

Aquatic Trophic Ecology
WL 717, 3 credits
Spring 2006

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Lectures: T, TH; 10:00-10:50 am; SNP 102
Lab: TH; 2:30-4:50 pm; SNF 142

Course description¹: This course covers theoretical and applied aspects of aquatic food web management with an emphasis on shallow lake ecology. Quantitative methods for food web analysis and applied approaches to food web management are major themes of the course. The course is intended for advanced students in fisheries and wildlife sciences, biology, or zoology.

Course objectives: To explore and discuss the application of ecological theory to applied management problems in lake ecosystems.

Course requirements: No text is required. Topics are covered via lectures, assigned readings and handouts. Reading material is placed on reserve in the library. Class discussions are an integral part of the course. Attendance and class participation are imperative.

Laboratory: Laboratory time will be spent reviewing concepts of bioenergetics modeling and learning to use Fish Bioenergetics (version 3.0) software. Laboratory exercises will consist of individual (written reports) and group projects (class presentation). We will occasionally meet in room SNP 179 for the laboratory section.

Evaluation²: Grades are based on a 10 pt scale (i.e., A=100-90, B=89-80, etc.) and are determined as follows:

		<u>Pts</u>
Class participation	10%	50
Discussion questions	20%	100
Laboratory projects	30%	150
Midterm & final exam	40%	200
	Total	500

¹Students are entitled to reasonable accommodations under the provision of the Americans with Disabilities Act. Those in need of such accommodations should notify the instructor and make appropriate arrangements with the SDSU Office of Disabilities Services, 110 West Hall, 688-4504 or 688-4032.

²Review the Department's Academic Dishonesty Policy (<http://wfs.sdstate.edu/wfsdept>) for procedural details that address plagiarism and cheating.

Lecture/Discussion
(Aquatic Trophic Ecology WL 717)

Date	Topic	Assigned reading (by senior author)
	Lentic Ecosystems	
Jan 19	Introduction Physical/chemical properties of lakes Nutrient dynamics	Sheldon (1972)
Jan 31	<i>Discussion: Nutrient reduction</i> Sedimentation and resuspension Causes of turbidity Lake vs. reservoir ecosystems	Van der Molen (1994); Welch (1999)
Feb 14	<i>Discussion: Spatial and temporal scales</i>	Carpenter (1996; 1999); Drenner (1999); Huston (1999)
	Aquatic Food webs	
Feb 21	Overview of freshwater algae/plants <i>Discussion: Lake productivity</i> Niche concept Regulation of algal biomass Equilibria modeling	Carlson (1977); Schindler (1978)
Mar 16	Midterm Exam	
Mar 21	<i>Discussion: Alternative equilibria</i> Algae-zooplankton dynamics The role of benthic invertebrates	Scheffer (1993; 2001; 2003)
Mar 30	<i>Discussion: Fish-plant interactions</i> Aquatic food web analysis Stable isotope analysis	Bronmark (1998); Olson (1998)
Apr 11	<i>Discussion: Application of stable isotopes</i>	Kitchell (1999); Vander Zanden (1999)
	Food Web Management	
Apr 13	<i>Discussion: Trophic cascade hypothesis</i>	Carpenter (1985; 1992); Demelo (1992)
Apr 18	<i>Discussion: Omnivory in food webs</i>	Stein (1995); Chipps (2000)
Apr 20	<i>Discussion: Role of food web structure</i>	Schindler (1993); Vanni (1997)
Apr 25	<i>Discussion: OPEN</i>	
	Stressors: Aquatic Food Webs	
Apr 27	<i>Discussion: Non-native species</i>	Whittier (2002); Kolar (2002)
May 2	<i>Discussion: Effects of fishing</i>	Pauly (2000); Rahel (2001); Conover (2002)
May 4	<i>Discussion: Urbanization, agriculture and climate change</i>	Scheffer (2001; 2003); Vandonk (2003)
May 12	Final Exam (12:00-1:40 pm)	

Nutrient reduction (Jan 31)

Van der Molen, D, and P.C. Boers. 1994. Influence of internal loading on phosphorus concentration in shallow lakes before and after reduction of external loading. *Hydrobiologia* 275:379-389.

Welch, E.B., and D.C. Cooke. 1999. Effectiveness and longevity of phosphorus inactivation with alum. *Journal of Lake and Reservoir Management* 15:5-27.

Spatial and temporal scales in food web studies (Feb 14)

Carpenter, S.R. 1996. Microcosm experiments have limited relevance for community and ecosystem ecology. *Ecology* 77:677-680.

Drenner, R.W., and A. Mazuder. 1999. Microcosm experiments have limited relevance for community and ecosystem ecology: Comment. *Ecology* 80:1081-1085.

Carpenter, S.R. 1999. Microcosm experiments have limited relevance for community and ecosystem ecology: Reply. *Ecology* 80:1085-1088.

Huston, M.A. 1999. Microcosm experiments have limited relevance for community and ecosystem ecology: Synthesis of comments. *Ecology* 80:1088-1089.

Lake productivity (Feb 21)

Carlson, R. 1977. A trophic state index for lakes. *Limnology and Oceanography* 22:361-369.

Schindler, D.W. 1978. Factors regulating phytoplankton production and standing crop in the world's freshwaters. *Limnology and Oceanography* 23:478-486.

*Ryder et al. 1974. The morphoedaphic index, a fish yield estimator -- review and evaluation. *J. Fish. Res. Board Can.* 31:663-688

*Optional reading: But read if you are unfamiliar with MEI.

Alternative equilibria (Mar 21)

Scheffer, M. (and 4 coauthors). 1993. Alternative equilibria in shallow lakes. *TREE* 8:275-279.

Scheffer, M. (and 4 coauthors). 2001. Catastrophic shifts in ecosystems. *Nature* 413:591-596.

Scheffer, M., S. Szabo, A. Gragnani, E. H. van Nes, S. Rinaldi, N. Kautsky, J. Norberg, R. M. M. Roijackers & R. J. M. Franken, 2003. Floating plant dominance as a stable state. *Proceedings of the National Academy of Sciences* 100: 4040-4045.

Fish-plant interactions (Mar 30)

Brönmark, C., and J.E. Vermaat. 1998. Complex fish-snail-epiphyton interactions and their effects on submerged freshwater macrophytes. In Jeppesen et al., editors. *The structuring role of submerged macrophytes in Lakes*. Springer-Verlag, New York.

Olson, M.H. and 9 coauthors. 1998. Managing macrophytes to improve fish growth: a multi-lake experiment. *Fisheries* 23:6-11.

Application of stable isotopes (Apr 11)

Kitchell, J.F. (and 5 coauthors). 1999. Nutrient cycling at the landscape scale: the role of diel foraging migrations by geese at the Bosque del Apache National Wildlife Refuge, New Mexico. *Limnology and Oceanography* 44:828-836.

Vander Zanden, J. et al. 1999. Stable isotope evidence for the food web consequences of species invasions in lakes. *Nature* 401:464-467.

Trophic cascade hypothesis (Apr 13)

Carpenter, S.R. et al. 1985. Cascading trophic interactions and lake productivity. *Bioscience* 35:634-639.

Carpenter, S.R., and J.F. Kitchell. 1992. Trophic cascade and biomanipulation: Interface of research and management – A reply to the comment by DeMelo et al. *Limnology and Oceanography* 37:208-213.

Demelo, R., R. France, and D.J. McQueen. 1992. Biomanipulation: Hit or myth? *Limnology and Oceanography* 37:192-207.

Omnivory in food webs (Apr 18)

Stein R.A. et al. 1995. Food-web regulation by a planktivore: exploring the generality of the trophic cascade hypothesis. *Can. J. Fish. Aquat. Sci.* 52:2518-2526.

Chipps S.R., and D.H. Bennett. 2000. Zooplanktivory and nutrient regeneration by invertebrate and vertebrate planktivores: implications for trophic interactions in oligotrophic lakes. *Transactions of the American Fisheries Society* 129:569-583.

Role of food web structure (Apr 20)

Schindler, D.E., J.F. Kitchell, X. He, S.R. Carpenter, J.R. Hodgson, and K.L. Cottingham. 1993. Food web structure and phosphorus cycling in lakes. *Transactions of the American Fisheries Society* 122:756-772.

Vanni, M.J. and C.D. Layne. 1997. Nutrient recycling and herbivory as mechanisms in the "top-down" effect of fish on algae in lakes. *Ecology* 78:21-40.

Non-native species (Apr 27)

Whittier, T. R. and 5 coauthors. 2002. Indicators of ecological stress and the extent in the population of northeastern lakes: a regional-scale assessment. *Bioscience* 52:235-248.

Kolar, C.S. & Lodge, D.M. 2002. Ecological predictions and risk assessment for alien fishes in North America. *Science* 298:1233 - 1236.

Effects of fishing (May 2)

Pauly, D. et al. 2000. Fishing down aquatic food webs. *Am. Sci.* 88:46-51.

Rahel, F. 2001. Homogenization of fish faunas across the U.S. *Science* 288:854-856.

Conover, D.O. and S.B. Munch. 2002. Sustaining fisheries yields over evolutionary time scales. *Science* 297: 94-96.

Urbanization, agriculture and climate change (May 4)

Scheffer, M. (and 3 coauthors) 2001. Climate warming causes regime shifts in lake food webs. *Limnology and Oceanography* 46:1780-1783.

Vandonk, E., L. Santamaria, W.M. Mooij. 2003. Climate warming causes regime shift in lake food webs: a reassessment. *Limnology and Oceanography* 48:1350-1353.

Scheffer, M. 2003. Climatic effects on regime shifts in lakes: a reply. *Limnology and Oceanography* 48:1353-1356.

Laboratory schedule

Aquatic Trophic Ecology
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Date	Lab activity	
26 Jan	Review of empiricism	NPB 179
2 Feb	Bioenergetics theory/exercises	NPB 179
9 Feb	Bioenergetics theory/exercises	NPB 179
16 Feb	Fish Bioenergetics v 3.0	SNF 142
23 Feb	Fish Bioenergetics v 3.0	SNF 142
2 Mar	Modeling exercises	SNF 142
16 Mar	Group project	SNF 142
23 Mar	Group project	lab time
6 Apr	Group project	lab time
13 Apr	Group project	lab time
20 Apr	Group presentation	SNF 142
27 Apr	Group presentation	SNF 142
4 May	Reports due	

Aquatic Trophic Ecology (WL 717) Laboratory Section

Potential Research Topics

Bioenergetics of smallmouth bass in the Missouri River *

Walleye-rainbow smelt interactions in Lake Oahe *

Modeling mercury accumulation*

Effects of feeding rate*

Climate change