This model builds on the basic fisheries enforcement theory developed by Arnason by:

1. Incorporating revenue generated by tourism into the social benefit function. Tourism revenue is a function of biomass.
2. Incorporating a behavioral preference parameter into the private illegal fishing profit function that determines how likely a given fishery is likely to fish illegally. This parameter is determined by social norms within the fishery.
3. Incorporating a financing mechanism to cover the costs of enforcement (licensing fee, tax per unit of catch, tourism revenue, fines from enforcement violations)

Enforcement Model

where *ECt* is the cost of enforcement given an enforcement effort *et* (from 0 to 1) and enforcement cost parameters *EC1*, *EC2*, and *EC3* (Arnason, COBECOS).

where *EPt*is the probability of receiving an enforcement fine given an enforcement effort *et* (from 0 to 1) and enforcement probability parameters *EP1*, *EP2*, and *EP3*. This represents a combination of detection probability and persecution probability (Arnason, COBECOS).

Economic Model

*Tourism:*

where *Dt* is the number of dives in each time step, α0, α1, and α2 are tourism preference parameters, and *xt* is the biomass in each time step (Sala et al 2013).

where *OPt* is the optimal fee per dive in each time step that maximizes tourism revenue (Sala et al 2013).

Where *OTRt* is the optimal tourism revenue in each time step using the optimal fee per dive (Sala et al 2013).

*Fishing:*

where *πt,Legal*is the private legal fishing profit in each time step for a legal fishing catch of *Qt,Legal*, price per unit weight of catch *p*, cost of fishing *c*, licensing fees for the entire legal fleet *LFt*, and tax per unit weight of catch *vt* (Arnason 2006).

where *πt,IUU*is the private illegal fishing profit in each time step for illegal fishing catch of *QIUU*, price per unit weight of catch *p*, cost of fishing *c,* and fine per unit IUU catch *f*. *β* represents a behavioral preference value of the community that adjusts their likelihood to fish illegally. A *β* of 1 represents a community that will fish illegally purely on a profit maximizing objective function. A *β* of 0 represents a community that will do no illegal fishing, regardless of how profitable it is. The value can also be found somewhere between 0 and 1. This parameter is determined by social norms within the fishery. *Qt,IUU* varies in each time step such that this profit function is maximized (Arnason 2006).

Biological Model

where *xt* is the biomass in each time step, *r* is the intrinsic growth rate of the population, and *K* is the carrying capacity.

Harvest Policies

1. Begin fishing at *FMSY* today and continue fishing at *FMSY* going forward. *FMSY* = *r*/2.
2. If *B*<*BMSY*, close the fishery until *B*=*BMSY*. Once *B*=*BMSY*, begin fishing at *FMSY* going forward. *BMSY* = *K*/2.
3. If *B*<*BMSY*, close the fishery and then increase fishing level linearly each year until *B*=*BMSY*. Once *B*=*BMSY*, begin fishing at *FMSY* going forward. Slope will be determined by maximizing NPV of the private fishing profits.

Objective Functions

**Scenario 1**: Under various policy functions, adjust enforcement during each time step to maximize NPV of social profit (no tourism)

where *T* is the time horizon and *r* is the discount rate. This function represents the total social benefit resulting from legal fishing, licensing fees, catch tax, enforcement fines, and the cost of enforcement. It is maximized by optimizing the vector of enforcement effort over time, *et* given a harvest policy *Qt,Legal*.

**Scenario 2**: Same as scenario 1, but with the constraint that social profit in each time period must be positive (to allow for contemporaneous financing)

**Scenario 3**: Under various policy functions, adjust enforcement during each time step to maximize NPV of social profit (include tourism)

where *T* is the time horizon and *r* is the discount rate. This function represents the total social benefit resulting from legal fishing, tourism revenue, licensing fees, catch tax, enforcement fines, and the cost of enforcement. It is maximized by optimizing the vector of enforcement effort over time, *et* given a harvest policy *Qt,Legal*.

**Scenario 4**: Same as scenario 3, but with the constraint that social profit in each time period must be positive (to allow for contemporaneous financing)

Parameters needed for the case study:

* Enforcement
  + *EC1*, *EC2*, *EC3, EP1*, *EP2*, *EP3* (or other enforcement parameters if functional form is different)*, f*
* Economics
  + Tourism
    - α0, α1, α2
  + Fishing
    - *p*, *c, LFt, vt*
* Biological
  + *r*, *K*

Parameters to be varied under all scenarios

* *x0*
* *β*