



# The ecology of **fear** & biotic resistance

Nicola Smith, 8<sup>th</sup> Oct. 2019  
BISC 204: Introduction to Ecology



# Outline

1. Summary of my journey in science
2. Key terms, concepts & examples
  - Non-consumptive (fear) effects of predators
  - Invasive species & biotic resistance
3. Case study: Biotic resistance through fear of predators on Caribbean coral reefs

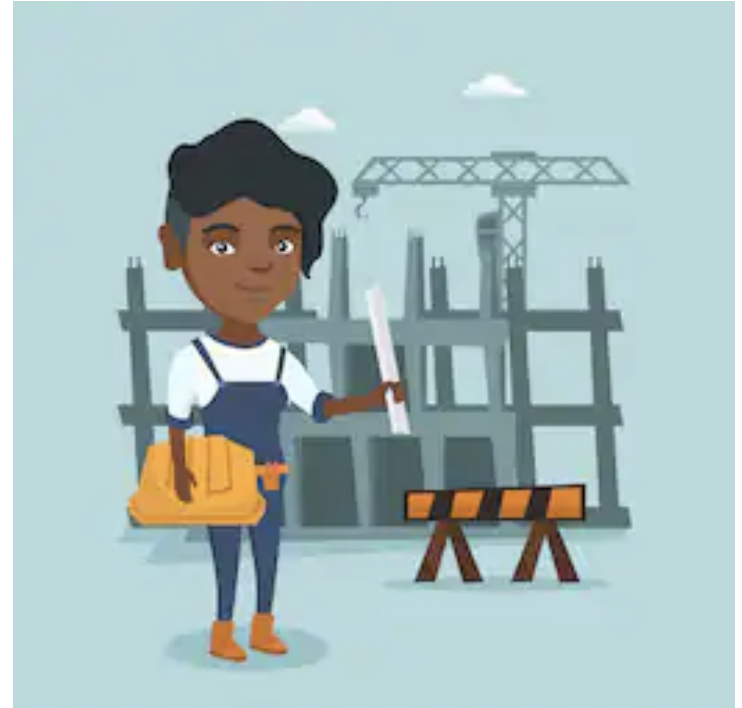


Good at science = 2 potential careers



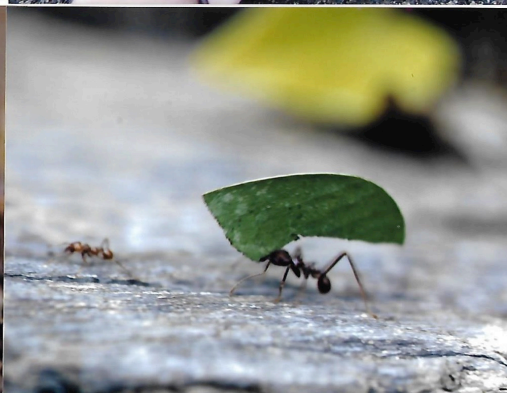
Doctor

or



Engineer

# Discovered field courses!





# Got a job

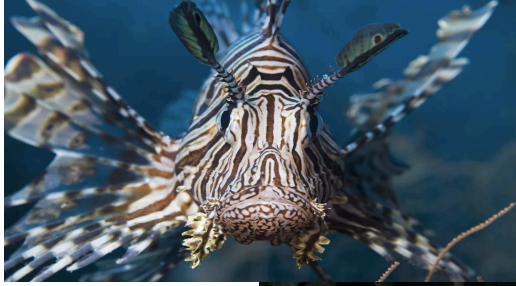
- Financial independence (a bit)
- Learnt new field skills
- Found **inspiration** for future career





# Grad school 1.0





# Got another job



GLOBAL ENVIRONMENT FACILITY  
INVESTING IN OUR PLANET







# Grad school 2.0





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# Lethal & nonlethal effects of predators



# Lethal (consumptive) effects



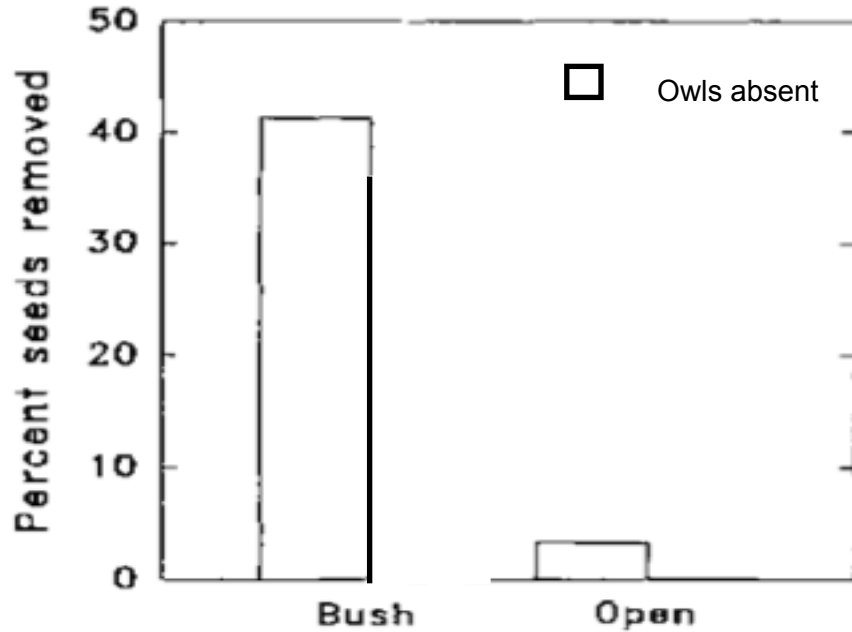
- Direct predation/ consumption removes individuals from a population.

# Nonlethal (non-consumptive) effects



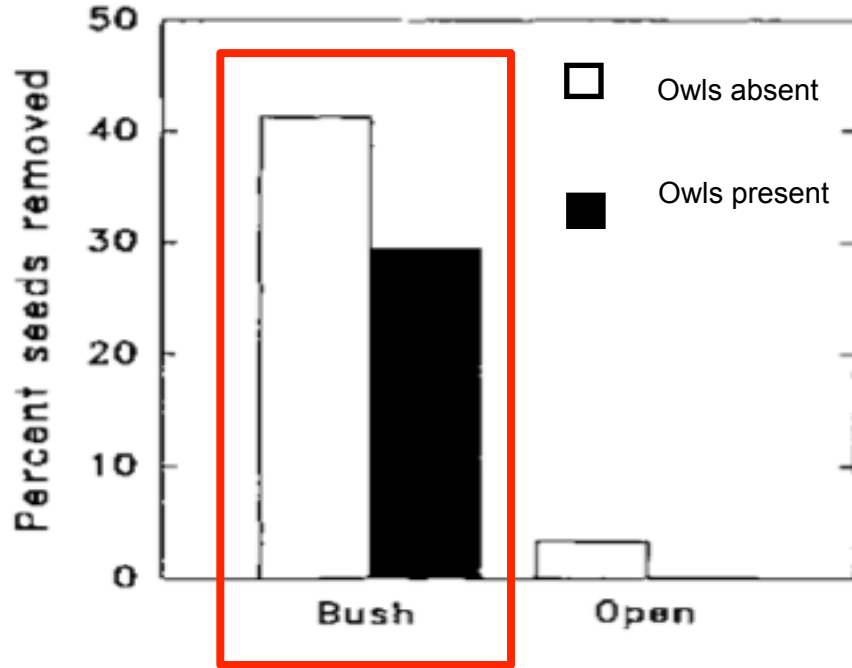
- Also called “**fear effects**”
- Adaptive changes in prey behavior or morphology in the presence of predators that make it more difficult for predators to detect, encounter, or capture prey.

# Fear effects on **where** gerbils forage



- Gerbils removed fewer seeds in the open, where **perceived predation risk** from owls was greater than in the bush

# Fear effects on **how much** gerbils foraged



- Gerbils removed fewer seeds in the open, where perceived predation risk from owls was greater than in the bush
- Within the bush, gerbils removed fewer seeds **when owls were present** than when owls were absent.



# Class question



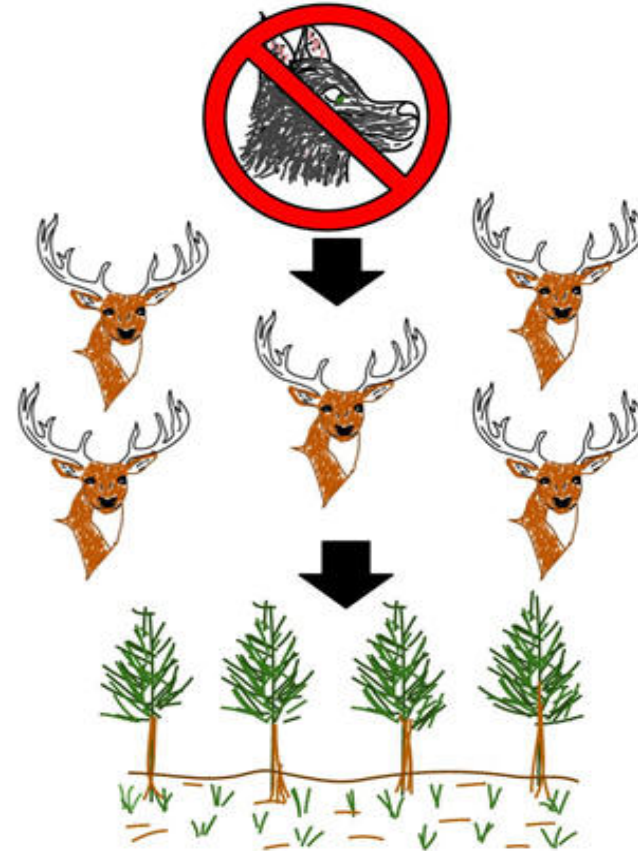
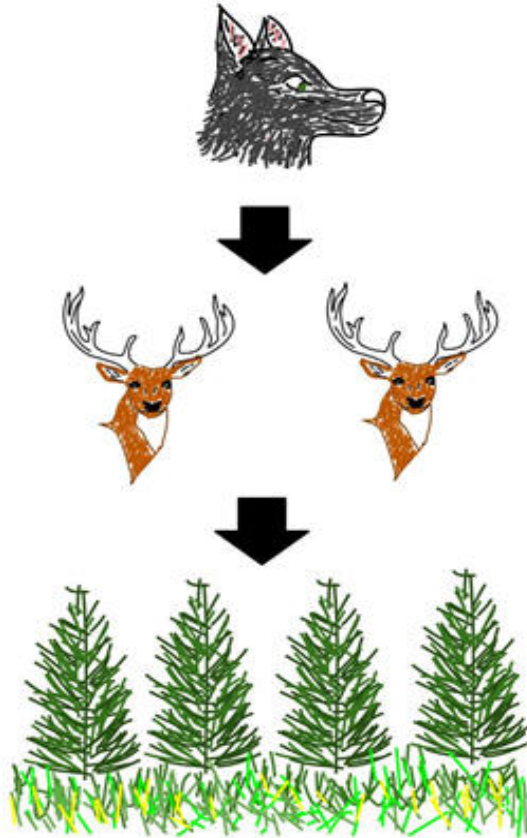
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What other changes in prey behaviors might occur because of fear of predators?

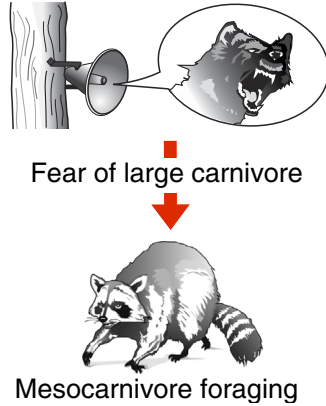
# Trophic cascade

Strong, indirect interactions that affect more than two trophic (feeding) levels within a food web, and typically occur when predation at one trophic level is suppressed (either due to direct predation on or changes in behavior at that trophic level), leading to an increase in abundance of prey at a lower trophic level.

# Trophic cascade

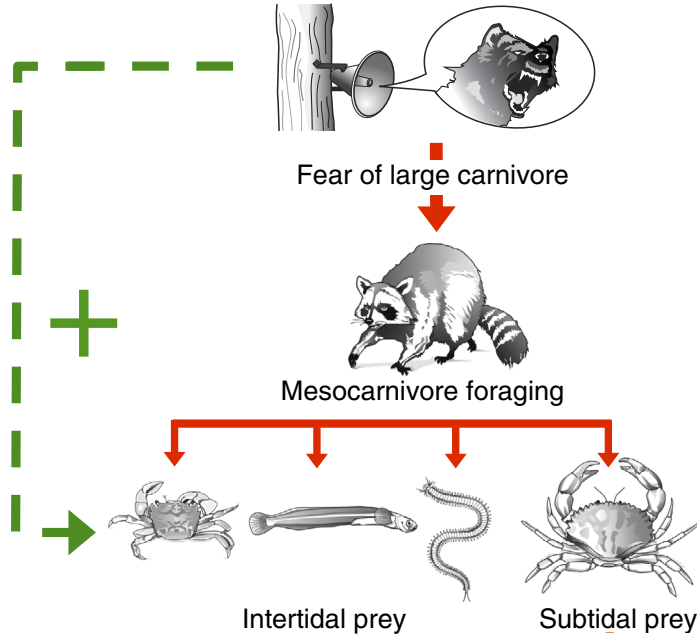


# Fear-induced trophic cascade



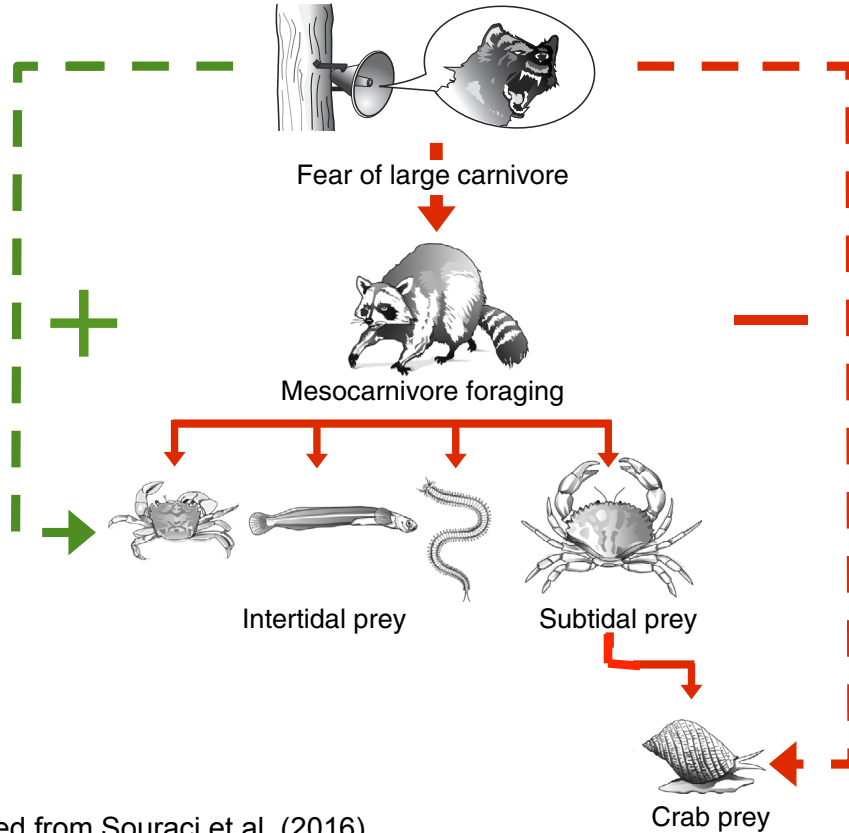
- Fear of large predators caused reduced raccoon foraging

# Fear-induced trophic cascade



- Fear of large predators caused reduced raccoon foraging
- Reduced raccoon foraging increased abundance of raccoon prey species.

# Fear-induced trophic cascade



- Fear of large predators caused reduced raccoon foraging
- Reduced raccoon foraging increased abundance of raccoon prey, including subtidal crabs.
- Increased subtidal crab abundance (raccoon prey) decreased abundances of subtidal crab prey.



# Outline

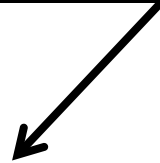
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# Biological invasions

Include both human-mediated and 'natural' (i.e., without human intervention) forms of dispersal in which a species arrives, establishes a self-sustaining population, and spreads throughout a region where it did not historically occur (Carlton 1989)

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## Introduction

Human-assisted dispersal

# Biological invasions

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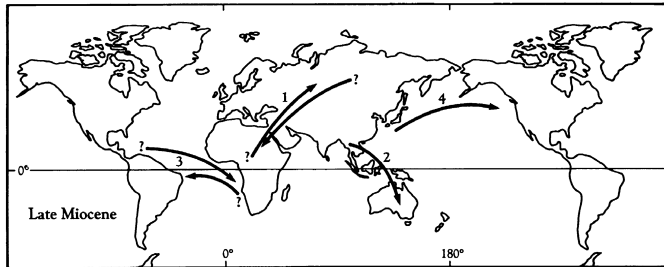
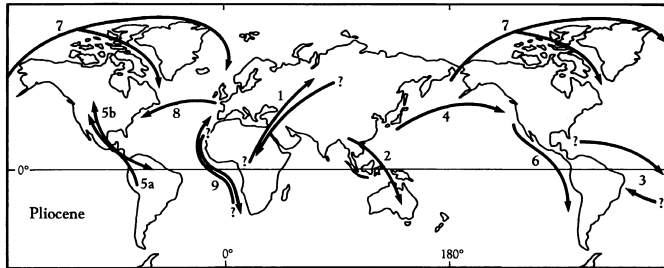
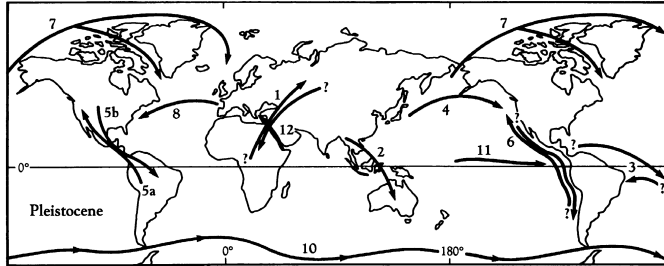
## Introduction

Human-assisted dispersal

## Range expansion

Natural diffusion (movement) of species into new areas

# Invasions as an “historical fact of life”



Invasions (in the form of range expansions) have occurred throughout the history of life itself, as some species gradually evolved the ability to overcome physical or ecological barriers, while large-scale elimination of geographic barriers (e.g., tectonic plate activity), allowed for species from neighboring communities to extend their ranges.

Vermeij (1991)

# Accelerating rise in contemporary invasions/species introductions due to global travel & trade





## Class question

In what ways do natural range expansions in geologic time differ from contemporary species introductions? (Hint: think about speed of invasions, types of species involved, geography, etc.)

# Biotic resistance



- The ability of a resident (typically native) community to prevent the establishment or limit the success of non-native species.
- Factors thought to provide biotic resistance = native predators, parasites, pathogens competitors & local diversity (e.g., genetic, species, functional – more diverse communities are typically more resistant to invasions than less diverse communities).

## Class question

You suspect that a native eel may provide biotic resistance to an invasive crayfish via direct predation. How would you test for this?

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# Biotic resistance through **fear** of predators on Caribbean coral reefs

Nicola S. Smith & Isabelle M. Côté  
(in review, J. Animal Ecol.)











**POW!**







# Native range



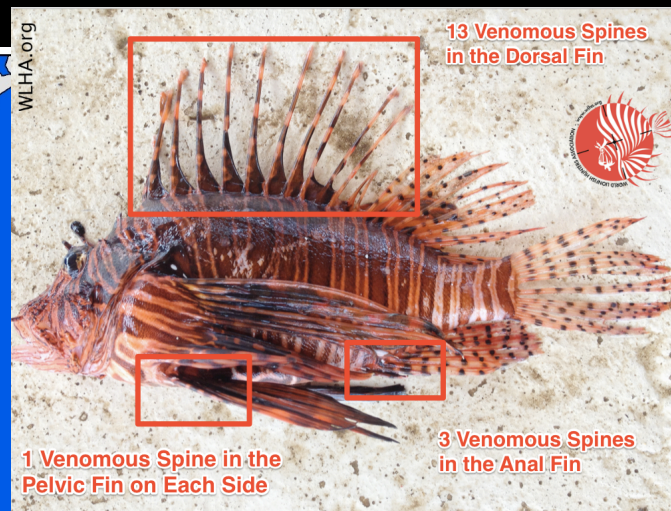
1985



2018







**Predation on the invasive red lionfish, *Pterois volitans*  
(Pisces: Scorpaenidae), by native groupers in the Bahamas**

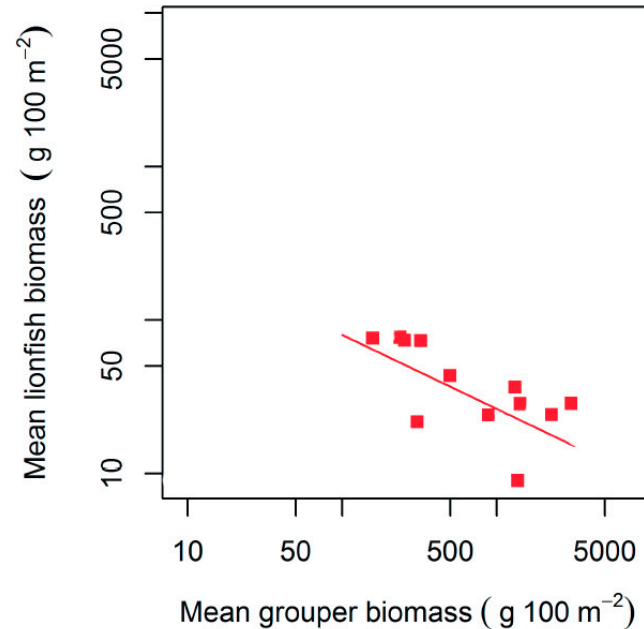




# Grouper as a Natural Biocontrol of Invasive Lionfish

Peter J. Mumby<sup>1,2\*</sup>, Alastair R. Harborne<sup>1,2</sup>, Daniel R. Brumbaugh<sup>3,4</sup>

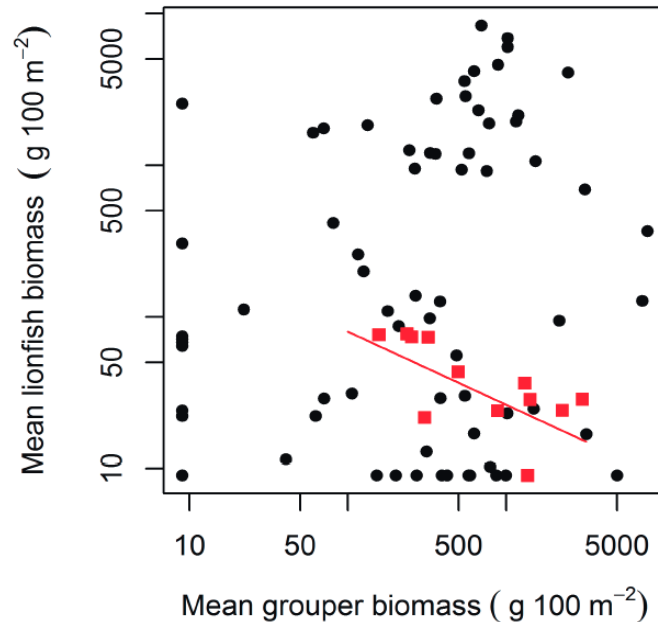
2011



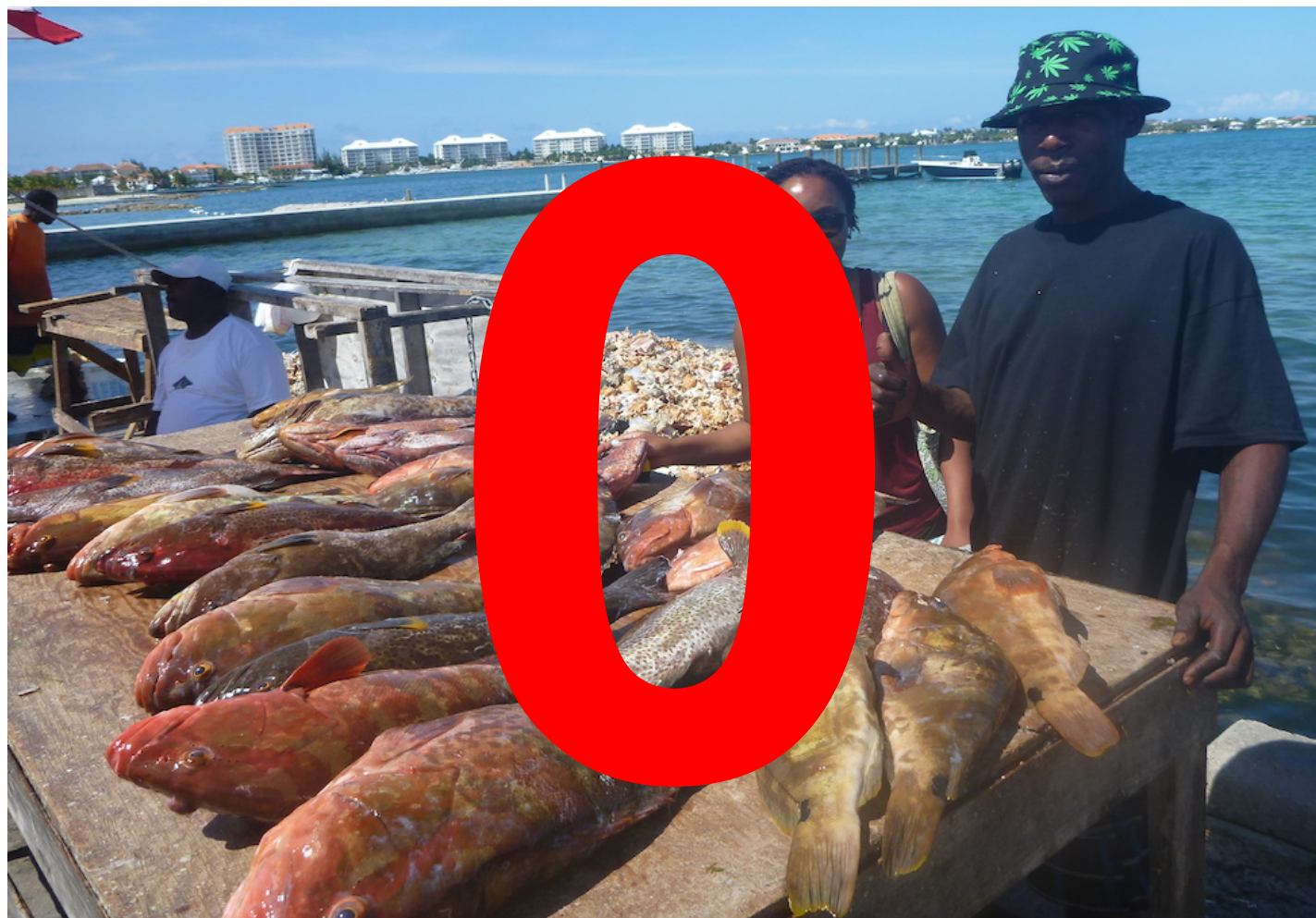
# Native Predators Do Not Influence Invasion Success of Pacific Lionfish on Caribbean Reefs

Serena Hackerott<sup>1\*</sup>, Abel Valdivia<sup>1</sup>, Stephanie J. Green<sup>2</sup>, Isabelle M. Côté<sup>2</sup>, Courtney E. Cox<sup>1</sup>, Lad Akins<sup>3</sup>, Craig A. Layman<sup>4</sup>, William F. Precht<sup>5</sup>, John F. Bruno<sup>1</sup>

2013



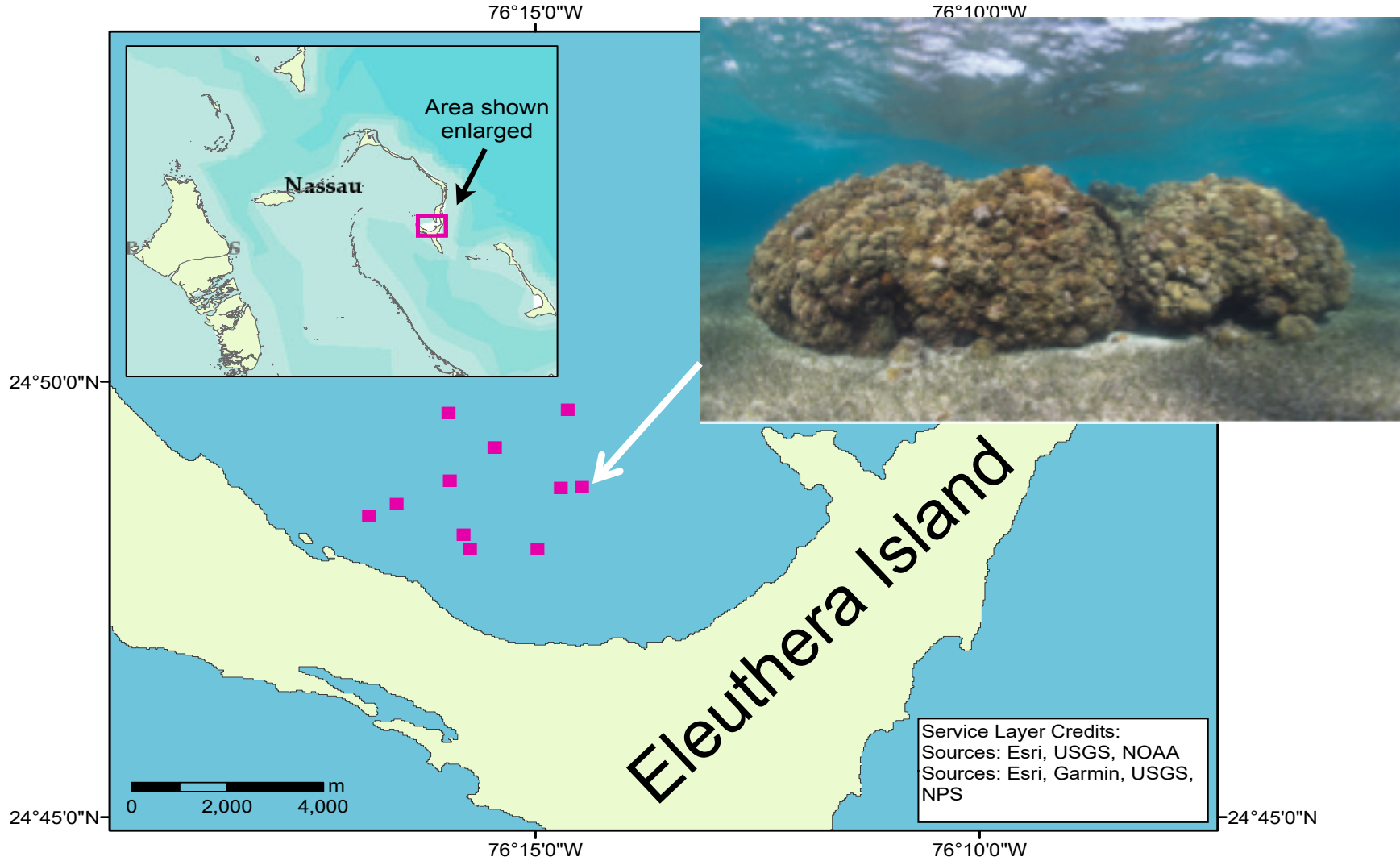






What about **fear effects** of predators?







13 July 2015





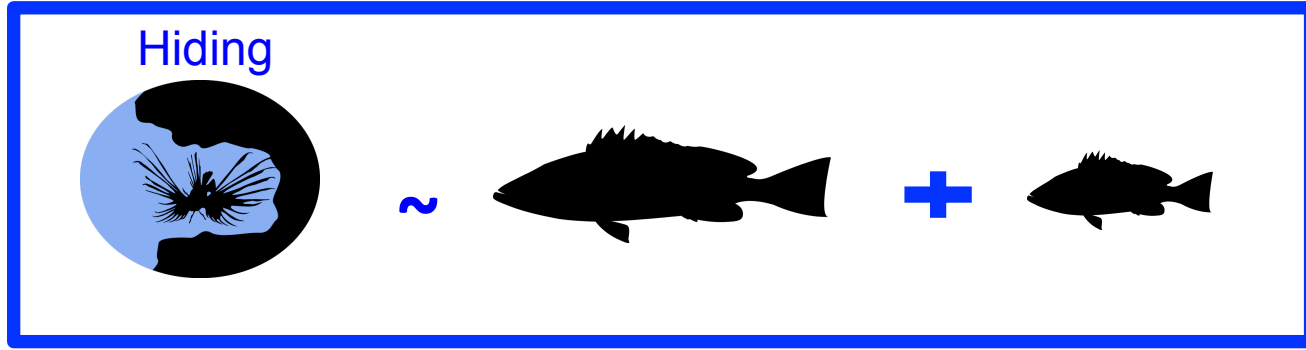


## Lionfish Behavioral surveys

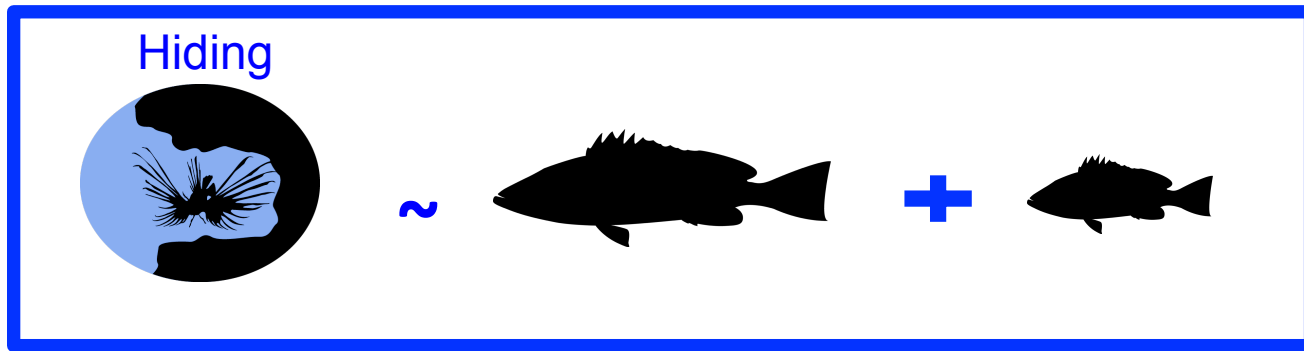
Monitored abundance & biomass:

- Groupers
- Native prey fishes

# Information theory (AICc)



# Information theory (AICc)



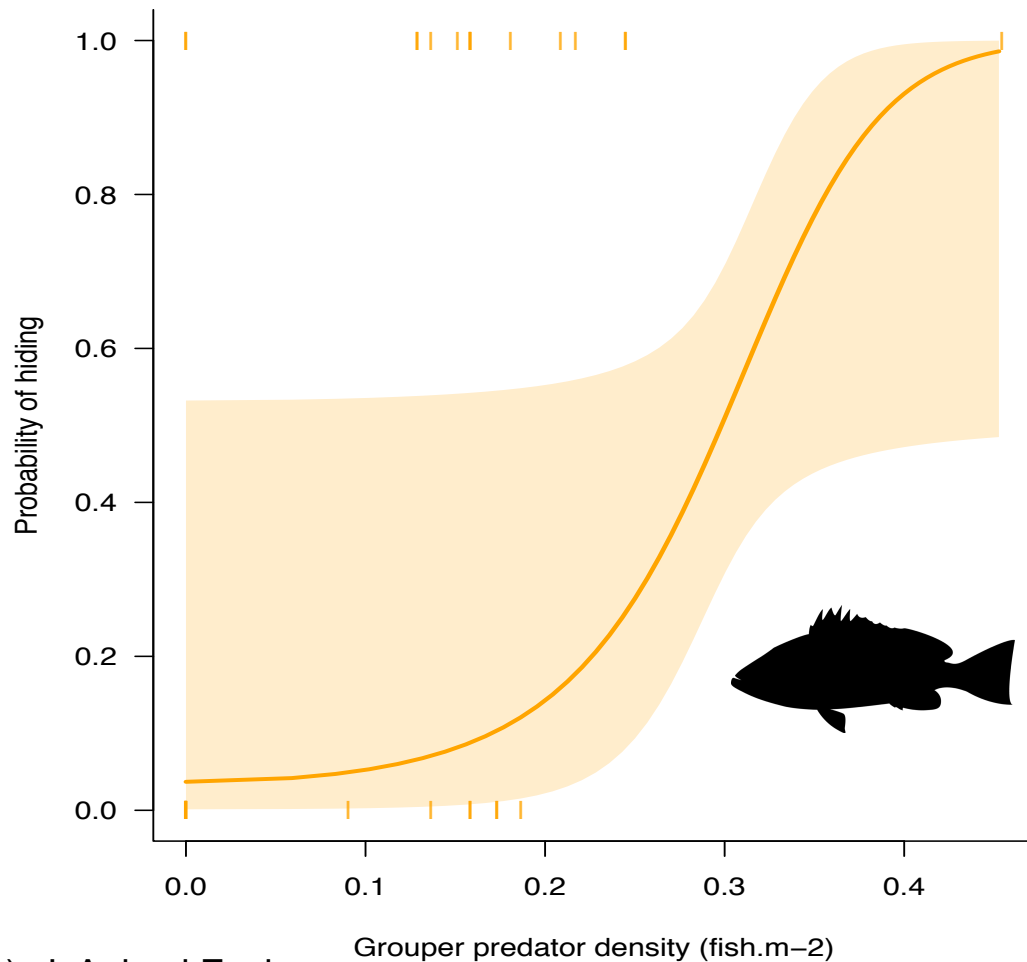
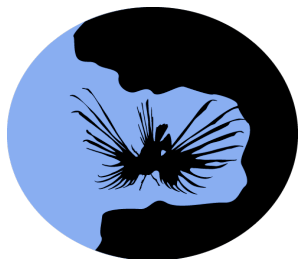
Predation

Size

Species

Interspecific competition

Body size



# No evidence of fear-induced trophic cascade

