NR 993 - Applied Evolution in Managed Systems

Mondays 3:10-5pm, James G49

Overview:

Among the many consequences of accelerating human dominance on the planet is the intensification of management of populations, landscapes, and ecosystems. A central irony therein is that, generally speaking, the more effective the management intervention the stronger the evolutionary response. This has led to the rapid evolution of traits that often stand in stark contrast to management goals. Examples include the repeated evolution of resistance to herbicides and pesticides (including biological control agents), multiple resistance to antibiotics, anti-retrovirals, or anti-cancer drugs, and altered life histories and morpohologies in harvested wild populations, among others. On the flipside, human-induced changes in climate, land use, and disruption of biotic communities place strong evolutionary pressures on myriad wild and domestic species that humans depend on and/or value. Paradoxically, while pest populations readily mount swift and effective responses to even our best control efforts, species and populations of conservation concern often struggle to "keep up" with the rapid pace of change, for a variety of complex and interacting reasons.

Theodore Dobzhansky is famous for the (somewhat overused) 1973 statement that "nothing in biology makes sense except in the light of evolution." Clearly, this extends to management of species, communities, ecosystems during the Anthropocene. Careful consideration of evolutionary principles is absolutely critical to designing successful, long term strategies that minimize unintended consequences and maximize the durability of effective approaches. In this course we will survey the literature surrounding this fascinating and emerging field via the lens of various sub-disciplines such as agriculture, forestry, wild-harvested populations, conservation, invasive species, human health and medicine, etc. By engaging with the primary literature, we will cultivate the basic tools for understanding the opportunities and challenges of managing populations and ecosystems using evolutionary principles.

Basic approach

This is a discussion course rooted in the primary literature. We will focus on honing our skills to interrogate the papers we read deeply and critically, and in what will hopefully become a synthetic way.

A non-trivial part of this course will be developing your skills as discussion leaders. This will surely be a friendly audience but it is still a very good idea to have a plan for how you will engage the group and challenges them to collectively struggle with and debate core concepts. In service of this goal, you will each be expected to lead 1-2 discussions during the course of the semester. ***All discussion leaders meet with me (preferably in person) by at least the Friday***

before each class. It is your responsibility to schedule this meeting – please plan ahead so that we can accommodate each other's schedules.

Note:

Please help me to make this course as fun, interesting, and as relevant as possible! With a few minor exceptions, I am not wedded to any particular paper or topic – we can mix things up and accommodate your specific areas interests as we go. Your feedback is welcome at any point, in whatever form.

The course schedule is a work in progress and a living document which can be found here:

https://docs.google.com/spreadsheets/d/1ZuqqEddpy8e5gW0zHg2D39pEAQ3M9LHQuLvfmtarpXA/edit?usp=sharing

(Current snapshot of the schedule (2/6) follows)

Date range	Co-leaders		Topic	Paper 1	Paper 2
Week 0 (1/21-1/26)				No class (MLK Day)	
Week 1 (1/28-2/2)	JG	-		Carroll SP, Jorgensen PS, Kinnison MT, et al. (2014) Applying evolutionary biology to address global challenges. Science 346:1245993	Palumbi S (2001) Humans as the World's Greatest Evolutionary Force. Science 293:1787-1790, Carroll SP, Jorgensen PS, Kinnison MT, et al. (2014) Applying evolutionary biology to address global challenges. Science 346:1245993
Week 2 (2/4-2/9)	JG		One more week of semi-general principles we will build on. Suggest picking a second paper	Hendry, A. P.,et al. 2011. Evolutionary principles and their practical application. Evol Appl 4:159-183	
Week 3 (2/11-2/16)	KM	DM	Agriculture--deployment strategies	Zhu, Y., H. Chen, J. Fan, Y. Wang, Y. Li, J. Chen, J. Fan, S. Yang, L. Hu, H. Leung, T. W. Mew, P. S. Teng, Z. Wang, and C. C. Mundt. 2000. Genetic diversity and disease control in rice. Nature 406:718-722.	Jones, J. D. G., and J. L. Dangl. 2006. The plant immune system. Nature 444:323-329.
Week 4 (2/18-2/23)	DM		Applications to forestry and forest management		
Week 5 (2/25-3/2)	BA		Evolution in biological control		
Week 6 (3/4-3/9)	MK		Evolutionary approaches to human nutrition		
Week 7 (3/11-3/16)	Spring Break, no class				
Week 8 (3/18-3/23)	all			BYOP (Bring your own paper) -- any related topic	
Week 9 (3/25-3/30)	SW	DF	Evolution and invasive species management		
Week 10 (4/1-4/6)	EP	BA	Restoration Ecology		
Week 11 (4/8-4/13)	EP	SW	Assisted migration, breeding or genetic sourcing for novel conditions		
Week 12 (4/15-4/20)	MK		Fisheries, trophy animials, plants, fungi		
Week 13 (4/22-4/27)	DF		Responses to pollution, radiation, environmental estrogens, plastics, etc.		
Week 14 (4/29-5/4)	KM		CRISPR-Cas9 and related tech		
Week 15 (5/6-5/11)	all			BYOP (Bring your own paper) -- any related topic	

students	initials	
Breanne Aflague	BA	2
Danyi Feng	DF	2
Mackenzie Kalp	MK	2
David Moore	DM	2
Kathleen Moran	KM	2
Eric Morrison	EM	0
Emily Patterson	EP	2
Shana Whitney	SW	2
Jeff Garnas	JG	2

Discipline	Topic	Topic taken? (x if yes). If you choose a topic that you feel encompasses more than one, mark multiple subtopics. If a topic you want is taken AND you feel you can produce a fruitful, non-redundant discussion, we could potentially have duplicate topics
Agriculture		
	Resistance durability (to herbicides, pathogens, insects, Bt)	
	GMO/breeding approaches (gene stacking v. pyramiding, major v. minor gene resistance, QTLs and marker-assisted selection, etc.)	
	Deployment stategies (spatiotemporal approaches, e.g., mixtures, crop/genotype rotation, field and landscape management)	x
	Applications to forestry and forest management	x
Medicine		
	Antibiotic resistance (livestock, humans)	
	Cancer evolution, infectious disease	
	Evolutionary approaches to human nutrition	x
Harvested wild populations		
	Fisheries, trophy animals, plants and fungi	x
Small population considerations in conservation, invasion biology and biological control		
	Evolution and invasive species management	x
	Evolution in biological control	x
	Restoration ecology	x
Harnessing evolution in global climate change mitigation efforts		
	Assisted migration, breeding or genetic sourcing for novel conditions	x
	Other aspects of climate adaptation and/or phenotypic response	
Evolution in the biotech revolution		
	CRISPR-Cas9 and related technologies	x
	Gene drive and evolutionary constraints	
	Maintaining genetic identity (hybrid suppression, etc).	
Evolutionary toxicology		
	Responses to pollution, radiation, environmental estrogens, plastics, etc.	x
Other	Other topics of interest?	