# Implications of how the competition term is implemented in MARAM/IWS/DEC16/Hake Pred/P2

A. Ross-Gillespie

Contact email: *mlland028@myuct.ac.za*

Some equations from Appendix A of MARAM/IWS/DEC16/Hake Pred/P2 are repeated here to illustrate the implications of the way in which the "competition" term limiting the predation mortality rate has been implemented.

## 1 Hake prey

Then the total predation rate on these particular prey is:

$$P_{saym} = \sum_{s_p,a_p} V_{saym}^{s_p a_p} \tag{1}$$

where $V_{saym}^{s_p a_p}$ is modelled here by a Holling Type II functional form:

$$V_{saym}^{s_p a_p} = \breve{N}_{ym}^{s_p a_p} \gamma_{sa}^{s_p a_p} \frac{\nu_s^{s_p} \theta^{s_p a_p}}{1 + \sum_s \tilde{\nu}_s^{s_p} \Phi_{sym}^{s_p a_p} + \tilde{\nu}_{other}^{s_p} O_{other}^{s_p a_p}} \tag{2}$$

$\nu_s^{s_p}$, $\tilde{\nu}_s^{s_p}$ and $\tilde{\nu}_{other}^{s_p}$ are estimable parameters.

The number of hake prey of species $s$ and age $a$ consumed in month $m$ of year $y$ by predators of species $s_p$ and age $a_p$ is given by:

$$E_{saym}^{s_p a_p} = V_{saym}^{s_p a_p} N_{saym} \frac{\left(1 - e^{-Z_{saym}}\right)}{Z_{saym}} \tag{3}$$

Finally, the mass of hake of species $s$ consumed in year $y$ by predators of species $s_p$ and age $a_p$ is given by:

$$Q_{sym}^{s_p a_p} = V_{saym}^{s_p a_p} \left( \sum_{\tilde{a}=12a}^{12a+11} \widetilde{N}_{s\tilde{a}ym} w_{s\tilde{a}} \right) \frac{\left(1 - e^{-Z_{saym}}\right)}{Z_{saym}} \tag{4}$$

The term $\sum_{\tilde{a}=12a}^{12a+11} \widetilde{N}_{s\tilde{a}ym} w_{s\tilde{a}}$ is the total weight of prey taking their individual weight by age in months into account.

## 2 Other prey

Let the total mortality rate for other prey be given by:

$$Z_{other,ym}^{s_p a_p} = M_{other}^{basal}/12 + P_{other,ym} \tag{5}$$

where

| | |
|---|---|
| $M_{other}^{basal}$ | is the basal mortality rate for the other prey, fixed at 0.2 p.a., and |
| $P_{other,ym}$ | is the predation mortality on other prey due to hake predators, given by: |

$$P_{other,ym} = \sum_{s_p,a_p} V_{other,ym}^{s_p a_p} \tag{6}$$

$V_{other,ym}^{s_p a_p}$ is the mortality of other prey due to hake predators of species $s_p$ and age $a_p$ in month $m$ of year $y$, also modelled by a Holling Type II functional form:

$$V_{other,ym}^{s_p a_p} = \breve{N}_{ym}^{s_p a_p} \frac{\nu_{other}^{s_p} \theta^{s_p a_p}}{1 + \sum_s \tilde{\nu}_s^{s_p} \Phi_{sym}^{s_p a_p} + \tilde{\nu}_{other}^{s_p} O_{other}^{s_p a_p}} \tag{7}$$

The mass of other prey consumed in year $y$ by predators of species $s_p$ and age $a_p$ is then given by:

$$Q_{other,ym}^{s_p a_p} = V_{other,ym}^{s_p a_p} \tilde{O}_{other}^{s_p,a_p} \frac{\left(1 - e^{-Z_{other,ym}}\right)}{Z_{other,ym}} \tag{8}$$

$\tilde{O}_{other}^{s_p,a_p}$ is a measure of the **mass** of the other prey available to a hake predator of species $s_p$.

# 3 $P_{lim}$ constraint

The section of code implementing the $P_{lim}$ constraint is reproduced below.

```
Plim=0.06;
    for(s=1;s<=2;s++){
        for(at=amin;at<=max_a_max;at++){
            Calc_V();
            P(s,year,m,at)=sum(V(year,m,s,at));
            if(P(s,year,m,at)<0.9*Plim){
                P(s,year,m,at)=P(s,year,m,at);
            }else if(P(s,year,m,at)>=0.9*Plim&P(s,year,m,at)<=1.1*Plim){
                P(s,year,m,at)=P(s,year,m,at)-(2.5/Plim)*(P(s,year,m,at)-0.9*Plim)*(P(s,year,m,at)-0.9*Plim);
            }else{
                P(s,year,m,at)=Plim;
            }
        }
    }
```