not exceed F_{max}, even temporarily when it would improve long-term yield. Even with spatial averaging, inherent in the present overfishing definition, it would be difficult to accommodate a control rule that would maximize yield from the fishery after a period of greater than average closures to postpone mortality on strong year classes. With area rotation and the current overfishing definition, it would also be questionable whether F_{max} and B_{max} would be acceptable proxies for F_{MSY} and B_{MSY}, respectively, without modifying the overfishing definition to account for long term closures and area rotation.

Lastly, the basis for the control rule (Figure 4) presumes that F_{max} is a valid proxy for Fmsy and rebuilding would occur according to a logistic growth curve whose rate is maximized when biomass is some fraction of the carrying capacity (Pella and Tomlison 1969). In many cases, it is assumed that this maximum population growth rate occurs at 50 percent of carrying capacity. With a heterogeneous resource caused by long-term closures, its probable that the population growth is not maximized when the spatial average of the two types of areas (closed and open) are near ½ of the carrying capacity when averaged together. In this case, the scallops in long-term closures have slow growth rates and density dependent factors may adversely affect productivity. In open areas with high exploitation rates (as permitted with the present overfishing definition), the young scallops contribute less than optimum amount of spawning.

3.5 Optimum Yield

Optimum yield (OY) is a long term average, defined as the amount of biomass that can be landed when the stock biomass is at B_{max} by using regulated fishing gear in resource areas that are not managed as long term closures, at a rate equivalent to the open area fishing mortality target. The stock-wide fishing mortality target is 80% of Fmax, accounting for the risk that the numerical estimate exceeds the true value of F_{max}. The open area fishing mortality target increases linearly from 80% of F_{max} in proportion to the amount of exploitable biomass in long-term closed areas, but cannot exceed F_{max}.

Table 6. Open area target fishing mortality for determining optimum yield.

Percent of scallop productivity in long-term closed areas	Stock wide target fishing mortality	Open area target fishing mortality for defining OY
0	80% of F_{max}	80% of F_{max}
5	80% of F_{max}	85% of F_{max}
10	80% of F_{max}	90% of F_{max}
20	80% of F_{max}	F_{max}
> 20	80% of F_{max}	F_{max}

Long term closures are excluded from the calculation of OY, because other than an insignificant movement of large scallops, long term area closures contribute to total scallop productivity only through the amount of spawning activity that produces settlement elsewhere. The recruitment from spawning activity is a component of Bmax, which may change due to differences in long-term average recruitment.

Annual yield targets may differ from the long-term average optimum due to variations in exploitable stock biomass and age structure of the scallop stocks. When stock biomass is less than B_{max} or when the abundance of older scallops is low, the annual yield target that achieves this long-term average optimum is less than optimum yield. This may be determined from the control rule (see above) that defines overfishing when stock biomass is less than B_{max}. When stock biomass is greater than B_{max}

and the abundance of older scallops is high, the annual yield target that achieves this long-term average optimum is more than optimum yield.