Strait of Georgia Ecosystem Research Initiative
Modelling component

Ecosystem-based assessment and management requires new tools which take a whole-ecosystem approach rather than focus on single species. One of these tools being developed to better understand the Strait of Georgia ecosystem is an end-to-end model representing all ecosystem components from primary producers to top predators, linked through trophic interactions and affected by the physical abiotic environment. This system comprises a physical circulation model (ROMS) coupled to a lower trophic level model (NPDZ) which then feeds into an upper trophic level model (OSMOSE). In addition, a whole-ecosystem model (ECOPATH) is also being applied to the Strait of Georgia, which uses a different modeling framework from the previous three models.

The Regional Ocean Modeling System, or ROMS, is a free-surface, terrain-following, primitive equations ocean model widely used by the scientific community for a diverse range of applications. The ROMS model (D. Masson, IOS) is now being developed to provide the underlying circulation and water properties (temperature and salinity) for the Straits of Georgia and Juan Fuca over a typical seasonal cycle. The model is forced by freshwater inflow from major rivers, tidal forcing at the open boundaries, as well as wind stress and heat flux at the surface. The output from the physical model will be used to drive the lower trophic level (NPZD) model.

To address the climate change issue (M. Foreman, IOS), potential initial conditions and boundary forcing for simulations with ROMS of future conditions will be computed from two sources: i) results from a 15km resolution regional climate model for the Pacific Northwest, and ii) downscaled results from an ensemble of global climate models that were used for the recent IPCC assessment reports. Though we expect that the regional climate model values will be more accurate and thus the ones actually used in the simulations, that expectation will be confirmed (or refuted) through model comparisons against oceanic and atmospheric observations taken over the 1980-2005 period. Work will also be done into examining the impact of the predicted changes in the Fraser River watershed and resulting river flows (J. Morrison, IOS) on the Strait of Georgia oceanic conditions.

A lower trophic level ecosystem model (NPZD – Nitrate, Phytoplankton, Zooplankton and Detritus) is being developed (A. Pena, IOS) and coupled to the ROMS circulation model for the Strait of Georgia to study the dynamics of the planktonic ecosystem and to identify and understand key factors responsible for temporal and geographical changes in productivity and biogeochemical cycles. At present, a copepod compartment is being added to the model and biological parameter values are being constrained by using available field observations. Initial tests of the model will be done by simulating summer average conditions and evaluating the model output with available observations.

The coupled physical – lower trophic model will then be coupled with the OSMOSE upper trophic level of the Strait of Georgia, under development (C. Fu, I. Perry, PBS). OSMOSE (Object-oriented Simulator of Marine Ecosystems Exploitation)

is an individual-based multi-species model that has a flexible structure and allows for the study of the spatial dynamics, structured in age and size, and of a great number of species that interact. The present development of the Strait of Georgia implementation of the model includes the addition of modules for marine mammals and benthic invertebrates in the SoG ecosystem, the determination of spatio-temporal scales and parameters, and forcing with ROMS-NPZD, as well as the calibration of the model to a climatological year.

In parallel to the modeling system described above, work is also done towards the development of the ECOPATH model in order to link changing climate and ocean conditions within the Strait of Georgia to the shifting dominance of upper trophic level species. The ECOPATH approach creates a static mass-balanced snapshot of the resources in an ecosystem and their interactions, represented by trophically linked biomass 'pools'. The updated ECOPATH model package (ECOPATH with ECOSIM, EWE) includes a dynamic simulator which permits the inclusion of temporal (inter-annual) variability in time series. The EwE model for the Strait of Georgia (R. Beamish, PBS) will be extended in an attempt to directly link historical trends in species abundance with trophic relationships and environmental changes. It serves as an alternative or competing model for comparisons with the ROMS-NPZD-OSMOSE model approach.