

Secwépemc/Shuswap culture), through a series of interrelated tables (Pauly et al 1993a, Palomares et al. 1993), thus enabling comparisons between LEK and scientific knowledge, and cross validation. Field and literature-based projects devoted to accumulating and encoding such knowledge, e.g., in the context of Cury's (1994) theory of site fidelity in spawning fishes, would seem particularly worthwhile, given that FishBase, once it incorporate this knowledge, could be used to disseminate it in schools, community centers, etc.

The second approach would consist of a workshop that would be convened to present an Ecopath model of a coastal area to a group of knowledgeable fishers from First Nations and the community-at-large. This workshop would begin the process of

correlating local knowledge and intuitions with the relationships, data gaps and conflicts identified through the model. Without wanting to prejudge the results of such an exercise, there is little doubt that such cross validation would lead to new insights and directions for future collaboration to address, and perhaps resolve some data gaps and conflicts.

Updates on Ecopath development and applications

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The workshop reported upon in this report did not only generate three models of ecosystems important to the fisheries of

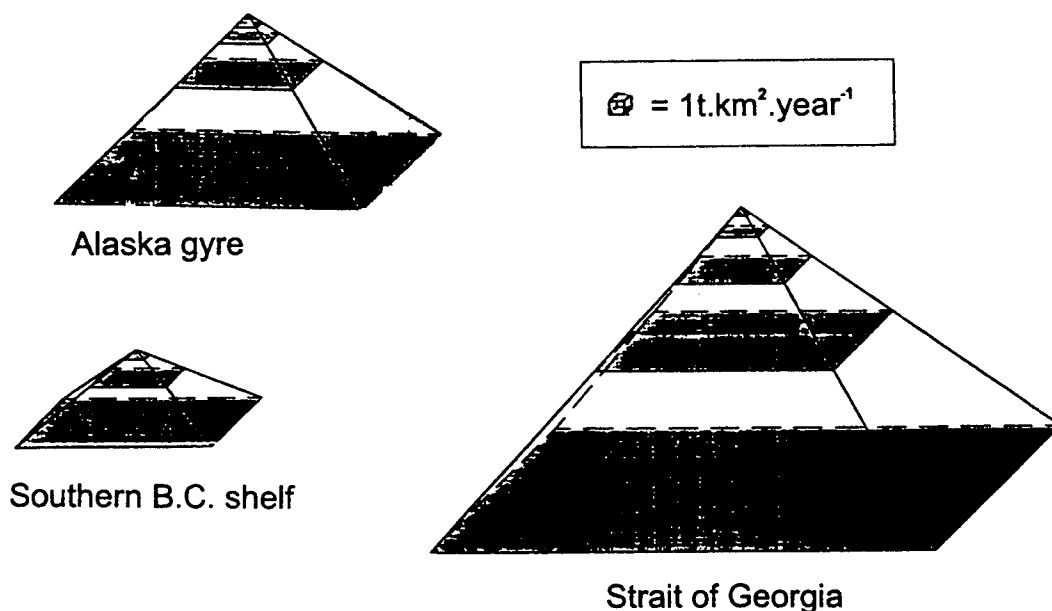


Figure 6 Trophic pyramids representing the three ecosystem models documented here. The pyramids are scaled such that the volume at each (trophic) level corresponds to the sum of all flows at that level, while the top angle is inversely related to the transfer efficiency prevailing in the system (acute angle = high efficiency). These pyramids allow direct comparisons of whole ecosystem properties.

British Columbia (see Figure 6) — though this, by itself would have been enough to meet our stated goals. Rather, the workshop became a watershed in the development of the Ecopath approach and software—and probably for the discipline of ecosystem modeling as a whole—thanks to the input of Carl Walters (see above), who contributed to:

1. re-expression of the Monte-Carlo routine built into the β -release of Ecopath 3.0 (Christensen and Pauly 1995) in form of a semi-Bayesian approach for considering uncertainties;
2. explicit incorporation of seasonal cycles of biomass and related parameters when mass-balancing a model; and
3. reexpression of the system of linear equations behind Ecopath (see Box 1) into a system of differential equations that can be integrated over time, and hence generate fully operational simulation models from Ecopath files.

Ecopath 3.0 as now distributed (free of charge, see Christensen and Pauly 1996) incorporates item (1), [in the semi-Bayesian context proposed by Walters (this vol.), i.e., the SIR approach of McAllister et al. (1994)], and hence can be used to generate, besides distributions of the *output* values, posterior distributions of the *input* values, given (uniform, triangular, or normal) distributions of the inputs.

This we hope will go a long way towards overcoming the doubts of those who feel that mass-balance models - or ecosystem models in general - do not sufficiently take account of uncertainties. However, the model in this report has been constructed

before the SIR approach was incorporated into Ecopath, and hence the power of this approach will have to be demonstrated elsewhere (e.g. with the next iterations of these models).

We have developed a hybrid design for the incorporation of item (2) in Ecopath, i.e. for explicit consideration of seasonality, which we envision as driven by seasonally-varying empirical observations of biomass, catches, and diet compositions, and using a monthly cycle of temperature to force changes in P/B and Q/B, both known to be temperature-dependent (Pauly 1980, 1989).

This design is to be implemented later in 1997, and hence Ecopath users wanting to explicitly account for seasonality will continue, for a short while, to have to construct one model per month or season of a seasonal cycle, as in Jarre and Pauly (1993), and in Jarre-Teichmann (1995, respectively). The three models presented above all represent “summer” situations and colleagues interested in the ecosystems these models represent should complement these with “winter” models, for which we present much of what is required in terms of biomasses or population sizes, catches, diet compositions, etc.

Then, later the summer and winter models can provide the input for “annual” models, explicitly taking seasonal changes of biomass and fluxes when establishing mass balance.

Item (3), the use of Ecopath assessments to parametrize the system of differential equations required for simulation models has been fully conceptualized (Walters et al. in press). Also, a software module (Ecosim) has been developed whose stand-alone

version (which reads unmodified Ecopath files) is presently being tested at the Fisheries Centre, while also being modified such that it can be incorporated as a routine of the next (4.0) release of Ecopath (Christensen and Pauly, in press).

Ecopath has been used so far to describe nearly hundred aquatic ecosystems as well as numerous farms (see, e.g., Dalsgaard et al. 1995), a recent, and unexpected development.

However, these earlier applications - successful as they were in integrating a vast amount of data, and describing the functioning of these ecosystems, remained - for some colleagues at least - under the dark clouds of assumptions of determinism (there were no procedure to explicitly account for uncertainties) and equilibrium (change was hard to express, for lack of an explicit temporal dimension). These dark clouds have now been blown away, and we anticipate a bright future for mass-balance modelling.