Recruitment of American Eels (*Anguilla rostrata*) to a Northeast Florida Estuary: Effects of a Changing Climate on Early Life History

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Phenology is the study of cyclic and seasonal natural phenomena, especially in relation to climate and plant and animal life.

Shifts in phenology can lead to “ecological mismatches”

The European pied fly-catcher. Its chicks, now born later than the caterpillars on which they feed, are missing the peak of food availability, causing a decline in the bird's population.

Source: Ecological impacts of climate change

Mismatches between predators and their prey

Flowers and trees blooming up to 3 weeks earlier than normal in the Eastern US

By Jennifer Gray, CNN meteorologist
Published 12:30 PM EST, Mon February 13, 2023

John Tlumacki/The Boston Globe/Getty Ima

Some pussy willow buds have already opened at Arnold Arboretum in Boston.

Source: CNN.com

Mismatches between plants and pollinators.

The changing global climate is altering the phenology of fish species in myriad ways.


Image: Bureau of Land Management

Pink, chum and coho salmon populations in southeast Alaska are beginning spawning migrations earlier in the season (Kovach et al., 2014).

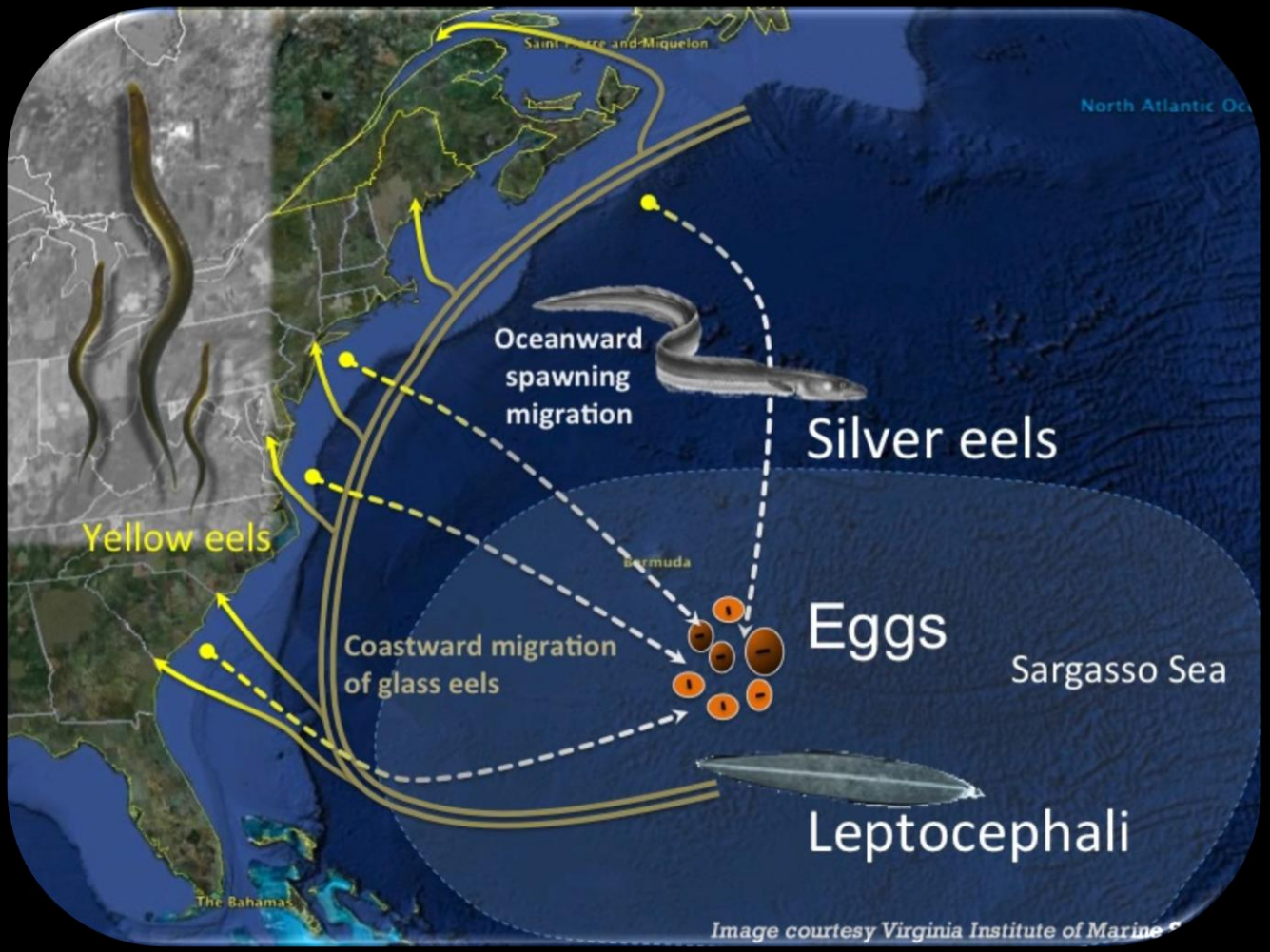

Image: CA Sea Grant

Shifts in zooplankton blooms may result in reduced survival of larval fishes that do not shift reproduction synchronously with their prey (Asch, 2015)


Image: Weitzman, SH, Britannica

The reproductive midpoint of yellow perch in Lake Michigan has advanced earlier in the season by 6.2 days per decade (Lyons et al., 2015)

Life cycle of the American Eel (*Anguilla rostrata*)



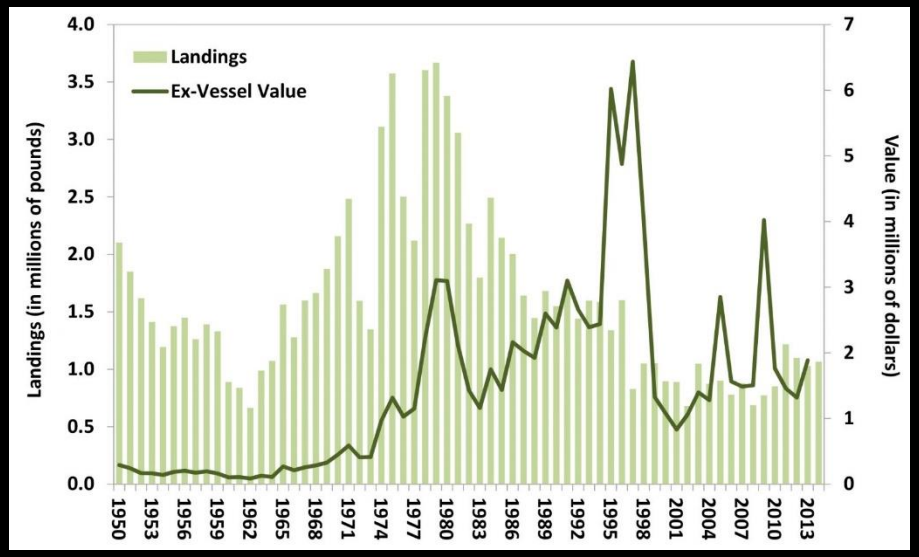
American eels are **catadromous** – adult eels spawn in ocean waters in the Sargasso Sea and planktonic larvae migrate into freshwater systems where they metamorphose into juveniles and grow into adults.

Globally, over 285,000 metric tons of catadromous eels valued at over $2 billion were produced in 2016.

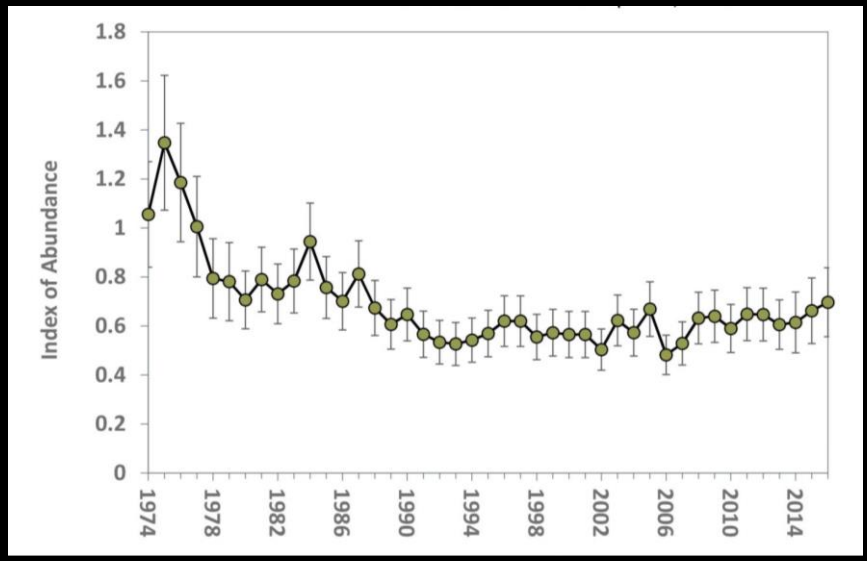
Most recent assessment found the American eel population is depleted

STATUS/ TRENDS	SPECIES		OVERFISHED	OVERFISHING	REBUILDING STATUS & SCHEDULE
↓		American Eel	Depleted	Unknown	Harvest restrictions adopted for glass, yellow, and silver eel fisheries in response to 2012 benchmark assessment

Landings & Value



Abundance



SUSTAINABILITY

American Eel Is in Danger of Extinction

The IUCN put the American eel on its Red List as Maine fishermen saw a deep cut in their fishing quota for the species

PRESS RELEASE

American Eel Population Remains Stable, Does not Need ESA Protection

Conservation efforts should continue for long-term species health

October 7, 2015

National Fisherman

Eel king gets shackles: Maine man sentenced for elver trafficking

By Samuel Hill | May 8, 2018

WILDLIFE WATCH

NATIONAL GEOGRAPHIC™

19 Eel Smugglers Sentenced, But Lucrative Trade Persists

With prices for baby eels soaring to a high of nearly $3,000 a pound, illegal traders continue to chance their luck with the police.

EUROPOL

GLASS EEL TRAFFICKERS EARNED MORE THAN EUR 37 MILLION FROM ILLEGAL EXPORTS TO ASIA

Study objectives

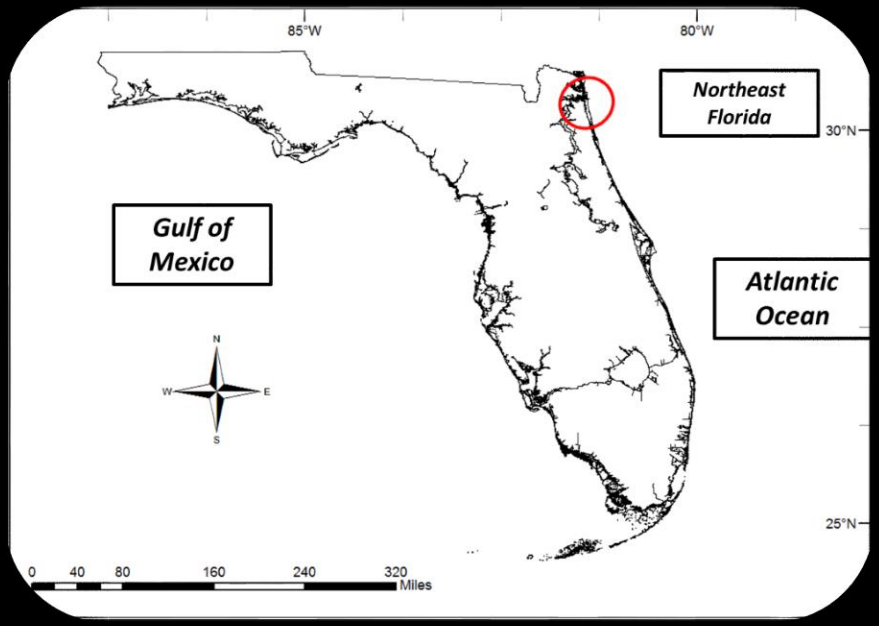
This ongoing study has management, research and educational goals.

(1) Identify long-term trends in glass eel recruitment to northeast Florida for use in stock assessments

(2) Investigate potential changes in eel phenology and impacts on biology and management

(3) Provide opportunities for student research and to train the next generation of fishery biologists.

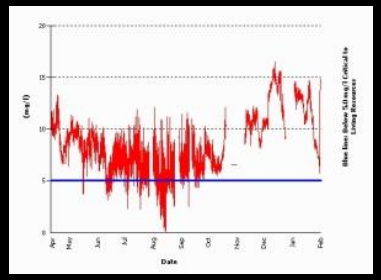
Study Site: GTMNERR Guana River Dam

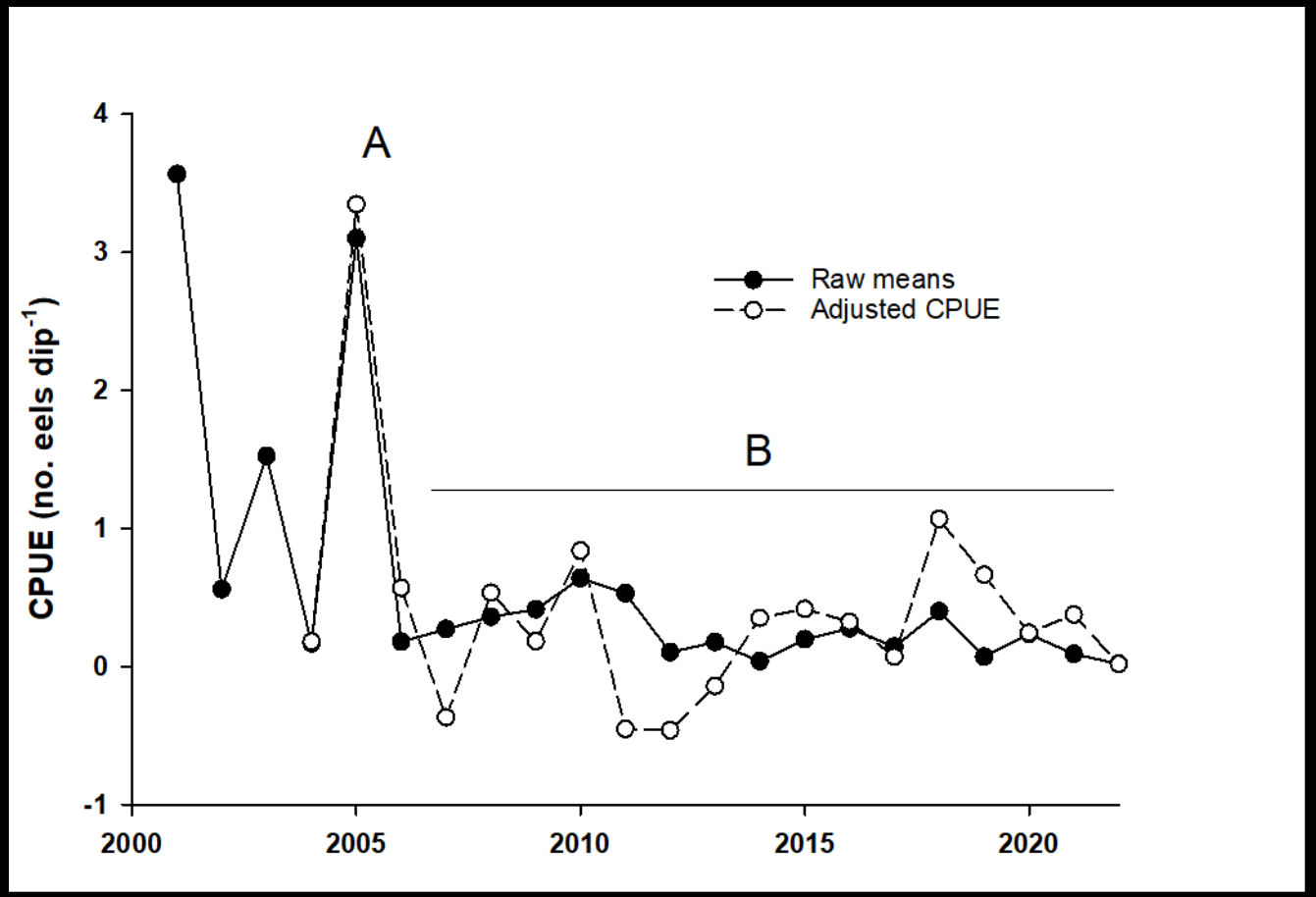


Field methods: quantifying glass eel abundance

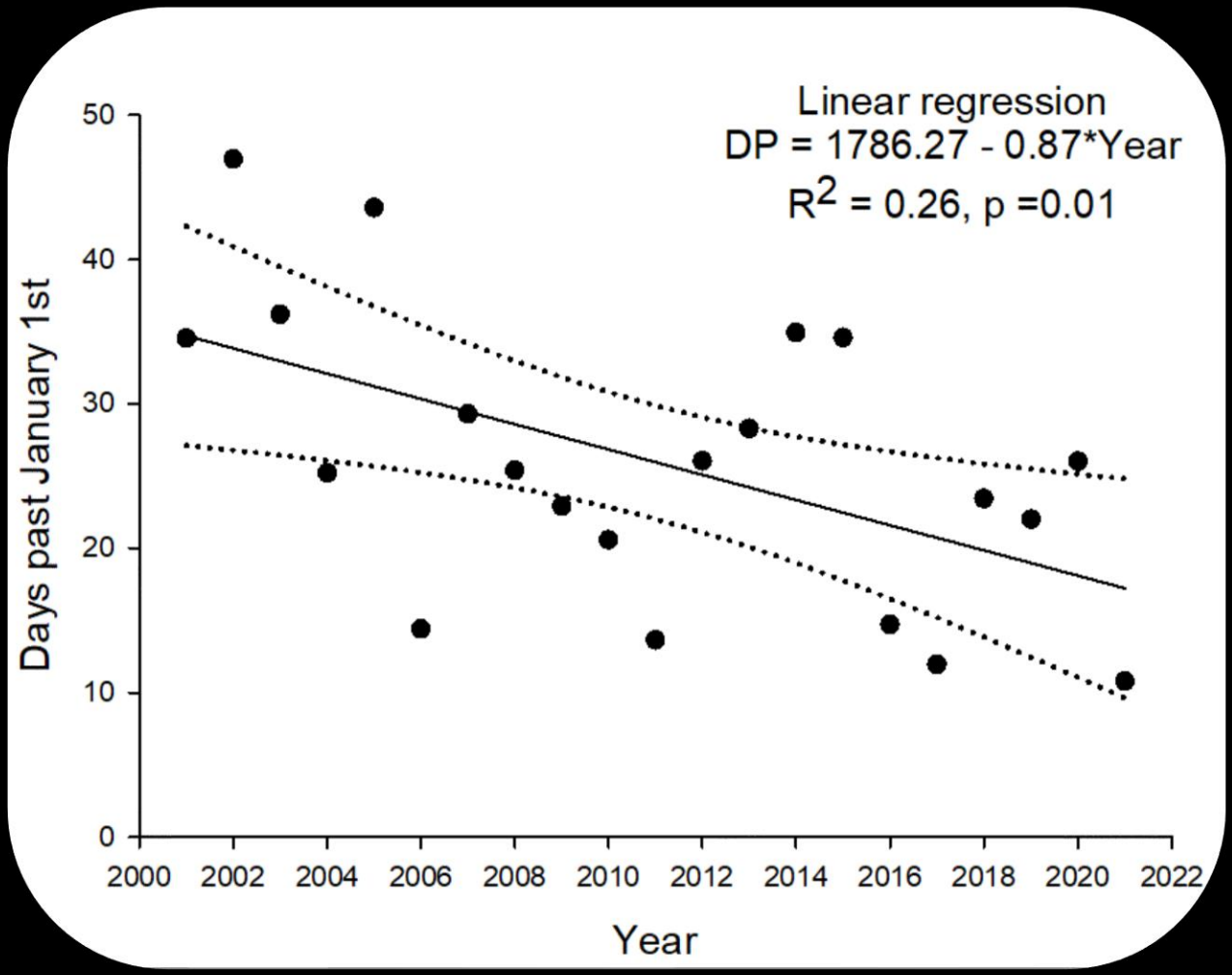
- Standardized dip net survey (CPUE eels dip^{-1})
- January-February (4 nights week^{-1})
- Dark, flood tides
- Samples are collected every 30 minutes
- Eels are preserved for species identification, length and weight measurements
- Environmental data and water quality recorded concurrently.

Index of American eel recruitment (2001-2022)



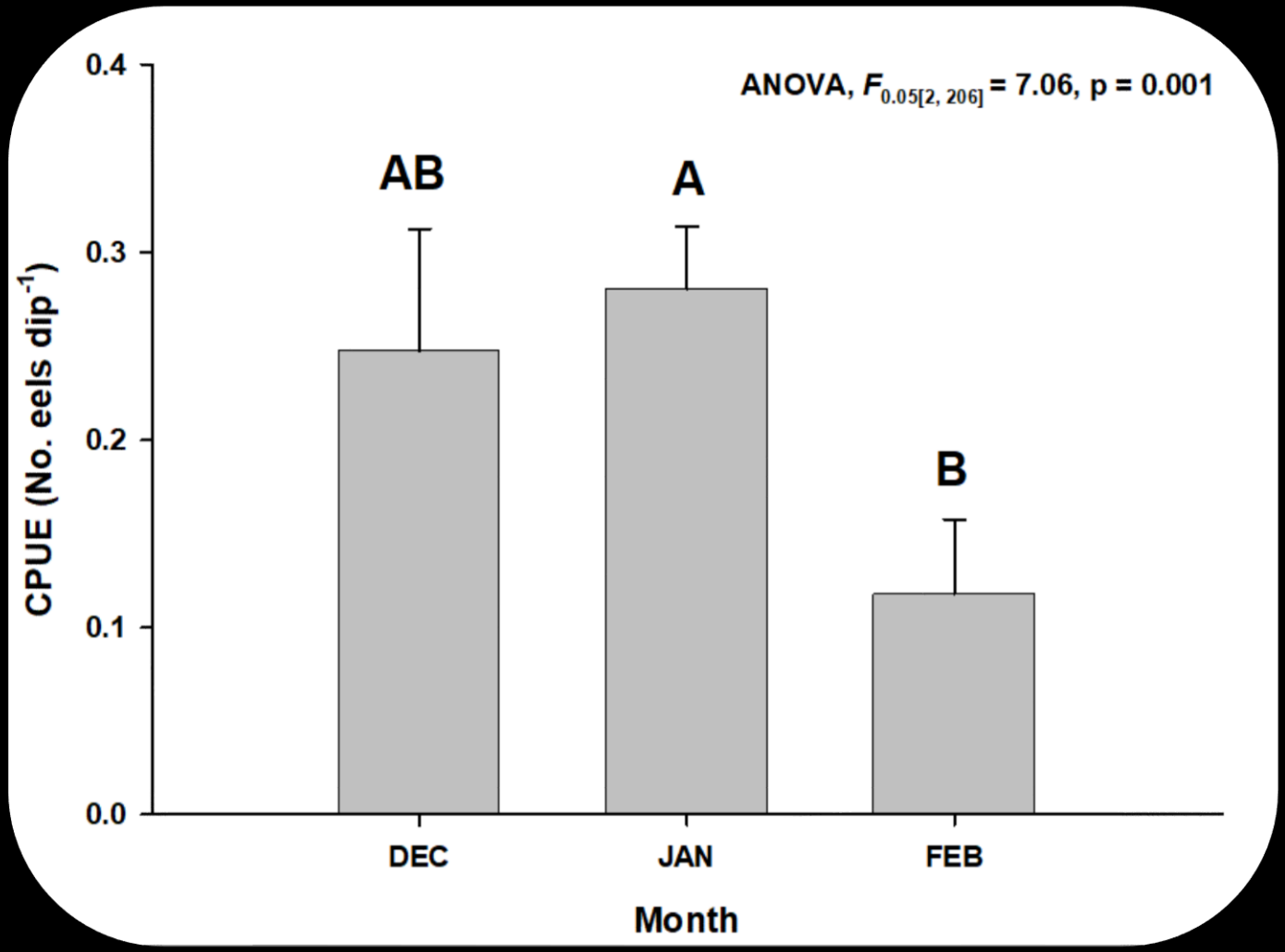


American eel recruitment is shifting earlier



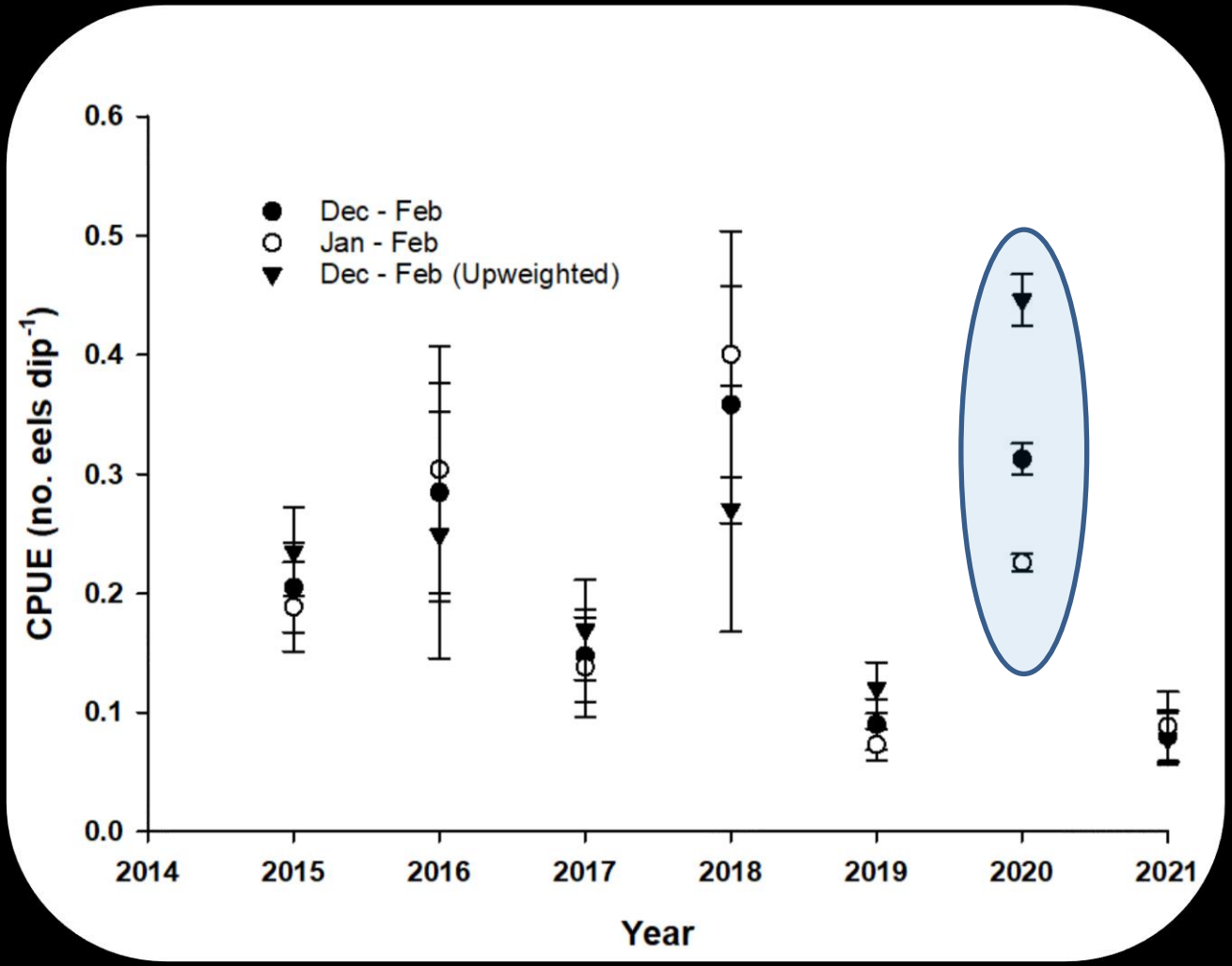
We identified a highly variable ($R^2 = 0.26$), but consistent and significant ($p = 0.01$) trend of earlier recruitment of eels over the 21 year period of the survey and estimate an approximately 18 day shift of the MAR date over the last 21 years (-0.87 days year^{-1}).

American eel recruitment by month



Historically, ASMFC survey protocol begins standardized sampling on January 1st. Supplemental sampling in December since 2015 indicates significant recruitment occurs prior to the survey start date; information used to change ASMFC survey protocols.

Modeled effect on recruitment index

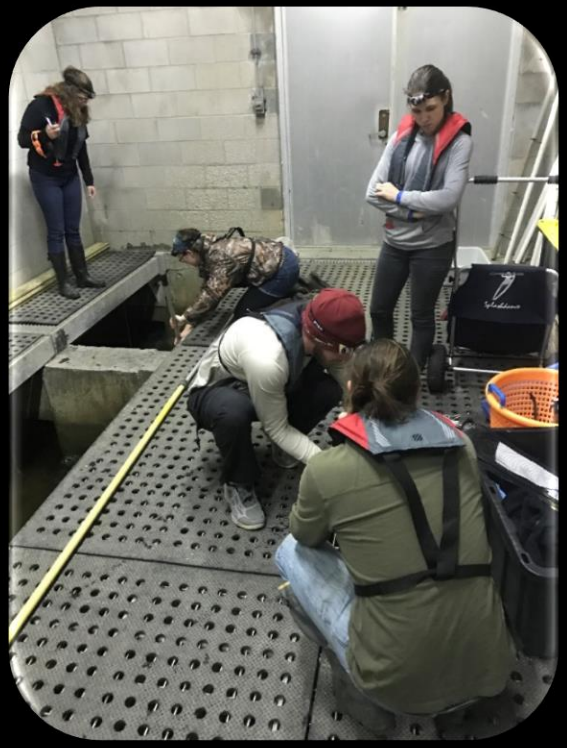


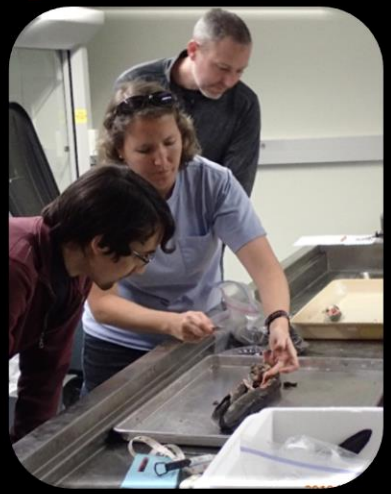
The overall effect of inclusion of December sampling on CPUE is small in most years (but note 2020 where index doubled).

FWC-UNF-GTM NERR partnership has worked

- FWC fulfills ASMFC mandate to collect annual glass eel data.
- GTM NERR provides an ideal sampling location with strong infrastructure.
- UNF students provided meaningful field research opportunities.

Student training and research opportunities





2020-2022

- 45 UNF undergraduates regularly participated in the collection of field data.
- Five UNF graduate students have lead the field sampling effort and gain experience in overseeing field teams collecting research.
- 20 UNF undergraduates participated in Directed Independent Study, 11 Senior Seminar Projects, and one student completed Honors Thesis on eel project related data.

Summary and conclusions

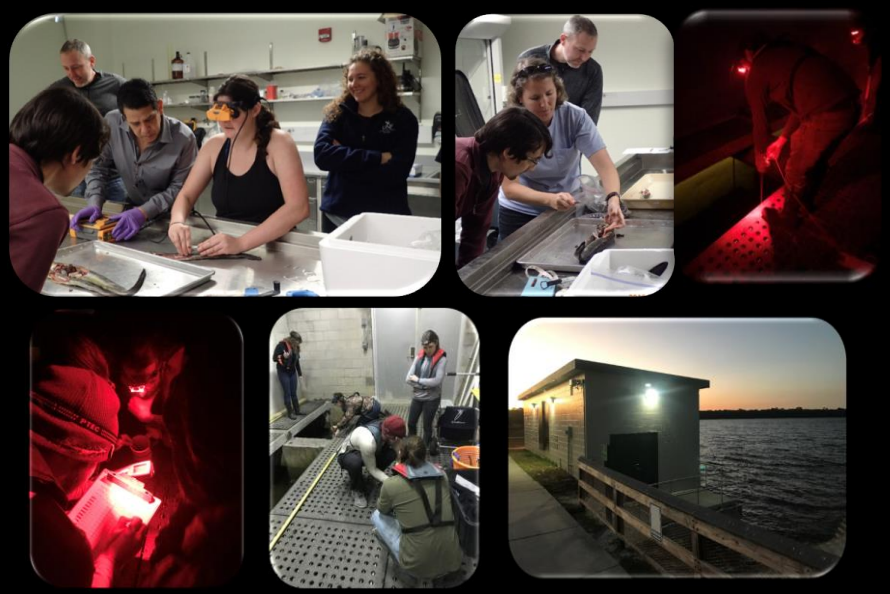
(1) Recruitment of glass eels has declined from an initial period of high, but variable, abundance to a sustained period of low abundance.

(2) American eel recruitment is occurring earlier in the season with an approximate 15 day shift over the study period (21 years). The underlying cause of the shift is currently unknown.

(3) The project represents an effective partnership among various stakeholders permitting the efficient collection of fishery-independent data, directed hypothesis testing, and professional training and student research opportunities.

Acknowledgements

- Many dozens of undergraduates collecting field data on cold, dark nights in northern Florida.
- Seven UNF graduate student field leaders



- GTM NERR for site access and support.
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