**Supplemental File**

**Explanation of parameter selection**

*Growth*

The growth parameters regarding shell height at age identified in Table 1 were chosen to be broadly consistent with the available growth information on Bay Scallops that we could find in the literature. These sources included Fig 1 in Barber and Blake (1983), Figures 1-3 in Leverone et al. (1992), and Figure 7 in Geiger et al. (2006).

The growth parameters relating shell height at age to the weight at age of a scallop were assumed to follow a standard cubic function of length, a common assumption in fisheries. The *a* parameter for this relationship was arbitrarily chosen as we had no data on which to base it. Weight at age is only used for a fecundity at age ogive and thus is in effect a relative weight at age and the model is insensitive to the choice of *a*.

*Natural Mortality*

The monthly instantaneous mortality rate at age in the simulation was calculated using the length-inverse Lorenzen function (Lorenzen 2000), which assumes that natural mortality is a function of length at age and declines with age. This natural mortality function is commonly used in many fisheries stock assessment models. The reference rate for this formulation was chosen to be reasonably consistent with the instantaneous natural mortality estimate in Granneman et al. (2021), where the mean daily instantaneous natural mortality rate on the scalloping grounds was estimated at 0.0078 (Table 6 - Granneman et al., 2021). This value multiplied by the average number of days in a month, 30.4375, renders a monthly instantaneous rate of ~0.24. The reference length and allometric exponent for this formulation were left at their default values of L∞/2 and -1 as there was little information available (natural mortality at length) to justify altering these.

*Recruitment*

We calibrated the number of recruits in the population by minimizing the difference between model-estimated average gallons of scallops caught per person at equilibrium and the estimate from Granneman et al. (2021) (0.81 gallons of scallops per person), using seasonal effort and baseline catchability estimates from (Granneman et al., 2021)

The compensation ratio is not known for scallops, to our knowledge. We selected a moderate value of steepness that allowed for substantial but not overwhelming improvement in juvenile survival rate at low stock abundances (Myers 2001).

*Maturity parameters*

The age at 50% maturity and growth rate of the logistic maturity function were chosen to be roughly consistent with Figure 2 in Barber and Blake (1983) which depicts the mean oocyte diameter (representative of the reproductive cycle in *A. irridans*, Shumway and Parsons, 2016) of Florida bay scallops from May-Nov. This figure depicts the mean oocyte diameter beginning to increase in May, corresponding to an age 5 bay scallop in our model, and saturating from Aug-Oct, consistent with the asymptote of our maturity ogive. In addition, results from Blake (1972) also suggest bay scallops can begin to become mature around 6 months of age.

The probability of spawning in a given month, , was derived by extracting mean gonadal somatic indices in each month from the Homosassa area in Fig 5. within Geiger et al., 2006. Since there is evidence of some protracted spawning throughout the year (Sastry, 1963; Geiger et al., 2010), for months not included in the plot, we assumed the minimum mean gonadal-somatic index of 0.05. These values were then normalized by dividing by the sum, to obtain the probability of spawning in a given month.

*Selectivity and Catchability*

The selectivity parameters were chosen based on authors familiarity with the fishery (Dr. Granneman, pers. comm).

The baseline catchability was obtained from Granneman et al. (2021) and divided by 3.8 average persons per vessel (Granneman et al. (2021)) to rescale the catchability to the level of an individual rather than vessel. This catchability level was then altered to generate three levels of initial exploitation. Low, moderate, and high levels of initial exploitation were defined for which the initial spawning escapement equaled 50%, 35%, and 20% of that in the unfished simulation after the 25-year initialization period, respectively.

*Effort*

Effort estimates were obtained from Granneman et al. (2021), who estimated vessel effort at different dates throughout the course of the 2018 scallop season in the Steinhatchee area of northwest Florida (Region C, Figure 1). This data was used to estimate the total vessel effort in a given month. To aggregate the daily effort counts into monthly total effort, we first fit a model to the observed vessel effort as a function of the days since the first sampled effort count for that month and with a random effect for the weekday of the observation (Figure S1) to account for both the general decline of effort throughout the season and the weekday/weekend pattern. We then predicted the effort for 90 days since the start of the scalloping season to approximate the three-month season Granneman et al. (2021) observed. This allowed us to calculate the total expected effort for each month in a hypothetical three-month season regardless of the weekday/weekend pattern. Vessel effort was then multiplied by the average persons per vessel (3.8; Granneman et al., 2021) to get the total number of scallopers.

There exists little information on effort levels in this fishery over time and thus effort between years was assumed either constant or increasing such that it doubled by the end of the time series.

**Table S1.** Management regulations tested. When bag limit is presented in parentheses it refers to the bag limit for each open month of the fishing season.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Number** | **Name** | **Bag Limit** | **Bag Type** | **Season Length** | **Season Start** | **Season**  **End** |
| 1 | Base | 2 | fixed | 3 | July | Sept |
| 2 | Increased bag | 3 | fixed | 3 | July | Sept |
| 3 | Decreased bag | 1 | fixed | 3 | July | Sept |
| 4 | Increased season (later) | 2 | fixed | 4 | July | Oct |
| 5 | Increased season (earlier) | 2 | fixed | 4 | June | Sept |
| 6 | Later season | 2 | fixed | 3 | Aug | Oct |
| 7 | Earlier season | 2 | Fixed | 3 | June | Aug |
| 8 | Rolling bag limit | (1,2,2) | Rolling | 3 | July | Sept |
| 9 | Rolling bag limit and later season | (1,2,2) | Rolling | 3 | Aug | Oct |
| 10 | Rolling bag limit and earlier season | (1,2,2) | Rolling | 3 | June | Aug |
| Supplemental |  |  |  |  |  |  |
| 11 | Earlier season reduced bag | 1 | Fixed | 3 | June | Aug |
| 12 | Earlier season increased bag | 3 | Fixed | 3 | June | Aug |
| 13 | Later season reduced bag | 1 | Fixed | 3 | Aug | Oct |
| 14 | Later season increased bag | 3 | Fixed | 3 | Aug | Oct |
| 15 | Rolling bag | (1,1,2) | Rolling | 3 | July | Sept |
| 16 | Rolling bag | (1,2,2) | Rolling | 3 | July | Sept |
| 17 | Rolling bag | (2,2,3) | Rolling | 3 | July | Sept |
| 18 | Rolling bag | (2,3,3) | Rolling | 3 | July | Sept |
| 19 | Rolling bag earlier season | (1,1,2) | Rolling | 3 | June | Aug |
| 20 | Rolling bag earlier season | (1,2,2) | Rolling | 3 | June | Aug |
| 21 | Rolling bag earlier season | (2,2,3) | Rolling | 3 | June | Aug |
| 22 | Rolling bag earlier season | (2,3,3) | Rolling | 3 | June | Aug |
| 23 | Rolling bag later season | (1,1,2) | Rolling | 3 | Aug | Oct |
| 24 | Rolling bag later season | (1,2,2) | Rolling | 3 | Aug | Oct |
| 25 | Rolling bag later season | (2,2,3) | Rolling | 3 | Aug | Oct |
| 26 | Rolling bag later season | (2,3,3) | Rolling | 3 | Aug | Oct |
| 27 | Increased Season (Earlier), reduced bag | 1 | Fixed | 4 | June | Sept |
| 28 | Increased Season (Earlier), increased bag | 3 | Fixed | 4 | June | Sept |
| 29 | Increased Season (Earlier), rolling | (1,1,2,2) | Rolling | 4 | June | Sept |
| 30 | Increased Season (Earlier), rolling | (1,1,2,2) | Rolling | 4 | June | Sept |
| 31 | Increased Season (Later), reduced bag | 1 | Fixed | 4 | July | Oct |
| 32 | Increased Season (Later), increased bag | 3 | Fixed | 4 | July | Oct |
| 33 | Increased Season (Later), rolling | (1,1,2,2) | Rolling | 4 | July | Oct |
| 34 | Increased Season (Later), rolling | (1,1,2,2) | Rolling | 4 | July | Oct |



**Figure S1**. Results of generalized linear mixed model fit to the logarithm-transformed effort as a function of day with a random effect for weekday. The observed data from Granneman et al. (2021) is shown in black circles and the model-based predictions are shown in the red line.

**Figure S2.** Results of spawning output relative to unfished for the different management regulations simulated in this study under different starting levels of population exploitation (columns, only low and high depicted here) and different assumptions about the level of effort expended between years (rows). The first row depicts a scenario with constant effort in each year of the simulation, where the second row depicts a scenario with effort doubling over the course of the 25-year simulation period. The horizontal lines depict the sensitivity analysis for natural mortality (M = 0.25), where the red lines represent 25% decrease in natural mortality (M = 0.19) and the orange lines represent 25% increase in natural mortality (M = 0.32). The x-axis denotes the management regulations tested which are identified in Table S1 (regulations 1-10 are regulations which were presented in the main text).

**Figure S3**. Results of spawning output relative to unfished for the different management regulations simulated in this study under different starting levels of population exploitation (columns, only low and high depicted here) and different assumptions about the level of effort expended between years (rows). The first row depicts a scenario with constant effort in each year of the simulation, where the second row depicts a scenario with effort doubling over the course of the 25-year simulation period. The horizontal lines depict the sensitivity analysis for steepness (h = 0.67; CR = 8), where the red lines represent 25% decrease in steepness (50% decrease in compensation ratio; h = 0.5 and CR = 4) and the orange lines represent 25% increase in steepness (150% increase in compensation ratio; h = 0.83 and CR = 20). The x-axis denotes the management regulations tested which are identified in Table S1 (regulations 1-10 are regulations which were presented in the main text).

**Figure S4**. Results of harvest per unit of effort for the different management regulations simulated in this study under different starting levels of population exploitation (columns, only low and high depicted here) and different assumptions about the level of effort expended between years (rows). The first row depicts a scenario with constant effort in each year of the simulation, where the second row depicts a scenario with effort doubling over the course of the 25-year simulation period. The horizontal lines depict the sensitivity analysis for natural mortality (M = 0.25), where the red lines represent 25% decrease in natural mortality (M = 0.19) and the orange lines represent 25% increase in natural mortality (M = 0.32). The x-axis denotes the management regulations tested which are identified in Table S1 (regulations 1-10 are regulations which were presented in the main text).

**Figure S5**. Results of harvest per unit of effort for the different management regulations simulated in this study under different starting levels of population exploitation (columns, only low and high depicted here) and different assumptions about the level of effort expended between years (rows). The first row depicts a scenario with constant effort in each year of the simulation, where the second row depicts a scenario with effort doubling over the course of the 25-year simulation period. The horizontal lines depict the sensitivity analysis for steepness (h = 0.67; CR = 8), where the red lines represent 25% decrease in steepness (50% decrease in compensation ratio; h = 0.5 and CR = 4) and the orange lines represent 25% increase in steepness (150% increase in compensation ratio; h = 0.83 and CR = 20). The x-axis denotes the management regulations tested which are identified in Table S1 (regulations 1-10 are regulations which were presented in the main text).

**Figure S6.** Results of catch per unit of effort for the different management regulations simulated in this study under different starting levels of population exploitation (columns, only low and high depicted here) and different assumptions about the level of effort expended between years (rows). Catch per unit effort includes both scallops harvested and scallops caught and released in order to comply with the bag limit. The first row depicts a scenario with constant effort in each year of the simulation, where the second row depicts a scenario with effort doubling over the course of the 25-year simulation period. The horizontal lines depict the sensitivity analysis for natural mortality (M = 0.25), where the red lines represent 25% decrease in natural mortality (M = 0.19) and the orange lines represent 25% increase in natural mortality (M = 0.32). The x-axis denotes the management regulations tested which are identified in Table S1 (regulations 1-10 are regulations which were presented in the main text).

**Figure S7**. Results of catch per unit of effort for the different management regulations simulated in this study under different starting levels of population exploitation (columns, only low and high depicted here) and different assumptions about the level of effort expended between years (rows). Catch per unit effort includes both scallops harvested and scallops caught and released in order to comply with the bag limit. The first row depicts a scenario with constant effort in each year of the simulation, where the second row depicts a scenario with effort doubling over the course of the 25-year simulation period. The horizontal lines depict the sensitivity analysis for steepness (h = 0.67; CR = 8), where the red lines represent 25% decrease in steepness (50% decrease in compensation ratio; h = 0.5 and CR = 4) and the orange lines represent 25% increase in steepness (150% increase in compensation ratio; h = 0.83 and CR = 20). The x-axis denotes the management regulations tested which are identified in Table S1 (regulations 1-10 are regulations which were presented in the main text).

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