Wikiprint Book

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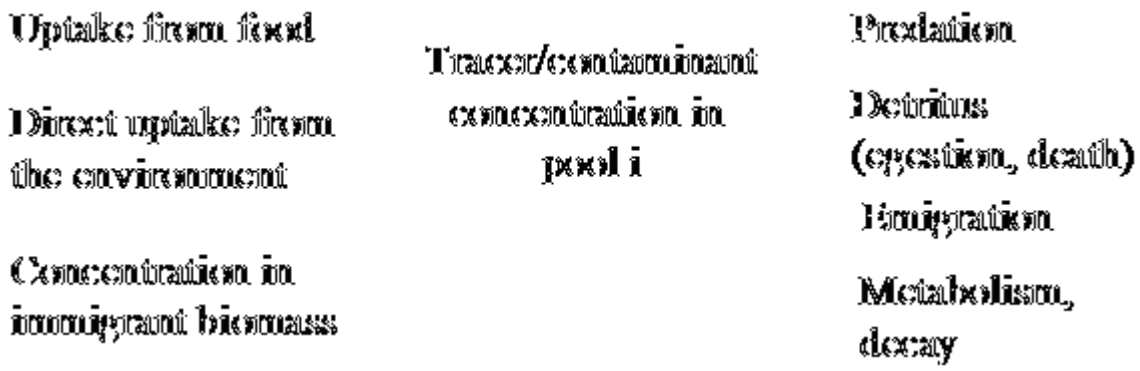
(To be inserted in TOC) Contaminant Tracing

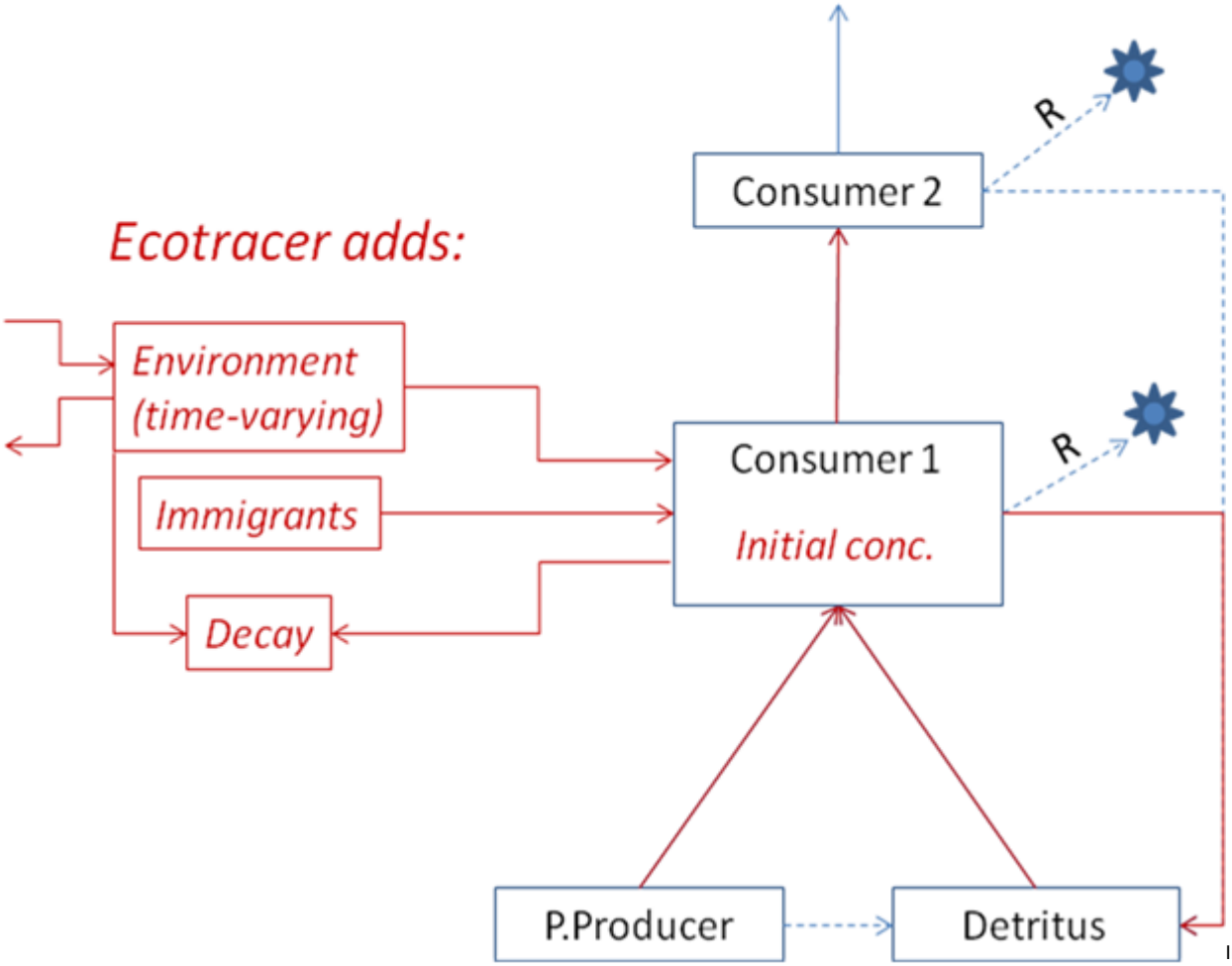
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ECOTRACER: Using Ecosim to predict movement and accumulation of contaminants and tracers in food webs

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:





In the rate equation for time changes in contaminant concentration in pool i, these components are represented as follows:

i. Uptake from food: $C_j GC_i Q_{ji}/B_j$ where C_j=conc in food $_j$, GC_i=proportion of food assimilated by type $_i$ organisms; Q_{ji}=biomass flow rate from $_j$ to $_i$, B_j=food $_j$ biomass;
ii. Direct uptake from environment: $u_i B_i C_o$, where u_i=parameter representing uptake per biomass per time, per unit environmental concentration, B_i=biomass, C_o=environmental concentration;
iii. Concentration in immigrating organisms: $c_i I_i$, where c_i=parameter (tracer per unit biomass in immigrating biomass), I_i=biomass of pool I immigrants per time;
iv. Predation: $C_i Q_{ij}/B_i$, where C_i=concentration in pool $_i$, Q_{ij}=consumption rate of type $_i$ organisms by predator type $_j$, B_i=biomass in pool $_i$.
v. Detritus: $C_i MO_i+(1-GC_i)S_j C_j Q_{ji}/B_j)$, where MO_i=non-predation death rate of type $_i$ (yr-1), GC_i=fraction of food intake assimilated, Q_{ji}=intake rate if type $_j$ biomass by type $_i$;
vi. Emigration: $e_i C_i$, where e_i=emigration rate (yr-1);
vii. Metabolism: $d_i C_i$, where d_i=metabolism+decay rate for the material while in pool $_i$.

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_i, including environmental concentration C_o;
ii. direct uptake rate parameters u_i as rates per time per biomass per unit C_o;
iii. conentrations per biomass c_i in immigrating organisms;
iv. metabolism/decay rates d_i.

The other parameters (GC_i, MO_i) 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 ($_i$=0 to number of biomass pools), and time patterns of concentration per biomass C_i/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).