**Biomass Dynamics Lab**

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**Purpose:** To assess the New Zealand spiny lobster fishery.

We’ll begin with the catch, effort, and CPUE statistics over time. As is apparent from these graphs while catch has not necessarily followed any kind of monotonic trend over the time frame in the study (1945 – 1990) effort has steadily increased over the years. These two patterns have resulted in a steadily declining CPUE. In short, over time it has taken more and more effort to catch the same amount of biomass.

A graph with a line

Description automatically generatedA graph showing the growth of a company

Description automatically generated with medium confidence

A graph showing a line

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We then fit two biomass dynamics models – Schaefer and Fox – to the CPUE data over time. The loss for the Schaefer model was -72.5 while the Fox model had a loss of -74.48 making the Fox model a slight preference (in terms of loss). Both models have a hard time fitting the very early years but then do reasonably well from ~1960 onwards.

A graph showing the time and the fox fit

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A graph showing the growth of a fox equilibrium yield

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The MSY for Fox and Schaefer were 2488 and 1702 (t) respectively with EMSY being 1970 and 1078 (1000’s of potlifts) respectively.

|  |  |  |
| --- | --- | --- |
|  | Fox | Schaefer |
| r | 0.058 | 0.047 |
| K | 115591 | 145580 |
| q | 2.97E-05 | 2.17E-05 |
| Loss | -74.48 | -72.5 |
| MSY | 2488 | 1702 |
| EMSY | 1970 | 1078 |

We can summarize the comparison of our models as follows:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | L | m | AIC |  | w |
| Fox | -74.48 | 4 (r, K, q, ) | -66.48 | 0 | 0.73 |
| Schaefer | -72.5 | 4 (r, K, q, ) | -64.5 | 1.98 | 0.27 |

Fox, as was stated before, is the preference.

At the end of our timeline (1990) the effort is 5130 (1000 potlifts). Therefore, this fishery is undergoing overfishing as the effort is significantly higher than either EMSY estimate.

A graph showing the growth of a company

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Likewise, in either case (Fox or Schaefer) the biomass at the end of the time series is far lower than the equilibrium biomass at either EMSY point. Therefore, we can conclude that the fishery is also overfished.

A graph of red and blue dots

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Clearly while this fishery has been undergoing overfishing for some time given the large size of the original biomass and the steadily increasing effort the fishermen have been able to keep catches far above the equilibrium yields. I.e. for the amount of effort being put in the fishery is still above the equilibrium biomass and therefore higher than equilibrium yields have been obtained.

Next, we looked at what would happen to the fishery in the coming decade under different effort scenarios (current effort in 1990, EMSY, and half of EMSY).

A graph showing the number of projections

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Description automatically generated with medium confidenceA graph showing the difference between the number of projections

Description automatically generated with medium confidence

Nothing particularly surprising here. If the current level of effort continues catches and stock biomass will continue decline. If the effort is brought down to EMSY then the stock will begin to recover (given the stock is overfished and therefore below equilibrium biomass for EMSY). However, doing this comes at a steep cost in terms of catch tonnage.

Finally, out of curiosity we plotted the loss as a function of K and r (holding q constant) for the Fox model:

A graph with a blue gradient

Description automatically generated with medium confidence

We can see that there’s quite a long ridge around the optimal values of K and r that changes r quite a bit (relatively speaking). We then determined all values where the loss was within 2.99 ( of the peak and computed MSY for all of these values. This gave us a confidence interval of [2160, 2764]. Given our current estimate for the Fox model is firmly centered within these bounds and the intent is to be risk neutral I don’t think this changes anything about our overall assessment.