**BIO 591 THE ECONOMICS OF CONSERVATION**

**Spring 2015**

**Meeting times:** Tuesday, Thursday, 10.30-11.45, LSA 335

**SCRs**: 3

**Course instructor**: Charles Perrings (LSA 127) Charles.Perrings@asu.edu

**Office hours**: Tuesdays 1.00pm-3.00pm or by appointment

**Prerequisites**: One of the following courses – or approved alternatives:

BIO/AML 424/524 Mathematical Models in Ecology

BIO 434 People and Nature

BIO 4XX Conservation Biology

**Aims**: To introduce students to the economic foundations for the conservation of natural and other assets

**Objectives**: (a) to develop students’ understanding of the economic principles of conservation,

(b) to show how these principles connect to biological principles of conservation

(c) to enable students to apply these principles to a range of problems in the conservation of natural resources

**Description**: The course offers training in the economics of conservation. It assumes some prior familiarity with the principles of economics, but does not require prior knowledge of constrained optimization methods. It includes a review of the basic theory of conservation—when to keep an asset in a particular state or use, or to convert it to an alternative state or alternative use. Examples extend from wine storage to world heritage sites. The theory is then related to the principles applied in biological conservation, and is used to reveal the factors that enter into conservation decisions inside and outside of protected areas. It is also used to show why conservation effort is underprovided in market economies, and what options exist to assure the optimal level of conservation. Students will apply the economic theory of conservation to an analysis of a range of conservation problems at multiple scales.

The course comprises lectures and seminars. The first part of the course will be largely composed of lectures, supported by three problem sets. The second part of the course will include student presentations on specific conservation problems.

**Assessment**: Problem sets: 30%

Mid term exam: 30%

Term paper: 40%

**Readings:** There is no prescribed text for this course, although you will find the following particularly useful:

Perrings, C. (2014) *Our Uncommon Heritage: Biodiversity, Ecosystem Services and Human Wellbeing*. Cambridge University Press, Cambridge.

Some readings will be posted online. For others you will be given the citations and expected to retrieve the readings yourselves.

**Outline** **Introduction**

Current approaches to the conservation of natural resources and the field of conservation biology; scarcity and resource allocation in economics; concepts of value and opportunity cost.

Hoffmann, M., et al (2010) The Impact of Conservation on the Status of the World's Vertebrates. *Science*, **330**, 1503-1509.

Myers, N., R. A. Mittermeier, C. G. Mittermeier, G. A. B. da Fonseca, and J. Kent. (2000) Biodiversity hotspots for conservation priorities. *Nature*, **403**, 853-858.

Naeem, S., Bunker, D., Hector, A., Loreau, M. & Perrings, C. (eds) (2009) *Biodiversity, Ecosystem Functioning, and Human Wellbeing: An Ecological and Economic Perspective*. Oxford University Press, Oxford.

Perrings, C. (2014) *Our Uncommon Heritage: Biodiversity, Ecosystem Services and Human Wellbeing*. Cambridge University Press, Cambridge.

Soule, M.E. (1986) What is Conservation Biology? *Bioscience*, **35**, 727-734.

Tallis, H., Kareiva, P., Marvier, M. & Chang, A. (2008) An ecosystem services framework to support both practical conservation and economic development. *Proceedings of the National Academy of Sciences*, **105**, 9457-9464.

Tisdell, C. (2005) *Economics of Environmental Conservation*. Edward Elgar, Cheltenham.

**The Hotelling rule and the conservation of natural resources**

The Hotelling rule and implications for the conservation of natural resources; whether and when to exploit environmental resources; whether and when to cut forests; environmental protection as a ‘wine storage problem’; how the value of resources evolves over time; sensitivity to changes in preferences and technology; the discount rate.

Clark, C.W. (2010) *Mathematical Bioeconomics: The Mathematics of Conservation*. John Wiley & Sons, Hoboken N.J.

Conrad, J. M., and C. W. Clark. 1987. Natural Resource Economics Notes and Problems. Cambridge University Press, New York.

Deverajan, S. & Fisher, A. (1981) Hotelling's "Economics of Exhaustible Resources" Fifty Years Later. *Journal of Economic Literature*, **XIX**, 65-73.

Hotelling H. (1931) The Economics of Exhaustible Resources, Journal of Political Economy 39(2): 137-175.

Mangel, M., et al (1996) Principles for the conservation of wild living resources. *Ecological Applications*, **6**, 338-362.

**The value of natural capital**

Biodiversity, ecosystem services and the value of environmental assets; methods for valuing ecosystems and ecosystem services; the Solow-Hartwick rule and conservation of the value of natural capital; tradeoffs and synergies between natural and other forms of capital; inclusive wealth and sustainable income; the Fenichel-Abbott measure of the value of natural capital; the portfolio of natural assets; valuation and wealth measurement

Atkinson, G., Bateman, I. & Mourato, S. (2012) Recent advances in the valuation of ecosystem services and biodiversity. *Oxford Review of Economic Policy*, **28**, 22-47.

Balvanera, P., Pfisterer, A.B., Buchmann, N., He, J.-S., Nakashizuka, T., Raffaelli, D. & Schmid, B. (2006) Quantifying the evidence for biodiversity effects on ecosystem functioning and services. *Ecology Letters*, **9**, 1146–1156.

Barbier, E.B. (2007) Valuing ecosystem services as productive inputs. *Economic Policy*, **January**, 178-229.

Barbier, E.B. (2009) Ecosystems as Natural Assets. *Foundations and Trends in Microeconomics*, **4**, 611-681.

Barrett, C.B., Barbier, E.B. & Reardon, T. (2001) Agroindustrialization, globalization, and international development: the environmental implications. *Environment and Development Economics*, **6**, 419-433.

Cardinale, B.J., Duffy, J.E., Gonzalez, A., Hooper, D.U., Perrings, C., Venail, P., Narwani, A., Mace, G.M., Tilman, D., Wardle, D.A., Kinzig, A.P., Daily, G.C., Loreau, M., Grace, J.B., Larigauderie, A., Srivastava, D.S. & Naeem, S. (2012) Biodiversity loss and its impact on humanity. *Nature*, **486**, 59-67.

Dasgupta P. 2009. The Welfare Economic Theory of Green National Accounts, Environmental and Resource Economics 42: 3-38.

Fenichel, E.P. and Abbott J.K. 2014. Natural Capital: From Metaphor to Measurement. Journal of the Association of Environmental and Resource Economists 1(1): 1-27.

Hanley, N. & Barbier, E.B. (2009) *Pricing nature: cost-benefit analysis and environmental policy*. Edward Elgar, Cheltenham.

Hartwick J.M. 2000 National accounting and capital. Edward Elgar, Cheltenham.

Hartwick, J.M. 1977. Intergenerational Equity and the Investing of Rents from Exhaustible Resources. American Economic Review, 66, 972-974.

MartÌn-Lopez, B., Montes, C. & Benayas, J. (2007) The non-economic motives behind the willingness to pay for biodiversity conservation. *Biological Conservation*, **139**, 67-82.

Solow, R.M. 1974. Intergenerational Equity and Exhaustible Resources. Review of Economic Studies, Symposium, 29-46.

**Why the environment is underprotected**

a) Environmental public goods; common pool and open access resources; property rights, laws and patents; the problem of jurisdiction; b) environmental external effects of market transactions; land use change and habitat loss; roads, railways and habitat fragmentation; trade, travel and the dispersal of pests and pathogens; c) poverty, risk, and time preference; landlessness and land insecurity; impacts on the discount rate and resource use.

Barbier, E.B. (2000) The economic linkages between rural poverty and land degradation: some evidence from Africa. *Agriculture Ecosystems & Environment*, **82**, 355-370.

Barrett, C.B., Travis, A.J. & Dasgupta, P. (2011) On biodiversity conservation and poverty traps. *Proceedings of the National Academy of Sciences*, **108**, 13907-13912.

Pearce, D.W. (2005) Paradoxes in Biodiversity Conservation. *World Economics*, **6**, 57-69.

Perrings, C. & Gadgil, M. (2003) Conserving biodiversity: reconciling local and global public benefits. *Providing Global Public Goods: Managing Globalization* (ed. by I. Kaul, P. Conceicao, K. Le Goulven and R.L. Mendoza), pp. 532-555. Oxford University Press, Oxford.

Rodriguez, J.P., Taber, A.B., Daszak, P., Sukumar, R., Valladares-Padua, C., Padua, S., Aguirre, L.F., Medellin, R.A., Acosta, M., Aguirre, A.A., Bonacic, C., Bordino, P., Bruschini, J., Buchori, D., Gonzalez, S., Mathew, T., Mendez, M., Mugica, L., Pacheco, L.F., Dobson, A.P. & Pearl, M. (2007) Globalization of conservation: a view from the south. *Science*, **317**, 755-6.

Sachs, J.D., Baillie, J.E.M., Sutherland, W.J., Armsworth, P.R., Ash, N., Beddington, J., Blackburn, T.M., Collen, B., Gardiner, B., Gaston, K.J., Godfray, H.C.J., Green, R.E., Harvey, P.H., House, B., Knapp, S., Kumpel, N.F., Macdonald, D.W., Mace, G.M., Mallet, J., Matthews, A., May, R.M., Petchey, O., Purvis, A., Roe, D., Safi, K., Turner, K., Walpole, M., Watson, R. & Jones, K.E. (2009) Biodiversity Conservation and the Millennium Development Goals. *Science*, **325**, 1502-1503.

Starrett, D. (2003) Property Rights, Public Goods and the Environment. In, K. G. Maler, and J. R. Vincent, eds. Handbook of Environmental Economics, vol. 1. Amsterdam, Elsevier, pp. 98-125.

**Protected areas from an economic perspective**

Protected areas as a conservation strategy; the institutional and historical context; protected areas in terrestrial and marine systems; biological conservation value and the selection of protected areas; the ecosystem services yielded by protected areas and the opportunity cost of protection; the external effects of protection; determining the size and location of protected areas.

Andam, K.S., Ferraro, P.J., Pfaff, A., Sanchez-Azofeifa, G.A. & Robalino, J.A. (2008) Measuring the effectiveness of protected area networks in reducing deforestation. *Proceedings of the National Academy of Sciences*, **105**, 16089-16094.

Bauer, D.M., Swallow, S.K. & Paton, P.W.C. (2010) Cost-effective conservation of wetland species in exurban communities: a spatial analysis. *Resource and Energy Economics*, 32, 180-202.

Brandon, K. & Bruner, A. (2008) Benefits of Protected Areas: Perspectives and Experiences of Conservation International. *Protected Areas in Today’s World: Their Values and Benefits for the Welfare of the Planet* (ed. by Secretariat of the Convention on Biological Diversity), pp. 29-36. Convention on Biological Diversity, Montreal.

Chan, K.M.A., Shaw, M.R., Cameron, D.R., Underwood, E.C. & Daily, G.C. (2006) Conservation planning for ecosystem services. *Plos Biology*, **4**, 2138-2152.

Ciriacy-Wantrup, S.V. (1952) *Resources Conservation*. University of California Press, Berkley.

Ferraro, P.J., Hanauer, M.M. & Sims, K.R.E. (2011) Conditions associated with protected area success in conservation and poverty reduction. *Proceedings of the National Academy of Sciences*, **108**, 13913-13918.

Franklin, J., Regan, H.M. & Syphard, A.D. (2014) Linking spatially explicit species distribution and population models to plan for the persistence of plant species under global change. *Environmental Conservation*, **41**, 97-109.

Langpap, C. & Kerkvliet, J. (2010) Allocating conservation resources under the Endangered Species Act. *American Journal of Agricultural Economics*, **92**, 110-124.

Sanchirico, J. N., and J. E. Wilen. A Bioeconomic Model of Marine Reserve Creation. Journal of Environmental Economics and Management 42, no. 3(2001): 257-276.

Wells, M.P. & Brandon, K. (1992) *People and Parks: Linking Protected Areas with Local Communities*. World Bank, Washington D.C.

**The conservation problem beyond protected areas**

Conservation in agriculture, forestry, and fisheries; ex situ and in situ protection of the genetic diversity of crops, livestock, and wild relatives; conservation in multiple use forests; conservation in urban environments; conservation and development tradeoffs; ICDPs, tradable development rights, biodiversity and environmental offsets; incentive systems and payments for ecosystem services.

Brussaard, L., Caron, P., Campbell, B., Lipper, L., Mainka, S., Rabbinge, R., Babin, D. & Pulleman, M. (2010) Reconciling biodiversity conservation and food security: scientific challenges for a new agriculture. *Current Opinion in Environmental Sustainability*, **2**, 34-42.

Bulte, E.H. & Horan, R.D. (2003) Habitat conservation, wildlife extraction and agricultural expansion. *Journal of Environmental Economics and Management*, **45**, 109-127.

Ferraro, P.J. & Simpson, R.D. (2002) The cost-effectiveness of conservation payments. *Land Economics*, **78**, 339-353.

Ferraro, P. & Kiss, A. (2007) Direct payments to conserve biodiversity. *Science*, **298**, 1718-1719.

Hanley, N., Banerjee, S., Lennox, G.D. & Armsworth, P.R. (2012) How should we incentivize private landowners to ‘produce’ more biodiversity? *Oxford Review of Economic Policy*, **28**, 93-113.

Jackson, L.E., Brussaard, L., de Ruiter, P.C., Pascual, U., Perrings, C. & Bawa, K. (2007) Agrobiodiversity. *Encyclopedia of Biodiversity* (ed. by S.A. Levin), pp. 1-13. Elsevier, New York.

Kinzig, A.P., Perrings, C., Chapin, F.S., 3rd, Polasky, S., Smith, V.K., Tilman, D. & Turner, B.L., 2nd (2011) Sustainability. Paying for ecosystem services--promise and peril. *Science*, **334**, 603-4.

Lichtenberg, E., Shortle, J., Wilen, J. & Zilberman, D. (2010) Natural Resource Economics and Conservation: Contributions of Agricultural Economics and Agricultural Economists. *American Journal of Agricultural Economics*, **92**, 469-486.

Nelson, E., Mendoza, G., Regetz, J., Polasky, S., Tallis, H., Cameron, D.R., Chan, K.M.A., Daily, G.C., Goldstein, J., Kareiva, P.M., Lonsdorf, E., Naidoo, R., Ricketts, T.H. & Shaw, M.R. (2009) Modeling multiple ecosystem services, biodiversity conservation, commodity production, and tradeoffs at landscape scales. *Frontiers in Ecology and the Environment*, **7**, 4-11.

Perrings, C. & Walker, B.H. (2004) Conservation in the optimal use of rangelands. *Ecological Economics*, **49**, 119-128.

Polasky S., Nelson E., Camm J., Csuti B., Fackler P., Lonsdorf E., Montgomery C., White D., Arthur J., Garber-Yonts B., Haight R., Kagan J., Starfield A. & Tobalske C. (2008). Where to put things? Spatial land management to sustain biodiversity and economic returns. Biol Conserv, 141, 1505-1524.

Polasky S., Nelson E., Lonsdorf E., Fackler P. & Starfield A. (2003). Conserving species in a working landscape: land use with biological and economic objectives. Ecological Applications, 15, 1387-1401.

Sato, R. & Kim, Y. (2002) Hartwick's rule and economic conservation laws. *Journal of Economic Dynamics and Control*, **26**, 437-449.

Skonhoft, A. (1997) On the principles of conservation and utilization of wild living resources. *Environment and Development Economics*, **2**, 39-110.

Wells, M.P., McShane, T.O., Dublin, H.T., O'Connor, S. & Redford, K.H. (2004) The future of integrated conservation and development projects: building on what works. *Getting biodiversity projects to work: towards more effective conservation and development* (ed. by T.O. Mcshane and M.P. Wells), pp. 397-422. Columbia University Press, New York.

Wunder, S. (2007) The efficiency of payments for environmental services in tropical conservation. *Conservation Biology* **21**, 48-58.

Zabel, A. & Roe, B. (2009) Optimal design of pro-conservation incentives. *Ecological Economics*, **69**, 126-134.

**International dimensions of the conservation problem**

The nature of the international problem; global environmental change and global economic change; multilateral conservation agreements; the intergovernmental organizations and the Global Environment Facility; strategic behavior and the protection of areas beyond national jurisdiction.

Arriagada, R. & Perrings, C. (2011) Paying for international environmental public goods. *Ambio*, **40**, 798-806.

Brooks, T.M., Mittermeier, R.A., da Fonseca, G.A.B., Gerlach, J., Hoffmann, M., Lamoreux, J.F., Mittermeier, C.G., Pilgrim, J.D. & Rodrigues, A.S.L. (2006) Global Biodiversity Conservation Priorities. *Science*, **313**, 58-61.

Costello, C., Ovando, D., Hilborn, R., Gaines, S.D., Deschenes, O. & Lester, S.E. (2012) Status and Solutions for the World’s Unassessed Fisheries. *Science*, **338**, 517-520.

Gerber, L.R., C. Costello and S. Gaines (2014) Conservation markets for wildlife management with case studies from whaling. Ecological Applications 24: 4–14.

Gerber, L.R., C. Costello and S. Gaines (2014) Facilitate, don’t forbid trade between conservationists and resource harvesters. Ecological Applications. 24: 23–24.

Mitchell, R.B. (2003) International environmental agreements: a survey of their features, formation and effects. *Annual Review of Environment and Resources*, **28**, 429-462.

Perrings, C. (2014) *Our Uncommon Heritage: Biodiversity, Ecosystem Services and Human Wellbeing*. Cambridge University Press, Cambridge.

Sandler, T. (2004) *Global Collective Action*. Cambridge University Press, Cambridge.

Sandler, T. & Sargent, K. (1995) Management of transnational commons: coordination, publicness and treaty formation. *Land Economics*, **71**, 145-162.

Worm, B., Barbier, E.B., Beaumont, N., Duffy, J.E., Folke, C., Halpern, B.S., Jackson, J.B.C., Lotzke, H.K., Micehli, F., Palumbi, S.R., Sala, E., Selkoe, K.A., Stachowicz, J.J. & Watson, R. (2006) Impacts of Biodiversity Loss on Ocean Ecosystem Services. *Science*, **314**, 787-790.

Worm, B., Barbier, E.B., Beaumont, N., Duffy, J.E., Folke, C., Halpern, B.S., Jackson, J.B.C., Lotzke, H.K., Micehli, F., Palumbi, S.R., Sala, E., Selkoe, K.A., Stachowicz, J.J. & Watson, R. (2006) Impacts of Biodiversity Loss on Ocean Ecosystem Services. *Science*, **314**, 787-790.

Zimsky, M., Fonseca, G., Cavelier, J., Gaul, D., Sinnassamy, J.-M., Watanabe, Y. & Yang, M. (2013) The Global Environment Facility: Financing the Stewardship of Global Biodiversity. *Encyclopedia of Biodiversity (Second Edition)* (ed. by S.A. Levin), pp. 136-143. Academic Press, Waltham.