland and contribute to harvested stocks. Combined, those species contributed over $170 million to Oregon's 2019 commercial fishing industry and supported over 12,000 jobs within the commercial and recreational fishing industries (National Marine Fisheries Service, 2024).

Water Quality

Excessive levels of sediment, nutrients, and pollutants can be removed by tidal wetlands through sediment accretion, and biological processes. High levels of sediment can cause access issues for boats and can impact crabbing/clamming activities if the sediment level is too high for long periods of time (Ainsworth et al, 2014). High levels of nutrients can lead to algal blooms which in turn can cause eutrophication events (aka dead zones) which can impact fisheries and recreational activities (Stone and Hitchko, 2009).

Habitat

Many valuable species relay on tidal wetland habitat for shelter and/or food. Endangered species such as coho salmon, brown pelican, bald eagle, and marbled murrelet all utilize tidal wetland habitat. Additionally, tidal wetlands help support state-sensitive or sensitive-critical species such as Pacific lamprey, chum salmon, and numerous bird species (Oregon Department of Fish and Wildlife, 2021 Having access to this vital habitat helps support the populations of these vital species.



Carbon Storage

Tidal wetlands capture and store carbon primarily through soil accretion (Murray et al, 2011) and have some of the highest carbon sequestration rates per area compared to all other ecosystem types Laffoley and Grimsditch, 2009). Pacific Northwest tidal wetlands have particularly high levels of carbon in their soil, suggesting high carbon sequestration potential (Batzer and Sharitz, 2014; Kauffman et al, 2020; Laffoley and Grimsditch, 2009,Mcleod et al, 2011). Burying carbon rich sediment helps fight climate change by trapping the carbon underground, preventing it from breaking down and being released as CO_2.

Social Benefits

The open waterways, rich resources, and aesthetic beauty of tidal wetlands provide many social benefits to location communites. These include cultural value, educational resources, recreational opportunities, economic promotion, and visual aesthetics. One study found that a tidal wetland restoration project increased the value of the 1,000 nearby homes by $19,000. Which increased the value of the whole housing market by $19 million (Shaw and Dundas, 2021).

Section 2

Valuation Steps and Points to Consider

Tidal wetlands are fascinating, dynamic, and highly productive ecosystems which provide vital habitat for fish and wildlife while also benefiting people and communities. However, the value these soggy, mushy landscapes provide is not always easy to see. Therefore, the question becomes: how does one determine this value and present it in a usable way?

Why Value Tidal Wetlands?

Research indicates that tidal wetlands provide bountiful benefits and services to local communities. However, it can be difficult for policymakers, project managers, and community members to recognize and appreciate the value of these benefits. One way to demonstrate the value of ecosystem services (ES) is to present them in a different context (Jaeger, 2005). Instead of focusing on the physical aspect of the ES benefits, as described in section 1, one can estimate a value (usually monetary) for the ecosystem's benefits. For example, imagine that the city of Cannon Beach wants to create a new natural area. The restoration work is expensive, so the city wants to show that the benefits outweigh the costs. The project planners anticipate that the new park will provide increased health benefits to the community. The planners could use health statistics of nearby residents to show that community health has improved since the park was opened. They could then express those benefits as dollars saved from reduced medical expenditures, resulting in an estimated dollar value of the health benefits provided by the new natural area. Additionally, the planners could look into how the new area affected home values nearby or increased recreational access for residents. Knowing the value of ES can help communities better understand the importance of such ecosystems, potentially leading to an increased effort to restore and protect them. With a greater understanding of how valuable an ecosystem is to their community, decision-makers will be more likely to work to protect and manage that ecosystem (Schuster and Doerr, 2015).

Tidal Wetland Valuation Steps

Four key steps are necessary to capture the value of a tidal wetland through a valuation analysis. First, identify the goals of the analysis—why is it being conducted? Second, determine which groups and individuals can help with the analysis either through ES identification/valuation, or through a deeper partnership. Next, decide which ES provided by the tidal wetland should be included in the analysis. And finally, select which valuation methods are right for the situation. More detail is provided below for each of these steps with detailed guidance provided in each section of this document.

1 Goal Setting

At the start of a tidal wetland valuation study, it is important to know what the point of the analysis is and for whom the analysis is being conducted. Setting goals ensures time and resources are not wasted and that the ecosystem services analyzed are focused on community needs. Determining goals also helps make sure the results of the analysis will be informative to those who need them. For example, it might be interesting to know the monetary value of recreation activity within a restored wetland, however that might not be useful information to decision makers concerned about increasing local carbon storage. When drafting a goal, it is important to include which ES are being valued and who benefits from it. An example goal could be, *determine the value of improved water quality from the tidal wetland to the local fishing community*. The process for creating goals is discussed more in section 3.

2 Engagement Strategies

After the goals have been set, it is time to determine who is benefiting from the ES provided by the tidal wetland and determine to what degree they should be involved in the analysis. First, technical experts in relevant fields such as ecology, socioeconomics, natural resources, and Indigenous practices are important to find. Technical experts can help identify stakeholders and co-managers, aid in the design and implementation of the study, and interpret the results. Technical experts may also play a dule role as a co-manager or stakeholder. Any individuals or groups who are impacted directly or indirectly by the tidal wetland's ES are potential stakeholders or co-managers. Co-managers are groups who have authority over, or ownership of, the resources/lands involved and are affected by the ES provided by the tidal wetland. Co-managers can include sovereign Tribal Nations, other governmental entities, and property owners. Stakeholders are groups or individuals who are impacted by the wetland's ES but do not have the authority of a co-manager. Stakeholders can be, but are not limited to, citizens of a community, local businesses, or industries. Technical experts, stakeholders, and co-managers will be included in the valuation analysis. However, co-managers and potentially Tribal governments (through a consultation process if federal or state government(s) are involved) will be involved in the design and implementation of the valuation study due to their jurisdiction or ownership over the lands/resources affected by the tidal wetland's ES. The inclusion of stakeholders and co-managers has many benefits, such as assisting with the study's design, identifying ES, determining the significance of ES, and providing valuation data. There is a simple four step process for identifying and selecting stakeholders and co-managers which is discussed in more detail in section 4.

3 Ecosystem Service Identification

After goals have been set, and Tribal Nations, co-managers, and stakeholders have been identified, it is time to determine which ES will be included in the analysis. This process is iterative and ample time for selection should be provided given the large number of ES that a single tidal wetland can produce. Note that it is likely unfeasible to measure all of them. It is important to rely on the determined goals, co-managers, Tribal Nations, stakeholders, and technical experts to help identify ES and determine the magnitude of their effect. ES that have the potential to be analyzed will also be narrowed down by project feasibility constraints such as time limitations, data availability, and analysis resource limitations. Section 5 lays out a four-step process for identifying and selecting ES for the analysis.

4 Valuation Methods

The final step is to select which valuation method(s) will be used in the analysis to find the value of the ES provided by the wetland. Selecting the appropriate valuation method is vital; if the wrong method is used the results of the ES valuation could be incorrect leading to inaccurate estimates of the tidal wetland's value. Or it might not be possible to use specific valuation methods due to data, time, or analysis resource limitations. Section 6 lays out some common valuation methods, broadly recommends the data and resources necessary to conduct each analysis type, and provides examples of how each method is used.

Why Value Each Wetland Individually?

Valuing anything in economic terms requires knowing its quantity and price per amount. This process can be straightforward when a good or service's price is known (the market price of fish for example). However, it becomes more complex when something has no direct or known market value to refer to. The same goes for goods or services whose values are heavily influenced by numerous factors, such as the price of a home. This is the case for ecosystems and tidal wetlands in particular. The value of tidal wetland habitat can vary wildly—numerous studies have reported the value of wetland habitats from hundreds to billions of dollars (Costanza et al, 2006; Feagin et al, 2010; Johnson et al, 2002). The variability of ES value comes from many aspects, such as who is valuing it, what services and benefits it provides, its location, and so on. With so many locally influenced variables, it becomes necessary to conduct a socioeconomic valuation study for the specific tidal wetland in question. Without data relating to the tidal wetland being valued and the local community it impacts, the accuracy of the analysis results will be limited. Benefit transfers from similar wetlands will be discussed in Section 6. For now, it is important to remember that each tidal wetland is unique and will provide distinctive services which will be valued differently by each community.

Should Tidal Wetlands be Valued? An Ethical Note

While it isn't mandatory to place wetlands in an economic valuation framework, understanding ecosystem services through a socio-economic lens can be helpful. Within any ES valuation, a disclaimer should be included that acknowledges the ethical challenges associated with such an analysis. A brief discussion about the limitations of ES valuation is recommended, with particular attention given to how a subset of economic and social values selected for analysis do not represent the whole value of an ecosystem. This way, readers are provided an opportunity to reflect on what the analysis is demonstrating, which is not the entire value of a given wetland, but certain, measurable social and economic elements that demonstrate why a wetland should be restored and protected.

Section 3

Setting Goals

Before embarking on any journey with limited time and resources, it is important to know what you'd like to achieve by the end. The same applies to studies such as these. In order to not waste time and resources, it is important to determine why the socioeconomic study is being conducted and for whom. Setting a goal will guide which ecosystem service(s) (ES) are valued as well as which communities will be focused on. Once a goal is set, the rest of the valuation journey can begin.

Selecting Analysis Goals

Goal setting for tidal wetlands should indicate what aspect of the tidal wetland is being valued, state what value is being assessed (monetary, non-monetary, or both) and indicate 'who' or 'what group(s)' are or will be affected. For example, a goal could be: *Determine the monetary value of the time saved by drivers on HW 101 due to flooding mitigation from the tidal wetland per average annual flood event.* It is likely that the analysis goal(s) will be socioeconomic in nature, as the analysis is focused on the value (economic) effect of the tidal wetland on a specific group or community (social).

The goal can be more vague or specific depending on the project. For example, say project planners know a tidal wetland reduces flooding, but they don't know how the benefits transfer from that service to the community. In that case, the goal of the analysis could simply be: *Identify ecosystem service benefits associated with flood mitigation and determine the benefit's monetary and non-monetary value to the local community.*

Sometimes, the framework for the analysis's goals are already provided by a previous or ongoing project. For example, restoration projects usually have ecological goals for the restoration efforts such as restoring a set amount of habitat or capturing a specific amount of carbon. The goals of the analysis can then build off the ecological goals of the restoration effort. If the intent of the analysis is to determine if the benefits of the restoration outweigh the costs, then the goals could be: *Determine the monetary benefits of the captured carbon over the next 100 years and determine the monetary value of the restored habitat in terms of increased fish production to the local community.* Aligning the ecological goals of the restoration project with the goals of the analysis will ideally provide relevant and useful results to project planners and funders. Some projects may even have their own socioeconomic goals, for example, the planners of a restoration project may want to boost the economy of a low socioeconomic neighborhood by increasing ecotourism in the area. If that is the case, then the goals of the analysis will likely be very similar. For instance, the analysis goal could be: *Determine the economic impact of ecotourism from the restored site on the neighborhood's economy.*

If the goals of the two endeavors are not aligned, the socioeconomic benefits of the restoration effort might not be as clear to the original project funders. This isn't to say that an analysis can't look at ES other than those identified in the restoration project goals, just that for best results, the analysis goals should usually be in line with those of the restoration project. In the absence of prior or currently running projects with defined goals to draw upon, the subsequent section will explore the effectiveness of employing 'why' and 'who' questions to establish clear-cut goals that will direct the analysis and generate meaningful results.

Why?

A good place to start when pondering the goal of an analysis is to answer the question, *'Why is the tidal wetland being valued? What decisions will the analysis inform? Is the goal to justify the cost of restoration to a funding source, to prove the tidal wetland has conservation value to a local community, to support a bill in a governing body, or to encourage an industry to invest in best conservation practices?'* Thinking of how the results of the valuation analysis will be used is key for choosing goals. The goals will ideally direct the analysis so that the results provide actionable information, rather than fun facts about the wetland. Once the 'why' has been determined, the next question to answer is 'who'.

Who?

Who is the valuation for and who is being included in the analysis? It is important to consider who is the audience of the study. Is the goal to inform law makers or the general public? What aspects of the wetland would the audience be interested in? The group or organization that requested the analysis might also have their own goals that need to be considered. To clarify that point, consider a few examples: If the health office's goal is to show that wetlands provide value in terms of social welfare, then it would be wise to craft goals for the valuation analysis that help validate the wellness benefits the health office is focused on. If the group needs the analysis to receive funding for a project, then the goals should focus on determining the services that produce the most monetary value. If the group wants to protect the wetland from destruction, then showing the value the community places on the wetland might be a good approach.

Next, consider who is receiving the ES benefits. The goal should specify who will be included in the study. Are the ES benefits being valued in terms of the benefits received by the local community as a whole or a specific

neighborhood? Is an entire Tribal Nation included in the analysis or just a few select members who live near the tidal wetland? By default, many of the groups mentioned in the goals will become co-managers or stakeholders in the project, so deciding who to include in the analysis helps set the scope for determining co-managers and stakeholders in the next step.

Examples

If the exact goals of the valuation still aren't in focus, answer the following questions laid out in *A Guide for Incorporating Ecosystem Service Valuation into Coastal Restoration Projects* by Schuster and Doerr, 2015, which were adapted from Waite et al., 2014.

- What are the ecosystem services at stake? (e.g., tourism, fisheries, shoreline protection)
- What is the appropriate geographical scale that would be affected by a targeted policy change? (i.e., beyond the restoration site, what is the area that may be affected by the restoration project and desired policy changes; this may be site-specific/protected area, subnational, national, regional)
- What are the policy options or range of possible futures under consideration?
- What are the current and desired human uses of the environment?
- What are the likely economic effects of policy action or inaction? What is likely to change?
- What is the necessary level of accuracy of the study?

Goals set during this stage in the analysis are not set in stone and, if necessary, can be updated or modified depending on developments and changes in the valuation analysis and who is involved in it. If a co-manager, identified in the next section, wishes to add or modify a goal, then review the previously created goals and determine how they could be updated to accommodate the new goals proposed by the co-manager without jeopardizing the original intent of the study.

Finally, to give some examples of what specific goals actually look like, here are some further examples of socioeconomic analysis goals, some of which were adapted from Schuster and Doerr, 2015.

- Measure the cost-effectiveness of a low tidal marsh compared to a bulkhead.
- Quantify the change in economic benefits provided by the project to visitors interested in wildlife viewing.
- Measure the increase in spending by recreational fishers after successful tidal wetland habitat restoration.
- Demonstrate the effectiveness of flood attenuation and reducing damage costs for homeowners through thin-layer placement of dredged materials on salt marshes.
- Determine how much the community values carbon capture and storage by the tidal wetland.
- Identify and value benefits neighboring landowners receive from the tidal wetland.
- Determine the social value of ES produced by a restored wetland through a survey of a representative portion of the community.

Section 4

Engagement Strategies

When trying to estimate the value of an ecosystem service (ES) provided by a tidal wetland, it is important to determine who is benefiting from it. Beneficiaries could be neighboring landowners, sovereign nations, other governmental entities, industries, community residents, non-governmental organizations, or business owners. Identifying and engaging these individuals or groups is vital for conducting an accurate socioeconomic analysis.

What is Tribal and Co-Manager Engagement and Other Stakeholder Engagement?

The rights of Tribal Nations, including but not limited to treaty rights and usual and accustomed hunting and fishing rights, must be given thoughtful consideration before, during, and after any ES valuation effort. Non-tribal leaders of these efforts should exercise humility and be aware that their work may impact Tribes who may not, at a cursory glance appear, to have current and historical rights to the lands and waters of a given location. Identification of one or more local experts will provide helpful guidance and input on a respectful and appropriate process.

A Tribal advisor or co-manager may, if willing, provide important information and insights for valuing ES. If Tribal members or Tribal government staff provide little or no response to outreach efforts, it is important to continue to try and reach them. A lack of response does not necessarily indicate disinterest in the project, but may indicate other factors that could affect participation, like staff capacity or a timing conflict with the project and other Tribal government priorities.

Tribal staff or members may also be invited to offer input on how the valuation study is conducted, how it is framed, what happens to the data and results, and how the results are shared.

To further clarify who could fill the roles of co- managers and stakeholders, here are two examples to help provide some perspective. 1) A tidal wetland near a small town is located partially on Tribal lands, and partially within the boundaries of a city. To estimate the value that the tidal wetland provides to both the Tribal government and its citizens as well as the city's government and its citizens, the researchers must include the Tribal Nation, the city government, citizens, and members of the two communities to participate.

Additional stakeholders may be identified as the full extent of the tidal wetland's ES influence is uncovered. 2) Another more complicated example involves a tidal wetland located near a fishing-dependent community that was restored with support from a partnership between a Tribe, the state of Oregon, and a non-profit organization. The restored tidal wetland provides ES that benefit citizens of a small unincorporated community, members of the fishing industry, and a Tribal Nation. In order to understand the value of the ES, the researchers and technical experts must include as many of the

Traditional Knowledge

Also sometimes referred to as Traditioinal Ecological Knowledge, is "…a cumulative body of scientific knowledge, passed through cultural transmission, that evolves adaptively through time as a result of Indigenous peoples living in and observing the local environment for many generations; it is a form of adaptive management."

—Berkes et al, 2000; Berkes, 1999

"This knowledge includes the relationships between people, plants, animals, natural phenomena, landscapes, and timing of events for activities such as hunting, fishing, trapping, agriculture, and forestry."

—NPS, 2023

affected groups and individuals as possible and comply with regulations of the involved governments. So, they invite the Tribe, state government, and the non-profit organization to participate because a) they participated in the wetlands restoration and therefore would have invaluable background information, data, and knowledge of the restoration project, and b) because of their unique authorities and expertise over major aspects of the restoration project. Finally, the residents of the unincorporated community and of the fishing industry are included as stakeholders, as they benefit from the ES provided and would have insight into what benefits they receive from the wetland. The fishing industry may also be able to provide data or anecdotal information that may help increase the accuracy of an analysis.

Including Tribal co-managers and other stakeholders in a valuation study:

- Is essential to ensuring that efforts reflect Tribal priorities and are conducted respectfully. This helps researchers better understand the situation and context surrounding the tidal wetland,
- Increases communication between project managers, experts, and the impacted communities,
- May improve access to local, traditional, and/or non-public data, experiences, expertise, and knowledge,
- Helps create a fairer process, especially for traditionally disadvantaged/under-represented parties,
- Aids in conflict prevention and resolution of differences,
- Increases social capital through the promotion of trust and partnership,
- Enhances stewardship of the study promoted through cooperation,
- May help co-managers and stakeholders develop a shared understanding of the value of the tidal wetland and its ES,
- Helps identify flaws or gaps in valuation study plans,
- Enables superior survey and outreach materials,
- Helps researchers better understand the ES and value provided by the tidal wetland.

(list adapted from: Council on Environmental Quality, 2021; National Oceanic and Atmospheric Administration, 2015; Talley et al, 2016;)

Despite the significant benefits co-manager and stakeholder engagement can have for an analysis, it can be challenging, and planning is key. Engagement can cost extra time and money to organize meetings, host focus groups, create and distribute surveys, etc. Co-managers, stakeholders, and the researchers may also disagree on study objectives, methods, or other aspects of the analysis. This can add tension to the process and take time to resolve. However, even with the possible challenges, the benefits of early and intentional technical expert, stakeholder, and co-manager engagement make it well worthwhile.

Co-Manager, Technical Expert, and Stakeholder Identification

Technical experts and stakeholders are defined as any person or group who is potentially affected by the ES provided by the tidal wetland and who may have special knowledge regarding them. The list of those who could be included can easily grow in size and may feel overwhelming. This is especially true for studies considering non-use benefits or benefits that people do not directly receive, but still gain value from their existence. These will be discussed further in section 6. Don't worry about the potential list's size and just focus on major stakeholders and co-managers.

To start, use the following four-step co-manager and stakeholder identification process to help identify those major stakeholders who can aid in the ES identification and selection process, discussed in the next section.

They might also be able to help identify additional co-managers and stakeholders who should be included in the analysis. It is possible that during the analysis process, the project team will have to circle back to the identification process multiple times.

The following simplified process (see figure below) was inspired by the Rapid Stakeholder Assessment, which is a part of *A Guide For Incorporating Ecosystem Services Valuation Into Coastal Restoration Projects* from 2015 (Schuster & Doerr, 2015). The guide was written by the Nature Conservancy in partnership with the National Oceanic and Atmospheric Administration and is adapted here to provide a high level overview.

1

Convene an Interdisciplinary Work Group

The work group should include individuals representing a variety of roles and specializations, such as tribal staff or representatives, ecologists, engineers, economists, hydrologists, social scientists, or community leaders.

2

Define the Geographic Boundaries

Boundaries should be drawn to include all biological and physical aspects that are affected by the tidal wetland or proposed restoration project. Nearby communities, or groups with political jurisdiction should also be included.

3

List Connected Co-Managers

Using the defined geographic boundaries as an initial guide, identify tribes with rights including but not limited to treaty and usual and accustomed hunting and fishing rights. Consult one or more local experts to ensure that tribes with historic and current interests are properly invited to participate, and that adequate time is allotted. When agencies are leading ensure that there is time for government-to-government consultation, if desired.

4

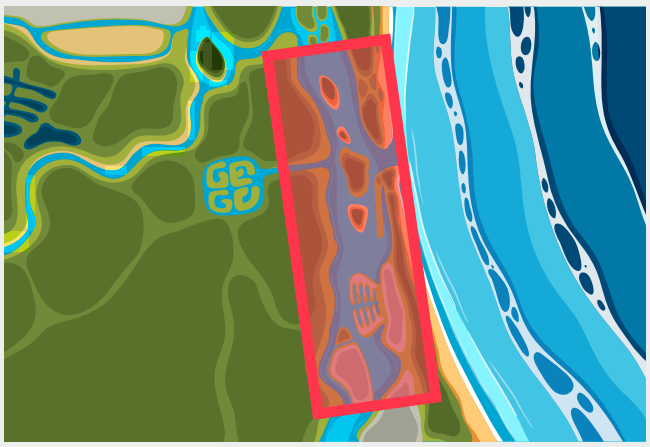
List Clear Stakeholders and Remain Open to Additions

Use the defined geographic boundaries to identify stakeholders, such as vulnerable communities, agricultural producers, and industry groups.

1 Convene an Interdisciplinary Work Group

To identify possible stakeholders and co-managers it is best to assemble a team. But not just any team--a team of the finest wetland evaluation experts! Biologists, ecologists, hydrologists, indigenous knowledge experts, cultural resource specialists, economists, engineers, and political scientists should be included if possible. With their expertise, the team of experts can then best identify the ES the tidal wetland produces (or would produce if the wetland has yet to be restored). These experts can be managers of the current site, as well as scientists and engineers involved in planning or implementing a restoration effort, leaders or representatives of local Tribes or communities, agency or industry experts, non-profit scientists, researchers from a local university, or even poor, hungry graduate students. From experience, it is highly recommended to, at a minimum, include an environmental economist.

They will be able to help provide vital guidance and advice not only on participant inclusion but also the data and information necessary from these groups.



2 Define the Geographic Boundaries

Once the team has been gathered, it is time to determine the geographic boundaries of the project. It is best to determine the full scope of the tidal wetlands current or projected influence. The focus of the project can be narrowed down later so don't worry about thinking too big. To start, work with the team of experts to identify the ecosystems, communities, landowners, and industries the tidal wetland influences. All those that are influenced or affected by the tidal wetland should be included within the boundary. Maps and software (i.e. Google Earth, ArcGIS) can be used to help visualize the wetland's connections to other ecosystems, communities, roads, landowners, etc. Aside from the boundaries of physical influences there are also political boundaries to consider, such as agencies or governments that have influence or jurisdiction over the wetland. This process will likely create a large if not massive area. It is best to start with an area that is too large and cut away at it using analysis goals and resource limitations later. Adding to the geographic area later is not impossible but can complicate the process and add time to the analysis.

3 List Connected Co-Managers

Once the geographic boundary has been determined, it is time for the team to identify possible co-managers. Start early in the identification of co-managers because, as mentioned before, co-managers should be invited to help hone project goals, improve the project geographic scope, and aid with identifying stakeholders and ES. To identify co-managers, have the team consider what ecosystems, waterbodies, fish, game, culturally important materials, and natural resources the tidal wetland currently affects, or may affect in the future.

Next, determine which governments, agencies, or landowners have jurisdiction over the affected elements. If a restoration project was completed recently or is being planned, the co-managers of the restoration project could also be invited to join the analysis.

4 List Clear Stakeholders

Now it is time to use the combined power of the assembled team and co-managers to identify stakeholders within the geographic boundary. First focus on identifying key stakeholders who could aid in ES identification and selection. These key stakeholders could be community or neighborhood representatives, vulnerable or overburdened community members, businesses, or industry experts. They will be able to help with the second part. Identifying all the stakeholders who could benefit from the tidal wetland. This will be discussed further in the next section.

Co-Manager and Stakeholder Inclusion Methods

There are many ways to include participants in the valuation analysis. Some prominent ways are listed below. Many of these methods work for both stakeholder and co-manager inclusion, however, as mentioned above, the level of inclusion will vary between co-managers and stakeholders. Project leads may also need to provide honoraria for Tribal participants. The following list was adapted from *Engaging Stakeholders To Identify and Prioritize Future Research Needs* by O'Haire et al, 2011.

Method	Application
Interview	Including in-person, over the web, or phone. Allows time to have conversation with small groups or individuals. Great for gathering more personal responses, feelings, and feedback about the tidal wetland and its ES from individuals such as landowners, industry representatives, or local businesses.
Focus/Working Groups	Goal is to create a comfortable, culturally appropriate space where a small group of people are guided through a discussion by a facilitator. Great for testing surveys, identifying ES, and gathering valuation opinions.
Questionnaire	Good for surveying large amounts of people in a short amount of time. Useful when surveying large sections of a community or groups. Can be in-person, mailed, digital, or even on social media. Not appropriate for many communities.
Citizens' Juries	Usually consists of a pre-selected, diverse group of individuals who come together and are informed of general aspects of possible policy or project decisions. They then hear from experts who give "testimony" on various details of the topic under debate. The "jurors" are then asked to provide a written "verdict." The verdict can be an open-ended statement or answers to a set of questions. Great for identifying ES that may have been missed, asking community members about various alternative restoration projects, or determining the value of an ES.
Community	Individuals who reside within a specific area are invited to a public gathering space for a discussion. The meeting may begin with a welcome by a trusted community member, or a presentation or talk by a panel. Food may be provided as well.
Workshops	Typically used to gather a group of science, policy, and/or community experts to work on valuation analysis goals and methods. Great for gathering opinions from experts who might not have the capacity to join the analysis team, but still have valuable insight.

Additional Notes on Sovereign Nation Engagement

Tribal Nations have stewarded the Oregon coast since time immemorial. They have a strong cultural connection to tidal wetlands in Oregon. In the past, Tribal Nations used fish weirs and other structures to catch fish in tidal wetlands and potentially modified the wetland for better function (Byram and Witter, 2000). Tribal Nations today continue to rely on tidal wetlands to sustain their culture and lifeways. They hunt, gather materials for basket weaving and other culturally significant practices and ceremonies, fish and harvest shellfish, using traditional and contemporary methods, among other activities.

Tribal Nations are distinct sovereign nations with their own cultures, rights, rules, resources, governance, and interests. Given their status, it is critical to engage Tribes early and in meaningful ways. Tribal Nations could be considered co-managers, or depending on their preferred level of involvement, part of a steering committee, or as a governmental collaborator, but they are not stakeholders of the analysis. Fundamentally, the researchers conducting the ES analysis should consider that they are essentially trying to evaluate the benefits from ES received by a community within another country. The inclusion of the sovereign nation is particularly important if the tidal wetland is on allocated land owned by Tribal Nations. As a result, if the sovereign entity is invited to participate in the study, in recognition of legal and ethical responsibilities to these Nations, they should be afforded equal input in how the research project is conducted, retain ownership of their data, and the ability to inform how results are used. Including Tribal Nations in the analysis also helps the researchers make the assessment as effective and accurate as possible. The Tribe might have useful internal information, applicable traditional knowledge, or insight into community dynamics that would be missed or misinterpreted if the Tribe was not included. Working with a Tribe as a co-manager also gives the Tribe ownership over how they would like to be involved, such as if and how they would like a community survey to be conducted. This way Tribal rights and cultural norms are respected, and community knowledge and opinions are collected considerately. Including the Tribe as a co-manager is

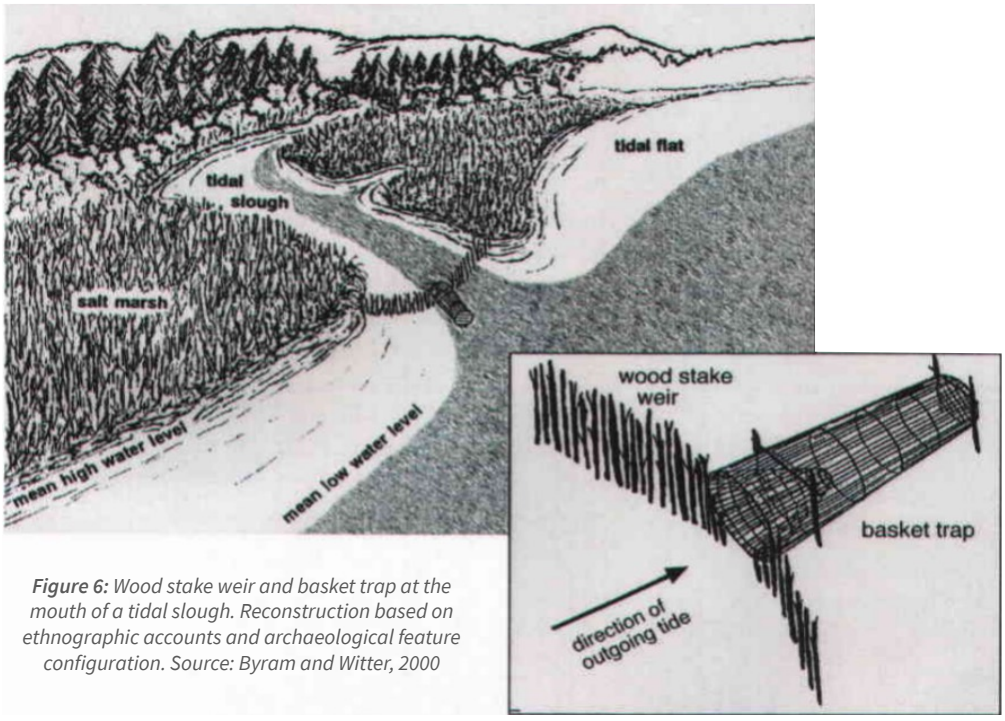


Figure 6: *Wood stake weir and basket trap at the mouth of a tidal slough. Reconstruction based on ethnographic accounts and archaeological feature configuration. Source: Byram and Witter, 2000*

not only beneficial to the analysis, but also respectful to the sovereignty and rights of the Tribe and critical for successful outcomes.

A Tribal Nation should be invited to participate in an analysis if any of the ES provided by the tidal wetland or the wetland itself are located on, connected to, impacting the resources of or associated with traditional sites or practices of said Nation. Within Oregon there are nine federally recognized Tribal Nations, and a few unrecognized ones, such as the Clatsop-Nehalem Confederated Tribes of Oregon and the Chinook Tribe (Oregon Legislature Policy and Research Office, 2016). No matter the recognition status of a Tribe, it is always recommended to recognize their inherent sovereignty. If a town, county government, or state or federal agency wants to include a Tribal Nation in an analysis of a tidal wetland, they must treat the situation as a government-to-government interaction. Most federal and state agencies have policies and directives for working with Tribal governments in Oregon, usually involving a consultation process. If a non-governmental organization is not working with a state or federal agency on an analysis, then they should approach a Tribe through a designated contact or public outreach individual. Contacts for the nine recognized tribes in Oregon are available on **The Oregon State Legislature Legislative Commission on Indian Services website**. When extending requests for engagement to non-recognized Tribes, in addition to federally recognized Tribes, it may be more difficult to find contact information; however, some non-recognized Tribes might have websites or social media with contact information. Additional guidelines and best practices for coordinating with Tribal Nations are provided below. The following recommendations are from another great resource on this topic, *Geographic Location Descriptions: Pathways and Considerations* by the Oregon Coastal Management Program, slightly edited here for relevancy (2022).

- Many Tribal Nations consider natural resources as cultural resources due to the deep connection that natural resources have to traditional uses, practices, and lifeways. Program managers should be respectful of this connection and where possible, implement policy that recognizes this relationship.
- Identifying the geographic locations of cultural and traditional resources should be handled with the highest level of sensitivity. A Tribal government may not allow sharing this information with non-tribal entities. In those cases, project managers should identify an alternative process to allow Tribal Nations to maintain confidential information while also contributing to the process and spatial analysis. Asking Tribal Nations if there is an alternative process, they would be comfortable with is the best way to succeed and to establish trust.
- Disclose applicable records release policy to avoid misunderstandings about what information and data the project managers can legally withhold in the event of a public records request.
- Science-based decision making will be strengthened and validated by traditional knowledge. Traditional knowledge often confirms what the scientific method has uncovered over the last few centuries. Traditional knowledge is rooted in observation, language, songs, traditional practices, ceremonies, places, and stories. This knowledge does not necessarily need to be recorded and published to exist. Referencing knowledge gained from the Tribe or Indigenous community with the date of personal communication is an important first step to establishing connection while respecting sensitive cultural information. Consultation with Tribes should address if and how to document analysis-related findings, data, and results so as to address them in the analysis write up.
- Tribal Nations are not members of the public and should not be addressed as such. Although Tribal governments are not excluded from providing public comment, out of respect for their sovereign status, coordination and engagement should occur separately from public comment periods, even at the staff-to-staff level. When tribal representative comments are provided, the commenter's affiliation should be noted within the record.
- While in the development and identification of resources for a valuation analysis communication with Tribal Nation leaders (like a Tribal Council) should be conducted by agency leadership or the Governor's office when appropriate, rather than staff members. This indicates respect for the Tribe's status as sovereign nations demonstrated by leader-to-leader communication. The West Coast Ocean Tribal Caucus's *Guidance and Responsibilities for Effective Tribal Consultation, Commination, and Engagement* document provides helpful guidance (West Coast Ocean Tribal Caucus, 2020).
- Silence in response to requests should not be taken as concurrence or disinterest. Tribal governments can struggle with staff and capacity constraints like any other governmental agency. Project managers should provide multiple methods and attempts of communication throughout the process to coordinate with Tribal Nations.

Section 5

Ecosystem Service Identification and Selection

Ecosystems consist of complex interactions and cycles which drive or are driven by chemical reactions, physical processes, and biological activities. These processes create beneficial effects, which help promote healthy habitats, economic prosperity, and social benefits. To capture the socioeconomic value of these benefits, they must first be identified and supported with applicable data. This section will address the definition of ES and their benefit flows, as well as discuss how to identify services for a valuation analysis.

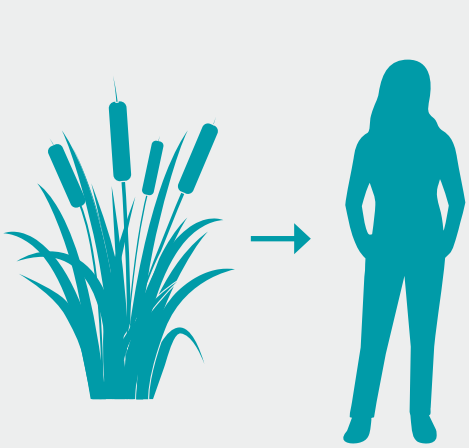
Finding Ecosystem Services in the Wild

As mentioned previously, ecosystem services (ES) are functions provided by the environment that benefit people economically, culturally, recreationally, and physically (Marcot et al, 2023). However, this is easier said than identified. Often many ES go unnoticed by communities, industries, and individuals who benefit from them. Therefore, it is first necessary to develop a general understanding of the biological, physical, and chemical processes going on in the tidal wetland, or at minimum involve someone who does. Having a working knowledge of these processes is vital to understanding how they function, are best studied, and most importantly, impact communities. Including ecologists, biologists, environmental economists, and social scientists will make it easier to identify ES as these experts will be able to determine what aspects of the tidal wetland impact nearby communities and how. Remember to think creatively about ways the tidal wetland might benefit the local community as ES can be found in some unexpected places, such as decreasing diversion time around flooded roads due to decreased flooding. Additionally, not all effects from the wetland are beneficial, therefore negative effects could be considered as well if a cost-benefit analysis of the wetland's effects is being conducted. However, this guide will only focus on the benefits for simplicity.

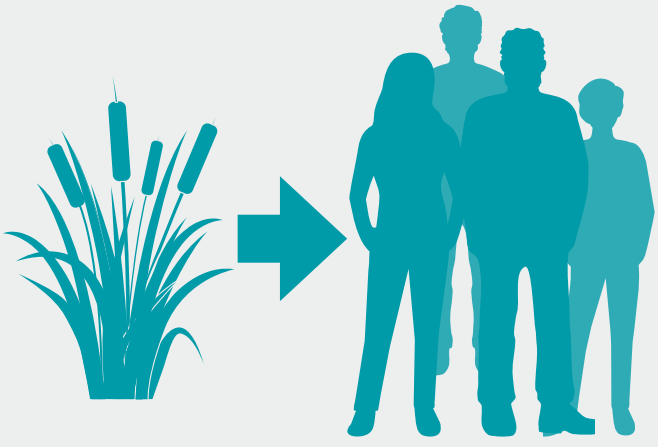
Flowing with the Benefits

When valuing the benefits from ES, the term benefit flow (also referred to as a service flow) can be used to help clarify the difference between the ES, which is producing a physical service, and the perception of benefits, which is a human concept not a physical thing. It is useful to consider and compare the relative size of the benefit flows produced by the ES within a wetland when determining which ES to include in the analysis. That way researchers can prioritize analyzing the ES with the largest benefit flows. For example, an ES such as flood mitigation for a town will usually affect many people and potentially save them significant amounts of money in avoided damages. Therefore, the ES would likely have a large benefit flow since it affects many people and the magnitude of the effect on each person is quite large. A small benefit flow for the same situation could be a remote road flooded for an average of one minute less per flood event. While a minute reduction in flood inundation time is an improvement, it is not very significant. Additionally, because the road is remote, it is unlikely many people will benefit from the minor reduction in flood inundation time. Therefore, the resulting benefit flow would likely be quite small.

Benefit Flows



Small Benefit Flow



Large Benefit Flow

Ecosystem Service Identification and Selection Process

Now for the fun part, figuring out what ES the wetland is providing and to whom. This process is straightforward, however, be warned: it will likely be time-consuming.

1

List the Ecosystem Service Benefits the Tidal Wetland Provides or Will Provide

Prioritize ecosystem service benefits that affect people and services of interest identified in the goals section, not on all services. Work with the team of experts, co-managers, and stakeholders to determine how a current tidal wetland or proposed restoration project benefits people.

2

Determine the Relative Importance of Each Ecosystem Service Benefit

Get a sense of which benefits, relatively speaking, are more important or relevant for a larger number of people, are providing high value services, and/or are benefiting a group of interest.

3

Review Project Data and Constraints

Collect and organize all relevant data. Consider the purpose, data, timeline, budget, and resources available for the analysis.

4

Select Ecosystem Services

Taking into consideration the project constraints and the identified importance of each ES, narrow down the ES to a point that is within the scope of the analysis.

1 List the Ecosystem Service Benefits the Tidal Wetland Provides or Will Provide

Remember that geographic boundary created for the co-manager/stakeholder selection process? Get that out again. And that team of experts? Well, don't free them from the conference room just yet! To start, list all the current or prospective ES provided by the tidal wetland. This could include both beneficial and harmful services (however this section will focus on benefits). To begin creating the list, review the study goals and identify any ES that have effects of interest, such as flood reduction or carbon sequestration. Once all the ES of interest are identified, move on to services that might not yet be known of or considered. To find these, focus on processes within the geographic boundary that affect stakeholders/co-managers, communities, or industries of interest.

Finally, list any other ES that can be identified. It might seem like a waste of time to list all the ES that can be thought of, especially if the analysis already has ES in mind to focus on. However, this is an important step because the team might uncover an ES that provides significant benefits which they were not aware of. If the team hadn't listed all the possible ES, then they might have missed out on the value the previously unknown ES provides.

It is also likely that ES will become apparent when reviewing available data. This is where having a diverse group of experts can help identify ES that might have been missed otherwise. Community experts and members can also be included through interviews, surveys, and focus groups to help determine additional ES. Do not worry about the size of the benefit flows at this time, just record the ES, who it benefits, how it benefits them, and most importantly what data will be needed to support it. This list will likely be very large; however, it will be narrowed down in later steps.

2 Determine the Relative Importance of Each Ecosystem Service Benefit

Now Now that the ES have been identified, it is time to estimate the size of each ES benefit flow for the analysis. The benefit flow of each ES can depend on many factors, however, to start, consider the magnitude of the service being provided and the number of people who receive the benefits. Services that provide a larger benefit flow and that affect the most people are likely to have a greater value. Therefore, services that have the potential to provide the most value should be rated highly, while services that provide small benefits and do not affect many people should be rated lower, as their value will contribute less to the total value of the wetland.

While it is recommended to rank services by the largest effect on the highest number of people, this is not the only way to view the importance of each ES. It may also be beneficial to consider services that provide very large effects but only affect a very small number of people as well as services that affect as many people but have a small effect. Pennies of benefits over thousands of people can add up quickly. This is also a good time to consult with local community experts and include their knowledge of the importance of an ES. Including local and traditional knowledge/expertise can help make sure researchers do not over or underestimate the importance of an ES. Ensuring that the importance of each ES is estimated correctly helps prevent an important ES from being cut from the analysis and that unimportant ones aren't included, wasting resources.

3 Review Project Data and Constraints

Limitations are important. They will likely be the largest influence on the scope of the analysis and which ES and corresponding stakeholders/co-managers will be included. Consider how the budget, timeline, available data, workers, and resources could limit the analysis scope. For example, a short timeline will limit what valuation analysis can be done resulting in limitations on which ES and corresponding stakeholders could be included in the analysis. As for budget—if there is no money available to pay for community surveys, then ES that require community surveys to be valued should not be included.

ES cannot be valued without data. Data collection can be a long and arduous process; however, researchers should try to collect as much data as possible during this step to determine what ES have supporting data, which have data that could be collected, and which have no or little available data. If the tidal wetland has yet to be restored, then consider what data needs to be collected before the restoration and what needs to be collected after. This is vital because one of the largest possible limitations when attempting to value a pre-existing tidal wetland is limited information about what conditions would be like if the wetland didn't exist or were like before the tidal wetland was restored—making it harder to prove there has been a change in ES function, in the services themselves, or their benefits.

Organize the collected data along with the ES and corresponding stakeholders/co-managers. This way when the analysis team moves on to the actual analysis, all the available data is clearly listed, tied to the corresponding ES and beneficiary, and can be easily cited. This table can be created using several software tools, however, excel or google sheets works well for easy document linking and data manipulation.

4 Select Ecosystem Services

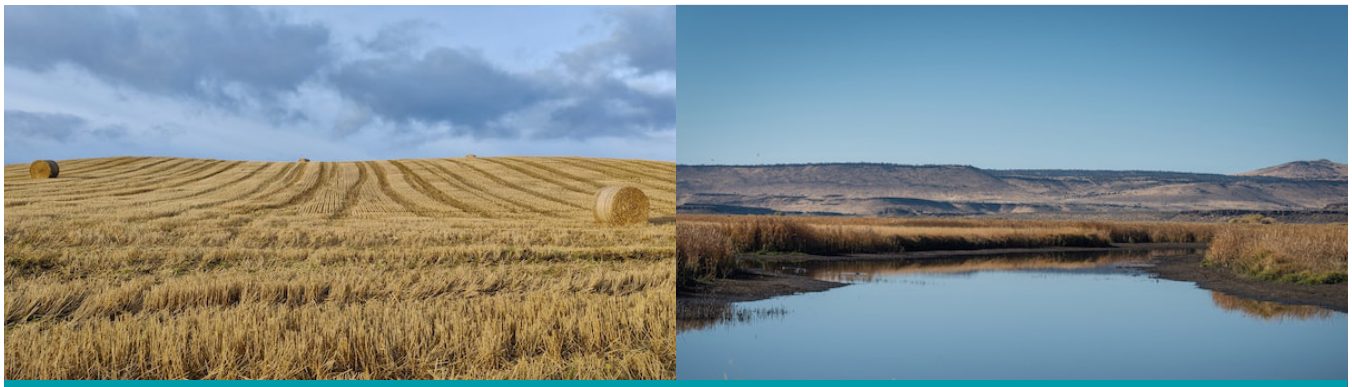
Putting it all together. Once resource and data limitations are identified it is time to narrow down the identified ES to the final contestants. Review the goals of the analysis, consider the insight provided by experts, co-managers, and stakeholders, look over the available data, and then select the ES that will be the focus of the analysis. Of course, these can always be updated to include or remove ES if more information becomes available later. At this point the team will have ideally developed a ranked list of ES provided by the tidal wetland with information about who benefits, how they benefit, and the supporting data available or needed. Now it is time for the next step: finally doing the analysis.

Supporting Data and Filling the Gaps

For a socioeconomic analysis, a provable change and a value per unit are needed to produce a valuation. Before and after data can prove that a change occurred and show the magnitude of that change. To value the ES, the magnitude of the change is multiplied by its value—usually a dollar value—to produce a dollar per unit of change. For a specific example, consider the data necessary to value the ES of salmon creation by a restored tidal wetland. Data on fish population size at the site before the wetland was restored must be compared to the population size after restoration. This way the change in the fish population due to the restoration can be proved. Then the magnitude of change (i.e. number of fish created) can be multiplied by the value of a salmon to find the value of the created salmon (dollars per fish).

This is most easily achieved with restoration projects that have not yet begun. With the wetland only existing on paper, it is possible to collect data before the restoration changes the conditions of the site. This opportunity is greatly enhanced if experts are involved early in the process and can recommend the data necessary to value ES provided benefits. If the project is planned for years in the future, it is possible to use that time to collect data on long term trends or uncommon events, such as annual floods or storm surges, which can prove vital when valuing flood reduction benefits. The data collection efforts conducted before the tidal wetland's restoration can then be replicated once the construction dust has settled. However, remember that many of the processes within the tidal wetland that produce ES take time to develop. Vegetation needs time to establish itself and fill in before it can start shading channels and preserving cool waters within. On that note, freshly completed restoration projects often look barren or ugly due to the recent construction. If an analysis is hoping to include aesthetic improvements, then it will be worthwhile to wait some time before asking people what they think of the restored wetland's aesthetics. It may also take years for a discernible increase in fish or shellfish populations to show up in the available data.

If the tidal wetland already exists, do not fret. In the case of a restored tidal wetland, pre-restoration site data might be available publicly or from the organizations involved in the restoration project. Furthermore, if the wetland is located along a major waterway, it is possible that government agencies or local non-profits have already been monitoring conditions within the wetland for some time. It is also possible that academic studies have been conducted on the tidal wetland or waterway which could provide useful data. Reference sites can also act as proxies for habitat conditions that are not currently present. For example, if there is a proposal to convert a tidal wetland into agricultural land, nearby farmland could be used as a proxy to determine what the site's conditions would resemble without the wetland. This can be very useful when considering ES such as a wetland's potential for carbon capture and storage compared to other types of ground cover or wetland sub-type. Finally, if no data on pre-restoration conditions is available and there isn't a good proxy in the area, another data source to consider is modeling. For example, creating flood models could estimate how floods would impact the community with or without the tidal wetland. The model results can then be compared to data that is available such as historical flood reports, or by comparing modeled damages to flood insurance claims from comparable historical floods.



Farmland **Wetland**

Section 6

Evaluation Methods

Intro to Evaluation Methods

Now for the best part: socioeconomic valuation methodologies! There are many ways to value the multiple benefit flows provided by restored wetlands. The goal of these methodologies is to 1) find a quantity for a good or service and 2) a price for that good or service. Once both are known, a monetary value of the ecosystem service's (ES) benefits can be estimated. Not all valuation methods need to include monetization. It is possible to show that ES provide emotional, cultural, or educational value, without the need to put a dollar amount on them. In these cases, it is still important to determine the quantity of a good or service, but instead of a price, a rating or indicator of value is used.

This section will delve into defining how ES are valued using economic markets and community inclusion. Furthermore, it will provide examples of how these evaluations are conducted and starting places for obtaining data. While this section does not dive into the mathematics and accompanying details necessary to conduct many of the analyses provided, it does provide an overview of the data and general methods needed to conduct said analyses. This information allows project planners to better estimate the cost, time, and resources that would be required to conduct their own evaluations.

Please, Consider the Following:

When reviewing economic valuation studies, it is likely that many of the results will be presented in net present value. The net present value is the sum of the appropriately discounted net benefits minus the initial costs (Knoke et al, 2020). For example, if a wetland stores $5,000 worth of carbon every year for 10 years, the net present value would be the sum of the $5,000 dollars received over the 10-year time period ($5,000*10yr=$50,000). However, before getting excited about the possible $50,000 in benefits, a discount rate must be applied to that value. This is due to the time preferences of humans in which possible funds in the future are discounted (worth less) than in the present. Said another way, $20 dollars is worth more now, than $20 five years from now, because money available now can be invested to make more money. Additionally, inflation can erode future earnings, further reducing their value. While this argument doesn't translate perfectly to ES valuation as the value of the services are not easily used to buy stocks, it is still recommended that net present value be used Therefore, a more accurate estimate of the project's net present value would be $42,650 assuming a discount rate of 3% per year.

Types of Valuation Methods for Tidal Wetland Ecosystem Services

There are numerous methodologies for estimating the value of ecosystem services. It is important to select the most appropriate method for the ES being valued, considering the data available and the applicability of the results. Each methodology has its own strengths and limitations to consider. The following sections outline a few of the most common valuation methods, however this is not an exhaustive list of all the possible methods available.

Market Price Method

The market price method is simply when the market price of the good or service is used to represent the value of an ES provided by a tidal wetland. This method is best used for commercial goods which are sold on the open market such as timber, fish, or shellfish. For example, suppose a tidal wetland provides habitat for juvenile Dungeness crab, which then grow up and are caught by local commercial crabbers. The profit from the caught Dungeness crab could be used to represent the value of the ES (juvenile crab habitat) provided by the tidal wetland.

When using this method, it is important to consider where goods that are harvested from the tidal wetland are sold. The price of goods can vary significantly from one location to the next, so it's important to find values as close as possible to the project location. For example, the landing price, which is the price that fishers receive for their catch at a processor, for Dungeness crab at Coos Bay was $5.39/lb. in 2022, but was $5.84/lb. in Tillamook (Pacific Fisheries Information Network, 2022). Sovereign nations might have their own market prices for goods collected on their lands or within their fisheries. Refer to section 4 for best practices when planning to engage with a Tribal Nation.

If values cannot be found at the local level, it is O.K. to take a step back and use values for the region or even the state. Just remember that the larger the geographic area, the less accurate the valuation will be. A valuation using a state level value is not unusable, it is just less accurate than a valuation that uses data from the same community the tidal wetland is located in. The relationship between the value of goods and services, distance from the tidal wetland, and accuracy of ES valuation is discussed further in the Benefit Transfer section. The price of goods and services can also change throughout the year. In such cases it is a good idea to average the values over time to get a general estimated value for that year.

Hypothetical Example 1

The city of Newport wants to know the value added to the local Chinook commercial fishery from the restoration of a tidal wetland within the Yaquina Bay estuary using a market price analysis. First, they determine the number of salmon "created" by the restored wetland. "Created salmon" is a shorthand way to say, the salmon that would not exist if the new habitat wasn't available. This method

Market Valuation Method

requires that project managers know the increase in salmon population attributed to the restored habitat. Let's say for the sake of simplicity that number is roughly 1,000 adult Chinook salmon.

The market price for Chinook salmon in Newport for that year could be used as the value of the created salmon. In 2021 the average price per pound of Chinook salmon landed in Newport was $8.37/lb. (Oregon Department of Fish and Wildlife, 2022). Multiplying the average weight of an adult Chinook salmon when caught in a commercial marine fishery (13.5 lbs.; Oregon Department of Fish and Wildlife, 2023) by the per lbs. price, gives a value per fish landed of ~$113. The final step is to multiply the value of one fish by the number of created fish. Which for this example, would result in ~$113,000 for the year 2021.

This result is handy because while doing the calculations, an estimate for the price of a single fish was found as well as the value that all the created fish potentially added to the fishery. The word potentially is important because this is not an estimation of the actual contribution that the created salmon made to the fishery. Instead, this method estimates the value of a fish created by the restoration project if it was caught by the local commercial industry. It is highly unlikely that all 1,000 created fish would be caught and landed in Newport.

Therefore, this value is more of a hypothetical increase in the value of the commercial fishery. One could think of it as the number of shots on goal a soccer player makes in a game vs. the number the player scores. The estimate also relies on the assumption that each fish weighs 13.5 lbs. and that the number of created Chinook salmon was an accurate estimate.

Hypothetical Example 2

A local utility company wants to restore a substantial area of tidal wetland, to offset some of their carbon emissions. Their plan is to value the amount of carbon that is being captured and stored (sequestered) and use that value to justify funding for the project's roughly $25 million price tag. Using nearby reference sites as proxies, and using the EPA's Greenhouse Gas Equivalencies Calculator, the company estimates that the wetland could sequester roughly the equivalent of 220,000 metric tons of CO_2). To determine if the cost of the restoration is less than the value of the captured carbon, the utility company uses the Social Cost of Carbon, which is currently $51 per ton of CO_2 (USG, 2021). The value of the captured carbon comes out to be $11.2 million, covering almost half of the cost of the restoration effort. However, using the latest

values proposed by the EPA of $190 per ton of CO_2 the value of the captured carbon skyrockets to $41.8 million, completely covering the cost of the restoration project and then some (National Center for Environmental Economics, 2022).

Real World Example

While Nigeria might be slightly outside of Oregon's borders, the following wetland valuation is a great example of applying market values to wetland ES. Two rivers, the Hadejia and the Jama combine to form the Hadejia-Nguru wetland, before they flow into Lake Chad in Northern Nigeria. The wetland provides numerous ES to the local community such as timber, irrigation water, and fishing. However, proposed upriver irrigation and dam projects were threatening to divert water from the wetland. At the time, the projects were not considering their impact on the ES provided by the Hadejia-Nguru wetland. To demonstrate the negative economic impacts the projects would cause, a team of researchers decided to use the market valuation method to help demonstrate some of the value the wetland was providing to the local community. This was not a full valuation of all the ES provided by the wetland; instead, the researchers wanted to focus on the impact on crop production, fuelwood, and fishing. Using local market rate prices for the produced goods, the researchers were able to estimate the dollar value of the products provided by the wetland in dollars per hectare and dollars per 1,000 liters of water used per day. Once they estimated these values, the numbers could demonstrate how reducing the amount of water and land available to the wetland would decrease the number of economic benefits provided to the local community by the wetland.

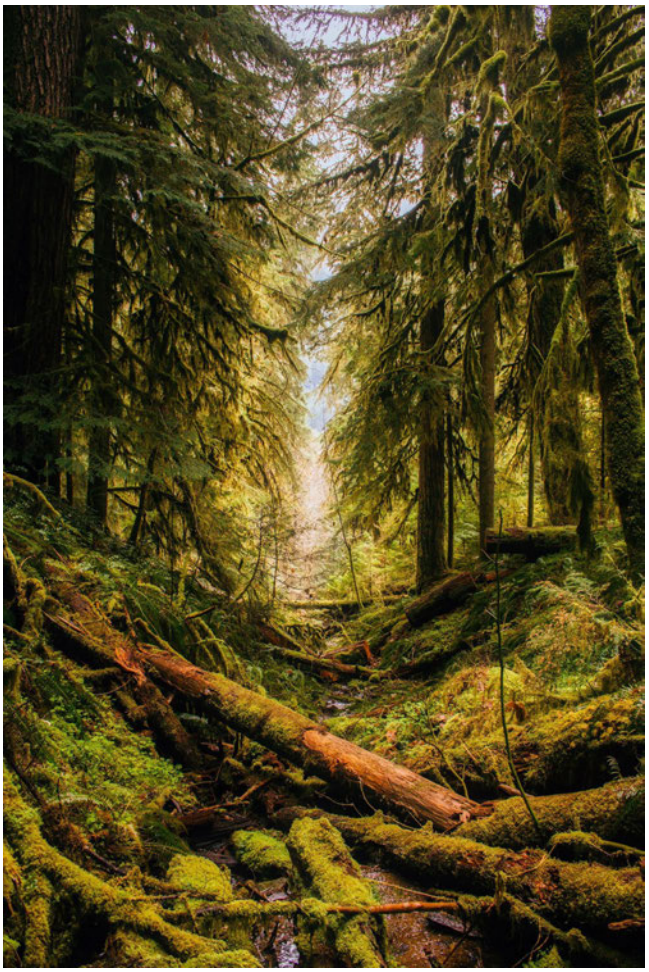
Economic Valuation of Wetlands: A Guide for Policy Makers and Planners. By E. Barbier et al. 1997.

Where to Get Started

The ODFW Commercial Landing Statistics web page is a good place to look for commercial fishing landing market values for all commercially fished species in Oregon.

This page has current and historical commercial fishery landings for all commercial ports along Oregon's coast as well as the value of those landings. Sovereign Nations adjacent to Oregon may have their own internal commercial fishery with their own regulations and prices. Sometimes the market information for Sovereign Nations is available to the public, however if not, it is recommended to build relations with the nation. A part of that relationship could include sharing market information.

Values for timber harvest can be found from the Oregon Department of Forestry's Current **Timber Sale Results Website**. The site shows recent and historical timber sales for each timber producing region of Oregon. Each sales record contains location information, the species of tree, the amount of wood harvested, and the price per MBF, which means 1,000 board feet. A board foot on its own is 144 cubic inches of wood. The board feet of a given tree is estimated by determining the tree's volume by using its trunk diameter and height. However, the true board feet available from a given tree can only be accurately determined once it has been cut down and processed. A good guide for estimating the value of a stand of trees is the "Measuring Your Trees" a step-by- step guide by Steve Bowers from Oregon State University (Bowers et al, 2013).



Productivity Method

The productivity method measures the value of one step in the production of a good or service that contributes to the value of the final product. For example, say a factory wants to know the value of increasing the efficiency of a piece of machinery. To do this they could look at the profits (income minus the cost of production) before the machinery was upgraded and compare that to the profits after the upgrade. The change in profit would be the value of the increased productivity, assuming nothing else changed. This method is great for capturing the value of habitat that hosts species of commercial interest.

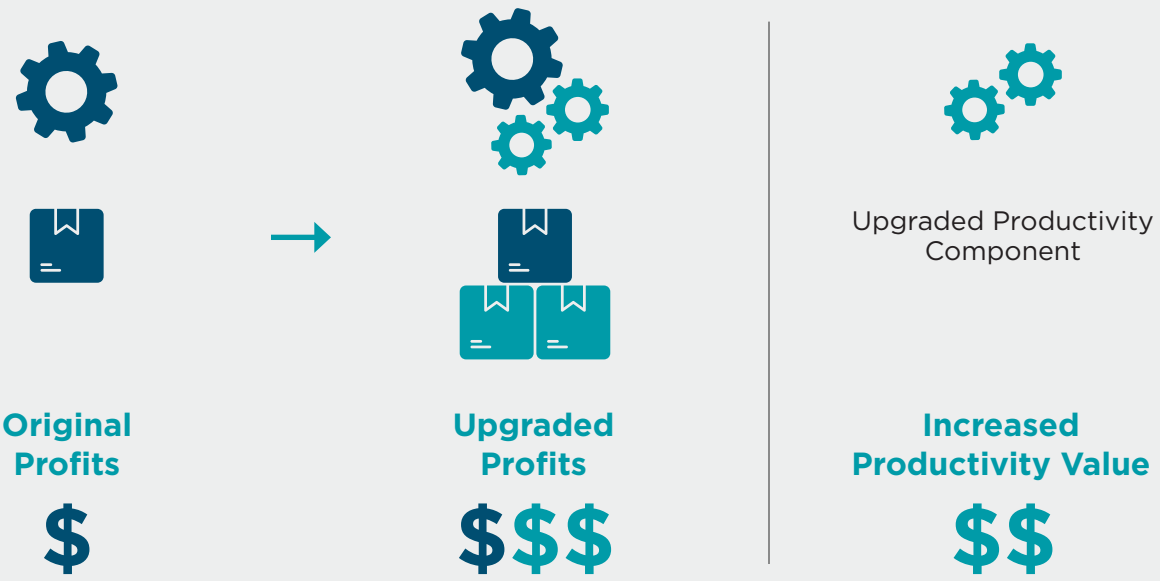
Because tidal wetlands play a key role in the production of numerous natural goods, such as providing rearing grounds for salmon and Dungeness crab, it is possible to value their contribution to these fisheries. This is typically done best with a before-after comparison and usually requires a fair amount of fancy math. The result will be a value per area of wetland (e.g. $ per acre of tidal forest wetland habitat). This is a great method for calling attention to a specific subclass of tidal wetland habitat, such as the value of tidal forest habitat in the production of salmon, or the benefit of groundwater storage for nearby agriculture.

Productivity analyses are also good for demonstrating the impact of a marginal increase or decrease in habitat area within a tidal wetland. Many policies and management programs change the size of wetlands by a few acres instead of completely removing or restoring them. This method can help apply a value to the small change in available habitat and related ES. This could look like the dollar value of fish habitat in terms of miles of restored tidal channels, or the value of flood damage increases per acre due to removing tidal marsh habitat.

Hypothetical Example

A Tribal Nation wants to value a tidal wetland they have restored. One goal of the restoration project was to decrease excessive levels of nutrients flowing out into the bay. High levels of nutrients in the estuary have been linked to harmful algal blooms. The blooms create areas of low oxygen which kill off juvenile Dungeness crab, impacting the local crab fishery. Monitoring efforts found that the restored wetland has significantly decreased the levels of nutrients flowing into the bay, leading to less low oxygen events and Dungeness crab die-offs.

Productivity Valuation Method



Project managers conducted surveys of juvenile Dungeness crab populations within the bay before the project was restored and compared them to population levels after the project was complete. They found that the populations had increased by a significant amount and further modeling and testing revealed a significant number of juveniles likely survive to adulthood when they could be caught. Using the landing price of commercially caught Dungeness crab within the Tribe's fishery, the project managers found the value of the likely increase in adult crabs. They could then divide the increased value across the area of restored Dungeness crab habitat, giving the ES productivity value in terms of dollars per acre of tidal wetland habitat. The dollar value of increased annual juvenile crab production could also be applied to the annual nutrient load reduction. This could be done by dividing the increased potential profit of crabs to the fishery by the amount of nitrogen removed (e.g. $ per removed mg of nitrogen).

Real World Example

In 1999, The Peconic Estuary Program in Long Island was considering multiple possible management actions for a tidal wetland that would either shrink or expand the wetland's area. The study they conducted focused on determining the value of the incremental change in wetland size to the commercial and recreational fish, shellfish, and waterfowl industries. Previous studies of the tidal wetland showed that the eelgrass beds, low-marsh, and intertidal mudflat habitats within the tidal wetland contributed significantly to the food chain and habitat needed for the growth of fish, crabs, scallops, clams, and waterfowl. The researchers conducted a productivity value analysis which estimated the per acre value of the three tidal wetland habitat subclasses. To do this, they first determined how each type of habitat contributed to the food chain of the species of interest (fish, shellfish, and waterfowl), providing them with a way to estimate how much of each species was "produced" by each of the three habitat types. Then, the team estimated commercial and recreational fishing and hunting values for each species. Finally, the two estimates could be combined to show how much each of the habitat types contributed to the local fishing and hunting industries in terms of dollars' worth of species of interest created per acre. The results were: an acre each of eelgrass was worth $1065 per year, saltmarsh was worth $338 per year, and intertidal mudflats were worth $67 per year to the local commercial and recreational fishing and hunting industries in terms of increased productivity of fish, crabs, scallops, clams, and waterfowl.

Recreational and Resource Economic Values for the Peconic Estuary System, by Opaluch et al., 1999. (Starts on page 86).

Where to Get Started

The data necessary for a productivity valuation analysis is like that for market valuation methods. For information on market rate data for common tidal wetland products please return to the Market Value Method section.

Avoided Cost, Replacement Cost, and Substitution Cost Methods

The avoided, replacement, and substitution cost methods use the dollar value of avoided costs from damages, the cost of replacing an ES, or the cost of substituting an ES as the value of the tidal wetland. These methods are not based on the direct market value of a good or service; instead, they use the amount of money that would need to be spent to avoid damages or replace ES provided by the tidal wetland to estimate the wetland's value. These analysis methods can be used to estimate the cost of removing or shrinking a tidal wetland to the local community. They can also help justify habitat restoration projects by comparing the cost of restoring and maintaining a tidal wetland to building and maintaining large complex infrastructure needed to provide the same service.

Less obvious ES provided by tidal wetlands, such as storm protection and water filtration, can be highlighted by these methods as well. The alternatives to those services which a tidal wetland provides naturally would be building a sea wall or levee system and a water filtration plant. Both would be expensive projects to plan, build, and maintain. The cost of those projects would be the replacement cost of destroying or failing to restore the tidal wetland. These methods are easiest if an estimate for the avoided, replacement, or substitution cost has already been made (e.g. cost of building a water treatment plant is already known) because it can be difficult to estimate the amount of money needed to replace those services.

Hypothetical Example 1: Avoided Cost

A town along the coast recently restored a large area of tidal wetland with the goal of decreasing annual flooding which ravages the town, causing significant damage. Using Federal Emergency Management Agency (FEMA) flood insurance payout data, the analysts were able to determine that the average cost of damages to affected homes decreased $1,000 per flood event. Through modeling and real-world data collection it was determined that an average of 400 homes experienced decreased flood levels due to the tidal wetland abating the flood waters. Therefore, the avoided cost of flood damages per flood event due to the tidal wetland was $400,000. The value of the avoided flood damages can

then be applied to the tidal wetland as it is providing a service that is saving the community money.

Hypothetical Example 2: Replacement and Substitution Cost

A local watershed council wants to estimate the value of an existing tidal wetland that is located upriver of a community which relies heavily on a healthy salmon run. Project managers conduct two studies which show that the tidal wetland is decreasing incoming water temperatures from harmful levels as well as providing substantial salmon habitat, all for the low price of free. These ES were identified by comparing the temperature of the water flowing into the tidal wetland to that which was flowing out. They also conducted surveys of the fish habitat within the tidal channels.

To capture the value of these two ES, the project managers look at the cost of replacing the temperature reduction ES with a water chilling plant. They estimate the cost of the plant by scaling up a bid placed by a construction firm to install a similar device at a local fish hatchery.

The project managers estimated the cost of replacing the fish habitat by scaling up the current production costs and expenses of a local salmon hatchery while referencing the construction cost of expanding a similar hatchery in the neighboring watershed. The two costs for replacing and substituting the ES provided by the wetland can then be used as the value of those services to the community.

Real World Example

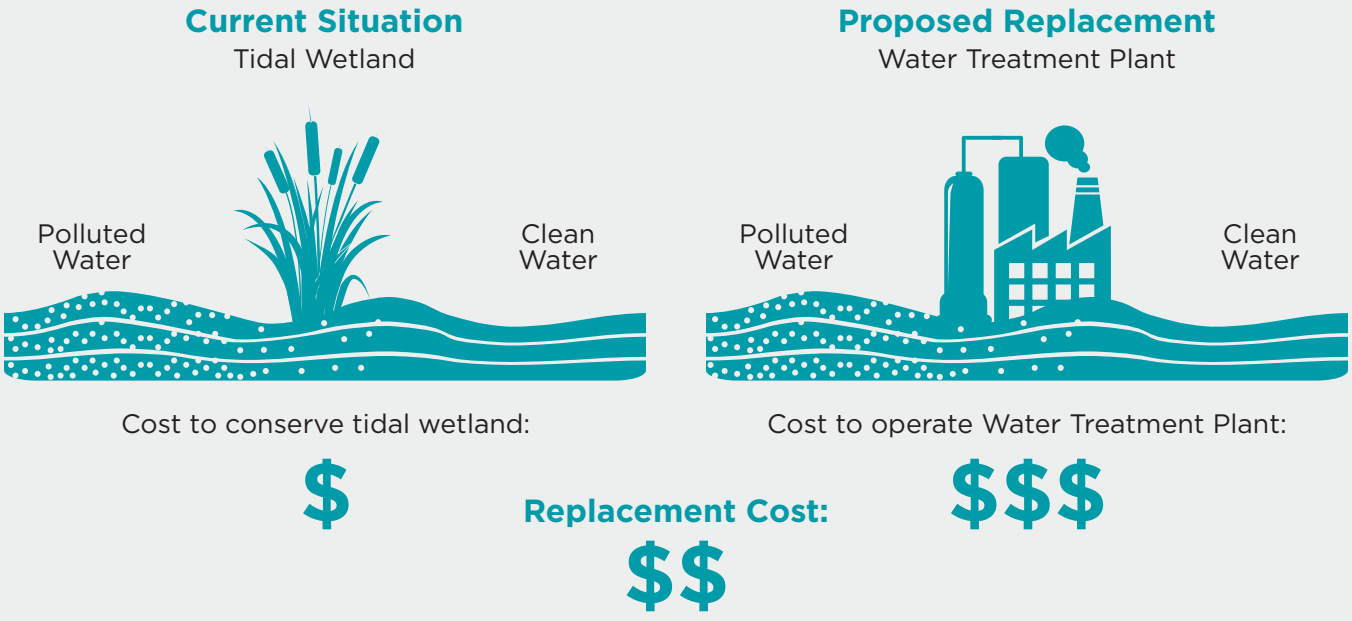
A study in Louisiana conducted a replacement cost analysis to compare two wastewater treatment options: Either restore natural tidal wetlands or construct a wastewater treatment plant. The investigators found that constructing a treatment plant would cost around $208,000 per year for 25 years while protecting and restoring coastal wetlands to do the same work would cost only an estimated $63,000 per year. Restoring and protecting tidal wetlands would save just under $150,000 per year compared to building a treatment plant. Therefore, the replacement cost was just under $150,000 per year.

An economic analysis of using wetlands for treatment of shrimp processing wastewater—a case study in Dulac, LA by Cardoch et al., 2000.

Where to Get Started

Estimating the cost of large infrastructure projects such as levees or a water treatment plant can be a complex endeavor as many of the factors that determine the cost

Replacement Cost



of construction are heavily impacted by local conditions such as the availability of materials and labor. However, there are some simpler places to start.

FEMA has a national database called FEMA National Flood Insurance Program claims. These claims do not represent all damages from a flood event but can provide a starting point for estimating the average damages from previous flood events or determine the average magnitude of damages. There is a public face for the **database online**, however more specific, and detailed data is available for download as well as upon request.

The EPA has a website with links to multiple **water treatment plant cost calculators**. There is also information on which filtration system would best suit the project's needs. The calculators are a good starting place to find estimates for the cost of water filtration systems. However, these are just rough estimates—the actual cost will likely be different due to local material and labor costs. These calculators can be quite detailed and may require input from a local expert.

A meta-analysis of flood adaptation costs was conducted by Jeroen Aerts in 2018 called *A Review of Cost Estimates for Flood Adaptation.* The study collected construction and maintenance costs for flood adaptation infrastructure such as sea walls, dikes, levees, and riprap. They then combined the studies using a model to provide cost estimates for each type of project in different regions around the world. The U.S. is included in all the cost estimation results. Aerts also provides information on the cost and maintenance of wetland restoration. Given the results come from a large geographic area over a long period of time they may not be very applicable to specific towns or areas. However, they can be used to provide rough estimates for the costs of theoretical infrastructure projects so long as these numbers are not used for official reports without a more site-specific study or at a minimum are presented within the proper context.

The U.S. Department of Transportation has a system of easily fillable equations that can be used to estimate the cost of detours to drivers. This can be used to estimate the value of time saved by drivers who no longer need to avoid flooded roads (Shaw and Dundas, 2021). If a tidal wetland project can or has removed the need for people to take detours, the value of the time saved per flood event can be placed on the wetland (Mallela and Sadasivam, 2011).

Local contractors or government agencies may be able to estimate the cost of new infrastructure if simple tools are unavailable or inadequate.

Travel Cost

The travel cost method estimates a tidal wetland's value by assessing the costs recreationalists are willing to pay to travel to, access, and recreate at the site. The travel cost method works through a principle like movie tickets. People are willing to pay a set price for a ticket to access the movie. Presumably they believe the enjoyment they will receive from the film is worth the direct cost of spending money on the entry ticket. The travel cost method uses the same logic, but since wetland access is usually free (tickets are not required to access), there is no direct cost to use as a proxy value for the wetland. Instead, the value is derived from the indirect costs required to travel to the site. These indirect costs typically include the value of the person's time traveling to the tidal wetland, the cost of physically traveling to the wetland (e.g. gas, tolls, bus fare, vehicle maintenance), and costs on location at the wetland, for instance parking fees. Once these costs are combined, they are referred to as the travel cost. The travel cost, along with other factors related to the trip, are combined using a mathematical model to estimate how much people would be willing to pay to access the wetland. If it is known how high of a travel cost people are willing to pay on average to get to a tidal wetland and how many people visit the wetland annually, then the community's willingness to pay for access to the tidal wetland can be determined.

Willingness to Pay
Is the maximum price an individual is willing to pay for a good or service. The willingness to pay for benefits provided by ES in tidal wetlands can be used to determine the value of the tidal wetland to the community.

To estimate the travel cost for an individual, information about the trip and the individual taking the journey are needed. This information typically includes:

- The distance they traveled to the wetland,
- The method(s) of travel they used (e.g. bike, car, bus, train), and
- The number of travelers they traveled with (e.g. alone, with a group in a van, etc.).

However, simply multiplying the average travel cost by the annual number of visitors will not provide an accurate estimated value for the wetland. This is because there are other factors that influence the travel cost of a given trip which can complicate the analysis. For example, if the trip to the tidal wetland is part of a larger trip, where the individual also went to the gym and the library, then those extra stops can add time, distance, and other additional costs to the trip. Also, the enjoyment from those additional unrelated stops can influence how high a travel cost the person would be willing to pay in making the trip, compared to the costs associated with a trip just to the wetland and back. Therefore, additional information about the trip and surrounding area is needed to help tease out all the possible influences on the demand to use the wetland. This information typically includes:

The number of times the person visits the tidal wetland per year,

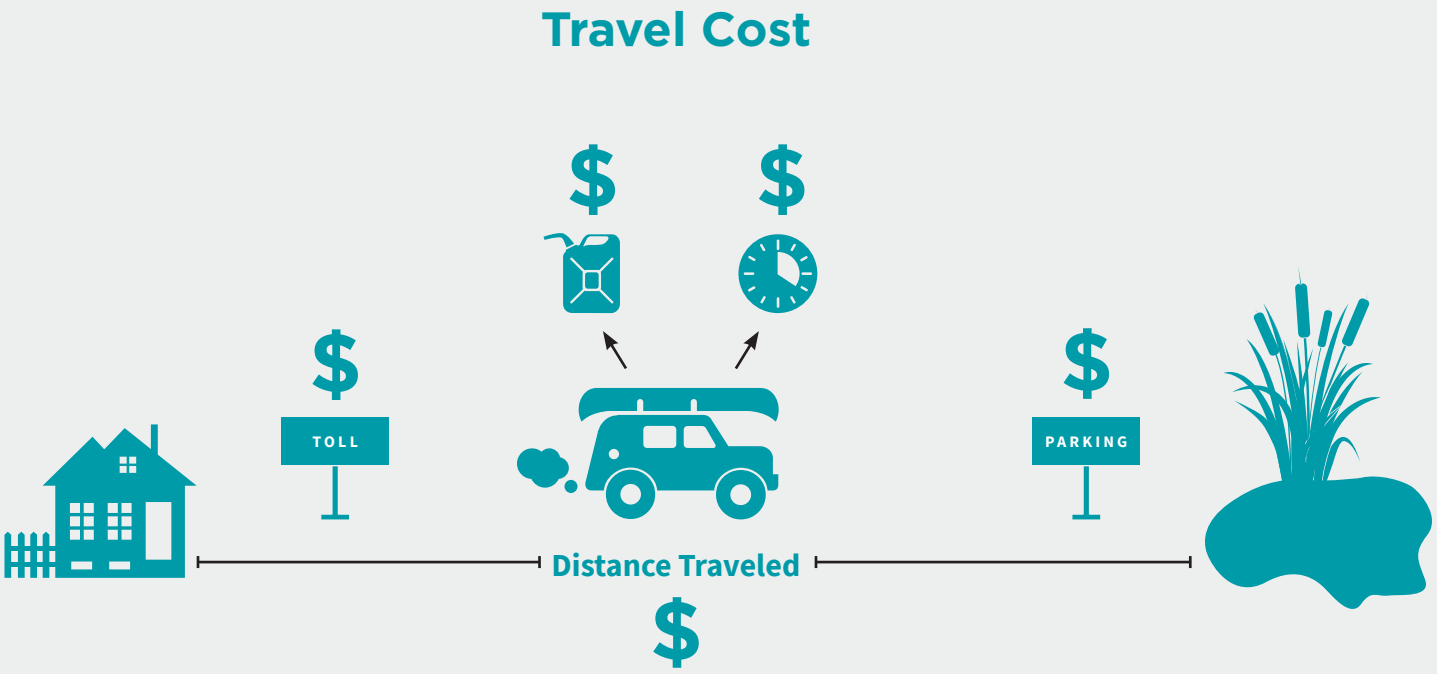
- Other typical stops they make on the trip,
- What they do at the wetland,
- Demographic information about them (e.g. age, income, etc.).

It is also necessary to know how many people visit the tidal wetland being analyzed per year and if there are similar sites nearby, such as another wetland or

recreational site. All this information is then put in a regression analysis to help determine how each factor influences the willingness to pay to travel to the tidal wetland. Once the influence of each factor has been estimated, it is possible to use the results to estimate the value of the tidal wetland's ES in terms of people's willingness to pay to travel to it.

The best way to collect information for this analysis is to interview recreationalists at the wetland or send out a survey to the community being analyzed. Sometimes physically interviewing individuals at the location is necessary. Other times, databases can be used to gather information on a specific group of recreationalists such as anglers. In Oregon, recreational anglers must be **licensed** and keep a record of what they harvest and from where, with a few exceptions. Information on tidal wetlands that are commonly visited for fishing could be pulled from the database as well as the addresses of anglers. The distance between the two could then be found, providing an estimate for the travel distance. Then a subset of anglers could be contacted and surveyed to obtain more personal information such as the number of visits they make, other typical stops and so on.

When crafting survey questions it is important to avoid bias and confusion. For example, asking "how far is the tidal wetland from your home?" could result in several different answers. One person might provide the distance to drive to the wetland, while another might provide the direct *as-the-crow-flies* distance. These could drastically throw off the results of the analysis. It is also important to consider that some people might not feel comfortable providing information that is too personal. For example, they might not want to provide the exact distance the tidal wetland is from their home but might be willing to say they live within one mile of the wetland. Considering how the questions could be interpreted by the intended audience is vital to ensuring accurate survey results.



Hypothetical Example

A local parks and recreation department wanted to estimate the value of recreational activity at a local tidal wetland. To estimate the recreationalist's willingness to pay for the recreation ES, project managers worked with a team of experts, co-managers, and stakeholders to create a questionnaire used to survey recreationalists at the tidal wetland. Once the questionnaire went through a thorough review process the project managers surveyed recreationalists for two consecutive Wednesdays and weekends during peak recreational activity for each season of the year. Surveying recreationalists during different times of year allowed the researchers to better capture the value of all recreational activity at the site as well as determine how recreationalist's willingness to pay and usage of the wetland changes throughout the year. They asked participants several questions about their trip to the wetland, how they use the wetland's ES, and demographic information about them. They also asked recreationalists if they make any other stops during the trip to and from the wetland and if the wetland was the primary purpose for the trip or just a side stop. The project team then created a model to interpret the travel cost survey results and extrapolate them to the larger community.

Real World Example 1

The Californian government wanted to know the economic benefits of abalone fishing for recreational fishers and what positive economic impact the fishery had on the local counties. In California abalone cannot be fished commercially, as a result there is no market-based price to use in an analysis. Instead, the project managers conducted a travel cost analysis to determine the fisher's willingness to pay to go recreational abalone fishing. Abalone fishers in California must obtain a license from the California Department of Fish and Wildlife (CDFW). As part of the licensing process fishers must report how many abalone they collect and from where as well as demographic information about the fisher such as their address and contact information. The project managers were able to utilize the CDFW's abalone fisher database of over 30,768 fishers as their population to be surveyed. They then randomly selected a subset of that population, specifically 516 fishers, for a phone survey. The surveyed recreationalists were asked about their abalone fishing habits as well as their demographic information. The survey results combined with the license data allowed the researchers to estimate the number of trips the fishers took per season, how many abalone they caught per trip, and how far the fishers had to travel. Finally, additional information about the abalone fishing sites was collected, such as which sites had easy access to parking, restrooms, a boat launch, and ADA accessibility. Collecting this information allowed the researchers to determine not only anglers' willingness to pay to travel to and access the fishery, but also which attributes of a particular fishing site they prefer. After constructing a mathematical model that looked like this,

$$U_{ijt} = \beta_1 TC_{ij} + \beta_2 ACC_j + \beta_3 BL_j + \beta_4 Parking_j + \beta_5 Bath_j + \beta_6 Protec_j + \beta_7 HAB_j + \beta_8 Pay_j + \mu_{ijt}$$

the researchers were able to estimate the angler's willingness to pay. They found the licensed fishers make an average of 3.6 trips per year and are willing to pay between $219-$406 per trip in incurred costs from physical driving costs and time spent. Applying the per trips costs to the average number of trips made by all 30,768 fishers resulted in a willingness to pay of $24-$44 million per year for the fishery.

The Economic Benefits of the Red Abalone Fishery in Northern California by Reid et al., 2016.

Real World Example 2

A travel cost analysis of Iowa residents was conducted in 1998. The study looked at how much people were willing to pay in terms of travel costs to visit local wetlands. The researchers created a five-part survey that was mailed out to a selection of Iowans. Prior to sending out the survey it was tested with small local communities and edited to address any points of confusion. The survey was divided into six parts. The first section provided background information on wetlands within Iowa while the following five asked participants questions such as, "how often do you visit a wetland?" and "would you visit with the same regularity if the price increased?" The results from the survey indicate that people were willing

to pay a substantial sum per person to visit wetlands and participate in recreational activities.

Iowa Wetlands: Perceptions and Values by Azevedo et al., 2000.

Data Sources

While the data necessary for a travel cost analysis often comes from survey results of the local community, there are some large national and state databases of recreation information that may prove useful.

The Oregon Department of Fish and Wildlife conducts annual surveys of recreational ocean and estuary fishing, called the *Ocean Recreational Boat Survey* (Schindler et al, 2021). The survey is conducted by ODFW staff who conduct surveys at major recreational fishing ports along the Oregon coast. The survey collects many useful data points such as,

- The type of vessel and its identification number,
- The number of anglers per vessel,
- Where the vessel fished,
- How long the fishing trip took,
- What species was the target of the trip,
- How many fish and of what species did the anglers catch, and
- Various biological attributes of their catch (e.g. fish weight, length, etc.)

The collected data is then analyzed to provide estimates such as total recreational catch per species, total number of recreational anglers, and average estimated effort needed to catch said fish. More details on what data is collected, how it is analyzed, and how the data is used is laid out in a document called the *Sampling Design of the Oregon Department of Fish and Wildlife's Ocean Recreational Boat Survey (ORBS)* (Schindler et al, 2021). Significant portions of the data collected are available at RecFIN.org. However, if more data is needed the ODFW recommends reaching out to them to discuss additional data needs.

The ODFW also provides annual survey results for hunting around the state. The information in the survey is mostly collected via reports from hunting tags and follow-up phone surveys. All hunters who purchase a hunting tag are required to submit data about their hunt, whether they caught something or not, and may be subject to a follow up phone survey to confirm their online report. The results of the survey are published in an annual report available at ODFW's *Big game hunting harvest statistics* website. Additional game bird hunting statistics for ODFW wildlife areas are available at ODFW's *Game bird hunting statistics from ODFW wildlife areas*.

Oregon Parks and Recreation Department conducted a statewide survey in 2017 titled the *Oregon Outdoor Recreation Survey*, which asked residents about various aspects of their outdoor recreation participation and opinion on future management of parks and associated recreation. The results of the study provide information on how different demographic groups participate in recreation activity within the state. Additionally, the survey provides information on how important various aspects of outdoor recreation, such as ease of access and proximity to home, are to the participants (Bergerson, 2018).

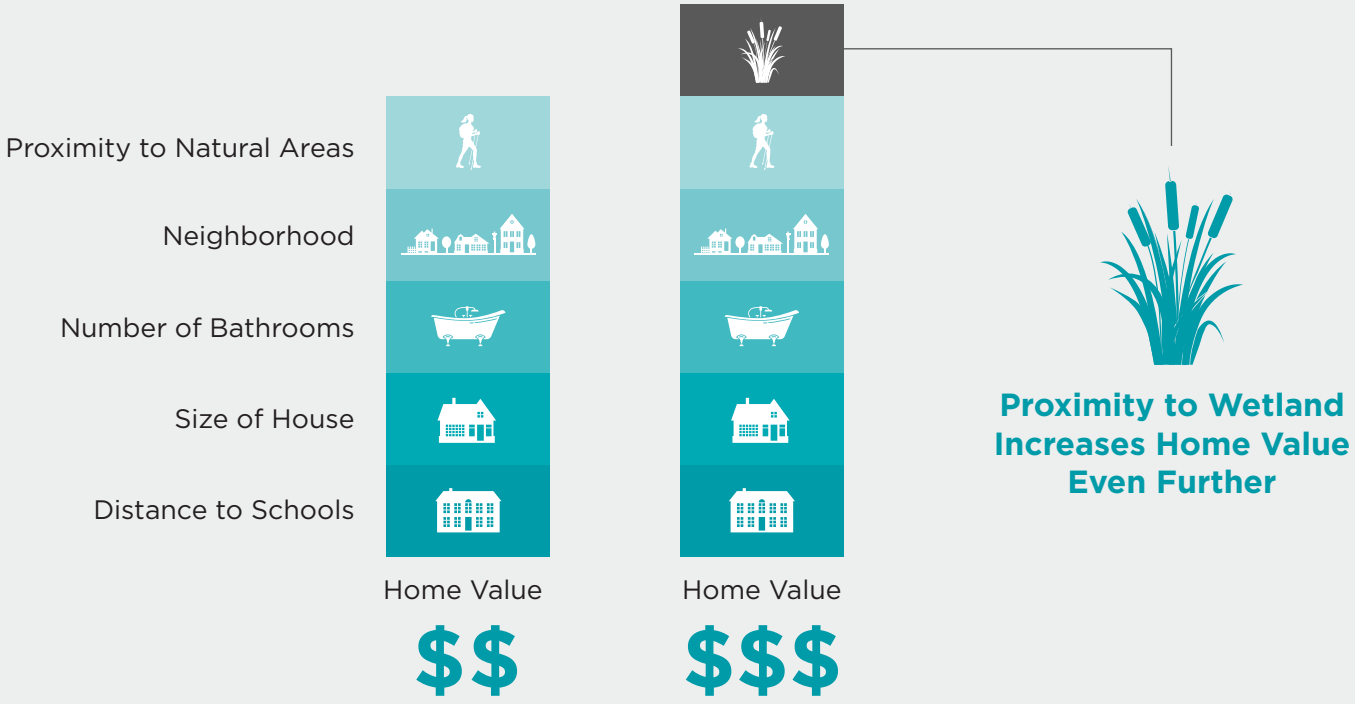
Hedonic Price Method

A hedonic model usually uses a regression analysis in a process that considers the variables which influence the price of a given product and then provides estimates for how strongly each variable influences the price of said product. For example, the price of a home can be influenced by its location, square footage, number of bathrooms, and proximity to areas of interest. A regression analysis estimates the influence that each of those variables has on the price of the home in terms of a percentage. The percentage of each variable can then be multiplied by the price of the home to provide a dollar value for each variable.

The hedonic price method is commonly used to estimate the value a natural area has added to local houses or land.

Tidal wetlands and other natural spaces can increase the value of homes nearby through the perceived ES they provide, such as aesthetic beauty or access to recreational activities. Home buyers are often willing to pay more for a home with a view of the ocean than for an identical one overlooking a parking lot. If the model finds that home values did increase due to their proximity to the wetland, then the increase in home values can be interpreted as the value home buyers place on the tidal wetland. However, these benefits do not apply equally across a whole town or even neighborhood. If the potential home buyers do not perceive they will receive any ES from the wetland, then they are not very likely to be willing to pay more for the home. To help determine how far from the wetland the benefits are perceived, the proximity of the house(s) to the tidal wetland is usually integrated into the analysis.

Influence on the Value of a Home



To determine how the tidal wetland and other attributes of the house influence its price, a hedonic regression analysis is used to compare the difference in the values of homes with and without the influence of the various attributes. The model estimates the influence of each attribute on the home's value by looking at hundreds or thousands of these comparisons. Comparing the differences in home price and the home's corresponding attributes, teases out how each attribute influences the price of the home.

To be able to show change, sales data needs to be available from either before and after the tidal wetland existed, or from homes near and far away from the wetland, or both! That way a comparison can be made between home sales that are influenced by a nearby tidal wetland and those that aren't. ES data necessary for a hedonic model can take the form of before-after data, such as conditions before a wetland was restored compared to after; or it can be data that is directly linked to the ES in question such as the level of pollutants in the water upstream of the wetland and the levels after it has passed through the wetland.

Beyond addressing the main variables of interest (e.g., sales price) the data used for the analysis needs to have more granular detail about the attributes of the homes being valued. For home sales the data could include number of bathrooms, size and age of the home, distance to grocery stores, and what school district it's in. The more information available about the home and the conditions influencing it, the better the model can tease out the effect the tidal wetland alone has on the home's value.

Variable	Definition
Sale Price	Price of home
Post Restoration (Sale Date)	Equal to 1 if transaction occurred after restoration was complete.
Distance to SFC site	Distance to SFC site from home [m]
Distance to Highway 101	Distance to highway 101 from home [m]
Mean Elevation	Mean Elevation of home [m]
Distance to New SFC Dog Park	Distance to newly created dog park at SFC site [m]
Bedrooms	Number of bedrooms
Bathrooms	Number of bathrooms
Square Footage (ft2)	Square footage of home
Acreage	Acreage of tax lot
Total Rooms	Total number of rooms in home
Located in Tsunami Zone	Equal to 1 if home is inside tsunami inundation area.
Bay City UGB	Equal to 1 if home is inside urban growth boundary of Bay City
Garibaldi UGB	Equal to 1 if home is inside urban growth boundary of Garibaldi.
Distance to Wilson River	Distance to the Wilson River from home [ft]
Distance to Supermarket	Distance to Super Market from home [m]
Distance to Coast	Distance to coast from home [m]
Flood Zone V	Equal to 1 if tax lot is in flood zone V.
Flood Zone A	Equal to 1 if tax lot is in flood zone A.
Flood Zone X	Equal to 1 if tax lot is in flood zone X.

Table 1: *Southern Flow Corridor Hedonic Regression Analysis Included Variables*

For example, researchers and project planners wanted to know how much value a restored tidal wetland brought to the nearby community of Tillamook. To estimate the value, the very handsome and talented researchers conducted a hedonic regression analysis of the home sales in the area from before and after the wetland was restored. Table 1 lays out the home attributes that were included in the study which were obtained from tax lot sales data and outputs from a GIS analysis, (Shaw and Dundas, 2021). These variables combined with additional ones necessary for the analysis revealed that the wetland increased home values within ¾ of a mile from the wetland by ~10%.

Hypothetical Example

A city along the coast is conducting a review of a tidal wetland restoration project that was completed 10 years ago. The project managers wanted to know if the restored wetland has had any impact on local housing values, due to the ES it provides, such as aesthetic views and flood reduction. An economist was brought in to conduct a hedonic price analysis. The economist obtained home sales data from the county for the last 20 years and compared sales data for homes near the project site with that of similar homes throughout the rest of the town and the neighboring community using a hedonic regression analysis. The results showed that since the tidal wetland's restoration, home values have increased by $1,200 per home per year.

Real World Example

A hedonic model was used to evaluate the effect the restoration of a 308-acre tidal wetland within the Nisqually River estuary in Washington had on the value of local homes. Researchers used sales data from the county to conduct their hedonic regression analysis. The results indicated that homes within ½ a mile from the refuge saw a $37,600 value increase, homes within ½ to 1 mile saw a $10,400 value increase, and homes within 1 to 1.5 miles saw a $31,100 increase.

Estimating the Effect of Tidal Marsh Restoration on Housing Prices: A Hedonic Analysis in the Nisqually National Wildlife Refuge, Washington, USA, by Good, A. and Pindilli, E. 2022.

Data Sources

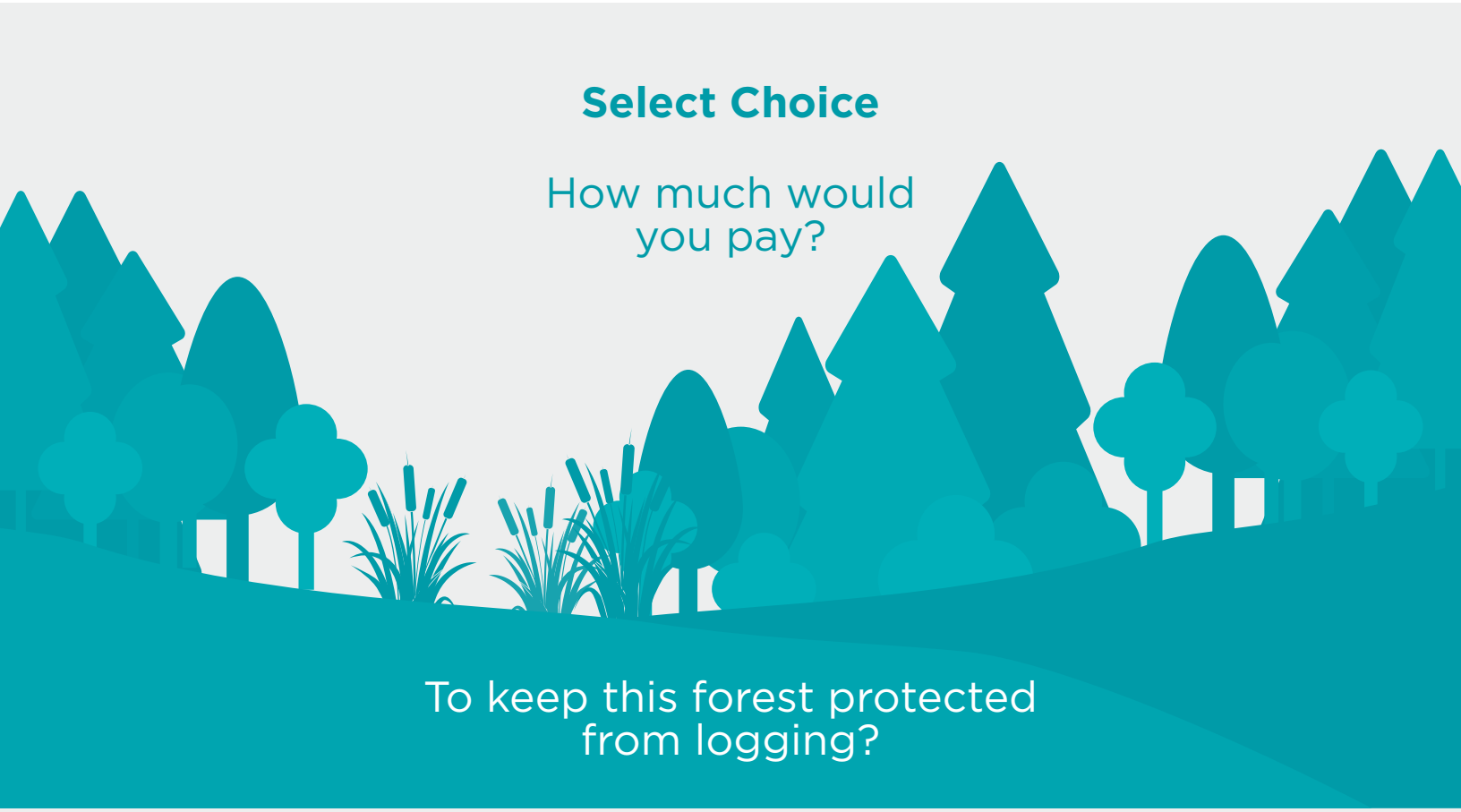
Counties often keep property sales records which are publicly available. However, the data can sometimes be difficult to access. Reaching out to the county office can be a good place to start the process if the data is not available on the county's website. Private companies can also have these data sets, or even more detailed ones. However, they often come at a cost and in some cases may just be the same data that the county has.

GIS data of tax lots and physical address locations are also very useful for a regression analysis. It is very important to be able to determine the distances from each home in the analysis to the project site and to other locations of interest such as grocery stores or highways. A good place to find GIS data for Oregon is the Oregon Spatial Data Library. There is also a GIS database of Oregon tax lots called ORMAP which has thousands of shape files and GIS layers, including the Oregon Property Tax Map. This GIS map has current tax lot maps for all counties in Oregon (Department of Revenue, 2022).

Stated Preference Methods

When valuing ES there are two types of values: use values for goods or services that provided direct benefits to people and non-use values for goods and services that people haven't and likely won't benefit directly from. Use values can include many of the ES discussed before such as, flood mitigation, fish production, or atheistic beauty. ES non-use values usually include, knowledge that faraway habitats of rare species exist *(existence value)* or preserving wilderness for the next generation *(bequest value)*. These things are benefits that an individual might be willing to pay for. However, there are few if any market values for ES non-use values. Additionally, some use values from ES do not have a market value that can be determined by the methods mentioned above.

Consider a tidal wetland restoration project which is focused on carbon sequestration and would be funded through an increase in local taxes. Given that there are no robust tidal wetland carbon sequestration markets, estimating the community's willingness to pay for the captured carbon could be difficult using revealed preference methods. The national social cost of carbon could be a starting place, but it is determined on the national level and can be influenced by political factors, making it difficult to know if a given community would value captured carbon at the same amount. Community members might also place additional non-use values on the restoration site. Since the project would be helping to address climate change which has a global influence and



the wetland could be preserved for future generations to enjoy, there may be non-use values that could be missed if only using market-based valuation methods. To answer the proposed question, project planners decided they will ask the community how much it would be willing to pay for the project using a survey and then analyze the results. This is the **stated preference valuation method**. Surveys or questionnaires of an individual's willingness to pay for use and non-use values (combined with some fancy math) are used to estimate the value people place on ES provided by a tidal wetland.

There are many kinds of stated preference methods such as contingent valuation, and choice experiments. Each has its own specific methods which can provide answers to different but seemingly similar questions. However, in their most basic form, a stated preference method analysis consists of drafting a survey, selecting a sufficient population to survey, distributing, and collecting the survey, and analyzing the results. This sounds simple but these analyses can be a fair amount of work. The analyses can range from simple and small, to very large and complex. Drafting a questionnaire can take significant time and resources, as multiple drafts and small-scale trial runs will likely be needed to iron-out the necessary details and questions. Once the survey is complete a sufficient section of the community being analyzed needs to be selected for the survey. Usually, a subsection of the community is surveyed because it can be prohibitively expensive in time and resources to try and get a survey in the hands of every person in a large community. Next proper logistics and money are required to distribute and collect the survey, either physically, or digitally, or both. Aspects of the selected survey population will need to be considered to determine the most effective ways to distribute the survey and encourage the most responses (e.g. internet accessibility within the community, age of community, etc). And finally, the results of the survey must be analyzed carefully for the estimates to be useful. This process can be quite complicated, and it is best if a professional statistician or economist is included early in the process. This way the professional can make sure the survey and following analysis is crafted and conducted to avoid bias and to tease out possible sources of error.

The complexity of stated preference analysis stems from the inherent uncertainty in relying on people to self-report how much they would pay for a good or service without being able to measure the amount they pay. This can lead to numerous sources of possible bias or error being introduced into the analysis causing the results to become less accurate. The issue is further complicated by the fact that people are being asked to value something they have little or no reference for. Try to calculate the dollar value of a hug. It's difficult without a social gesture-based economy to use as a reference. The nature of surveys also makes it possible for individuals to provide higher values than they would be willing to pay. People may do this because it makes them feel better to say they would pay a large sum, instead of providing a more realistic answer. Furthermore, some people might provide very high or very low values as a protest to the survey question or project as whole, in hopes of skewing the result in the direction they want. All these issues and more are lying in wait, to pounce and trip up an unaware analyst. Discussing these issues is not intended to portray this select choice method in a poor light. Far from it! However, it is intended to provide a simple overview of the inherent challenges of this method.

Despite the possible challenges have no fear, there are ways to help limit and account for sources of error. First is to bring in an expert early on. They will ideally be familiar with the best practices and the possible pit falls that could come up in this method. Many of the best practices are too complex to get into. But including an economist or other social-statistician at the end of the process just to manipulate the data can lead to some frustrating moments if it turns out the questionnaire, survey-population selection, or survey distribution methods were done incorrectly. Involving an expert(s) at the start of the process can help alleviate that issue by helping to design the study from the beginning and confirm it will be conducted the correct way.

Additional points to consider when planning a select choice method analysis is to provide detailed but not overly complex descriptions of the proposed project or scenario. If too little or too much background information is provided then survey participants might become confused about what it is exactly they are being asked to value, or they might not fully understand the benefits or costs a proposed project might have. Also, questionnaires must be crafted carefully and include specific questions to try and determine if a survey response is accurate or if the person is imparting significant bias on their responses, such as in the case of protest responses.

This list can go on for a while, in fact there so many things to consider and best practices to adhere to they could fill their own guidance document. And lo and behold there are a few! One of the first guidance documents was created by NOAA in 1993 and was creatively named the *"Report of the NOAA panel on Contingent Valuation"* (Arrow et al., 1993). This document lays out some of

the basic issues and best practices associated with contingent valuation. A more recent and comprehensive guide was published in the Journal of the Association of Environmental and Resource Economists in 2017, titled *"Contemporary Guidance for Stated Preference Studies"*. This more recent guide by Jonston et al. was built off of the 1993 NOAA report but attempted to incorporate the significant advances in the field of stated preferences methods research since the NOAA guide was published. The more recent guide has 23 recommendations which help provide best practice or address issues that can be encountered throughout the analysis process (Jonston et al, 2017).

As mentioned before, there are many forms of select choice method analysis methods, two common ones are contingent valuation and choice experiments. Contingent valuation is usually used to estimate a community's willingness to pay for a whole project or change within an ES. In its most basic form a contingent valuation could ask a participant how much they would be willing to pay to keep a tidal wetland as it is? Or how much they would be willing to pay to improve it? The way this question can be asked can take many forms depending on what the researchers are specifically trying to find out. But the general idea is to layout the current and/or proposed conditions and ask how much the participant would be willing to pay in some form to keep things the way they are or change them in some way. This could be asking people how much they would be willing to pay in increased taxes to preserve 1,000 acers of tidal forest habitat, or how much would they be willing to pay in a one-time payment to restore 500 acres of tidal wetland habitat? Answer options for contingent surveys can take the form of providing spaces for people to write in their own amounts or providing a list of amounts for them to choose from. However, there are numerous alternative formats in how the question is presented and how answers can be provided.

Alternatively, a choice experiments valuation can be used to determine how individual aspects of a project influence a community's willingness to pay for it (somewhat similar in idea to the hedonic price method discussed previously). Instead of asking participants how much they would be willing to pay to preserve or change an ES, it asks them how they value the individual aspects of the ecosystem, such as biodiversity or recreational access. In its very basic form this can be thought of as asking participants to choose between two options each with different aspects for different prices. For example, a survey question could say do you prefer option A or B? With option A consisting of medium biodiversity, low carbon storage, and high recreational access all for the low price of $5 annually. While option B consists of high biodiversity, high carbon storage, but low recreational access for the higher price of $25 annually. Variations of these surveys with different combinations of attributes and their associated cost would be made so that there are enough combinations of attributes, prices, and responses for the influence of each attribute on the community's willingness to pay can be estimated. The results can indicate which attributes of an ES or of a project they are willing to pay more for and which reduces or has no effect on it. Selecting which stated preference method to use is very important for providing results that will adequately inform decision makers of the community's willingness to pay for ES.

Hypothetical Example

A county along the coast is considering developing a natural gas terminal on an existing tidal wetland. The tidal wetland is remote with no roads or trails to it and public access is restricted; however, it is visible from parts of the town. A local non-profit decided to challenge the project to protect the wetland from development. As part of their campaign against the terminal the non-profit wants to demonstrate to county officials that the tidal wetland has value to the community. To determine how much the community values the use and non-use ES provided by the distant tidal wetland, the non-profit decides to conduct a contingent valuation study. First the non-profit determines the ES benefits provided by the tidal wetland, which include bald eagle nesting sites, aesthetic beauty, and preserving the wetland for future generations. The non-profit wants to make the survey quick and easy to fill out to encourage the most responses. But they also want to make sure they inform people of the benefits the tidal wetland provides even if they are not going to benefit directly from all of them.

Using focus groups, the non-profit develops a short but informative questionnaire to send out into the community. One question from the survey reads, "After reviewing the project description and visualization of the proposed refinery, what is the maximum you would be willing to pay per year to preserve the tidal wetland for future generations? a) $50, b) $75, c) $100, d) $125". After the survey results are analyzed, the non-profit determines that the community is willing to pay $72 per person to protect the tidal wetland.

Real World Example 1

A team of researchers wanted to know how much people in Oregon and Washington were willing to pay for local coho salmon enhancement programs in coastal communities. A contingent valuation study was conducted to determine the value of the non-use ES provided by coho salmon. The researchers created and sent out a survey to members of rural communities along the coast and asked them how much they would be willing to pay annually for increased coho run size through habitat restoration. The results indicated that people were willing to pay more, however, the results were not statistically significant due to a high range in the responses received.

Willingness to Pay for Local Coho Salmon Enhancement in Coastal Communities by Bell et al., 2003.

Real World Example 2

A conjoint analysis was used to estimate Georgian's willingness to pay for policies that would protect coastal wetlands. A rank choice survey was created where participants were asked to rank various policies which would protect different ES provided by wetlands. Each policy also had an associated cost. For example, a policy that would protect 225,000 acres of white shrimp habitat at a cost of $25 per household was compared to one that would protect only 150,000 acres but help blue crab, red drum, and white shrimp populations as well as address saltwater intrusion for $60 per household. The surveys were tested on the local university campus before being sent out around the community. The study estimated that Georgians were willing to make a one-time payment of $77 per household to protect the ES provided by the coastal wetlands.

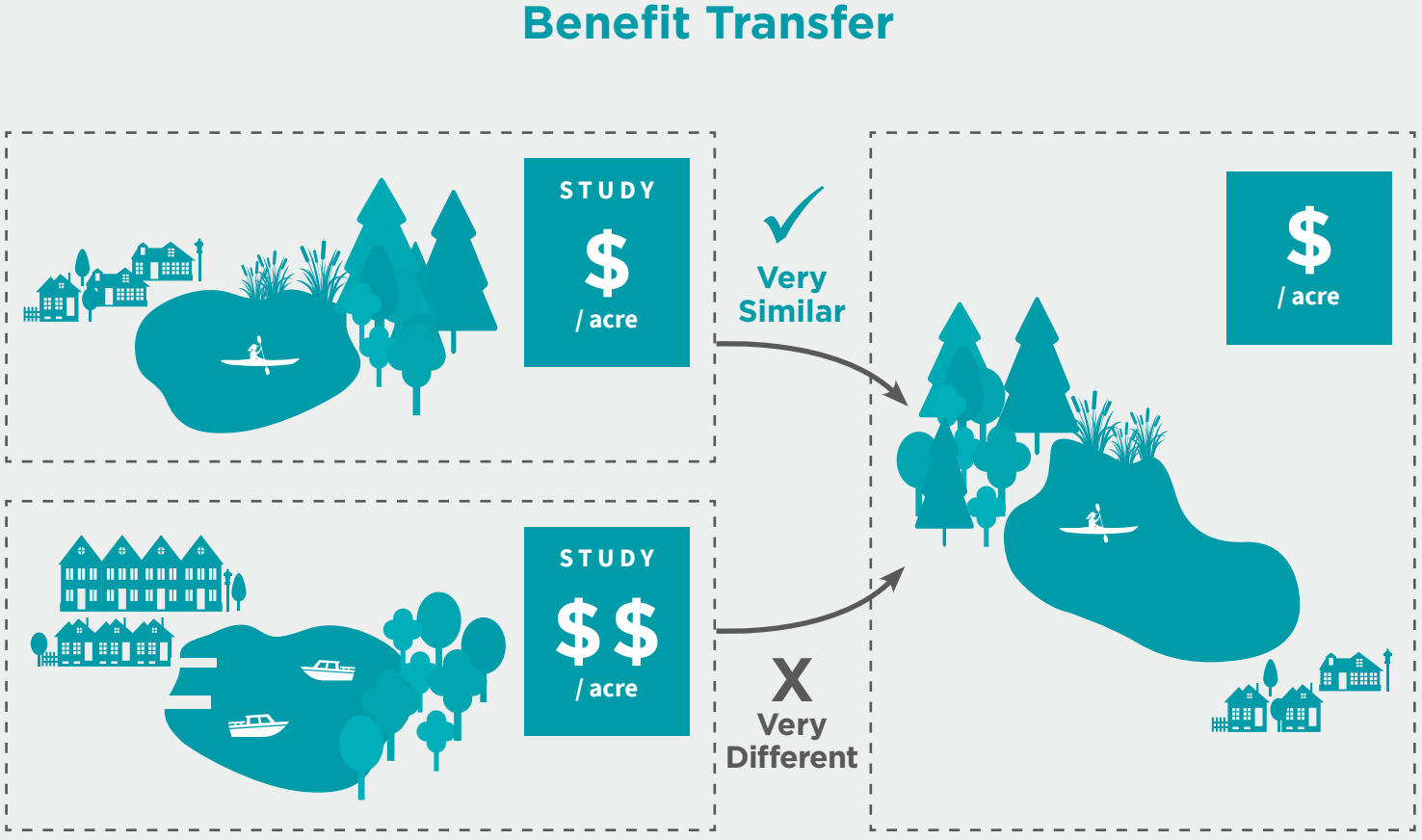
A Conjoint Analysis of Consumer Preferences for Wetlands Mitigation in Georgia by Phillips, W., 2006.

Benefit Transfer

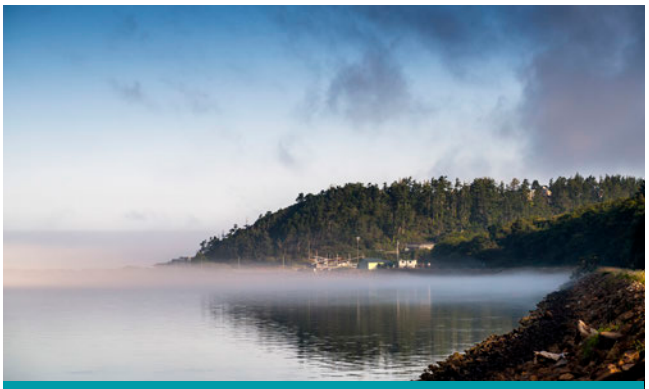
Benefit transfer is when the values obtained from one study are used for the valuation of a different study. This can be very useful as it removes the need to conduct expensive and time-consuming studies on the tidal wetland being valued by substituting values that have already been derived for a different wetland.

However, this method can be risky and controversial. This is because it is difficult to know how accurate the results of the analysis are when they are applied to a different tidal wetland with different physical and economic conditions. If the values used for a project are taken from a completely different wetland, the results will not be accurate because the analysis took place under different circumstances. The results could vastly over or underestimate the value of different ES and the tidal wetland as a whole.

It is also important to consider the accuracy of the original study being used because any error within the original study will be transferred along with the transferred values. Then if the study being conducted introduces more error into the analysis, the result may become too inaccurate to be useful. No studies are perfect and any error from transferred values will increase the total possible error within the analysis.



San Francisco, CA



Netarts, OR

Despite the risks, there are ways to use the benefit transfer method to provide reasonable valuation estimates. It is important to use studies or reviewed projects that are similar in location, attributes, ES, and local community demographics to the current project. If many of the major factors that influence a tidal wetland's value are similar between the comparison project and the current one, the ES values for the two are likely to be similar enough for comparison, producing reasonable estimates. For example, the ES values determined for benefits associated with kayaking access at a tidal wetland in Tillamook could be transferred to a tidal wetland in Netarts Bay as they are likely comparable sites. Both are tidal wetlands within bays, which are located near a small coastal town and are popular with kayakers. However, a study from a tidal wetland near San Francisco might not be as applicable due to the significant difference in location and local population.

Speaking of recreation related ES, some ES are easier to transfer than others. Recreation values can be transferred more easily as those values are based primarily on travel cost, which can be similar in comparable communities. However, ES with values that rely more on specific conditions or attributes of the site in question are more difficult to transfer.

When searching for benefit transfer studies it is not uncommon to encounter a benefit transfer meta-analysis, which is the result of numerous valuation studies being combined and averaged. Averaging is often done using a complex algorithm or analysis method to try and balance all the reference values. The result is a single or range of averaged value(s) for the ES in question.

The results of these analyses can be useful as they average the ES values from multiple locations each with their own conditions. This helps to create a general value for the ES which could be used in the event a more specific analysis isn't available. For example, if there aren't any studies on the value of hiking in a tidal wetland like the one being studied, then a value for hiking could be pulled from a meta-analysis of the value of hiking for the state of Oregon. However, it should be noted that the meta-analysis value will likely be less accurate than a value from a very similar wetland. In some lucky cases there are meta-analyses of studies focused on a specific area, such as the Columbia River. So long as the wetland being valued is within/near the area included in the meta-analysis, the results of the more focused meta-analysis are likely more applicable than those from a state level meta-analysis. Therefore, meta-analyses can be good for providing values for ES values, but they should be used carefully and with thorough consideration.

In short, the benefit transfer method can be very useful for conducting quick and inexpensive valuations of a tidal wetland's ES, but it should be used cautiously and with adequate context. Remember that their results cannot replace a survey or analysis of the specific ES being evaluated at the tidal wetland being evaluated.

Hypothetical Example

A local non-profit wants to bring attention to the potential value of improving recreational access within a tidal wetland. The group knows the site has potential for increased kayaking and hiking access as the current access points are overcrowded. A study conducted by the city estimated that recreationalist attendance to the parks could be increased by 15% if access was increased. However, the city is currently uninterested in the idea, citing the cost of developing more trailheads and kayak launching points. Previous attendance records show that around 15,000 people visit the wetland annually to participate in hiking and 2,000 for kayaking. Therefore, the improved recreational access points could increase the number of hikers by 2,250 and kayakers by 300 participants annually. However, the non-profit group does

not have the budget to conduct their own contingent valuation study to determine the possible value of adding recreational access. So, they decide to do the next best thing and conduct a benefit transfer analysis to provide an estimate for the value of the ES. While there appear to be no studies of similar recreation projects in the region, there are two meta-analyses that have valued recreational activities in Oregon. Using the results from the two studies provides a range of values for kayaking in Oregon at $49-$114 per person per day, and hiking at $78-$87 per person per day (Rosenberger, 2018; Rosenberger et al, 2017). Applying the activity values to the predicted increase in attendance indicates that hiking could provide an additional $110,250-$256,500 in annual benefits and kayaking could provide between $23,400-$26,100. Combined, the added recreational opportunities could generate between $133,650 and $282,600 in annual benefits to the local community. The group makes sure to clearly state that the valuation is based on statewide averages for value of recreational activities applied to historical attendance levels. They also make it clear that these values are only estimates based on averages. However, they offer a starting place for capturing the value of the recreational ES provided by the tidal wetland.

Real World Example

A non-profit organization wanted to determine the economic value of the major ES provided by Puget Sound. After determining all the major ES provided by Puget Sound the analysts concluded that it would likely take the better part of a decade, a dragon's hoard amount of money, and more data points than there are stars in the sky to conduct an in-depth analysis of all the services. Due to these exorbitant barriers, the analysts decided an analysis using the benefit transfer method was more attainable with their available resources. They used ArcGIS to determine the area of each habitat type within the sound, then researched the per-acre dollar values for the ES provided by each habitat type. The analysts noted that they were careful to select dollar values that were from studies with similar conditions to the Puget Sound. They multiplied the ES per-acre dollar values by the acreage of the corresponding habitat. Results from the analysis indicate that the ES provided by habitats within the Puget Sound create between $7.4 billion and $61.7 billion in benefits. The analysts acknowledged that the results are a rough estimate due to the scale of analysis and the use of the benefit transfer methods.

A New View of the Puget Sound Economy; The Economic Value of Nature's Services in the Puget Sound Basin. Batker, D. et al. 2008. (Tip: valuation discussion starts on page 43 of source)

Data Sources

Data sources for benefit transfer can be found far and wide. Again, the proximity and similarity of the report's subject should be as close as possible to the subject under study. Given the large number of studies and data sources that could be applied to tidal wetlands in Oregon, it is not possible to list them all. Therefore, only one source is provided below as an example of a good study in Oregon that found values which could reasonably be applied to tidal wetlands in Oregon.

The Oregon Department of Fish and Wildlife wrote a technical report that provided estimates for the economic value of commercial and recreational fishing along the Oregon Coast. One of the report's most applicable results can be found in Table 1, which provides estimates for travel costs for recreationalist, pay when commercial fishing in Oregon. Source: The Research Group, 2021.B

Non-Dollar Valuation Method

While some may disagree, money is not everything. Sometimes there are benefits or aspects of benefits from ES that are difficult or impossible to value though money, but can be valued through non-dollar, or non-monetary valuation methods. These can be things like a feeling of security for farmers who experience less floods due to a tidal wetland, physical or mental health benefits from access to nature within a tidal wetland, or a feeling of connection to heritage or culture. This method is great for catching additional value of a benefit that monetization can't. While non-dollar valuation methods don't provide monetary values for ES, they can provide data-backed evidence for people's views and feelings about ES and the tidal wetlands that provide them.

There are many ways to conduct non-monetary valuation methods and they range from the straightforward to the computer-meltingly complicated. However, usually these studies involve drafting a survey that will be filled out by community members who are asked to rate scenarios or project alternatives against each other, without any kind of monetary valuation or discussion of money. While the survey structure is like that of stated preference methods, a non-dollar valuation method focuses on the benefits received from the associated ES themselves instead of trying to determine the dollar value of the benefit.

Alternatively, instead of comparing the projects against each other, the survey could ask people to individually rate their support for different options. For example, a survey could provide background information on four restoration projects. The survey would include background information on the benefits and drawbacks of each alternative, then ask the respondent to rank how much they support the development of each individual ES on a scale of one to ten, with no limit on how many times participants can repeat a rating.

There is no limit to what these kinds of surveys can ask: anything from general interest surveys for guiding county-wide restoration efforts, to highly detailed surveys of a few property owners along a regularly flooding river. The survey's aim is capturing people's preference or feelings toward ES benefits and associated projects, purely on their physical, social, or psychological benefits. This approach frees people from having to try and condense their feelings down into dollar values and instead provides them with a subjective way to express themselves. That's great, but it also brings in an unavoidable source of error: subjectivity. It is unwise to assume that "strongly supporting" a project means the same thing to everyone. One person's strong support of a project could be signing an online petition against a new development, while another person's could involve being chained to a tree to stop the bulldozers. Therefore, it is important to be careful when crafting survey questions to make sure they allow people to express their feelings and thoughts clearly. For example, instead of asking people to circle which variation of agree/disagree they feel toward a statement, they could be asked to describe their feelings in their own words, or to pull five words from a provided word bank that they feel best describes their opinion or feeling.

When crafting surveys, it is also important to think about what form of response would be the most useful for demonstrating the value of the ES and how to encourage results that are not so subjective as to be unusable. Would ratings of alternative projects provide the insight desired, or would a dialogue box allow respondents a better way to express the benefits they receive from a project or wetland? Should people be asked to rate their support for a few project proposals on a scale from 1-10 or should the alternatives be rated against each other? Most approaches will have their own strengths and drawbacks and it is unlikely that a one-size-fits-all approach will provide the desired information. Consequently, a survey might require the use of various methods to gather respondent's answers. It is also important to remember that questions must be crafted carefully to avoid influencing people's responses. To accurately analyze the collected data and information it is recommended to consult an expert social statistician.

Once the results are in, they can be used to show which residents of a community believe a project will help them and which won't, why one neighborhood values a different project alternative higher than the rest of the community, or how community members feel they benefit from a tidal wetland. While these results might not help convince a budget-focused government official of the economic payoff of a restoration project, they can greatly help project managers or land-use managers understand why a tidal wetland provides social and personal value.

Hypothetical Example

The governments of a small coastal town and that of a neighboring Tribal Nation want to determine the value of restoring a tidal wetland to their respective communities. The potential restoration site straddles the border between the town and the Sovereign Nation. The town and Tribe have already worked together to determine that restoration of the tidal wetland would likely result in significant economic benefits for the two communities, however restoration planners from the two groups cannot agree on which of the five restoration designs they should implement. All the designs would effectively restore ES that benefit the two economies. However, the designs differ significantly in the way other ES could be utilized by the two communities.

For example, one design plans for an extensive trail network and dog park which would allow members from both communities to access and recreate in the wetland, however the extensive amount of foot traffic would likely limit wildlife utilization and the development of pristine hunting and foraging habitats. Another option has a park located on the city side of the wetland, but an educational facility on the Tribe's side. While still another design calls for essentially no access for anyone, and instead focuses solely on habitat restoration. To determine which option would best benefit both communities, the project planners from the city and Tribe work together to create a survey to send out to the two communities. They decide that since they are already aware of the economic benefits from the proposed restoration project, they want to conduct a non-dollar valuation analysis as this will allow them to determine how members from each community feel about the project alternatives and which design, they believe would be the most beneficial.

A survey is drafted which aims to explain the intent of the study, the benefits of the restoration, and the five proposed designs. One of the sections of the survey asks participants to rank the five proposed projects against each other, while another section asks for specific feedback on perceived benefits and drawbacks from the restoration effort. The project managers and associated statistical experts set up a test group to provide feedback about the survey's design. Once they have applied the survey design feedback, they mail the survey out to the two communities. They also decided to set up physical stalls outside of major hubs within the two communities to survey as many people as possible. Results of the survey indicate that none of the provided designs meet the desires of the communities, however aspects of two of the designs could be combined into one, that would address most of the feedback received.

Real World Example

A team of researchers in Sweden wanted to determine the social value of wetlands near urban areas. They identified three communities located near wetlands and sent out surveys. The questionnaire asked participants about the wetland's impact on their quality of life, such as providing access to nature, physical activity, and exposure to aesthetic beauty. The researchers found that the wetlands incited "positive affective responses" and most respondents reported high social value for the wetland. The researchers hoped that these results could help inform local authorities about the social ES provided by the wetlands.

Wetland areas' direct contributions to residents' well-being entitle them to high cultural ecosystem values. Pedersen, E. et al. 2019.

Data Sources

As noted in the survey-based analysis methods above, the best data for a non-dollar value analysis is within the minds of the local community(s) under analysis. However, there are surveys that ask community members about their preference on recreational and natural resource management plans. As discussed previously the Oregon Outdoor Recreation Survey contains not only data potentially useful for a travel cost analysis, but also asked participants how they felt about different approaches to recreational and natural resources management.

Conclusion

In the pursuit of understanding and valuing the ecosystem services of Oregon's tidal wetlands, this guide has traversed a multidimensional landscape, uncovering the intricate tapestry of benefits these ecosystems provide. From their role as nurseries and vital habitat for diverse aquatic life to their capacity for flood mitigation and carbon sequestration, tidal wetlands emerge as invaluable contributors to both ecological integrity and human well-being.

Our exploration began by illustrating the essence and significance of tidal wetlands, setting the stage for a comprehensive valuation journey. As we navigated through the intricacies of goal setting, engagement strategies, and the identification of key ecosystem services, it became evident that the true value of these wetlands transcends mere economic considerations. It encompasses the interconnected web of ecological, social, and cultural benefits that define the unique character of Oregon's coastline.

The collaborative nature of this valuation process, involving diverse perspectives and backgrounds, reinforces the importance of inclusive decision making. By acknowledging the wisdom and experiences of co-managers, sovereign nations, local communities, and stakeholders alike, we establish a solid foundation for fostering and sustaining successful partnerships among the varied groups linked by the shared tapestry of tidal wetlands.

In the final stretch of our journey, we explored the myriad of methodologies available for valuing ecosystem services, acknowledging that no single approach fits all contexts or provides a full picture of the ecosystem services' value. The diversity of valuation methods presented in this guide underscores the need for adaptability, ensuring that the chosen methodology aligns with the unique characteristics and objectives of the tidal wetland and the valuation goals.

As we draw the curtains on this guide, we emphasize the pivotal role that informed decision making plays in the sustainable management of tidal wetlands. By understanding and quantifying their value, we empower policy and decision-makers, resource managers, and community organizations to make choices that safeguard these ecosystems for the benefit of current and future generations.

In conclusion, this guide serves as a compass, helping steer us towards a future where Oregon's tidal wetlands thrive as resilient and dynamic ecosystems. Through our collective efforts to recognize and understand the value of these natural wonders, we pave the way for a harmonious coexistence between human communities and the vital ecosystems that grace the Oregon coastline. May this report inspire greater stewardship and appreciation for the intricate beauty and functionality of tidal wetlands, ensuring their enduring presence in the rich tapestry of Oregon's ecosystems.

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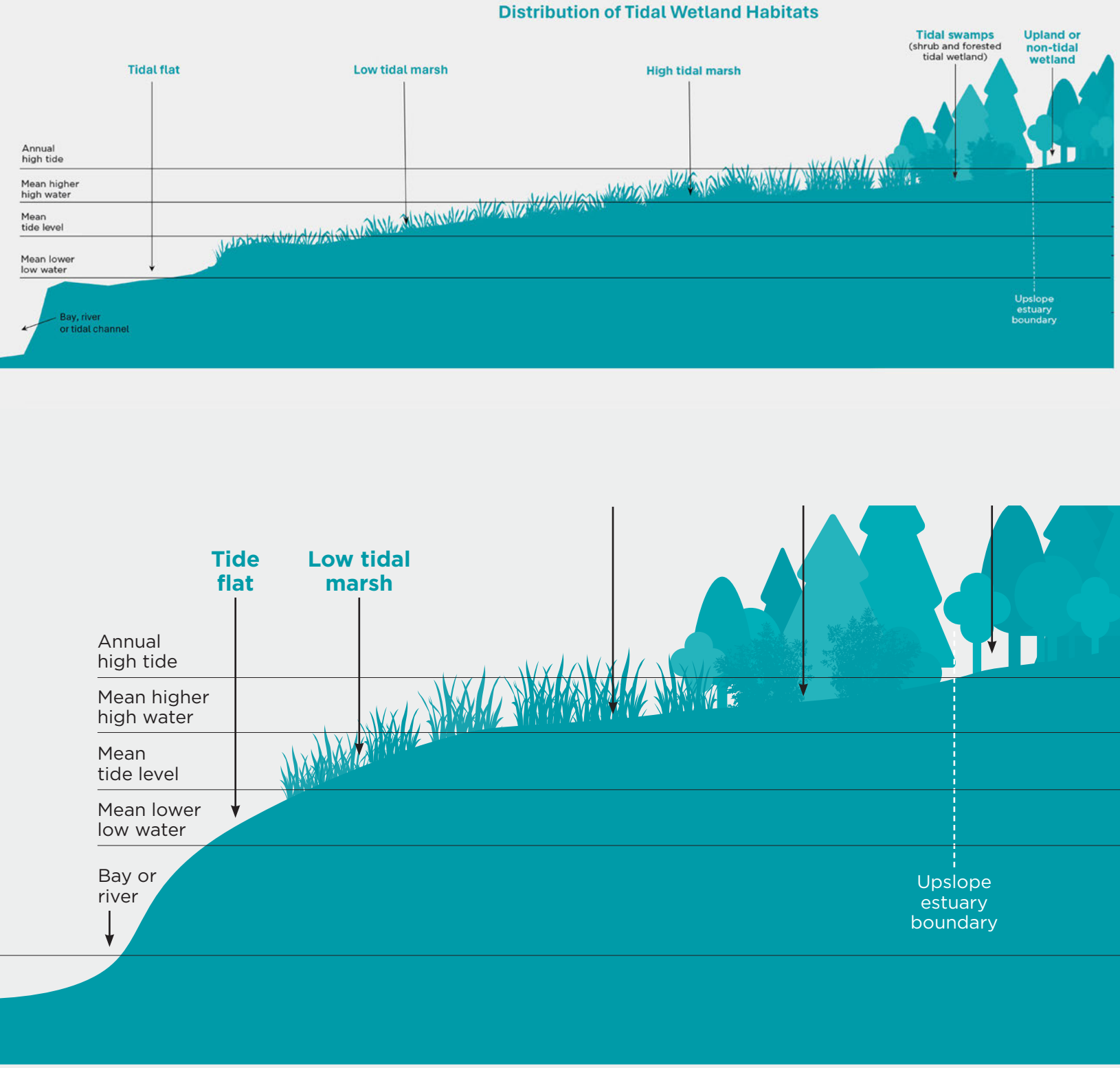

Figure 1: Depiction of how tides and topography influence the formation of tidal wetland habitats. Vertical scale is exaggerated in this diagram. (Original diagram by Laura Brophy, recreated with permission.)