

**FW 854: Adaptive Management of Natural Resource Systems**  
**Fall semester 2007**  
**Class Outline and list of readings**

**PART A: Lectures/debate/discussion on uncertainty, decision analysis and adaptive management**

**August 27<sup>th</sup>**: Welcome to FW 854 [LECTURE FOCUSED]. Course overview, “what would you need to know” exercise, Mike’s challenge about risk, hand out reading list, etc

**August 31<sup>st</sup>**: What is uncertainty? [DEBATE FOCUSED]

Thought experiment; discussion: The Tasmanian devil problem – brainstorming examples of epistemic and linguistic uncertainty

Debate: Suppress vs. Embrace: In the public (often adversarial) arena, acknowledging uncertainty will decrease scientific credibility and thus negotiating power VERSUS acknowledging uncertainty allows policy makers to make decisions that account for and thus are robust to uncertainty.

Lecture: A conceptual model of uncertainty in resource management

**Primary readings:**

Regan, H.M., M. Colyvan, and M. A. Burgman. 2002. A taxonomy and treatment of uncertainty for ecology and conservation biology. *Ecological Applications* 12(2):618-628.

Williams 1997. The management of waterfowl under uncertainty. *Wildlife Society Bulletin* 25(3): 714-720.

**September 7<sup>th</sup>**: NO CLASS

**September 10<sup>th</sup>**: Uncertainty in natural systems [DEBATE FOCUSED]. Resilience, command and control management.

Debate: Control vs. Adapt. There is a reason command and control management is so pervasive: many livelihoods depend on reliability of managed systems. Resilience-based strategies are unproven and thus also risky VERSUS Holling, Meffe and others persuasively argue that we must abandon command and control if we do not want to see the continued collapse of managed systems.

**Primary Readings:**

Holling, C.S. What Barriers? What Bridges? pp 3-34 *In* Gunderson, L.H., Holling, C.S., and Light, S.S. 1995. Barriers and bridges to the renewal of ecosystems and institutions. Columbia University Press., New York.

Holling, C.S. and G. K. Meffe 1996. Command and control and the pathology of natural resource management. *Conservation Biology* 10: 328-337

**September 14<sup>th</sup>**: Decision analysis 1 [LECTURE FOCUSED]. Ways in which we deal with uncertainty; Decision analysis, risk analysis

Lecture: What is decision analysis?

Discussion: Class brainstorms a DA example based on the Tasmanian devil issue introduced in the second session. Work through 8 steps of DA as per Peterman.

**Primary Readings:**

Clemen and Reilly 2001. Introduction to decision analysis. *In Making Hard Decisions with Decision Tools*. Duxbury Press, Pacific Grove, CA, pp1-9

Peterman, R.M., and C.N. Peters. 1998. Decision analysis: Taking uncertainties into account in forest resource management. *In Sit, V. and B. Taylor (eds). Statistical Methods for Adaptive Management Studies. Res. Br., B.C. Min. For., Victoria B.C. Land Management Handbook no. 42. pp105-127.*

**September 17<sup>th</sup>**: Decision analysis 2 [DEBATE FOCUSED]. Examples of decision analysis; does it work? What limits its utility?

Debate: Decision analysis can only be effectively applied in relatively simple situations where all management options and uncertainties can be clearly identified, and there are few objectives VERSUS decision analysis is valuable for all types of decision problems.

**Primary Readings**: Each student will choose 2-3 papers from the list of examples provided (pp 4-5 of this handout) to support their side of the debate.

**September 21<sup>st</sup>**: Adaptive management 1 [DEBATE then LECTURE]. Reducing uncertainty through management experiments.

Debate: Traditional scientific approaches are relied on FAR TOO MUCH to inform management decisions vs. traditional scientific approaches are used TOO LITTLE, OR APPROPRIATELY to inform management decisions.

Lecture: What is Adaptive Management? What is it, passive vs. active, dual control problem, advantages to using AM. Conclude lecture with a list of criteria for adaptive management (essential, and desirable) that will be used as context for work in next two sessions.

**Primary Readings:**

Walters, C. 1986. Introduction. *In Adaptive management of renewable resources*. MacMillan, New York, NY, pp 1-8

Lee, K. 1993. Compass: Adaptive Management. *In* Compass and gyroscope: integrating science and politics for the environment. Island Press, Washington, pp 51-86.

**September 24<sup>th</sup> and 28<sup>th</sup>**: Adaptive management 2 [DISCUSSION FOCUSED]. Review and analysis of adaptive management examples

Discussion: (Sept 24): Working in up to four groups, student review published examples of (or papers on) adaptive management from the list on pages 6-8 of this handout (and others they can find) and determine whether they meet our criteria for adaptive management.

Presentation: (Sept 28): Each group reports back to the entire class on what they learned.

Lecture: (Sept 28): Overview of adaptive management workshop – why, and what.

**Primary reading (for Sept 28):**

Walters C. 1986. Adaptive management of renewable resources (46-60). MacMillan, New York, NY.

**AFTER THE WORKSHOP**

**December 3rd**: Adaptive management challenges [DEBATE FOCUSED] Why isn't it used more, and why does it sometimes fail.

Debate: Adaptive management enterprises fail primarily because the critical questions are just too difficult to answer (too much variability, too many replicates or years needed to learn adequately vs. management agencies are not designed to facilitate adaptive management: too much fear of uncertainty, few rewards for risk taking and innovation.

**Primary readings:**

Walters, C.J. 2007. Is adaptive management helping to solve fisheries problems? *Ambio* **36**: 304-307.

McLain and Lee 1996. Adaptive Management: Promises and Pitfalls. *Environmental Management* 20:437-448.

**December 7th**: Well, what have we learned? [DISCUSSION FOCUSED].

Round-table discussion: How will the things you learned in this course affect what you do in the future? Your research? Your career? Your opinions about what's right and wrong with resource management? Your opinions about academic environmental science?

**Examples of Decision Analysis (resources to use for the debate on September 17):**

Alexander, C.A., C. N. Peters, D. R. Marmorek, and P. Higgins. 2006. A decision analysis of flow management experiments for Columbia River mountain whitefish (*Prosopium williamsoni*) management. *Canadian Journal of Fisheries and Aquatic Sciences* 63: 1142-1156.

Cohan, D., S.M. Haas, D.L. Radloff, and R.F. Yancik. 1984. Using fire in forest management: decision making under uncertainty. *Interfaces* 14: 8-19.

de Bruin, S. and G. J. Hunter 2003. Making the trade-off between decision quality and information cost. *Photogrammetric Engineering & Remote Sensing* 69: 91-98.

Dunning, D.J., S. Lockfort, Q.E. Ross, P.C. Beccue, and J.S. Stonebraker. 2001. New York power authority uses decision analysis to schedule refueling of its Indian Point 3 nuclear power plant. *Interfaces* 31: 121-135.

Hauser, C.E., M.C. Runge, E.G. Cooch, F.A. Johnson and W.F. Harvey IV. 2007. Optimal control of Atlantic population Canada geese. *Ecological Modelling* 201(1): 27-36.

Huth, A., M. Drechsler, and P. Kohler. 2005. Using multicriteria decision analysis and a forest growth model to assess impacts of tree harvesting in Dipterocarp lowland rain forests. *Forest Ecology and Management* 207: 215-232.

Jones M.L. and J.R. Bence. Uncertainty and Fishery Management in the North American Great Lakes: Lessons from Applications of Decision Analysis. (in review)

Macgregor, B.W., Peterman, R.M., Pyper, B.J., and Bradford, M.J. 2002. A Decision Analysis Framework for Comparing Experimental Designs of Projects to Enhance Pacific Salmon. *North American Journal of Fisheries Management* 22: 509-527.

McAllister, M.K., and G.P. Kirkwood. 1998. Using Bayesian decision analysis to help achieve a precautionary approach for managing developing fisheries. *Canadian Journal of Fisheries and Aquatic Sciences* 55:2642-2661.

McAllister, M.K. and R.M. Peterman. 1992. Decision-analysis of a large-scale fishing experiment designed to test for a genetic effect of size-selective fishing on British Columbia pink salmon (*Oncorhynchus gorbuscha*). *Canadian Journal of Fisheries and Aquatic Sciences* 49: 1305-1314.

Paulsen, C.M. and R.A. Hinrichsen. 2002. Experimental management for Snake River spring-summer Chinook (*Oncorhynchus tshawytscha*): trade-offs between conservation and learning for a threatened species. *Canadian Journal of Fisheries and Aquatic Sciences* 59: 717-725.

Peters, C.N. and D.R. Marmorek 2001. Application of decision analysis to evaluate recovery actions for threatened Snake River spring and summer Chinook salmon. *Canadian Journal of Fisheries and Aquatic Sciences* 58: 2431-2446

Peters, C.N., D.R. Marmorek, and R.B. Deriso. 2001. Application of decision analysis to evaluate recovery actions for threatened Snake River fall Chinook salmon (*Oncorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences 58: 2447-2458.

Peterson, J.T. and J.W. Evans. 2003. Quantitative decision analysis for sport fisheries management. Fisheries 28: 10-21.

Punt, A. E., A.D.M. Smith, and G. Cui. 2002. Evaluation of management tools for Australia's south east fishery 3: Towards selecting appropriate harvest strategies. Marine and Freshwater Research 53: 645-660.

Robb, C.A. and Peterman, R.M. 1998. Application of Bayesian decision analysis to management of a sockeye salmon (*Oncorhynchus nerka*) fishery. Canadian Journal of Fisheries and Aquatic Sciences 55: 86-98.

Sainsbury, K.J. 1991. Application of an experimental approach to management of a tropical Multispecies fishery with highly uncertain dynamics. ICES mar. Sci. Symp., 193:301-320

Taylor, B.L, P.R. Wade, D.P. de Master, and J. Barlow. 2000. Incorporating Uncertainty into Management Models for Marine Mammals. Conservation Biology 14:1243-1252.

VanderWerf E. A., J.J. Groombridge, J.S. Fretz, and K.J. Swinnerton. 2006. Decision analysis to guide recovery of the po'ouli, a critically endangered Hawaiian honeycreeper. Biological Conservation 129: 383-392.

Wright, E., and nine co-authors. 2005. Decision analysis application for Lake Erie walleye management: final report to the Lake Erie Committee. Great Lakes Fishery Commission, Ann Arbor, MI.

## **Adaptive management examples (for September 24 discussion)**

### Waterfowl management:

Johnson, F. and K. Williams. 1999. Protocol and practice in the adaptive management of waterfowl harvests. *Conservation Ecology* 3(1): 8 [online] URL: <http://www.consecol.org/vol3/uss1/art8>.

Williams, B.K. 2003. Policy, Research, and Adaptive Management in Avian Conservation. *Auk* 120: 212-217.

Williams, B.K. and F.A. Johnson. 1995. Adaptive Management and the Regulation of Waterfowl Harvests. *Wildlife Society Bulletin* 23: 430-436.

### Glen Canyon Dam:

Brouwer, G. 2002. Adaptive management group finds common ground at Glen Canyon. *Civil Engineering* 72(8): 24-25.

Meretsky, V.J, D.L. Wegner, and L.E. Stevens. 2000. Balancing endangered species and ecosystems: a case study of adaptive management in Grand Canyon. *Environmental Management* 25: 579-586

### Pacific Northwest Forests:

Baskerville, G. 1985. Adaptive management wood availability and habitat availability. *Forestry Chronicle* 61: 171-175.

Stankey, G.H., B.T. Bormann, C. Ryan, B. Shindler, V. Sturtevant, R.N. Clark, and C. Philpot, 2003. Adaptive Management and the Northwest Forest Plan - Rhetoric and Reality. *Journal of Forestry* 101: 40-46.

### Other systems:

Agrawal, A. 2000. Adaptive management in transboundary protected areas: the Bialowieza national park and biosphere reserve as a case study. *Environmental Conservation* 27: 326-333.

Arvai, J. and 11 co-authors. 2006. Adaptive management of the global climate problem: bridging the gap between climate research and climate policy. *Climatic Change* 78: 217-225.

Bearlin, A.R., E.S.G. Schreiber, S.J. Nicol, A.M. Starfield, and C.R. Todd. 2002. Identifying the weakest link: simulating adaptive management of the reintroduction of a threatened fish. *Canadian Journal of Fisheries and Aquatic Sciences* 59: 1709-1716.

Chavez, D.J. 2002. Adaptive management in outdoor recreation: serving Hispanics in southern California. *Western Journal of Applied Forestry* 17: 129-133.

Cinner, J., M. J. Marnane, T. R. McClanahan, and G. R. Almany 2005. Periodic closures as adaptive coral reef management in the Indo-Pacific. *Ecology and Society* 11(1): 31. [online] URL: <http://www.ecologyandsociety.org/vol11/iss1/art31/>

Dallmeier, F., A. Alonso, and M. Jones. 2002. Planning an adaptive management process for biodiversity conservation and resource development in the Camisea river basin. *Environmental Monitoring and Assessment* 76: 1-17.

Hennessey, T.M. 1994. Governance and Adaptive Management for Estuarine Ecosystems - the Case of Chesapeake Bay. *Coastal Management* 22: 119-145.

Innes et al. 1999. Successful recovery of North Island kokako *Callaeas cinerea wilsoni* populations, by adaptive management. *Biological Conservation* 87: 201-214

Irwin, E.R. and M.C. Freeman. 2002. Proposal for Adaptive Management to Conserve Biotic Integrity in a Regulated Segment of the Tallapoosa River, Alabama, U.S.A. *Conservation Biology* 16(5): 1212-1222.

Johnson, P.A., R.L. Tereska, and E.R. Brown. 2002. Using Technical Adaptive Management to Improve Design Guidelines for Urban Instream Structures. *Journal of the American Water Resources Association* 38: 1143-1152.

Lasiak, T.A., A.J. Underwood, and M. Hoskin. 2006. An experimental assessment of the potential impacts of longline mussel farming on the infauna in an open coastal embayment. *Aquatic Conservation: Marine and Freshwater Ecosystems* 16: 289-300.

Marmorek, D. and C. Peters. 2002. Finding a PATH Toward Scientific Collaboration: Insights From the Columbia River Basin. *Conservation Ecology* 5(2): 8 [online] URL: <http://www.ecologyandsociety.org/vol5/iss2/art8/>

Mcdaniels, T.L., M. Healey, and R.K. Paisley. 1994. Cooperative Fisheries Management Involving First-Nations in British-Columbia - an Adaptive Approach to Strategy Design. *Canadian Journal of Fisheries and Aquatic Sciences* 51: 2115-2125.

Parkes, J.P., A. Robley, D.M. Forsyth, and D. Choquenot. 2006. Adaptive management experiments in vertebrate pest control in New Zealand and Australia. *Wildlife Society Bulletin* 34(1): 229-236.

Ritchie, M.W. and K.A. Harcksen. 1999. Long-Term Interdisciplinary Research on the Goosenest Adaptive Management Area, Klamath National Forest, California. *Forestry Chronicle* 75: 453-456.

Sainsbury, K.J., R.A. Campbell, R. Lindholm, and A.W. Whitelaw. 1997. Experimental Management of an Australian Multispecies Fishery: Examining the Possibility of Trawl-Induced Habitat Modification *In: Global Trends: Fisheries Management*. E.L. Pikitch, D.D. Huppert, and M.P. Sissenwine, eds. pp107-112

Schubert, C.A., R.C. Rosatte, C.D. Macinnes, and T.D. Nudds, T.D. 1998. Rabies Control: an Adaptive Management Approach. *Journal of Wildlife Management* 62: 622-629.

Shea, K., H.P. Possingham, W.W. Murdoch, and R. Roush. 2002. Active Adaptive Management in Insect Pest and Weed Control: Intervention with a Plan for Learning. *Ecological Applications* 12: 927-936.

Theberge J. B., M. T. Theberge, J. A. Vucetich, and P. C. Paquet . 2006. Pitfalls of applying adaptive management to a wolf population in Algonquin Provincial Park, Ontario. *Environmental Management* 37: 451-460

Wieringa, M.J. and A.G. Morton. 1996. Hydropower, Adaptive Management, and Biodiversity. *Environmental Management* 20: 831-840.

Wilson, D.C., M. Ahmed, S. V. Siar, and U. Kanagaratnam 2006. Cross-scale linkages and adaptive management: fisheries co-management in Asia. *Marine Policy* **30**: 523-533.



## **Reading list of additional resources:**

### **What is uncertainty? (August 31)**

Morgan, G. and Henrion, M. 1990. *Uncertainty: A Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis*. Cambridge University Press, Cambridge, UK.

Vose, D. 2000. *Risk analysis: a quantitative guide*. John Wiley and Sons, Inc. West Sussex, England.

### **Uncertainty in natural systems (September 10)**

Folke, C. 2006. Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change* 16:253-267.

Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C.S., and Walker, B. 2002. Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations. *Ambio* 31: 437-440.

Haeuber, R.A. and Michener, W.K. 1998. Policy Implications of Recent Natural and Managed Floods. *Bioscience* 48: 765-772.

Nystrom, M., Folke, C., and Moberg, F. 2000. Coral Reef Disturbance and Resilience in a Human-Dominated Environment. *Trends in Ecology & Evolution* 15: 413-417.

Prato, T. 2007. Evaluating land use plans under uncertainty. *Land Use Policy* 24:165-174.

Reckhow, K.H. 1994. Importance of scientific uncertainty in decision making. *Environmental Management* 18: 161-166.

### **Decision Analysis (September 14)**

Clemen, R.T. 1996. *Making Hard Decisions: An Introduction to Decision Analysis*. Duxbury Press, Belmont, CA.

Clemen, R.T. and T. Reilly. 2001. *Making Hard Decisions Using Decision Tools*. Duxbury Press, Pacific Grove, CA.

Harwood, J. 2000. Risk Assessment and Decision Analysis in Conservation. *Biological Conservation* 95: 219-226.

Hinrichsen, R.A. 2001. High variability in spawner-recruit data hampers learning. *Canadian Journal of Fisheries and Aquatic Sciences* 58: 769-776.

Mendoza, G.A., and H. Martins. 2006. Multi-criteria decision analysis in natural resource management: A critical review of methods and new modeling paradigms. *Forest Ecology and Management* 230:1-22

Peterman, R.M. and Anderson, J.L. 1999. Decision Analysis: a Method for Taking Uncertainties into Account in Risk-Based Decision Making. *Human and Ecological Risk Assessment* 5: 231-244.

Punt, A.E. and R. Hilborn. 1997. Fisheries stock assessment and decision analysis: the Bayesian approach. *Reviews in Fish Biology and Fisheries* 7:35-63.

Raiffa, H. 1968. Decision analysis: introductory lectures on choices under uncertainty . Addison-Wesley, Don Mills, ON.

Rosenberg, A.A., and V.R. Restrepo, V.R. Uncertainty and risk evaluation in stock assessment advice for U.S. marine fisheries. *Canadian Journal of Fisheries and Aquatic Sciences* 51:2715-2720.

Von Winterfeldt, D. and Edwards, W. 1986. Decision analysis and behavioral research. Cambridge Univ. Press.

### **Adaptive Management (September 21)**

Bosch, O.J.H., Ross, A.H., and Beeton, R.J.S. 2003. Integrating Science and Management Through Collaborative Learning and Better Information Management. *Systems Research and Behavioral Science* 20: 107-118.

Bouma, J. 1998. Realizing Basic Research in Applied Environmental Research Projects. *Journal of Environmental Quality* 27: 742-749.

Brooks, H. 1987. Expanding Adaptive Management Principles. *Environment* 29: 3-4.

Carpenter, S.R. 1998. Keystone species and academic-agency collaboration. *Conservation Ecology* 2: R2.

Cottingham, P., S. Carpenter, R. Hilborn, J. Kitchell, and C. Stow. Large scale ecological studies and their importance for freshwater resource management. 2001. Canberra, Australia, Cooperative Research Centre for Freshwater Ecology, University of Canberra.

Enck, J.W., D.J. Decker, S.J. Riley, J.F. Organ, L.H. Carpenter, and W.F. Sierner. 2006. Integrating ecological and human dimensions in adaptive management of wildlife related impacts. *Wildlife Society Bulletin* 34(3):698-705.

Gunderson, L. 1999. Resilience, flexibility and adaptive management - - antidotes for spurious certitude? *Conservation Ecology* 3: 7.

Halbert, C.L. and Lee, K.N. 1991. Implementing Adaptive Management - a Conversation With Lee, Kai, N. *Northwest Environmental Journal* 7: 136-150.

Holling, C.S. 1978. Adaptive environmental assessment and management. Wiley, Chichester, UK.

- Houlahan, J. 1998. Big problems, small science. *Conservation Ecology* **2**: R1.
- Johnson, B.L. 1999. Introduction to the special feature: adaptive management - scientifically sound, socially challenged? *Conservation Ecology* [online] 3.
- Keen, M. and S. Mahanty. 2006. Learning in sustainable natural resource management: Challenges and opportunities in the Pacific. *Society and Natural Resources* 19:497-513.
- Lancia, R.A., Braun, C.E., Collopy, M.W., Dueser, R.D., Kie, J.G., Martinka, C.J., Nichols, J.D., Nudds, T.D., Porath, W.R., and Tilghman, N.G. 1996. Arm! For the Future: Adaptive Resource Management in the Wildlife Profession. *Wildlife Society Bulletin* 24: 436-442.
- McDaniels, T.L. and R. Gregory 2004. Learning as an objective within a structured risk management decision process. *Environmental Science & Technology* **38**: 1921-1926.
- Rogers, K. 1998. Managing science/management partnerships: a challenge of adaptive management. *Conservation Ecology* **2**: R1.
- Stringer, L. C., A. J. Dougill, E. Fraser, K. Hubacek, C. Prell, and M. S. Reed. 2006. Unpacking “participation” in the adaptive management of social–ecological systems: a critical review. *Ecology and Society* **11**(2): 39. [online] URL: <http://www.ecologyandsociety.org/vol11/iss2/art39/>
- Sutherland, W.M. 2006. Predicting the ecological consequences of environmental change: a review of the methods. *Journal of Applied Ecology* **43**: 599-616.
- Walters, C.J. and Green, R. 1997. Valuation of experimental management options for ecological systems. *Journal of Wildlife Management* 61: 987-1006.
- Walters, C.J. and Hilborn, R. 1978. Ecological Optimization and Adaptive Management. *Annual Review of Ecology and Systematics* 9: 157-188.
- Future and challenges in adaptive management (December 3)**
- Morghan K.J.R., R.L. Sheley, and T.J. Svejcar 2006. Successful adaptive management – the integration of research and management. *Rangeland Ecology Management* 59:216-219
- Gregory R., D. Ohlson, J. Arvai. 2006. Deconstructing adaptive management: criteria for applications to environmental management. *Ecological Applications* 16(6): 2411-2425
- Jacobson, S.K., J. K. Morris, J. S. Sanders, E. N. Wiley, M. Brooks, R. E. Bennetts, H. F. Percival, and S. Marynowski 2006. Understanding barriers to implementation of an adaptive land management program. *Conservation Biology* **20**: 1516-1527.
- Lee 1999. Appraising adaptive management. *Conservation Ecology* 3(2): 3. URL: <http://www.consecol.org/vol3/iss2/art3/>

Shindler, B., Steel, B., and List, P. 1996. Public Judgments of Adaptive Management - a Response From Forest Communities. *Journal of Forestry* 94: 4-12.

Thompson, A., P. Robbins, B. Sohngen, J. Arvaim and T. Koonz. 2006. Economy, politics, and institutions: From adaptation to adaptive management in climate change. *Climatic Change* 78: 1-5.

Walters, C. 1997. Challenges in adaptive management of riparian and coastal ecosystems. *Conservation Ecology* **1**: 1.