Modeling foodweb response to midge input in Mytvan

November 13, 2017

1 Model description

We constructed a simple model to track the change in nitrogen content among six components. At time t, the nitrogen pool is denoted by $N(t)$. The nitrogen content in the detritus, plants, detrivores, herbivores, predators, and midges are denoted by $D(t), P(t), V(t), H(t), R(t)$, and $M(t)$, respectively. Hereon, we omit the time notation for simplicity.

For all consumers but the plants, they follow a Holling type II functional response, i.e.,

$$f(X) = a_X X \frac{Y}{1 + a_X h_X Y}, \tag{1}$$

where X is the density of consumer, Y the density of prey, a_X and h_X the attack rate and handling time of the consumer. For the plants, we instead assume a logistic consumption, i.e.,

$$f(P) = a_P P N (1 - \frac{P}{K_p}), \tag{2}$$

where K_P is the carrying capacity of the plants.

We also assume that nitrogen is lost within each component at component-specific rate m_X (replace the X by the actual notation of each component). Only fraction a $1 - l_X$ of component returns to the detritus, and thus l_X is lost outside the system. Note that a fraction $1 - l_D$ moves from the detritus to the nitrogen pool. Finally, a constant input of nitrogen is added and is denoted by i_N and and a pulse of midge is added at a rate i_M. Putting all these assumptions, the change in nitrogen content in each pool is

$$
\begin{cases}
\frac{dN}{dt} & = i_N - a_P N P(1 - \frac{P}{K_P}) + (1 - l_D) m_D D - m_N N \\
\frac{dD}{dt} & = (1 - l_P) m_P P + (1 - l_V) m_V V + (1 - l_H) m_H H + (1 - l_R) m_R R + (1 - l_M) m_M M - \\
 & \quad \frac{a_V V D}{1 + a V h V D} - m_D D \\
\frac{dP}{dt} & = a_P N P(1 - \frac{P}{K_P}) - \frac{a_H H P}{1 + a_H h_H P} - m_P P \\
\frac{dV}{dt} & = \frac{a_V V D}{1 + a_V h_V D} - \frac{a_R R V}{1 + a_R h_R (V + H + M)} - m_V V \\
\frac{dH}{dt} & = \frac{a_H H P}{1 + a_H h_H P} - \frac{a_R R H}{1 + a_R h_R (V + H + M)} - m_H H \\
\frac{dR}{dt} & = \frac{a_R R (V + H + M)}{1 + a_R h_R (V + H + M)} - m_R R \\
\frac{dM}{dt} & = i_M - \frac{a_R R M}{1 + a_R h_R (V + H + M)} - m_M M
\end{cases}
$$

2 Model parameters

Table 1: Parameter values

	Nitrogen (N)	Detritus(D)	Plants (P)	Detrivores (V)	Herbivores (H)	Predators (R)	Midge (M)
$t = 0$	343000	114000	4300	81	24	13	??
$m_{\cdot}$	??	??	??	??	??	??	??
$a_{\cdot}$	N.A.	??	??	??	??	??	N.A.
$h_{\cdot}$	N.A.	??	N.A.	??	??	??	N.A.
$i_{\cdot}$	??	N.A.	N.A.	N.A.	N.A.	N.A.	??
$K_{\cdot}$	N.A.	N.A.	??	N.A.	N.A.	N.A.	N.A.