Natural Resource Economics

1430 Willamette St., # 553
Eugene, Oregon USA 97401-4049
Phone • (541) 937-3644 | Cell • (541) 505-2704
www.nreconomics.com
ernie.niemi@nreconomics.com

25 July 2017

TO: **Members, Oregon Board of Forestry**
FROM: **Ernie Niemi, President**
SUBJECT: **OREGON'S FOREST ECONOMY–IMPORTANCE OF UNLOGGED FORESTS**

A vast body of research and data demonstrates that the state's forests make many important, positive contributions to Oregon's economy. The Board and the Department of Forestry, however, ignore most of this information. They highlight the positive impacts and overlook the negative impacts of logging, but they either ignore or only briefly consider the economic contributions of unlogged forests. Although bearing a statutory requirement to provide the public with a "comprehensive analysis of the economic impact" of proposed changes in streamside management rules, for example, the Board and ODF instead provided the public with a description of negative impacts on logging that would accompany extensions of streamside protections and totally ignored the positive impacts that would accompany improvements in stream habitat, increased carbon storage, etc.

This disparity in its consideration of the different roles logged and unlogged forests play in Oregon's economy undermines the Board's efforts to meet various objectives, including these:

- Maintain economic stability in each management region.
- Ensure that the State Forester has developed Forest Management Plans based on the best available science.
- Meet the elements and breadth of the "greatest permanent value" rule, with means healthy, productive, and sustainable forest ecosystems that over time and across the landscape provide a full range of social, economic, and environmental benefits to the people of Oregon.
- Obtain the greatest benefit for the people of this state, consistent with the conservation of this resource under sound techniques of land management and accounting for all the features of the land that may offer revenue for the Common School Fund.
- Achieve a balance between short-term and long-term economic returns, with a full range of economic, social, and environmental benefits today, as well as in the future.
- Balance economic, social, and environmental values.
- Make trade-offs between revenue-producing and non-revenue producing activities.

To help fill this gap, this memorandum provides an introduction to the contributions unlogged forests make to Oregon's economy. It also identifies the analytical framework for fully considering these contributions, and offers an introduction to relevant research literature. I recommend that the Board incorporate this information into its future decision-making and direct ODF to utilize this information in its future economic analyses.

I. CONCEPTUAL FRAMEWORK

From an economics perspective, Oregon's forest resources are important not in and of themselves but because they produce things that benefit people, impose costs on them, and compose the environment.

One widely accepted approach for describing the economically important products derived from Oregon's forests combines economic with ecological concepts, as shown in Figure 1.[1] Its central feature is the ecosystem's production of *ecosystem goods and services*, which are important to people and, hence, have economic value. The ecosystem produces goods and services through processes, known as ecosystem functions, that derive from the ecosystem's structure. The right side of Figure 1 shows that sometimes humans place values on the structure of the ecosystem, e.g., the character of the landscape, rather than on the goods and services it produces. To simplify things, however, I use the terms, ecosystem services, to represent all those resource-related things that have economic value.[2]

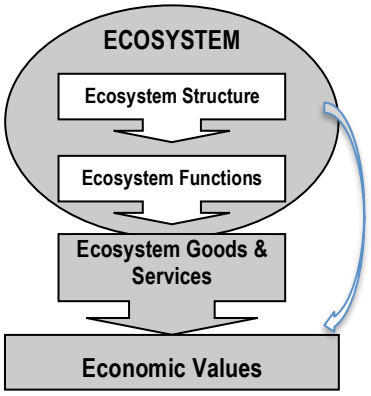

Figure 1. Connections between the Ecosystem and Economic Values[3]

To fully understand the economic impacts of their actions, the Board and ODF must explicitly identify all the services that flow from the state's forest ecosystems and are likely to meaningfully change because of their actions. They must, for example, consider the broad literature on the services produced by rivers, wetlands, floodplains, and other types of ecosystems.[4] Table 1 provides an illustrative list of ecosystem services derived from watersheds that the Board and ODF must address.

---

[1] An overview of goods and services produced by forest ecosystems is available at https://www.fs.fed.us/ecosystemservices/.

[2] Economists also use "goods and services" to include things, such as damaging floods, that are economically important in a negative rather than positive sense.

[3] Adapted from National Research Council, Committee on Assessing and Valuing the Services of Aquatic and Related Terrestrial Ecosystems. 2004. *Valuing Ecosystem Services: Toward Better Environmental Decision-Making*. National Academies Press.

[4] The separation of ecosystem services into three categories—provisioning, regulating, and cultural—reflects several efforts to distinguish among different types of services (Millennium Ecosystem Assessment (2005), CICES (2016), EPA (2015b), Fisher and Turner (2008)). The examples of cultural services reflect investigations subsequent to the development of the Millennium Ecosystem Assessment by economists and other social scientists (*see* Chan et al.

Table 1. Ecosystem Services Derived from Watersheds

Ecosystem Service	Potential Benefits to Oregon's Economy from Unlogged Forests
1. Provisioning Services[a] **Benefits ecosystems generate by delivering water (quantity, quality, timing) to directly provide products for human use**	
Deliver water for consumptive use	The watershed's ecosystem affects the quantity, quality, and timing of water supplies for municipal/industrial, domestic, and agricultural uses that remove water from the river.
Deliver water for non-consumptive uses	The watershed's ecosystem affects the quantity, quality, and timing of water supplies for uses that affect the supply of products without removing water from the river: • Salmon, steelhead, and other species for subsistence and commercial harvest. • Power generation • Navigation
2. Regulating Services[a] **Benefits ecosystems generate by regulating ecosystem processes, thereby supporting the production of provisioning and cultural services, and directly providing insurance, resilience, and adaptability benefits against undesirable ecosystem changes.**	
Support production of and reduce risk to fish and wildlife	The watershed's ecosystem affects the quantity, quality, and timing of water supplies that influence the supply of: • Salmon/steelhead • Lamprey • Other fish • Birds
Reduce risk to life and property	The watershed's ecosystem can buffer flood flows and control erosion.
Reduce risk of undesirable water quality	The watershed's ecosystem can influence risk from algae and pathogens influencing: • Chemical properties (natural filtration) • Biological properties (natural filtration and interactions) • Temperature
Reduce risk of harmful changes in climate	The watershed's ecosystem can influence the risk of warming, sea-level rise, intensity and frequency of storms, etc. by: • Storing carbon in active floodplains • Reducing storage of methane in reservoirs
Enhance resilience of and reduce	Variation of genetic diversity within a species in the watershed and of

(2012), Hernandez-Marcillo et al. (2013), Kovacs et al. (2013), Martin-Lopez et al. (2013), Milcu et al. (2013), and Plieninger et al. (2013)).

Ecosystem Service	Potential Benefits to Oregon's Economy from Unlogged Forests
risk to ecosystems' productivity through biodiversity	species across the watershed may be necessary for ecosystems to exhibit resilience in their functions and ability to sustain the production of services.
Enhance resilience of and reduce risk to ecosystems' productivity through nutrient recycling	Managing the watershed to support larger runs of adult salmon and steelhead, for example, would increase the import of nutrients from the ocean to the basin's aquatic, riparian, and upland ecosystems. A decline in numbers of adult spawners can trigger a shift in ecosystem state.
3. Cultural Services[b] Nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences	
Provide identity value	The ecosystem's status (species abundance, flow patterns, etc.), functions (provision of habitat for species, filtration, etc.), and services can tell people: • Who they are, to what group they belong. • Which practices and knowledge define them. • Which keystone species and associated events and activities shape their identity. • The extent to which the status of species, river flows, etc. signify the risk to whole cultures.
Provide heritage and place value	Past human presence and practices can determine the extent to which a particular site yields services that endow the site with value .
Provide recreational opportunities	The ecosystem, or elements thereof can generate benefits for people who enjoy fishing, river rafting, kayaking, etc.
Provide activity value	In addition to the recreational value derived from experiencing the ecosystem or the sustenance value obtained from fishing and gathering, people may realize benefits, e.g., improved physical and emotional health, from the activity itself.
Provide spiritual value	The ecosystem, or elements thereof can serve as a resource for religious, philosophical, or spiritual thought and experience.
Provide inspirational/educational value	Discrete from spiritual value, the ecosystem, or elements thereof, e.g., a free-flowing river with wilderness characteristics, can create benefits by enabling nature to serve as the inspiration for creative or intellectual thought.
Provide aesthetic value	The ecosystem, or elements thereof can provide aesthetic benefits separate from spiritual or inspirational/educational benefits.
Provide existence, altruistic, and bequest value	The ecosystem, or elements thereof can provide benefit to people who derive satisfaction from knowing that it/they exist or will be available to others in the current or future generations. Economists sometimes use the term, passive-use benefits, to describe these benefits.
Contribute to social cohesion	The realization, by multiple individuals or groups, of other benefits derived from the ecosystem can contribute to social cohesion and the evolution of social capital, thereby helping define behavioral norms that reduce the risk

Ecosystem Service	Potential Benefits to Oregon's Economy from Unlogged Forests
	of conflict, facilitate business transactions, and lower the costs of community governance.
Provide option value	Humans may derive benefits from preserving the processes and functions of an ecosystem so it has the ability to produce services in the future.

[a] Illustrative examples come largely from Abson and Termansen (2010), Brander et al. (2010),Bartkowski (2016), Kumar et al. (2010), Hearnshaw et al. (2010) Poff et al. (2015), Collins et al. (2015), Kohler et al. (2013), National Park Service (2005), Oliver et al. (2015), Scheuerell et al. (2005), and Scheuerell et al. (2015). These sources represent just a small portion of the relevant literature the Board and ODF must incorporate into their identification and analysis of provisioning and regulating services.

[b] Illustrative examples come largely from Chan et al. (2011). Careful research is required to determine the extent to which the categories yield mutually exclusive sets of ecosystem services. These sources represent just a small portion of the relevant literature the Board and ODF must incorporate into their identification and analysis of cultural services.

Sometimes the value of an ecosystem good or service materializes in market prices, as sellers and buyers trade a good or service, or a product derived from it. The absence of a market price, however, does not mean that a good or service has no value. Instead, a good or service can have value even though it is not traded in markets. The economic importance of a good or service may arise when it is extracted, as when the timber industry removes logs from a forest, or when it remains *in situ*, as when anglers fish in a river, or parents hold a desire to pass a healthy ecosystem to their children and grandchildren.

II. ANALYTICAL FRAMEWORK

Federal agencies responsible for managing water resources recently developed an analytical framework for determining and comparing the economic consequences of management alternatives. This framework (CEQ 2013), is known as the *Principles, Requirements and Guidelines for Water and Land Related Resources Implementation Studies* (PR&G). Table 2 briefly summarizes the major elements of this framework. The Board and ODF should develop a full understanding of this framework and then apply it to ensure that they provide Oregonians with a truly comprehensive analysis of the economic impact of future forest-management decision.

Table 2. Major Elements of a Comprehensive Economic Analysis (from the PR&G)

Analytical Component	Requirements for the Board and ODF
1. Net public benefits of each forest-management alternative	Describe the benefits and costs of each alternative, subtract costs from benefits, and determine which alternative will maximize net public benefits. This determination must account for all benefits (increases in the value of goods and services) and costs (decreases).
2. Net impact on jobs, income, etc.	Determine the positive impacts, negative impacts, and net impacts on economic activity for each alternative. They must assume that the economy will be operating at full employment, so that workers can fill new jobs only by leaving their existing jobs, and workers losing jobs will quickly find replacement jobs. This assumption will help the Board and ODF avoid overstatements of the economic impacts of their expenditures and related commercial/industrial expenditures.
3. Sustainable economic development	Assess the potential sustainability of the quantity (supply), quality, timing, location, accessibility, etc. of goods and services produced by the economy under each alternative. It also must assess the sustainability of jobs, incomes and other relevant indicators of economic activity. The assessment must account fully for the market components of the economy (commercial/industrial sectors) and for the non-market components (subsistence activities, ability of local environmental amenities to stimulate economic development by attracting households and businesses).
4. Economic importance of ecosystem services	Account for the economic importance of the services that the watershed's ecosystems provide households, businesses, and communities. They must identify and describe the services these ecosystems provided in the past, provide currently, and would provide in the future under each alternative. They must measure the expected increases and decreases in the value of the ecosystem services and incorporate these values in their determination of each alternative's net benefits. They must describe the roles these services play in the local and regional economies and measure the positive and negative impacts on population, jobs, incomes, etc. that would result from changes in ecosystem services that would take place under each alternative.
5. Economic value of benefits and costs that cannot be monetized	Integrate all effects—monetized, quantified but not monetized, and unquantified—into a single determination of each alternative's net public benefits. The determination must account for environmental, economic, and social goals for the entire watershed. The comparison of the net public benefits of different alternatives must reflect all these effects.

Analytical Component	Requirements for the Board and ODF

6. Non-market mechanisms of economic development

Account for both market and non-market mechanisms of economic development when describing each alternative's impacts on population, jobs, income, etc. The market mechanisms include the direct, indirect, and induced impacts of the expenditures by the timber industry, outdoor recreation industry, etc. The non-market mechanisms include the ability of the watershed's natural-resource amenities—recreational opportunities, scenic vistas, etc.—to attract households, entrepreneurs, and businesses investment to the watershed.

7. Cultural values

Account for cultural services Tribal members and others derive from fish and other components of the watershed's ecosystems as they determine each alternative's net public benefits and net economic-development impacts. Determine the value of these services looking through the eyes of the relevant individuals and communities, rather than apply values that represent other segments of society. In particular, when there exists no reasonable substitute for these services, measure losses of these services looking at the amount of compensation the affected parties would require as compensation before they would be willing to accept the loss, rather than at the amount the parties would be willing to pay to prevent the loss. Fully investigate the potential for healthy ecosystems in the watershed to generate subsistence and other activities that have economic-development impacts comparable to those of market-based expenditures.

8. Subsidies and externalities

Account for all of the costs incurred to produce each type of good or service derived from the CRSO. Their determination of each alternative's net public benefits must fully reflect all subsidies (costs imposed on third parties by intent) and externalities (costs imposed inadvertently).

9. Self-sustaining floodplains

The determination of each alternative's net public benefits must explicitly and completely incorporate all services derived from floodplains. The determination of the impacts on sustainable economic development similarly must reflect these services. Acknowledge there exist national objectives that give preference to actions that would increase the sustainability of floodplains' ecological processes, functions, and services.

10. Climate change and other risks

Describe the expected level of each benefit or cost, the uncertainty inherent in this measurement, and the risk that a cost might be larger and more harmful than expected. Similarly describe each alternative's expected impacts on economic development, the uncertainty in this expectation, and the risk that impacts might be more negative than expected. Especially describe risks associated with the potential for climate change to have greater than expected impacts on the ecosystem and on commercial/industrial sectors of the economy. The analysis of risks must recognize that, if commercial/industrial production increases risks for fish populations or other ecological assets, these risks may limit future commercial/industrial operations.

III. REFERENCES POTENTIALLY USEFUL TO THE BOARD AND ODF

Abson, David J., and Mette Termansen. 2010. Valuing Ecosystem Services in Terms of Ecological Risks and Returns. *Conservation Biology.* https://www.researchgate.net/profile/David_Abson/publication/49700099_Valuing_ecosystem_services_in_terms_of_ecological_risks_and_returns/links/00b7d5278b7031da78000000.pdf.

Amiran, E. Y., and D.A. Hagen. 2003. Willingness to Pay and Willingness to Accept: How Much Can They Differ? Comment. *American Economic Review.* 93, 458–463. http://www.jstor.org/stable/3132189.

Aylward, Bruce, Jayanta Bandyopadhyay, Juan-Carlos Belausteguigotia (Coordinating Lead Authors) and others. 2005. "Freshwater Ecosystem Services." *Millennium Ecosystem Services.* http://www.millenniumassessment.org/documents/document.312.aspx.pdf.

Bartkowski, Bartosz. 2016. Are Diverse Ecosystems More Valuable? A Conceptual Framework for Economic Valuation of Biodiversity. https://www.econstor.eu/bitstream/10419/144178/1/863322263.pdf.

Brander, Luka, Erik Gomez-Baggethum, Berta Martin-Lopez, and Madhu Verna. 2010. The Economic of Valuing Ecosystem Services and Biodiversity. http://www.teebweb.org/wp-content/uploads/2013/04/D0-Chapter-5-The-economics-of-valuing-ecosystem-services-and-biodiversity.pdf.

Chan, Kai M.A., Terre Satterfield, and Joshua Goldstein. 2011. "Rethinking ecosystem services to better address and navigate cultural values." *Ecological Economics*. 74: 8-18.

Chen, Yong and Lewis, David J. and Weber, Bruce.2016. Conservation Land Amenities and Regional Economies: A Postmatching Differenc-In-Differences Analysis of the Northwest Forest Plan. *Journal of Regional Science*, Vol. 56, Issue 3, pp. 373-394, 2016. https://ssrn.com/abstract=2790379 or http://dx.doi.org/10.1111/jors.12253.

Collins, Scott F., Amy M. Marcarelli, Colden V. Baxter, Mark S. Wipfli. 2015. A Critical Assessment of the Ecological Assumptions Underpinning Compensatory Mitigation of Salmon-Derived Nutrients. *Environmental Management.* http://link.springer.com/article/10.1007%2Fs00267-015-0538-5.

Common International Classification of Ecosystem Services (CICES). 2016. *CICES Version 4.3.* http://cices.eu/content/uploads/sites/8/2015/09/CICES-V4-3-_-17-01-13a.xlsx.

ECONorthwest, Natural Resource Economics, and ESA. 2012. *Yakima River Basin Integrated Water Resource Management Plan: Four Accounts Analysis of the Integrated Plan.* Bureau of Reclamation and Washington Department of Ecology. http://www.usbr.gov/pn/programs/yrbwep/reports/fouraccounts.pdf.

Fisher, B, and R.K. Turner. 2008. Ecosystem service: Classification for valuation. *Biological Conservation.* 141:1167–1169. http://www.sciencedirect.com/science/article/pii/S0006320708000761.

Folke, Carl. 2004. Traditional Knowledge in Social-Ecological Systems. *Ecology and Society*. http://www.ecologyandsociety.org/vol9/iss3/art7/.

Hanemann, W.M. 1991. Willingness to Pay and Willingness to Accept: How Much Can They Differ? *American Economic Review*. 81(3), 635-647. https://www.fnu.zmaw.de/fileadmin/fnu-files/courses/ere4_val/aerhanemannwtpwtac.pdf.

Hanemann, W.M. 2003. Willingness to Pay and Willingness to Accept: How Much Can They Differ? Reply. *American Economic Review*. 81(3), 635-647.

Hauer, F. Richard, Harvey Locke, Victoria J. Dreitz, Mark Hebblewhite, Winsor H. Lowe, Clint C. Muhlfeld, Cara R. Nelson, Michael F. Proctor, and Stewart B. Rood. 2016. Gravel-Bed River Floodplains are the Ecological Nexus of Glaciated Mountain Landscapes. *Science Advances.* http://advances.sciencemag.org/content/2/6/e1600026.

Hearnshaw, Edward, Ross Cullen, and Ken Hughey. 2010. Ecosystem Services Review of Water Projects. *Australian Agricultural and Resource Economics Society Annual Conference* http://ageconsearch.umn.edu/bitstream/58895/2/Cullen,%20Ross.pdf.

Henderson, J. 2002. "Building the Rural Economy with High Growth Entrepreneurs"." *Economic Review* 87 (3): 45-70. http://www.kc.frb.org/Publicat/econrev/Pdf/3q02hend.pdf

Hernandez-Morcillo, Monica, Tobias Plieninger, and Claudia Bieling. 2013. An Empirical Review of Cultural Ecosystem Service Indicators. *Ecological Indicators*. https://www.researchgate.net/profile/Tobias_Plieninger/publication/257592979_An_empirical_review_of_cultural_ecosystem_service_indicators/links/5405cbd60cf23d9765a75847.pdf

Howarth, R.B. and R.B. Norgaard. 1993. Intergenerational Transfers and the Social Discount Rate. *Environmental and Resource Economics.* 3: 337-58.

Irwin, E.G., A.M. Isserman, M. Kilkenny, and M.D. Partridge. 2010. "A Century of Research on Rural Development and Regional Issues." *American Journal of Agricultural Economics*. 92(2): 522–553.

Kahneman, D., J.L. Knetsch, and R.H. Thaler. 1991. Anomalies: The Endowment Effect, Loss Aversion, and Status Quo Bias. *Journal of Economic Perspectives*. 3(1), 192-206. https://www.princeton.edu/~kahneman/docs/Publications/Anomalies_DK_JLK_RHT_1991.pdf.

Kohler, Andre E., Paul C. Kusnierz, Timothy Copeland, David A. Venditti, Lytle Denny, Josh Gable, Bert A. Lewis, Ryan Kinzer, Bruce Barnett, and Mark S. Wipfli. 2013. Salmon-Mediated Nutrient Flux in Selected Streams of the Columbia River Basin, USA. *Canadian Journal of Fisheries and Aquatic Sciences.* http://www.nrcresearchpress.com/doi/pdf/10.1139/cjfas-2012-0347.

Kovacs, Kent, Stephen Polasky, Erik Nelson, Bonie L. Keeler, Derric Pennington, Andrew J. Plantinga, and Steven J. Taff. 2013. Evaluating the Return in Ecosystem Services from Investment in Public Land Acquisitions. PLOS One. http://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0062202&type=printable.

Kumar, Pushpam, Madhu Verma, Michael D. Wood, and Dhaval Negandhi. 2010. *Guidance Manual for the Valuationnof Regulating Services.* http://www.unep.org/pdf/Guidance_Manual_for_the_Regulating_Services.pdf.

Mansfield, Carol, George Van Houtven, Amy Hendershott, Patrick Chen, Jeremy Porter, Vesall Nourani, and Vikram Kilambi. 2012. Klamath River Basin Restoration Nonuse Value Survey. https://klamathrestoration.gov/sites/klamathrestoration.gov/files/DDDDD.Printable.Klamath%20Nonuse%20Survey%20Final%20Report%202012%5B1%5D.pdf.

Martin-Lopez, Berta, Erik Gomez-Baggethun, Marina Garcia-Llorente, and Carlos Montes. 2013. Trade-offs across Value-Domains in Ecosystem Services Assessment. *Ecological Indicators*. https://www.researchgate.net/profile/Berta_Martin-Lopez/publication/265686387_Trade-offs_across_value-domains_in_ecosystem_services_assessments/links/5418e4460cf203f155adb92c.pdf

McGranahan, D., and T. Wojan. 2007. "The Creative Class: A Key to Rural Growth." *Amber Waves*. April: 16-21.

McGranahan, D. 1999. *Natural Amenities Drive Rural Population Change*. AER-781 USDA, Economic Research Service.

McGranahan, D., J. Cromartie, and T. Wojan. 2010a. *Nonmetropolitan Outmigration Counties: Some are Poor, Many are Prosperous*. ERR-107. U.S. Department of Agriculture, Economic Research Service.

McGranahan, D., T. Wojan, and D. Lambert. 2010b. "The rural growth trifecta: outdoor amenities, creative class and entrepreneurial context." *Journal of Economic Geography*. May 17. joeg.oxfordjounals.org

Milcu, Andra Ioana, Jan Hanspach, David Abson, and Joern Fischer. 2013. Cultural Ecosystem Services: A Literature Review and Prospects for Future Research. *Ecology and Society.* https://www.researchgate.net/profile/David_Abson/publication/258119318_Cultural_ecosystem_services_A_literature_review_and_prospects_for_future_research/links/0deec5278b6be0e114000000.pdf

Millennium Ecosystem Assessment. 2005. *Global Assessment*. http://www.millenniumassessment.org/en/Global.html.

Naiman, R. J., H. Decamps, and M. Pollock. 1993. The role of riparian corridors in maintaining regional biodiversity. *Ecological. Applications*. http://onlinelibrary.wiley.com/doi/10.2307/1941822/epdf.

National Ecosystem Services Partnership (NESP). 2016. *Federal Resource Management and Ecosystem Services Guidebook 2nd ed.: Section1 – The Guidebook and Ecosystem Services in Federal Decision Making; Section 2 – Federal Agency Use and Examples; and Section 3 – Ecosystem Service Assessment Methods.* https://nespguidebook.com/

National Park Service. 2005. *Elwha River Ecosystem Restoration Implementation: Final Supplement to the Final Environmental Impact Statement.* https://www.nps.gov/olym/learn/nature/loader.cfm?csModule=security/getfile&PageID=136240

National Research Council. 2004. *Valuing Ecosystem Services: Toward Better Environmental Decision-Making.* https://www.nap.edu/login.php?record_id=11139&page=https%3A%2F%2Fwww.nap.edu%2Fdownload%2F11139.

Office of Management and Budget (OMB). 2003. *Circular A-4: Regulatory Analysis*. https://www.whitehouse.gov/omb/circulars_a004_a-4.

Olander, Lydia, Robert J. Johnston, Heather Tallis, Jimmy Kagan, Lynn Maguire, Steve Polasky, Dean Urban, James Boyd, Lisa Wainger, and Margaret Palmer. 2015. *Best Practices for Integrating Ecosystem Services into Federal Decision Making.* https://nicholasinstitute.duke.edu/sites/default/files/publications/es_best_practices_full pdf_0.pdf.

Oliver, Tom H., Matthew S. Heard, Nick J.B. Isaac, David B. Roy, Deborah Procter, Felix Eigenbrod, Rob Freckleton, Andy Hector, C. David L. Orme, Owen L. Petchey, Vânia Proença, David Raffaelli, K. Blake Suttle, Georgina M. Mace, Berta Martín-López, Ben A. Woodcock, and James M. Bullock. 2015. Biodiversity and Resilience of Ecosystem Functions. *Trends in Ecology & Evolution*. http://www.cell.com/trends/ecology-evolution/abstract/S0169-5347(15)00218-9.

Pender, John, Alexander Marré, and Richard Reeder. 2012. *Rural Wealth Creation: Concepts, Strategies and Measures.* ERR-131, U.S. Department of Agriculture, Economic Research Service. http://www.rd.usda.gov/files/reports/rd-ERR131.pdf

Plieninger, Tobias, Sebastian Dijks, Elisa Oteros-Rozas, and Claudia Bieling. 2012. Assessing, Mapping, and Qualtifying Cultural Ecosystem Services at Community Level. *Land Use Policy*. https://www.researchgate.net/profile/Tobias_Plieninger/publication/235256765_Assessing_mapping_and_quantifying_cultural_ecosystem_services_at_community_level/links/00463518cd8dc80207000000.pdf.

Poff, N. LeRoy, Casey M. Brown, Theodore E. Grantham, John H. Matthews, Margaret A. Palmer, Caitlin M. Spence, Robert L. Wilby, Marjolijn Haasnoot, Guillermo F. Mendoza, Kathleen C. Dominique, and Andres Baeza. 2015. Sustainable Water Management under Future uncertainty with Eco-Engineering Decision Scaling. *Nature Climate Change.* http://rydberg.biology.colostate.edu/poff/Public/poffpubs/Poff_etal_2015_NCC+Suppl.pdf.

Scheuerell, Mark D., Eric R. Buhle, Brice X. Semmens, Michael J. Ford, Tom Cooney, and Richard W. Carmichael. 2015. Analyzing Large-Scale Conservation Interventions with Bayesian Hierarchical Models: a Case Study of Supplementing Threatened Pacific Salmon. *Ecology and Evolution.* http://onlinelibrary.wiley.com/doi/10.1002/ece3.1509/abstract.

Scheuerell, Mark D., Phillip S. Levin, Richard W. Zabel, John G. Williams, and Beth L. Sanderson. 2005. A New Perspective on the Importance of Marine-Derived Nutrients to Threatened Stocks of Pacific salmon. *Canadian Journal of Fisheries and Aquatic Sciences.* http://www.nrcresearchpress.com/doi/abs/10.1139/f05-113#.V_wjWNz7bi_

Schmidt, Lucie G., and Paul Courant. 2006. Sometimes close is good enough: The value of nearby environmental amenities. *Journal of Regional Science*, 46(5): 931-951. http://onlinelibrary.wiley.com/doi/10.1111/j.1467-9787.2006.00491.x/abstract;jsessionid=E8E6C6BAA0F060D70CCF7FA1A8AA0480.f02t03.

U.S. Council on Environmental Quality (CEQ). 2013. *Updated Principles, Requirements and Guidelines for Water and Land Related Resources Implementation Studies.* 79 FR 77460. https://www.whitehouse.gov/administration/eop/ceq/initiatives/PandG.

U.S. Environmental Protection Agency (EPA). 2010 (2014 update). *Guidelines for Preparing Economic Analyses*. https://www.epa.gov/environmental-economics/guidelines-preparing-economic-analyses.

_____. 2015b. Policy and Guidance: Policy and Technical Guidance Documents. http://www.epa.gov/cwa-404/policy-and-guidance

_____ Science Advisory Board. 2011. *Valuing the Protection of Ecological Systems and Services.* https://yosemite.epa.gov/sab/sabproduct.nsf/WebBOARD/SAB-09-012/$File/SAB%20Advisory%20Report%20full%20web.pdf.