The last naturally active delta complexes of the Mississippi River (LNDM): Discovery and implications

Richard Condrey*
Paul Hoffman**
D. Elaine Evers**

*coecnd@lsu.edu
**Department of History
**Department of Oceanography and Coastal Sciences
Louisiana State University

Answering Fundamental Questions about Mississippi River Delta Restoration
Science and Engineering Special Team
Louisiana State University, Baton Rouge, LA
Tuesday, October 9, 2012

Problem 1: >400yr of human alteration make visioning the natural delta difficult.

Hope: Awareness of the protohistoric Deltaic Plain may help guide restoration.

Approach:

a. Test the historic record for a consistent description of the LNDM

Chaves ca. 1537
Barroto 1687
Iberville 1699 (Bellin 1764)
Evia 1785 (Lafon; Dumain; Humphreys, Abbot, etc. 1805-1880)

b. Compare with Plan – 2 active delta complexes during historic period,
   1. Active Mississippi Delta in the Modern
   2. Atchafalaya Delta

Restoration Plan

Definitions:

LNDM -- all delta complexes occupied during the protohistoric and colonial period (ca. 1519- 1812) by distributional channels(s) of the Mississippi River.

Distributional channel -- any branch of the Mississippi River which annually delivered a flume of fresh water I km into the GoM

'Mississippi River Deltaic Plain, 'delta complex', and 'delta lobe' based on Frazier (1967).

Generally follow Plan's geographical description of the 5 most recent delta complexes:

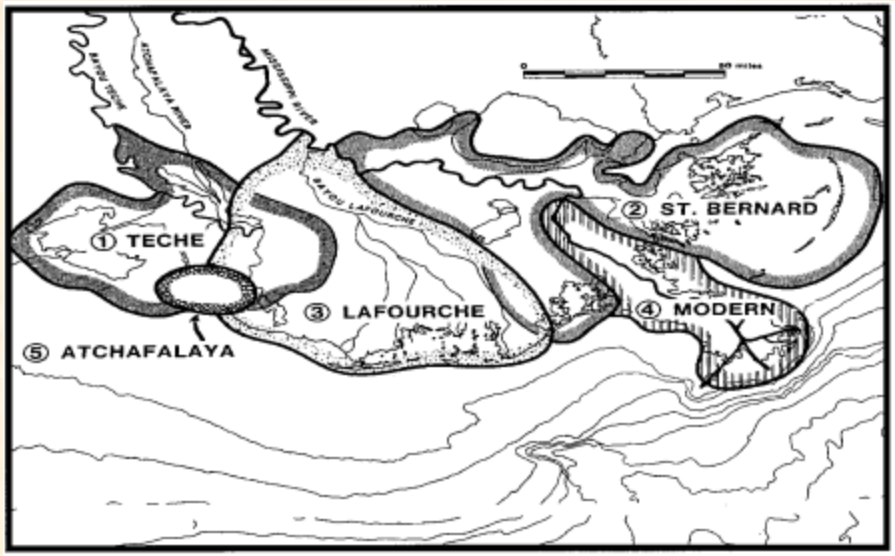


Figure 3-2. The deltaic plain landmass was built by a sequence of overlapping deltaic lobes which developed during the last 5,000 years (Teche = 6,000-350 B.P., St. Bernard = 5,000-500 B.P., Lafourche = 3,500-50 B.P., Modern = 1,000 B.P. to present, Atchafalaya = 50 B.P. to present) (modified from Frazier 1967).

Alonso de Chaves ca. 1537

Chaves: Divides GoM into Yucatán, Nueva España , and la Florida
Singles out 2 major rivers and a cape.

First river is the Río del Espíritu Santo

"is at 30˚ … the largest on all this coast of Nueva España. It is 6 leagues wide at the mouth. In the middle of the entrance is a small island. Then, entering the river there is a great embayment that runs NE, and is called the Mar Pequeña. It is 20 leagues deep by 10 leagues wide…In this bay one may anchor… From the mouth of this river to the E [as far as] Bahía de Miruelo, the whole coast is full of shallows and reefs. It is very dangerous. The Coast of Nueva España ends at this river and the west coast of la Florida begins."

Cabo de Cruz, approx. 10 leagues S of Río del Espíritu

"is the most notable [cape] that there is in all this coast. This cape is high and shaved toward the sea and round with some bluffs….On the S side it has a good port in which large ships can anchor. Some great bluffs there give them shelter. On the sea side this port has a reef that goes more than a league into the sea."

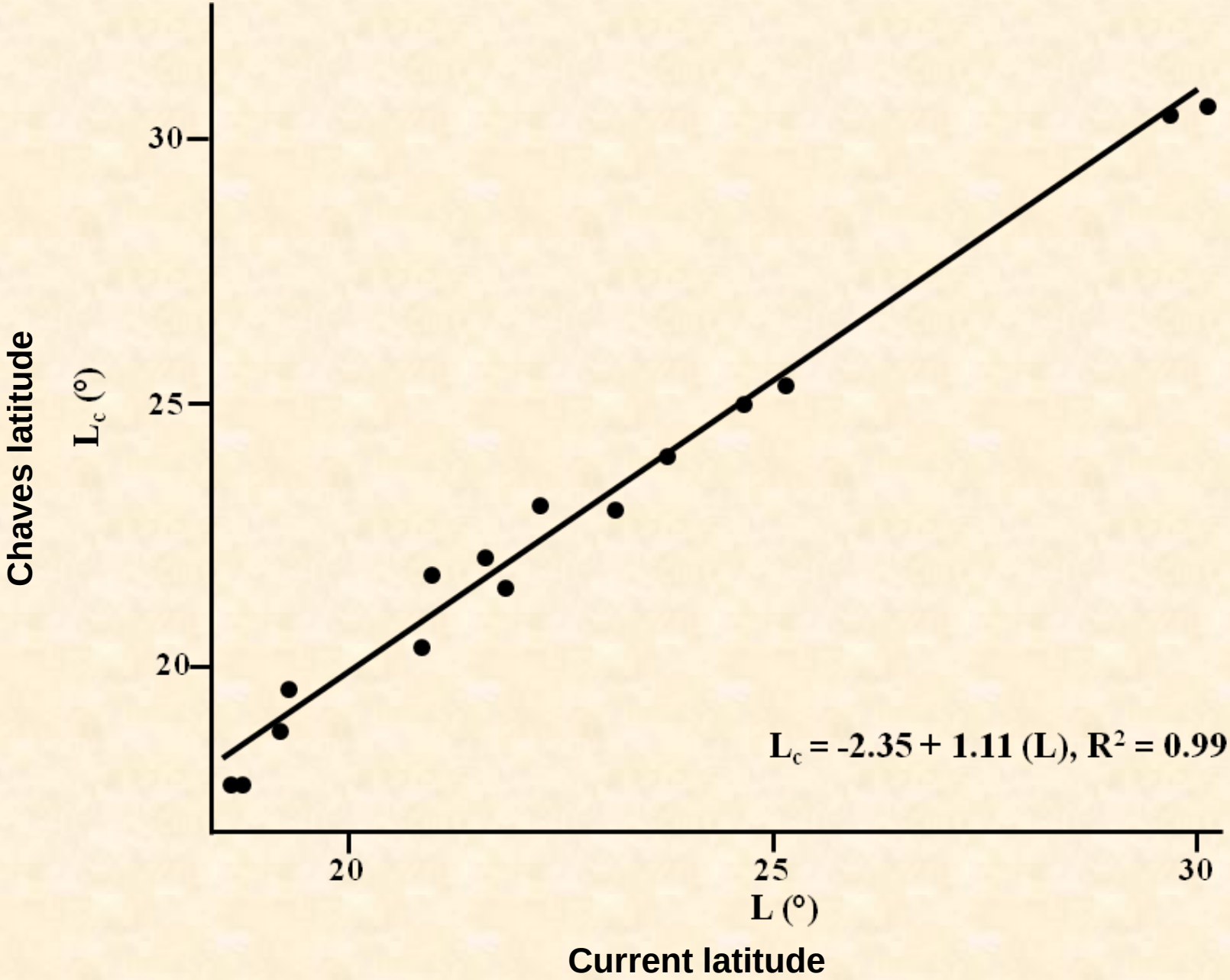
Second major river: Río de Flores,

“on the W coast of la Florida, is at 30° ….68 leagues E of Río del Espíritu Santo… This river is the largest on this coast [W coast of la Florida]. On the W side it has a cape that goes further to sea than the one on the E. In the mouth of this river are three small islands in a line N-S. All of the coast is full of reefs and … shallows.”

Do Chaves' latitudes approximate reality?

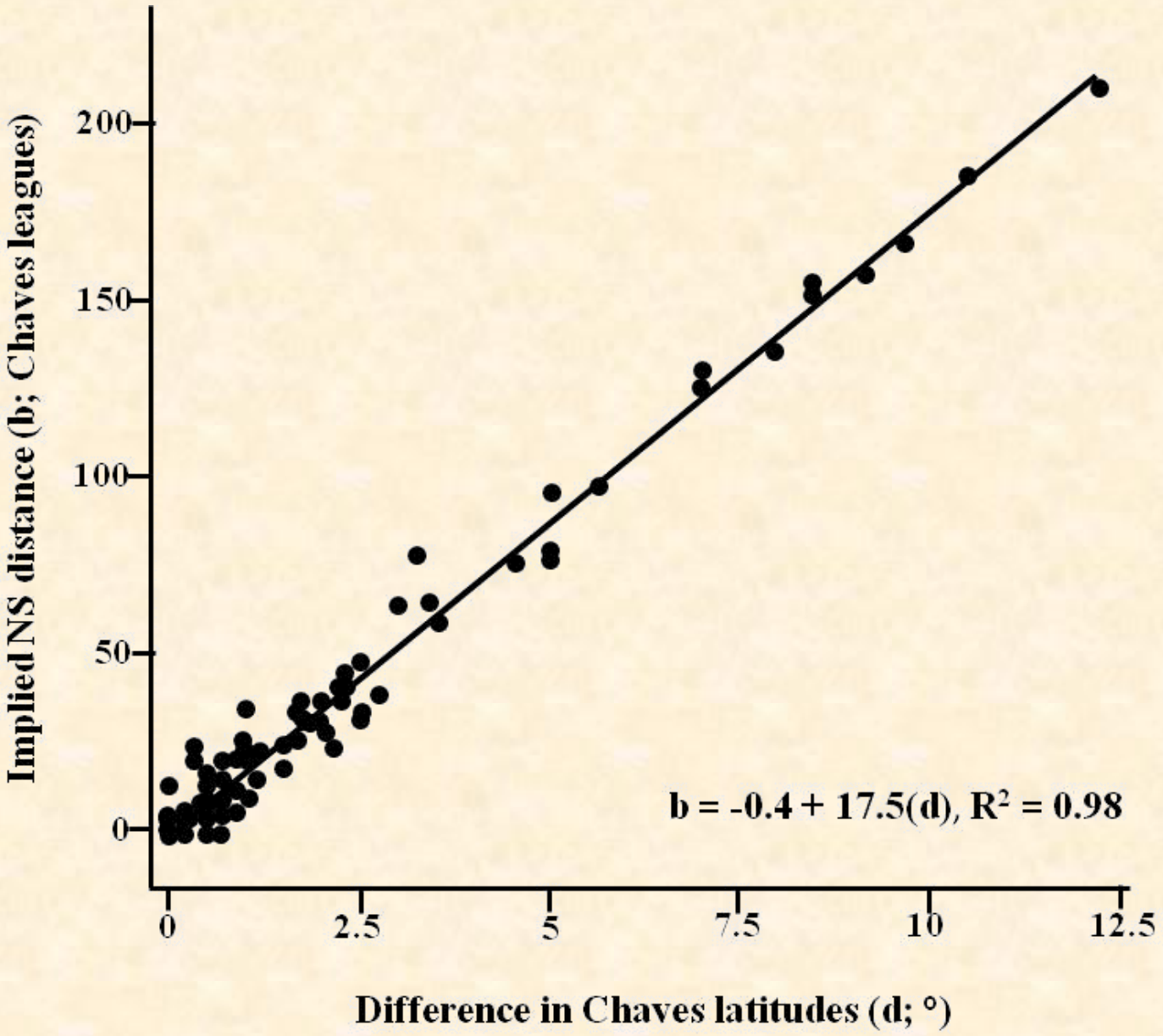
Yes: ~1:1; $R^2 = 0.99$

Chaves' versus current latitudes



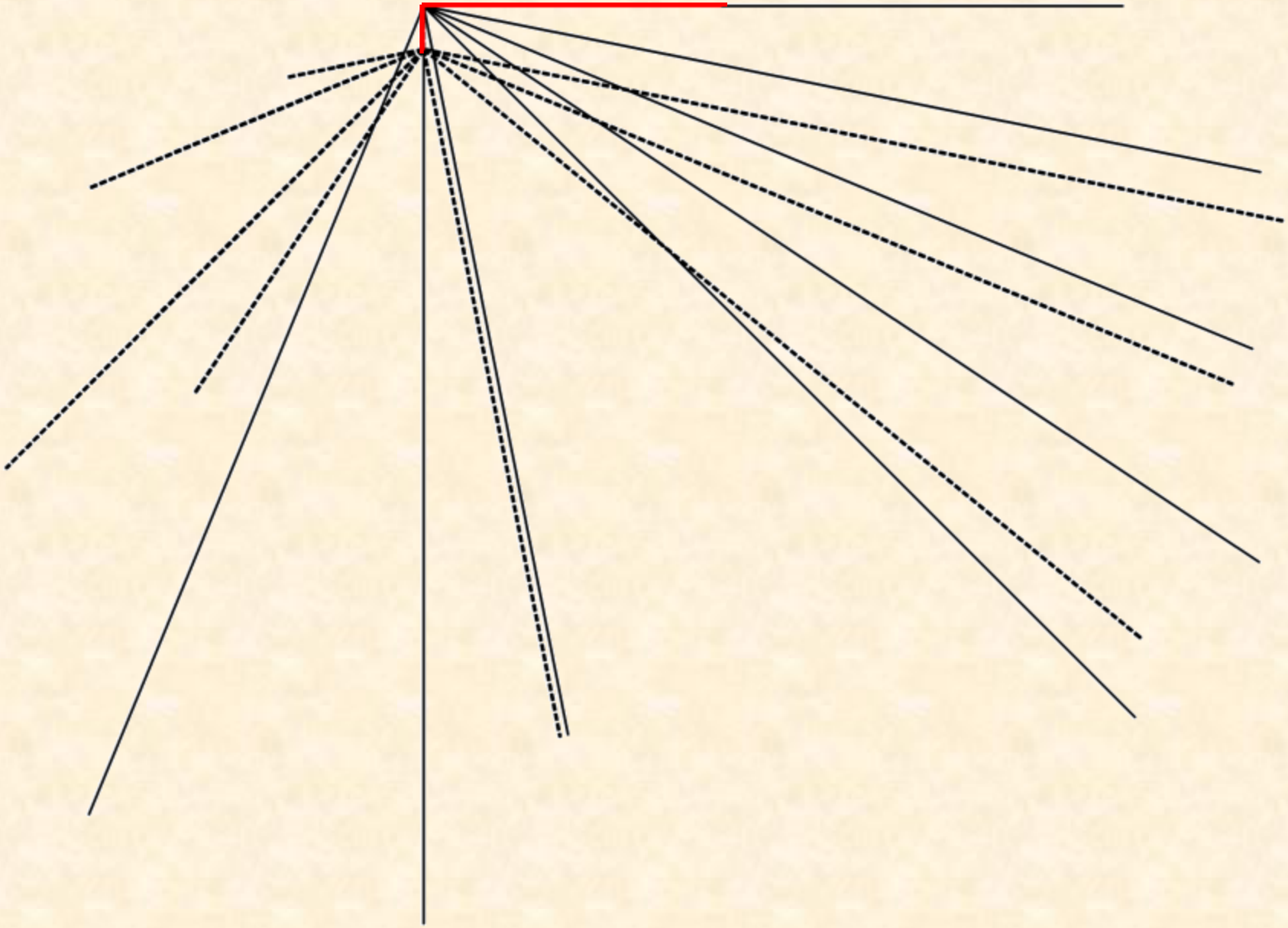
What was Chaves' definition of distance?

6.3 km, $R^2 = 0.98$

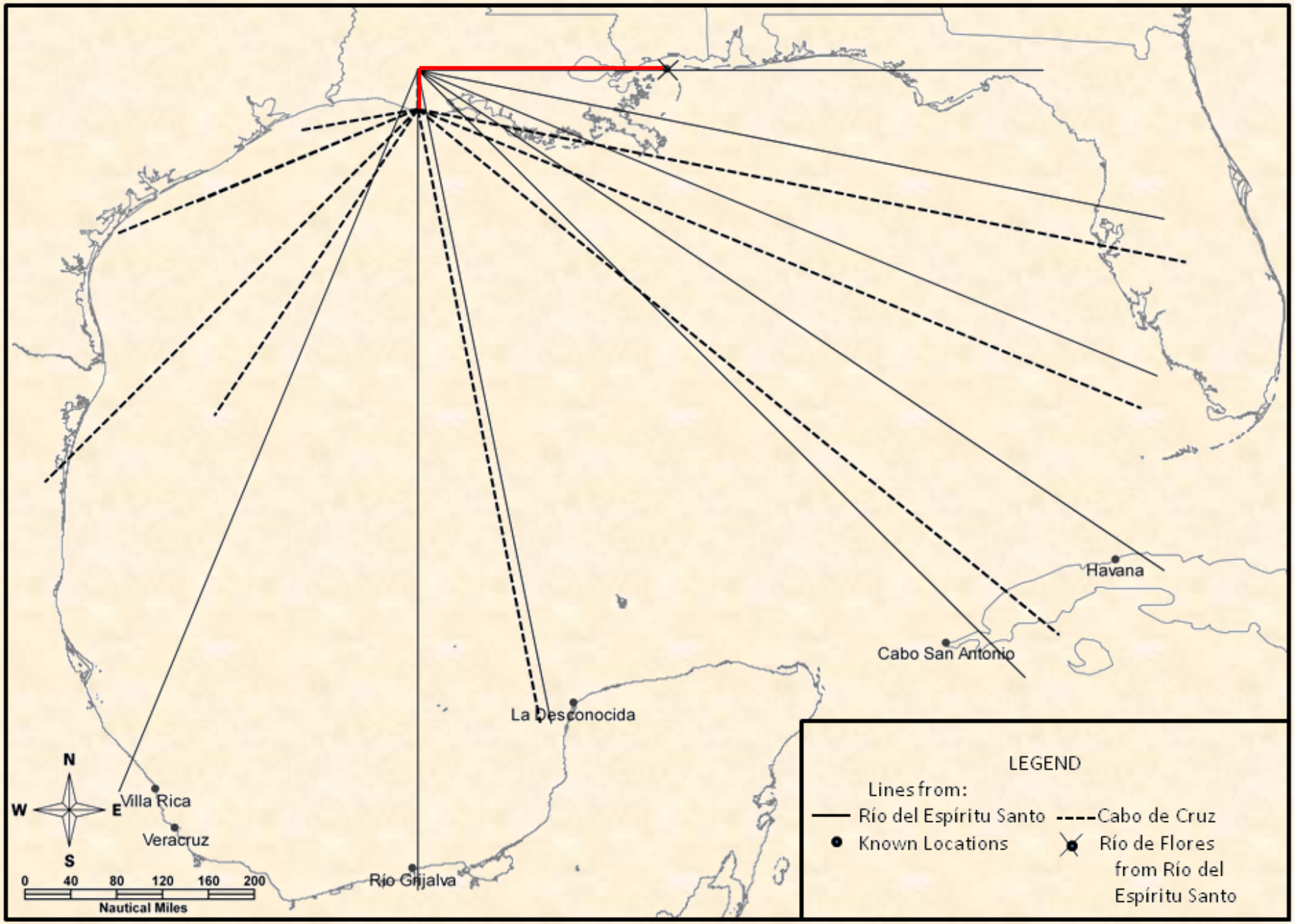

Implied NS distance (b; Chaves leagues)
200
150
100
50
0
0
2.5
5
7.5
10
12.5
Difference in Chaves latitudes (d; °)
b = -0.4 + 17.5(d), R² = 0.98

Use these measures to …

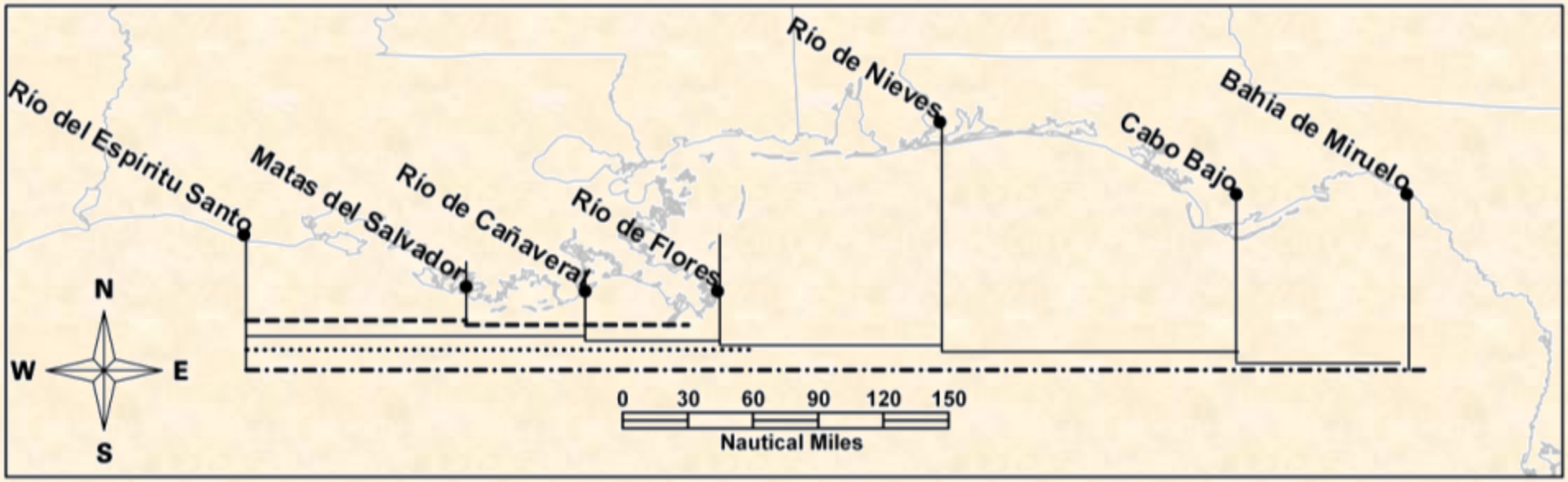
create an Array (sailing vectors) and Axis (2 major rivers and cape)



Fit Array to GoM map

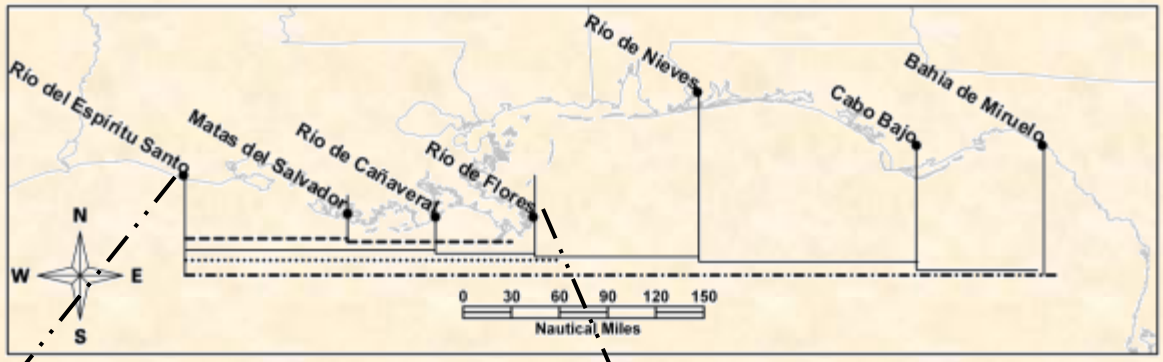


E-W alignment along NGoM coast



dashed horizontal line -- Matas del Salvador
solid horizontal line -- Río de Cañaveral, Río de Nieves, and Cabo Bajo. Río de Flores and Bahía de Miruelo (averages)

Chaves (ca. 1537) describing a broad and active delta



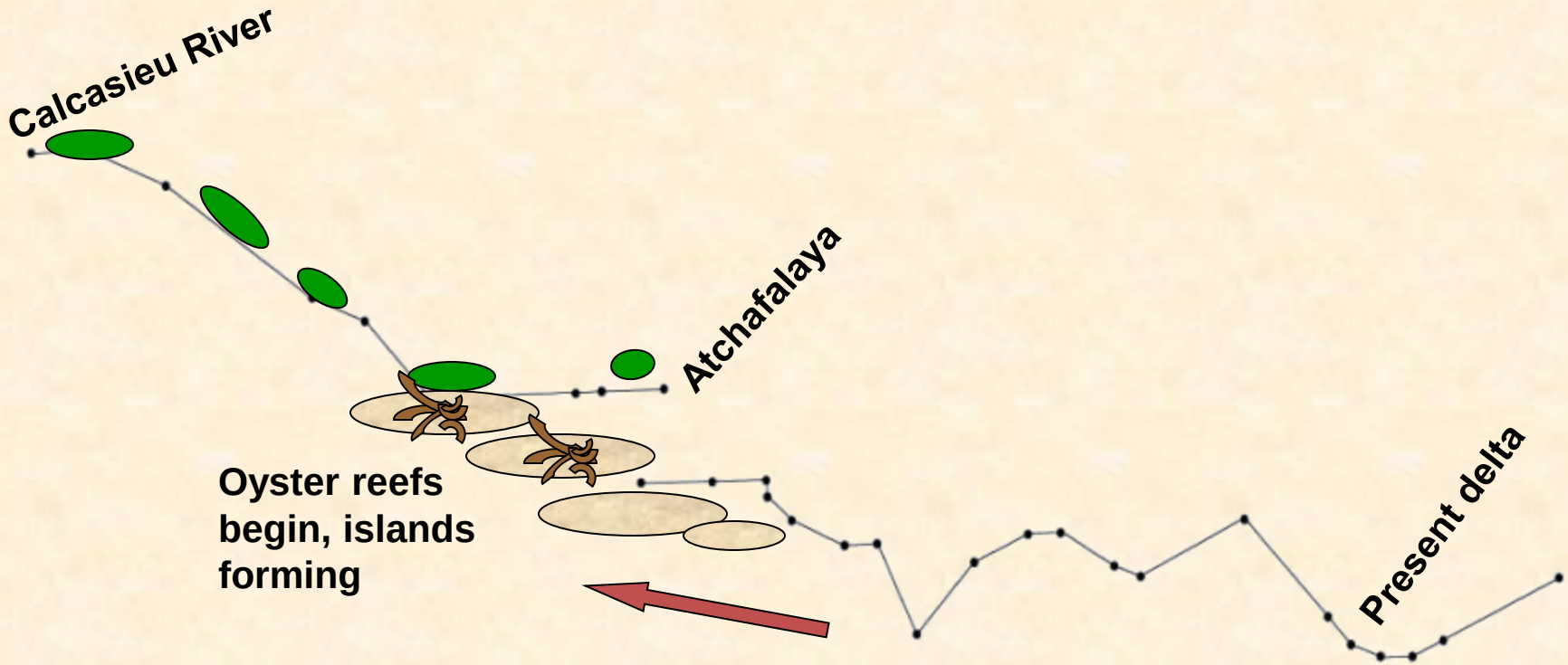
Chaves' extent of the last natural delta of the Mississippi River

Enriquez Barroto 1687 : Oldest first-hand account

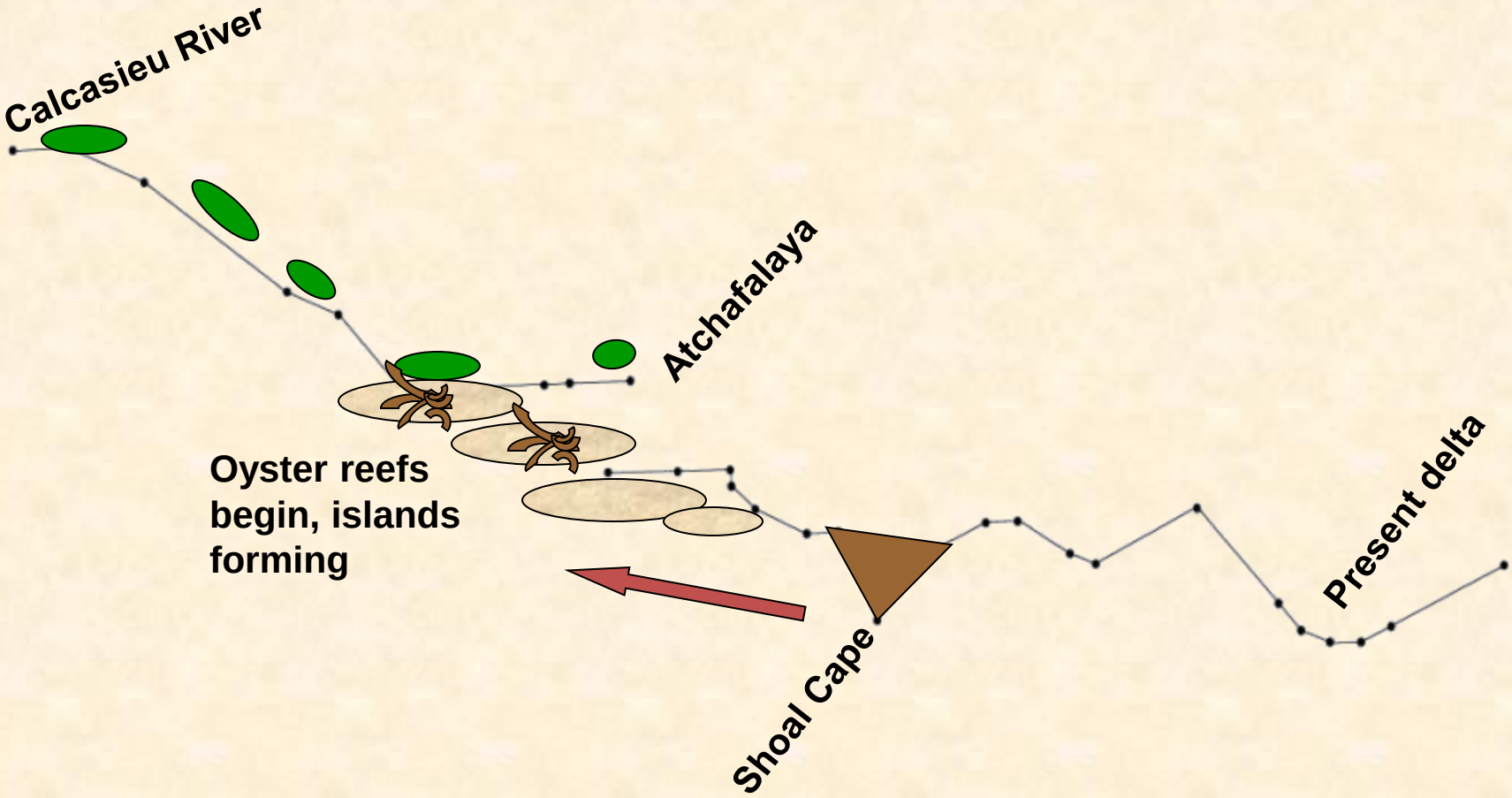
Barroto's Coast of Louisiana in May 1687

Weddle, R. S. et al. 1987. La Salle, the Mississippi, and the Gulf : three primary documents Texas A&M University Press, College Station, Tx. 328 p.

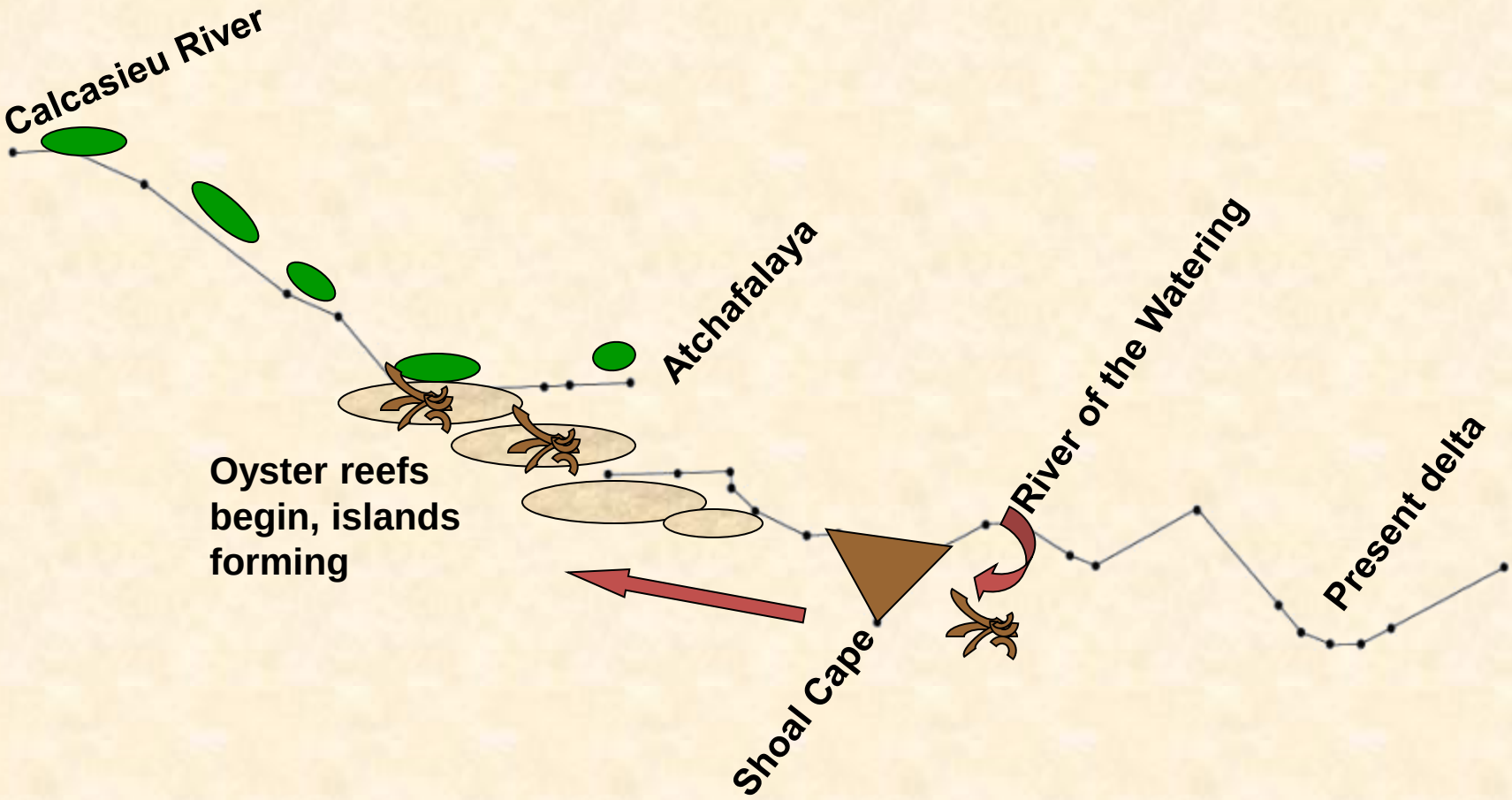
Enriquez Barroto's Coast of Louisiana in May 1687



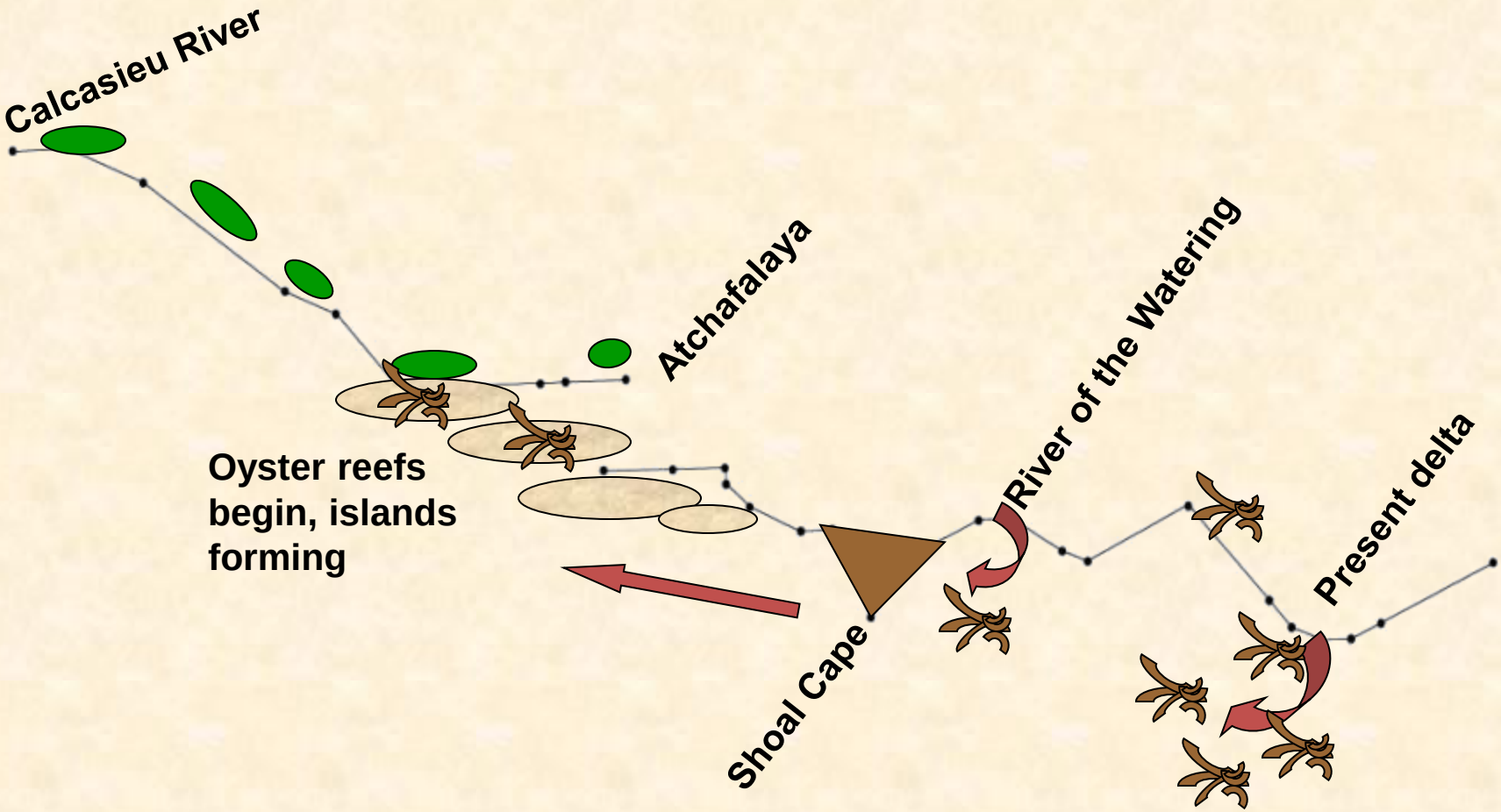
Enriquez Barroto's Coast of Louisiana in May 1687

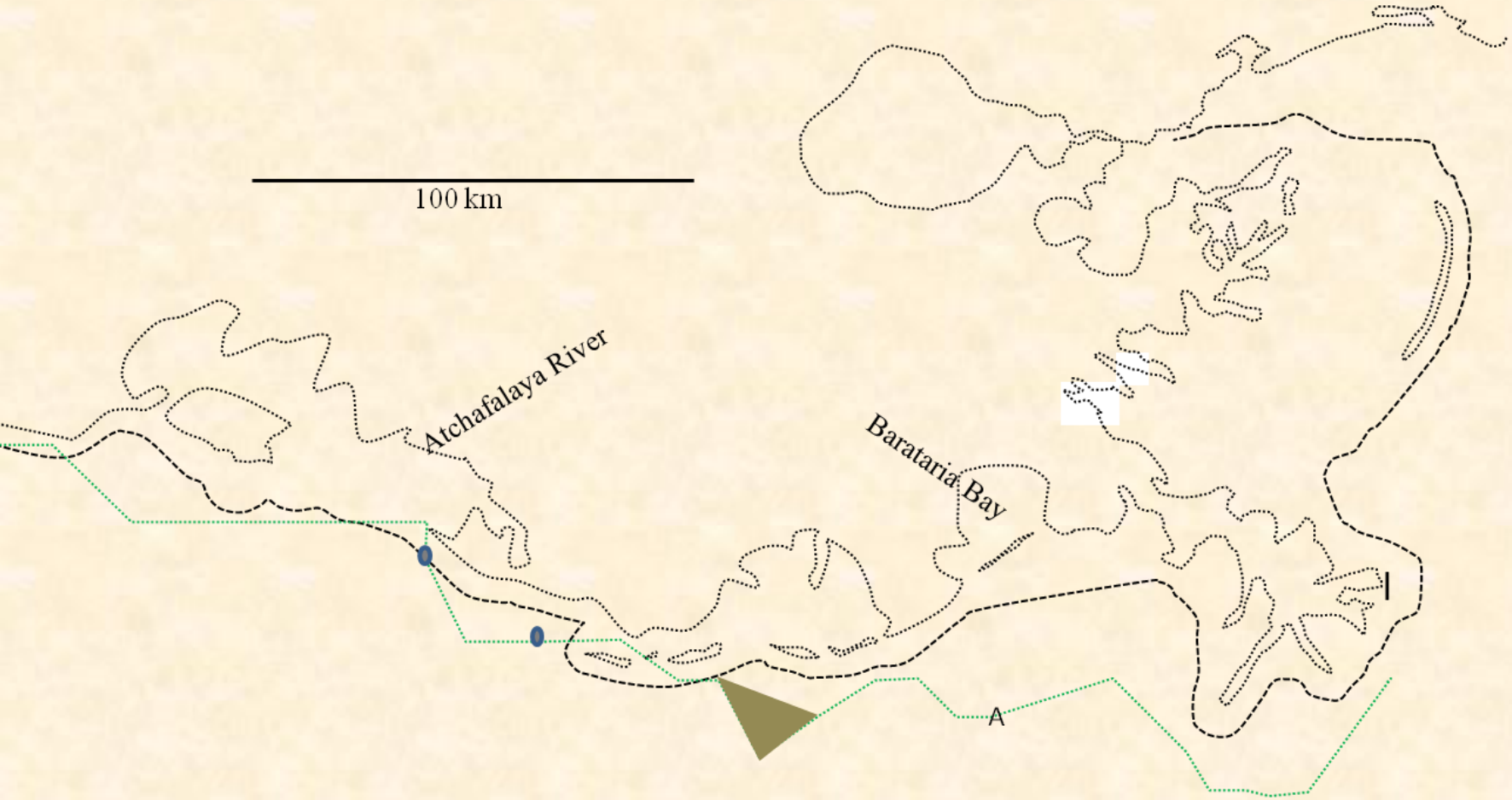


Enriquez Barroto's Coast of Louisiana in May 1687



Enriquez Barroto's Coast of Louisiana in May 1687





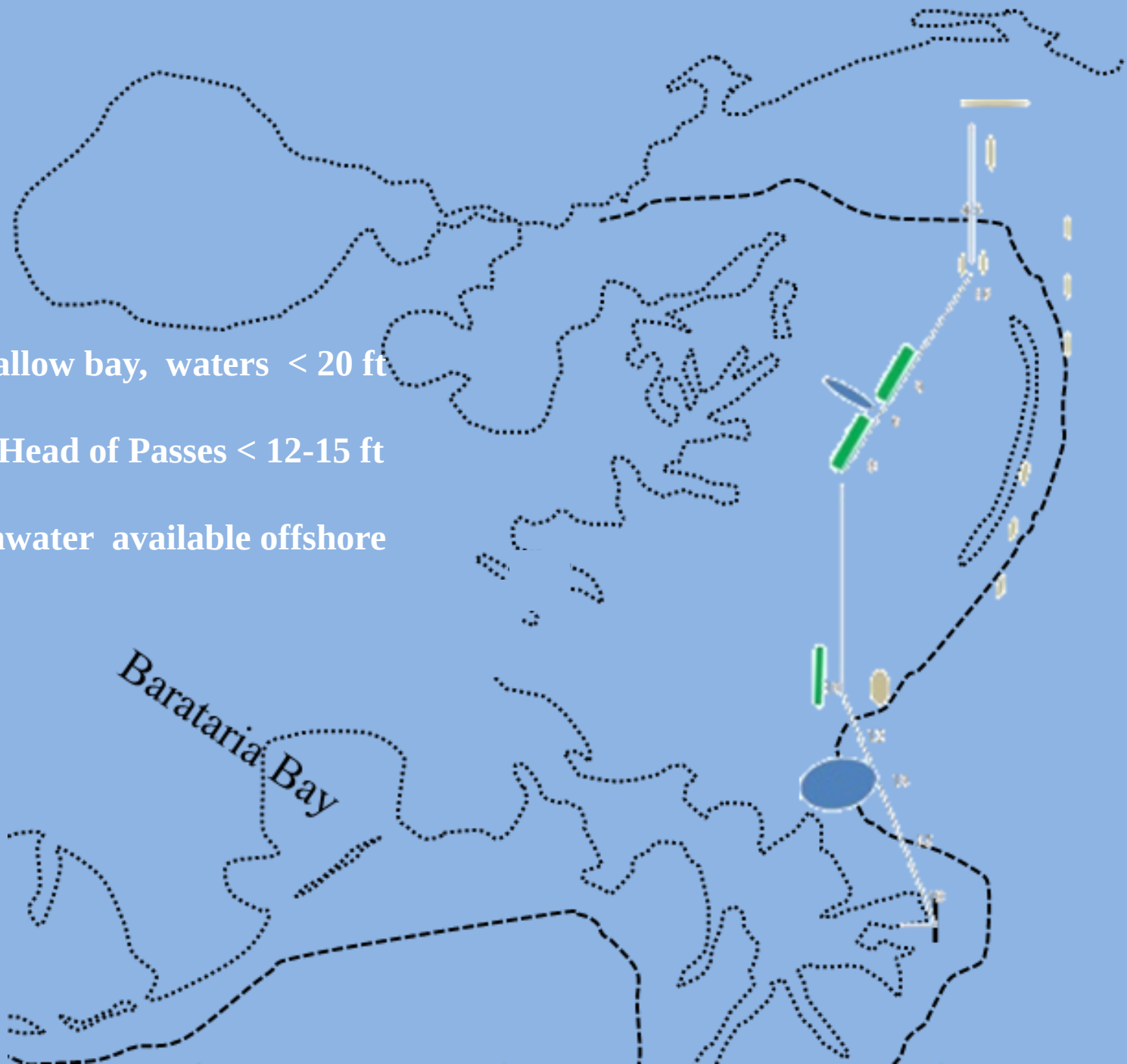
Enriquez Barroto's Coast of Louisiana in May 1687

Iberville, Feb.- April,1699

explores delta from Ship Island to Tunica Hills

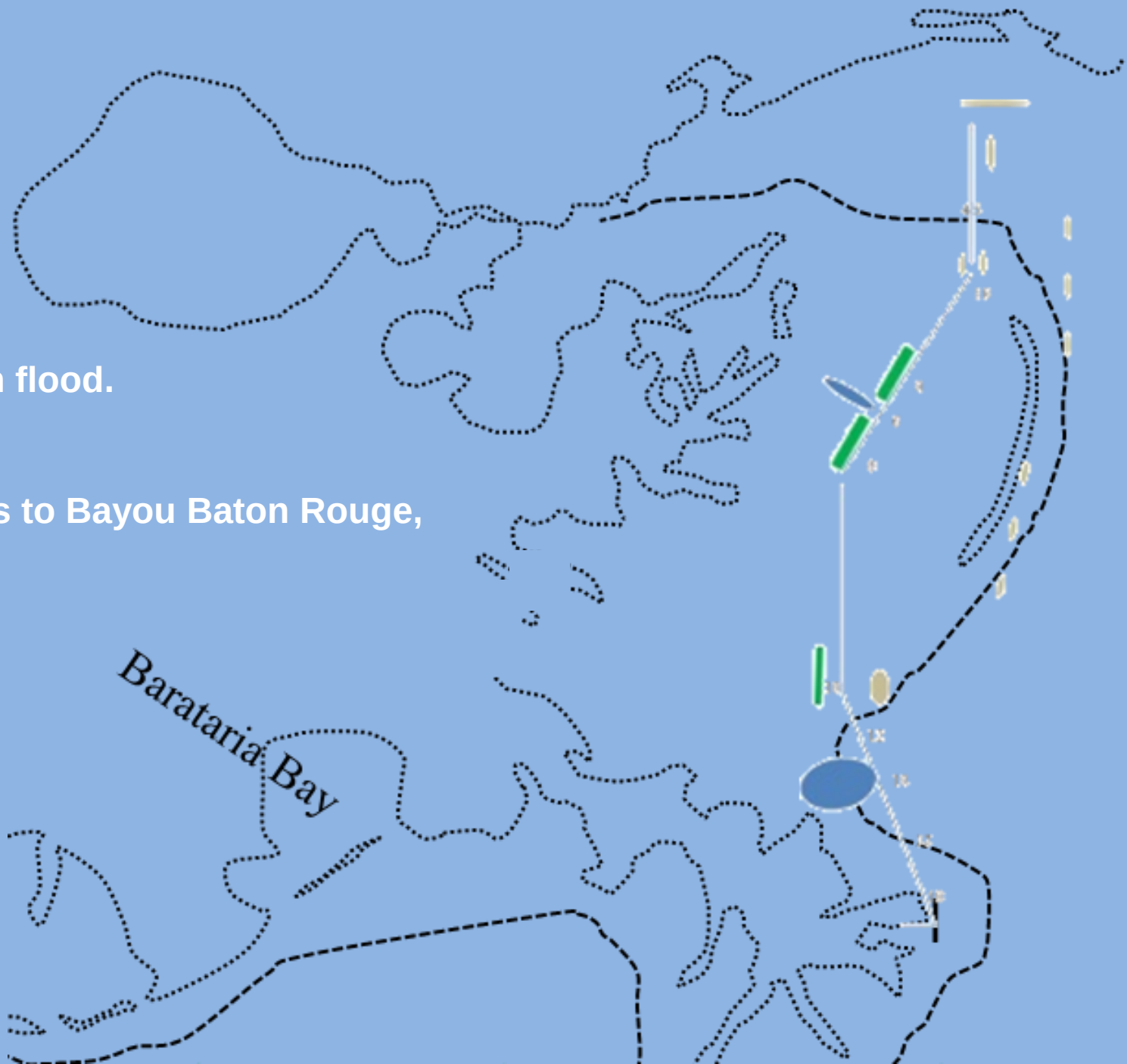
7 findings

1. **Narrow and shallow bay, waters < 20 ft**
2. **Entrances into Head of Passes < 12-15 ft**
3. **Drinkable freshwater available offshore**



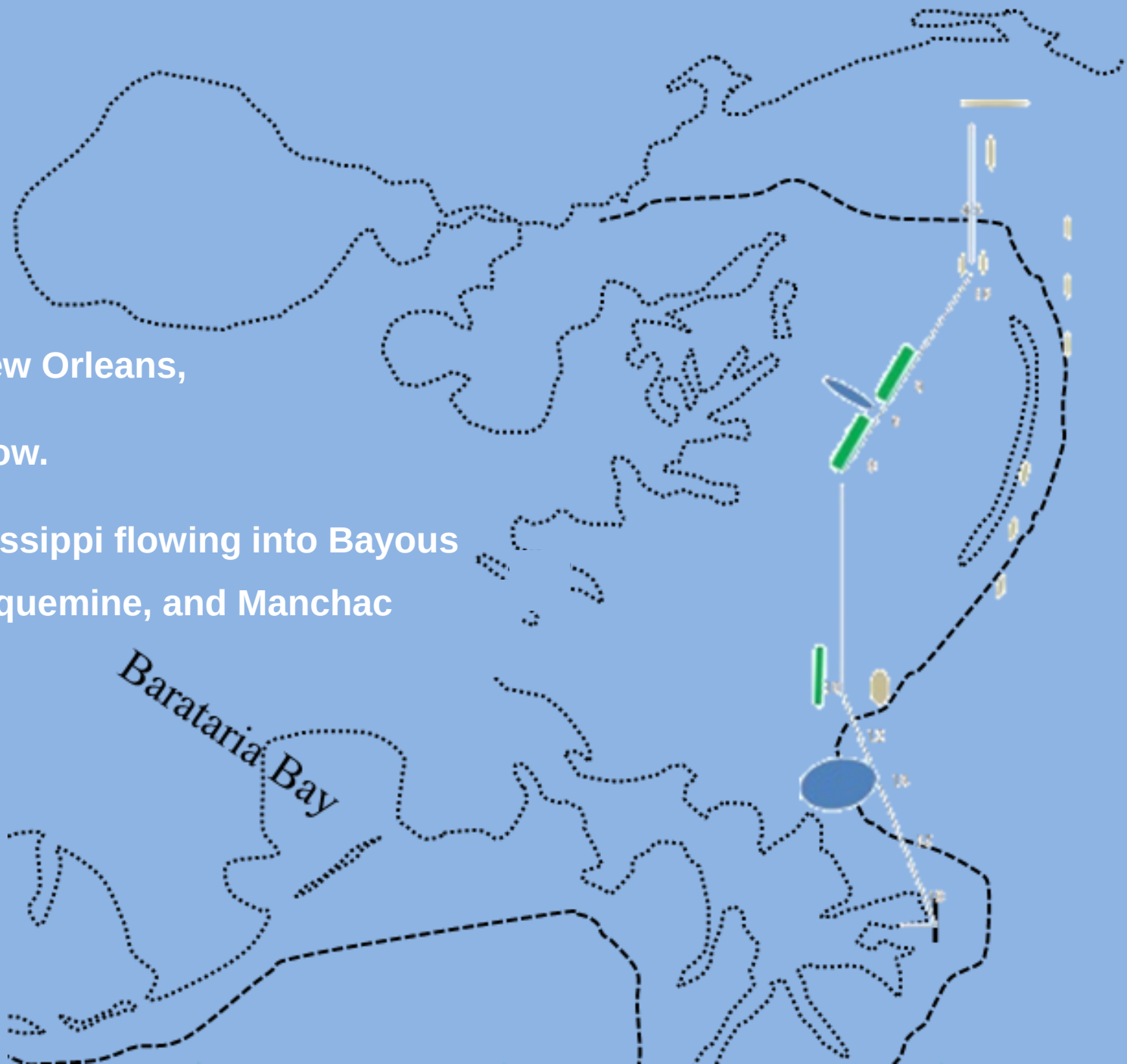
4. River not yet in flood.

5. River ‘miles’
   Head of Passes to Bayou Baton Rouge,
   $R^2 = 0.999$



6. Inundation
inflection at New Orleans,
<1 ft above,
up to 5.5 ft below.

7. Pre-flood Mississippi flowing into Bayous
Lafourche, Plaquemine, and Manchac

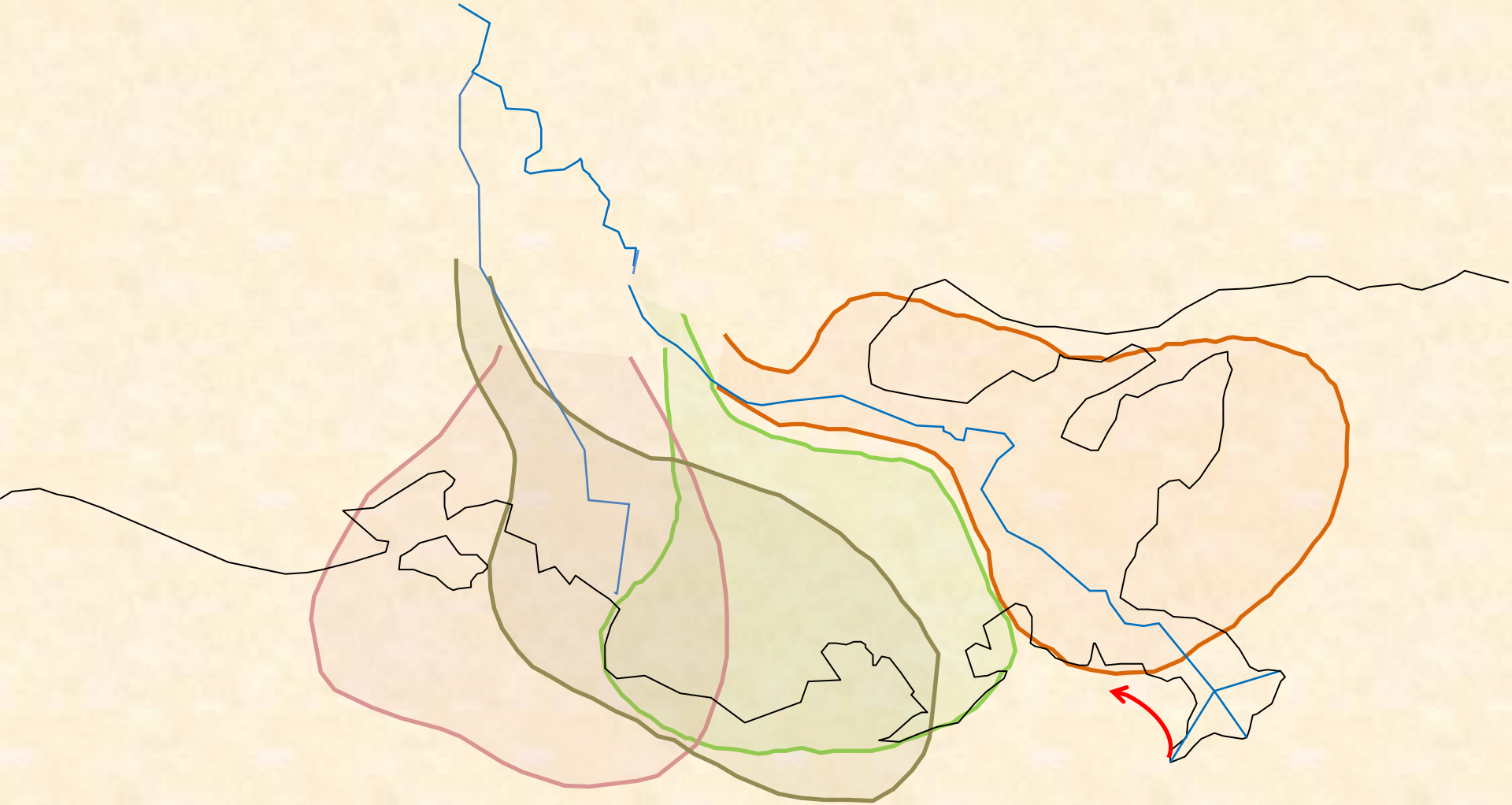


Bellin 1764

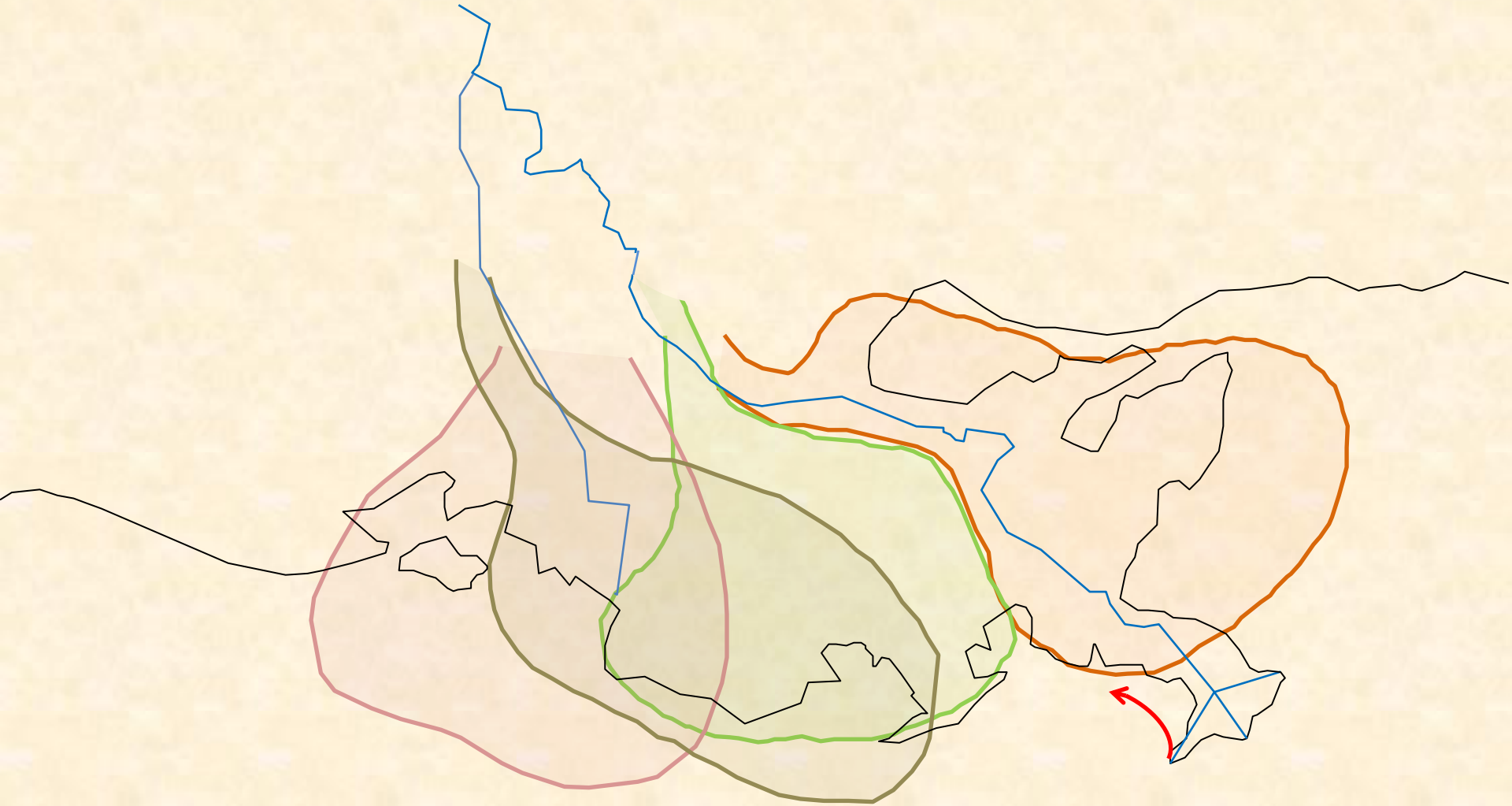

CARTE REDUITE
DES COSTES DE LA LOUISIANE
ET DE LA FLORIDE
L O U I S I A N E
F L O R I D E
G O L P H E D U
M E X I Q U E
ISLES BAHAMA
Cap Canaveral
CANAL DE BAHAMA
Cap Escondido
ISLE DE CUBE
CARTE DES
EMBOUCHURES DU FLEUVE ST LOUIS
BOUCHES DU FLEUVE MISSISSIPI
Longitude Occidentale du Meridien de Paris

Bellin 1764: Coastal outflows

José Antonio de Evía, Spanish surveyor, 1785

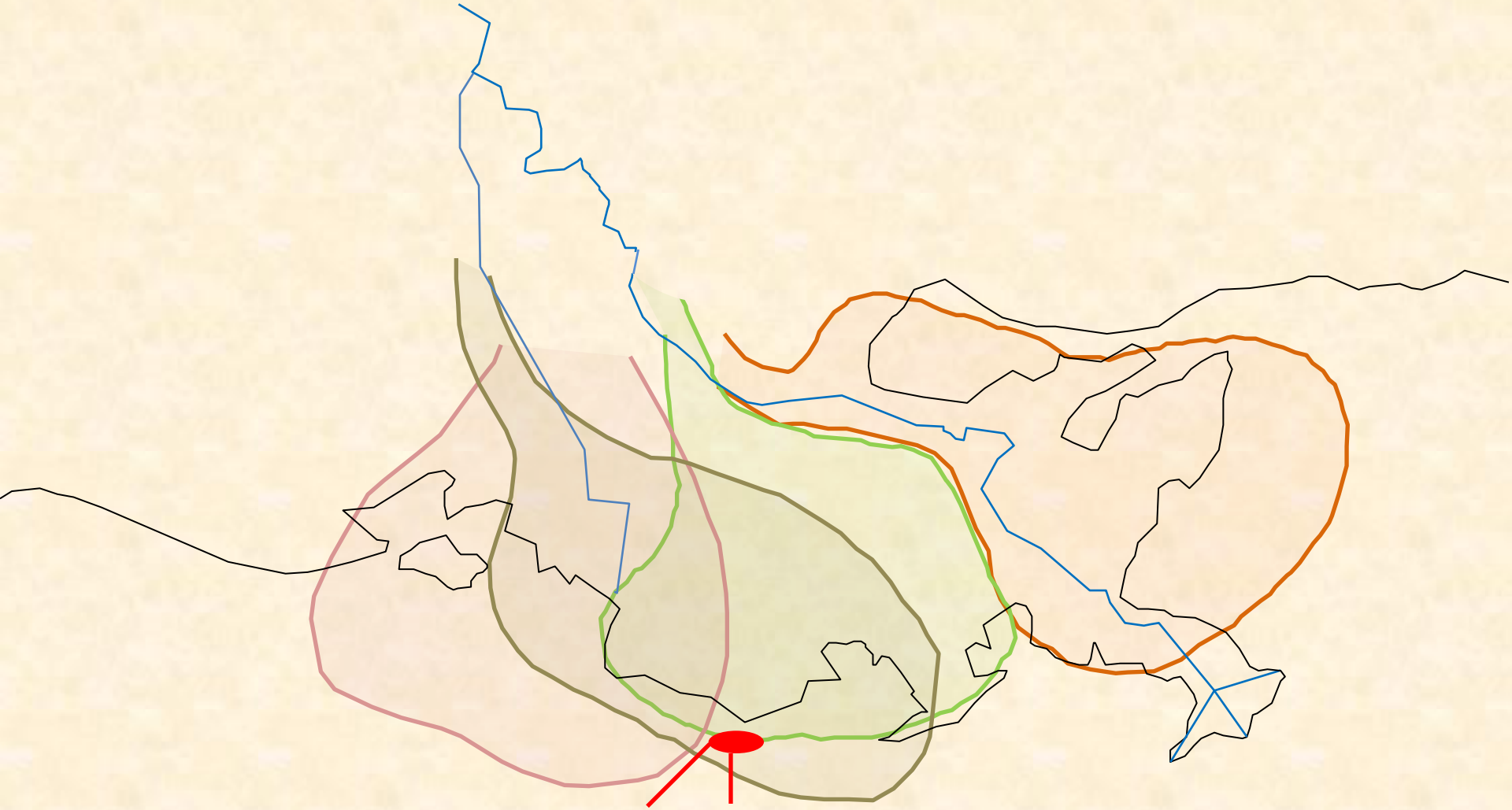


Evía, 1785



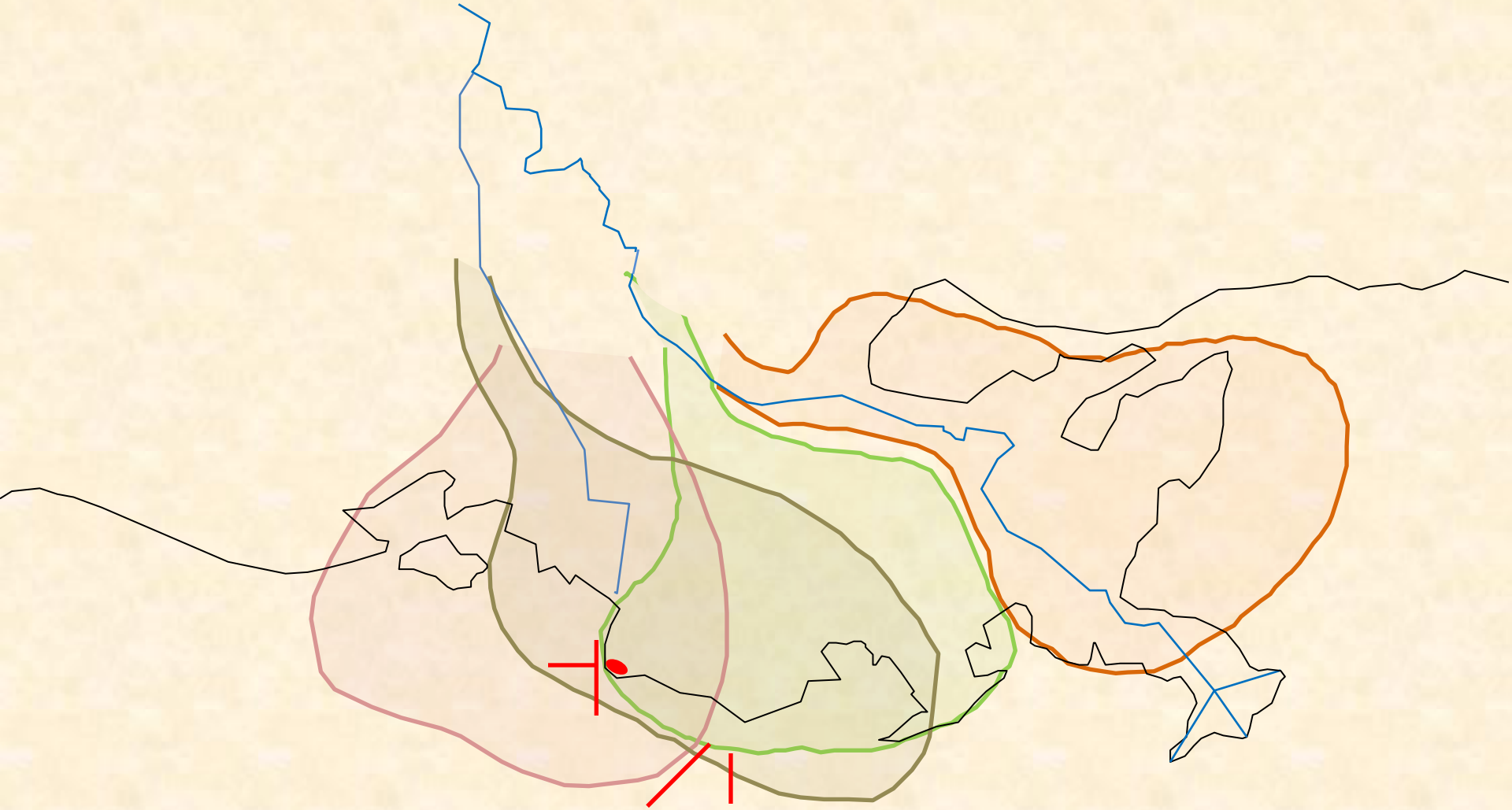
All these lands are flat and subject to overflow, with no trees except myrtles, and full of drift logs that come down the Mississippi. These the storms and currents cause to be beached. They are only encountered on the shores, on some beaches of oyster shells about 2 ft high… Between these islands and the peninsula there is no passage except for pirogues, as is shown on the chart….

Evía, 1785



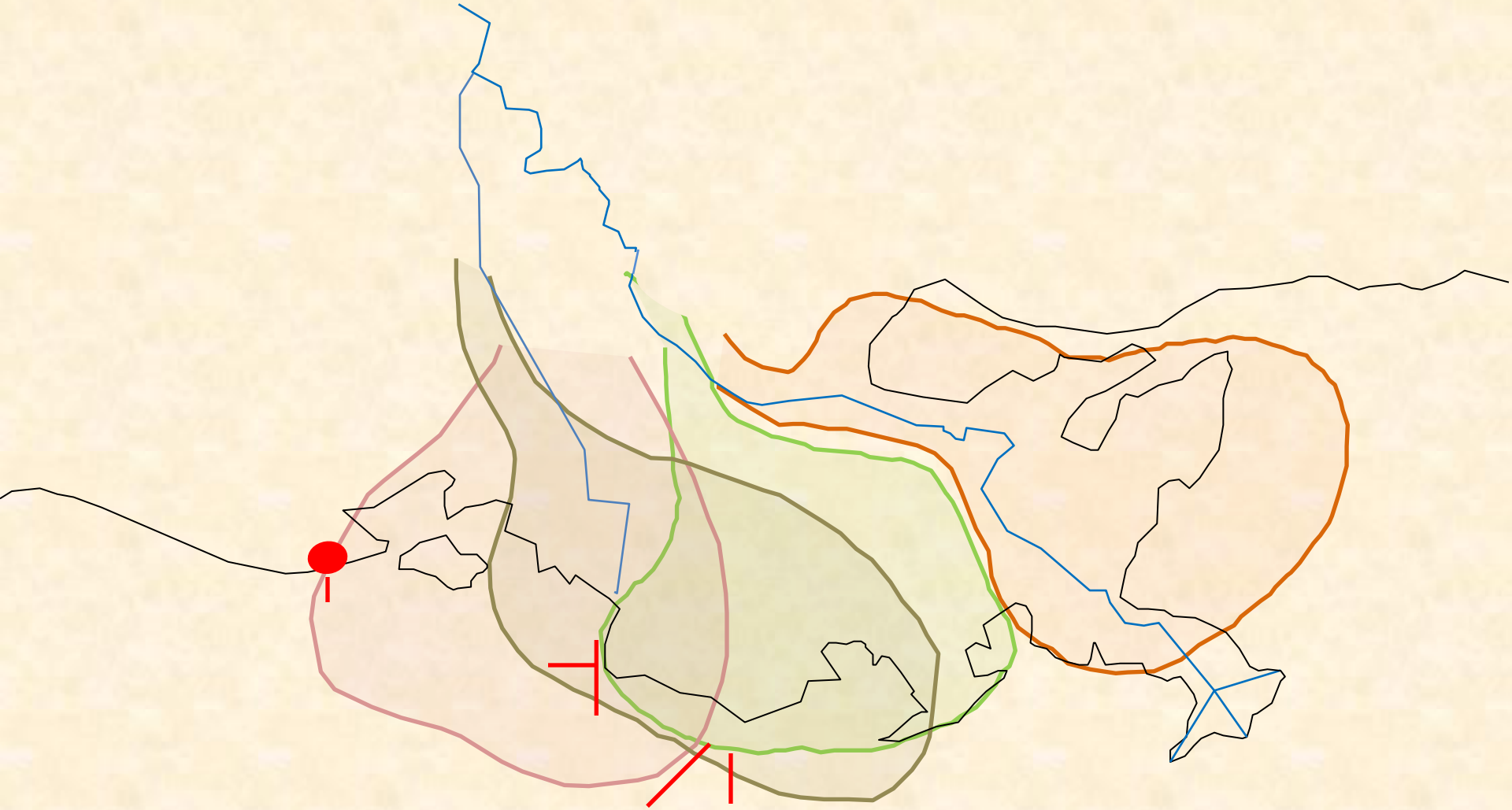
From the western point of Ultima Island, the oyster banks stretch 16 miles to the SW, and 10 miles to the S…and if the tide is out, they are visible.

Evía, 1785



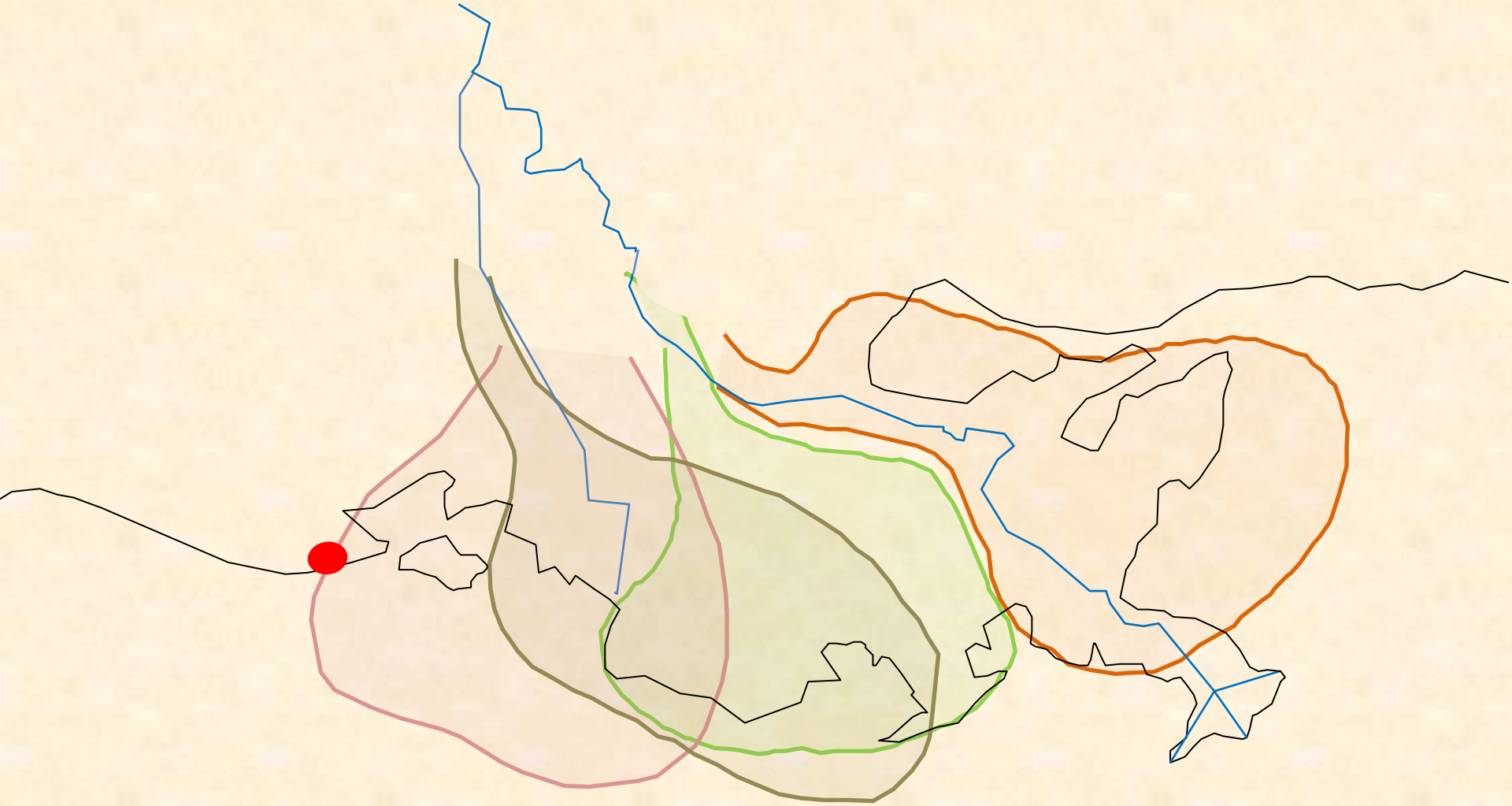
To the WNW of Ultima Island, at a distance of 12 leagues, is the Punta del Fierro (Point of the Branding Iron), which …. is surrounded by oyster banks for a distance of 10 miles…. To the N of Punta del Fierro the oyster banks extend for 5 miles, under 3 and 4 feet of water."

Evía, 1785



I followed the coast to the Encinal de la Cruz ([Live] Oak Grove of the Cross). Here the oyster banks which extend from this port 5 miles to the S, come to an end….

Evía, 1785

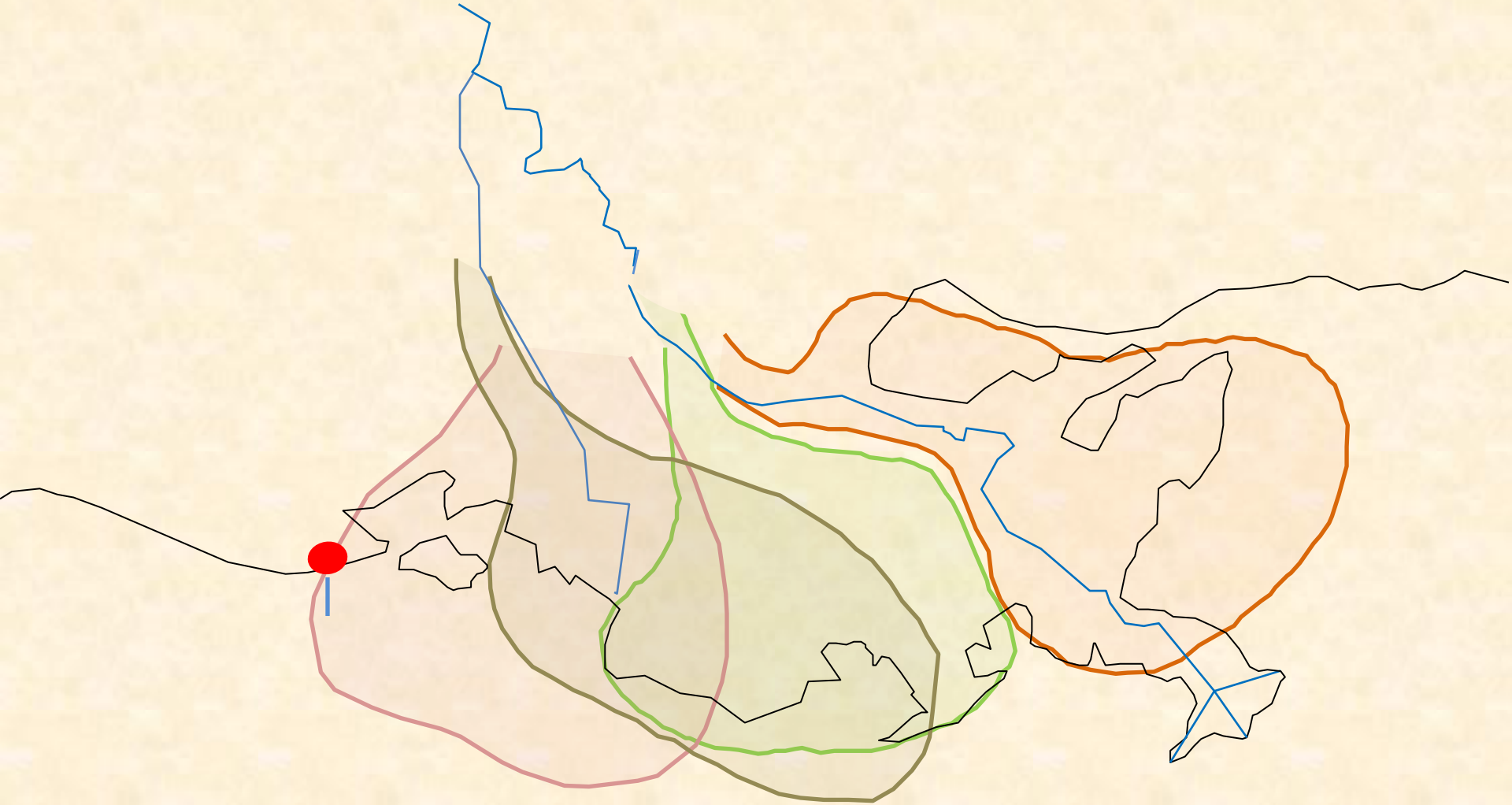


At sunset I anchored opposite Encinal de la Cruz, and passed the night there.

Evía, 1785

Because of the frequent squalls, I turned the pirogues, and although there was a strong wind from the S and SW, it did not produce a surf, because of the protection of the oyster banks.

Evía, 1785

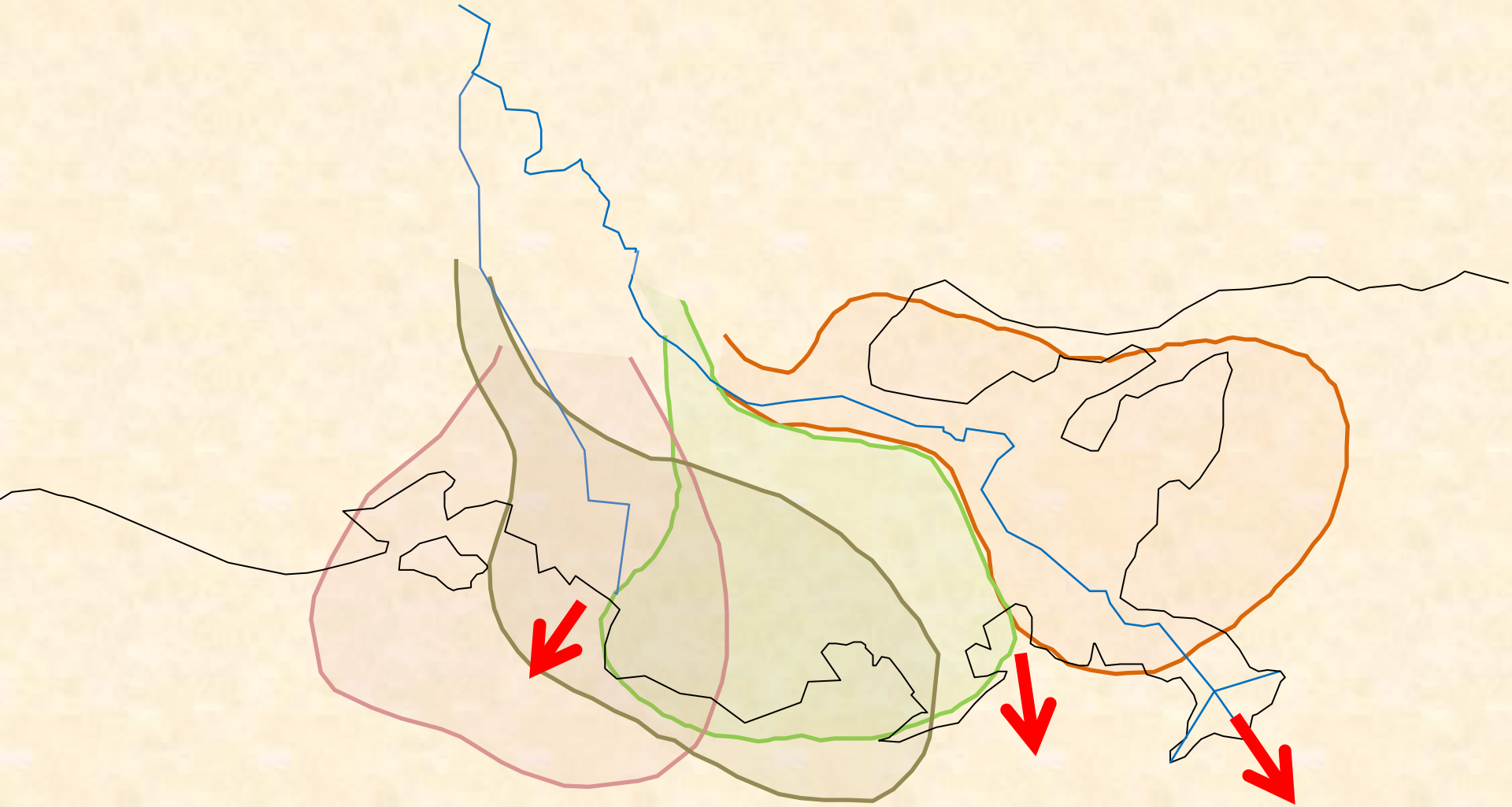


Throughout this place, and for more than 2 leagues out to sea, fresh water is encountered

Evía, 1785

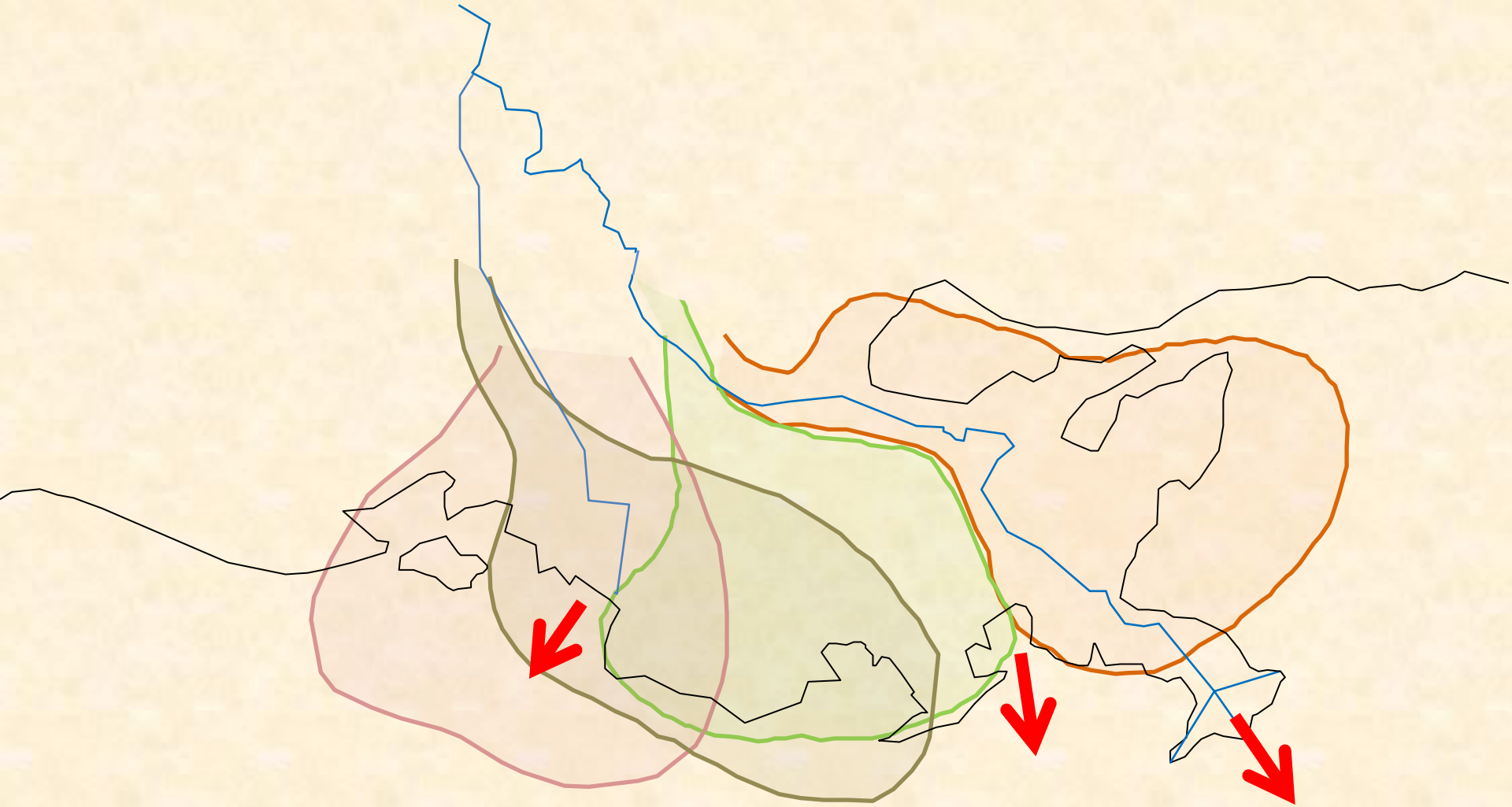
during the months from December to May, when the Mississippi is swollen

Evía, 1785



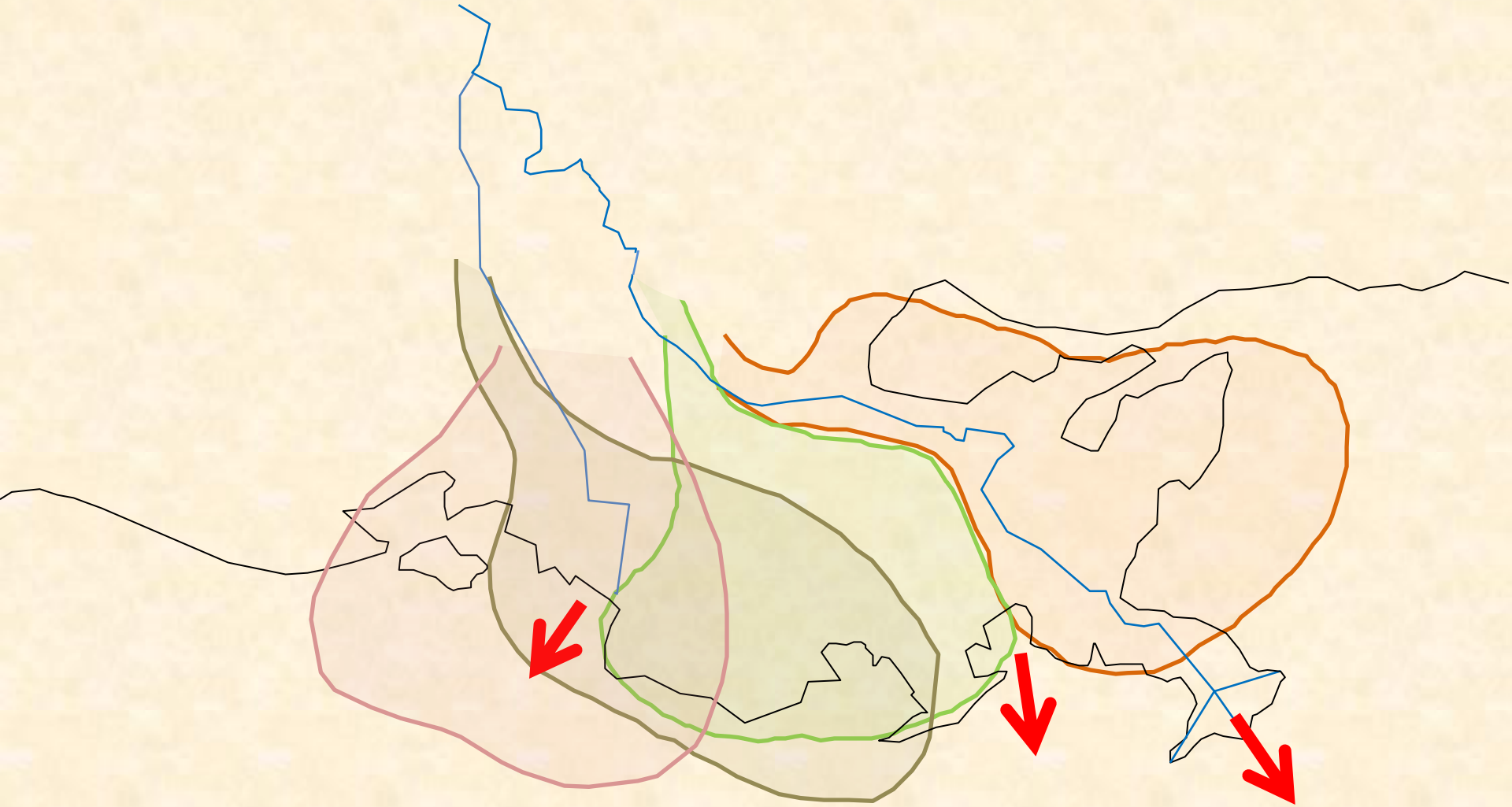
during the months from December to May, when the Mississippi is swollen and discharges through it (the Atchafalaya River) and Barataria (Bay), a strong current reaching 3 leagues out to sea, where fresh water is found.

Evía, 1785



This current unites with that which flows from the Mississippi and is the cause which varies the direction to the W and W-SW with greater force.

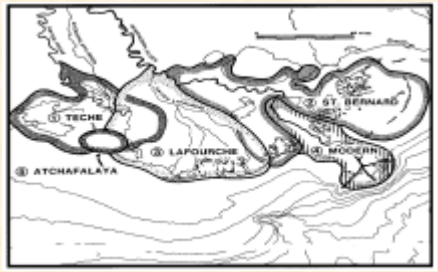
Evía, 1785



Evia -- Three distributaries

Findings: 1. LNDM – a vast seaward-advancing arc

which occupied



4 distributaries: Mississippi and Atchafalaya Rivers and Bayous Lafourche and Plaquemines

the 5 most recent delta complexes of the Mississippi River: coastal Louisiana east of the Chenier Plain.

and was characterized by

vast plumes of freshwater -- >10 km into GoM during spring flood

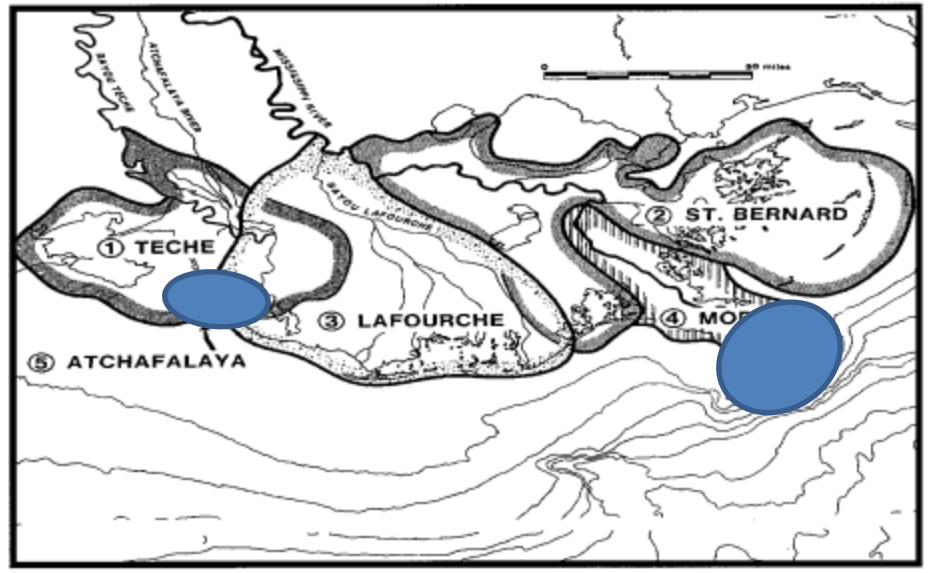
a vast offshore oyster reef – east from Chenier au Tigre past Ship Shoal

shallow inlets (<15 ft)

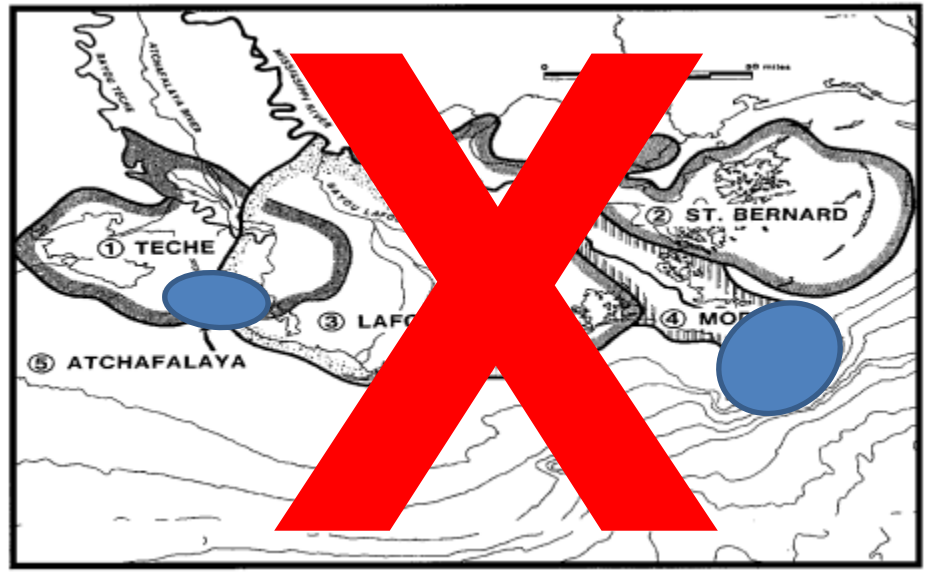
‘infinite trembling prairies’ and the ‘finest oaks in the world’

drift trees building the coast and offshore islands

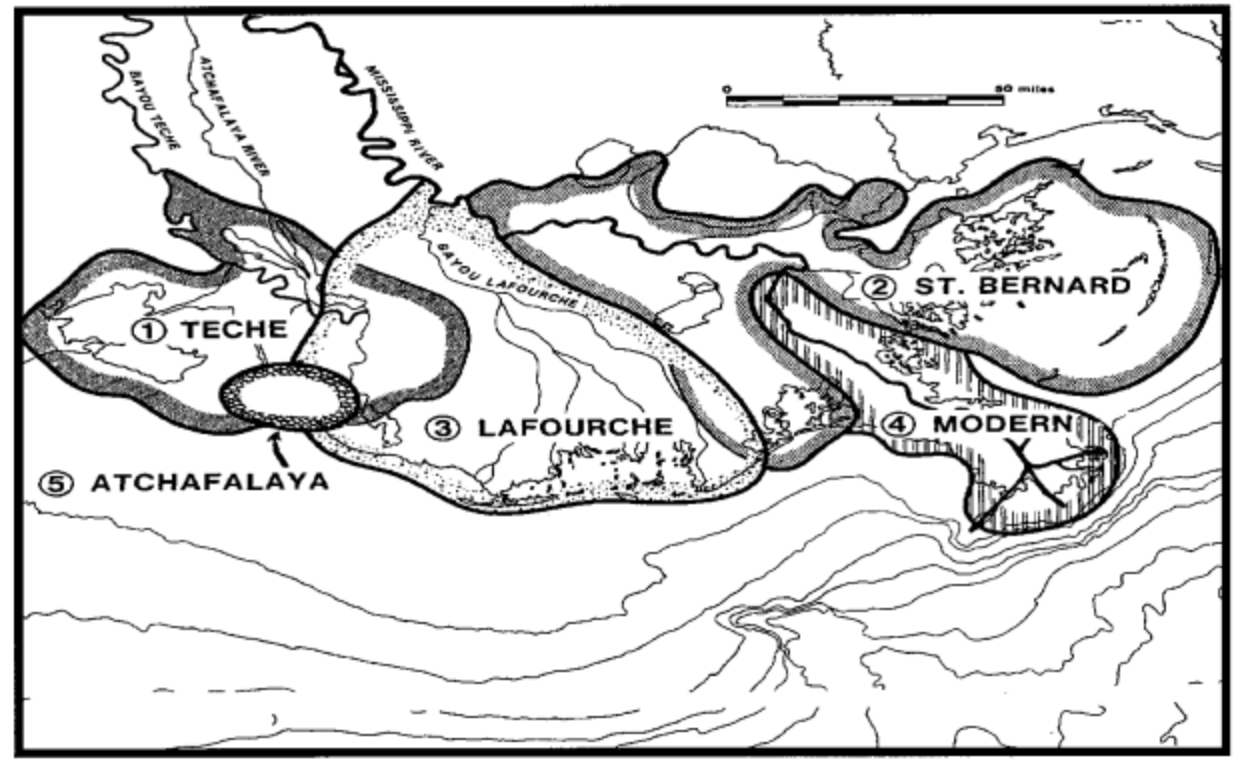
Finding: 2. The Plan's view (blue circles) of the LNDM is…



not correct and built on an incomplete and incorrect consideration of the historic record, …



rather the LNDM is more like this…



and even more like this (Bellin 1764).

Finding: 3. Plan underestimates the onset and magnitude of land loss in Louisiana. Many of the Plan's benchmarks are incompatible with a sustainable coast.

1. Human-restricted distributaries,

2. Artificial levees,

3. Brackish estuaries during spring flood,

4. Deep-water (>15 ft) inlets,

5. Oyster reefs confined to estuaries

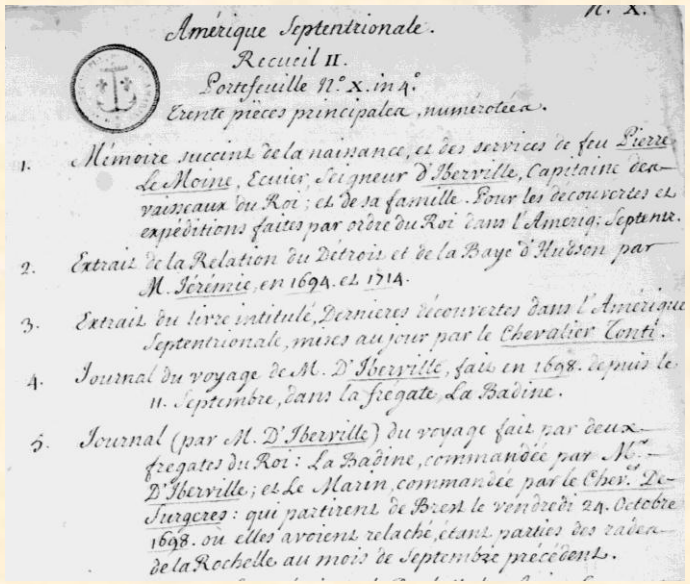
What is needed:

1. A comprehensive study of the historic record

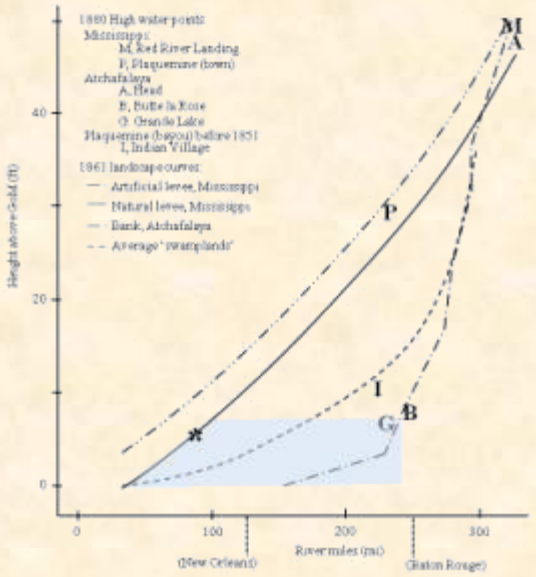
2. Appropriate revision of the plan's LNDM discussion.

3. Serious consideration of

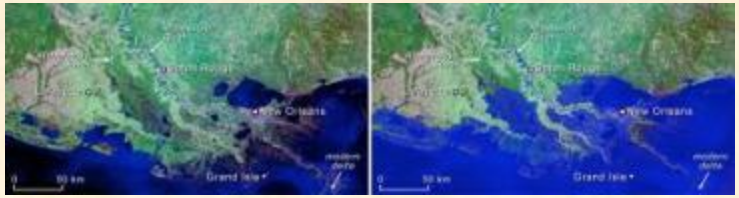
a. meaningful up-stream diversions
b. long-term impacts of deep water (>15 feet) inlets and artificial levees
c. Ironies of 'Berms to Barriers'.


Amérique Septentrionale.
Recueil II.
Portefeuille N.° X. in 4.°
Trente pièces principales, numerotées.

1. Mémoire succinct de la naissance, et des services de feu Pierre Le Moine, Ecuier, Seigneur d'Iberville, Capitaine de vaisseaux du Roi; et de sa famille. Pour les découvertes et expéditions faites par ordre du Roi dans l'Amerique Septentr.
2. Extrait de la Relation du Detroit et de la Baye d'Hudson par M. Jeremie, en 1694. et 1714.
3. Extrait du livre intitulé, Dernieres découvertes dans l'Amerique Septentrionale, mises au jour par le Chevalier Conti.
4. Journal du voyage de M. D'Iberville, fait en 1698. depuis le 11. Septembre, dans la fregate La Badine.
5. Journal (par M. D'Iberville) du voyage fait par deux fregates du Roi: La Badine, commandée par M.r D'Iberville; et Le Marin, commandée par le Chev.r de Surgeres: qui partirent de Brest le vendredi 24. Octobre 1698. ou elles avoient relaché, etant parties des rades de la Rochelle au mois de Septembre precedent.



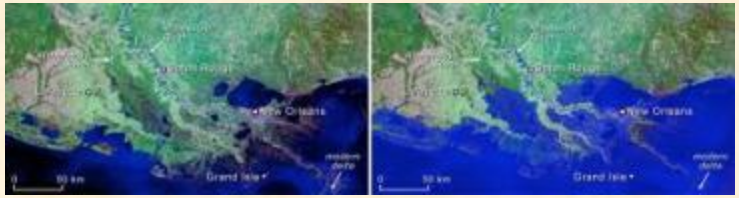
Human consequences not minimal.
given Blum and Roberts (2009)'s model,



without effective restoration efforts -- most of the emergent Holocene deposits of the Mississippi River Deltaic Plain below Butte la Rose will be converted to open water or brackish/saline marsh in 90 years.

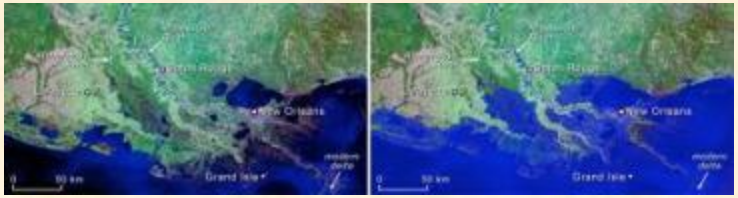
This Area contains > 1 million people (USCB 2010), covers ≥ 10,000 km^2, and affects > 10 parishes[1].

[1] Jefferson, Lafourche, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. Martin, St. Mary, and Terrebonne

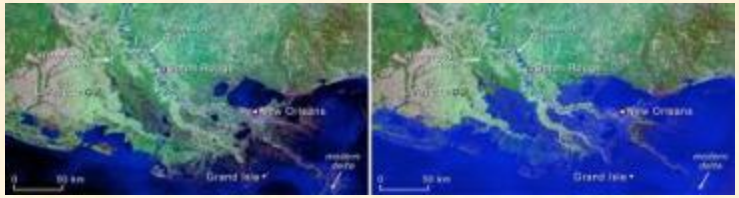


Freshwater diversions restricted to the Birdsfoot and the Atchafalaya delta complex will not build or maintain land in most of this Area because these structures are not located far enough upstream to mimic the natural processes which operated in the LNDM.

Ironically, this same Area subject to fresh water flooding in the spring of 1880.



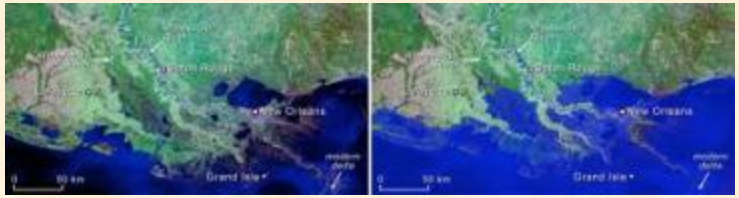
Ironically, this same Area subject to
fresh water flooding in the spring of 1880.



Tower et al. (1880) to Congress :

When spring floods of the Mississippi reached Butte la Rose through the Atchafalaya River, they would spread out over the face of the land.

Ironically, this same Area subject to
fresh water flooding in the spring of 1880.

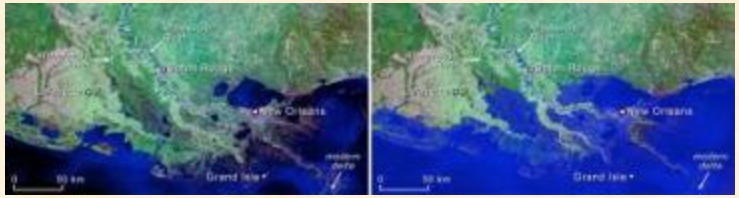


Tower et al. (1880) to Congress :

When spring floods of the Mississippi reached Butte la Rose through the Atchafalaya River, they would spread out over the face of the land.

In the 1850-1880s, however,

the flood consisted of sediment-rich fresh water, occurred in the spring/summer, enriched the land, advanced the coast, and encountered comparatively little human settlement.



In 2100, the inundation (predicted in Blum and Robert's model) will not be confined to the spring, enrich the land, or advance the coast. Moreover it will adversely affect major human population centers and millions of lives.