AN ILLUSTRATION OF THE CALIBRATION NECESSARY BETWEEN SINGLE-SPECIES AND ECOSYSTEM MODEL BASED ESTIMATES OF THE UNEXPLOITED EQUILIBRIUM BIOMASS (*K*) FOR A FORAGE FISH SPECIES

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The initial four slides in the attached illustrate broadly:

- a typical single-stock assessment situation: a Beverton-Holt stock-recruitment curve,
- a replacement line (straight given the assumption of density independent natural mortality) which intersects the recruitment curve at *K*, and
- a sustainable yield (catch) curve in relation to (spawning) biomass which in most cases closely corresponds to the difference between the recruitment curve and the replacement line.

The parameters of the recruitment curve are chosen to give $B_{MSY} = 0.4\ K$. Note that in this case the sustainable yield at a biomass of 0.75 *K* is about 40% less than MSY.

The next two slides show also a yield curve for forage fish species typical of that inferred from ecosystem models in Smith *et al.* (2011) is flatter topped than that for the Beverton-Holt stock-recruitment curve above. This implies a recruitment function showing more compensatory behaviour as *B* approaches *K*, as well as a lesser reduction of sustainable yield below MSY for $B = 0.75\ K$.

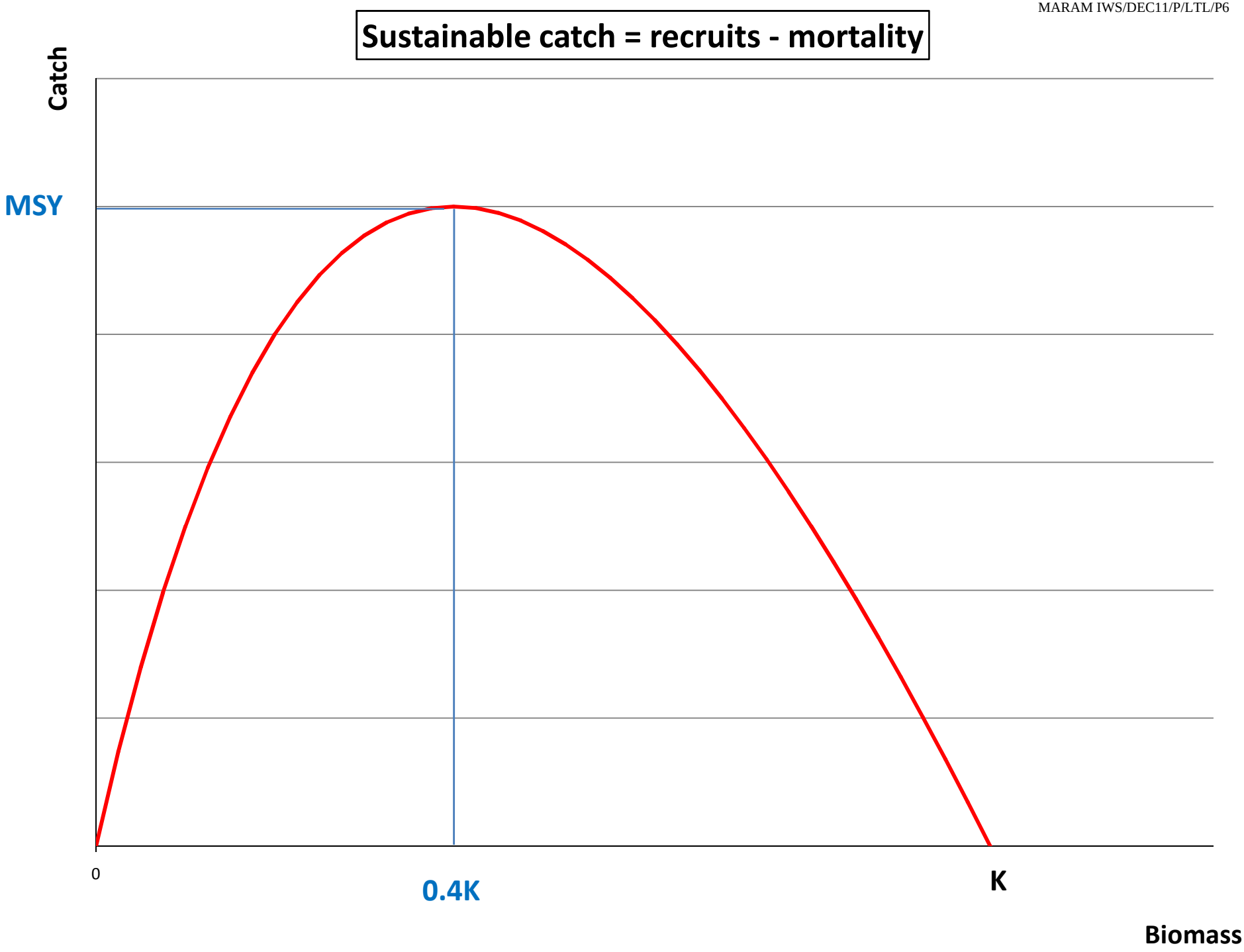
However, if a Beverton-Holt stock recruitment curve was fitted to data generated from this more compensatory curve, it would tend to look like the dashed curve, which intersects the replacement line at a higher *B* value (indicated as *K**) than the single-stock model's *K*. Thus the estimated single-stock value *K** will tend to be larger than it's ecosystem model equivalent of *K*. The associated "calibration factor" between the two approaches different *K*'s then means that a reference point such as 0.75 K from the ecosystem models will be **LOWER** when expressed in terms of the unexploited equilibrium value of *K** as would be estimated in a single species assessment.

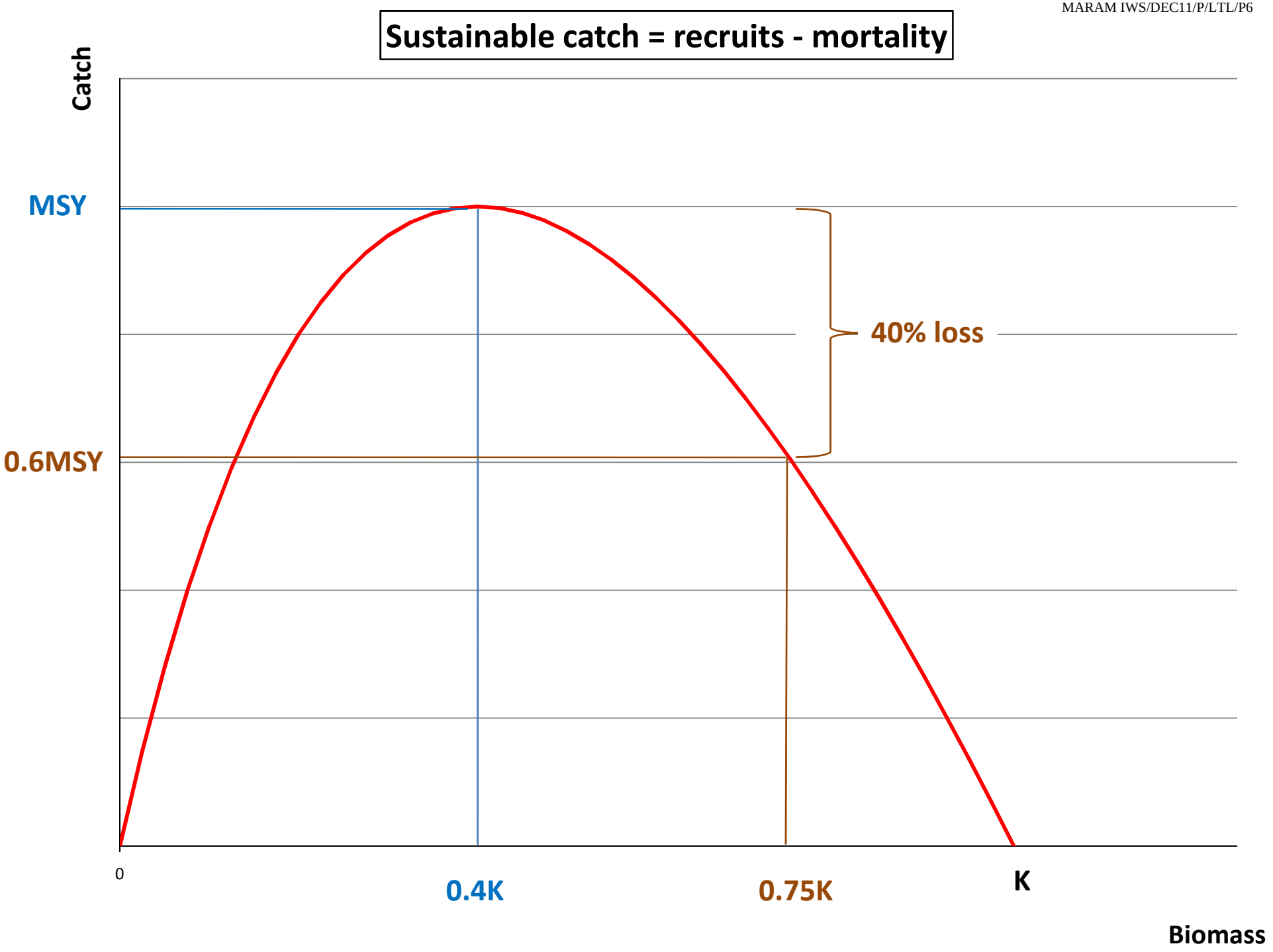
Reference

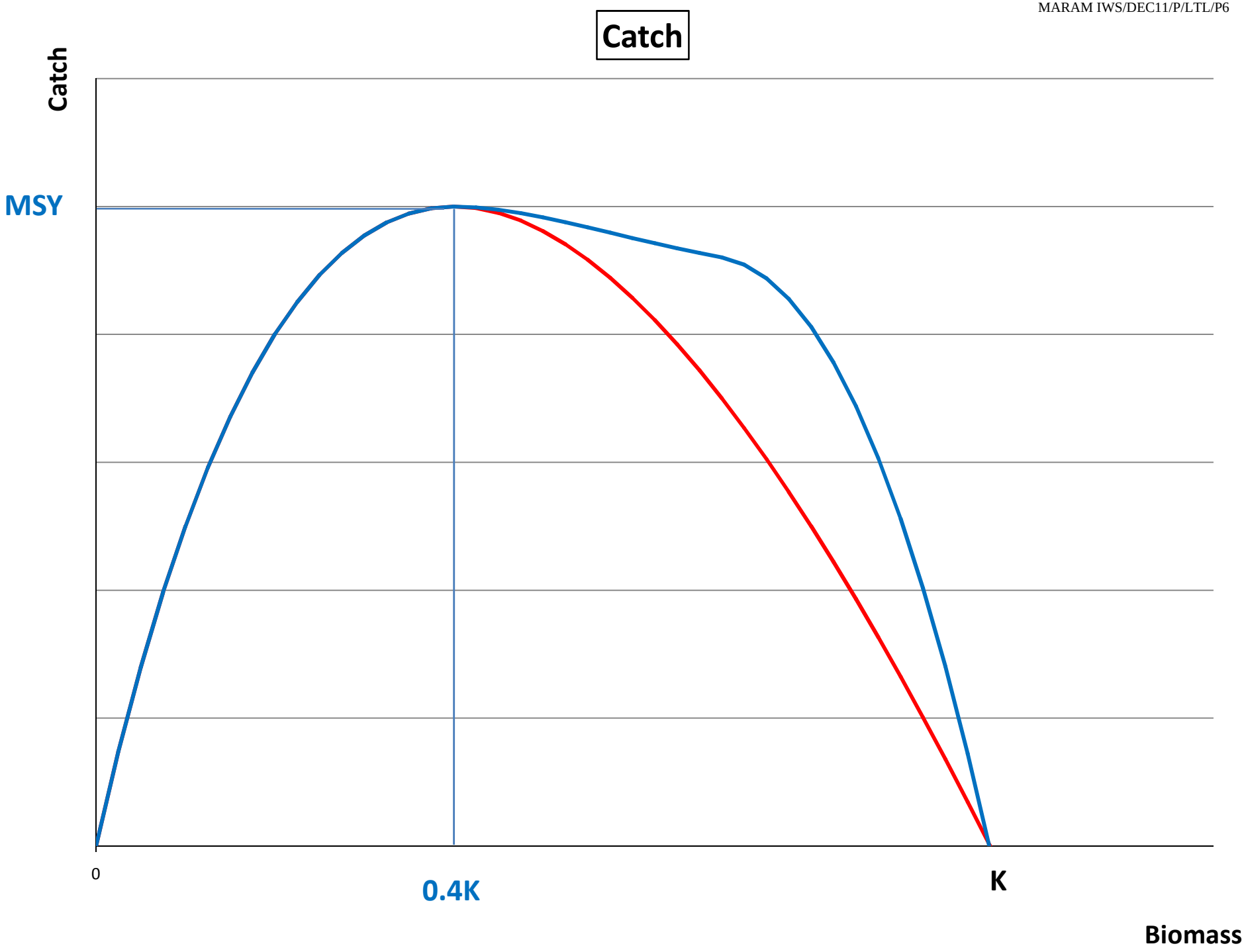
Smith, A.D.M., Brown, C.J., Bulman, C.M., Fulton, E.A., Johnson, P., Kaplan, I.C., Lozano-Montes, H., Mackinson, S., Marzloff, M., Shannon, L.J., Shin, Y-J. and Tam, J. 2011. Impacts of fishing low–trophic level species on marine ecosystems. *Science*, 333(6046): 1147-1150.


Recruits
R
0
Biomass

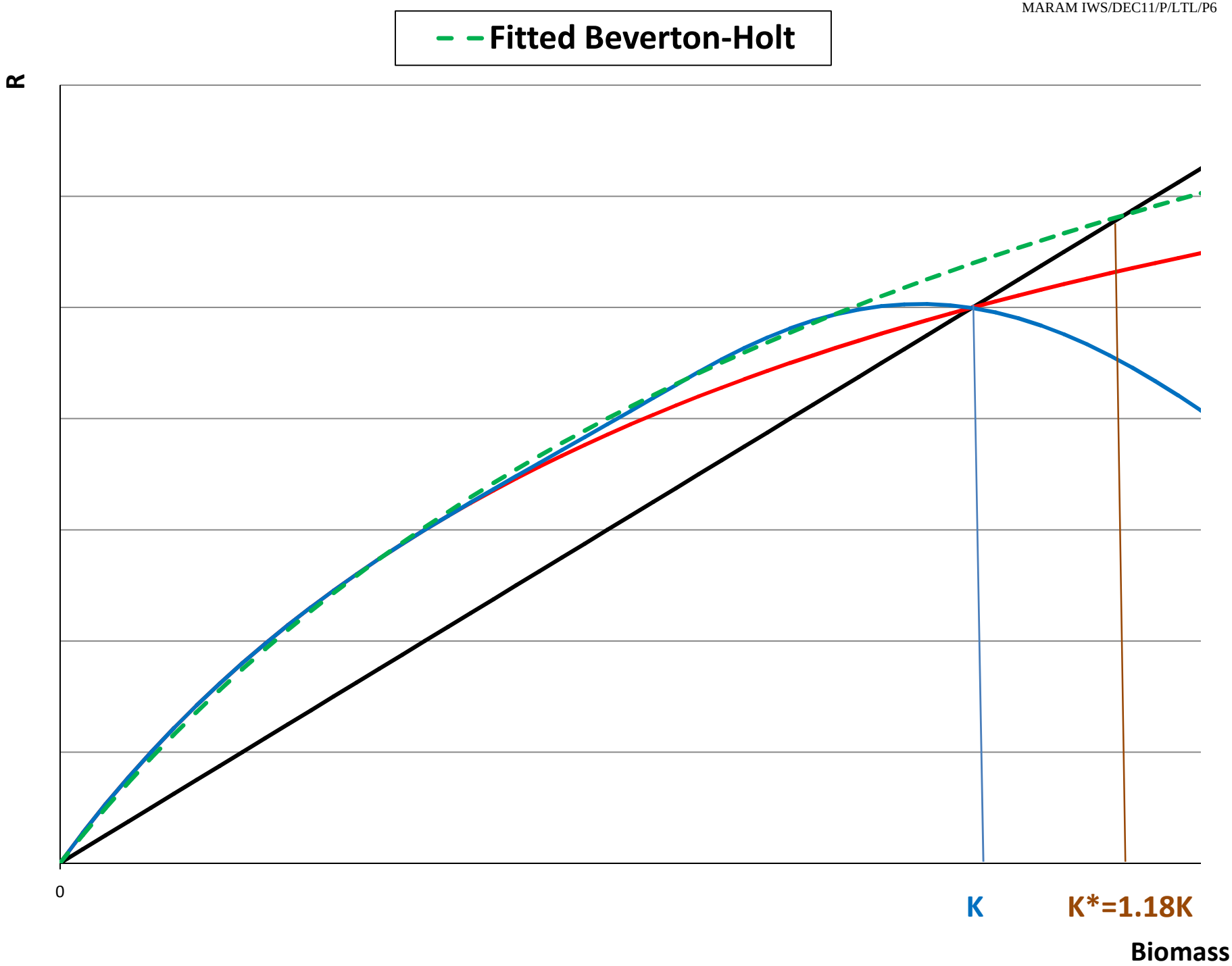

Replacement line
Recruits
R
0
K
Biomass

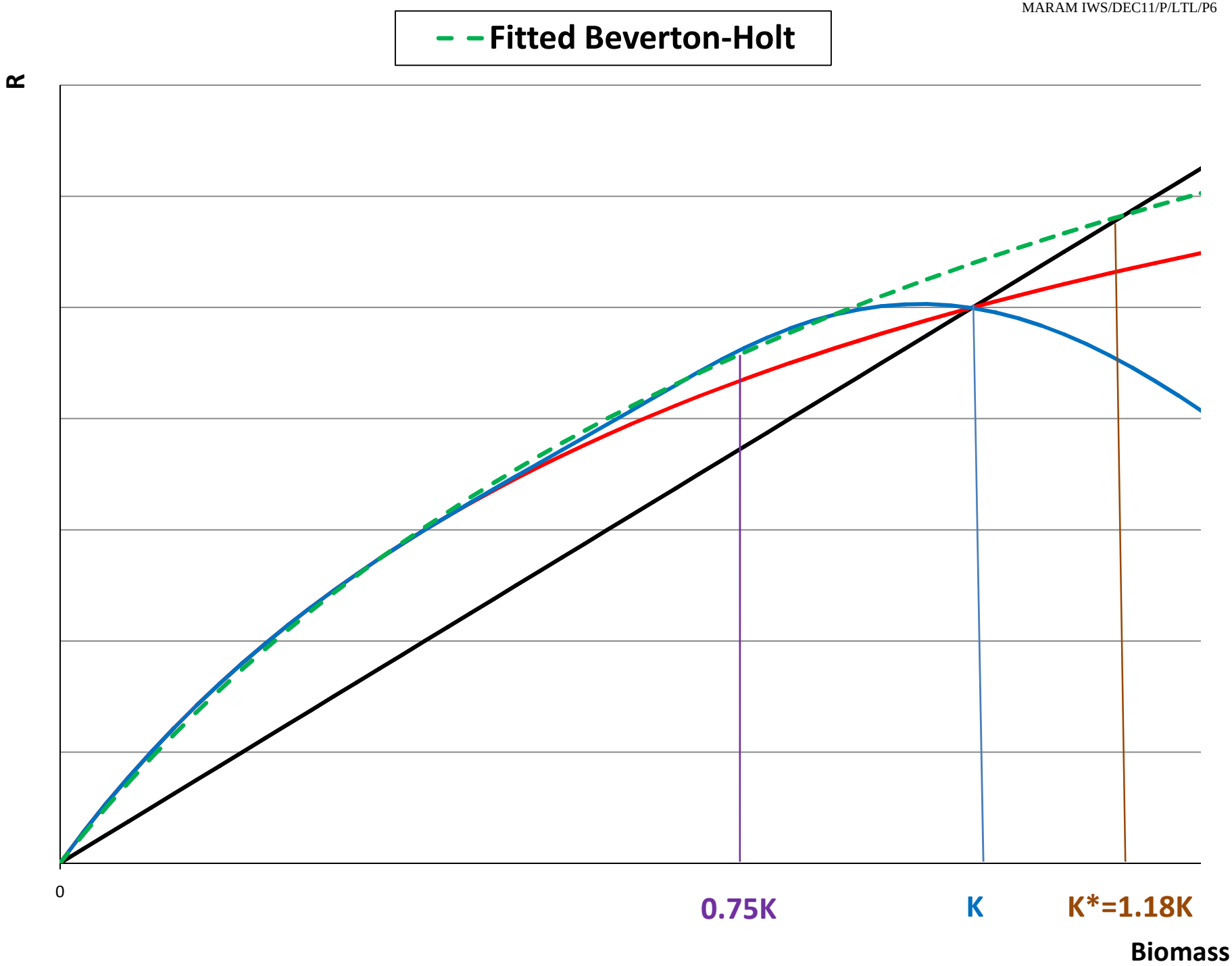

Sustainable catch = recruits - mortality
Catch
MSY
0
0.4K
K
Biomass

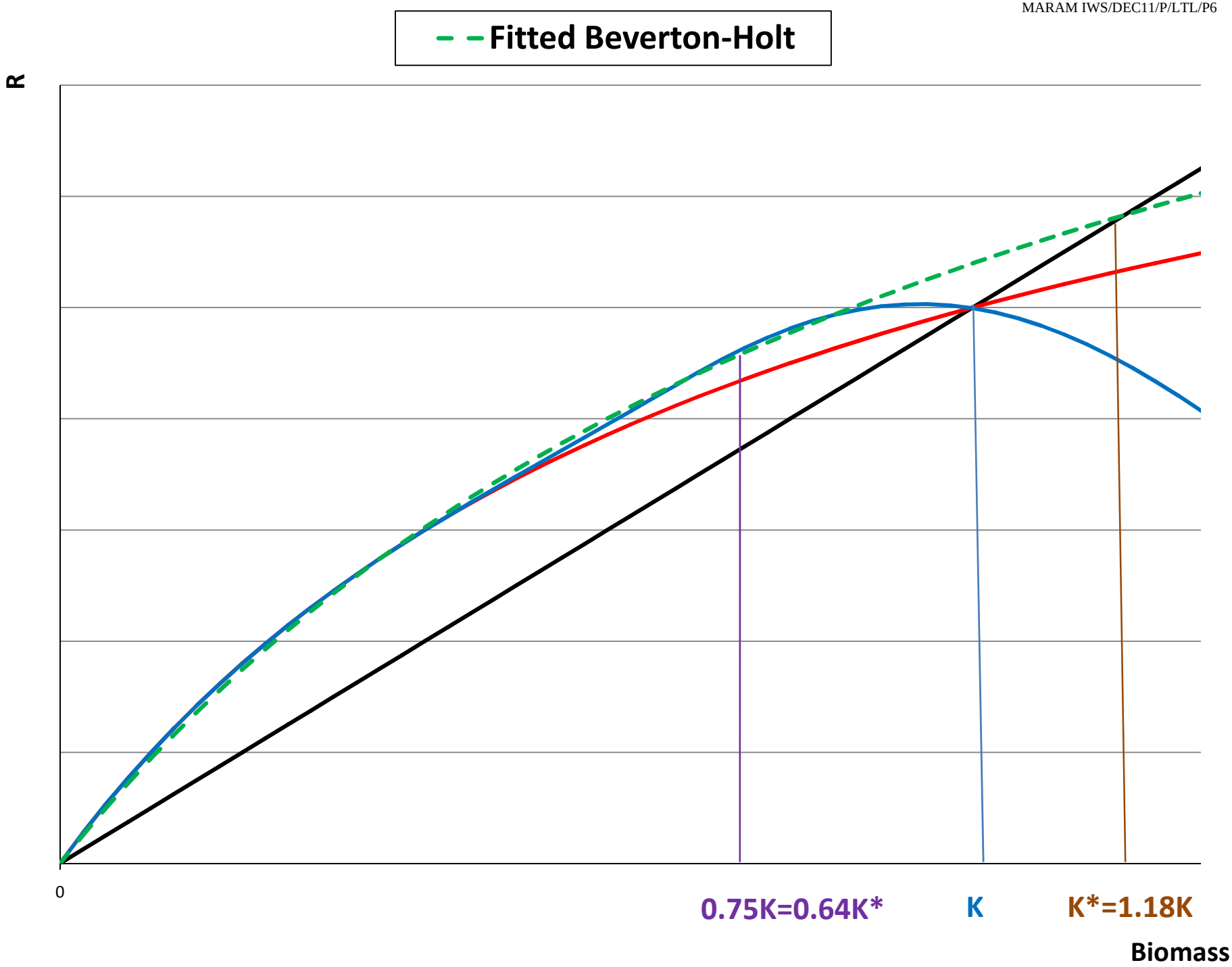

Sustainable catch = recruits - mortality
Catch
MSY
0.6MSY
40% loss
0
0.4K
0.75K
K
Biomass


Catch
Catch
MSY
0
0.4K
K
Biomass


Recruits
R
0
K
Biomass


Fitted Beverton-Holt
R
0
K
K*=1.18K
Biomass


Fitted Beverton-Holt
R
0
0.75K
K
K*=1.18K
Biomass


Fitted Beverton-Holt
R
0
0.75K=0.64K*
K
K*=1.18K
Biomass