Hydrology drives fish calling behavior in Florida Bay:

the potential for an ecosystem indicator

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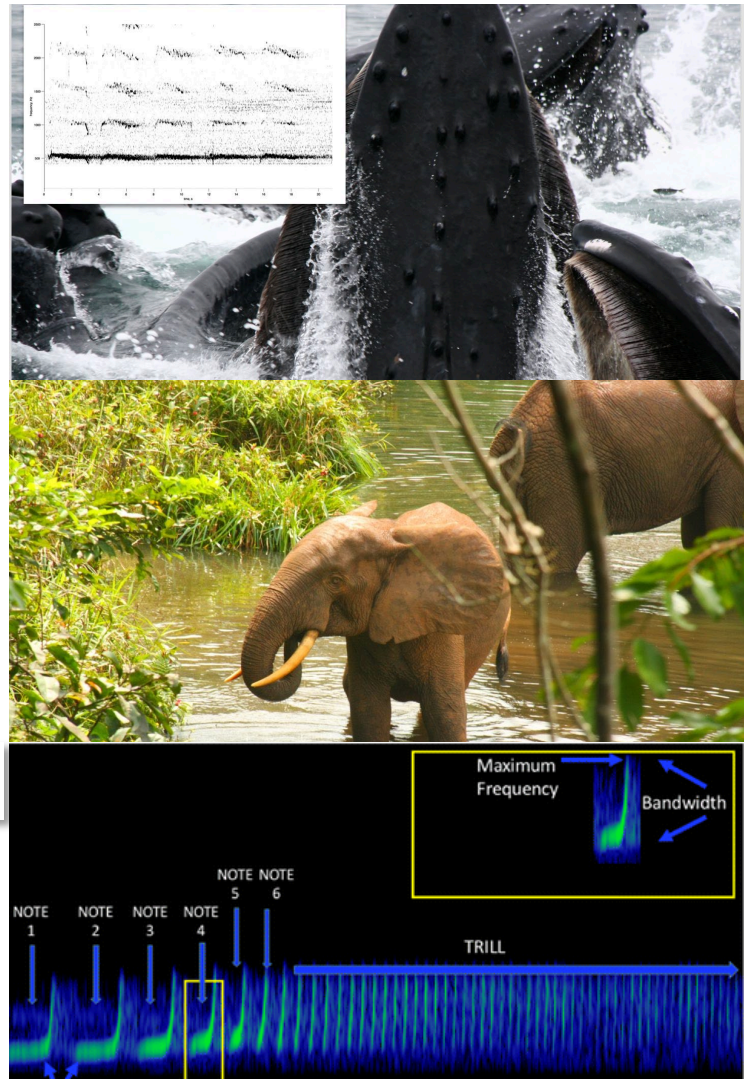
Applied Bioacoustics:

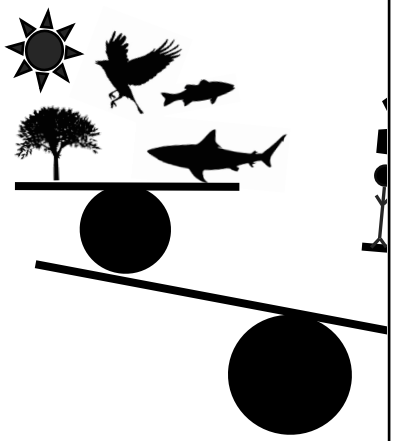
Using sound to answer questions
and make decisions about the natural world

- Conservation
- Environmental Impacts
- Management

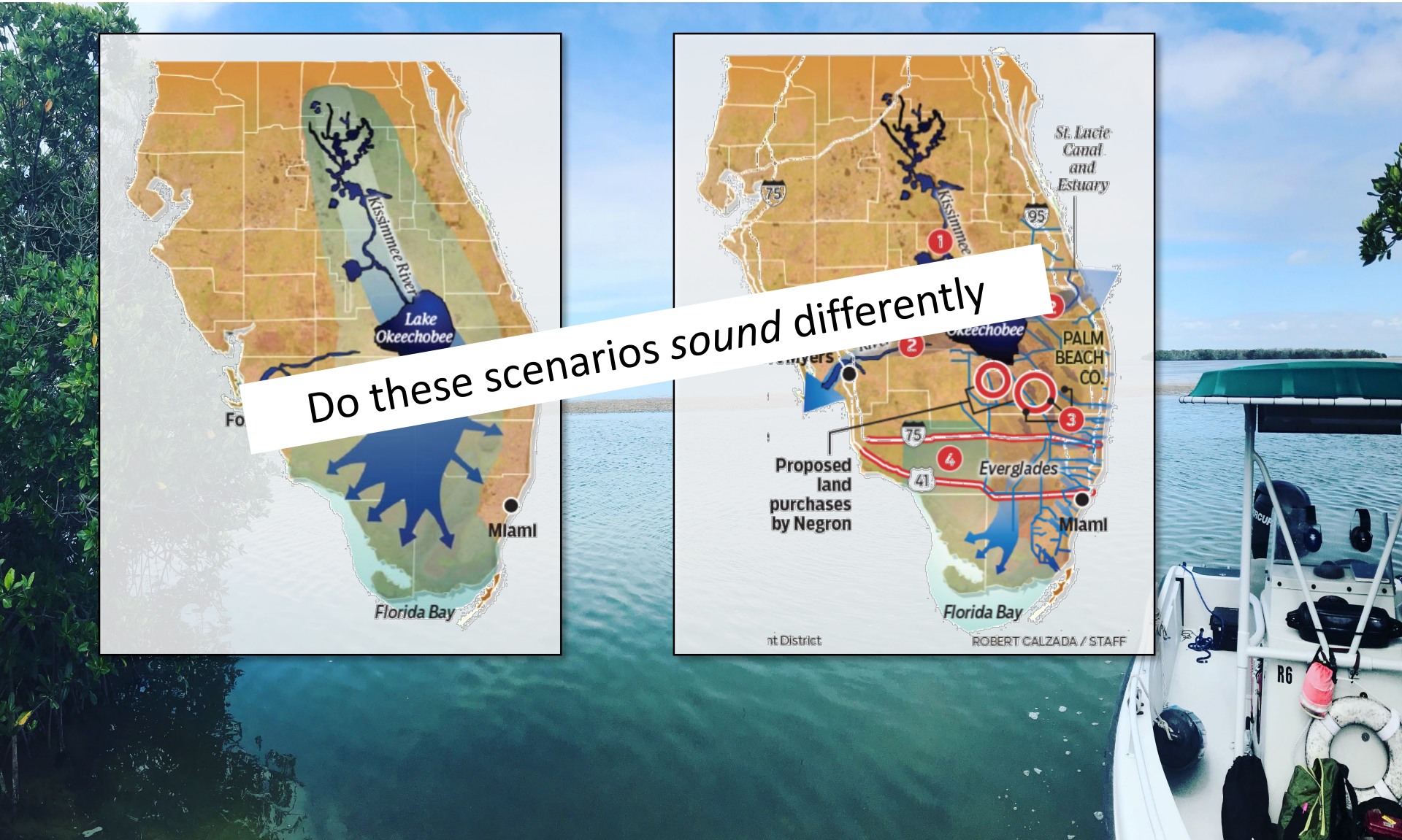
Most often done with Passive Acoustic Monitoring (PAM)



Dynamic Management



Florida Everglades: *river of grass*



Do these scenarios sound differently

Florida Everglades: *indicators*

Gulf Toadfish (*Opsanus beta*)

“Squatty and flat, the toadfish is not a specimen to be appreciated by looking at it, though still perfectly suited for its needs”

- Widespread
- Vocal
  - Mate attraction
  - Territoriality
- High site-fidelity
- Widely studied
- Not endangered
- Not commercially fished
- Mid-trophic level

Model system for bioacoustics

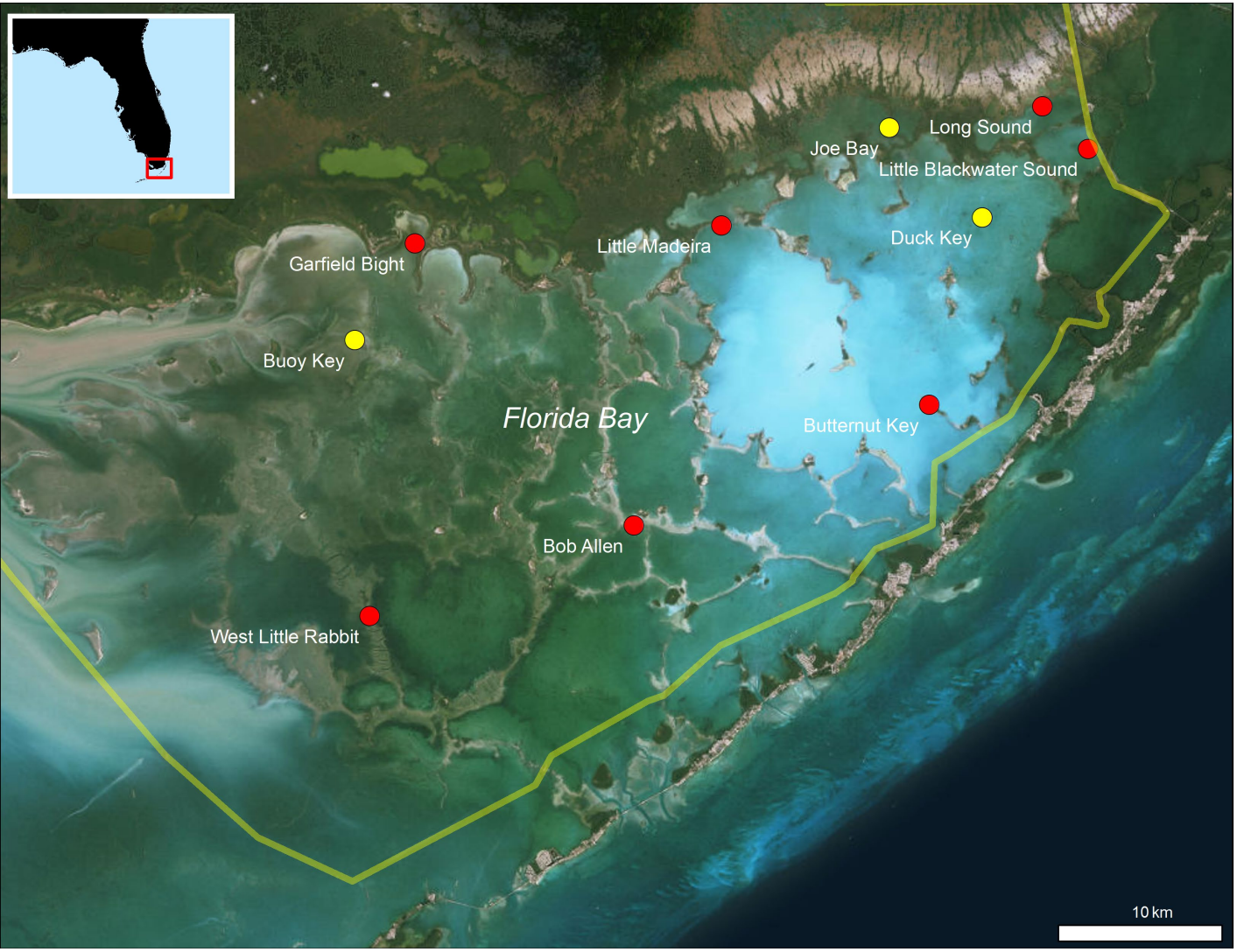
Gulf Toadfish (***Opsanus beta***)

Can be monitored at the same scale as the environment

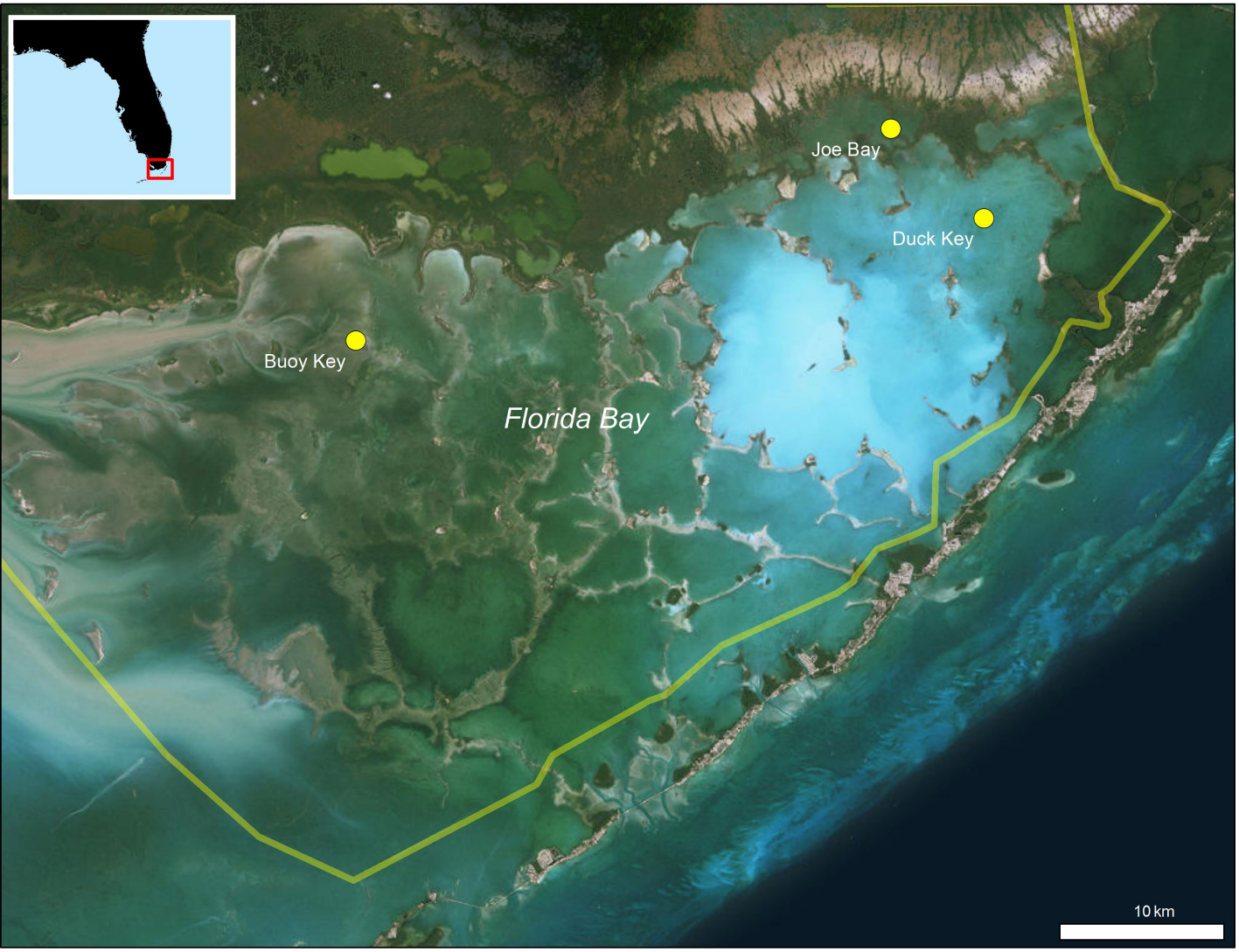
"Squatty and flat, the toadfish is not a specimen to be appreciated by looking at it, though still perfectly suited for its needs"

Data Collection

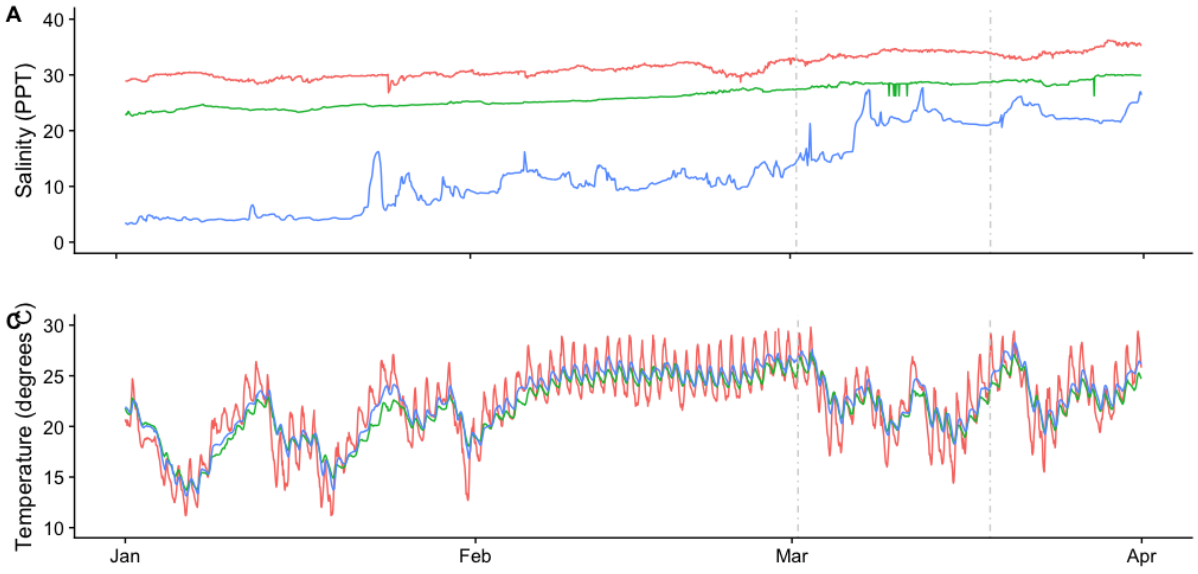
- 10 water quality monitoring stations

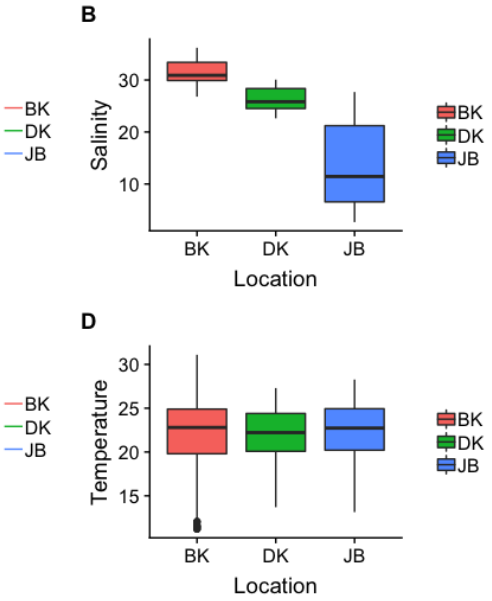


Data Collection



- 10 water quality monitoring stations
- Recording (acoustically) continuously
  - 8 or 16 kHz
  - “Hydro-Swift”
- Deployed in ~1.5 feet of water


A
Salinity (PPT)
40
30
20
10
0
C
Temperature (degrees C)
30
25
20
15
10
Jan
Feb
Mar
Apr
BK
DK
JB


B
Salinity
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Temperature
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DK
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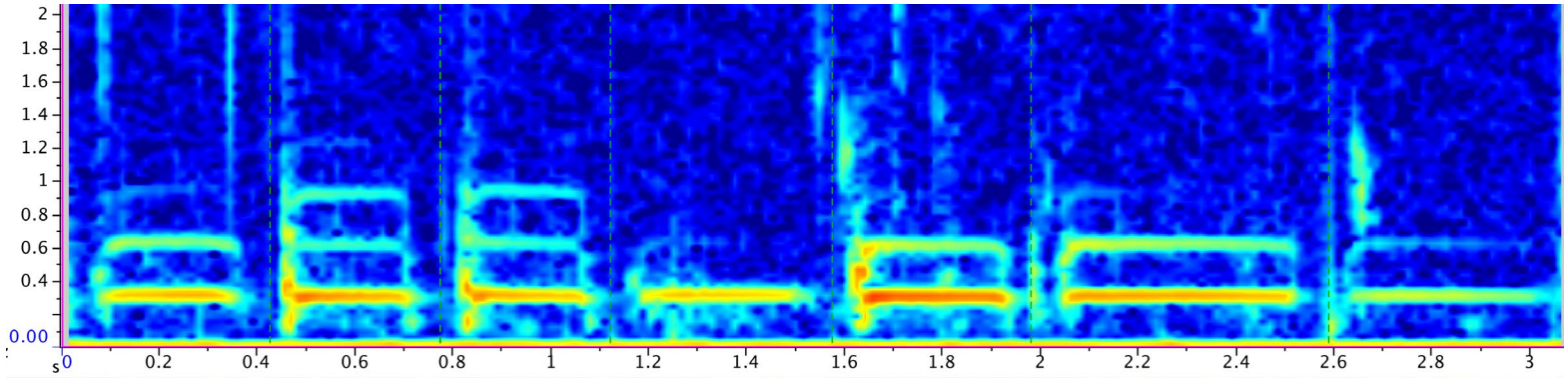
Location


2
1.8
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1.2
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0.4
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s
0
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1.8
2
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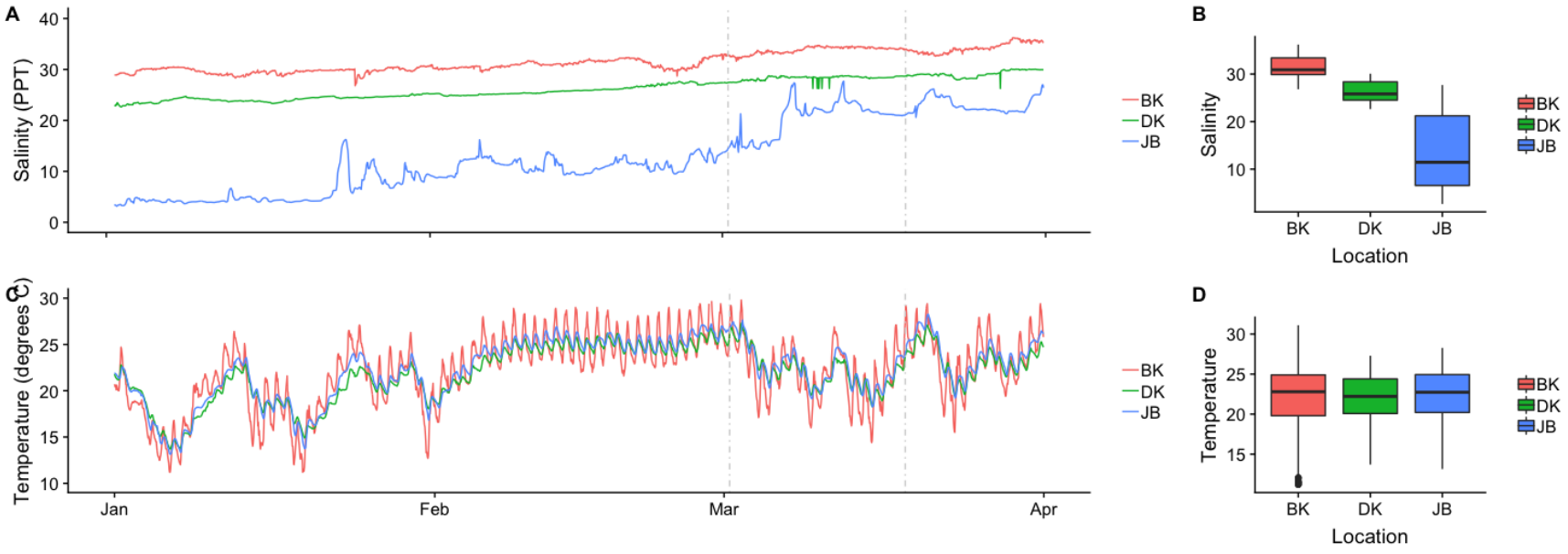
2.4
2.6
2.8
3


A
Salinity (PPT)
40
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BK
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JB
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Salinity
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10
BK
DK
JB
Location
C
Temperature (degrees C)
30
25
20
15
10
Jan
Feb
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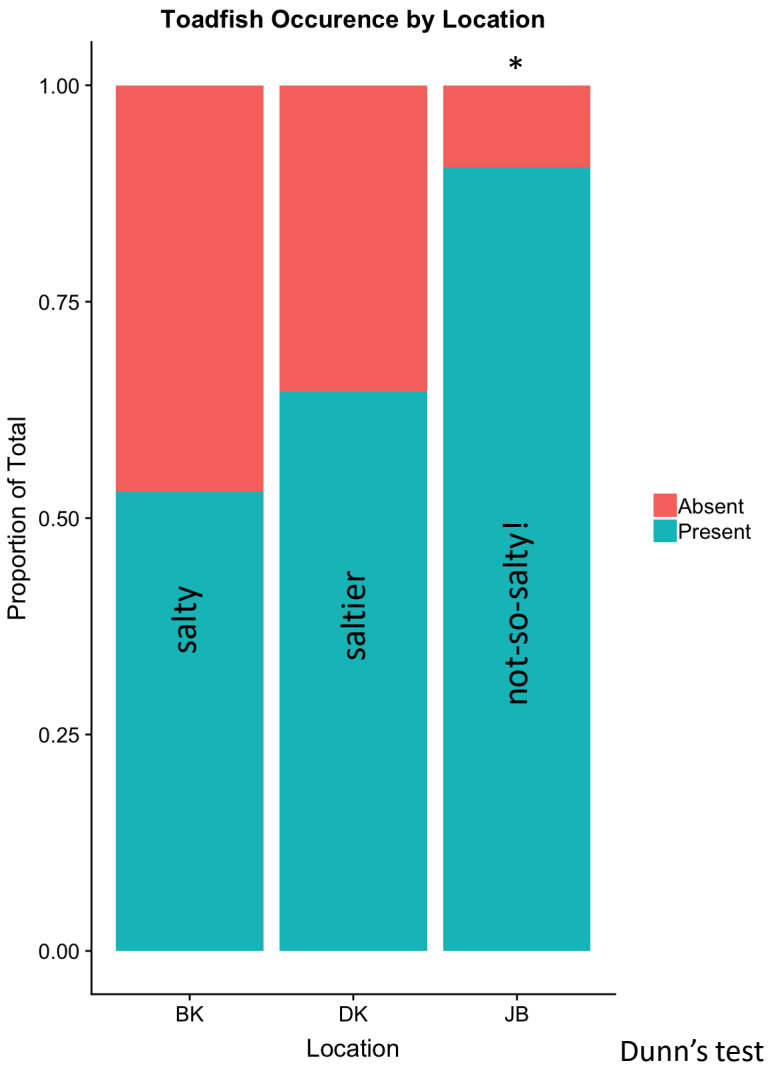
BK
DK
JB
D
Temperature
30
25
20
15
BK
DK
JB
Location

Scaled Data Analysis

Between Site

- Total observations across the breeding season
- Quantified differences in salinity and temperature

Site	Salinity (ppt)		Temperature (C)	
BK	*31.5	+/-0.04	22.2	+/-3.9
DK	*26.2	+/-0.04	21.9	+/-3.1
JB	*12.8	+/-0.1	22.3	+/-3.3



Dunn's test

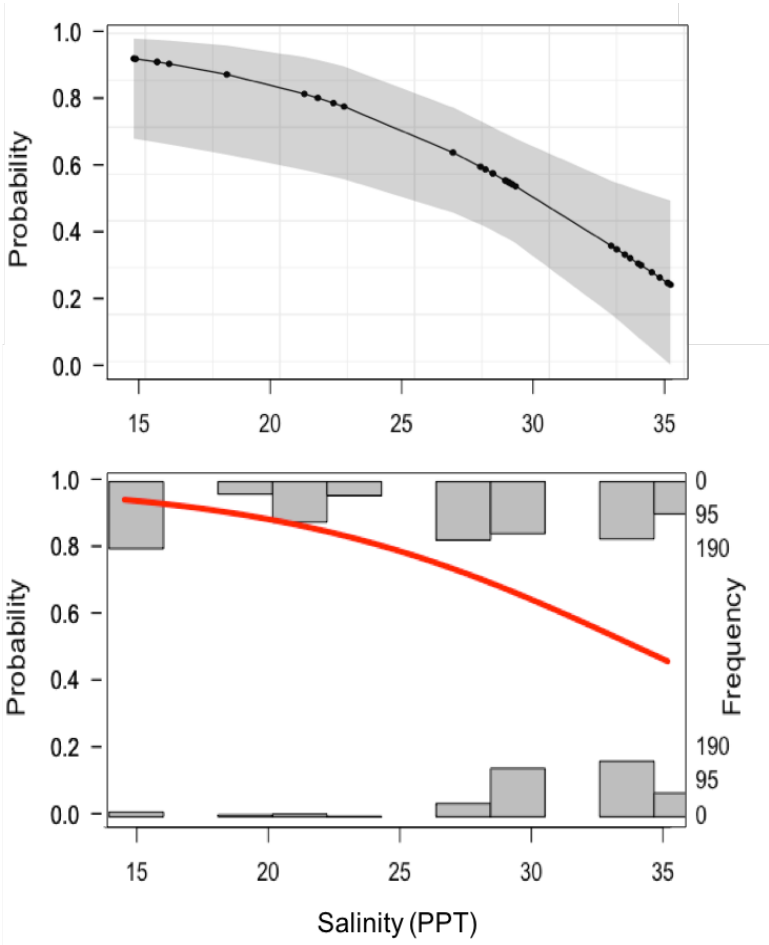
Scaled Data Analysis

Within Site

- Quasibinomial regression models
- Drop-in-deviance test for variable selection

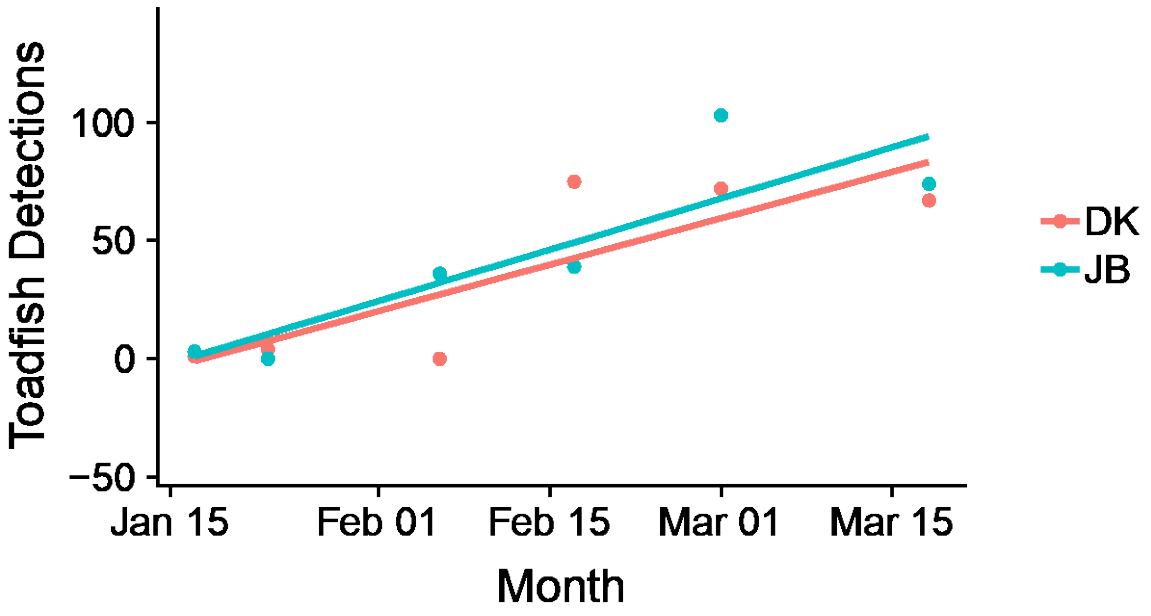
***p*(toadfish)|Temp + salinity + moon+ site +1/date**

Across the three locations in Florida Bay the probability of toadfish occurrence was found to decrease by 14% with ever one unit increase in salinity (95% C.I.= 6%-23%; $t_{1,32}$= -2.901, p<0.006)

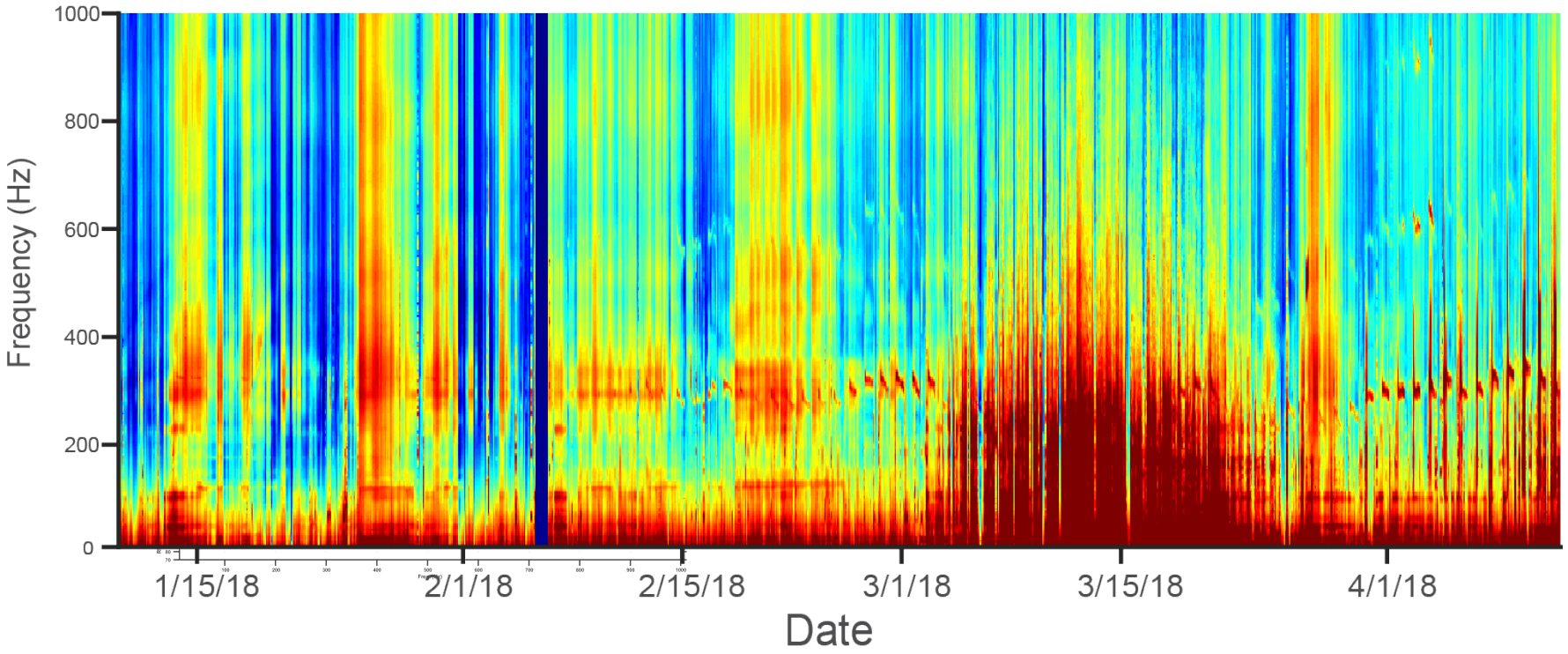


Scaling up: Seasonality

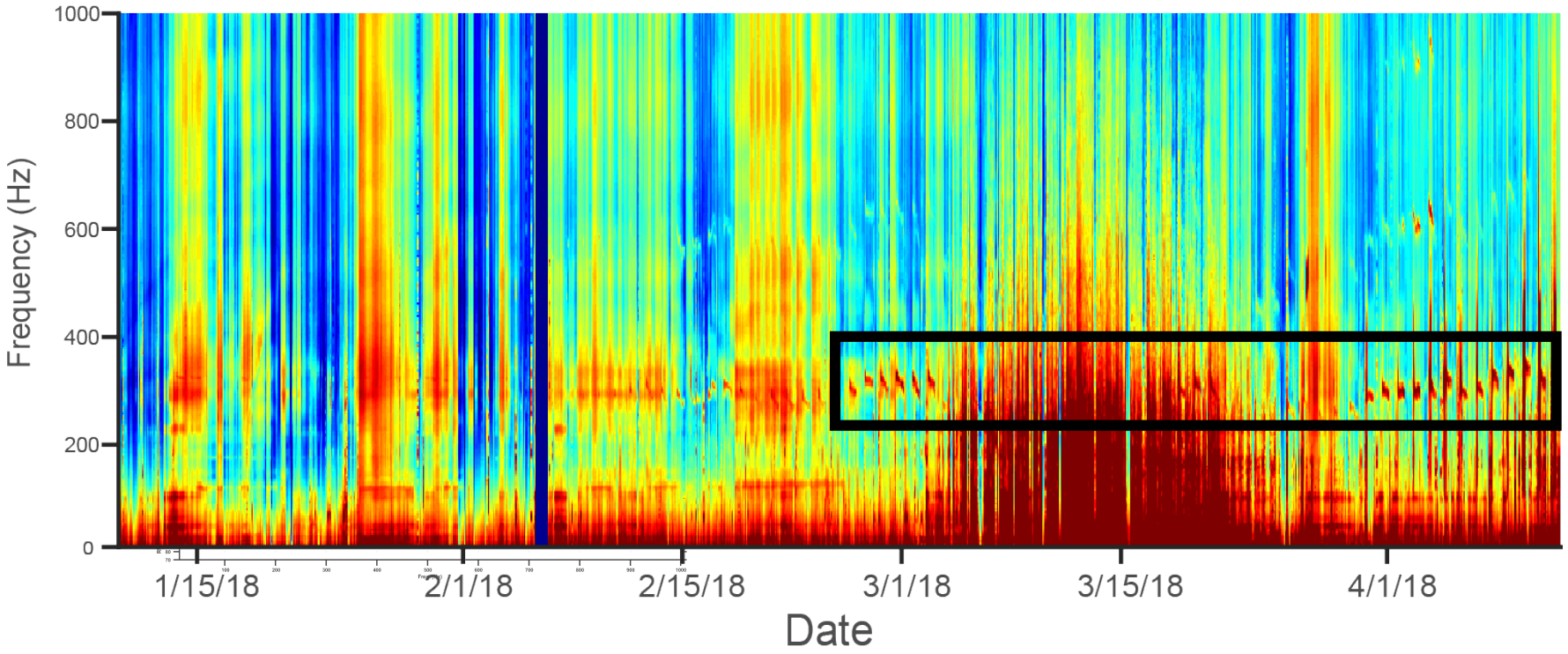
- Trend consistent across seasons
- Learn something about reproductive timing
- Can be used to assess change across several scales (within and between sites)



Scaling up: Acoustic community



Scaling up:
Acoustic community



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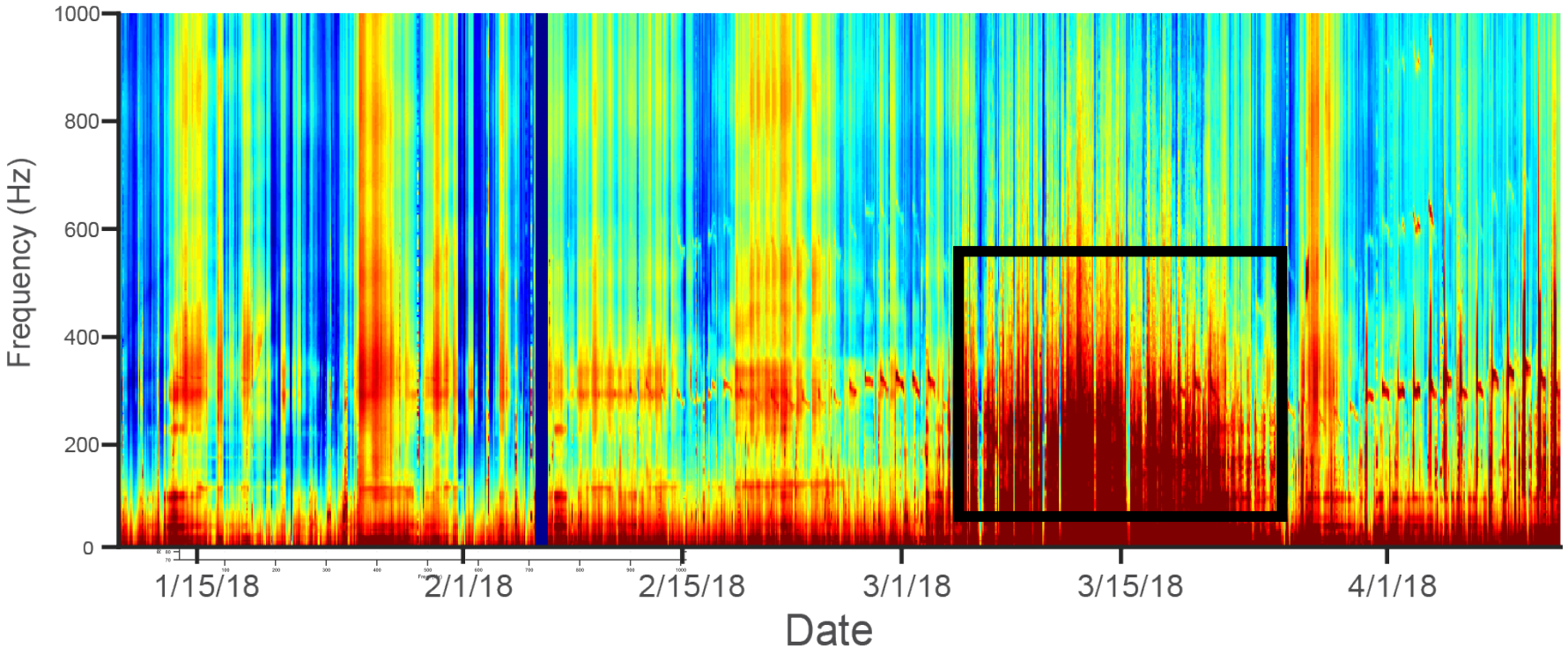
Acoustic community



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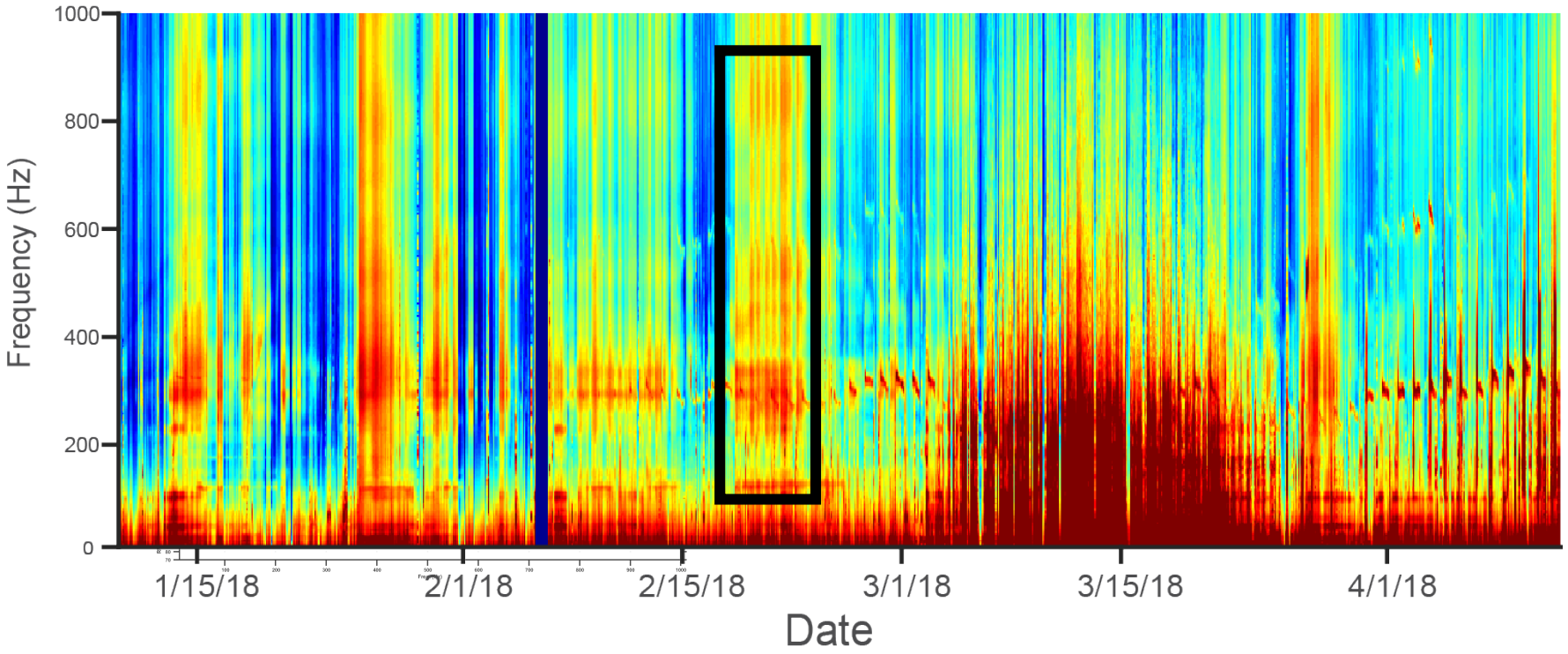

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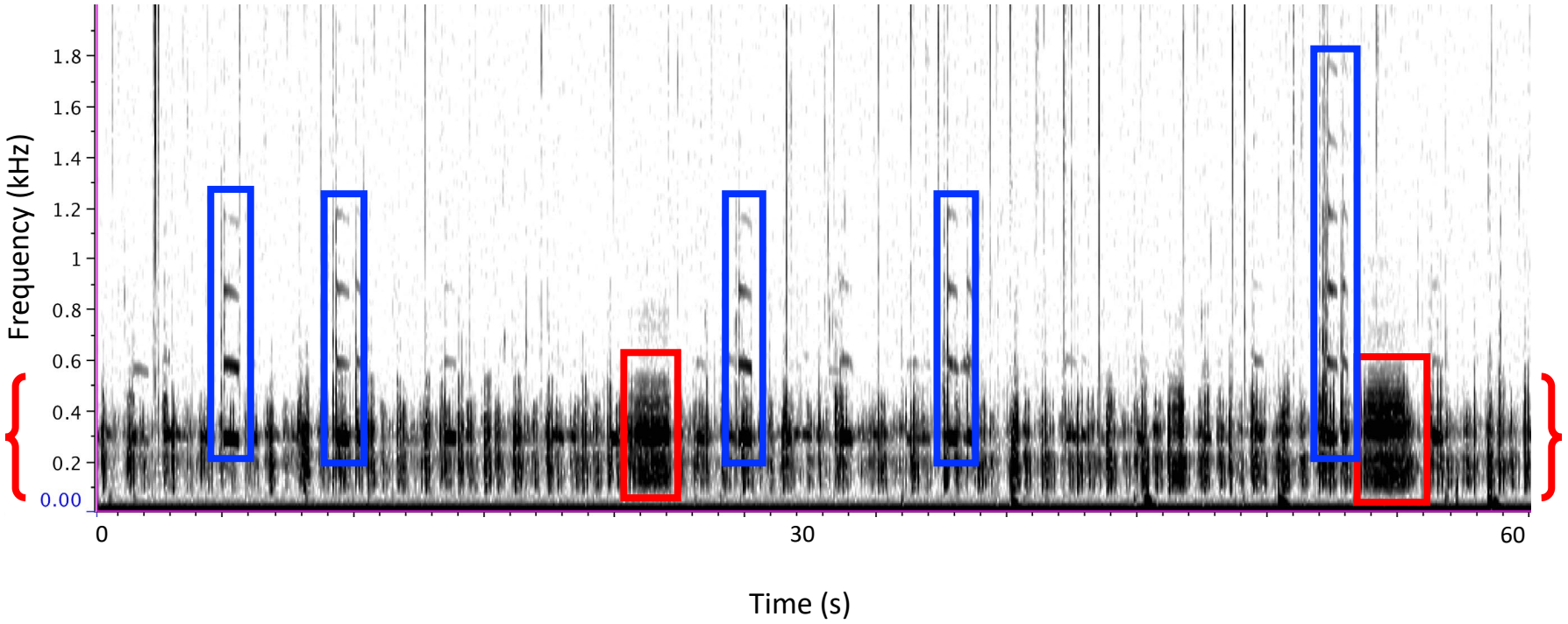
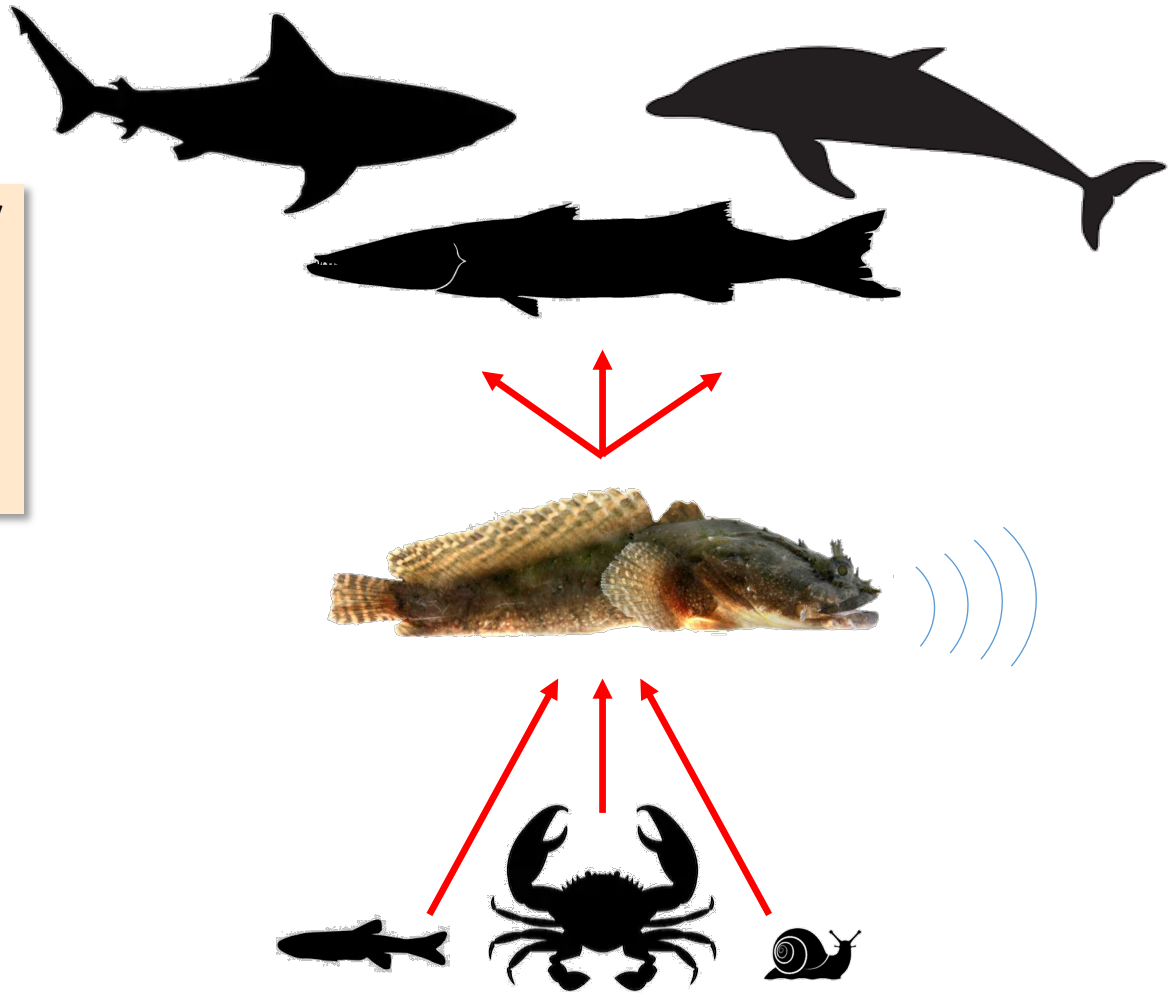


Indicator Species?

The goal of a successful estuary indicator is to evaluate the overarching condition of the environment without having to capture the full complexity of the system



- Broadly distributed
- Limited movement
- Biologically responsive
- Ecologically Important
- Feasible (acoustics)

Thank you

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The Cornell Lab of Ornithology

NATIONAL PARK SERVICE