

## Modeling energy flow in a large Neotropical reservoir: a tool to evaluate fishing and stability

Ronaldo Angelini\*, Angelo Antonio Agostinho\*\* and Luiz Carlos Gomes\*\*

Recently, there is an increasing perception that the ecosystem approach gives important insights to support fisheries stock assessment and management. This paper aims to quantify energy flows in the Itaipu Reservoir (Brazil) and to simulate increase of the fishing effort of some species, using Ecopath with Ecosim software, which could allow inferences on stability. Therefore, two steady-state Itaipu models were built (1983-87 and 1988-92). Results showed that: a) there are no differences between models, and results on aging trends do not vary over time indicating that fishery does not alter the ecosystem as a whole; b) results of fisheries simulations are approximate to mono-specific stock assessment for the same species and periods; c) many authors believe that tropical ecosystems are environments where biotic and abiotic oscillations are annual and sometimes unexpected, but the results found for the Itaipu Reservoir indicate that stability was met after 16 years.

Nos dias atuais, aumenta a percepção que a análise ecossistêmica fornece importantes esclarecimentos na avaliação e manejo de estoques pesqueiros. Este trabalho objetiva quantificar o fluxo de energia na teia trófica do reservatório de Itaipu e simular o aumento de pesca de algumas espécies usando o programa "Ecopath com Ecosim", que permite inferências sobre a estabilidade do sistema. Desta forma, dois modelos de "estado-estacionário" foram construídos (o primeiro para o período 1983-87 e o outro para 1988-92). Os resultados mostraram que: a) não há diferenças entre os modelos e os resultados sobre tendências de amadurecimento não variam com o tempo indicando que a pesca não altera o sistema como um todo; b) os resultados de simulação de pesca se aproximam de avaliações mono-específicas, realizadas por outros autores, com dados de mesmas espécies e períodos; c) muitos autores acreditam que reservatórios tropicais são ambientes submetidos a oscilações antrópicas que alteram grandemente sua dinâmica dificultando a estabilidade, mas os resultados para o reservatório de Itaipu indicam que a estabilidade foi encontrada 16 anos após a sua formação.

**Key words:** Ecopath, Food web, Fisheries, Ecosystem, Simulation.

### Introduction

Trophic ecosystem models allow measurement of trophic flows among various system components (primary producers, consumers and predators) and provide fundamental information on their influences on recycling, primary production and food web (Christensen, 1995). Foundations of this ecosystem approach were established by Odum (1969) and Lindeman (1942), which described development of systems restricted by the Second Law of Thermodynamics and therefore susceptible to simulation.

Recently, there is an increasing recognition that the ecosystem approach gives important insights to support fish stock assessment and management (Christensen & Pauly, 1993; Walters *et al.*, 1997; Mace, 2001; Hilborn *et al.*, 2003; FAO, 2003). This new approach is called Ecosystem-Based

Fishery Management (EBFM), and its overall objective is to maintain the health of aquatic ecosystems and the fisheries they support (Pikitch *et al.*, 2004).

Multi-specific policy decisions can be simulated in ecosystem models (Christensen & Pauly, 1998; Heymans *et al.*, 2004), and comparisons of these models have increased our understanding on ecosystem functioning and fisheries trends (Vasconcellos *et al.*, 1997; Jarre-Teichmann, 1998; Aoki & Mizushima, 2001; Christensen *et al.*, 2003).

Although most studies on EBFM deal with marine systems, application of this approach in freshwater is important because inland fisheries are apparently more susceptible to environmental changes and play a fundamental role as food source in many countries (FAO, 2002).

Food web simulation in freshwater ecosystems, especially reservoirs, has aided to test several fisheries management

\*Universidade Estadual de Goiás – UnUCET, Laboratório de Biodiversidade do Cerrado, BR 153 Km 98, Jd. Arco Verde, CP 459, 75074-840 Anápolis, GO, Brazil. e-mail: ronangelini@yahoo.com.br

\*\*Universidade Estadual de Maringá – UEM, Departamento de Biologia-NUPELIA, Av. Colombo, 5790, 87020-900 Maringá, PR, Brazil.