(To be inserted in TOC) Contaminant Tracing

Page under development

ECOTRACER: Using Ecosim to predict movement and accumulation of contaminants and tracers in food webs

Ecosim predicts temporal changes flows of biomass among living and detritus pools using nonlinear functional relationships between flow rates and abundances of the interacting species. These flow rates (along with auxiliary information about factors such as isotope decay rate and physical exchange rates) can be used to predict changes in concentrations (and per-biomass burdens) of chemicals like organic contaminants and isotope tracers that ?flow? passively along with the biomass flows. The dynamic equations for such passive flow (and accumulation, e.g. ?bioamplification?) are not the same as the biomass flow rate equations, and in fact are generally linear dynamical equations with time-varying rate coefficients that depend on the biomass flow rates; these linear equations are relatively easy to solve in parallel with the Ecosim biomass dynamics equations.

In Ecosim we allow parallel simulation of one tracer or contaminant type while the biomass dynamics equations are being solved. Tracer molecules are assumed to be either in the ?environment?, or in the biota (in biomass and detritus pools) at any moment. Molecules are assumed to flow between pools at instantaneous rates (i.e. to be sampled along with biomass during biomass flows at rates) equal to the probabilities of being ?sampled? as part of the biomass flow: instantaneous rate=(flow)/(biomass in prey pool). We also allow for direct flows from the environment into pools, representing direct uptake or absorption of the tracer material, and for differential decomposition/decay/export rates by pool and from the environmental pool. Schematically, the flow of tracer molecules through any biomass pool is represented by the components shown below:

Your browser may not support display of this image. In the rate equation for time changes in contaminant concentration in pool i, these components are represented as follows:

- i. Uptake from food: C_jGC_iQ_j/B_j where C_j=conc in food _j GC_j=proportion of food assimilated by type _j organisms; Q_{jj}=biomass flow rate from _j to _j B_j=food , biomass;
- ii. Direct uptake from environment: uB_iC_o, where u=parameter representing uptake per biomass per time, per unit environmental concentration, B_i=biomass, C_o=environmental concentration;
- iii. Concentration in immigrating organisms: c₁, where c_i-parameter (tracer per unit biomass in immigrating biomass), I_i-biomass of pool I immigrants per time;
- iv. Predation: C₁Q₁/B_p where C_i=concentration in pool _p Q_i=consumption rate of type _i organisms by predator type _p B_i=biomass in pool _p
- v. Detritus: C₁MO₁+(1-GC₁)S₁C₂Q₁/B₂), where MO₁=non-predation death rate of type _i (yr-1), GC₁=fraction of food intake assimilated, Q₁=intake rate if type _j biomass by type _j.
- vi. Emigration: e_iC_p, where e_i=emigration rate (yr-1);
- vii. Metabolism: $d_i C_p$, where d_i =metabolism+decay rate for the material while in pool r_i

Hence Ecotracer users must specify some parameters (using the Ecotracer input form) besides those needed for Ecopath/ecosim mass balance and biomass dynamics calculations:

- i. initial pool concentrations C, including environmental concentration C,
- ii. direct uptake rate parameters u, as rates per time per biomass per unit Co;
- iii. conentrations per biomass c_i in immigrating organisms;
- iv. metabolism/decay rates d,

The other parameters (GC_{*p*} MO_{*j*}) are already be entered or calculated in Ecopath, and the Q_{ij} flows are calculated dynamically in Ecosim. Ecotracer users can also enter inflow, outflow (dispersal/advection exchange to outside systems), and decay rates for the ?environmental? (abiotic) concentration C_{o} .

When the Ecotracer simulation component is enabled (check box on Ecotracer entry form), Ecosim integrates the rate components listed above to generate time concentration patterns C_i (=0 to number of biomass pools), and time patterns of concentration per biomass C/B_i for all Ecopath/Ecosim? biomass pools. These results can be compared to data on bioaccumulation or tracer movement. Discrepancies between model and data may help identify weaknesses in the ecopath/ecosim trophic flow rate (Q_{ij}) estimates, and/or in the Ecotracer rate parameters ($u_i e_i d_i$).