Automated Recreational Fisheries Monitoring : An Artificial Intelligence Feasibility Study in Florida

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Outline

- Recreational Fishery Overview
- Current Monitoring Methods
- Camera-based Methods
- Machine Learning in Rec Fisheries
- Florida's Pilot Study
  - Methods
  - Results
  - Lessons Learned
- Future Work

Recreational Saltwater Fishing in Florida

LICENSE

2.4
MILLION

88,500
JOBS

SRFS
STATE REEF FISH SURVEY
MyFWC.com/SRFS

700
THOUSAND

ECONOMIC IMPACT
$9.2
BILLION

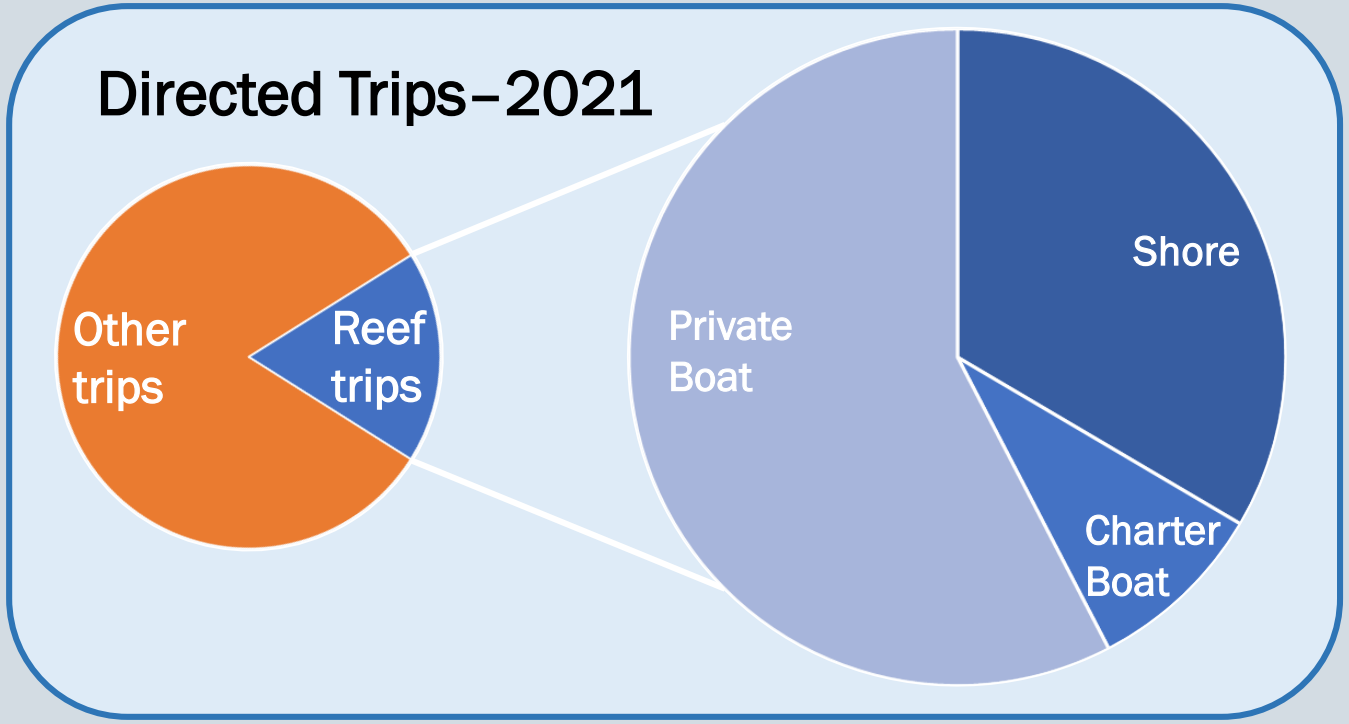
FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

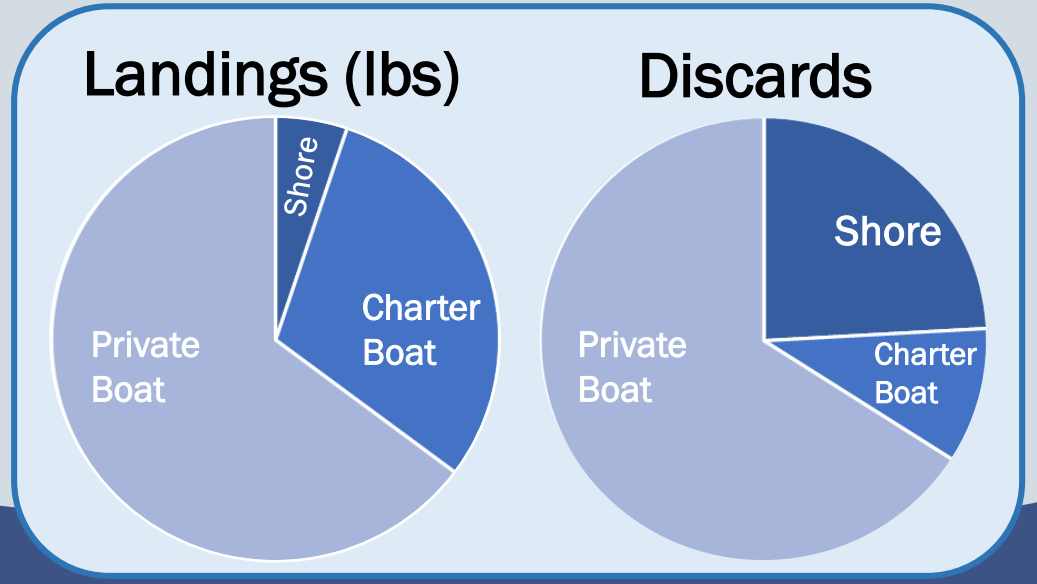
FWC FY 19/20 The Economic Impacts of Saltwater Fishing in Florida
Southwick and Associates; American Sportfish Association

Florida Recreational Reef Fish Fishery

- Small proportion of trips
- Private boat mode
- Difficult to monitor
  - Pulse fisheries
  - High effort
  - High temporal and spatial variability
  - Dispersed over large area

Reef fish trips are less frequently encountered in general surveys



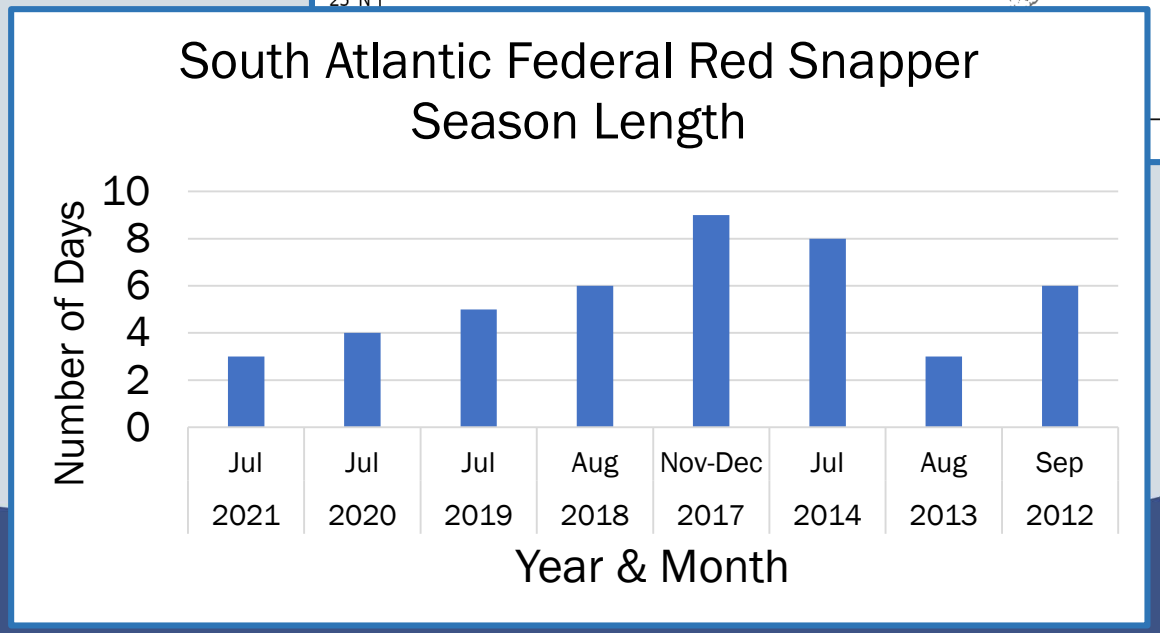


NOAA Fisheries MRIP Directed Angler Trips for Custom Domains, Catch Estimation for Custom Domains (SAS), 2021 Data

Recreational Reef Fish Fishery in South Atlantic

- Offshore boat-based
- Distinct inlets
- Highly managed
  - South Atlantic Red Snapper
- Short seasons

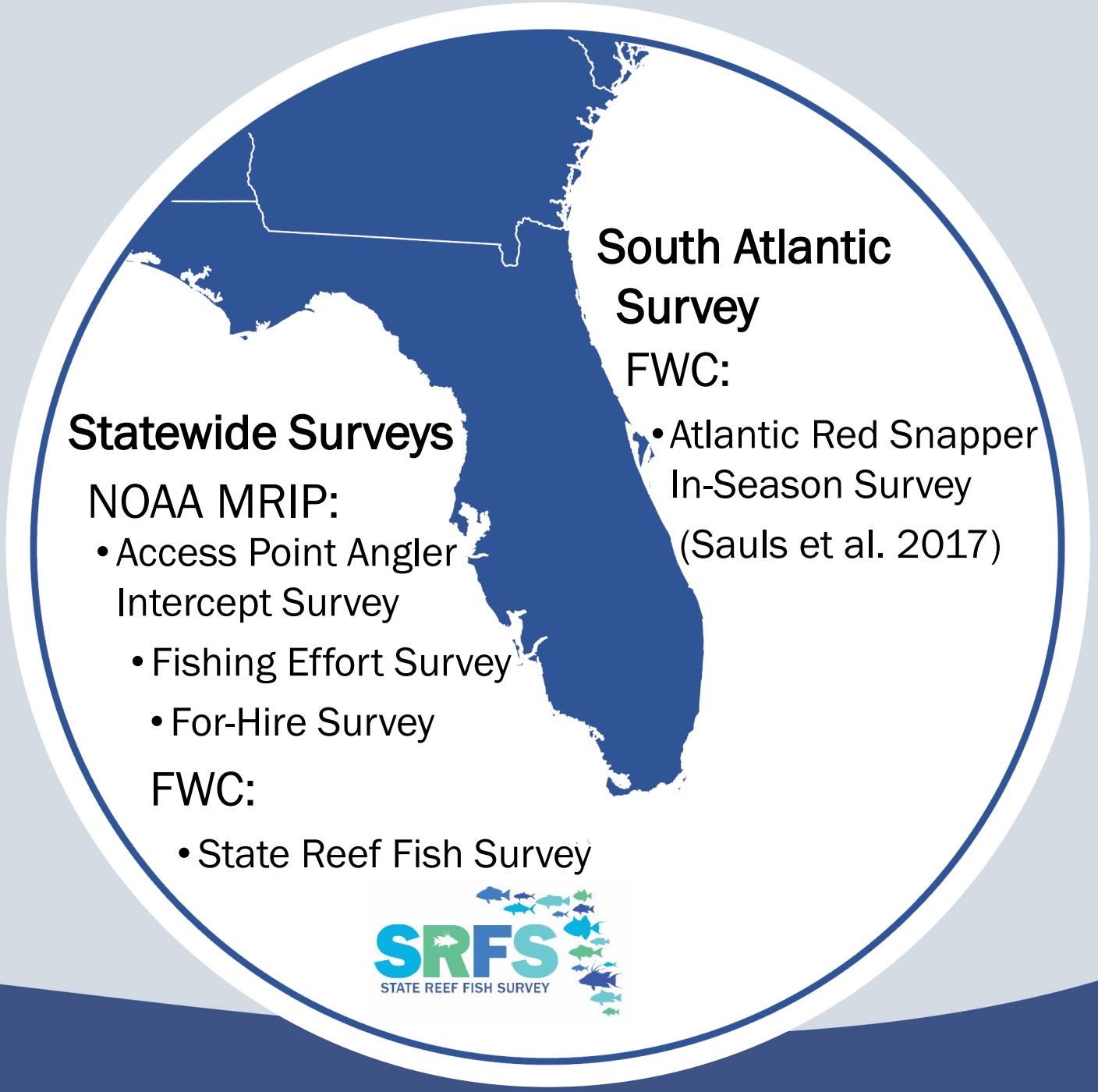
General surveys not designed to monitor derby events precisely



Ongoing Monitoring

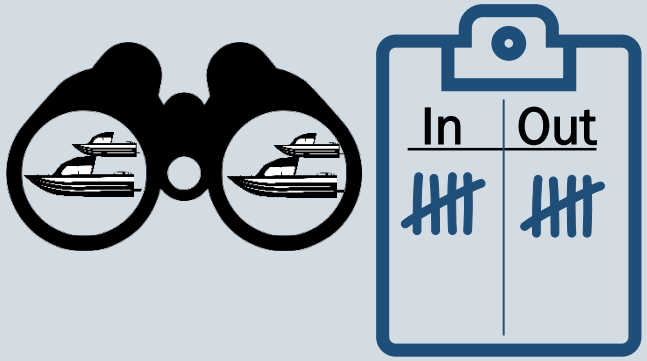
- Surveys concurrent and overlapping
- All surveys have inherent sources of error and unknown bias

Need exists to validate accuracy of the estimates generated by these surveys



Atlantic Red Snapper In-Season Survey

INLET BOAT COUNTS



ANGLER INTERCEPTS

Produces precise estimates

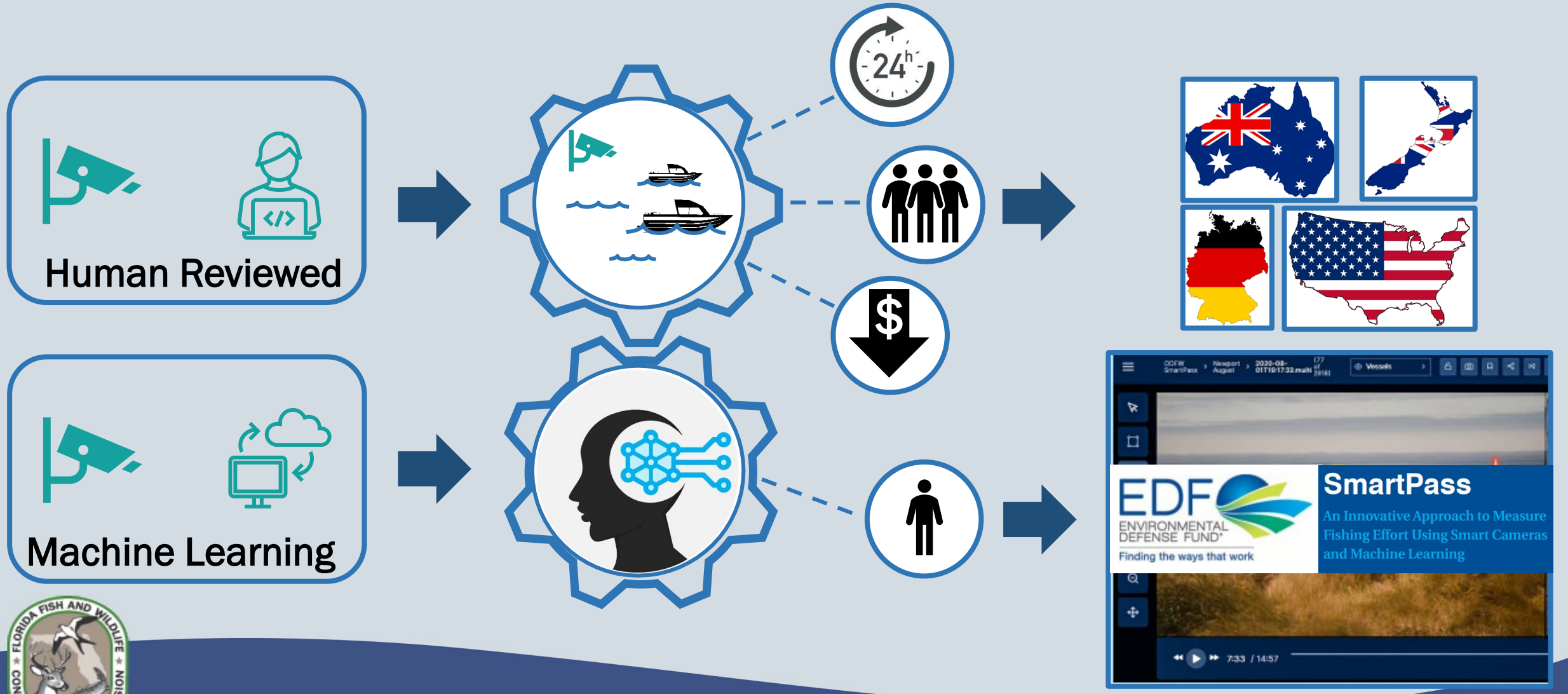
- landings and effort

Need cost-efficient methods to scale this survey temporally and spatially

Sauls et al. 2017

https://myfwc.com/research/saltwater/fishstats/srfs/atlanticredsnapper/

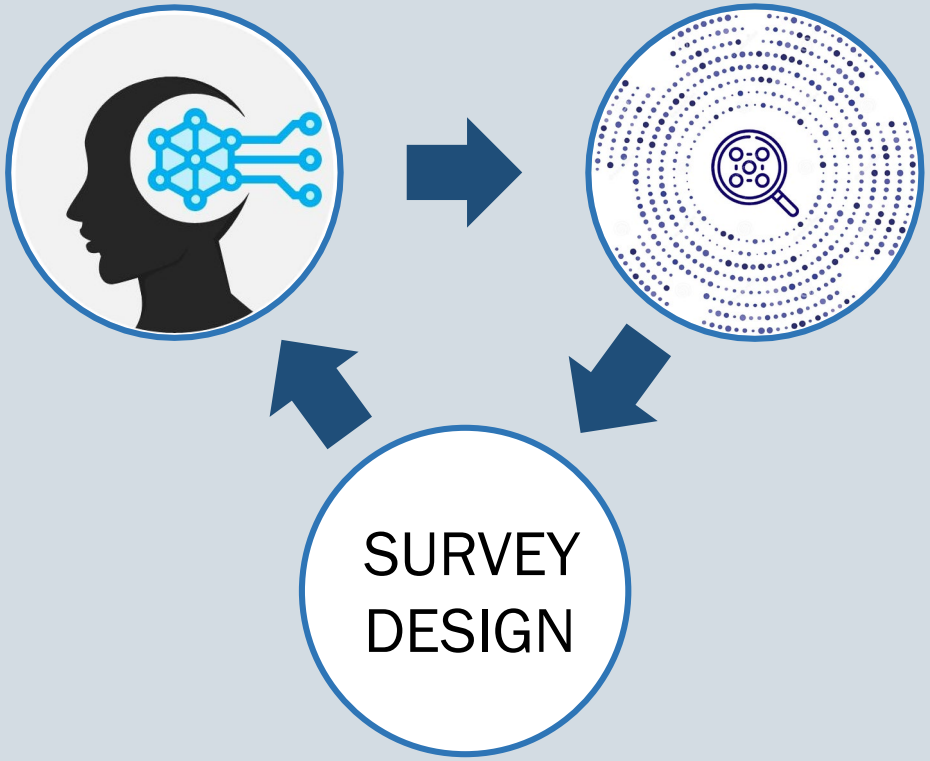
Camera-based Recreational Fisheries Monitoring



Powers and Anson 2016, Hartill et al. 2019

https://www.edf.org/sites/default/files/content/EDFSmartPass-whitepaper.pdf

Machine Learning in Recreational Fisheries Monitoring



- Near real-time counts
- Year-round, 24-hours
- Fill coverage gaps
- Improve cost efficiency
- Refine survey methods
- Increase precision
- Better understanding of fishery

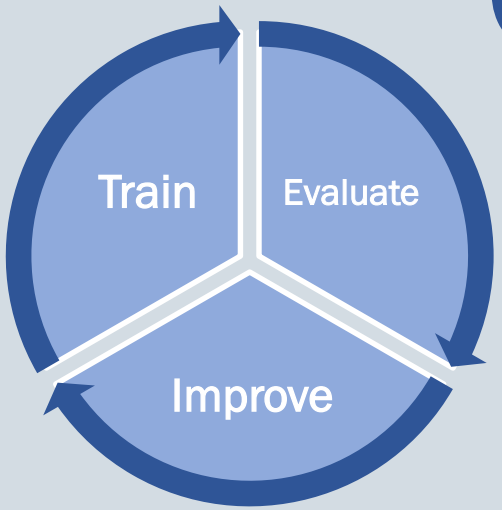
Florida's Pilot Study

- Florida's Atlantic coast
- Three (3) inlets
- Vary by:
  - Size, logistics, vessel traffic
- Contracted CVision AI

Test feasibility of using AI technology to continuously monitor recreational boating activity

Objectives – Year 1

- Install vessel monitoring systems
  - Three sites
- Refine existing algorithms using video from Florida sites
- Detect, classify, track, and count vessels entering and exiting inlets
- Evaluate performance of algorithms vs. human observers



Logistical Considerations

- Contracts with partner agencies
- Special Use Permits
- Agency-required restrictions
- Site characteristics
  - Electricity & internet/cellular network
  - Size (optics)
  - Ease of access
- Exposure to elements

US Army Corps of Engineers ®
Jacksonville District

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

FLORIDA STATE PARKS
...the Real Florida℠

Volusia County
FLORIDA

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

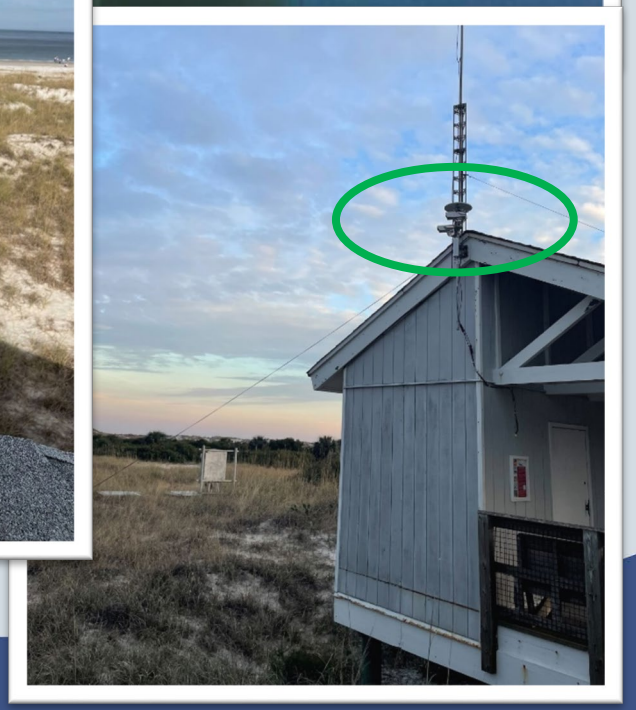
US NAVY

Hardware

- Cameras
  - Lucid Technology 4k imaging sensors
- Rugged Intel-based dataloggers
  - DC capable for solar/battery
- 4G cellular antenna
- Waterproof housing
- Brackets & cables
- Lithium battery and charger

Cumberland Sound

- January 2022
- Remote location
- Poor cellular connectivity
- Unreliable electricity
- Very large inlet
  - ~1.75 miles: cameras to jetty tips
- Military and cargo ships
- Borders Georgia

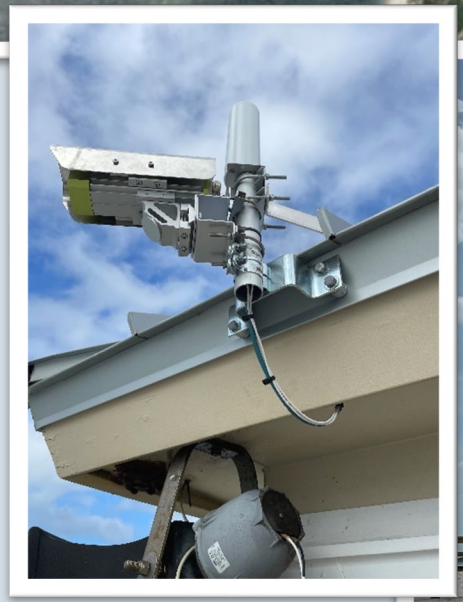


Mayport

- May 2022
- U.S. Naval Station Mayport
- Restricted cellular network
  - Hard drive swaps
  - Manual upload to cloud
- Reliable electricity
- Large inlet
  - 1+ mile: camera to jetty tips
- Military and cargo ships

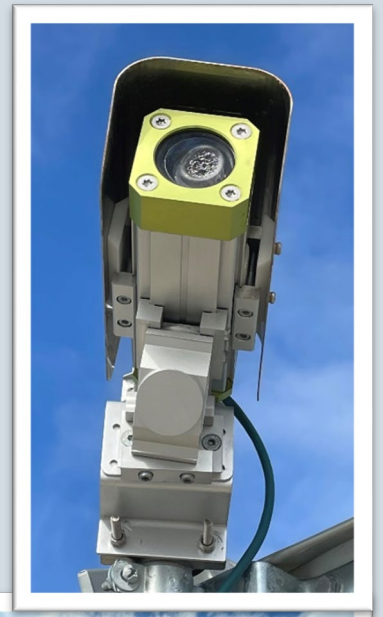
Ponce Inlet

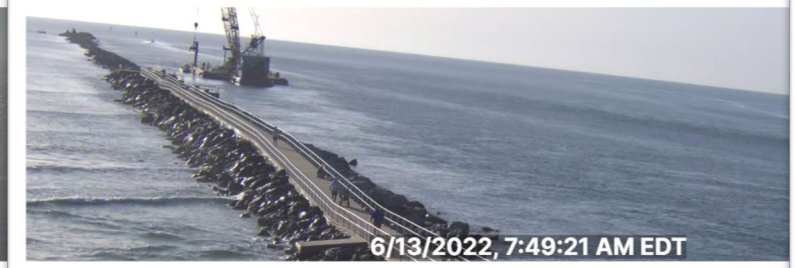
- December 2021
- Installation Contractor
- Strong cellular network
  - Upload to cloud
- Reliable electricity
- Medium-sized inlet
  - ~3,300 feet: camera to jetty tips
- Proximity to ocean/salt spray

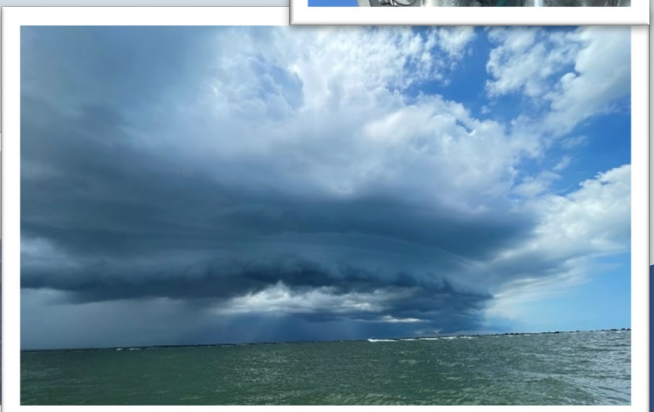


Speed Bumps Along the Way

Challenges	Solutions
Sun glare	Polarizing filters
Lens condensation	Desiccant packs
Power outages	Battery backup
Cellular outages	Record to hard drive
Lightning damage	Surge protection

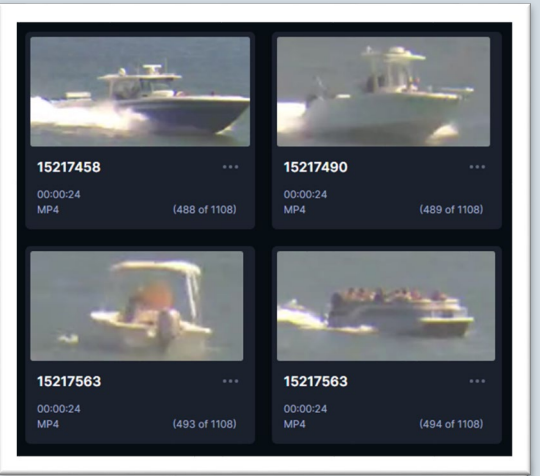


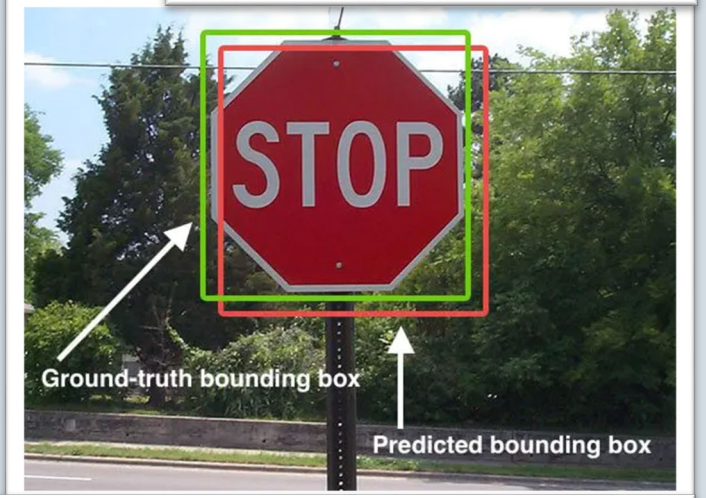


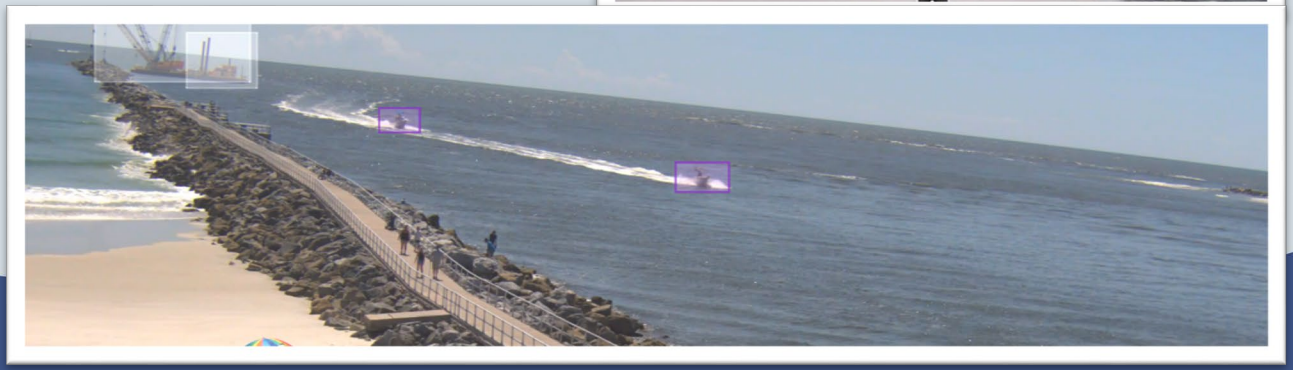


Machine Learning Algorithms

- Vessel Detection
  - Utilized Yolov5 detection architecture
  - Vessel imagery across United States
- Measure Detection Accuracy
  - Intersection over Union (IoU)
- Vessel Tracking
  - Motion estimation filters



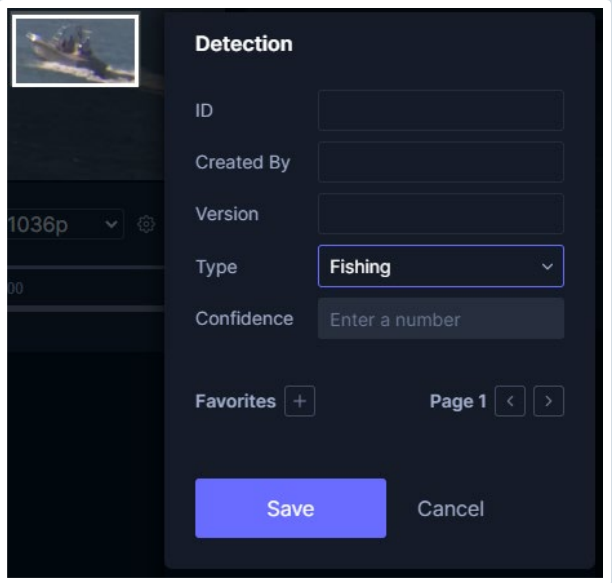


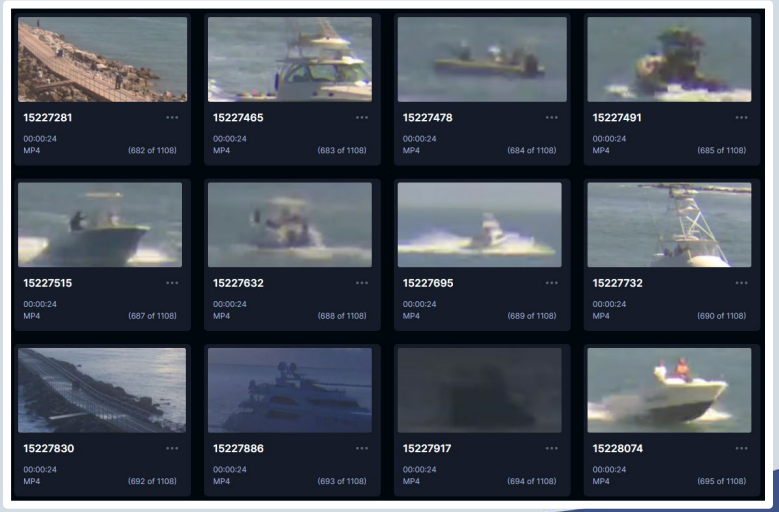


Algorithm Training & Development

- Annotation
  - Draw boxes around boats
  - Assign “Type”
  - Creates “Ground Truth” dataset

- Iterative Process
  - Identify detection and tracking errors
  - More annotation
  - Rerun model
  - Rinse, repeat





Detection and Tracking Criteria

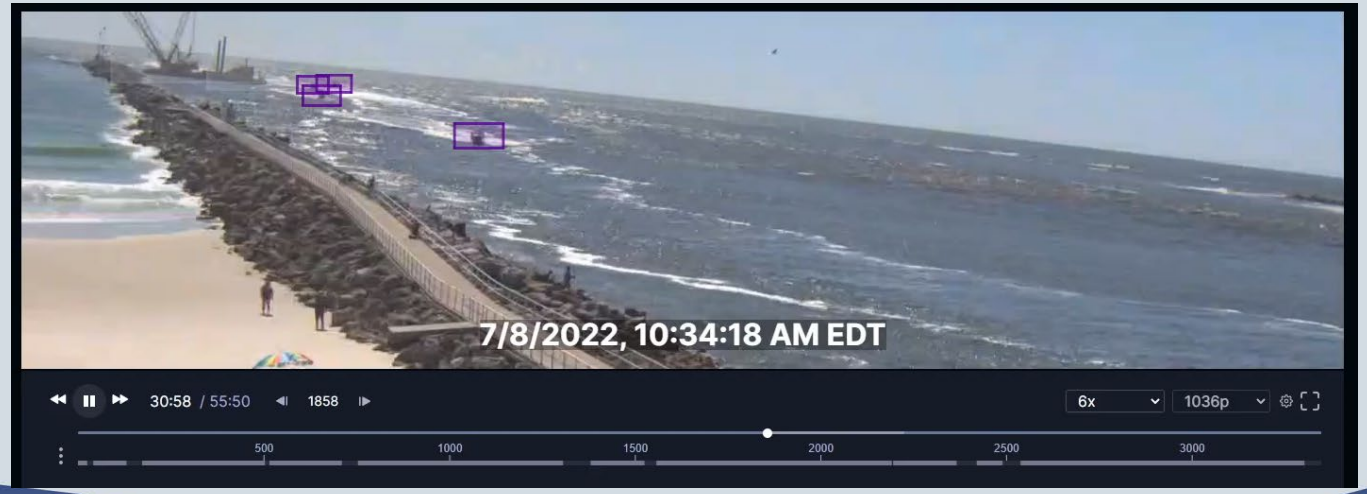
- Detections
  - ✓ Recreational Boats
  - ⊘ Waves
  - ⊘ Birds
  - ⊘ People
- Tracking
  - ✓ Travels at least 50% of channel
  - ✓ Meets height-to-length ratio

Algorithm in Action

Tracked object
Counted

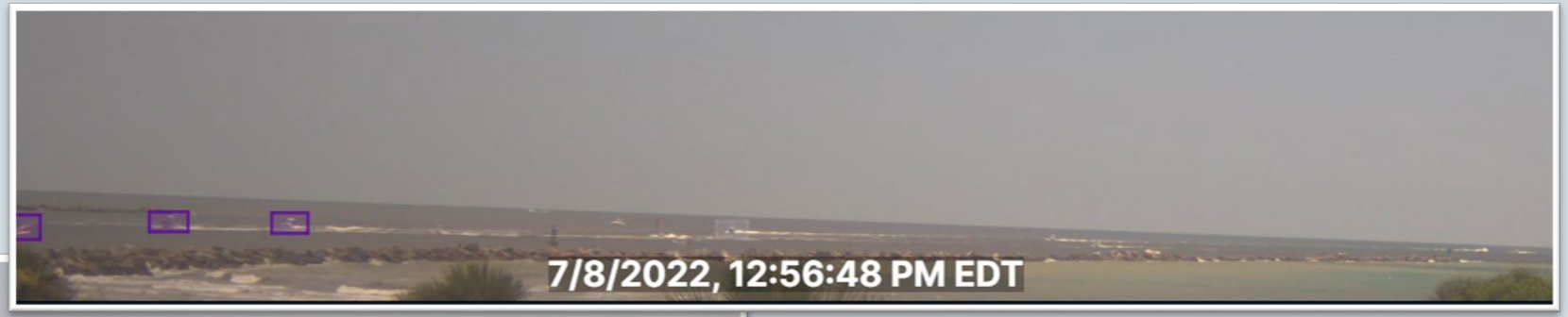
Tracked object
- Counted already
- To be counted

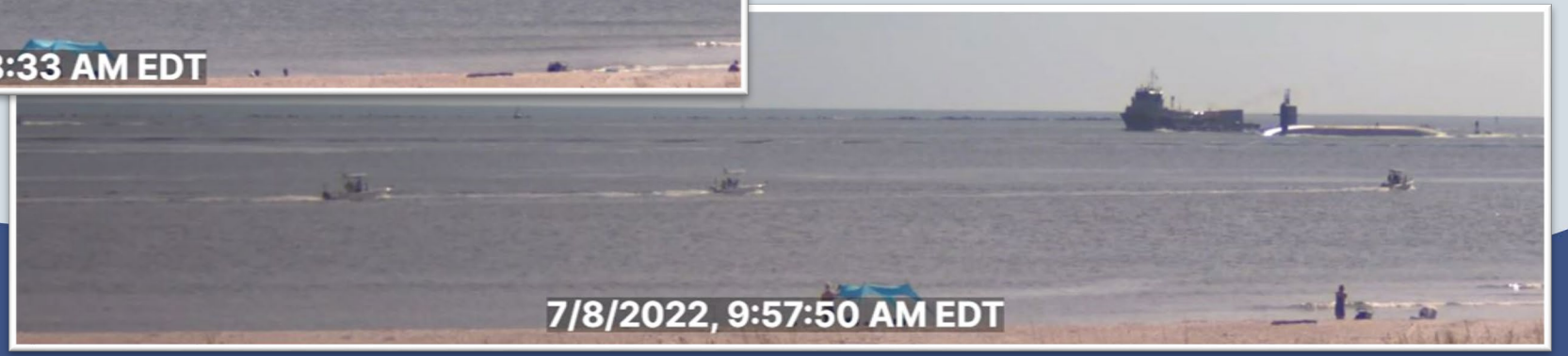
Untracked object
Do not count



Speed Bumps Along the Way

- Large inlets and not enough zoom
- Recreational vessels too small to reliably count
  - Humans
  - Algorithms



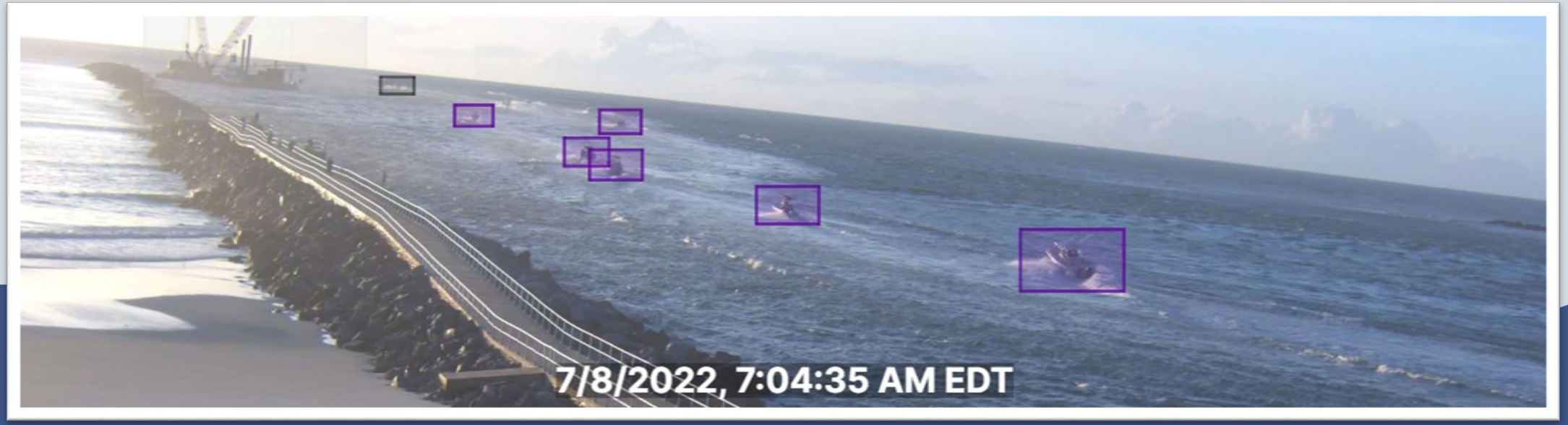


Evaluate Algorithm Performance

- Atlantic Red Snapper Season – July 8th & 9th
- Ponce Inlet
- Algorithms
  - Detect, track, and classify vessels
- Human Observers
  - Real-time vessel counts

VS. Human-reviewed video

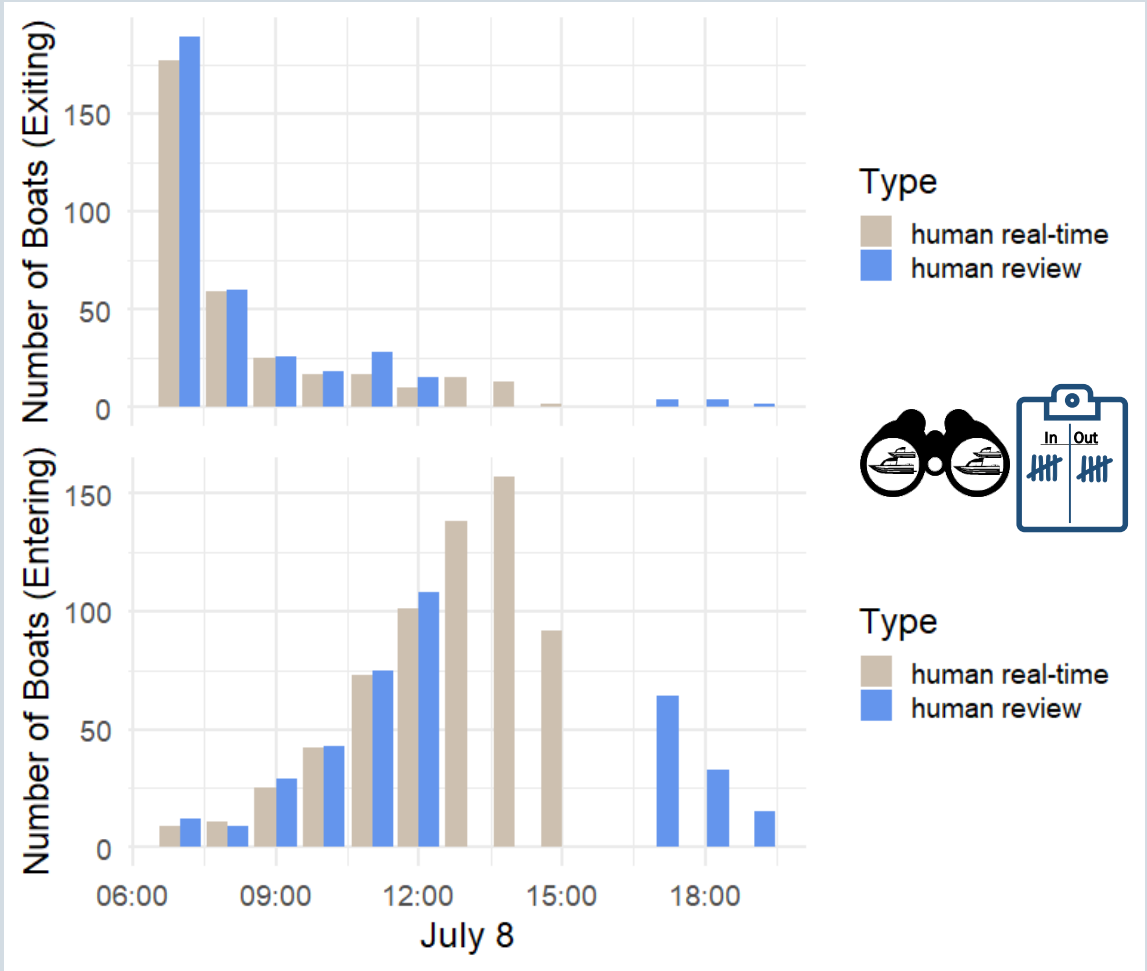
aka “Truth Dataset”



Preliminary Results

- Human real-time VS. Human Review
  - Real-time observers undercounted consistently
  - Average error: $0.04 - 0.08$

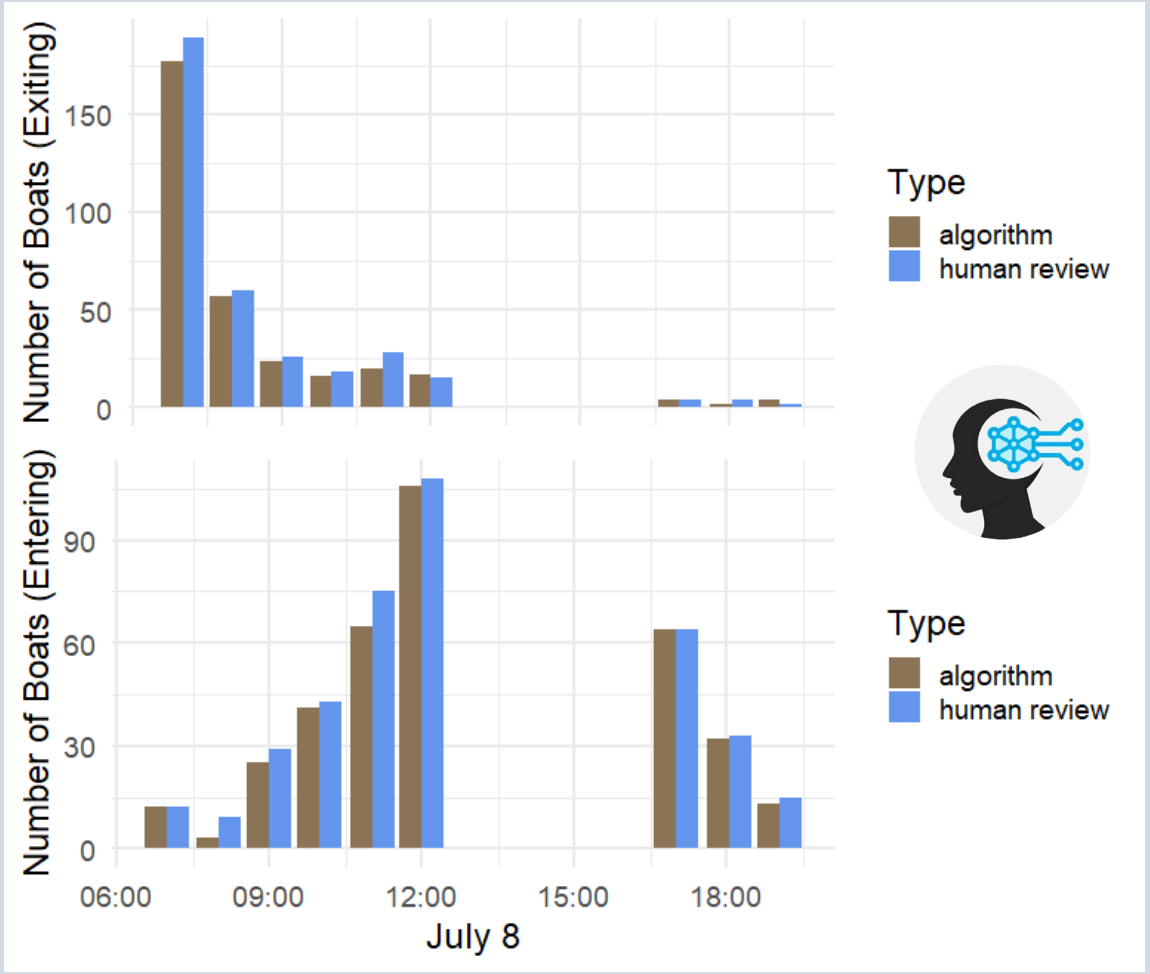
Number of Recreational Boats:	Exiting Inlet	Entering Inlet
Human Review	335	399
Human Real-time	310	382
Absolute Error	25	17
Average Error	**0.044**	**0.078**



Preliminary Results

- Algorithm VS. Human Review
  - Algorithm undercounted consistently
  - Average error: $0.07 - 0.10$

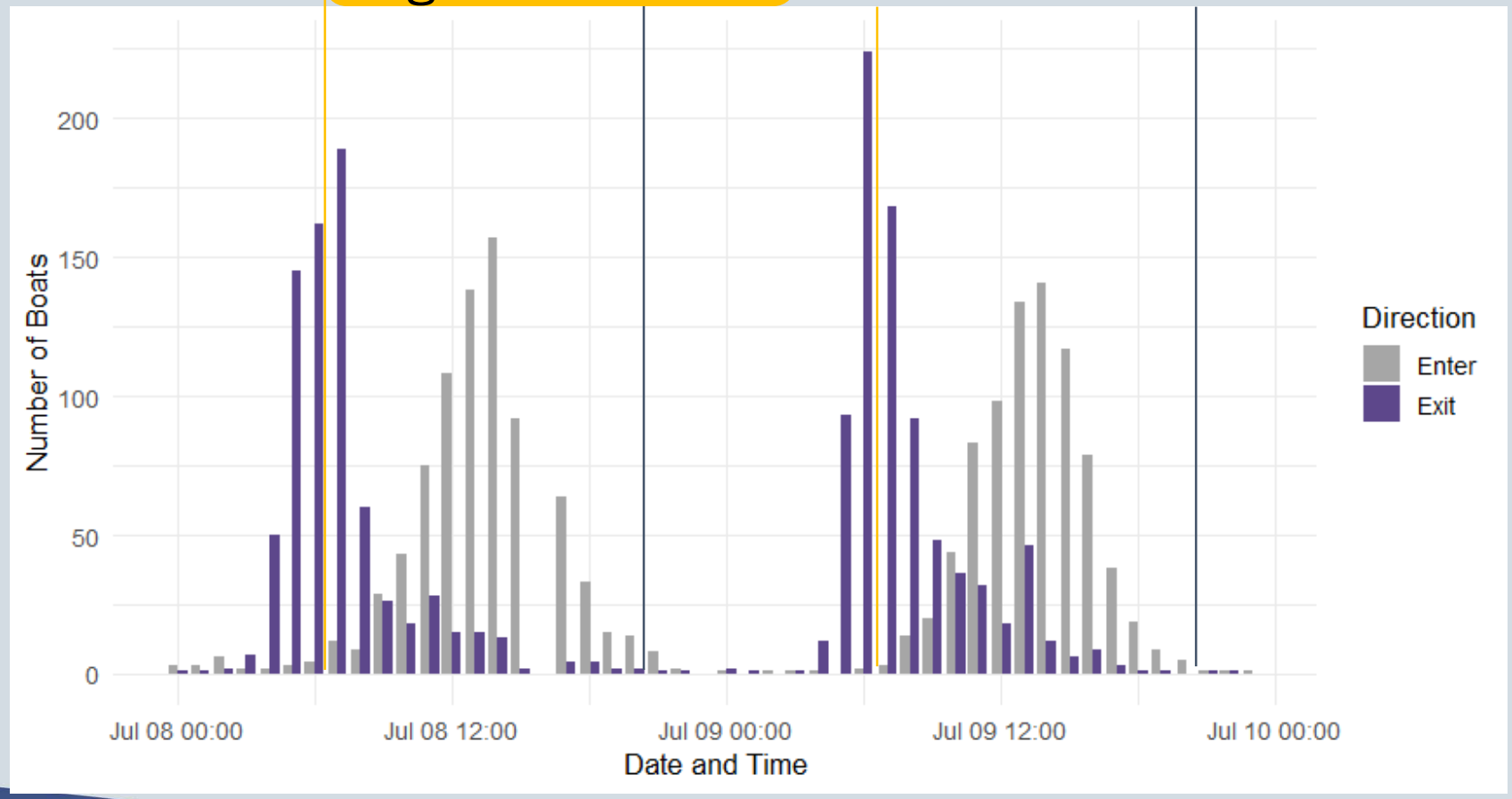
Number of Recreational Boats:	Exiting Inlet	Entering Inlet
Human Review	1,023	1,064
Algorithm Estimate	928	995
Absolute Error	95	69
Average Error	**0.097**	**0.067**



Preliminary Results

- Temporal Patterns
  - AM Peak – Exiting
  - PM Peak – Entering

Capture boat trips occurring outside of observer hours

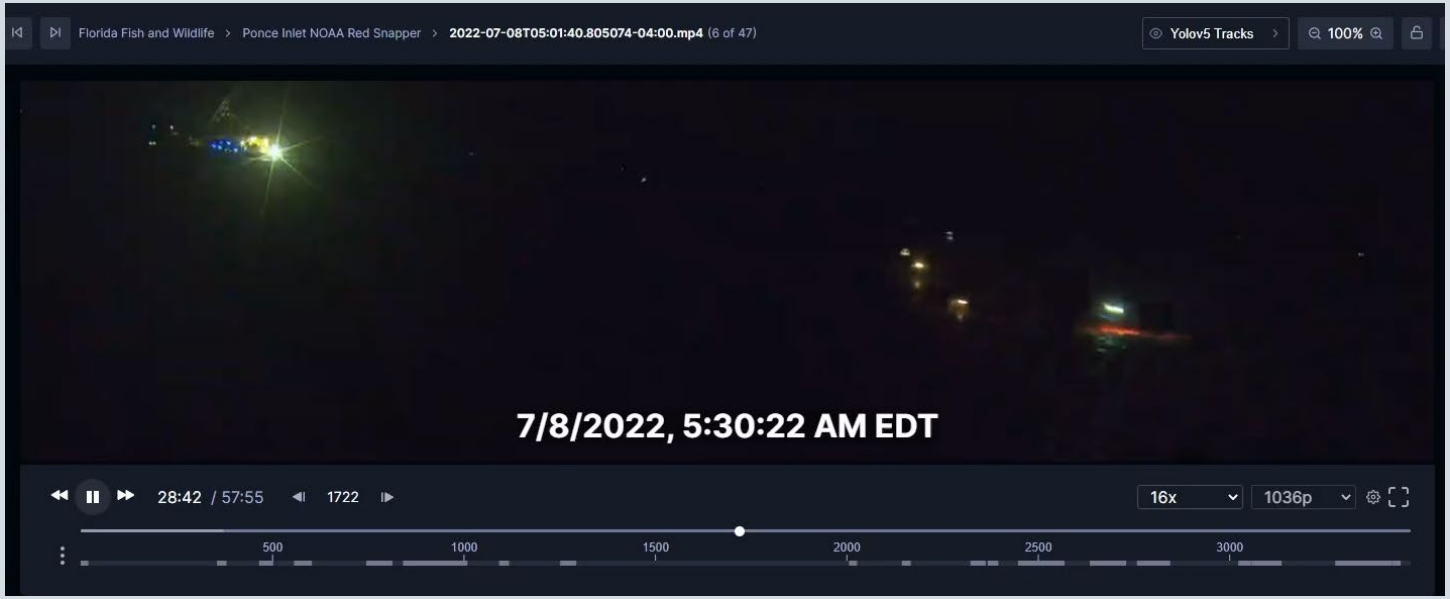


Algorithm in Action – After Dark

Tracked object
Counted

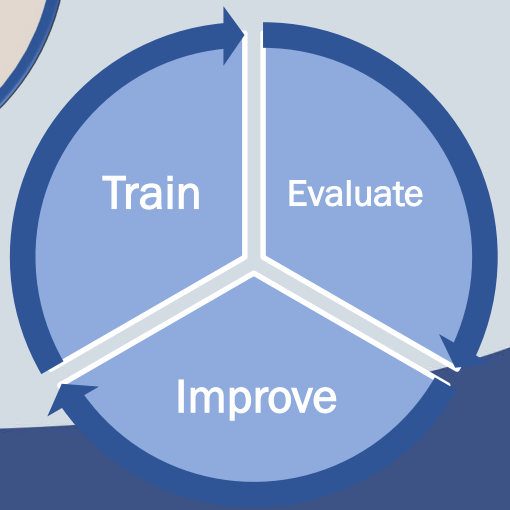
Tracked object
- Counted already
- To be counted

Untracked object
Do not count



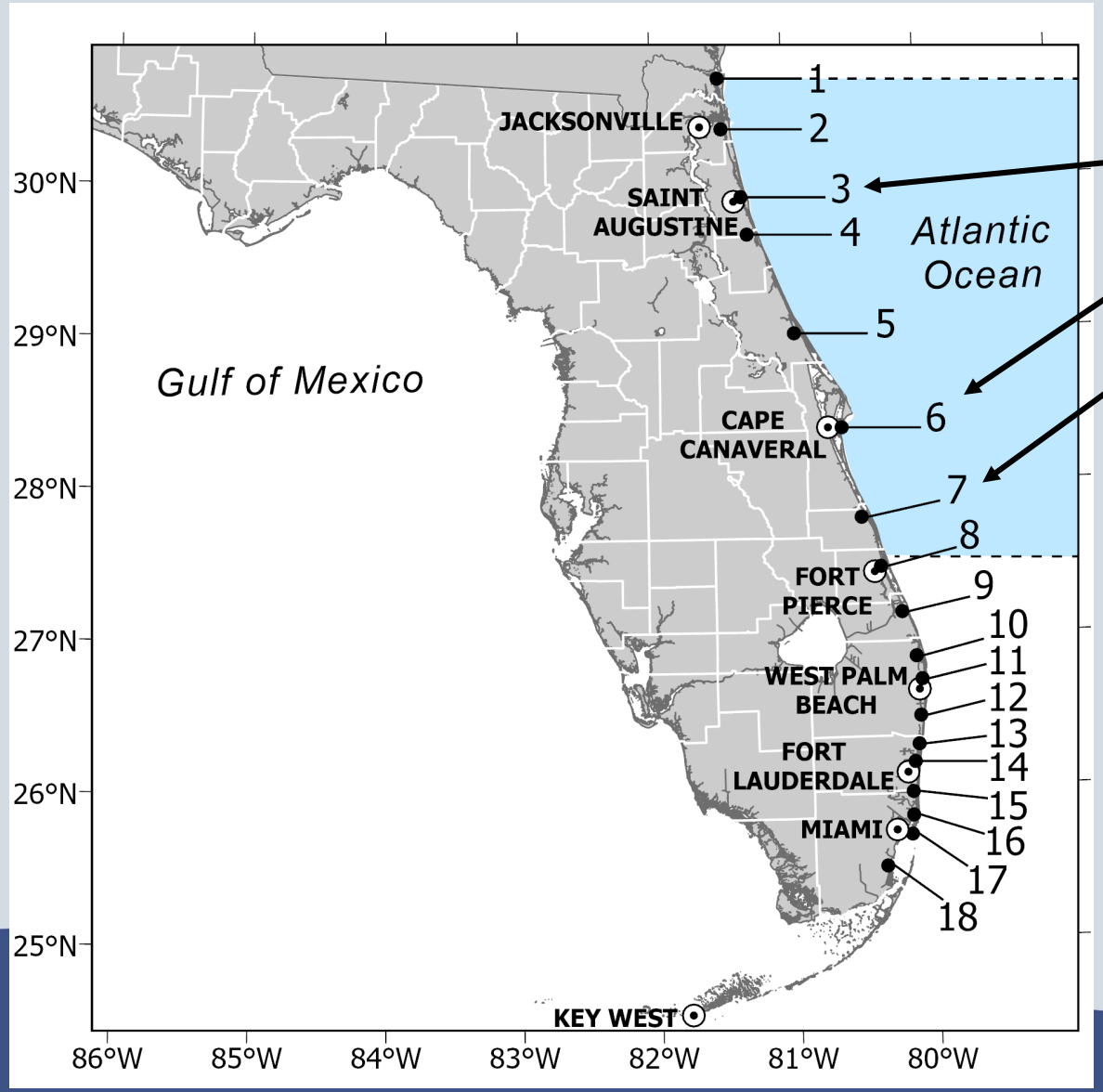
Looking Ahead – Year 2

- Optics Improvements
  - Fixed vs variable zoom
- Test cross-channel view
- Refine algorithms for night detection
- Overall algorithm performance
- Scale to additional sites



Cross-Channel Test: Mayport

Effort Validation: Scaling to Additional Sites



Expand to:

- Vilano Inlet
- Port Canaveral Inlet
- Sebastian Inlet

Evaluate SRFS-estimated effort vs algorithm-estimated effort

Acknowledgments

US Army Corps of Engineers ®
Jacksonville District

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FLORIDA STATE PARKS
...the Real Florida℠

Heath Alboher
Adam Balding
Jason Allgood

Volusia County
FLORIDA

Beach Safety Team
Chris Dembinsky
Lifeguard Staff

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Permitting &
Guidance

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Questions?