Curso de Posgrado
IV Congreso Argentino de Limnología

Bioenergetics Modelling of Aquatic Food Webs

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Fecha de Dictado: 3 y 4 de Noviembre del 2008

Duración: 20 hs

Idioma de cursado: Inglés
Lugar: Centro Regional Universitario Bariloche, UNComahue Quintral 1250, 8400, Bariloche
Cupo máximo: 15 alumnos
Matrícula: $100 participantes CAL IV y $120 alumnos externos
Coordinador del curso: Dr. Pablo Vigliano y Dra. Daniela Milano
Cierre de inscripción: 3 de Octubre del 2008

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Avalado por la Comisión del Doctorado en Biología CRUB, UN Comahue

Descripción y Programa del curso

Bioenergetically-based food web models, when coupled with directed sampling for diet, growth, size structure, thermal experience, and estimates of relative or absolute abundance of consumers and prey populations, provide an effective method for quantifying trophic interactions in a temporal, spatial, and ontogenetic framework. By quantifying linkages in a food web, we can identify strong interactions that potentially regulate populations in aquatic communities. We can address commonly recurring questions such as:

1. Determine whether predation, food supply, competition, or environmental conditions are important factors limiting survival or production of various species or life stages of interest;

2. Identify which species or size classes interact most strongly, and periods when critical interactions occur.

3. Simulations can be extended to examine the likely outcome of various scenarios to determine if various management options are feasible and potentially effective.

4. What are the strengths and weaknesses of this approach? What are viable alternatives, and how do we decide among them?

This course is intended for graduate students, advanced undergraduates, and professional biologists. A basic understanding of descriptive statistics and regression will be useful background for this course. Students are encouraged to bring questions and data from their research projects into the course.

Course Description

Learn to construct and apply bioenergetics models for fish and invertebrates to a wide array of management and research questions about trophic interactions, design supporting studies, and critically examine this approach and others through lecture, literature discussion, computer exercises, and projects. Basic understanding of descriptive statistics, regression, and Excel recommended.

Elements of the course

1. A general approach to modeling aquatic food web interactions will be presented initially through case histories to demonstrate the types of information that can be gained and the flexibility of this conceptual framework for quantitatively modeling a wide variety of problems.

2. Interactive lecture/class participation sessions will: describe the mathematical and experimental development of the model; explore and develop effective designs for field, lab, and simulation studies that utilize or contribute to enhancement of bioenergetics modeling approaches.

3. Computer exercises will be employed throughout to demonstrate model software and to explore various questions regarding physiology and ecology of aquatic organisms.

4. Critical discussion of readings on development, application, and alternatives to bioenergetics modeling.

5. Individual or group projects using the model.

Model Documentation:

Hanson, P. C., T. B. Johnson, D. E. Schindler, and J. F. Kitchell. 1997. Fish bioenergetics 3.0. Wisconsin Sea Grant Institute. WISCU-T-97-001.

Bioenergetics modeling overview and alternative methods for estimating consumption:

***Ney, J. J. 1990. Trophic economics in fisheries: assessment of demand-supply relationships between predators and prey. Rev. Aquat. Sci. 2:55-81.

Evaluation of applications, capabilities and research needs for bioenergetics models

Brandt, S. B. and K. J. Hartman. 1993. Innovative approaches with bioenergetics models-Future applications to fish ecology and management. Trans. Am. Fish. Soc. 122:731-735.

Hansen, M. J., D. Boisclair, S. B. Brandt, and S. W. Hewett. 1993. Applications of bioenergetics models to fish ecology and management-where do we go from here. TAFS 122:1019-1030.

Ney, J. J. 1993. Bioenergetics modeling today- Growing pains on the cutting edge. Trans. Amer. Fish. Soc. 122:736-748.

Model development and evaluation (Sensitivity analysis, corroboration)

***Bartell, S. M., J. E. Breck, R. H. Gardner, and A. L. Brenkert. 1986. Individual parameter perturbation and error analysis of fish bioenergetics models. Can. J. Fish. Aquat. Sci. 43:160-168. General approach to error analysis

***Kitchell, J. F., D. J. Stewart, and D. Weininger. 1977. Applications of a bioenergetics model to perch (Perca flavescens) and walleye (Stizostedion vitreum). J. Fish. Res. Board Canada 34:1922-1935. Viewed as the original published application of the “Wisconsin bioenergetics modeling approach

***Rice, J. A., and P. A. Cochran. 1984. Independent evaluation of a bioenergetics model for largemouth bass. Ecology 65:732 739.

Model application and testing against field data for consumption & growth

***Beauchamp, D. A., D. J. Stewart, and G. L. Thomas. 1989. Corroboration of a bioenergetics model for sockeye salmon. Transactions of the American Fisheries Society 118:597 607. -model development, sensitivity analysis, tested vs field data

Brodeur, R. D., R. C. Francis, and W. G. Pearcy. 1992. Food consumption of juvenile coho (Oncorhynchus kisutch) and chinook (O. tshawytscha) on the continental shelf off Washington and Oregon. Canadian Journal of Fisheries and Aquatic Sciences 49:1670 1685.

***Boisclair, D. and W. C. Leggett. 1989. The importance of activity in bioenergetics models applied to actively foraging fishes. CJFAS 46:1859-1867.- Yellow perch model tested vs field consumption estimates. Began debate over importance of activity metabolism

Wahl, D. H., and R. A. Stein. 1991. Food consumption and growth of three esocids: field tests of a bioenergetics model. Transactions of the American Fisheries Society 120:230-246.

Evaluated model estimates vs. field data for juvenile esocids (northern pike, muskie, tiger muskie)

Madenjian 1999 (systematic bias in consumption estimates in lake trout model) Transactions of the American Fisheries Society

Ruggerone, G. T., and D. E. Rogers. 1992. Predation on sockeye salmon fry by juvenile coho salmon in Chignik Lakes, Alaska: implications for salmon management. North American Journal of Fisheries Management 12:87 102.

Prey Energy Density

Bryan et al. 1996. Caloric densities of three predatory fishes and their prey in Lake Oahe, South Dakota. J. Freshwater Ecology 11:153-161.

Cummins, K. W. and J. C. Wuycheck. 1971. Caloric equivalents for investigations in ecological energetics. Mitt. Int. Ver. Limnol. Comm. No. 18. 151 pp.

***Hartman, K. J., and S. B. Brandt. 1995. Estimating energy density of fish. Transactions of the American Fisheries Society 124:347-355.

***Luecke & Brandt 1993. Estimating energy density of daphnid prey for use with rainbow trout bioenergetics models. Transactions of the American Fisheries Society 122:386-389.

***Rand et al. 1994. Energy density and size of pelagic prey fishes in Lake Ontario 1978-1990: implications for salmonid energetics. Transactions of the American Fisheries Society 123:519-534.

Snow, N. B. 1972. The effect of season and animal size on the caloric content of Daphnia pulicaria Forbes. Limnology and Oceanography 17:909-913.

Stockwell, J. D., K. L. Bonfantine, and B. M. Johnson. 1999. Kokanee foraging: a Daphnia in the stomach is worth two in the lake. Transactions of the American Fisheries Society 128:169-174.

Model applications to management of consumers and their forage base

Piscivores:

***Stewart, D. J., J. F. Kitchell, and L. B. Crowder. 1981. Forage fishes and their salmonid predators in Lake Michigan. Trans. Am. Fish. Soc. 110:751 763. --Classic early application of bioenergetics model

Two follow-up articles that assessed accuracy of predictions by Stewart et al. 1981:

Kitchell, J. F., and L. B. Crowder. 1986. Predator prey interactions in Lake Michigan: model predictions and recent dynamics. Env. Biol. Fish. 16:205 211.

Stewart, D. J., and M. Ibarra. 1991. Predation and production by salmonid fishes in Lake Michigan, 1978 88. Can. J. Fish. Aquat. Sci. 48:909 922.

Stewart et al. 1983,CJFAS (Lake trout model development and application)

Ruggerone, G. T., and D. E. Rogers. 1992. Predation on sockeye salmon fry by juvenile coho salmon in Chignik Lakes, Alaska: implications for salmon management. North American Journal of Fisheries Management 12:87 102.