Examining the Threat of Pharmaceuticals to South Florida Bonefish: a spatial approach

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Analysis of bonefish plasma and muscle tissue reveals the presence of 14 different pharmaceuticals in bonefish from South Florida, Puerto Rico, and the Bahamas at levels with potential physiological effects

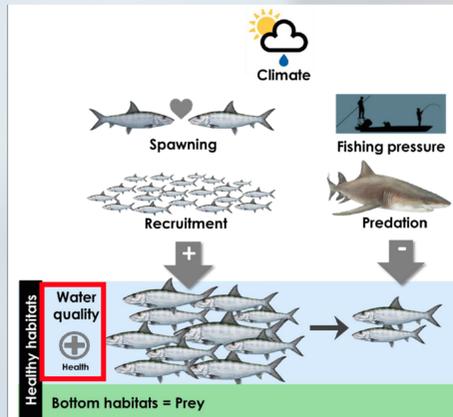## Bonefish : An Important Fishery in Decline

Bonefish, *Albula Vulpes*, is an ecologically and economically important mesoconsumer species found throughout the Caribbean Basin and South Florida in coastal areas. The bonefish recreational fishery accounts for $154 million in annual revenue in the Florida Keys alone (Fedler 2013).
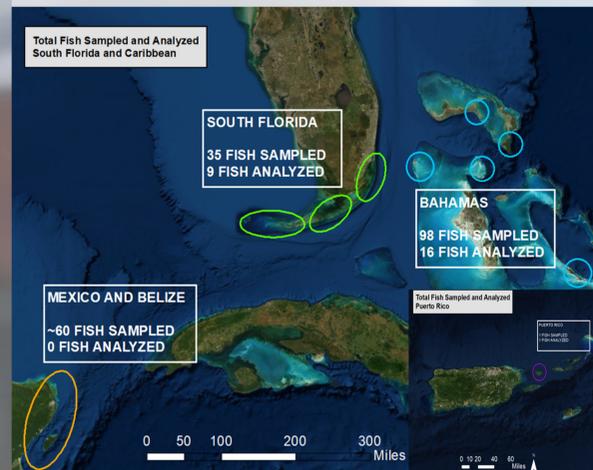
A fishery in decline
➢ A marked decline in Bonefish population in South Florida over the past few decades
➢ The specific cause is unknown.

Does water quality play a role in this decline?

Do pharmaceutical contaminants have a potential to impact bonefish?

Project Design and Hypothesis

Design

Component 1A. Sampling of South Florida bonefish blood plasma
Component 1B. Sampling of bonefish from Puerto Rico, Bahamas, Belize, and Mexico
Component 2. Examine the trophic pathway by prey sampling along transects in South Florida

Hypotheses

1. Presence of pharmaceuticals highest in South Florida.

Florida > Caribbean
Biscayne Bay > Upper Keys > Lower Keys

2. Pharmaceutical levels in prey species will be highest in locations close to nearshore canals, and highest in Biscayne Bay.

Spatial Distribution of Bonefish Sampling

Total Fish Sampled and Analyzed South Florida and Caribbean

SOUTH FLORIDA
35 FISH SAMPLED
9 FISH ANALYZED

BAHAMAS
98 FISH SAMPLED
16 FISH ANALYZED

MEXICO AND BELIZE
~60 FISH SAMPLED
0 FISH ANALYZED

Total Fish Sampled and Analyzed Puerto Rico

Spatial Distribution in the Caribbean
➢ Sampling from the Bahamas, Puerto Rico, Mexico, and Belize
➢ 31 of the target 45 fish collected with 15 fish from the Bahamas analyzed and 1 fish from Culebra, Puerto Rico analyzed
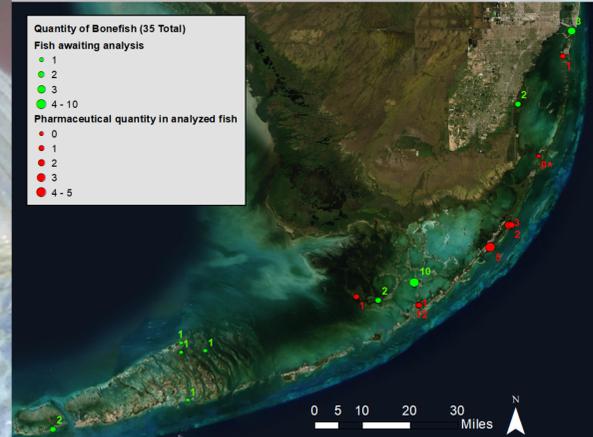
Quantity of Bonefish (35 Total)
Fish awaiting analysis
● 1
● 2
● 3
● 4 - 10
Pharmaceutical quantity in analyzed fish
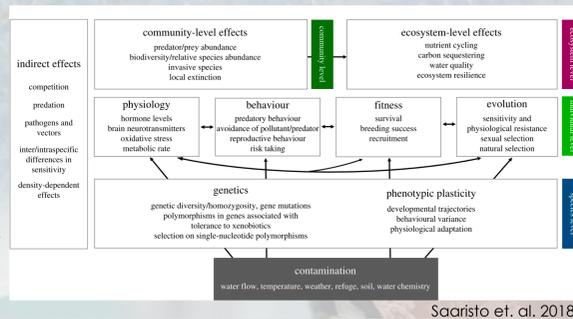● 0
● 1
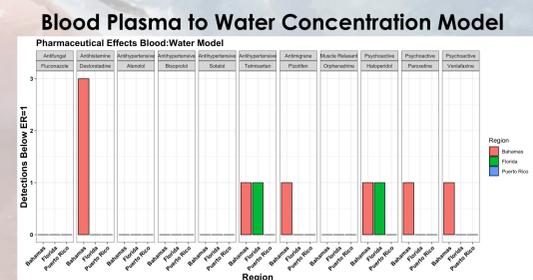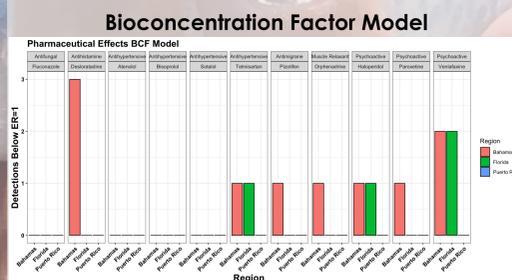● 2
● 3
● 4 - 5

Spatial Distribution in South Florida
➢ Sampling from Biscayne Bay in the north through the Florida Keys to the Marquesas west of Key West
➢ Bonefish collected in nearshore shallow water habitat
➢ 35 of the target 45 fish collected with 9 analyzed for pharmaceuticals

Pharmaceutical Effects on Fish

Pharmaceuticals are **persistent and prevalent** contaminants in the marine environment (Ojemaye 2018; McEneff et. al. 2014). Once in the marine environment, pharmaceuticals can **bioaccumulate in fish**, since they are largely nonpolar, and affect their target receptors resulting in **numerous behavioral and physiological alterations** (Corcoran et. al. 2010; Fabbri et. al. 2016; Brodin 2014).

Saaristo et. al. 2018

The Blood Plasma Model as an Estimate for Chronic Pharmaceutical Effects

The Blood Plasma Model allows for an estimate of chronic receptor mediated responses in fish based on the **conservation of many enzyme and receptor systems** across mammals and fish (Huggett et. al. 2003; Schreiber et. al. 2011; Fick et. al. 2010; Owen et. al. 2007).

Based on this conservation of enzymes and receptors, an estimate of chronic effects is quantified by a calculated Effect Ratio **using the measured concentrations in the bonefish.**

Human Therapeutic Plasma Concentration (H$_T$PC)
Fish Steady State Plasma Concentration (F$_{SS}$PC)

Effect Ratio (ER) = H$_T$PC/F$_{SS}$PC

ER ≤ 1

Potential Physiological Effects

Log P$_{Blood:Water}$ = 0.73 × Log K$_{OW}$ – 0.88
Log BCF = 0.85 (log K$_{OW}$) – 0.70
F$_{SS}$PC = EC × (P$_{Blood:Water}$ or BCF)

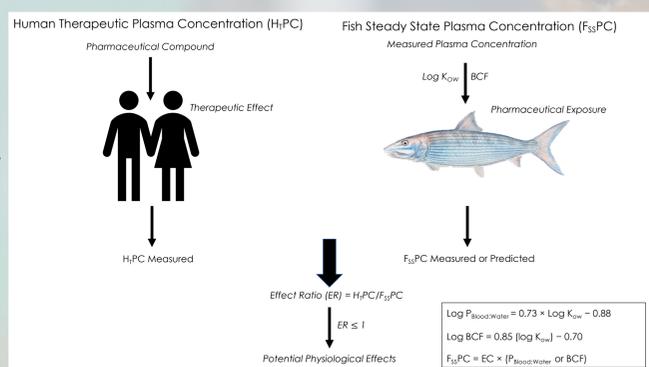## Pharmaceutical Effects: Effect Ratio <1

Bioconcentration Factor Model

The BCF model found **effects for 10 Bahamas pharmaceutical concentrations** and **4 South Florida Pharmaceutical concentrations**

Blood Plasma to Water Concentration Model

The Blood:Plasma model found **effects for 8 Bahamas pharmaceutical concentrations** and **2 South Florida Pharmaceutical concentrations**

Key Pharmaceutical Results

Florida
8 of 9 fish with pharmaceuticals, 16 total detections
4 pharmaceutical detections with ER < 1
Bahamas
13 of 15 fish with pharmaceuticals, 23 total detections
10 pharmaceutical detections with ER < 1
Puerto Rico
1 of 1 fish with pharmaceuticals, 1 total detection
0 pharmaceutical detections with ER < 1
Bahamas > Florida > Puerto Rico

Key Findings and Future Work

Key Findings
➢ The most common pharmaceuticals were **betablockers** followed by **psychoactive** pharmaceuticals and **antihistamines**
➢ **All plasma samples** had detectable pharmaceuticals
➢ Initial results show **more pharmaceuticals in the Bahamas**

Future Work
➢ Further sample collection in Puerto Rico and South Florida
➢ Prey sampling in South Florida

Acknowledgements