Yellowfin Tuna (*Thunnus albacares*) as an Indicator of Ecosystem State in the Oceanic Eastern Tropical Pacific

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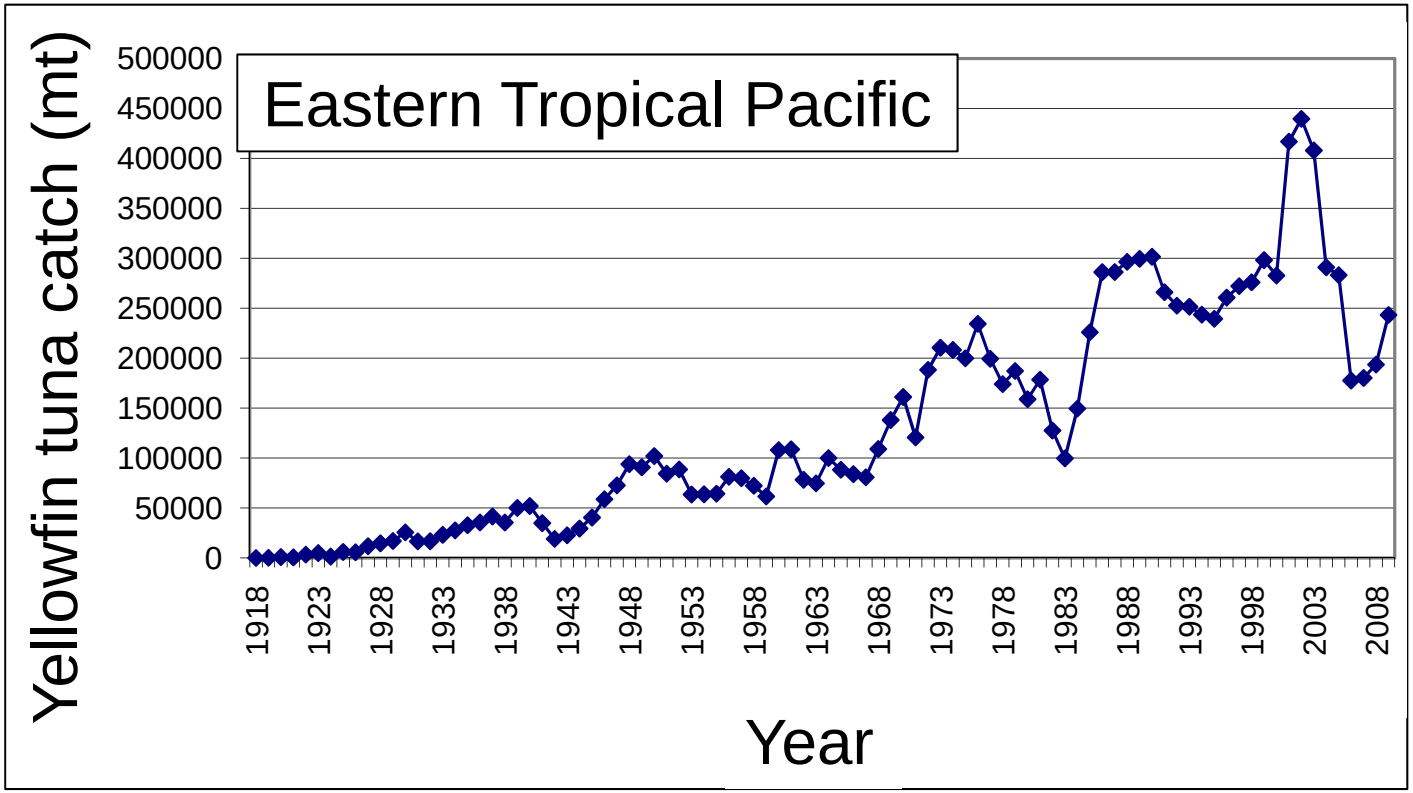
Single species fisheries management

- track metrics of target population
  - catch, abundance, biomass
- assess: does management meet objectives?

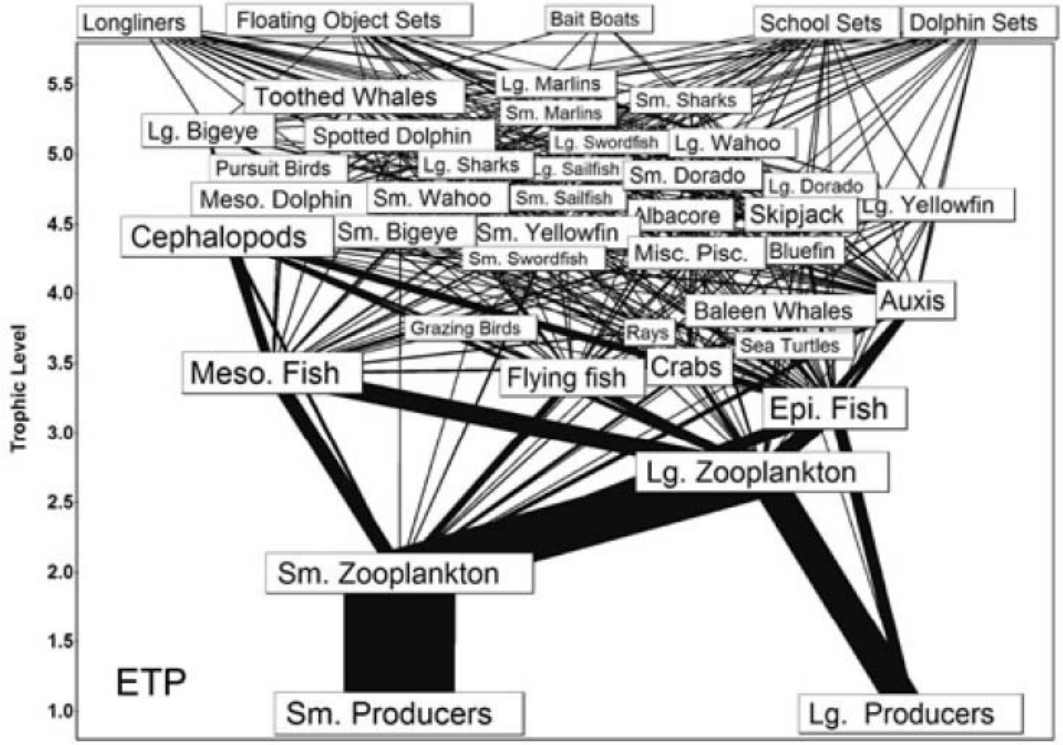


IATTC public data

Introduction

Ecosystem-based management (EBM)

- monitor metrics of ecosystems
  - biodiversity, biomass, community, food web, etc.
- collect data continuously → detect changes



Hinke et al. 2003

Introduction

Indicators as EBM tools

- Ecosystem/biodiversity data
  - difficult, costly to collect
- More feasible to develop ***indicators***

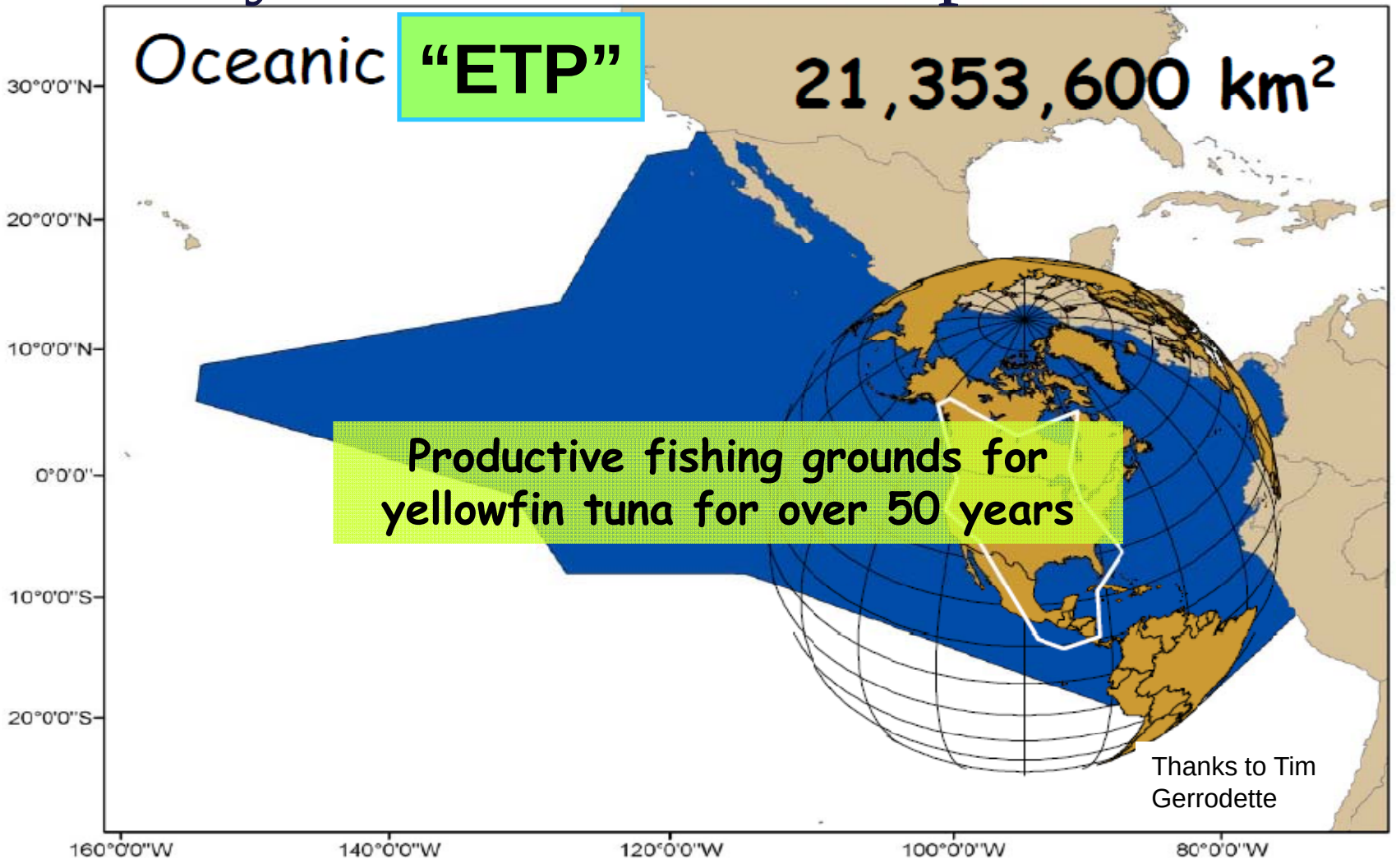
  Carpenter et al. 2001, *Niemeijer and de Groot 2008, Levin et al. 2009, Samhouri et al. 2009*
- Indicators relate to management objectives
  - "maintain resilience" & "maintain productive fisheries"

    Leslie and Kinzig 2009, Samhouri et al. 2009
- Ideal qualities:
  - Relatively easy to measure/obtain
  - Relatively inexpensive

Objective

What do yellowfin tuna *indicate* about the ecosystem?

Study Area: Eastern Tropical Pacific

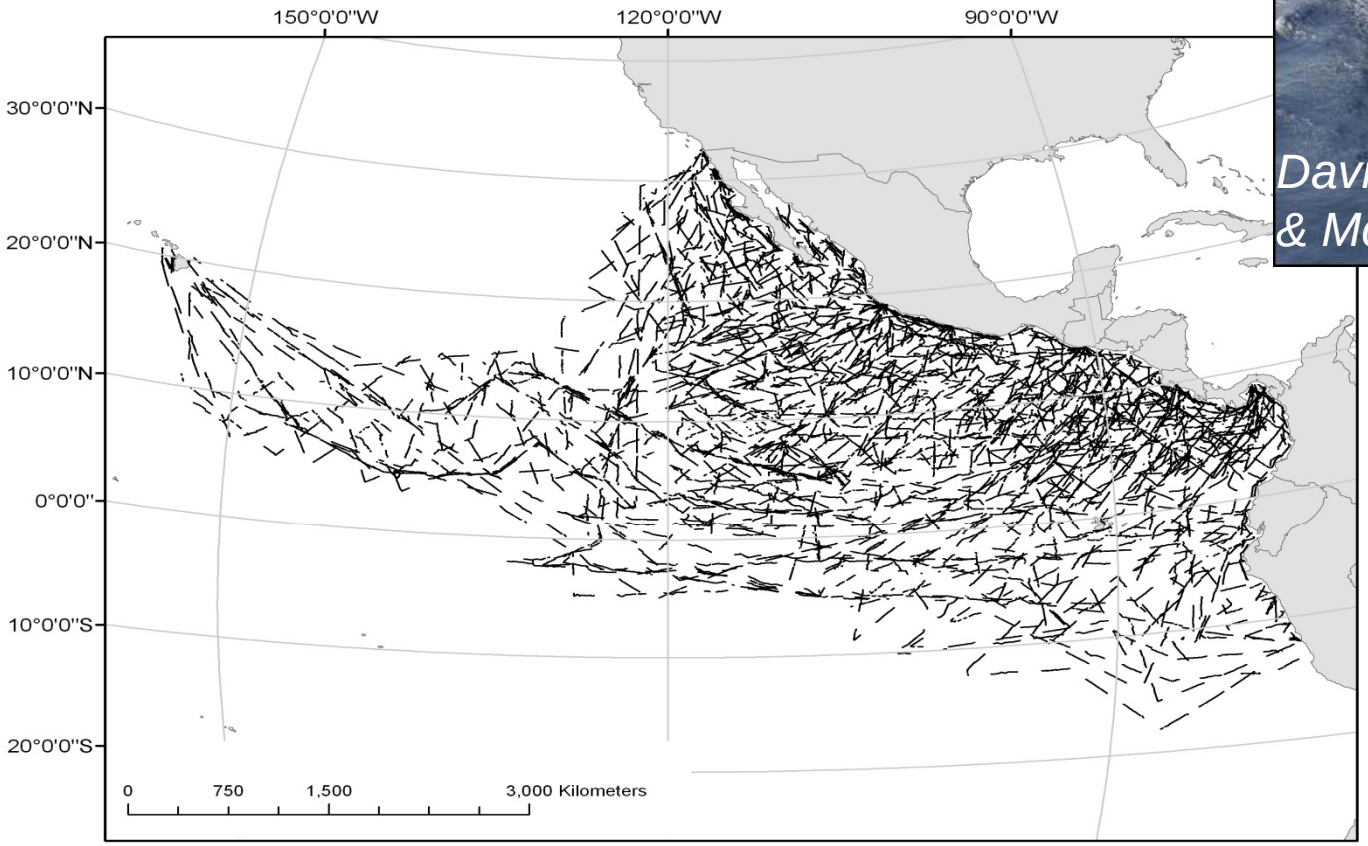


Methods

Why ETP? Data sets.

1. NOAA Fisheries

- Data collected from NOAA research vessels



- 10 years
- 20 yr span:
  1986 – 2006
- Aug – Nov
- 2116 sea days

Methods

1. NOAA Fisheries

Continuous Sampling

- **Cetaceans & Seabirds**
- **Sea Surface:**
  - temperature
  - salinity
  - chlorophyll

Station-Based Sampling

- **Every 200 linear nautical miles:**
  - dipnet (flyingfish)
  - net tows (larval fish)
- **Every 100 linear nautical miles:**
  - water column salinity
    - to 1000m
  - euphotic zone chlorophyll
    - to 1000m
- **Every 30 linear nautical miles:**
  - water column temperature
    - to 1000m

Cetaceans: line-transect

Starting with biodiversity as our metric for ecosystem state

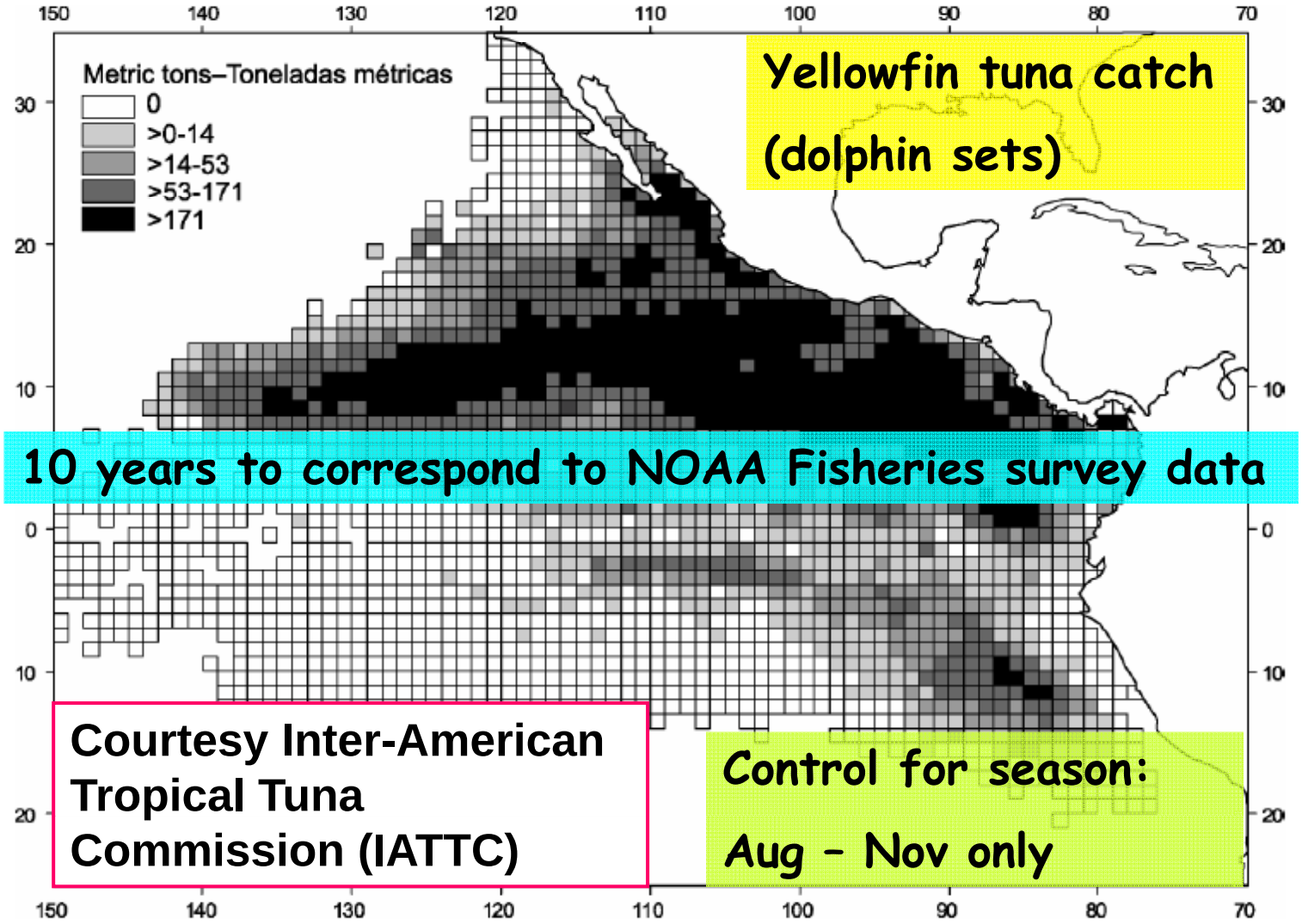
Flyingfish: dipnet

Larval fish: net tows

Methods

Why ETP? Data sets.

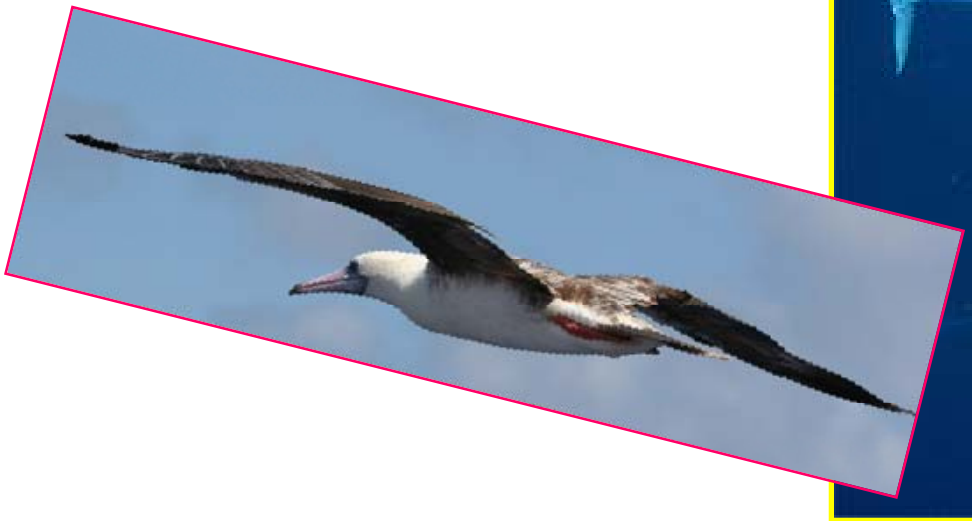
2. Inter-American Tropical Tuna Commission



Methods

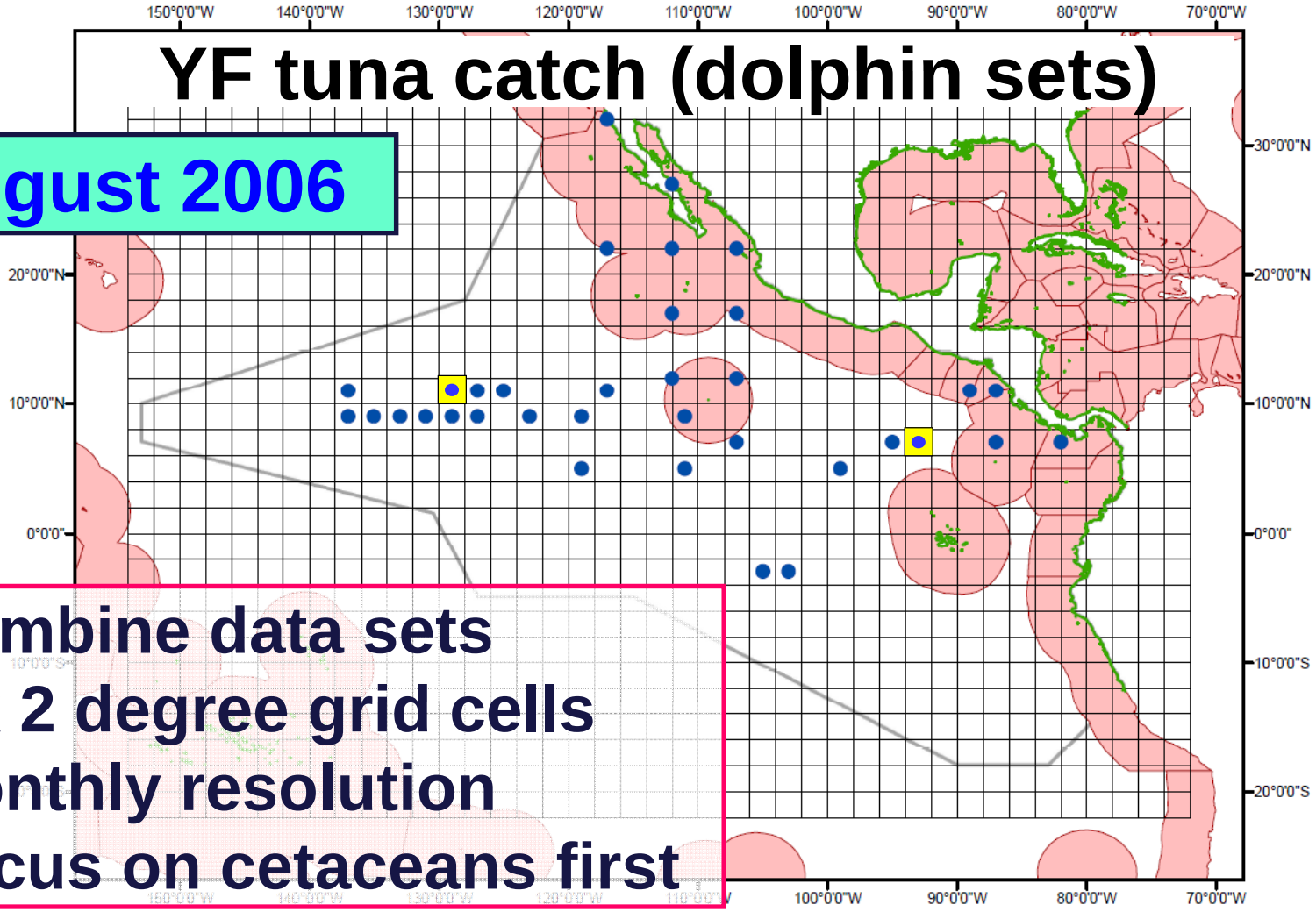
Why yellowfin tuna?

- ✓ tuna-dolphin-seabird association
- ✓ commercially important
- ✓ data relatively easy to obtain
- ✓ data widely available



Methods

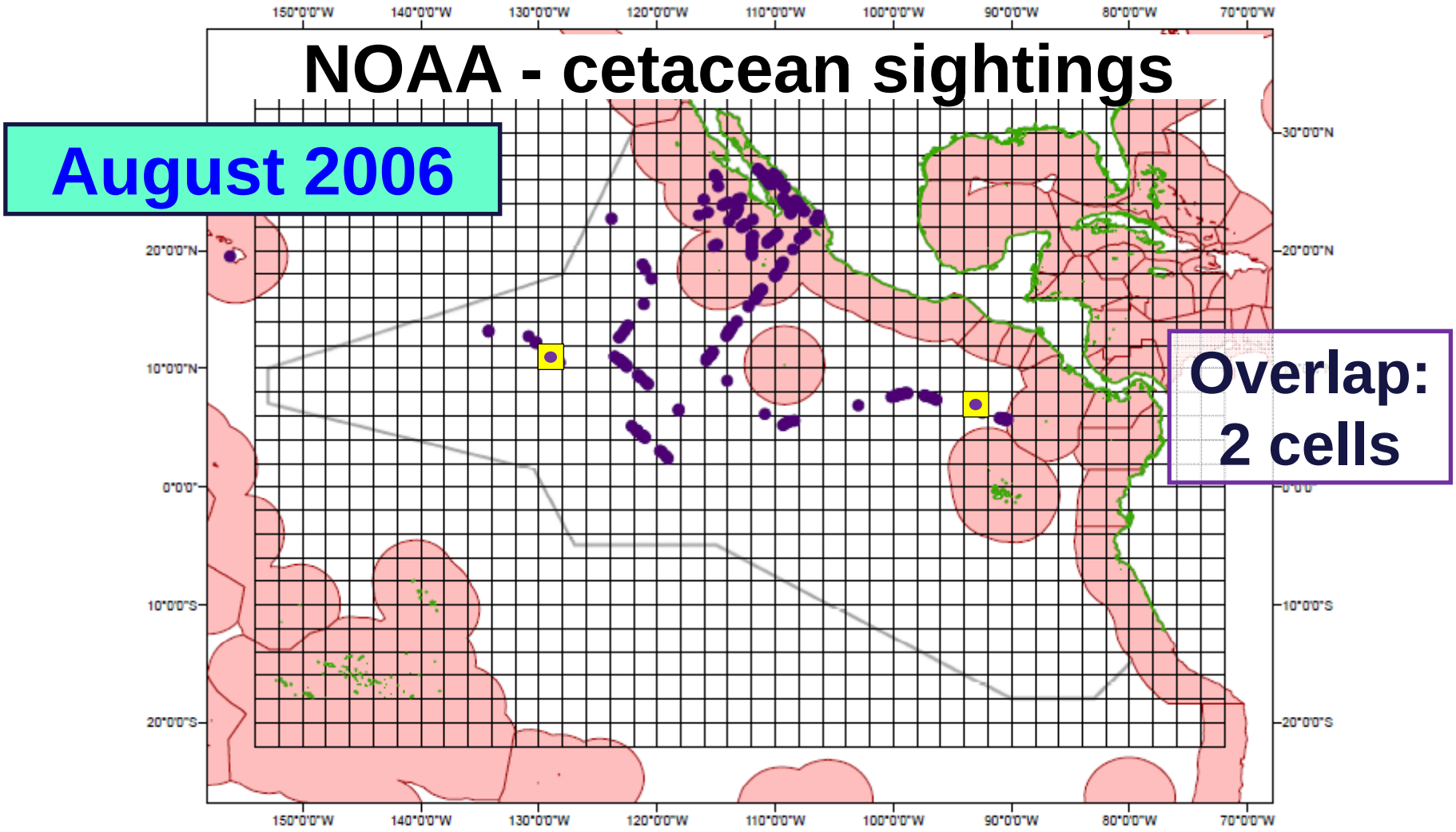
Approach: overlapping data



- Combine data sets
- 2 x 2 degree grid cells
- Monthly resolution
- Focus on cetaceans first

Methods

Approach: overlapping data



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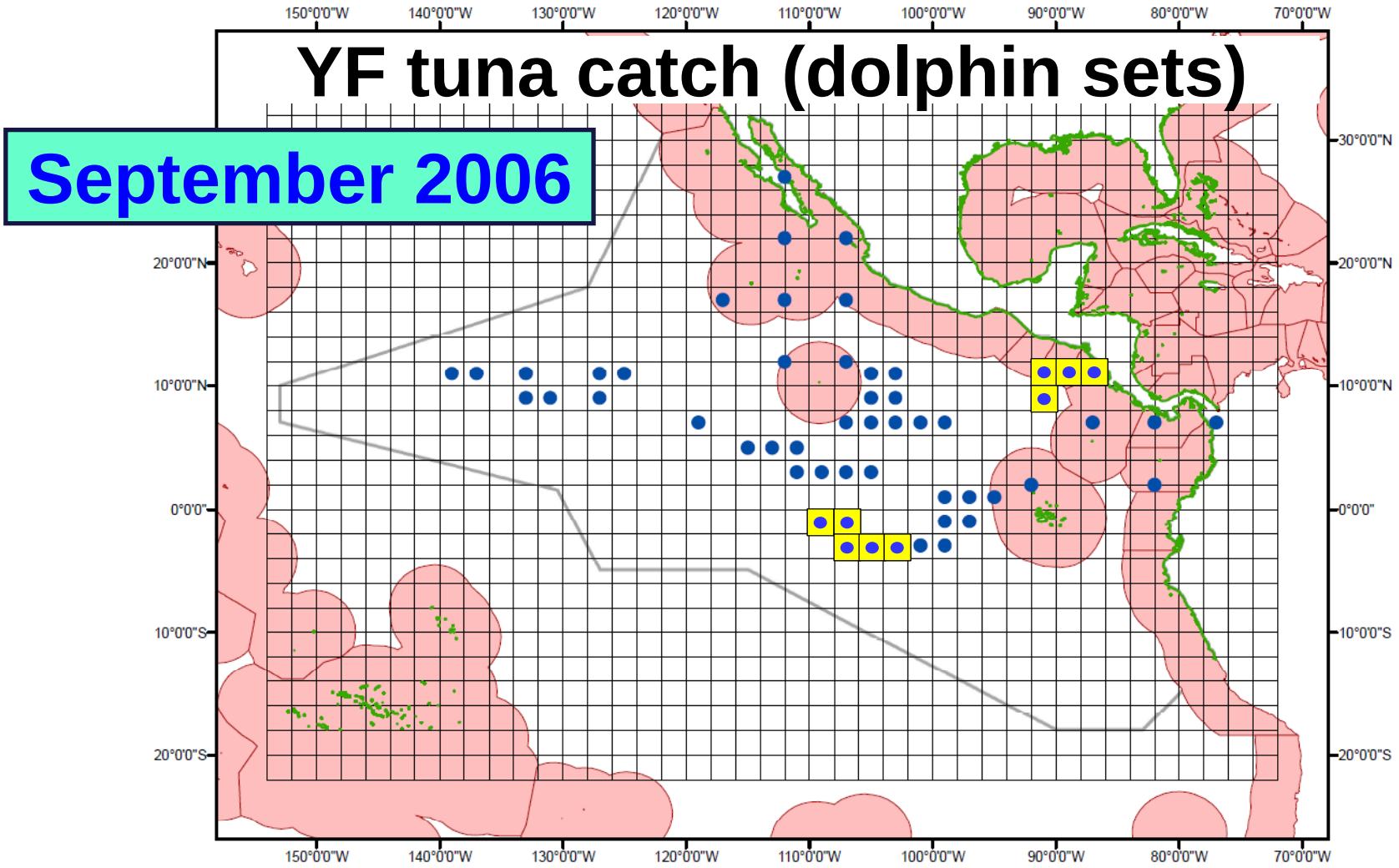

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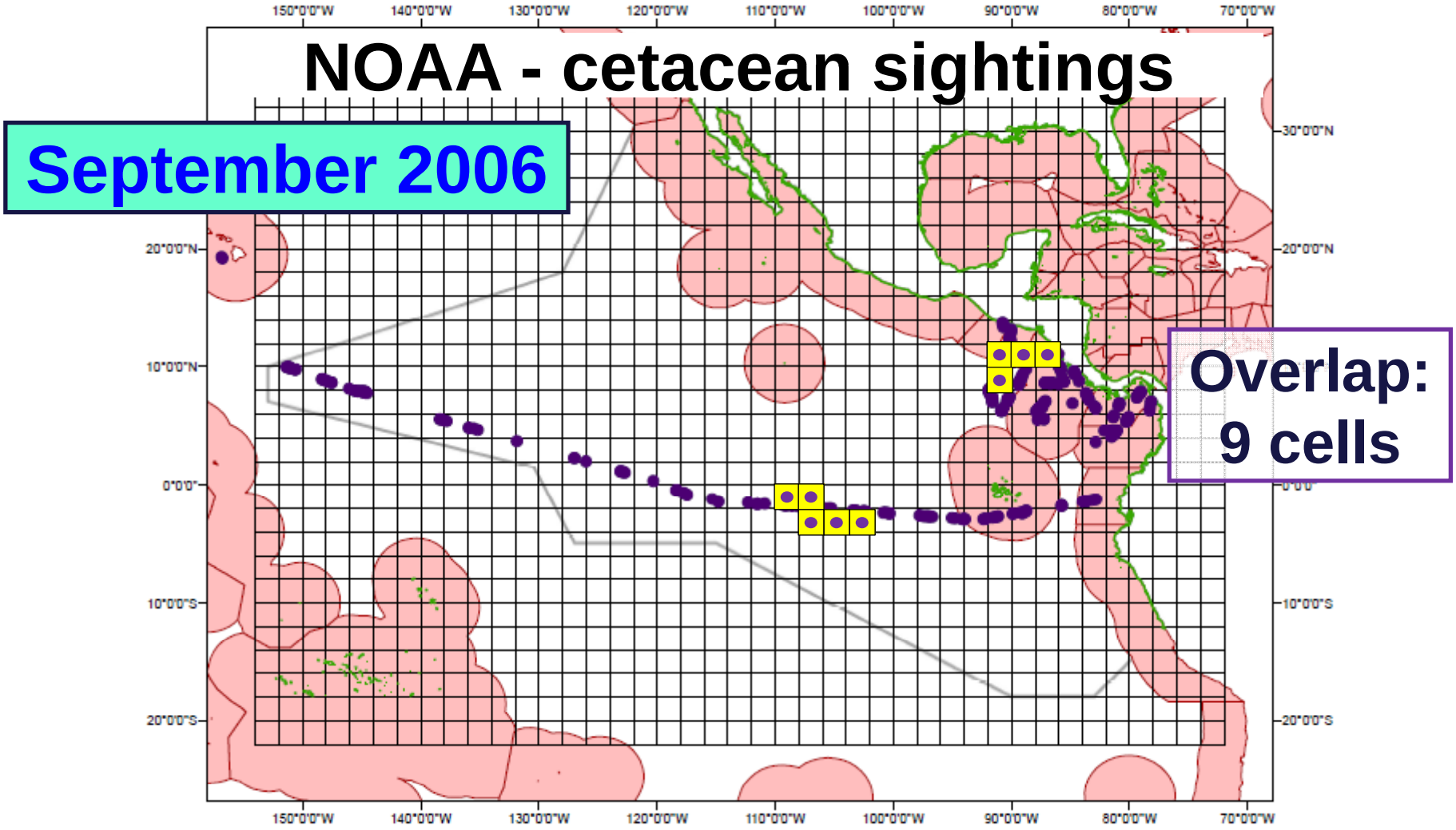

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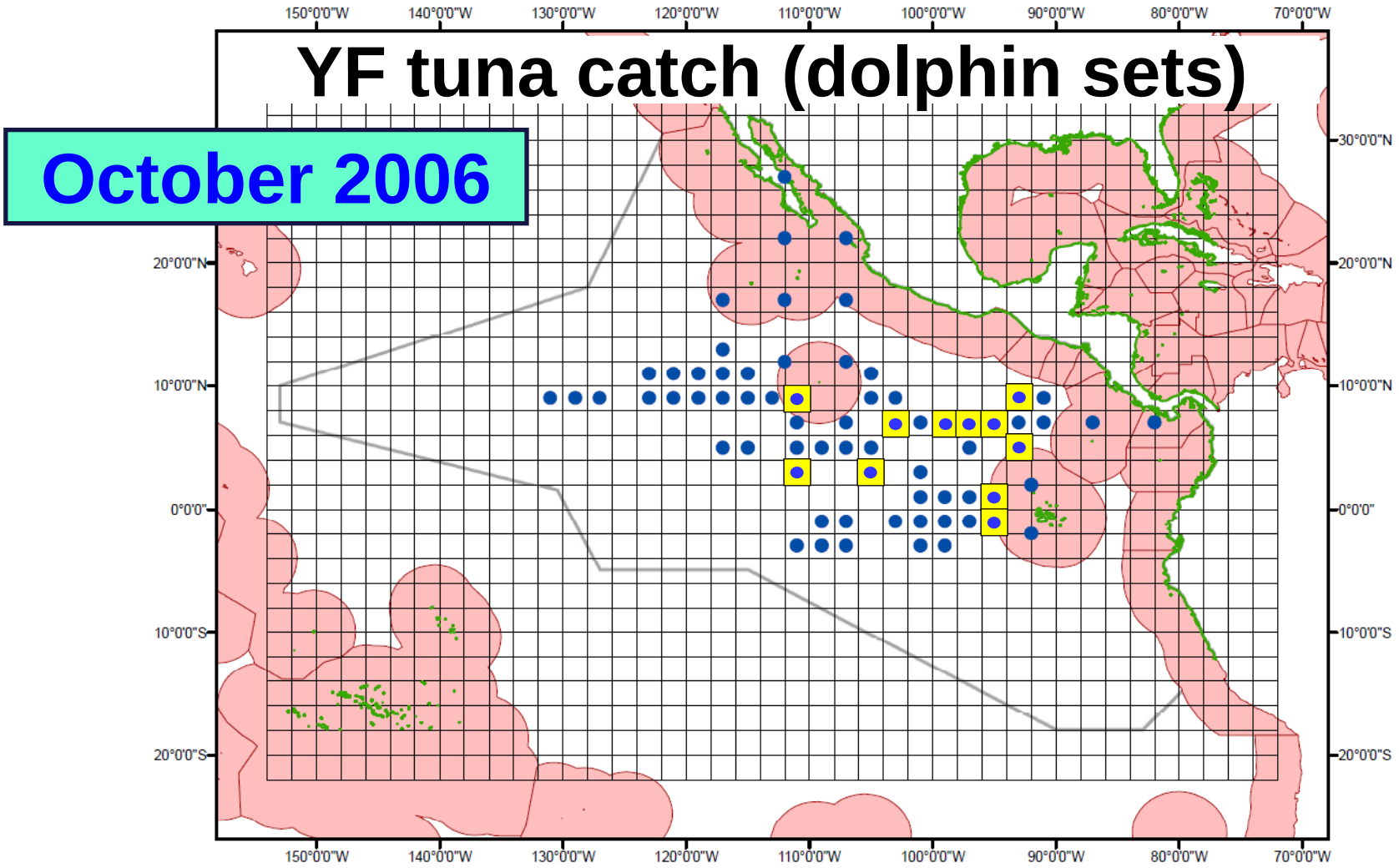

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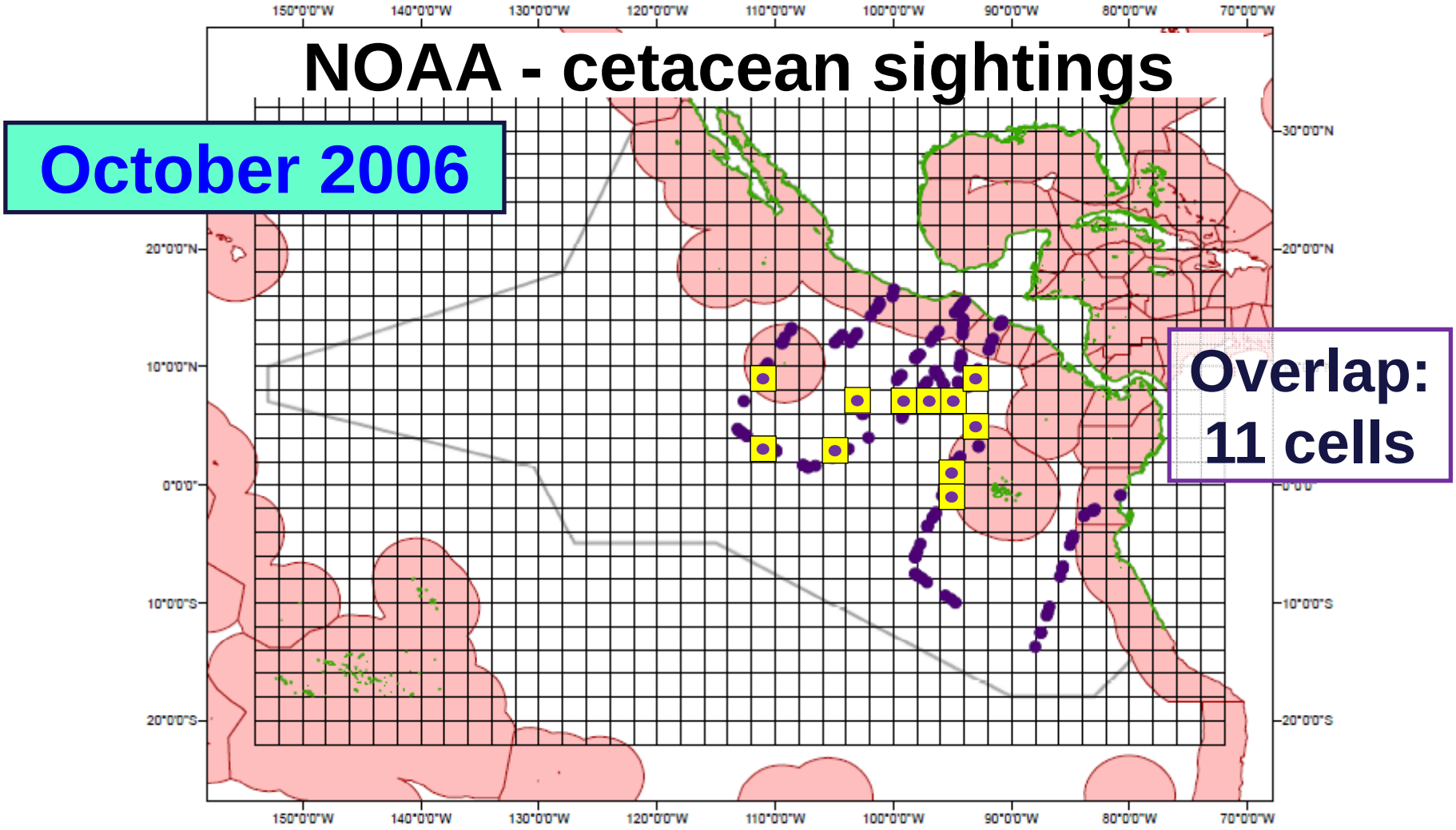

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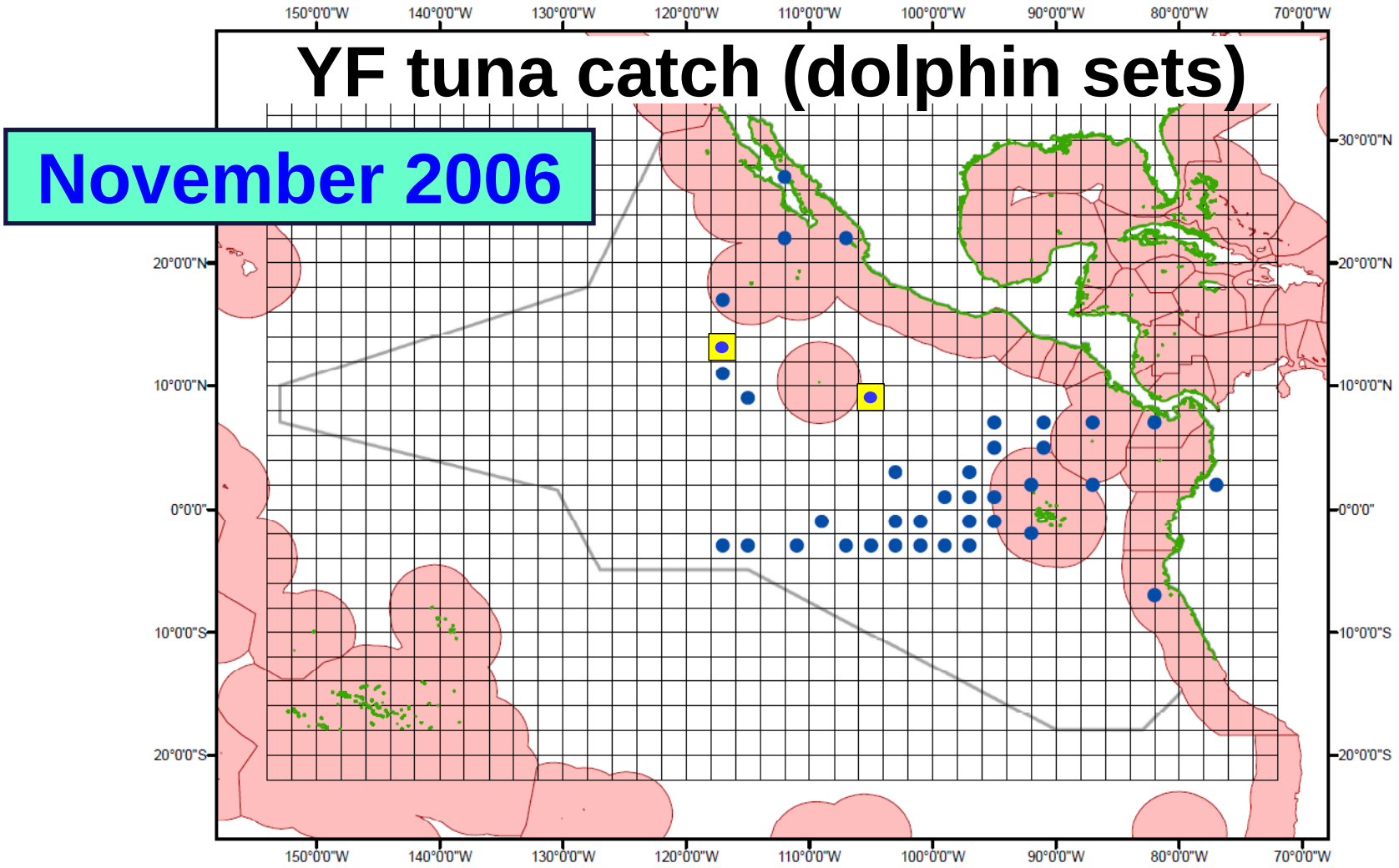

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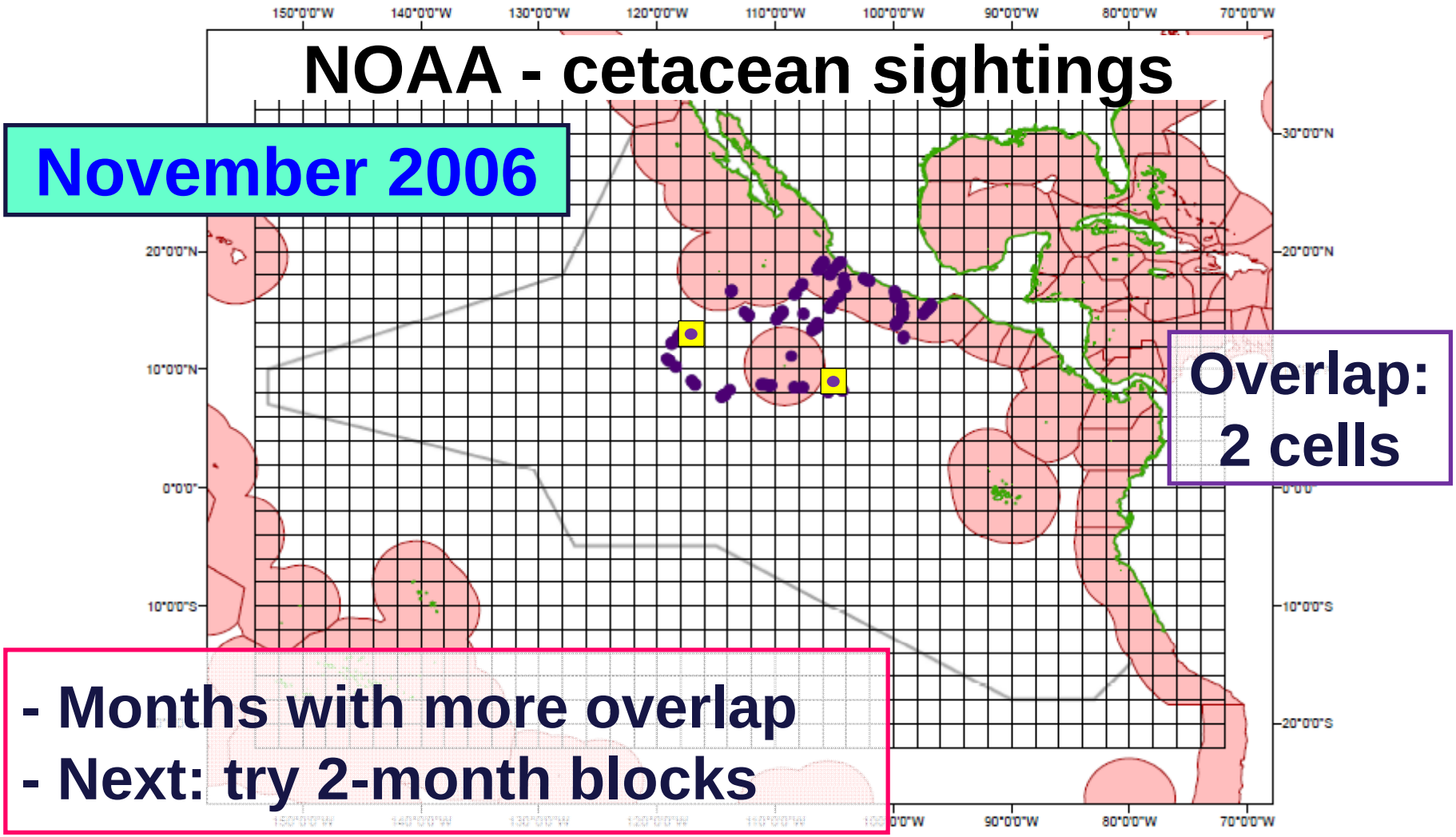


- Months with more overlap
- Next: try 2-month blocks

Methods

Approach: overlapping data

Number of overlapping cells

Resolution	Minimum	Mean	Maximum
1 month	0	6	14
2 month	5	12	20

Bins: 2x2 degree spatial and 2-month temporal

Methods

Approach: overlapping data

Partial Data Overlap Table: 2x2 degree spatial, 1-month temporal

Year	Mon	Cell	Lat	Lon	CPUE Yellowfin (dolphin sets)	Cetacean Species Richness
1986	Aug	391	15	-111	14.9	8
1986	Aug	392	15	-109	30.1	5
1987	Oct	482	11	-93	10.1	10
1987	Oct	483	11	-91	7.4	12
1998	Oct	479	11	-99	22.9	13
2006	Sep	763	-3	-105	9.8	2
2006	Sep	764	-3	-103	6	5

Examine relationship between YF tuna CPUE and cetacean species richness

Results

Model relationship

Cetacean richness ~ cpue + mon + year + grid #

Bins = 2 x 2 degree, 1-month

Generalized linear model (glm)

Coefficients:

(Intercept)	CPUE	mon	year	grid
37.72	-0.04	0.32	-0.017	-0.003

Degrees of Freedom: 929 Total; 925 Residual

Null Deviance: 6562

Residual Deviance: 6282

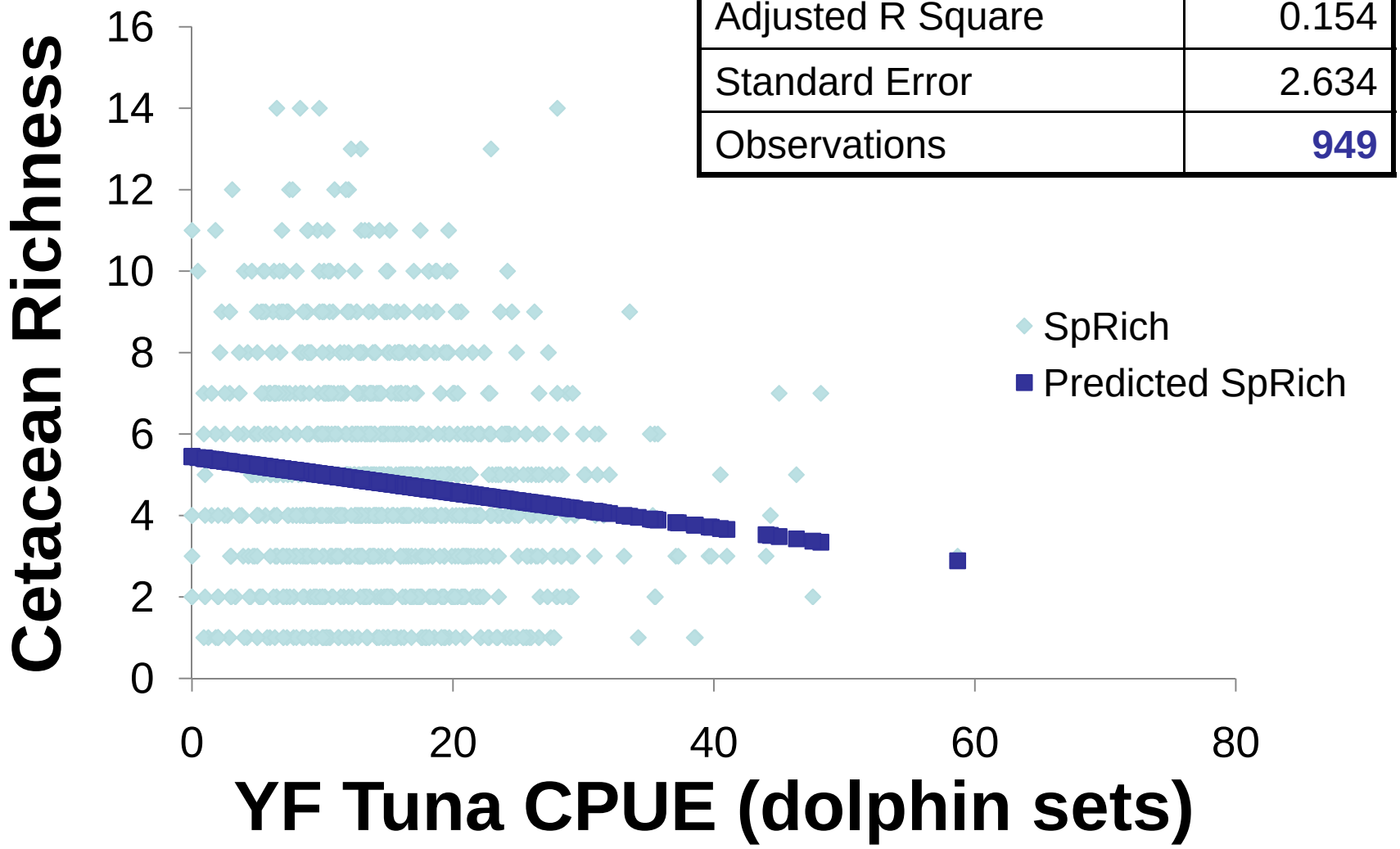
AIC: 4428

If this model were true:

- As fishing CPUE increases,
- Cetacean richness decreases

Results

Regression Statistics	
Multiple R (correlation)	**0.128**
R Square	**0.016**
Adjusted R Square	0.154
Standard Error	2.634
Observations	**949**



Future Work

Further Analysis

- 2-month temporal resolution
- Restrict cetacean richness to delphinids
- Investigate biomass as an ecosystem metric
  - Large bodied, abundant dolphins and seabirds
- Include seabird survey data in analysis
- More sophisticated models
  - non-linear (e.g. GAMs) and time series

What do yellowfin tuna *indicate* about the ETP ecosystem?

Acknowledgements

THANK YOU!

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