

AMERICAN EEL IN TEXAS – WHAT WE DO, DON'T, AND NEED TO KNOW

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Melissa Casarez, Doug Martin (all at UT Austin, Biodiversity Collections (Texas Natural History Collections))



A Virtual Museum on the State's Fish Biodiversity

Hendrickson, Dean A., and Adam E. Cohen. 2015.
"Fishes of Texas Project Database (Version 2.0)"
doi:10.17603/C3WC70.

The "classical" life history of *Anguilla rostrata* – catadromous; reproduces in Sargasso Sea; 400,000 - 20 million eggs/female; larvae (leptocephali) marine; glass eels enter estuaries & move upstream becoming elvers; yellow eels (immature) live many years in freshwater and mature into silver eels that return to Sargasso to spawn/die



November 14, 2014 -
Texas State Comptroller releases RFP



October 18, 2015 -
USFWS announces decision not to list
species as Endangered.

Comptroller withdraws RFP



GLENN HEGAR TEXAS COMPTROLLER OF PUBLIC ACCOUNTS

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**REQUEST FOR PROPOSALS (RFP # 212c)
FOR
ENDANGERED SPECIES RESEARCH PROJECTS
FOR THE AMERICAN EEL**

TO: All Proposers

FROM: Laurie Velasco *LV*
Assistant General Counsel, Contracts

DATE: December 2, 2015

RE: RFP for Endangered Species Research Projects for the American Eel (RFP #212c)

There will be no contract award under Request for Proposals No. 212c ("RFP") for Endangered Species Research Projects for the American Eel. The notice of the RFP was posted on the Electronic State Business Daily ("ESBD") on November 14, 2014.

The Comptroller appreciates your interest in this project and looks forward to reviewing your responses to future solicitations such as this.

Schedule of Events	Date
RFP Released:	November 14, 2014
Written Questions Submitted:	December 1, 2014
Answers to Questions Posted by:	December 5, 2014
Proposals Due:	January 30, 2015
Contract Execution:	March 16, 2015
Commencement of Work:	March 16, 2015



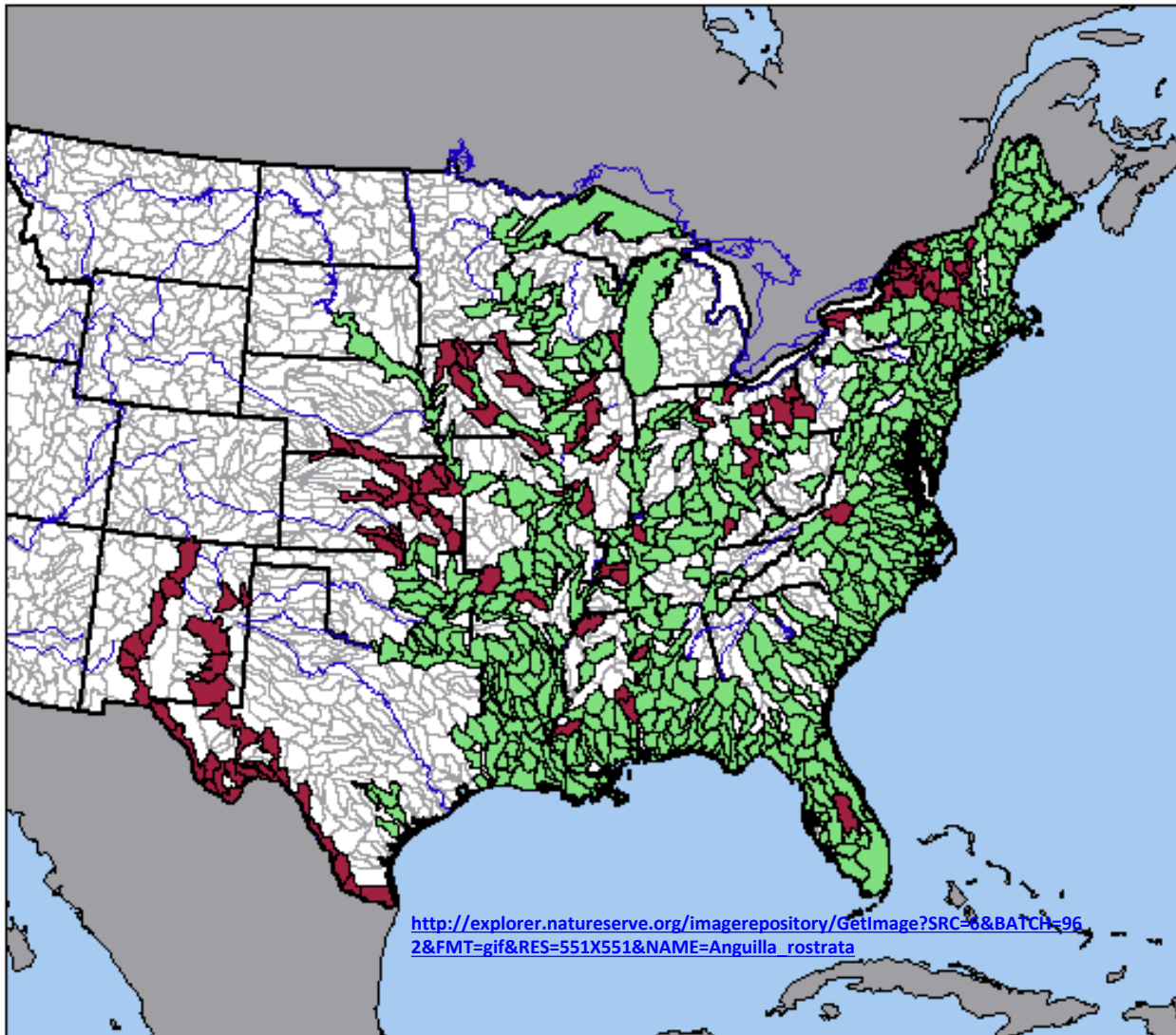
Anguilla rostrata

- Native HUCs
- HUC 8 Level Record
- HUC 6 Level Record
- Non-specific State Record

map from: <http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=310>

Map created on 12/31/2015. United States Geological Survey





Neither of these maps from prominent and authoritative sources have any link to who or where the data used to produce them came from.

- Administrative Boundary
- Major Rivers
- Hydrological Unit
- Current Distribution
- Extirpated/Possibly Extirpated
- Out of Scope

Anguilla rostrata
American Eel

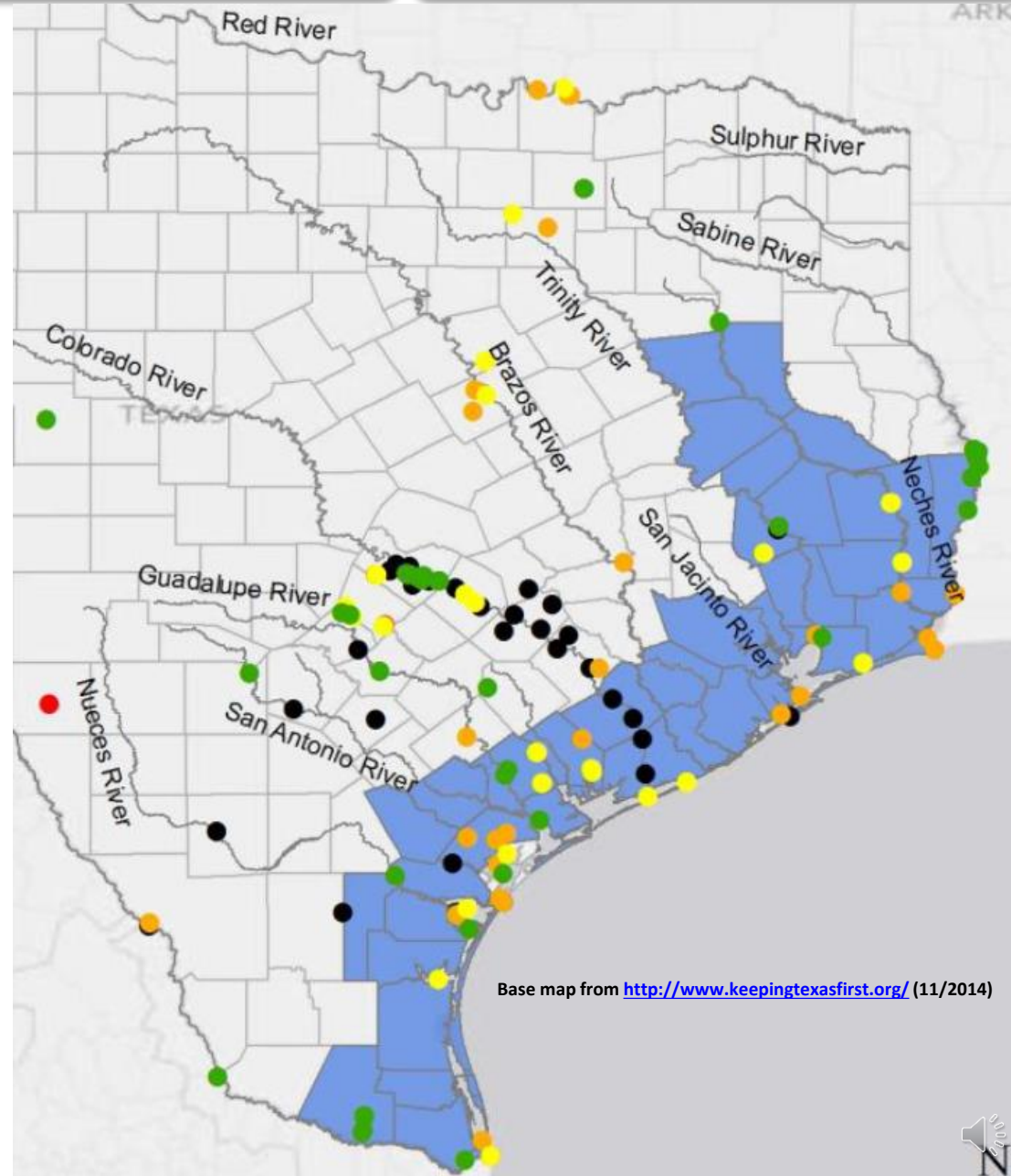
100 0 100 Kilometers

Map created September 2010



Not even the locals could find comprehensive information about Texas eels. Texas Comptroller determined economic impacts related to listing of the eel as endangered would be restricted mostly to lower parts of rivers (blue counties), yet data we quickly compiled many recent occurrences far upstream in nearly all rivers.

- 1964 – 1990
- 1991 – present
- others older or unknown



- ❑ **Nov 2014** - Web of Science - all years, “Topic=Anguilla” - **6,438** hits
- ❑ **Nov 25, 2015** – same query produced **13,404** hits
- ❑ = **humanly impossible to keep up with the literature on the genus**

- changing to “Topic=Anguilla rostrata” reduced hits to **1,142**
 - published in the last 2 decades - **779**

– **adding “Texas”** to filters produced only **2** hits:

1. parasites of eels in Texas (1996)
2. mention of eel in checklist of fishes of Caddo Lake (2002)

Expanding geographically to “Gulf of Mexico” (GoM) added 3, but 2 focused on other species, mentioning *Anguilla* only in passing.

= almost nothing has been published on eels in TX or GoM

YET we knew there was extensive specimen-based data in museum databases (mostly already mined by FoTX), and much more in unpublished reports, other online databases, newspapers, Facebook, fishing forums, peoples’ memories, etc.

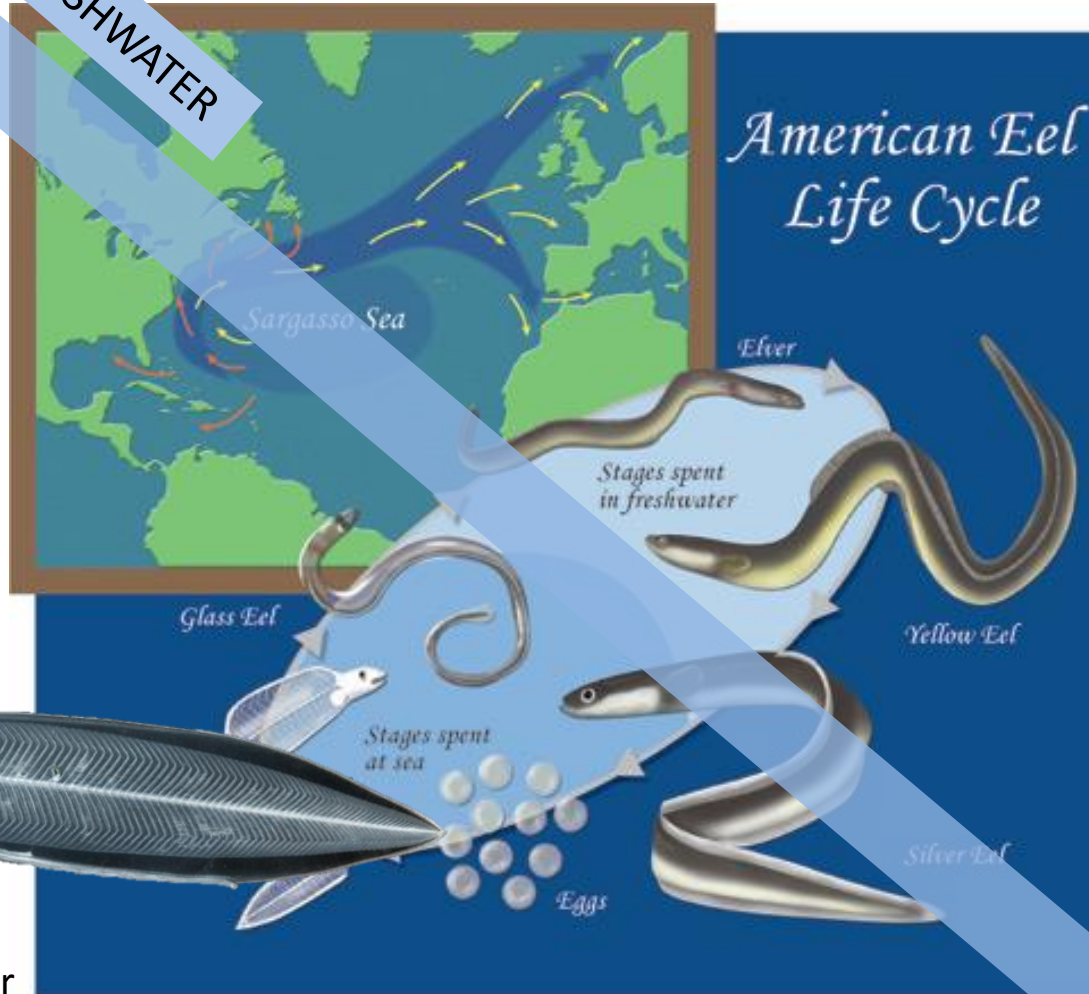


MARINE

FRESHWATER

Updated life history differs from “classical” primarily in that eels are **FACULTATIVELY CATADROMOUS**.

Leptocephali are clearly exclusively marine, but all other life history stages may go back and forth to some degree.



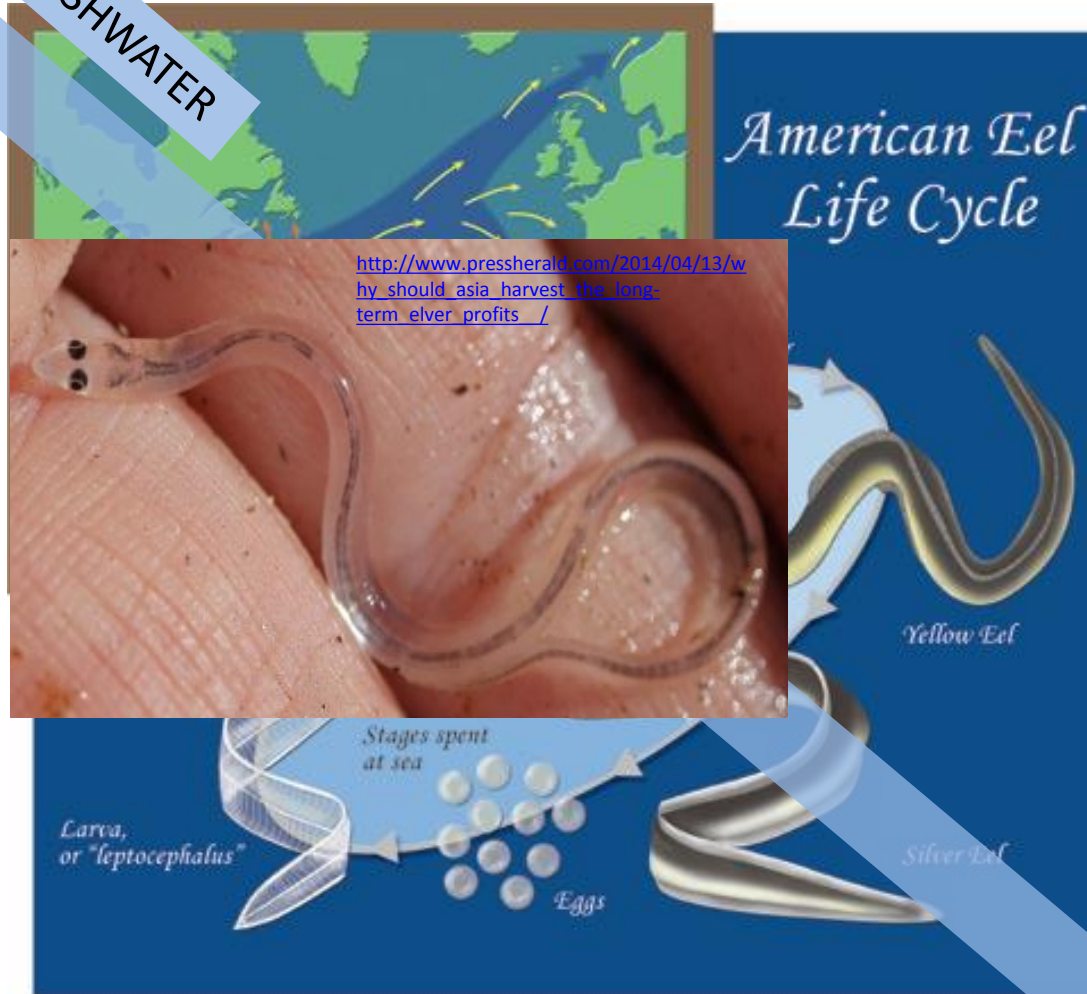
<http://www.naturalhistoryillustration.com/website%20images/American%20Eel.html> (Natural History Magazine, Nov. 2009).
Leptocephalus image from <http://www.newyorker.com/tech/elements/the-poetic-life-of-the-lowly-eel>



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Leptocephali transform to glass eels as they come over the continental shelf & swim into estuaries to head upstream en masse using tidal transport and active swimming.



<http://www.naturalhistoryillustration.com/website%20images/American%20Eel.html>
(Natural History Magazine, Nov. 2009)



New info - life history is more variable

Texas Natural History Collection

MARINE



Image from <http://www.glooskapandthefrog.org/eel%20gallery.htm>



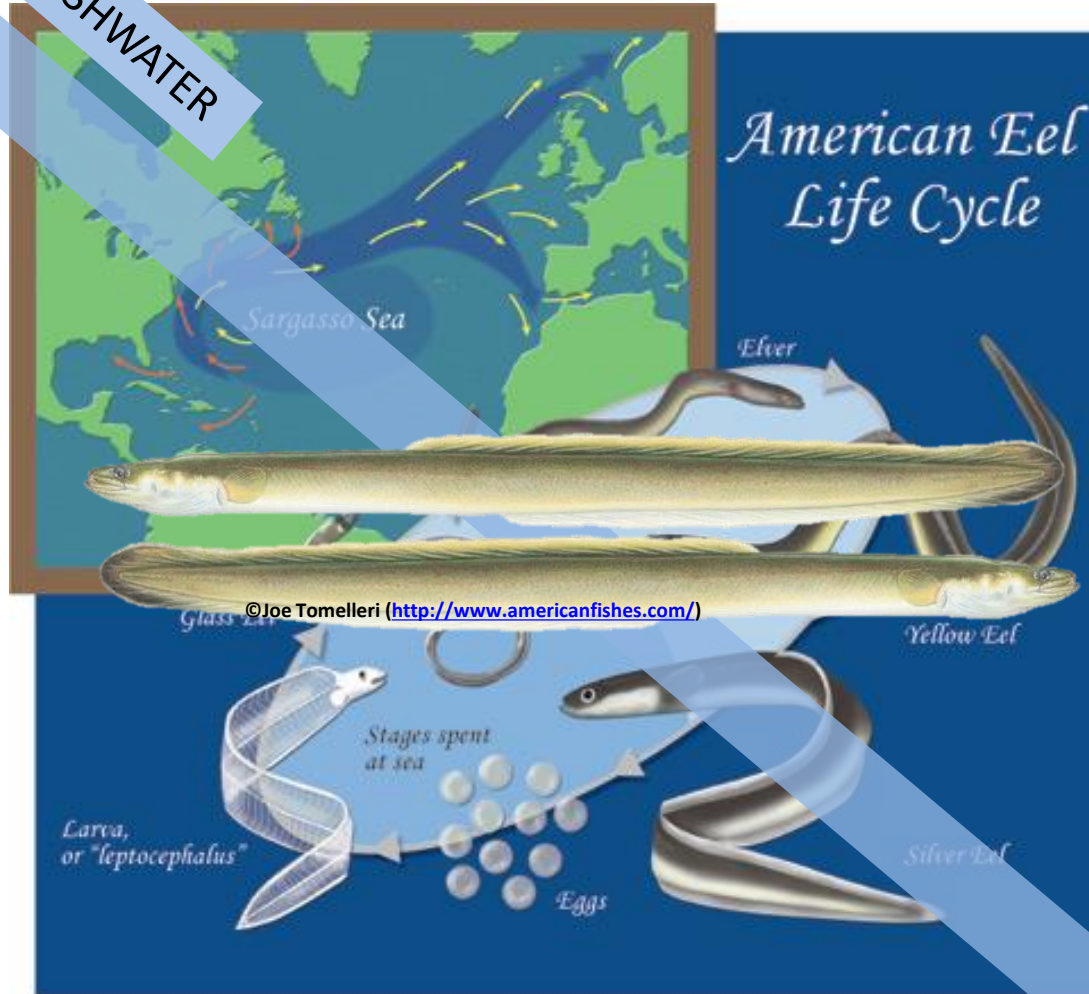
Eelers **may or may not enter freshwater.** Those that do are amazingly adept at surmounting barriers as they ascend rivers and streams.

<http://www.naturalhistoryillustration.com/website%20images/American%20Eel.html>
(Natural History Magazine, Nov. 2009)



MARINE

FRESHWATER



Yellow (immature) eels **may or may not enter freshwater** and at least some may complete entire lifecycle in estuaries. Many go back and forth between estuary and lower river reaches.

<http://www.naturalhistoryillustration.com/website%20images/American%20Eel.html>
(Natural History Magazine, Nov. 2009)



MARINE

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Far inland females are much more prevalent than males. As they mature, eels become silver and transform in other



©Garold W. Sneegas

<http://www.naturalhistoryillustration.com/website%20images/American%20Eel.html>
(Natural History Magazine, Nov. 2009)

ways before they head downstream en masse.



- ❑ GoM specimens have *not* been used in genetic studies since the 1970s
- ❑ But, Atlantic eels recently **extensively** studied
 - Panmixia is confirmed = no local genetic differentiation
 - But, evidence of genetic response to local environments
 - “In absence of local adaptation, plasticity and spatially varying selection rule”
 - “brackish/saltwater vs freshwater ecotypes have a polygenic basis resulting from intra-generational mechanisms”
 - “within-generation polygenic selection in response to anthropogenic organic and metal contamination”
 - Those who did all that work were aware that GoM eels were excluded. They searched for GoM samples, but the literature and readily accessible data led them to believe they were exceedingly rare, so they quickly gave up.



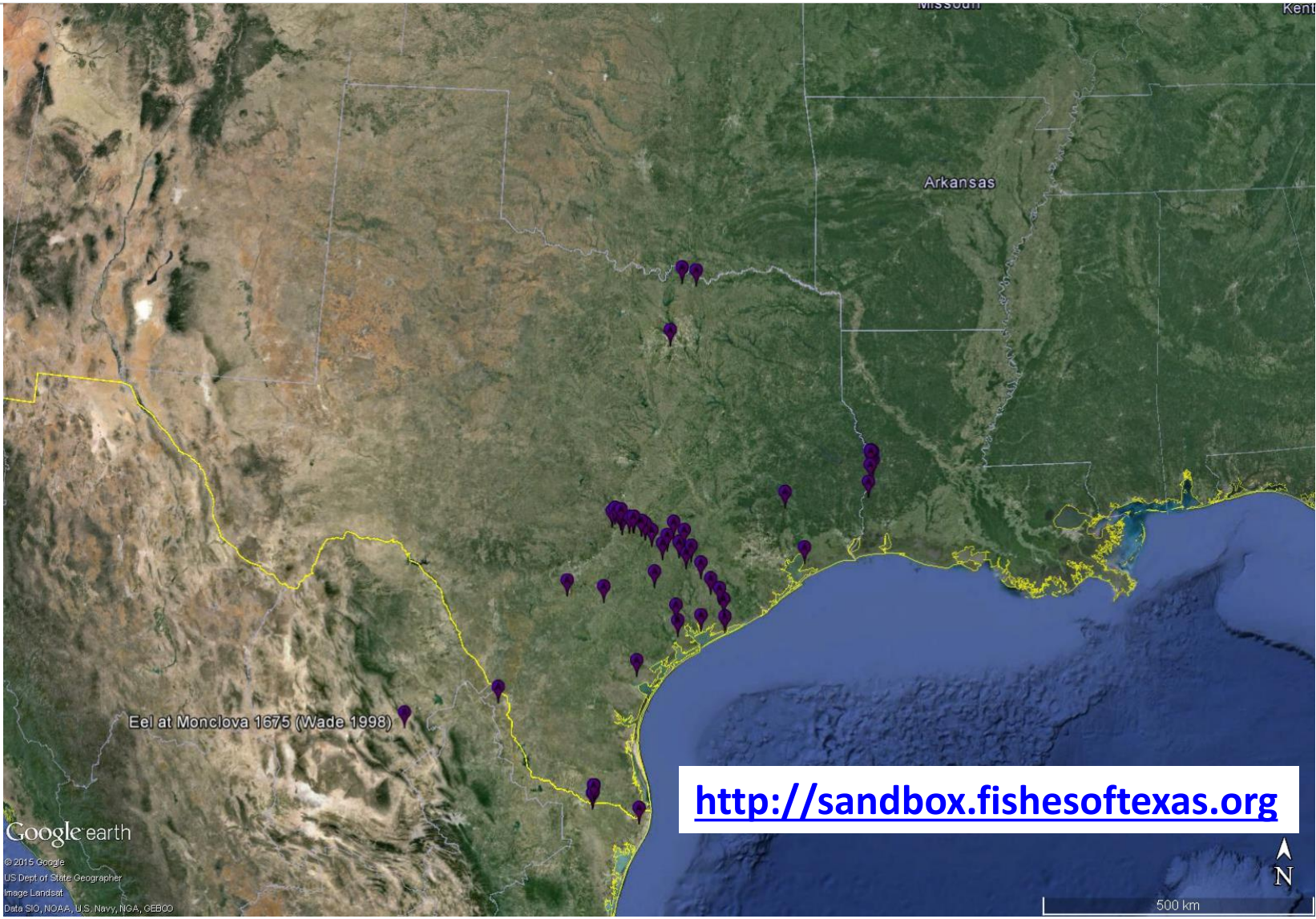
Data sources found

- ❑ Texas and region
 - Fishes of Texas website
 - Fishes of Texas sandbox
 - FoTX non-vouchered
 - Literature
 - Agency databases (inland fish surveys, coastal fish surveys, others)
 - Personal accounts and photo vouchers (iNat, fishing forums, newspapers, etc.)
 - unpublished
 - FoTX DLCC project database
 - FoTX MARIS
- ❑ Broader Regional/Global coverage
 - GBIF, FishNet2, VertNet
 - CONABIO
 - Long Term Upper Mississippi Monitoring Program
 - ICES eggs and larvae database

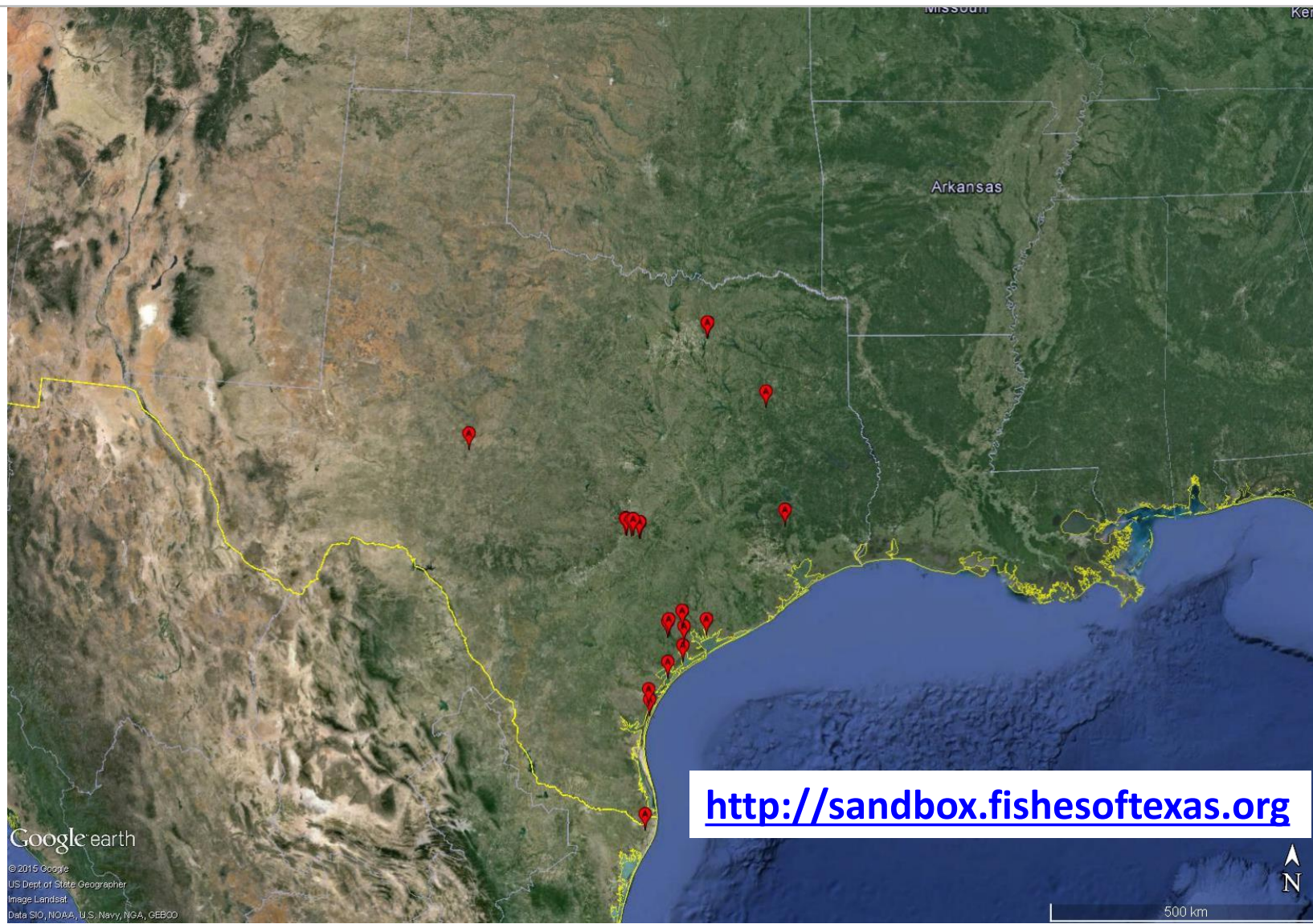




Literature



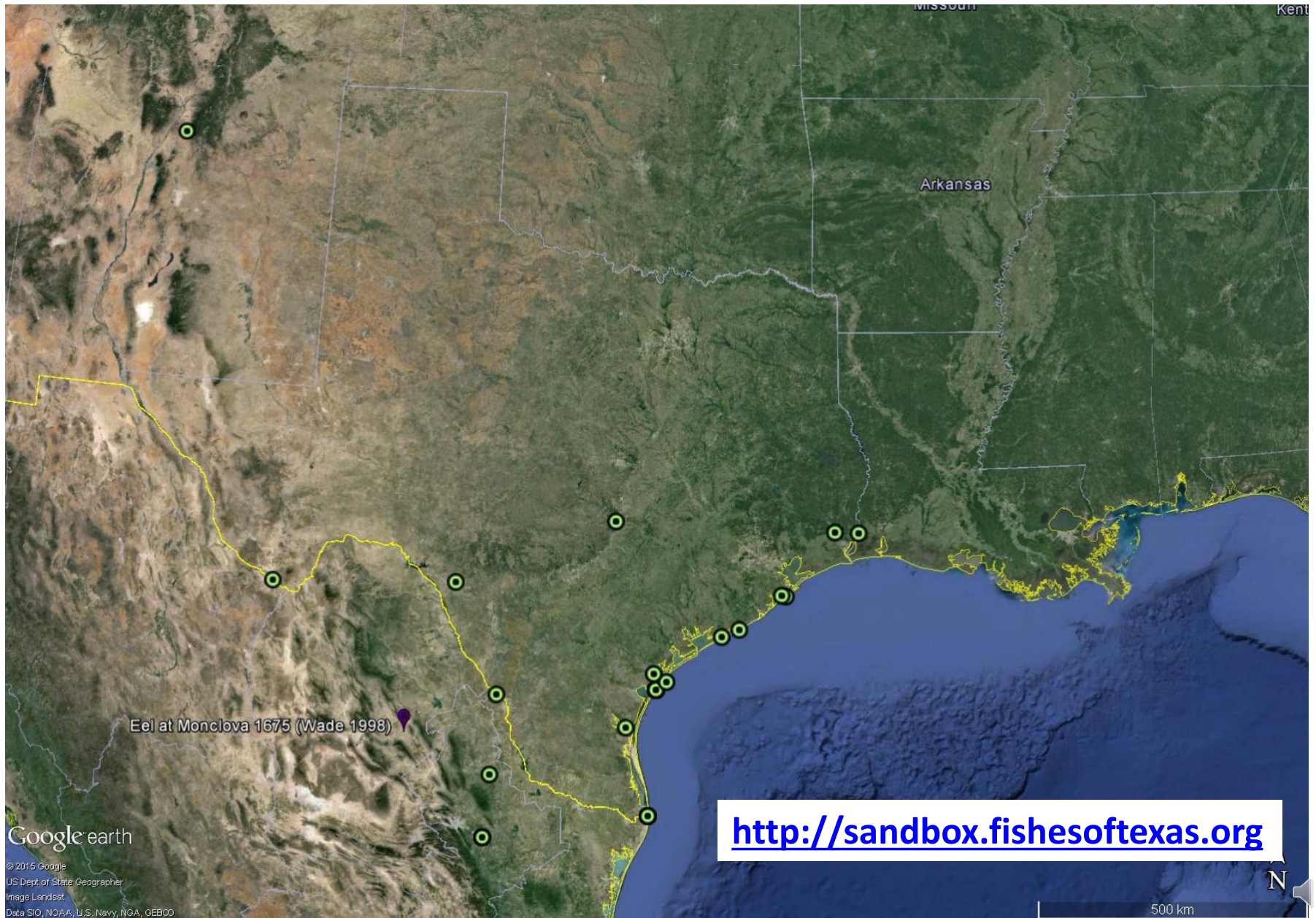
TPWD Inland, Coastal, GoFish

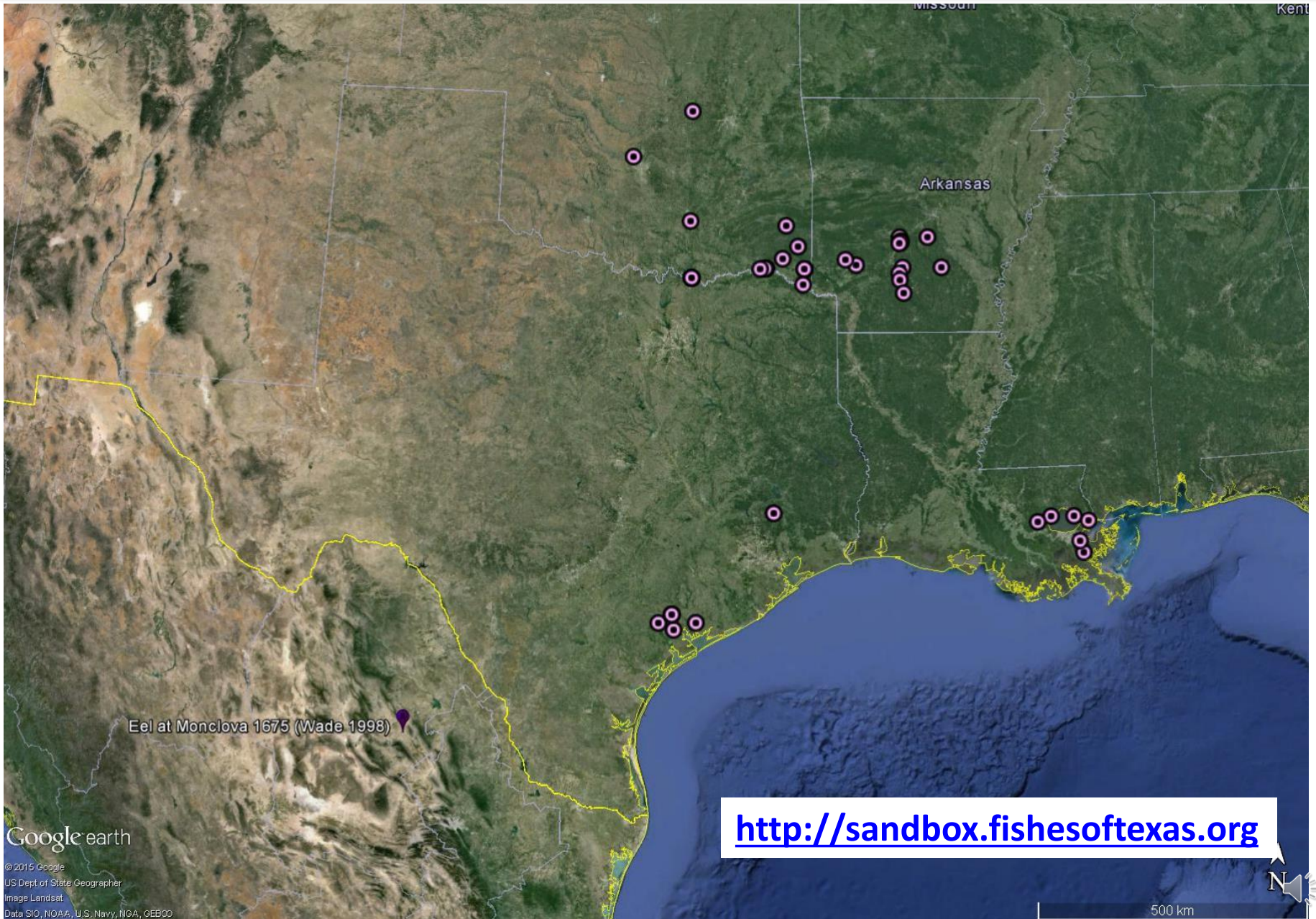


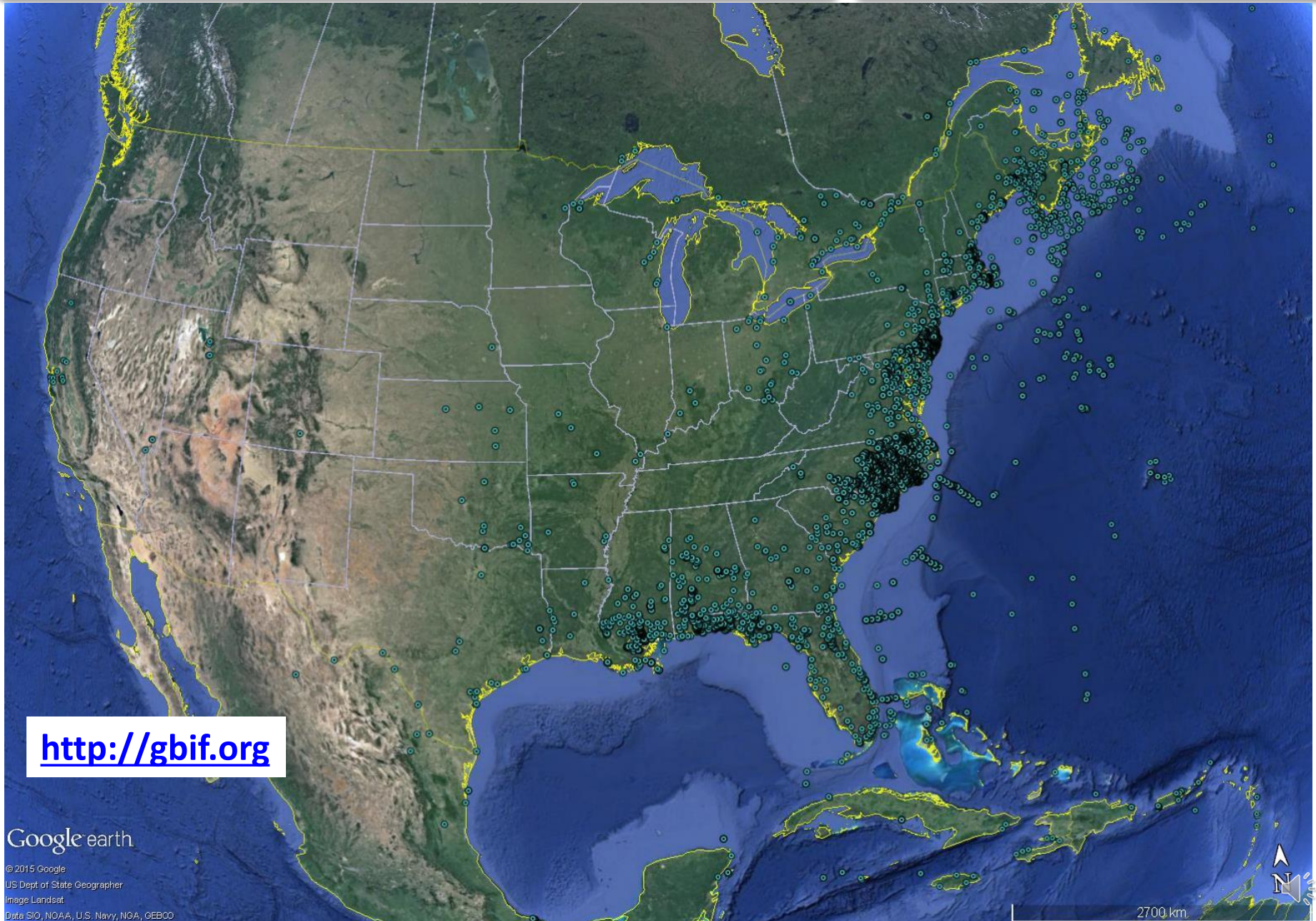
Personal accounts & photo vouchers

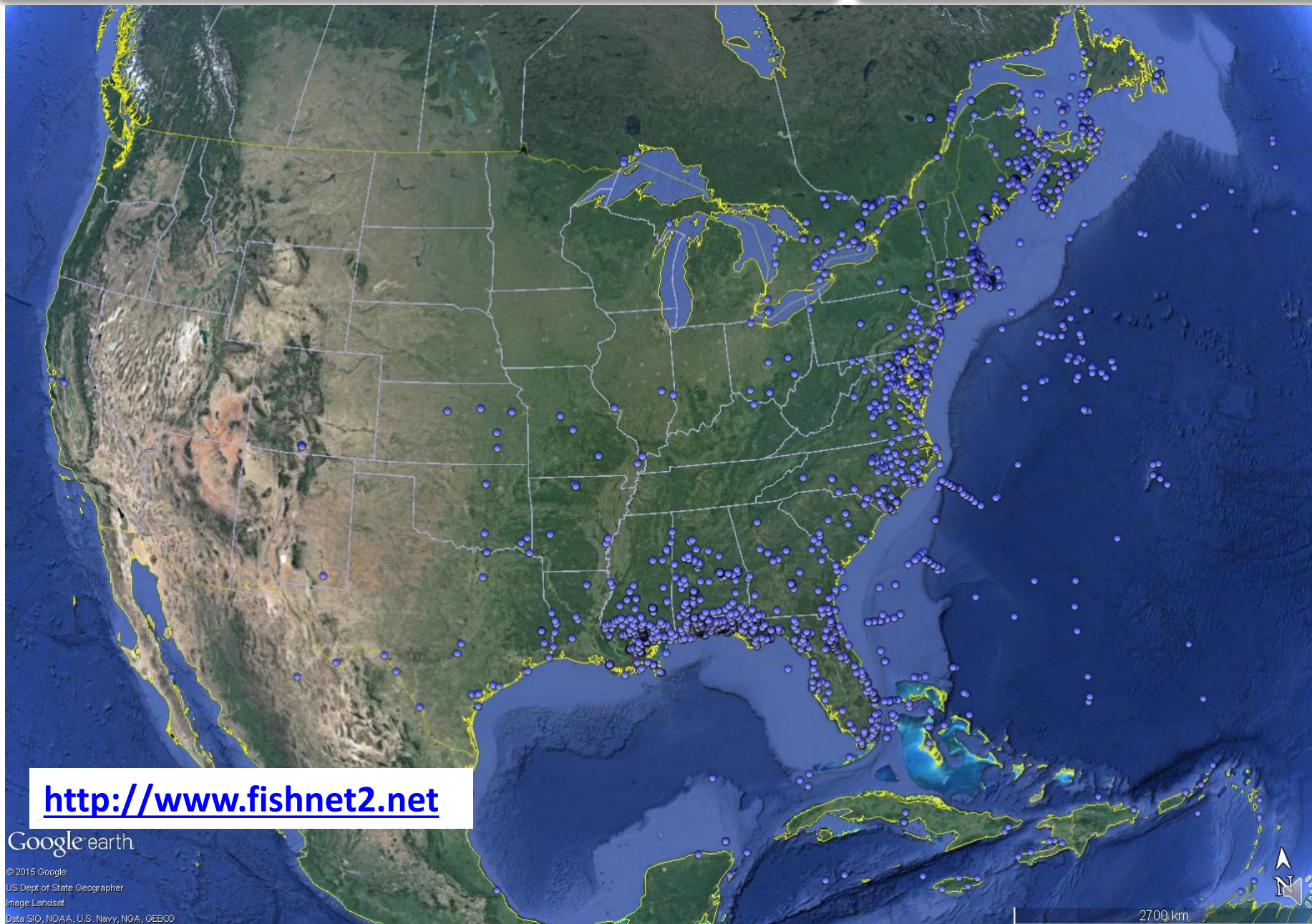


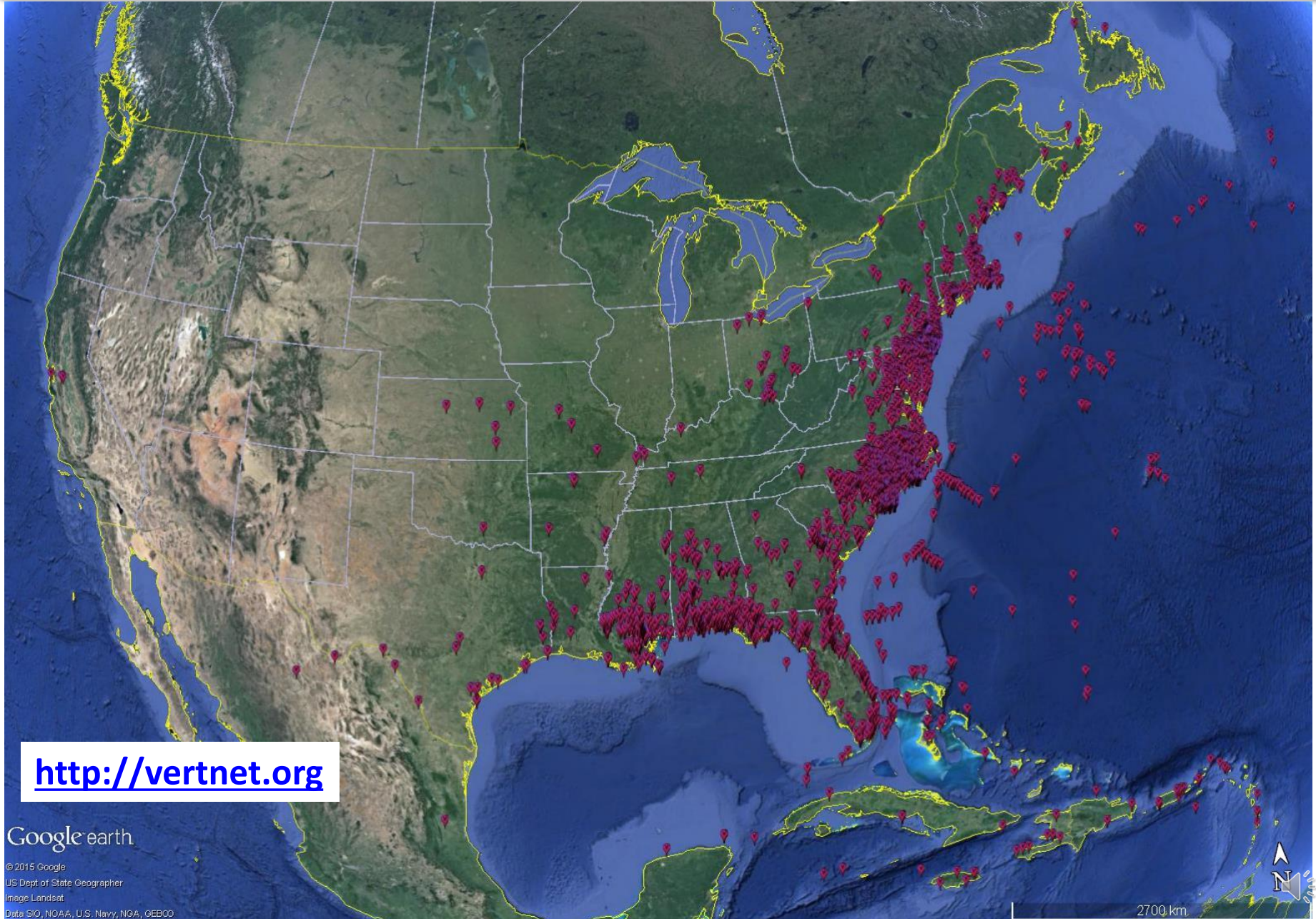
<http://sandbox.fishesoftexas.org>

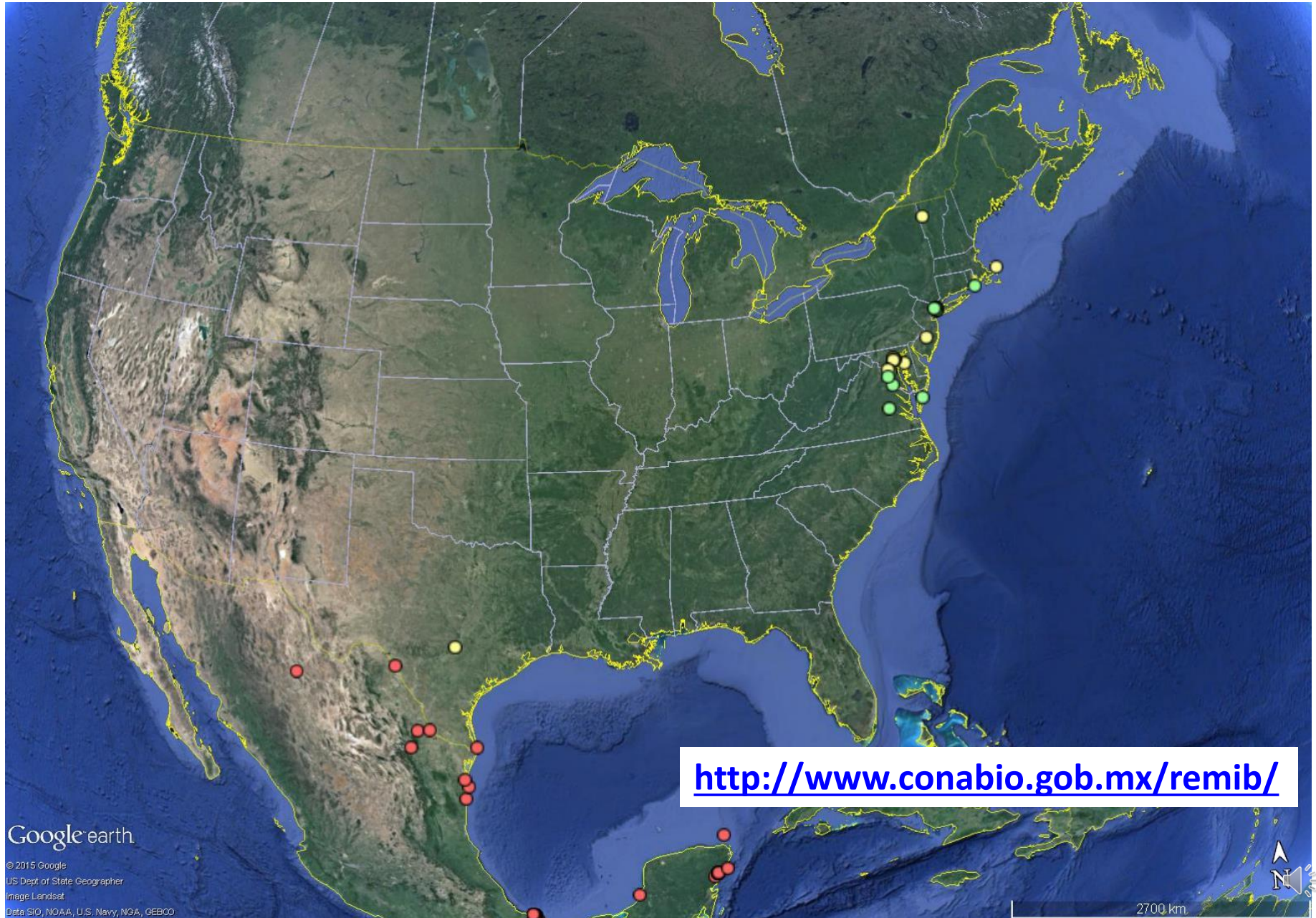


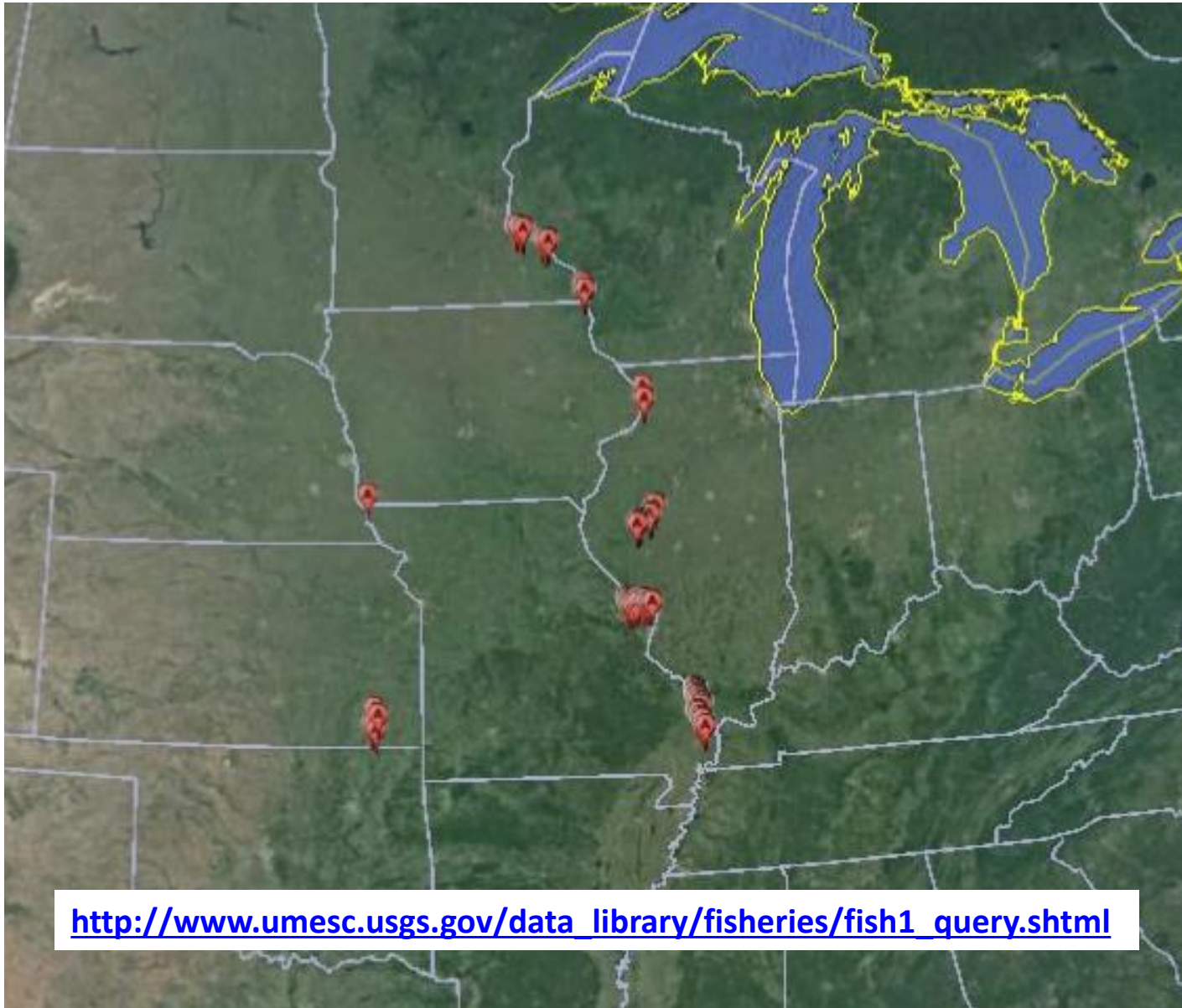


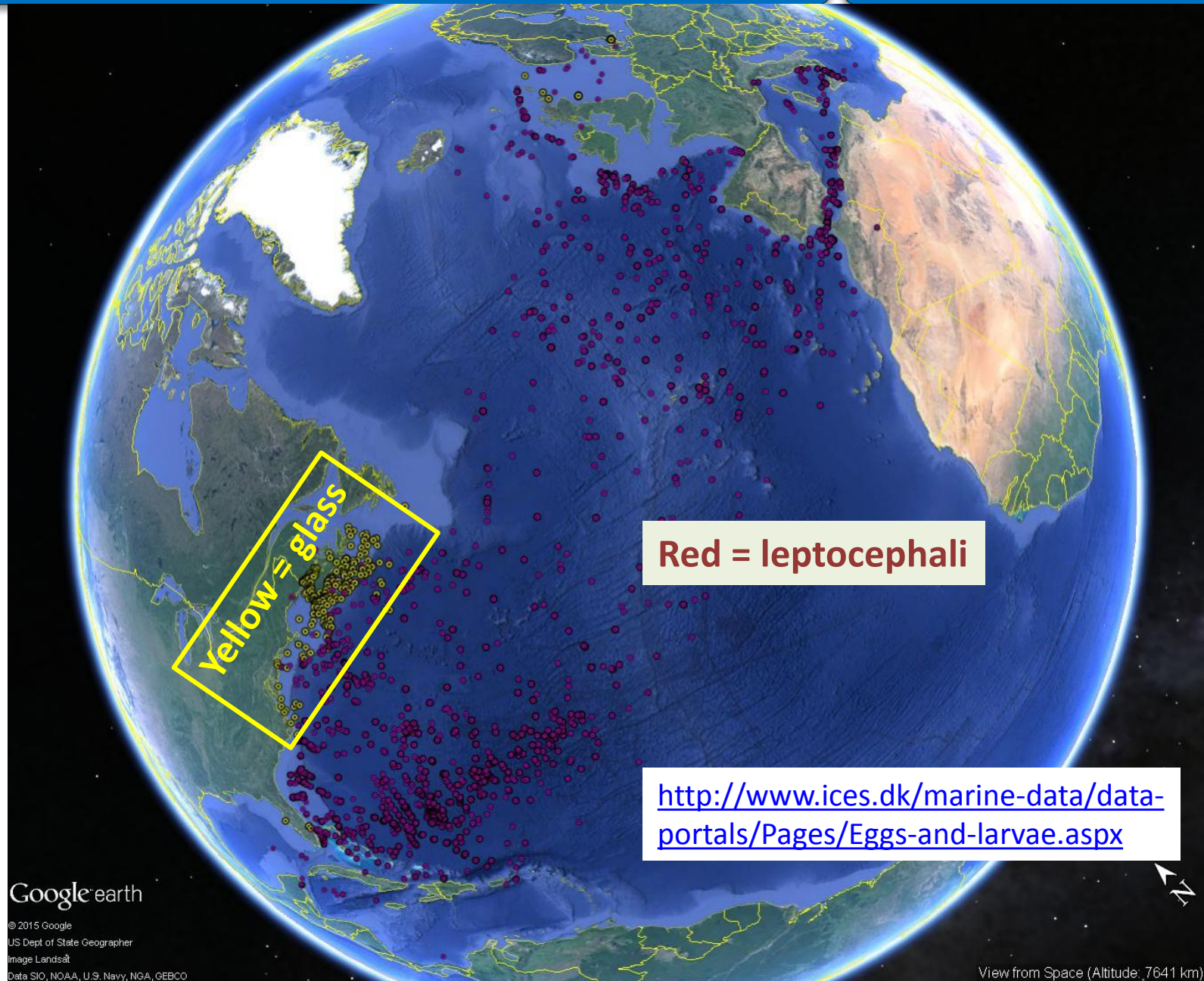






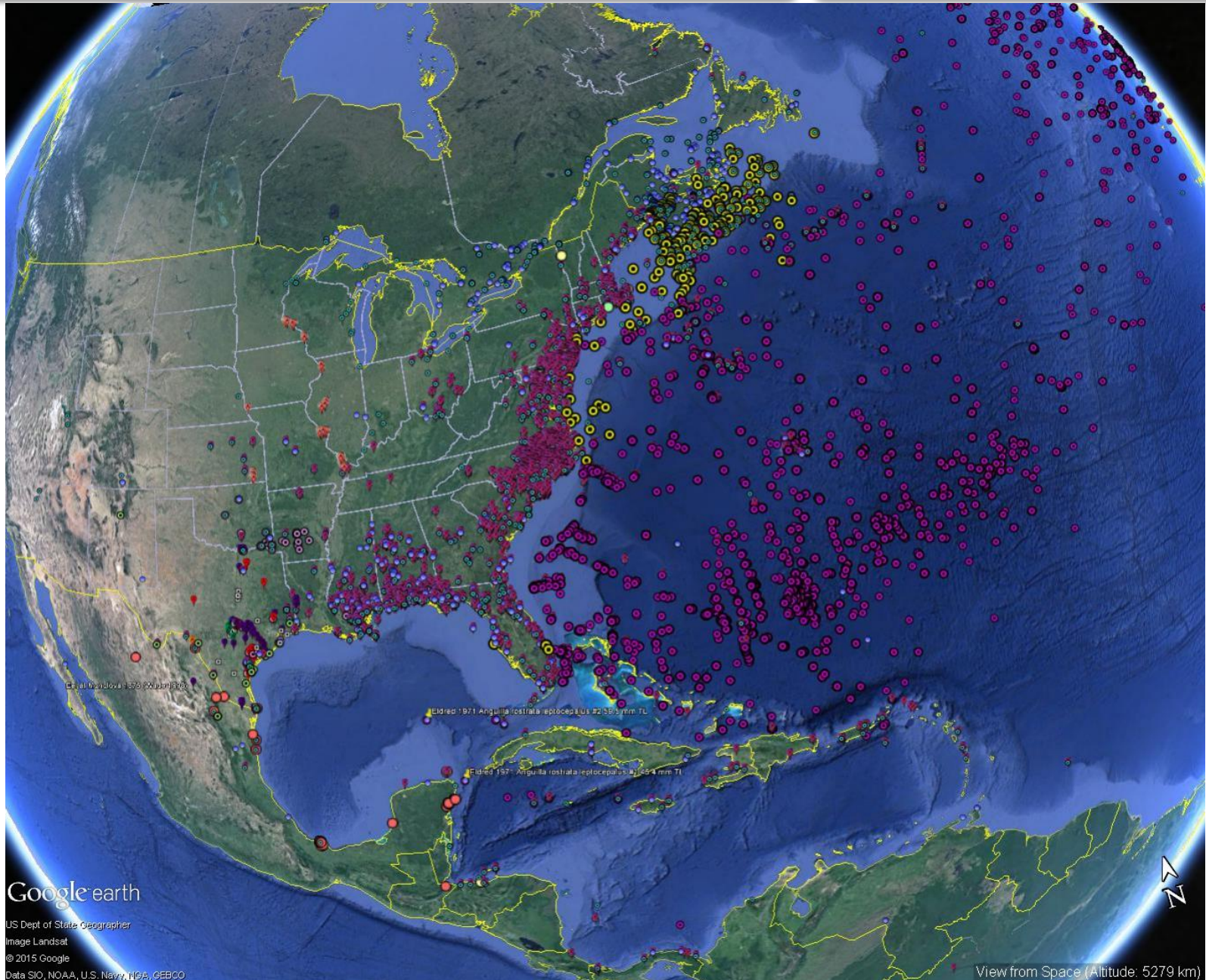


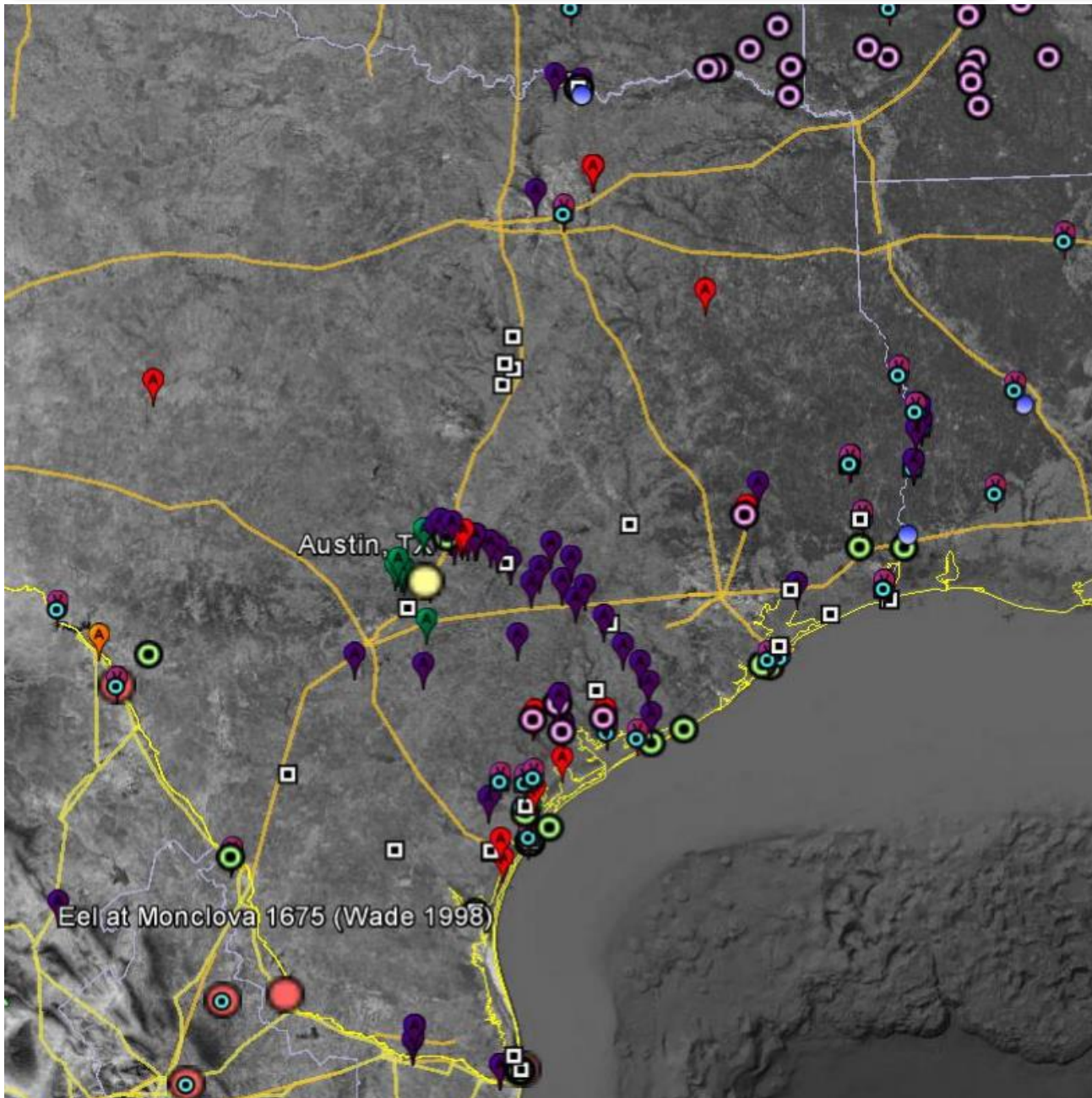




Eel data mining results – ALL COMBINED

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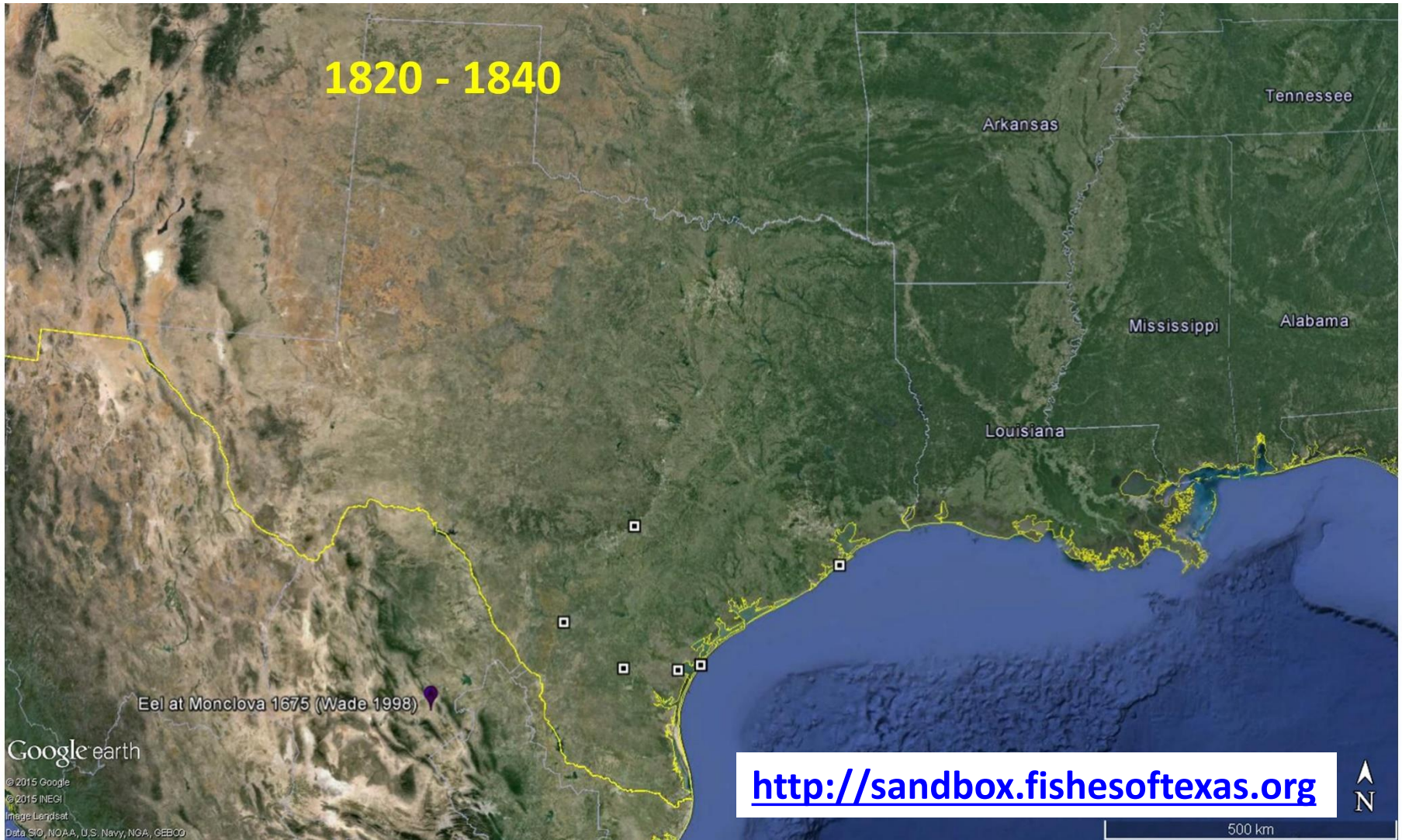


Quick, but diverse, data mining produced a much better baseline of eel occurrences in TX rivers. At least for TX, overlap among datasets was minimal and every dataset had valuable, unique records.

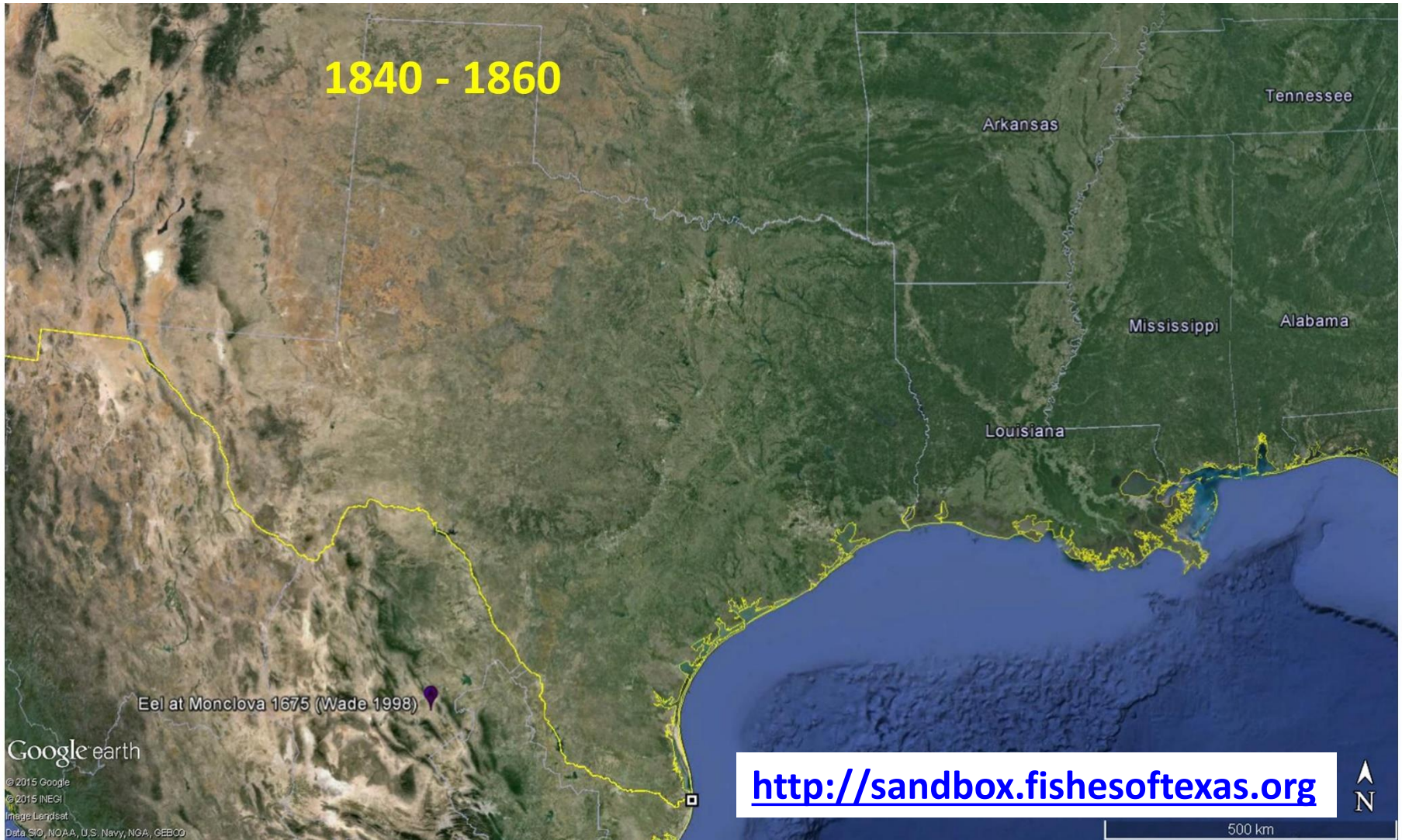
And, we can now explore the temporal dimension of these occurrences

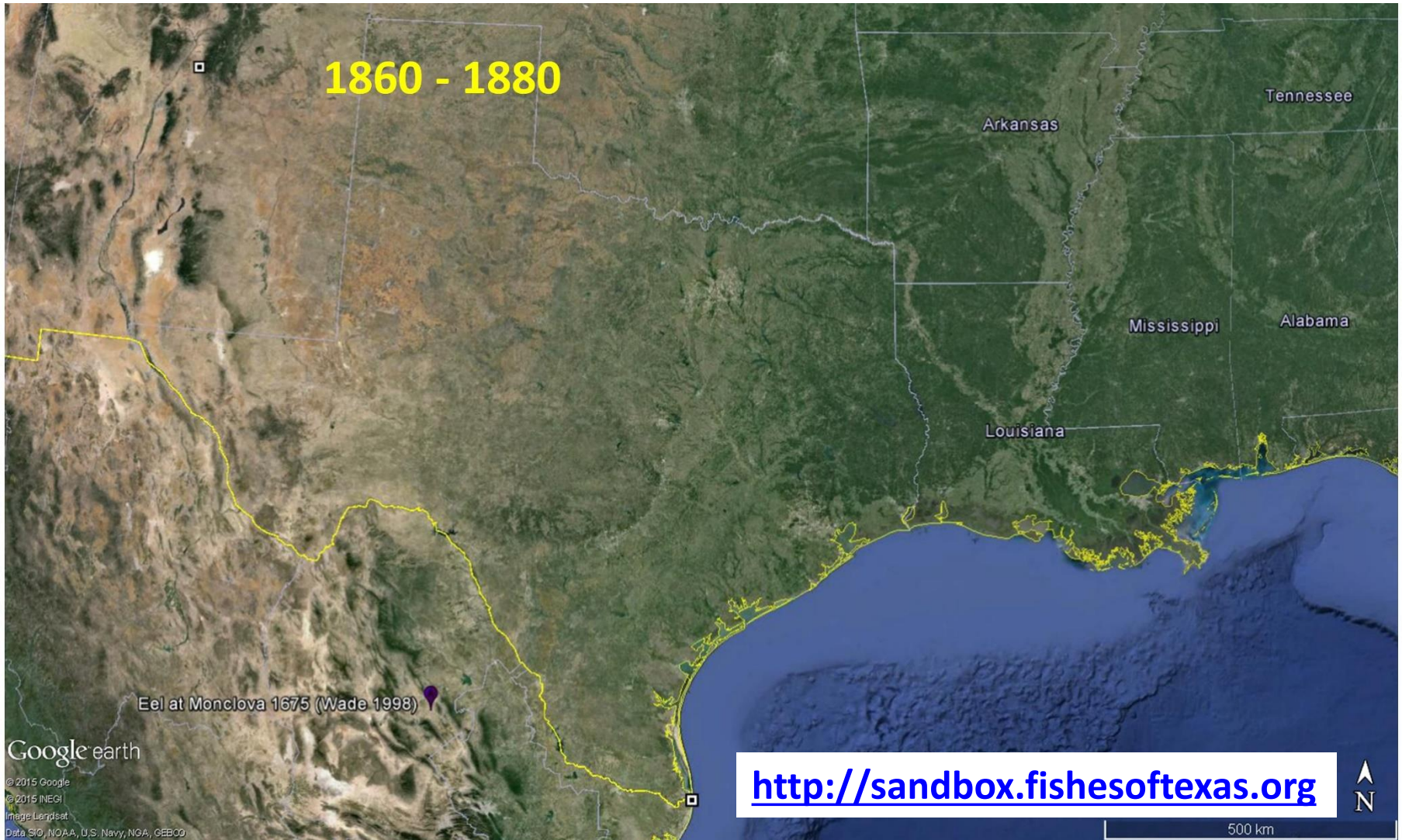
1674 - 1824

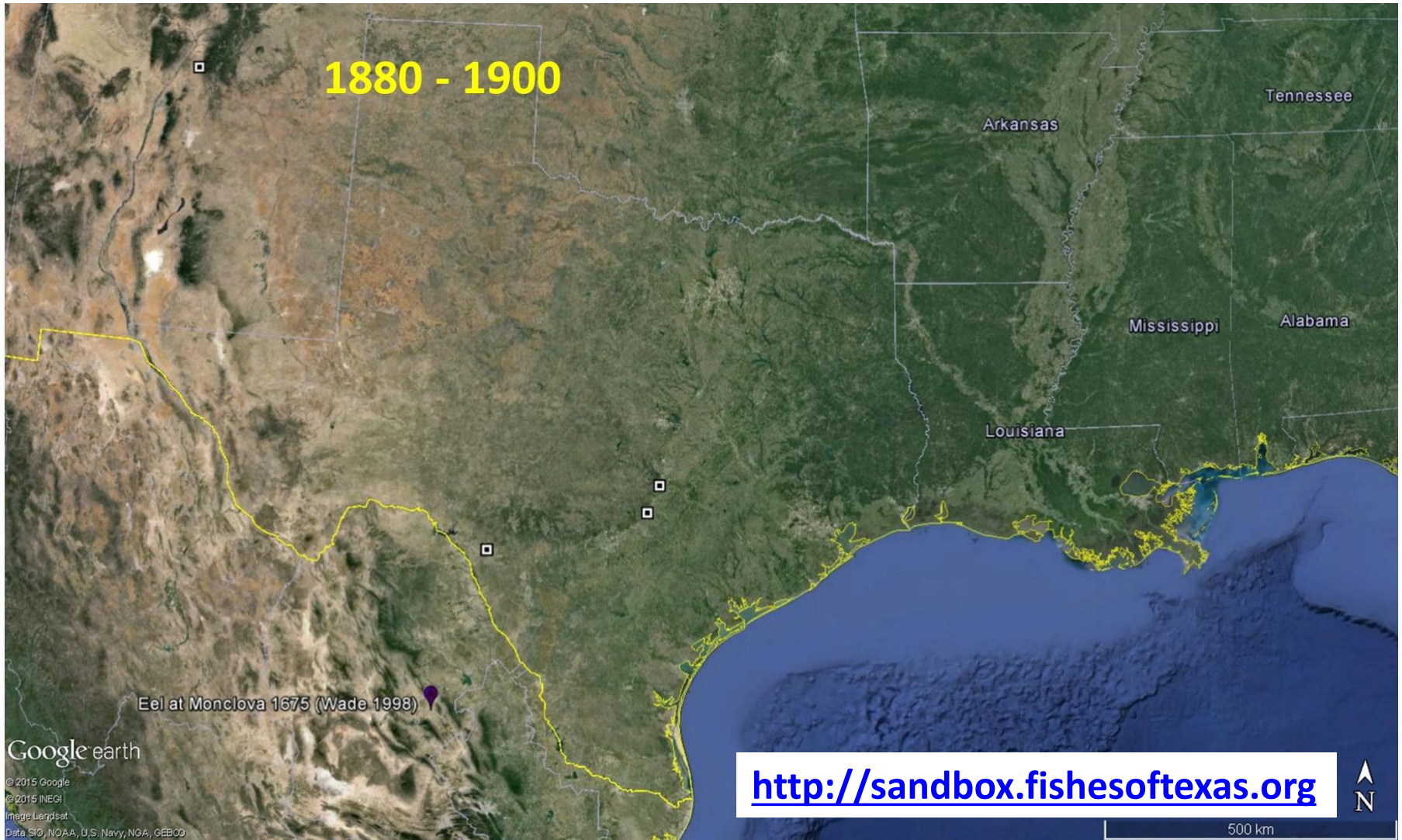


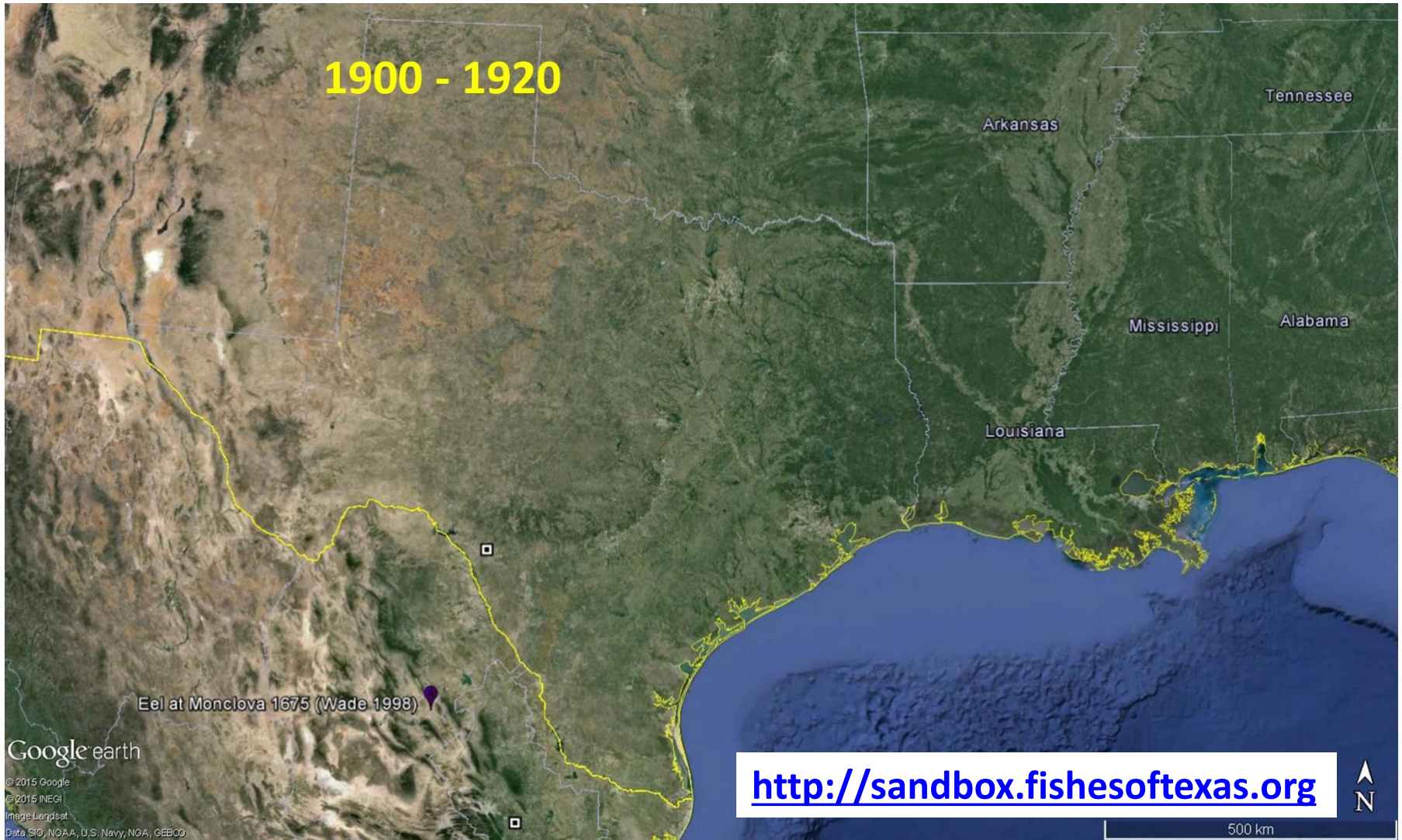


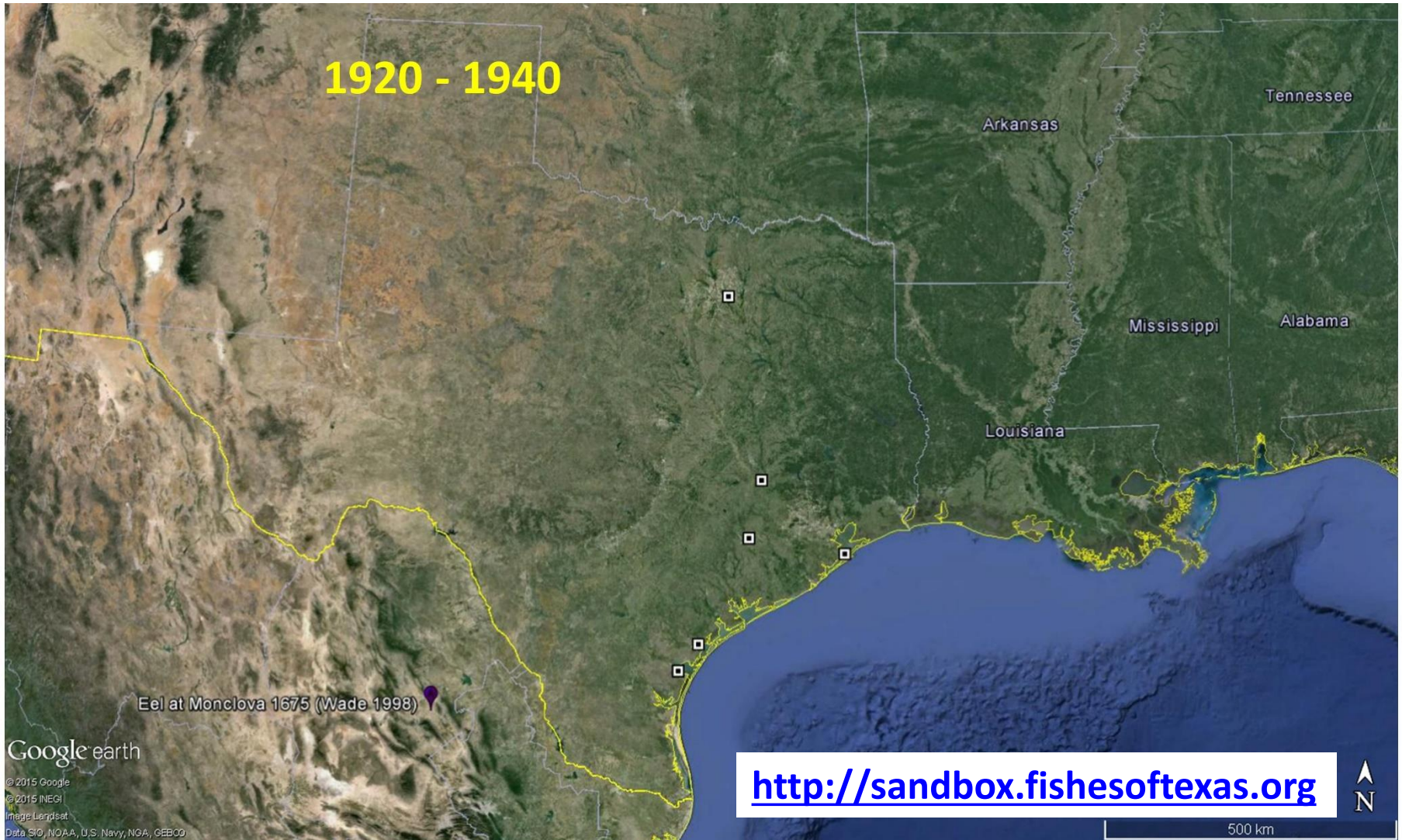
1840 - 1860



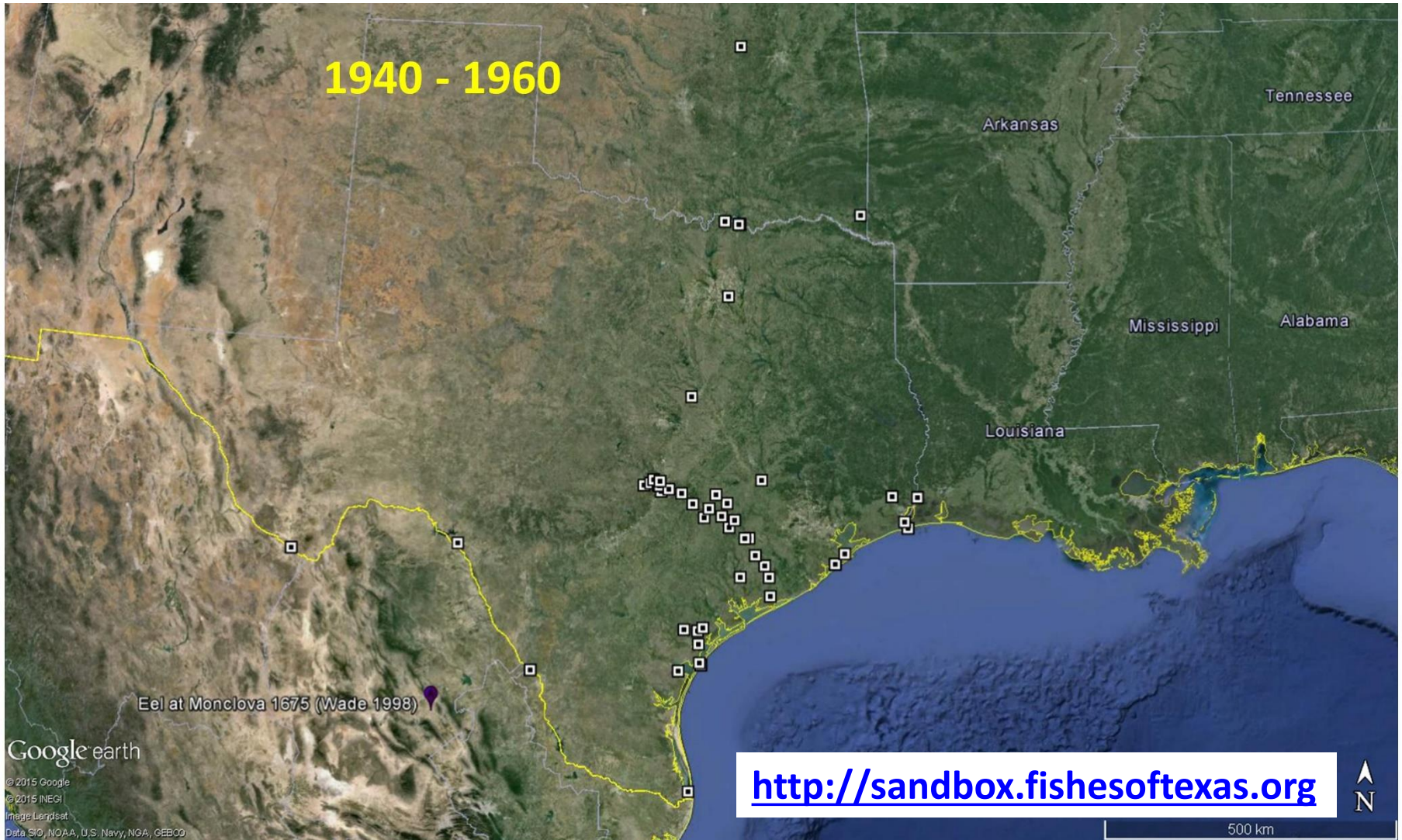








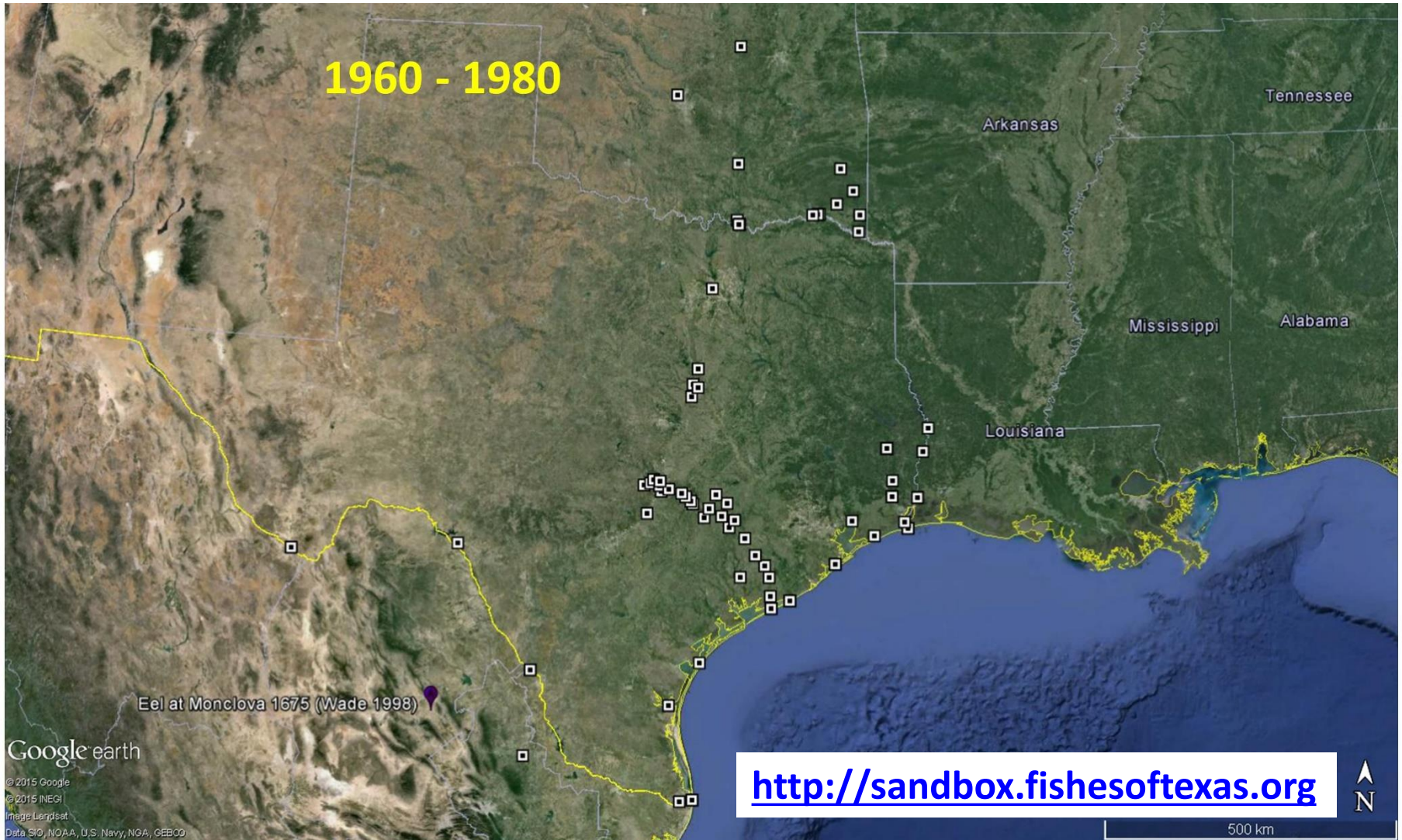
1940 - 1960



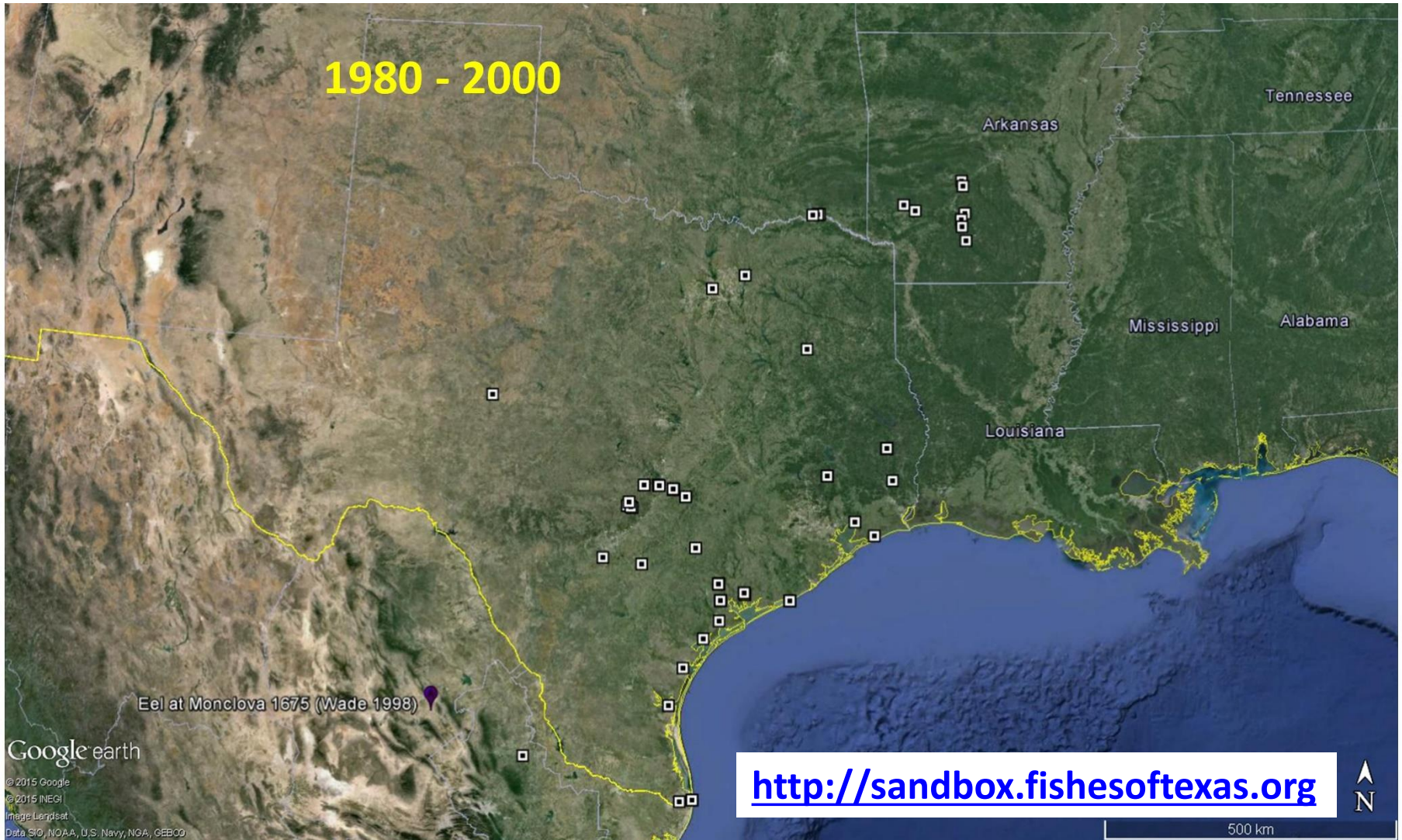
Google earth

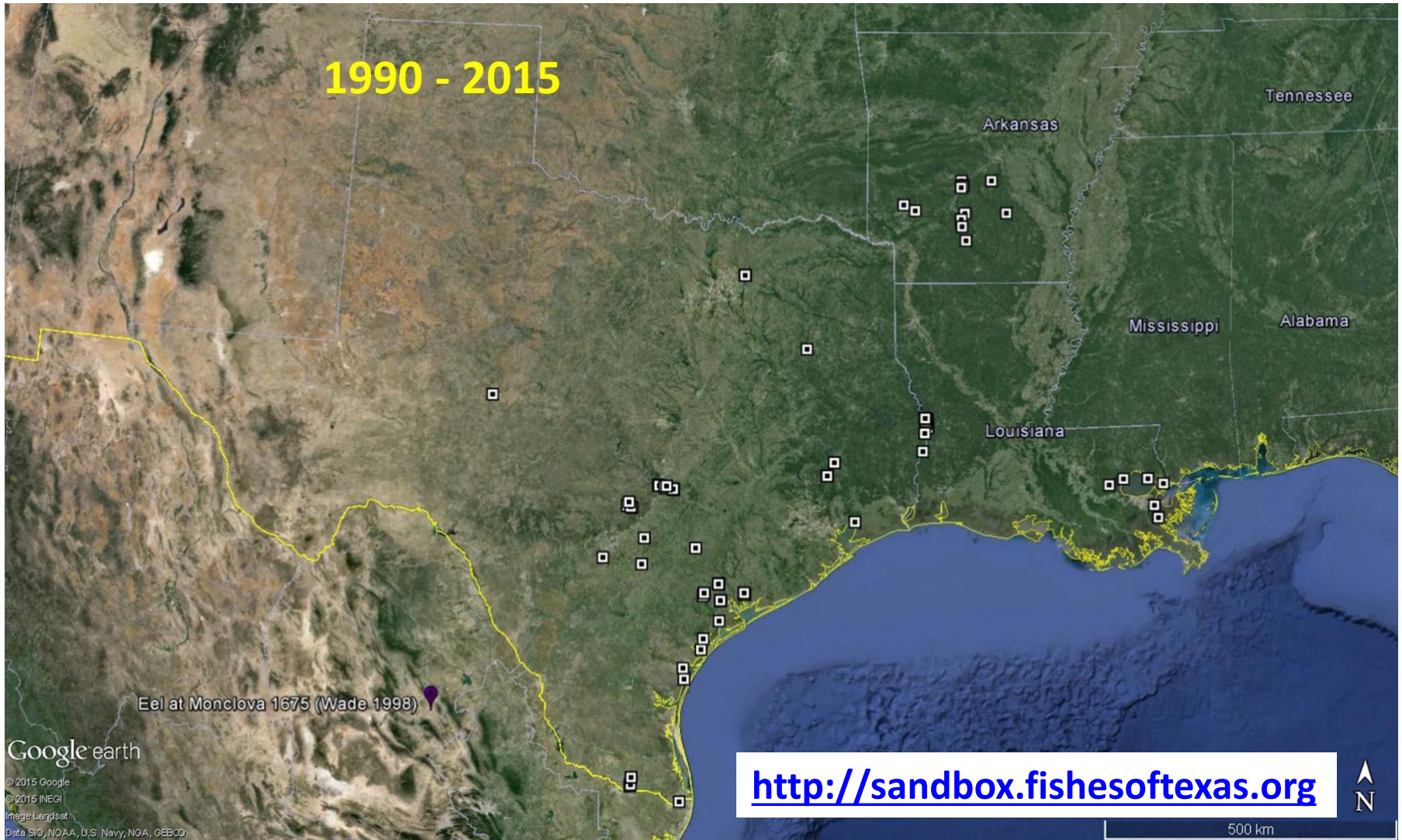
© 2015 Google
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Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO



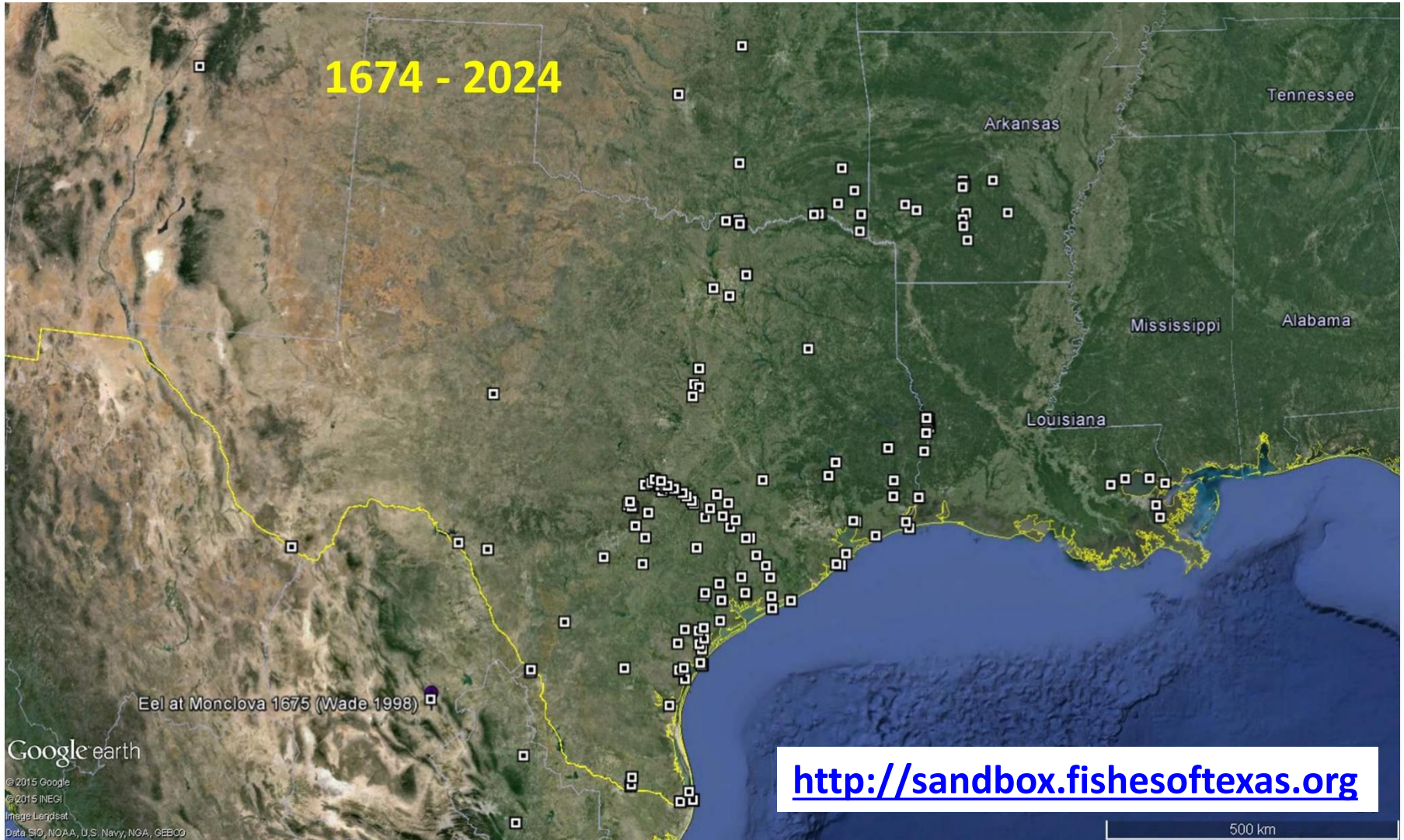


1980 - 2000





1674 - 2024



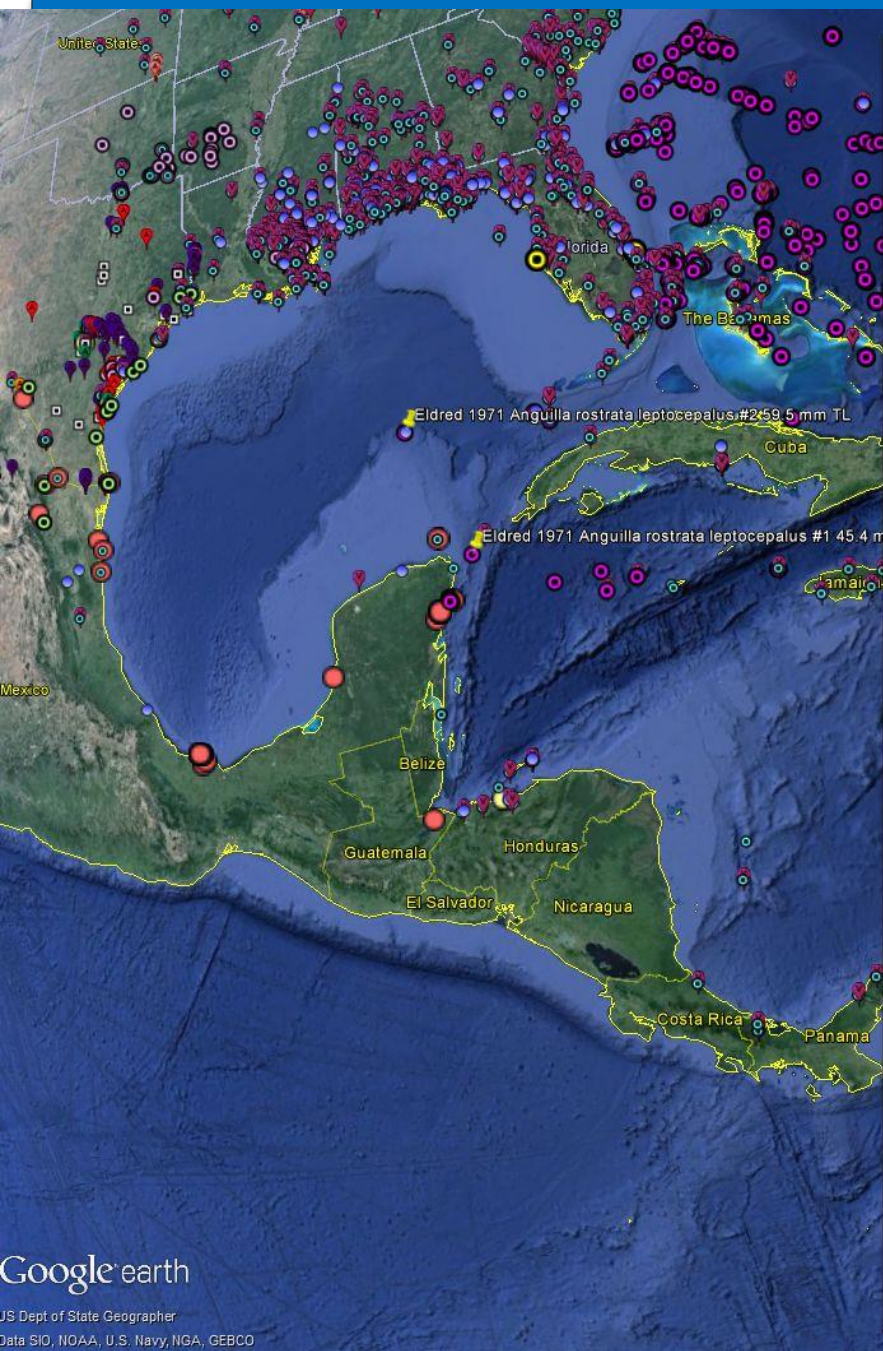
<http://sandbox.fishesoftexas.org>

Google earth

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Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO



- ❑ We relatively quickly compiled a huge amount of data relevant to most anything anyone might want to ask about eels, and serve it on our website (sandbox.fishesoftexas.org)
- ❑ Data are much more easily digested and rigorously summarized (by human or machine) than is the huge mass of literature on eels, and unlike literature, data can always be reanalyzed and corrected
- ❑ Mapping interactively facilitates error trapping and learning:



modified	17:25.0
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rightsholder	President and Fellows of Harvard College
accessrights	
bibliographiccitation	
references	http://mczbase.mcz.harvard.edu/quid/MCZ:Ich:1604b4640710-8e03-11d8-b956-b8a03c50a862
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recordedby	RV Atlantis 286
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organismquantitytype	0
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lifestage	0
reproductivecondition	0
behavior	0
establishmentmeans	
occurrencestatus	
preparations	whole animal (alcohol)
disposition	in collection
associatedmedia	0
associatedreferences	0
associatedsequences	0
associatedtaxa	0
othercatalognumbers	0
occurrenceremarks	
organismid	0
organismname	0
organismscope	0
associatedoccurrences	0
associatedorganisms	0
previousidentifications	0
organismremarks	0
materialsamplid	0
eventid	0
parenteventid	0
fieldnumber	
eventdate	9/26/1962
eventtime	0

[← Back to Google Earth](#)

<http://mcbase.mcz.harvard.edu/guid/MCZ:Ich:160494> - Ichthyology 160494: Anguilla rostrata

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MCZBASE: The Database of the Zoological Collections
Museum of Comparative Zoology - Harvard University

[Search](#) [My Stuff](#) [Help](#)

Ichthyology 160494 [\[VERBATIM DEPTH:50 m\]](#) whole animal (alcohol) [Login or Create Account](#)
Anguilla rostrata Atlantic Ocean: North Sargasso Sea
26/9/1962-26/9/1962 (1962-09-26)

Anguilla rostrata (Lesueur, 1817)

Animalia Anguillidae Anguilla rostrata

Identified by Bottle Label(s)

Nature of ID: migration

Remarks: [MUSE DETERMINER: Bottle Label(s)]

Continent/Ocean: Atlantic Ocean

Specific Locality: [VERBATIM DEPTH:50 m]

Locality Remarks: Hydro St. 6319-20 taken 26-27 Sept, 200 mwo.

General Habitat: [SALINITY: M]

Collecting Method: 6' IKMT

Collecting Source: wild caught

Depth: 0 to 50 m

Coordinates: 32° 24' N 64° 4' 30" W (unknown) , Error: 0 m

[no agent data]; 2010-03-19; unknown

Collecting Date: 26/9/1962-26/9/1962 (1962-09-26)

Ich. Field Number: ATLAN6319

Identifiers

field number: ATLAN6319

group number: 70

Part Name	Condition	Disposition	#	Remarks
whole animal (alcohol)	unchecked	in collection	1	

age class: larval

[no agent data]

Collectors

RV Atlantis 286

Data Providers



A collaboration with multiple natura

Two clicks from map view to the record in Harvard's database, and one more to email the collection manager about its obviously erroneous geographic placement

Administrator

Distributed Databases:





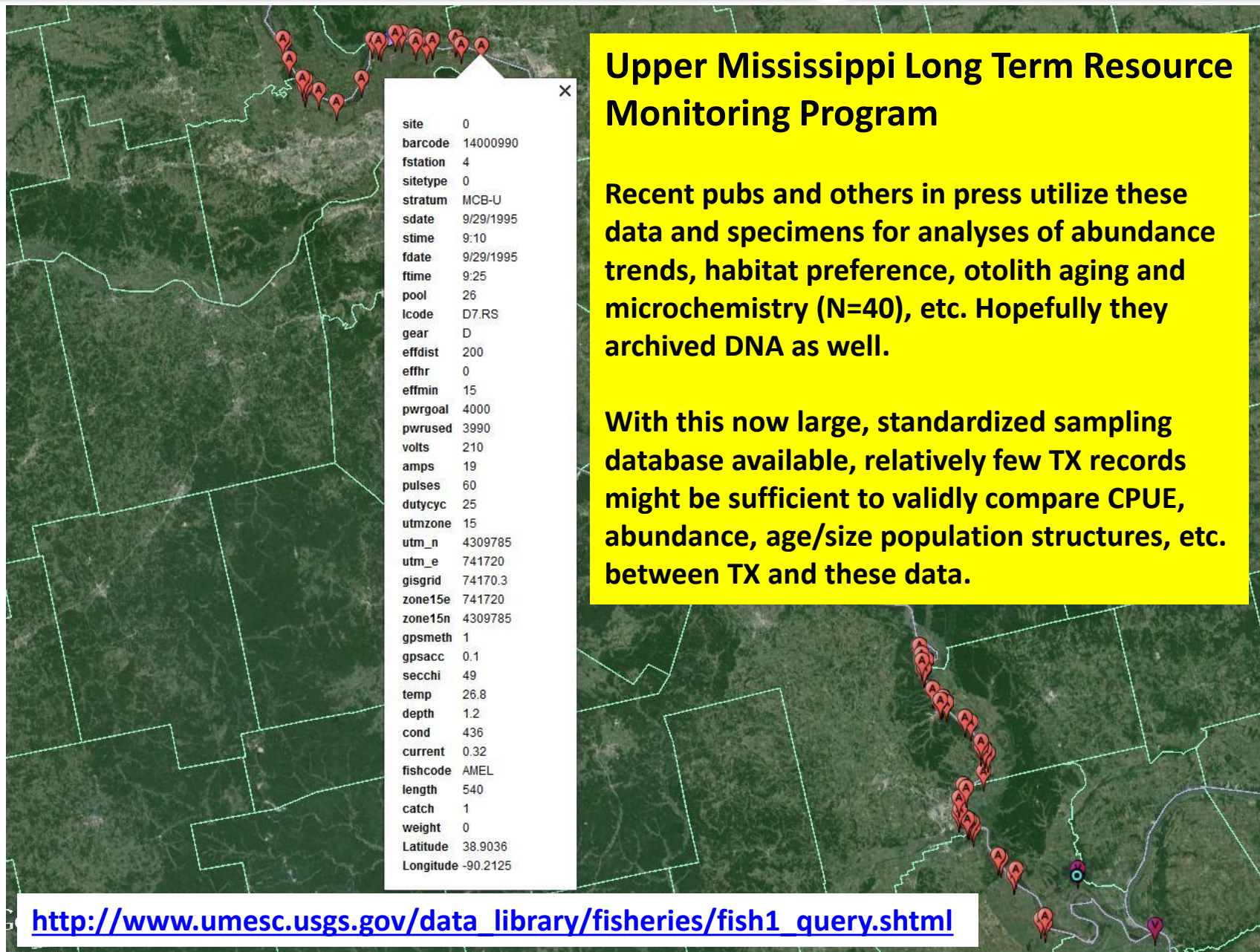
500 km inland in the Orinoco!? Emailed curator and quickly had photos of glass eels, solid confirmation of location, and an offer to loan the specimens for I.D. confirmation

MCNG 39876

MCNG 39876
Anguilla rostrata
No. specimens: 2
Río Cinaruco, Laguna abajo de Laguna Larga; ; Apure;
Collected by:
Year collected: 1999
Month collected: 15
Day collected: 2

[Wrong location or other problem? Click here to report it.](#)

Directions: [To here](#) - [From here](#)



Eldred 1971 *Anguilla rostrata* leptocephalus #2 59.5 mm TL

From Eldred, B. 1971. First Records of *Anguilla Rostrata* Larvae in the Gulf of Mexico and Yucatan Straits. Part 1 (Pisces) No. 19. Vol. IV - Immature Vertebrates. Leaflet Series, Florida. Marine Research Laboratory).: Immature Vertebrates. St. Petersburg, Florida: Florida Department of Natural Resources, Florida Marine Research Laboratory.

"...metamorphosing larva (59.5 mm TL, 31 October 1968) from the Gulf of Mexico agrees with the size and development of Schmidt's *A. rostrata* larvae in fall samples from the western Atlantic and is 8 or 9 months old.

2. Metamorphosing specimen: 59.5 mm TL (FSBC 6343L, Table 1). R/V Alaminos (Texas A. & M.). Cruise No. 12, Gulf of Mexico, lat. 24°43'N, long. 87°20'W, 31 October 1968 (1300 hrs). 40-min. tow at 250 meters, one-meter plankton net (mesh # 00)."

Directions: [To here](#) - [From here](#)

There are VERY few lepto records from GoM. I had earlier mined a couple from an obscure pub and wanted to verify ICES database had it too. Duplicate records are often useful. Here the pub had much more detail.

What's this one doing metamorphosing here?

Surely more plankton sampling has been done in the GoM. They may be archived somewhere and found to contain *A. rostrata* that could shed more light on how and when leptocephali get to Texas.

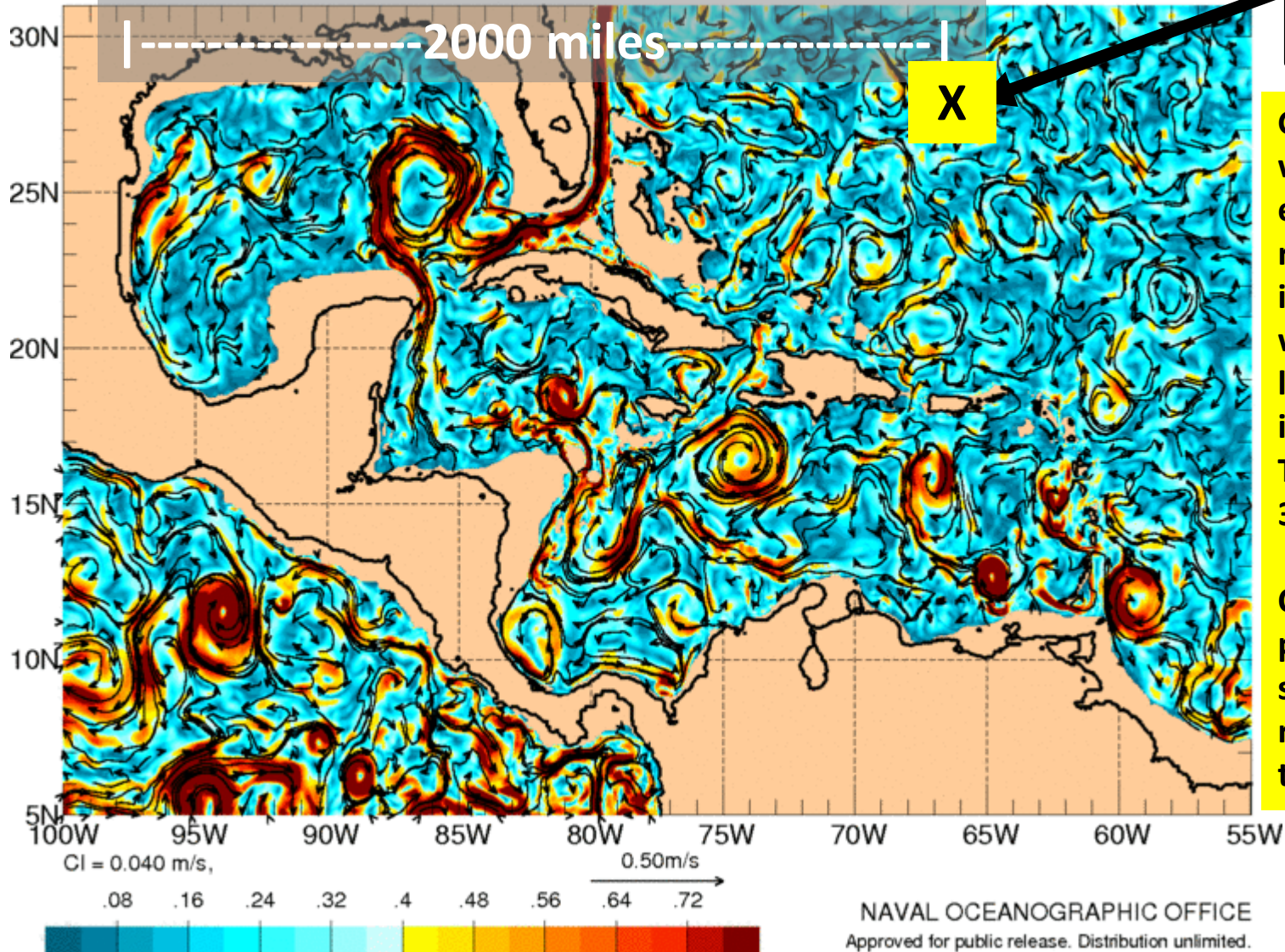
Eldred 1971 *Anguilla rostrata* leptocephalus #1 45.4 mm TL

amai

How long would it take a leptocephalus from Sargasso to TX?

Texas Natural History Collection

UNCLASSIFIED: 1/32° Global NLOM
CURRENT/SPEED LAYER 1 ANALYSIS: 20100422



Approximate birthplace of eels in Sargasso

Gulf Current would seem to exclude direct route to TX. Leptos increasing in size were tracked leaving Sargasso into Caribbean. That route to TX is 3,000+ miles!

Currents change – periodicity and size of TX recruitment is totally unknown.

NAVAL OCEANOGRAPHIC OFFICE
Approved for public release. Distribution unlimited.

Adapted from:
<http://www.eoearth.org/edit/article/51cbefea7896bb431f69f769/?topic=51cbfc79f702fc2ba812a1b7>

- ❑ Marine research shedding light on transport of leptocephali to TX is needed
- ❑ Problematic sporadic accumulations of Sargassum affect Texas beach area tourism – existing research on predicting those events may be relevant to predicting when eels might arrive at the Texas coast



- ❑ Otoliths can provide detailed info on:
 - specimen age (to days in larvae)
 - Timing and periodicity of marine/freshwater transition (microchemistry)
- ❑ But, no otolith studies on this species in TX



- ❑ The data we mined are from global sources, but in the end, data quality is hugely dependent on regional interests and expertise, as well as data sharing
- ❑ Fish biology/ecology is quickly entering the world of “linked, big data”, but remains constrained by reluctance, and/or other impediments, to sharing data
- ❑ Until we get regional data and specimens openly available, we can't expect to benefit from more global studies
- ❑ **Everyone benefits by open sharing of data and specimens**



□ Glass eels and elvers

- Systematically monitored in many Atlantic rivers as an excellent and efficient way to quantify eel recruitment to rivers. Methods well developed.
- How is it that we have no records of glass eels from TX?
- Sampling for glass/elver eels can be carried out inexpensively. Atlantic river standardized monitoring is largely done by citizen science groups (e.g. <http://www.dec.ny.gov/lands/49580.html>).



- ❑ Glass eels enter estuaries and start transforming into elvers
- ❑ Not all enter freshwater, but for those that do, timing of peak movements is predictable on the basis flood tides [Selective Tidal Stream Transport], temperature, lunar phase [new moon] and location – January-February in Florida to May in Nova Scotia).
- ❑ No clue when they might be coming into TX rivers
- ❑ In river, move nocturnally upstream in waves close to shore (shore-based dipnet fisheries)
- ❑ Pigmentation increases as they move upstream @ 3-13 miles/day



Eel mops

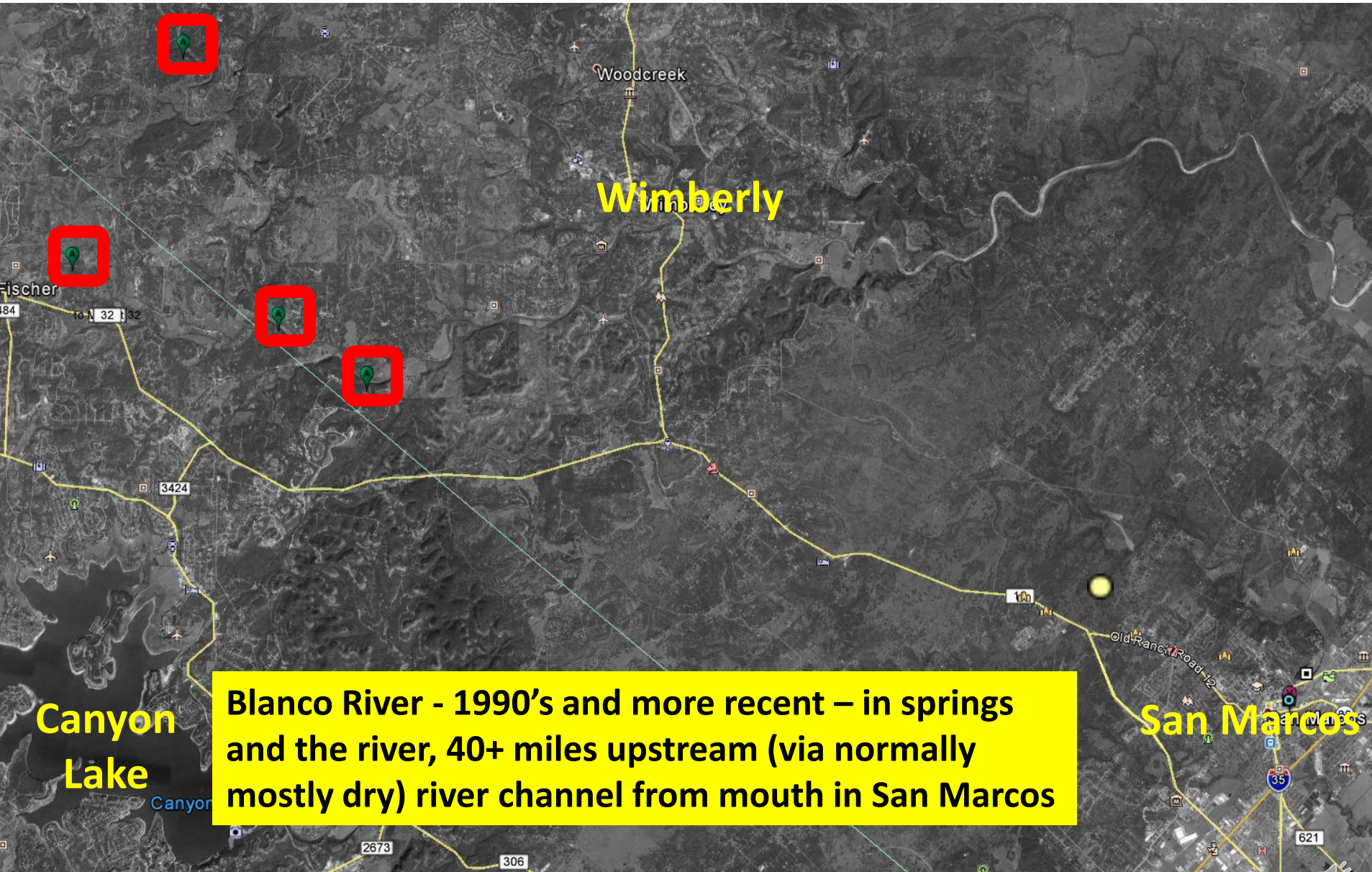
Catching glass eels/elvers is not hard. Each trap took us, 8 high school volunteers, herpetologists and their kids 6-8 person hours to assemble at a total cost of about \$120 ea. Let us know if you are willing to help build and/or deploy them (best in lower reaches, especially at barriers, rapids, etc.).



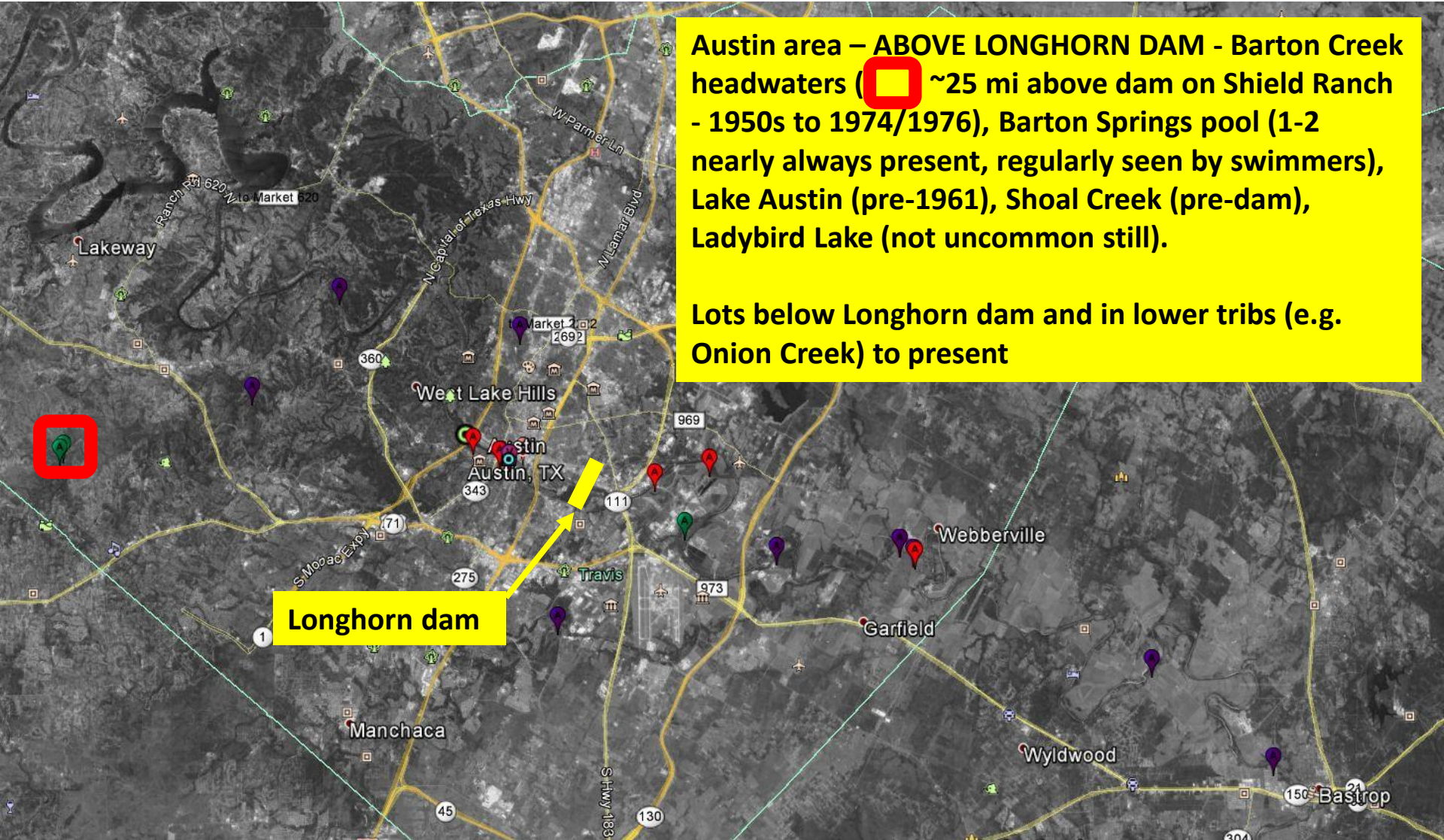
Eels in Texas occur today above what most would guess would stop them.


How do they get to those places?





Blanco River - 1990's and more recent – in springs and the river, 40+ miles upstream (via normally mostly dry) river channel from mouth in San Marcos



Austin area – ABOVE LONGHORN DAM - Barton Creek headwaters ( ~25 mi above dam on Shield Ranch - 1950s to 1974/1976), Barton Springs pool (1-2 nearly always present, regularly seen by swimmers), Lake Austin (pre-1961), Shoal Creek (pre-dam), Ladybird Lake (not uncommon still).

Lots below Longhorn dam and in lower tribs (e.g. Onion Creek) to present

Longhorn dam



How do they get there? elver barrier passage capabilities

Texas Natural History Collection



Image from <http://www.glooskapandthefrog.org/eel%20gallery.htm>



How do they get there? elver barrier passage capabilities

Texas Natural History Collection



Image from <http://www.glooskapandthefrog.org/eel%20gallery.htm>



How do they get there? elver barrier passage capabilities

Texas Natural History Collection



Image from <http://www.glooskapandthefrog.org/eel%20gallery.htm>



How do they get there? elver barrier passage capabilities

Texas Natural History Collection



Image from <http://www.glooskapandthefrog.org/eel%20gallery.htm>



Leaving the river and heading up wet wall



Negotiating a vertical wall



Cooperating to get past an overhang?



Taking another route at different discharge





- ❑ Eels are probably still in all Texas rivers
- ❑ How they get to Texas is totally unclear
- ❑ We know nothing about recruitment, age structure, genetics of TX eels
- ❑ Facultative catadromy may diminish the importance of TX freshwaters to the species
- ❑ Some “barriers” are not really barriers to upstream movements (but may be to downstream-bound silver eels)
- ❑ Broadly collaborative efforts will be necessary to address most questions
- ❑ Publishing and openly sharing all data (including non-vouchered observations) is recommended
- ❑ Report all anecdotal (historic and current) observations via our web forms, email, phone
- ❑ If you absolutely must release a captured eel, weigh, measure, take notes and a fin clip, photograph and use iNaturalist (or phone, email) to quickly inform us. See “wanted poster” below.





Studies of other organisms with similar life histories, like *Macrobrachium* spp. (Freshwater Prawns) mapped here, *Agonostomus monticola* (Mountain Mullet), and others with similar movements, may shed further light on GoM eel-related questions

LOOKING FOR AMERICAN EELS



Please report specimens or observations to Melissa Casarez
or Adam Cohen, the Fishes of Texas Project

fishesoftexas@gmail.com

512-475-8171 (Melissa) / 512-471-8845 (Adam)

Maintain specimens alive if possible, or put on ice and give us
a call. See links below for more information:



<http://www.fishesoftexas.org>



<https://sites.cns.utexas.edu/hendricksonlab>



iNaturalist

<http://www.inaturalist.org/projects/fishes-of-texas>

