Group Project Description
Caio Faro and Juan Carlos Villaseñor

A fishing community in Baja California has been awarded with the concession of an area to fish lobster for 50 years, starting in 2017. This area, known as a TURF (Territorial Use Rights for Fishing) has 100 km^2, in a 10 by 10 km polygon. The community has exclusive access to this TURF, and are not allowed to fish elsewhere.

The fishers have heard from nearby communities about an option to enhance the productivity and the income by closing fishing grounds within the TURF (i.e. a TURF-reserve), and have seeked consultation to find the optimum way in which they can maximize profits. The reasoning for the implementation of a TURF-reserve is that by having a no-take area, the TURF will benefit from the spillover (i.e. organisms that step out of the reserve). This relation is described by the difference equation:

$$N_{i,j,t+1} = N_{i,j,t} + N_{i,j,t}\, r\left(1-\frac{N_{i,j,t}}{K}\right) - U_{i,j,t} + M_{i,j,t} - E_{i,j,t}$$

Where subindices *i* and *j* represent vertical and horizontal positions of the parcels that divide the TURF. Subindex *t* represents the timestep in years. *r* is the population growth rate. *K* denotes the carrying capacity in organisms / parcel. $U_{i,j,t} = u_{i,j,t} N_{i,j,t}$ represents the extracted organisms, determined by the proportion $u_{i,j,t}$ of the total population. The value of u for parcels *i, j* within the reserve is u = 0 (i.e. No extraction). $E_{i,j,t} = m(1-u_{i,j,t})N_{i,j,t}$ represents the number organisms that move out of the parcel, given by movement rate *m* (proportion of organisms that leave a cell), after they have been harvested. $M_{i,j,t} = m/4(1-u_{i,j,t})(N_{i-1,j,t} + N_{i+1,j,t} + N_{i,j-1,t} + N_{i,j+1,t})$ represents the movement of organisms into the parcel, after they have been harvested.

Within this model, total catches at time *t* can then be derived from U and calculated as:

$$Ct = \sum_{i=1}^{n}\sum_{j=1}^{n} u_{i,j,t} N_{i,j,t} = \sum_{i=1}^{n}\sum_{j=1}^{n} U_{i,j,t}$$

Therefore, total profit from fishing at time *t* can be expressed as $R_t = C_t(p-c)$, where *p* = price, and *c* = costs.

We will evaluate two possible strategies:

1) Close a percentage of the TURF get benefits from spillover. The reserve will remain closed forever, and we would have to find the optimum size of the reserve that maximizes profits.
2) Close a percentage of the TURF for some years, allowing the population to recover. Then, after *t* years open the reserve and fish all organisms.

We are going to assume that:

1) The entire concessioned area has a starting density of $N_0 = K/2$
2) Organisms are recruited once a year, with no age or size structure
3) Proportion of organisms caught (*u*) outside the reserve is equal for every parcel
4) Price and costs are constant through time