

Ecosystem Services (RMES 508): Quantifying Nature’s Bounty towards Better Environmental Decisions

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(Headings are clickable hyperlinks, as are cross-references throughout)

Purpose

RMES 508 will prepare researchers and future decision-makers to foster sustainable management of ecosystem-based activities, for the competing and complementary ends of sustaining and enhancing human well-being and protecting biodiversity. The concept of ‘ecosystem services’ (ES, the processes by which ecosystems render benefits for people) is *not* a framework for valuation (e.g., “putting a price tag on nature”), although it has been applied and understood as such. Rather, ES provides one novel approach for putting a ‘human face’ on ecosystem change, facilitating trade-off evaluation, and identifying ‘win-win’ opportunities. But management is never the simple implementation of any approach; accordingly, students will learn about the following facets of the concept from ecological, economic, ethical, and also institutional (law, policy, and business) perspectives: philosophical underpinnings, debates and controversies, analytical tools and approaches, recent developments, limitations, and opportunities.

ES—as the provision of benefits—can be understood as the nexus of two processes: ecosystem provision (e.g., how watersheds yield clean water) and human consumption or appreciation (e.g., how people access water). Study of ES is therefore inherently interdisciplinary, involving an integration of the natural sciences, social sciences, and humanities. Students will work in diverse teams, learn from peers, and integrate across disciplines to analyze real-world cases in partnerships with government agencies, NGOs, etc., of their choosing.

Learning Objectives and Outcomes

Students who complete this course will be able to:

1. Explain to policymakers and lay people the concept of ES and its relevance for sustainability and policies;
2. Communicate how biophysical and social changes might increase the benefits of specific ES, and the basis for this understanding from relevant science, etc.;
3. Critically and constructively review academic papers and research reports pertaining to ES;
4. Constructively critique real or possible programs, policies, and institutions that impact ES, based on those possible impacts and the concepts of efficiency, equity, and sustainability;
5. Advocate and support their views on the pros and cons of economic valuation of ES and other routes to affecting decision-making based on ES research and stakeholder input.

Course Description

Through participatory lectures, role-plays, discussions, debates, and workshops, students will:

- Learn the history of thinking on ES and new developments in policy;
- Characterize the ecological dynamics underpinning numerous key services, and their relationship with biodiversity conservation;
- Critique environmental policies to increase benefits relative to costs in different circumstances;
- Evaluate ES readings as a peer reviewer;
- Identify opportunities for profit from ES, and the feasibility of creating markets for ES;
- Describe the opportunities and impediments to laws, regulations, and programs for ES in BC;
- Evaluate decision-making processes and the methods and theory and practice of economic valuation in light of social, cultural, and ethical considerations;
- Apply these skills individually and in teams, demonstrating the learning objectives and outcomes through assignments and presentations, including a self-chosen final paper.

Course Policies

(The formal language in this section is to conform to University requirements.)

Attendance

Following university regulation, regular attendance is expected of students. Students who neglect their academic work and assignments may be excluded from the final examinations (note: there are no exams in this course). Students who are unavoidably absent because of illness or disability should report to their instructor on return to classes.

The University accommodates students with disabilities who have registered with the Disability Resource Centre. The University accommodates students whose religious obligations conflict with attendance, submitting assignments, or completing scheduled assignments. Please let me (Kai) know in advance, preferably in the first week of class, if you will require any accommodation on these grounds. Students who plan to be absent for varsity athletics, family obligations, or other similar commitments, cannot assume they will be accommodated, and should discuss their commitments with the instructor before the drop date.

Late assignments

This course is not intended to run or ruin your life. So when exceptional circumstances will prevent you from completing an assignment on time, you may request an extension and it will be granted where possible and appropriate. In the absence of a granted extension, grades will be reduced by 5% per day for the first four days and 2% per day thereafter.

Academic Dishonesty

Please review the UBC Calendar “Academic regulations” for the university policy on cheating, plagiarism, and other forms of academic dishonesty.

Students should retain a copy of all submitted assignments (in case of loss) and should also retain all their marked assignments in case they wish to apply for a Review of Assigned Standing. Students have the right to view their marked examinations with their instructor, providing they apply to do so within a month of receiving their final grades. This review is for pedagogic purposes. The examination remains the property of the university.

Schedule

At a glance

Nine weeks of lessons featuring lectures, role-plays, discussions, and debates:

1. Sep 2 2014. Birth of a concept: ecosystem services

- [Introduce 'Weekly Responses to Readings'](#) Bockstael, N. E., A. M. Freeman, R. J. Kopp, P. R. Portney and V. K. Smith (2000). "On measuring economic values for nature." Environmental Science & Technology **34**(8): 1384-1389. <http://dx.doi.org/10.1021/es9906731>

Gómez-Baggethun, E., R. de Groot, P. L. Lomas and C. Montes (2010). "The history of ecosystem services in economic theory and practice: From early notions to markets and payment schemes." Ecological Economics **69**(6): 1209-1218. <http://www.sciencedirect.com/science/article/B6VDY-4XXM2HP-1/2/262d5bd14da586b14dfa2e2590ac30fd>

2. Sep 9 2014. ES 'childhood' (first decade): what progress? Daily, G. C. and K. Ellison (2002). The New Economy of Nature: The Quest to Make Conservation Profitable. Washington, D.C., Island Press.

http://www.amazon.ca/gp/product/1559631546/sr=1-3/qid=115595726/ref=sr_1_3/702-8872424-7903261?ie=UTF8&s=books

van Jaarsveld, A. S., R. Biggs, R. J. Scholes, E. Bohensky, B. Reyers, T. Lynam, C. Musvoto and C. Fabricius (2005). "Measuring conditions and trends in ecosystem services at multiple scales: the Southern African Millennium Ecosystem Assessment (SAfMA) experience." Philosophical Transactions of the Royal Society B-Biological Sciences **360**(1454): 425-441. <http://dx.doi.org/10.1098/rstb.2004.1594>

3. Sep 16 2014. Ecological underpinnings

- [Policy Brief, Blog, or Op-Ed \(upload to Connect and send to partner\)](#)

4. Sep 23 2014. The context for ES in BC, in management, law, and policy

[Fellow Review](#) Gregory, R., L. Failing and C. Joseph (2011). Making Informed Decisions about the Enbridge

Northern Gateway Project: Evaluating the Anticipated Costs, Benefits, and Risks of Marine Oil Transportation on the Gitga'at Nation and Canada's Public Interest. ENGP Impacts Review report: 41.

Price, K., A. Roburn and A. MacKinnon (2009). "Ecosystem-based management in the Great Bear Rainforest." Forest Ecology and Management **258**(4): 495-503. <http://www.sciencedirect.com/science/article/B6T6X-4VIMFG0-1/2/102def005750a31b3eaab8a6293ae94b>

Ruhl, J. B., C. Lant and S. Kraft (2007). The Law and Policy of Ecosystem Services. Washington, DC, Island Press. <http://books.google.com/books?id=VEF48vqc0zcC>

5. Sep 30 2014. Economic valuation of ES

6. Oct 7 2014. Multiple ES & biodiversity—interactions, mapping & modeling

- [Final Project proposal](#)

Egoh, B., M. Rouget, B. Reyers, A. T. Knight, R. M. Cowling, A. S. van Jaarsveld and A. Welz (2007). "Integrating ecosystem services into conservation assessments: A review." Ecological Economics **63**(4): 714-721.

<http://dx.doi.org/10.1016/j.ecolecon.2007.04.007>

Kareiva, P., H. Tallis, T. H. Ricketts, G. C. Daily and S. Polasky (2011). Natural Capital: Theory & Practice of Mapping Ecosystem Services. Oxford, UK, Oxford University Press.

<http://www.oup.com/us/catalog/general/subject/Economics/Policy/?view=usa&ci=9780199588992>

Naidoo, R., A. Balmford, R. Costanza, B. Fisher, R. E. Green, B. Lehner, T. R. Malcolm and T. H. Ricketts (2008). "Global mapping of ecosystem services and conservation priorities." Proceedings of the National Academy of Sciences **105**(28): 9495-9500. <http://www.pnas.org/content/105/28/9495.abstract>

Willemsen, L., P. H. Verburg, L. Hein and M. E. F. van Mensvoort (2008). "Spatial characterization of landscape functions." Landscape and Urban Planning **88**(1): 34-43.

<http://dx.doi.org/10.1016/j.landurbplan.2008.08.004>

Winfree, R. and C. Kremen (2009). "Are ecosystem services stabilized by differences among species? A test using crop pollination." Proceedings of the Royal Society B: Biological Sciences **276**(1655): 229-237.

<http://rspb.royalsocietypublishing.org/content/276/1655/229.abstract>

7. Oct 14 2014. Policies & institutions for ES, and human responses Bowles, S. (2008). "Policies designed for self-interested citizens may undermine "the moral sentiments": Evidence from economic experiments." Science **320**(5883): 1605-1609. <http://www.sciencemag.org/content/320/5883/1605.abstract>

- Heal, G. (2000). *Nature and the Marketplace: Capturing the Value of Ecosystem Services*. Washington, D.C., Island Press. <http://books.google.com/books?id=3Y8NIiq7FpsC>
http://www.amazon.ca/gp/product/155963796X/sr=1-4/qid=1155595980/ref=sr_l_4/702-8872424-7903261?ie=UTF8&s=books
- Polasky, S., H. Doremus and B. Rettig (1997). "Endangered species conservation on private land." *Contemporary Economic Policy* **15**(4): 66-76.
<http://proquest.umi.com/pqdlink?did=19221593&Fmt=7&clientId=6993&RQT=309&VName=PQD>
- Wilcove, D. S. and J. Lee (2004). "Using economic and regulatory incentives to restore endangered species: Lessons learned from three new programs." *Conservation Biology* **18**(3): 639-645. <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1523-1739.2004.00250.x>
8. Oct 21 2014. Markets and the social context for ES; profit-making for the good
- [Annotated Bibliography](#) Bayon, R. (2004). *Making Environmental Markets Work: Lessons from Early Experience with Sulfur, Carbon, Wetlands, and Other Related Markets*. Washington, DC, Forest Trends: 27. [http://www.forest-trends.org/biodiversityoffsetprogram/BBop library 2/International/Not Printed/Making Envr Markets Work.pdf](http://www.forest-trends.org/biodiversityoffsetprogram/BBop%20library%20International/Not%20Printed/Making%20Envr%20Markets%20Work.pdf)
- Chan, K. M. A., R. M. Pringle, J. Ranganathan, et al. (2007). "When agendas collide: Human welfare and biological conservation." *Conservation Biology* **21**(1): 59-68. <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1523-1739.2006.00570.x>
- Fox, J., G. C. Daily, B. H. Thompson, K. M. A. Chan, A. Davis and A. Nino-Murcia (2006). *Conservation Banking. The Endangered Species Act at Thirty: Conserving Biodiversity in the Human-Dominated Landscape*. J. M. Scott, D. D. Goble and F. W. Davis. Washington, DC, Island Press: 228-243.
- Gómez-Baggethun, E. and M. Ruiz-Pérez (2011). "Economic valuation and the commodification of ecosystem services." *Progress in Physical Geography* **35**(5): 613-628.
<http://ppg.sagepub.com/content/35/5/613.abstract>
- Heal, G. (2000). *Nature and the Marketplace: Capturing the Value of Ecosystem Services*. Washington, D.C., Island Press. <http://books.google.com/books?id=3Y8NIiq7FpsC>
http://www.amazon.ca/gp/product/155963796X/sr=1-4/qid=1155595980/ref=sr_l_4/702-8872424-7903261?ie=UTF8&s=books
- McMillan, J. (2002). *Reinventing the Bazaar: A Natural History of Markets*. W. W. Norton & Company, New York, NY.
9. Oct 28 2014. Cultural and moral values and ES

Two weeks of guidance on final projects:

10. Nov 4 2014. In-class, group guidance on final projects (additional meetings with instructor by request)
 Nov 11 2014. NO CLASS (Remembrance Day public holiday)

Two weeks of presentations of final projects:

11. Nov 18 2014. First groups
 12. Nov 25 2014. Second groups

(No class) Dec 2 2014: [Final Project papers](#)

Weekly descriptions are below: date, title, learning objectives ("LO"), readings and references (see [Readings and References](#) regarding the volume and expectations), and reading directions.

1. Sep 2 2014. Birth of a concept: ecosystem services (ES)

- LO:** (1) Meet other students and instructor and learn what knowledge and skills they possess to complement each of ours; (2) understand and communicate the concept of ecosystem services; (3) use the syllabus and understand how to use it throughout the course and later; (4) (time permitting) learn a framework for critically and constructively reviewing academic papers and research reports.

Readings:

Costanza, R., R. d'Arge, R. de Groot, et al. (1997). "The value of the world's ecosystem services and natural capital." *Nature* **387**(15 May 1997): 253-260.

<http://www.nature.com/nature/journal/v387/n6630/abs/387253a0.html>

Daily, G. C. (1997). Introduction: What are ecosystem services? *Nature's Services: Societal Dependence on Natural Ecosystems*. G. C. Daily. Washington, DC, Island Press: 1-10. See [Connect course page](#).

Nature (1998). "Audacious bid to value the planet whips up a storm." *Nature* **395**(6701): 430-430.

http://www.nature.com/nature/journal/v395/n6701/full/395430a0_fs.html

Key Extra References:

Bockstael, N. E., A. M. Freeman, R. J. Kopp, P. R. Portney and V. K. Smith (2000). "On measuring economic values for nature." *Environmental Science & Technology* **34**(8): 1384-1389.

<http://dx.doi.org/10.1021/es990673l>

Gómez-Baggethun, E., R. de Groot, P. L. Lomas and C. Montes (2010). "The history of ecosystem services in economic theory and practice: From early notions to markets and payment schemes." *Ecological Economics* **69**(6): 1209-1218. <http://www.sciencedirect.com/science/article/B6VDY-4XXM2HP-1/2/262d5bd14da586b14dfa2e2590ac30fd>

<http://www.sciencedirect.com/science/article/B6VDY-4XXM2HP-1/2/262d5bd14da586b14dfa2e2590ac30fd>

2. Sep 9 2014. ES 'childhood' (first decade): what progress?

LO: (1) Understand the progress from 1997-2006 on the ecology, values, and policy of ES, including the Millennium Ecosystem Assessment (MA; through several case studies); (2) identify the major pressing needs for the future; and (3) learn the purpose and structure of op-eds and policy briefs.

Activity: Mock open-forum, post-MA but pre-IPBES on the possible creation of an IPCC-like structure. See [Connect course site](#).

Readings:

Carpenter, S. R., R. DeFries, T. Dietz, H. A. Mooney, S. Polasky, W. V. Reid and R. J. Scholes (2006).

"Millennium Ecosystem Assessment: Research needs." *Science* **314**(5797): 257-258.

<http://dx.doi.org/10.1126/science.1131946>

Economist, T. (2005). Are you being served? *The Economist*. **2005**: 76-78. See [Connect course page](#).

Millennium Ecosystem Assessment (2005). *Ecosystems and Human Well-being: Synthesis*. Washington, DC,

Island Press. <http://www.millenniumassessment.org/documents/document.356.aspx.pdf> (focus on p.1-24)

Tallis, H. M. and P. Kareiva (2006). "Shaping global environmental decisions using socio-ecological models."

Trends in Ecology & Evolution **21**(10): 562-568. <http://dx.doi.org/10.1016/j.tree.2006.07.009>

Key Extra References:

Daily, G. C. and K. Ellison (2002). *The New Economy of Nature: The Quest to Make Conservation Profitable*.

Washington, D.C., Island Press. http://www.amazon.ca/gp/product/1559631546/sr=1-3/qid=1155595726/ref=sr_1_3/702-8872424-7903261?ie=UTF8&s=books

http://www.amazon.ca/gp/product/1559631546/sr=1-3/qid=1155595726/ref=sr_1_3/702-8872424-7903261?ie=UTF8&s=books

van Jaarsveld, A. S., R. Biggs, R. J. Scholes, E. Bohensky, B. Reyers, T. Lynam, C. Musvoto and C. Fabricius

(2005). "Measuring conditions and trends in ecosystem services at multiple scales: the Southern African Millennium Ecosystem Assessment (SAfMA) experience." *Philosophical Transactions of the Royal Society B-Biological Sciences* **360**(1454): 425-441. <http://dx.doi.org/10.1098/rstb.2004.1594>

<http://dx.doi.org/10.1098/rstb.2004.1594>

3. Sep 16 2014. Ecological underpinnings, toward ecological production functions?

LO: (1) Learn the basis for ecosystem services research in ecology (e.g., diversity-ecosystem function and diversity-stability relationships); (2) understand and communicate two ways of studying the ecological basis of provision of ecosystem services (from Kremen 2005); (3) explain the notion of an ecological production function, and the extent to which this can capture the complexity of ecosystem processes; (4) glean and understand scientific concepts associated with ecosystem services from reading primary literature (with a focus on graphs).

Activity (possible): Mock expert panel decision, as at Environment Canada or Fisheries and Oceans Canada (DFO), whether to employ mapping of ES based on production functions or statistically-derived functions. See [Connect course site](#).

Readings:

- Brauman, K. A., G. C. Daily, T. K. e. Duarte and H. A. Mooney (2007). "The nature and value of ecosystem services: An overview highlighting hydrological services." *Annual Review of Environment and Resources* **32**(1). <http://dx.doi.org/10.1146/annurev.energy.32.031306.102758>
- Kremen, C. (2005). "Managing ecosystem services: what do we need to know about their ecology?" *Ecology Letters* **8**(5): 468-479. <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1461-0248.2005.00751.x>
- Kremen, C. and R. S. Ostfeld (2005). "A call to ecologists: measuring, analyzing, and managing ecosystem services." *Frontiers in Ecology and the Environment* **3**(10): 540-548. [http://dx.doi.org/10.1890/1540-9295\(2005\)003\[0540:ACTEMA\]2.0.CO;2](http://dx.doi.org/10.1890/1540-9295(2005)003[0540:ACTEMA]2.0.CO;2)
- Luck, G. W., R. Harrington, P. A. Harrison, et al. (2009). "Quantifying the contribution of organisms to the provision of ecosystem services." *Bioscience* **59**(3): 223-235. <http://caliber.ucpress.net/doi/abs/10.1525/bio.2009.59.3.7>
- Tilman, D., P. B. Reich and F. Isbell (2012). "Biodiversity impacts ecosystem productivity as much as resources, disturbance, or herbivory." *Proceedings of the National Academy of Sciences* **109**(26): 10394-10397. <http://www.pnas.org/content/109/26/10394.abstract>

Key Extra References:

- Barbier, E. B., E. W. Koch, B. R. Silliman, et al. (2008). "Coastal ecosystem-based management with nonlinear ecological functions and values." *Science* **319**(5861): 321-323. <http://dx.doi.org/10.1126/science.1150349>
- Duffy, J. E. (2009). "Why biodiversity is important to the functioning of real-world ecosystems." *Frontiers in Ecology and the Environment* **7**(8): 437-444. <http://dx.doi.org/10.1890/070195>
- Kareiva, P., H. Tallis, T. H. Ricketts, G. C. Daily and S. Polasky (2011). *Natural Capital: Theory & Practice of Mapping Ecosystem Services*. Oxford, UK, Oxford University Press. <http://www.oup.com/us/catalog/general/subject/Economics/Policy/?view=usa&ci=9780199588992>
- Norgaard, R. B. (2010). "Ecosystem services: From eye-opening metaphor to complexity blinder." *Ecological Economics* **69**(6): 1219-1227. <http://dx.doi.org/10.1016/j.ecolecon.2009.11.009>
- Ricketts, T. H. (2004). "Tropical forest fragments enhance pollinator activity in nearby coffee crops." *Conservation Biology* **18**(5): 1262-1271. <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1523-1739.2004.00227.x>

4. Sep 23 2014. The context for ES in BC, in management, law, and policy

Guest appearances (possible).

- LO:** Communicate a supported opinion of (1) how well a subset of federal and provincial laws and policies protect ES; (2) how well the same subset could do if optimally enforced; (3) the major regulatory and enforcement gaps regarding ES protection, and obstacles to real progress; and (4) how policymakers might address those gaps and foster sustainable and just use of ecosystems now and in the future.

Readings:

- Boyd, D. R. (2003). *Unnatural Law: Rethinking Canadian Environmental Law and Policy*. Vancouver, BC, UBC Press. www.unnaturallaw.com <http://books.google.ca/books?id=SeYgVGE9j3EC> (Chapters 1, 6—on [Connect](#); also read parts of 9, which is important but optional)
- Daily, G. C., P. M. Kareiva, S. Polasky, T. H. Ricketts and H. Tallis (2011). Mainstreaming natural capital into decisions. *Natural Capital: Theory & Practice of Mapping Ecosystem Services*. P. Kareiva, H. Tallis, T. H. Ricketts, G. C. Daily and S. Polasky. Oxford, UK, Oxford University Press: 3-14. <http://www.oup.com/us/catalog/general/subject/Economics/Policy/?view=usa&sf=toc&ci=9780199588992>
- Daily, G. C., S. Polasky, J. Goldstein, P. M. Kareiva, H. A. Mooney, L. Pejchar, T. H. Ricketts, J. Salzman and R. Shallenberger (2009). "Ecosystem services in decision making: time to deliver." *Frontiers in Ecology and the Environment* **7**(1): 21-28. <http://www.esajournals.org/doi/full/10.1890/080025>
- Lant, C. L., J. B. Ruhl and S. E. Kraft (2008). "The tragedy of ecosystem services." *Bioscience* **58**(10): 969-974. <http://caliber.ucpress.net/doi/abs/10.1641/B581010>
- Ricketts, P. and L. Hildebrand (2011). "Coastal and Ocean Management in Canada: Progress or Paralysis?" *Coastal Management* **39**(1): 4-19. <http://dx.doi.org/10.1080/08920753.2011.544552>

Key Extra References:

- Gregory, R., L. Failing and C. Joseph (2011). Making Informed Decisions about the Enbridge Northern Gateway Project: Evaluating the Anticipated Costs, Benefits, and Risks of Marine Oil Transportation on the Gitga'at Nation and Canada's Public Interest. *ENGP Impacts Review report*: 41.
- Price, K., A. Roburn and A. MacKinnon (2009). "Ecosystem-based management in the Great Bear Rainforest." *Forest Ecology and Management* **258**(4): 495-503. <http://www.sciencedirect.com/science/article/B6T6X-4V1MFG0-1/2/102def005750a31b3eaab8a6293ae94b>
- Ruhl, J. B., C. Lant and S. Kraft (2007). *The Law and Policy of Ecosystem Services*. Washington, DC, Island Press. <http://books.google.com/books?id=VEF48vqc0zcC>

5. Sep 30 2014. Economic valuation of ES

Guest lecture: Robin Naidoo

LO: (1) Articulate the purpose of economic valuation in current policy contexts, and its utility and limitations; (2) explain what prices reflect, and the pros & cons of market valuation; (3) identify the appropriate use of several methods of non-market valuation and (4) forms of discounting; [(5) perform simple cost-benefit analysis using net-present-value with discounting].

Activity (possible): Structured discussion re: the utility, benefits, risks and limitations of non-market valuation (stated and revealed preference methods separately) and benefit transfer. See [Connect course site](#).

Readings:

- Arrow, K. J., M. L. Cropper, G. C. Eads, et al. (1996). "Is there a role for benefit-cost analysis in environmental, health, and safety regulation?" *Science* **272**(5259): 221-222. <http://www.jstor.org/stable/2889625>
- Goulder, L. H. and D. Kennedy (2011). Interpreting and estimating the value of ecosystem services. *Natural Capital: Theory & Practice of Mapping Ecosystem Services*. P. Kareiva, H. Tallis, T. H. Ricketts, G. C. Daily and S. Polasky. Oxford, UK, Oxford University Press: 15-33.
- Goulder, L. H. and R. N. Stavins (2002). "Discounting: An eye on the future." *Nature* **419**(6908): 673-674. <http://www.nature.com/nature/journal/v419/n6908/full/419673a.html>
- Heal, G. (2000). "Valuing ecosystem services." *Ecosystems* **3**(1): 24-30. <http://www.springerlink.com/content/014p3eqwt9y78dfw/>
- Naidoo, R. and T. H. Ricketts (2006). "Mapping the economic costs and benefits of conservation." *PLoS Biology* **4**(11): 2153-2164. <http://biology.plosjournals.org/perlserv/?request=get-document&doi=10.1371%2Fjournal.pbio.0040360>

Key Extra References:

- Barbier, E. B. (2007). "Valuing ecosystem services as productive inputs." *Economic Policy* **49**: 178-229. <http://dx.doi.org/10.1111/j.1468-0327.2007.00174.x>
- Bockstael, N. E., A. M. Freeman, R. J. Kopp, P. R. Portney and V. K. Smith (2000). "On measuring economic values for nature." *Environmental Science & Technology* **34**(8): 1384-1389. <http://dx.doi.org/10.1021/es990673I>
- EPA (U.S. Environmental Protection Agency Science Advisory Board) (2009). Valuing the Protection of Ecological Systems and Services. Washington, D.C.: 121. [url](#)
- McDaniels, T. L., R. S. Gregory and D. Fields (1999). "Democratizing risk management: Successful public involvement in local water management decisions." *Risk Analysis* **19**(3): 497-510. <http://dx.doi.org/10.1023/A:1007060931193>
- Pascual, U., R. Muradian, L. Brander, et al. (2010). The economics of valuing ecosystem services and biodiversity. *The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations*. P. Kumar, Earthscan. [url](#)
- TEEB – The Economics of Ecosystems and Biodiversity for National and International Policy Makers (2009). Wesseling, Germany, United Nations Environment Programme. <http://www.teebweb.org/ForPolicymakers/tabid/1019/language/en-US/Default.aspx>

6. Oct 7 2014. Multiple ES & biodiversity—interactions, mapping & modeling

LO: Learn and communicate (1) a generalized understanding of the relationship between ecosystems, biodiversity, and ES, including trade-offs between these competing policy goals; (2) the evidence (scientific and logical/philosophical) to support those relationships; and (3) the differences and

similarities between the various approaches employed to map and model ES. In particular, defend a position on the assumption that initially fuelled ES research: that management for ES will foster intact ecosystems and biodiversity conservation.

Activity (possible): Mock annual general meeting (AGM) of WWF regarding a possible shift in conservation focus further toward ES. See [Connect course site](#).

Readings:

- Barbier, E. B., E. W. Koch, B. R. Silliman, et al. (2008). "Coastal ecosystem-based management with nonlinear ecological functions and values." *Science* **319**(5861): 321-323. <http://dx.doi.org/10.1126/science.1150349>
- Chan, K. M. A., M. R. Shaw, D. R. Cameron, E. C. Underwood and G. C. Daily (2006). "Conservation planning for ecosystem services." *PLoS Biology* **4**(11): 2138-2152. <http://biology.plosjournals.org/perlserv/?request=get-document&doi=10.1371/journal.pbio.0040379>
- Guerry, A., M. Ruckelshaus, K. Arkema, et al. (2012). "Modelling benefits from nature: Using ecosystem services to inform coastal and marine spatial planning." *International Journal of Biodiversity Science, Ecosystem Services & Management* **8**(1-2): 1-15. <http://dx.doi.org/10.1080/21513732.2011.647835>
- Luck, G. W., K. M. A. Chan and J. P. Fay (2009). "Protecting ecosystem services and biodiversity in the world's watersheds." *Conservation Letters* **2**: 179-188. <http://dx.doi.org/10.1111/j.1755-263X.2009.00064.x>
- Nelson, E., G. Mendoza, J. Regetz, et al. (2009). "Modeling multiple ecosystem services, biodiversity conservation, commodity production, and tradeoffs at landscape scales." *Frontiers in Ecology and the Environment* **7**(1): 4-11. <http://www.esajournals.org/doi/abs/10.1890/080023>

Key Extra References:

- Egoh, B., M. Rouget, B. Reyers, A. T. Knight, R. M. Cowling, A. S. van Jaarsveld and A. Welz (2007). "Integrating ecosystem services into conservation assessments: A review." *Ecological Economics* **63**(4): 714-721. <http://dx.doi.org/10.1016/j.ecolecon.2007.04.007>
- Kareiva, P., H. Tallis, T. H. Ricketts, G. C. Daily and S. Polasky (2011). *Natural Capital: Theory & Practice of Mapping Ecosystem Services*. Oxford, UK, Oxford University Press. <http://www.oup.com/us/catalog/general/subject/Economics/Policy/?view=usa&ci=9780199588992>
- Naidoo, R., A. Balmford, R. Costanza, B. Fisher, R. E. Green, B. Lehner, T. R. Malcolm and T. H. Ricketts (2008). "Global mapping of ecosystem services and conservation priorities." *Proceedings of the National Academy of Sciences* **105**(28): 9495-9500. <http://www.pnas.org/content/105/28/9495.abstract>
- Willemen, L., P. H. Verburg, L. Hein and M. E. F. van Mensvoort (2008). "Spatial characterization of landscape functions." *Landscape and Urban Planning* **88**(1): 34-43. <http://dx.doi.org/10.1016/j.landurbplan.2008.08.004>
- Winfree, R. and C. Kremen (2009). "Are ecosystem services stabilized by differences among species? A test using crop pollination." *Proceedings of the Royal Society B: Biological Sciences* **276**(1655): 229-237. <http://rspb.royalsocietypublishing.org/content/276/1655/229.abstract>

7. Oct 14 2014. Policies & institutions for ES, and human responses

LO: (1) Understand and communicate the way that different kinds of policies are assumed to impact people's behaviours and the social values associated with ES, based on economic logic; (2) explain the evidence and theory (including from other social sciences) regarding the limitations of these assumptions; (3) identify major categories of costs of policies and management actions; and (4) explain these dynamics through actual policies in various places.

Activity (possible): Mock parliament to propose and discuss a set of possible laws and amendments to improve ES protection. See [Connect course site](#).

Readings:

- Daw, T., K. Brown, S. Rosendo and R. Pomeroy (2011). "Applying the ecosystem services concept to poverty alleviation: the need to disaggregate human well-being." *Environmental Conservation* **38**(04): 370-379. <http://dx.doi.org/10.1017/S0376892911000506>
- Eigenraam, M. (2005, October 12 2005). "EcoTender: Paying for ecosystem services, not lemons." *Ecosystem Marketplace* October 12 2005. Retrieved December 9, 2005, from http://ecosystemmarketplace.com/pages/article.opinion.php?component_id=3947&component_version_id=5684&language_id=12.

- Jack, B. K., C. Kousky and K. R. E. Sims (2008). "Designing payments for ecosystem services: Lessons from previous experience with incentive-based mechanisms." *Proceedings of the National Academy of Sciences of the United States of America* **105**(28): 9465-9470. <http://dx.doi.org/10.1073/pnas.0705503104>
- Kinzig, A. P., C. Perrings, F. S. Chapin, S. Polasky, V. K. Smith, D. Tilman and B. L. Turner (2011). "Paying for ecosystem services—Promise and peril." *Science* **334**(6056): 603-604. <http://www.sciencemag.org/content/334/6056/603.short>
- Kosoy, N. and E. Corbera (2010). "Payments for ecosystem services as commodity fetishism." *Ecological Economics* **69**(6): 1228-1236. <http://www.sciencedirect.com/science/article/pii/S0921800909004510>
- Naidoo, R., A. Balmford, P. J. Ferraro, S. Polasky, T. H. Ricketts and M. Rouget (2006). "Integrating economic costs into conservation planning." *Trends in Ecology & Evolution* **21**(12): 681-687. <http://dx.doi.org/10.1016/j.tree.2006.10.003>

Key Extra References:

- Bowles, S. (2008). "Policies designed for self-interested citizens may undermine "the moral sentiments": Evidence from economic experiments." *Science* **320**(5883): 1605-1609. <http://www.sciencemag.org/content/320/5883/1605.abstract>
- Heal, G. (2000). *Nature and the Marketplace: Capturing the Value of Ecosystem Services*. Washington, D.C., Island Press. <http://books.google.com/books?id=3Y8NIiq7FpsC>
http://www.amazon.ca/gp/product/155963796X/sr=1-4/qid=1155595980/ref=sr_1_4/702-8872424-7903261?ie=UTF8&s=books
- Polasky, S., H. Doremus and B. Rettig (1997). "Endangered species conservation on private land." *Contemporary Economic Policy* **15**(4): 66-76. <http://proquest.umi.com/pqdlink?did=19221593&Fmt=7&clientId=6993&RQT=309&VName=PQD>
- Wilcove, D. S. and J. Lee (2004). "Using economic and regulatory incentives to restore endangered species: Lessons learned from three new programs." *Conservation Biology* **18**(3): 639-645. <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1523-1739.2004.00250.x>

8. Oct 21 2014. *Markets and the social context for ES; profit-making for the good?*

LO: (1) Understand and communicate how markets work—and don't—in the context of environmental protection and the role of government regulation in their construction and operation; (2) determine the applicability of market-based initiatives (MBIs) relative to regulations for various ES contexts, and the kind of regulations necessary to make the MBIs work effectively.

Activity (possible): Structured discussion regarding the utility, benefits, risks and limitations of markets for protecting and managing ES in different contexts. See [Connect course site](#).

Readings:

- Bayon, R. (2002). "Making money in environmental derivatives." *The Milken Institute Review First Quarter*(30-39). http://www.newamerica.net/publications/articles/2002/making_money_in_environmental_derivatives
- Daily, G. C. and K. Ellison (2002). *The New Economy of Nature: The Quest to Make Conservation Profitable*. Washington, D.C., Island Press. http://www.amazon.ca/gp/product/1559631546/sr=1-3/qid=1155595726/ref=sr_1_3/702-8872424-7903261?ie=UTF8&s=books
- Fish, R. D. (2011). "Environmental decision making and an ecosystems approach." *Progress in Physical Geography* **35**(5): 671-680. <http://ppg.sagepub.com/content/35/5/671.abstract>
- Luck, G., K. M. A. Chan, U. Eser, E. Gómez-Baggethun, B. Matzdorf, B. Norton and M. Potschin (2012). "Ethical considerations in on-ground applications of the ecosystem services concept." *BioScience* **62**(12): 1020-1029. <http://dx.doi.org/10.1525/bio.2012.62.12.4>
- Robards, M. D., M. L. Schoon, C. L. Meek and N. L. Engle (2011). "The importance of social drivers in the resilient provision of ecosystem services." *Global Environmental Change* **21**(2): 522-529. <http://www.sciencedirect.com/science/article/pii/S0959378010001172>

Key Extra References:

- Bayon, R. (2004). *Making Environmental Markets Work: Lessons from Early Experience with Sulfur, Carbon, Wetlands, and Other Related Markets*. Washington, DC, Forest Trends: 27. <http://www.forest->

[trends.org/biodiversityoffsetprogram/BBop_library_2/International/Not Printed/Making Envr Markets Work.pdf](http://trends.org/biodiversityoffsetprogram/BBop_library_2/International/Not%20Printed/Making%20Envr%20Markets%20Work.pdf)

- Chan, K. M. A., R. M. Pringle, J. Ranganathan, et al. (2007). "When agendas collide: Human welfare and biological conservation." *Conservation Biology* 21(1): 59-68. <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1523-1739.2006.00570.x>
- Fox, J., G. C. Daily, B. H. Thompson, K. M. A. Chan, A. Davis and A. Nino-Murcia (2006). Conservation Banking. *The Endangered Species Act at Thirty: Conserving Biodiversity in the Human-Dominated Landscape*. J. M. Scott, D. D. Goble and F. W. Davis. Washington, DC, Island Press: 228-243.
- Gómez-Baggethun, E. and M. Ruiz-Pérez (2011). "Economic valuation and the commodification of ecosystem services." *Progress in Physical Geography* 35(5): 613-628. <http://ppg.sagepub.com/content/35/5/613.abstract>
- Heal, G. (2000). *Nature and the Marketplace: Capturing the Value of Ecosystem Services*. Washington, D.C., Island Press. <http://books.google.com/books?id=3Y8Nliq7FpsC>
http://www.amazon.ca/gp/product/155963796X/sr=1-4/qid=1155595980/ref=sr_1_4/702-8872424-7903261?ie=UTF8&s=books
- McMillan, J. (2002). *Reinventing the Bazaar: A Natural History of Markets*. W. W. Norton & Company, New York, NY.

9. Oct 28 2014. Cultural and moral values and ES

Guest lecture: [Terre Satterfield](#)? Professor of Environment, Culture, and Risk

- LO:** (1) Understand the potential and realized roles of moral values and moral argument in ES management and policy; (2) communicate the major assumptions of economic methods (recounting salient evidence of violations of those assumptions) and the resulting utility of economic valuation in a context of cultural and moral values; (3) explain the difference between private preference and principles of public interest and the ramifications of this difference for environmental valuation and decision-making; (4) explain the way that diverse material and non-material (but important) benefits may be associated with individual activities or ES (the interconnected nature of ecosystem components, ES, benefits, and values); and (5) voice a supported opinion on appropriate approaches for valuation and decision-making in light of the above.

Readings:

- Chan, K. M. A., A. Guerry, P. Balvanera, et al. (2012). "Where are 'cultural' and 'social' in ecosystem services: A framework for constructive engagement." *BioScience* 6(8): 744-756. <http://dx.doi.org/10.1525/bio.2012.62.8.7>
- Chan, K. M. A. and T. Satterfield (2013). Justice, equity, and biodiversity. *The Encyclopedia of Biodiversity*. S. A. Levin. Oxford, Elsevier Ltd: 434-441. <http://store.elsevier.com/Encyclopedia-of-Biodiversity/isbn-9780123847195/ Dropbox>
- Jax, K., D. N. Barton, K. M. A. Chan, et al. (2013). "Ecosystem services and ethics." *Ecological Economics* 93: 260-268. <http://www.sciencedirect.com/science/article/pii/S0921800913002073>
- Ludwig, D. (2000). "Limitations of economic valuation of ecosystems." *Ecosystems* 3(1): 31-35. <http://www.springerlink.com/content/rwq345bu84uqhqr/v>
- Rees, W. E. (1998). "How should a parasite value its host?" *Ecological Economics* 25(1): 49-52. [http://dx.doi.org/10.1016/S0921-8009\(98\)00015-9](http://dx.doi.org/10.1016/S0921-8009(98)00015-9)

Key Extra References:

- Chan, K. M. A., T. Satterfield and J. Goldstein (2012). "Rethinking ecosystem services to better address and navigate cultural values." *Ecological Economics* 74: 8-18. <http://www.sciencedirect.com/science/article/pii/S0921800911004927>
- Daniel, T. C., A. Muhar, A. Arnberger, et al. (2012). "Contributions of cultural services to the ecosystem services agenda." *Proceedings of the National Academy of Sciences* 109(23): 8812-8819. <http://www.pnas.org/content/109/23/8812.abstract>
- Gregory, R., S. Lichtenstein and P. Slovic (1993). "Valuing environmental resources: A constructive approach." *Journal of Risk and Uncertainty* 7(2): 177-197. <http://www.springerlink.com/content/j63211xg2u604637/>

- Klain, S., T. Satterfield and K. M. A. Chan (accepted). "What matters and why? Ecosystem services and their bundled qualities." *Ecological Economics*.
- McCauley, D. J. (2006). "Selling out on nature." *Nature* **443**(7107): 27-28.
<http://www.nature.com/nature/journal/v443/n7107/pdf/443027a.pdf>
- Sagoff, M. (1998). "Aggregation and deliberation in valuing environmental public goods: A look beyond contingent pricing." *Ecological Economics* **24**(2-3): 213-230. [http://dx.doi.org/10.1016/S0921-8009\(97\)00144-4](http://dx.doi.org/10.1016/S0921-8009(97)00144-4)
- Satterfield, T., R. Gregory, S. Klain, M. Roberts and K. M. Chan (2013). "Culture, intangibles and metrics in environmental management." *Journal of Environmental Management* **117**: 103-114.
<http://www.sciencedirect.com/science/article/pii/S0301479712006184>

Assignments

Overview (% of total marks)

- Weekly Responses to Readings (9).
- Annotated Bibliography (10).
- Policy Brief, Blog, or Op-Ed (12).
- Fellow Review (8).
- Final Project (team analysis), including a proposal (6), presentation (15), and final paper (30). Project can involve program evaluation, analytical essay, literature review, or research proposal as appropriate for individual students.
- Class participation (10).

Details

Due Dates, file formats: All assignments should be submitted by UBC Connect (Blackboard) by the date noted as MS Word-compatible attachments (to enable commenting and suggested changes; rich text format, rtf, is fine) except the presentation slides (which should be submitted as a pdf or MS Powerpoint-compatible file) and the bibliography (which should be submitted as an EndNote library or EndNote compatible export).

File names: Please label assignments in the following manner: "(first name) (last name) (assignment title)", e.g., "Abe Lincoln op-ed.docx". Reviews should be labelled by tacking on the reviewer's initials: "(author first name) (author last name) (assignment) (reviewer initials)", e.g., "Abe Lincoln op-ed PET" (if Pierre Elliott Trudeau reviewed Abe Lincoln).

Word limits: Please keep within word limits; excessive violations will be penalized.

Group work, acknowledgments: You may work with and consult others. Please acknowledge all sources of help explicitly, and specify who did which parts.

Examples of previous assignments & Future dissemination of yours: Some students find it helpful to see examples of others' assignments from previous years. Feel free to request this. Similarly, I'm assuming that you don't mind me passing on your assignments as exemplars (excising your grade) or as references for other interested parties; *please let me know if you'd prefer to keep your work confidential.*

Weekly Responses to Readings

All students will be asked to write responses to questions about the week's readings. These questions are intended to aid and gauge your reflections about the readings in relation to the class material: I will generally not ask what the authors said, as I am more interested in your perspectives on and syntheses of that content. Questions will be distributed via email or Connect to other class members at latest the day before the class—by Monday noon. The emphasis here is demonstrating briefly that you have read the readings and done some related thinking that you can shape this into a concise response to particular questions, not that you can compose an eloquent essay or that you understand these readings inside-out (that's what we're aiming for after the class!). Answers should be <100 words, prefaced with the question (full wording). See the rubric below.

Criteria Answer (for each Q)	Levels of Achievement		
	No credit	Half marks	Full marks
	No responses; responses far too short, without explanation; or responses don't address question.	Responses too short, too long, or unclear; responses don't accurately reflect readings.	Responses of appropriate length and reflect readings, clearly showing comprehension and some reflection.

Annotated Bibliography

Some people can instantly recall anything they've read as the source for all its main points. If you're not like that (I'm not), bibliographic referencing tools are essential for future reference. To encourage habits that I believe will pay off greatly later, one assignment is to assemble an annotated bibliography of course readings. I'll start this off for you by giving you an EndNote exported (xml) file with class readings and references, and your task is to send me a total of 10 annotated references: 5 from the class list—the optional 'references' (but with your annotations regarding key points from your perspective including their specific utility to you; you can go from the 'key extra references' in this document and also the supporting references in the class readings EndNote library); and 5 additional ones not on the class list (also with annotation). Feel free to use point form for your notes, which should be 50-500 words as appropriate for your purposes (more is also fine if needed). Please submit these references to me as an EndNote library or EndNote-compatible exported file (e.g., from RefWorks, which is free for UBC students, instructions are available at <http://www.endnote.com/support/Faqs/Import/faq13.asp>) or docx with full-text urls. You will receive 1 mark for each reference, up to a total of 10 marks.

Policy Brief, Blog, or Op-Ed

One of the themes of this course is the crucial need to transfer technical knowledge from experts to stakeholders and decision makers. Such communication can differ starkly from the typical academic paper, which partly explains the dearth of effective communication on resource management and environmental issues to date. Accordingly, one crucial skill to be gained in this course is writing for lay people (e.g., in opposite-editorials, 'op-eds'), selected communities (e.g., blogs), and decision makers (e.g., in policy briefs). The key components here are (1) seizing and holding the attention of your audience, and (2) conveying complex concepts effectively in simple terms. For grading, see the rubric below.

Illustrate your points through some issue of current interest and some particular ecosystem service(s). Please plan to submit/post these to a real publication, blog, or decision-maker after comments and revision. References are not necessary for op-eds; if present, they should be streamlined into the text. Policy briefs should have references where appropriate (in one standard style of your choice). For more, see the following urls: <http://www.policy.hu/ipf/fel-pubs/samples/PolicyBrief-described.pdf>, <http://www.greenmediatoolshed.org/training/TopTenGuidesAndTutorials/WriteanOpEd.adp>, and instructions on [Connect](#). Please upload to Connect and also send to fellow-review partner.

Educating Canada about innovative programs/policies elsewhere: policy brief, blog, or op-ed. In 650 words, explain the concept of ecosystem services and describe an innovative program or policy from elsewhere (e.g., Australia, South Africa, Costa Rica) and how the Canadian (or BC) government could tailor such a program/policy to its context. **Also include** in your assignment your **byline** (a short biographical statement that establishes your credibility and credentials for this piece) and a paragraph explaining your **strategy** (audience, venue, hook, etc.—see more specific instruction doc).

Blog/Op-ed Grading Rubric (12 marks)

	Excellent (85-100%)	Competent (70-84%)	Needs work (<70%)
Title & Byline (.5 marks)	Title is clear, concise, and compelling. Brief byline establishes the author as an	Title is clear and concise. Byline is clear.	Title and/or byline are missing or wordy.

	authority.		
Interest (1.5)	Article begins with a strong 'hook', grabbing (and then maintaining) attention with a compelling perspective on an important problem.	Article has some 'hook', but this comes somewhat late or doesn't clearly offer a fresh perspective.	Article doesn't clearly relate subject matter to audience's issues of major concern.
Organization/ Style (2)	Article is easy and enjoyable to read—for all intended audiences. Clear, concise, elegant. Relevant, eye-catching supporting graphic, with caption.	Article is quite easy to read—for most intended audiences. Quite clear, and with a few memorable bits. Relevant supporting graphic.	Article is tough to read, at least for some intended audiences. Somewhat 'clunky'. No graphic, or not well connected to article.
Argument (3)	Clear central claim(s) is/are supported by compelling evidence (theoretical or empirical). Logical structure of argument is clear, consistent, tight.	Central claim(s) are supported by evidence. Argument structure is clear and consistent.	Argument is unclear or lacking support for key claims.
Science (3)	Author appropriately represents relevant available science, simplifying for accessibility without distortion.	Author appeals to science in several cases, representing findings accurately.	Argument lacks explicit scientific basis, or rests upon inaccurate representation of science.
Strategy (2)	Author explicitly explains (outside the text) a compelling strategy for convincing a particular audience towards a given end. Stated venue and dissemination approach are effective for given audience and purpose. The topic is clearly (and explicitly) timely and relevant to the intended audience.	Author explains (outside the text) a strategy for convincing a particular audience towards a given end. Stated venue and dissemination approach are appropriate given audience and purpose. Author explains the timeliness and relevance of the topic to the intended audience.	Strategy section does not clearly present an intended audience, purpose, or venue. Topic is not clearly timely and relevant to intended audience.

Fellow Review

Another theme of ecosystem services is the crucial need for collaboration with others, especially those from diverse backgrounds. In order to grapple with this multidisciplinary problem, we must work together and improve each others' work. Providing collegial input on papers can also be a tremendous short-cut to improving our own writing. Remember that input is worth little—and can be counterproductive—if it cannot be received as constructive. Also, we learn not only from suggestions about what might work better but also affirmation of what works well. Accordingly, make sure to commend as well as suggest.

Pick a partner, and send that person your paper on the due date above. Comment (≤ 500 words) on their paper and send it back to them and to me by the following week. These comments should be distributed across in-text embedded comments (e.g., in Word) and a short blurb with general remarks. Note that such a review differs from a commissioned peer-review in that the authors are your primary audience (not an editor). Thus, use second-person conjugation (e.g., "you"). No need to actually assign grades.

Fellow Review Template (to be completed by peer reviewers on the blog/op-ed)

- For each line, place a check mark in one of the boxes, based on your assessment, using the descriptions in *Final Project Grading Rubric* (separate from this rubric).

	Excellent	Competent	Needs work
Title and Byline			
Interest			
Organization/Style			
Argument			
Use of Science			
Strategy			

- Summarize the objective of the author and the key points of the paper.
- List at least three specific things about the paper that you think are well done. Explain why you think they are well done.
- List at least three specific things about the paper that you think could be improved. For each, include at least one specific suggestion for how it could be improved. **At least one of your items must be related to content and/or organization** (do not focus entirely on technicalities).

Fellow Review Grading Rubric (to be used by course instructor)

	Excellent	Competent	Needs work
Thinking/inquiry (5 marks)	The reviewer identified several strengths and areas to improve, and provided specific and creative suggestions to address deficiencies.	The reviewer identified strengths and areas to improve, and provided specific suggestions to address deficiencies.	The reviewer provided mainly generic feedback.
Communication style (3 marks)	Feedback was provided in professional, inviting and courteous manner. Review was well written.	Feedback provided in professional and courteous manner. Review contained 1-2 writing errors.	Feedback was abrasive, or otherwise unprofessional or not courteous. Review contained >2 writing errors.

Final Project

There are three components to this group assignment, which are intended to enable me and your peers to provide ample feedback along the way: a proposal, a presentation, and a final paper.

I would like this to be as meaningful as possible to your passions and future career. If your class project contributes to your thesis, fantastic! All that matters is that you do creative original work and learning regarding ecosystem services. Accordingly, please feel free to propose a project that suits you best in form and content. Below I present the desired format for a *case study evaluation*-type project, but other formats can be negotiated under special circumstances.

The **purpose** of the project is to analyze a program, policy or change for its ecosystem services implications. The emphasis is on (i) integrating across the disciplines to provide a perspective that is often missing in policy formation, and (ii) providing that as desired by particular decision makers (conceived broadly to include NGOs, government agencies, management boards, etc.). In class we often learned about each of the different disciplines separately because it is crucial to understand the key principles and underlying assumptions before integrating in a meaningful way. Now the challenge is for you to bring this understanding together. Do not let uncertainty or a paucity of good quality data prevent you from analyzing the data and theory available,

even if this means applying understanding from elsewhere. Decisions must and will be made, and it's far better that they are informed by the best available understanding of these ecological-social dynamics than not at all.

I've worked with colleagues at a range of organizations (e.g., CPAWS-BC) to design a mix of possible projects that will allow you to exercise your understanding of ES and put it to good use. If you request it, **we can adjust the rubric to fit the project objectives** as specified in collaboration with the partners. If you have questions along these lines, please come chat.

The core components of the project are (1) context, (2) characterization, and (3) recommendations. You need not organize your report by these headings or the sub-headings that follow; simply ensure that you're addressing questions like these (not necessarily the examples below, provided to trigger your thinking).

(1) Context:

- a. **Ecological:** What are the relevant ecological (and hydrological, etc.) dynamics and management/conservation priorities? What were they like, and what are they like now? What are the threats to future dynamics, and what are the ecological opportunities for change (e.g., has the system entered a new stable state)? How much is known about the relevant dynamics and how much is not (e.g., what determines the ecological provision of the relevant ecosystem services)?
- b. **Social:** Who are the relevant stakeholders? What are their needs and wants in relation to relevant ecosystem services and opportunity costs? How fundamental are the needs/desires being met, and how available are the substitutes for those needs/desires? Who gains or loses from the status quo and who stands to gain or lose from changes? What historical events, policies, etc., still have relevance to stakeholders and so bear upon current and future policy? What relevant rights do people have? What other programs or policies have relevant impacts on the way people interact with the ecosystems?
- c. **Integration:** How do the ecological dynamics impact social dynamics and vice versa? How do the ecological functions manifest in values to people and how do human actions play out in ecosystems? If there are multiple ecosystem services of value, do the key ecosystem-service providers interact with the providers of other ecosystem services? To what extent are the relevant ecosystem services captured privately vs. enjoyed publicly? Are there tragedies of the commons or other social traps?

(2) Characterization: What are the impacts of the policy/change in question?

- a. **Ecological:** How does the policy alleviate current or future threats? How does it impact or restore ecological function and conservation priorities? How much and what information is being gathered about the policy's ecological impact?
- b. **Social:** How does the policy impact stakeholders directly (through a well-being or other lens)? How are they responding to the policy? How much and what information is being gathered about the policy's social impact? How does the policy interact with other policies?
- c. **Integration:** What are the implications of the policy and resulting human actions for ecosystems and the values of ecosystem services (the indirect effects of the policy on stakeholders)? Does it favour one ecosystem service at the expense of others? Do the spatial and temporal scales of ecological provision of services mesh with the scales at which people derive value and at which the policies impact or manage the services or threats to them? How well does an ecosystem-services view address the key facets of the problem, and what is left out? Ditto re: valuation. How might the policy/change affect social-ecological interactions, potentially yielding non-linear change?

(3) Recommendations: How might the policy/situation be improved? How do the proposed changes improve ecological dynamics and enhance the social benefits or reduce social costs (to particular stakeholders) of the policy?

This is intended to be a **team** effort. As in every case with ecosystem services, the relevant expertise is distributed among different people. I prefer teams of 2 but will consider proposals with different numbers and will adjust grading expectations accordingly. Teams will receive the same grades on all components except for the delivery component of the presentation, as it is assumed that you will make use of your reviewing skills to improve your partner's contributions. Exceptions to the policy of equal grades will be considered only if requested by *both parties together at the due date*.

Wherever possible, please make your project useful to **decision makers** and consider this in your project design by discussing with the decision maker in question what would be most useful to them. If you do good work in this area, somebody somewhere will be deeply interested, and it's your responsibility to find them (but not necessarily alone: I have contact in NGOs and government and can facilitate finding appropriate contacts for your projects).

Proposal

In ≤ 1000 words, explain and justify your chosen area and policy (the need that you see, to set up how you intend to meet that need with your project), and lay out the structure and content of the paper. Describe the methods that you will use, and refer to some of the literature that you will consult. Please also describe your plan for ensuring that it will be considered appropriately by the decision makers in question (ideally you would already have established contact). Mark breakdown (6): 1 mark each for *context, methods, decision-maker contact/plans, feasibility, proposed report structure, and style*.

Presentation

In ≤ 30 minutes (variable depending on group size), present your initial findings in the areas outlined above. Presentations are intended to get valuable feedback from the instructor and peers. Please share presentation time equitably. See Grading Rubric below. Marks will be deducted for going over time.

Final Paper

In ≤ 7000 words (variable depending on group size; including figures, tables, and all text except references and supplementary appendices), present your findings. Papers should be fully referenced according to the style of your choice. Exceptions to the word limit will be considered if requested a week before the deadline, based on discussions with your decision-maker contacts. Please only send decision-makers the paper *after revisions based on my grade and feedback*.

Grading Criteria, General (presentation /15, paper /30)

The presentation will be graded based on the rubric below, with the breakdown of 'content' as in the Paper Grading Criteria. A more formalized rubric is used for the presentation than for the paper to account for the less formulaic nature of the latter.

Presentation Grading Rubric:

Category	Excellent (90-100%)	Good (74-89%)	Adequate (65-73%)	Inadequate (<65%)
Opening/intro (1)	Clearly, quickly established the focus of the presentation, gained audience attention.	Established focus by the end of the intro, but went off on a tangent or two. Gained audience attention.	Audience had an idea of what was coming, but the intro did not clarify the main focus.	Little or no intro, or intro unfocused such that audience did not know the speaker's main focus.
Clarity & Organization (2)	Main points clearly stated and explained; well thought out background; logical, smooth organization.	Main points clearly stated; background adequate; logical, smooth organization.	Main points must be inferred by audience; background adequate; audience can follow presentation, but holes are evident.	Presentation jumped among disconnected topics. Main points unclear.
Content (5)	Content presented and analyzed in an interesting, knowledgeable, logical way. Key points clearly expressed and integrated with logical links. Presented appropriate & useful, forward-thinking insights.	Content presented and analyzed in an interesting, knowledgeable, way. Key points clearly expressed and integrated with logical links. Presented appropriate insights.	Content presented in an interesting way. Some key points linked, but others "hanging". Presentation lacked clear synthesis and insight.	Content patchy. Lacked specific important information. Little effort to synthesize key points.
Style/Delivery (2.5)	Audience could see & hear presentation clearly, appropriate eye contact, gestures, and language.	Audience could see & hear presentation clearly, appropriate eye contact, gestures, and language.	Audience could see & hear presentation. Presentation poorly timed. Speaker	Presenter spoke to the screen or mostly to one person in the audience. Difficult to

	Effective pauses and verbal intonation. Graceful transitions.	Some pauses, verbal intonation, and transitions effective.	expressed hesitation or uncertainty.	hear/understand. Poorly timed.
Visual Aids (2)	Well-selected, well-placed images and text. Figures were explained to clearly support ideas presented without extraneous info.	Well-selected images and text, not always well-placed. Figures clearly support ideas presented. May have some extraneous info.	Chosen images extraneous to presentation or marginally support presentation. Too much extra detail.	Chosen images and text marginally useful and poorly ordered. Too much extra detail. Limited connection to topic.
Summary (1)	Conclusions clearly stated. Summary integrated main points and brought the presentation to a logical & effective close.	Conclusions clearly stated. Summary integrated main points and brought the presentation to an appropriate close.	Summary shown but poorly explained by speaker. Audience has to summarize for themselves.	Summary non-existent or very abrupt. Lack of synthesis.
Addressing questions (1.5)	Questions handled with confidence and in a knowledgeable way. Speaker clearly demonstrated further depth of knowledge than just the information in his/her presentation.	Questions handled in a knowledgeable way but with some hesitation. Speaker clearly demonstrated further depth of knowledge than just the information in his/her presentation.	Speaker made a strong effort to answer questions, but lacked depth of knowledge beyond what he/she already presented.	Speaker lacked answers to obvious questions the audience would be likely to ask. Speaker struggled to link answer to content of presentation.

Paper Grading Criteria:

Content (24):

- *Context/set-up* (5): how well you explain the issue and the relevant threats, policies, stakeholders, and how it all comes together.
- *Data* (5): the quality of the data you've marshalled (or, where good data are not available, the quality of your search for data as you describe it and your description of the kind of data you would want/need) for the relevant natural and social science.
- *Analysis* (9): the quality of your analysis of the data (their implications and limitations) and the integration across disciplines for a synthetic understanding of the relevant ecosystem services.
- *Recommendations* (5): the creativity and appropriateness of your recommendations (in light of the data & analysis).

Style (6):

- *Layout* (3): clarity, aesthetics, layout, outline (e.g., a table of contents is helpful, as is an executive summary), organization.
- *Visual aids* (3): balance of materials for different styles of learning (e.g., visual vs. verbal), clarity and relevance of figures and tables.

Class Participation

I believe that you will learn best through interactive lessons, and I've structured the course accordingly. But this also means that you won't learn much unless *you* are interactive, so to acknowledge that, 10% of your final grades are for participation. Timely attendance is mandatory; please let me know in advance if you will not be able to make it on time to class. So that students don't miss out on crucial information presented at the beginning of class (e.g., the learning objectives, which should structure your thinking throughout class), I like to wait until everyone is present; if you're late and don't let me know, everyone else will suffer.

	Excellent (80-100%)	Acceptable (60-80%)	Needs work (<60%)
Content	Asked and answered questions as appropriate, showing reflection and	Contributions were somewhat rare, or frequent but often superficial or oblique.	Contributions were very rare and/or superficial or off the mark.

	synthetic understanding.		
Delivery/ Group- Fostering	Respectful, clear, constructive questions and answers. In group activities, fostered timely and effective collaboration.	Respectful questions and answers. Group participation was generally passive (not attending to timely completion of the task).	Questions and answers were sometimes unclear, or not constructive or respectful. Group participation tended to be disruptive.

Instructor

(Kai M. A. Chan) I am an interdisciplinary sustainability scientist with training in ecology, evolutionary biology, and ethics, focussing on the management of ecosystem-based activities and biodiversity conservation. With colleagues at The Nature Conservancy (TNC; California chapter) and Stanford University, I completed one of the first ecoregional-scale spatially explicit analyses of the provision and societal importance of ecosystem services. I led a research project to understand ecosystem services associated with sea otters and kelp forests on the British Columbia coast, in partnership with non-governmental organizations and government agencies. This work was associated with the Natural Capital Project (a partnership of World Wildlife Fund (WWF), TNC, and Stanford University). I also work with the Nature Conservancy of Canada, WWF Canada, PacMARA, and the Canadian Parks and Wilderness Society (CPAWS)-BC chapter (I am also a director on the board of CPAWS-BC). Through other channels (e.g., I am a Leopold Leadership fellow, a member of the Global Young Academy, and a senior fellow of the Environmental Leadership Program), I collaborate with others in the US and internationally.

Letter to the Student

Dear student,

Welcome! RMES 508 will challenge you with its broad scope and integrative nature. If you like challenges, you should have a lot of fun. Three features will characterize this course. (1) I will give personal attention to students and also ensure considerable interaction with and learning from your peers. (2) RMES 508 will be all about what you get out of it. I have already structured the learning in a way that I hope will make it most useful for your futures, and I will happily tailor assignments to your particular circumstances (within reason) to further encourage this. (3) This course is an exercise in adaptive management, so I will be relying upon your patience and your constructive criticism to improve this course for this year and future years.

Developments in this arena are bubbling up everywhere, and human well-being and the planet's ecosystems are at stake, so I'm passionate about this subject. I hope you are, too!

Best,
Kai