Abstract

This dissertation introduces two bioeconomic models and an ecological-economic model of optimal natural resource management. I use the first bioeconomic model to study the control of invasive lionfish, which are a growing threat to native marine life in the Western Atlantic. I account for imperfect knowledge of lionfish abundance by posing the problem as a continuous-state partially observable Markov decision process (POMDP). This allows me to portray the dynamics of approximately optimal monitoring and population control. My results demonstrate that early monitoring helps limit the impact of a local lionfish infestation. I also consider the problem of native species bycatch arising from lionfish removal and identify scenarios where it is optimal to tolerate bycatch in order to suppress lionfish.

I develop an ecological-economic model to address the management of an invasive ecosystem engineer: a species that manipulates an environmental state in a way that is important for predicting its population dynamics. I use pseudospectral methods to numerically explore jointly optimal environmental restoration and biomass removal. My results show that accounting for the nonconvex structure of engineer-environment feedback may help resource managers avoid wasteful decisions. For example, I show that when the engineer’s dynamics are self-limiting in a region of the state space, the optimal response may be a no-intervention “ecological strategy.”

Managed relocation is a controversial climate change adaptation policy that involves moving a climate-threatened species to areas outside of its historic range where it is expected to
face more favorable conditions in the future. I explore the basic bioeconomics of managed relocation. In my nonautonomous spatial-dynamic model, a resource manager maximizes the net present value of nonconsumptive benefits by moving the focal species’ biomass. I find that economic heterogeneity can induce transient patterns in the optimal policy that are qualitatively similar to those that result solely from variation in biological or climate parameters. I also consider a selection of second-best policies. I demonstrate that limiting the resource manager’s spatial margin of action may carry a high cost when it bars the use of a “life boat,” or a site that provides a temporary climate refuge for the focal species.