An Indo-Pacific damselfish in the GoMx: ~~opening a can of worms~~ the worm turns

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Neopomacentrus cyanomos...Regal Demoiselle

Third introduced fish with established population in tropical NW Atlantic

Others are

Pterois volitans/miles & *Omobranchus punctatus*

Neopomacentrus cyanomos

Third exotic fish with established population in tropical NW Atlantic

First Records…. in GoMx

2013 1 site in SW corner

Gonzalez-Gándara y de la Cruz-Francisco 2014 Bioinvasion Rec 3:49

2014-5 larger area of SW Gulf

Robertson *et al* 2016. JOSF 19: 1

Questions to be considered

1 Where did *N cyanomos* in the GoMx come from and how did they get there?

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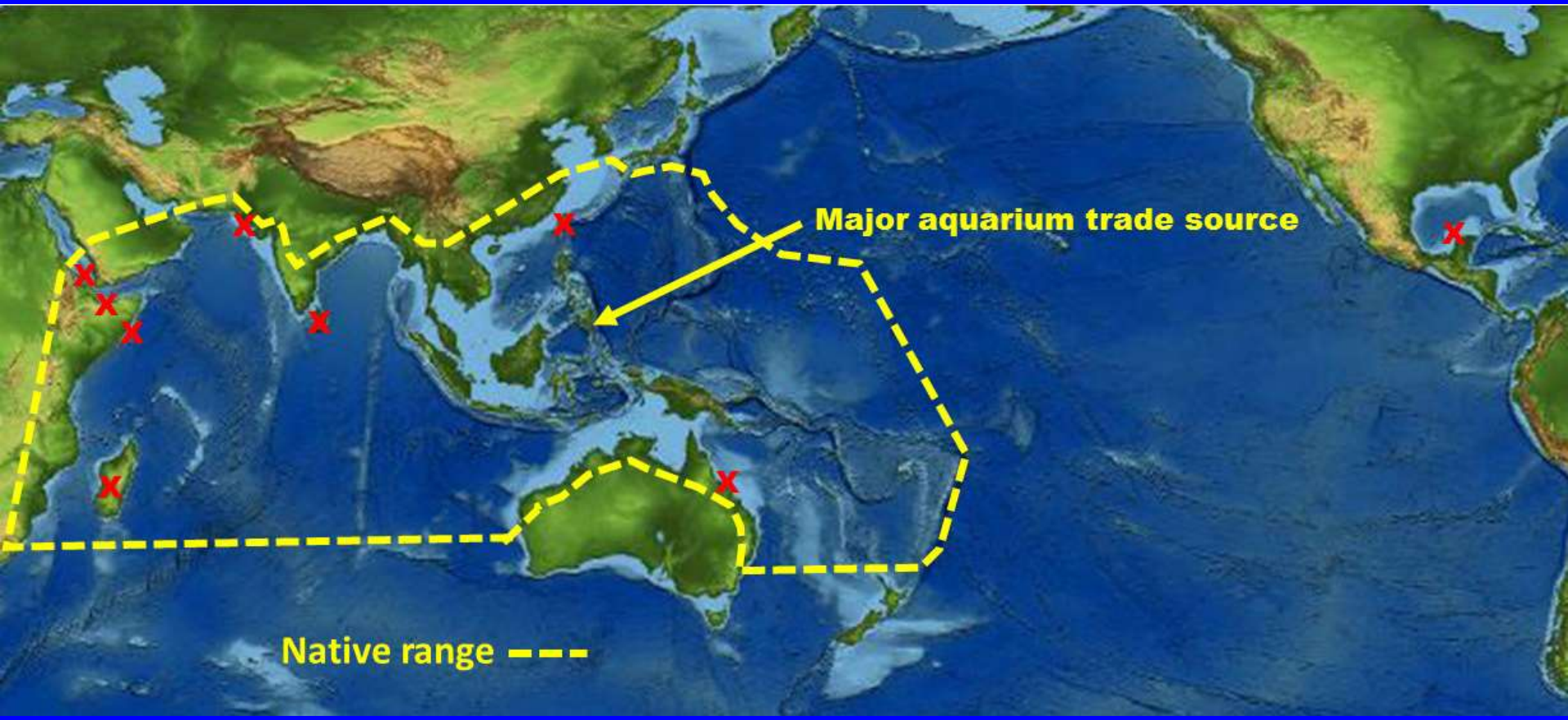
2 What is the current range of *N cyanomos* in the GoMx?

3 What is the potential for a wider, adverse invasion of the Greater Caribbean?

Question 1: where did *N cyanomos* in the GoMx come from and how did it get there?

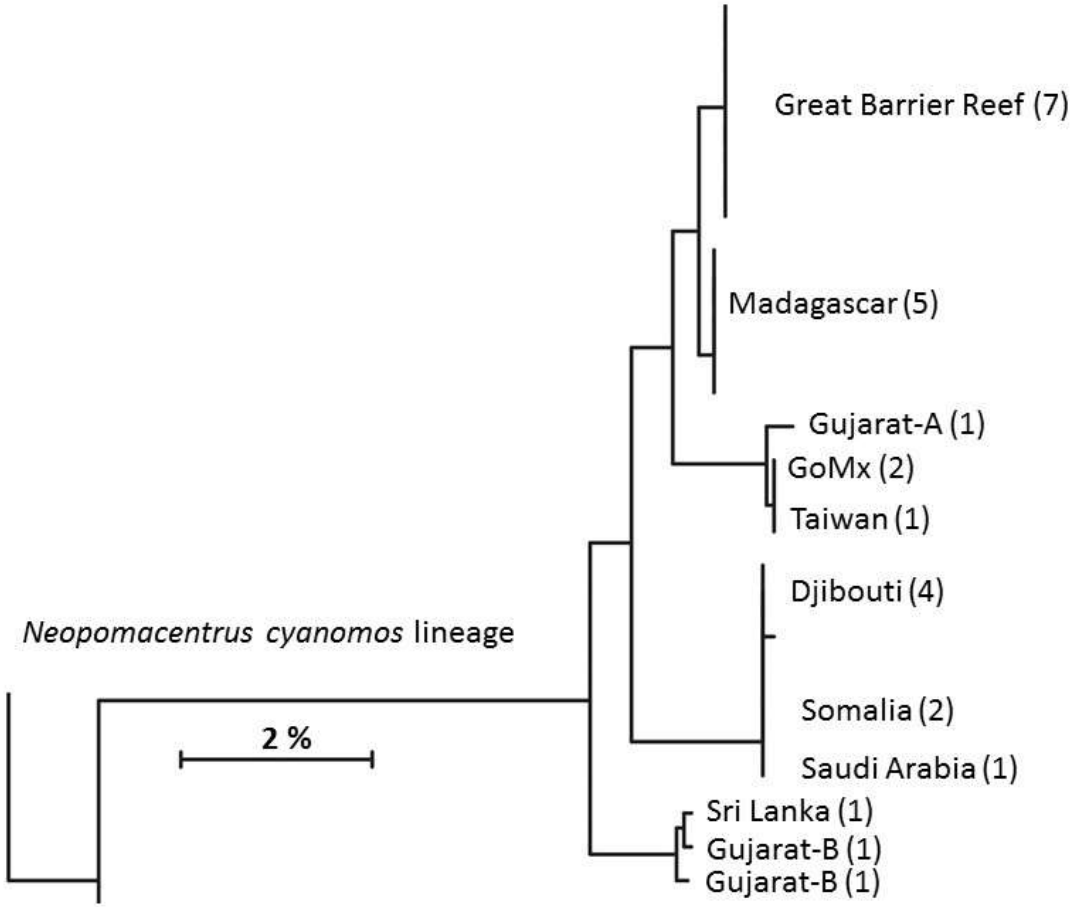
Origin: Compare barcodes of GoMx population to populations scattered across native range … hopefully enough structure & geographically localized populations to provide insights

Sites from which barcodes are currently available for *N cyanomos*

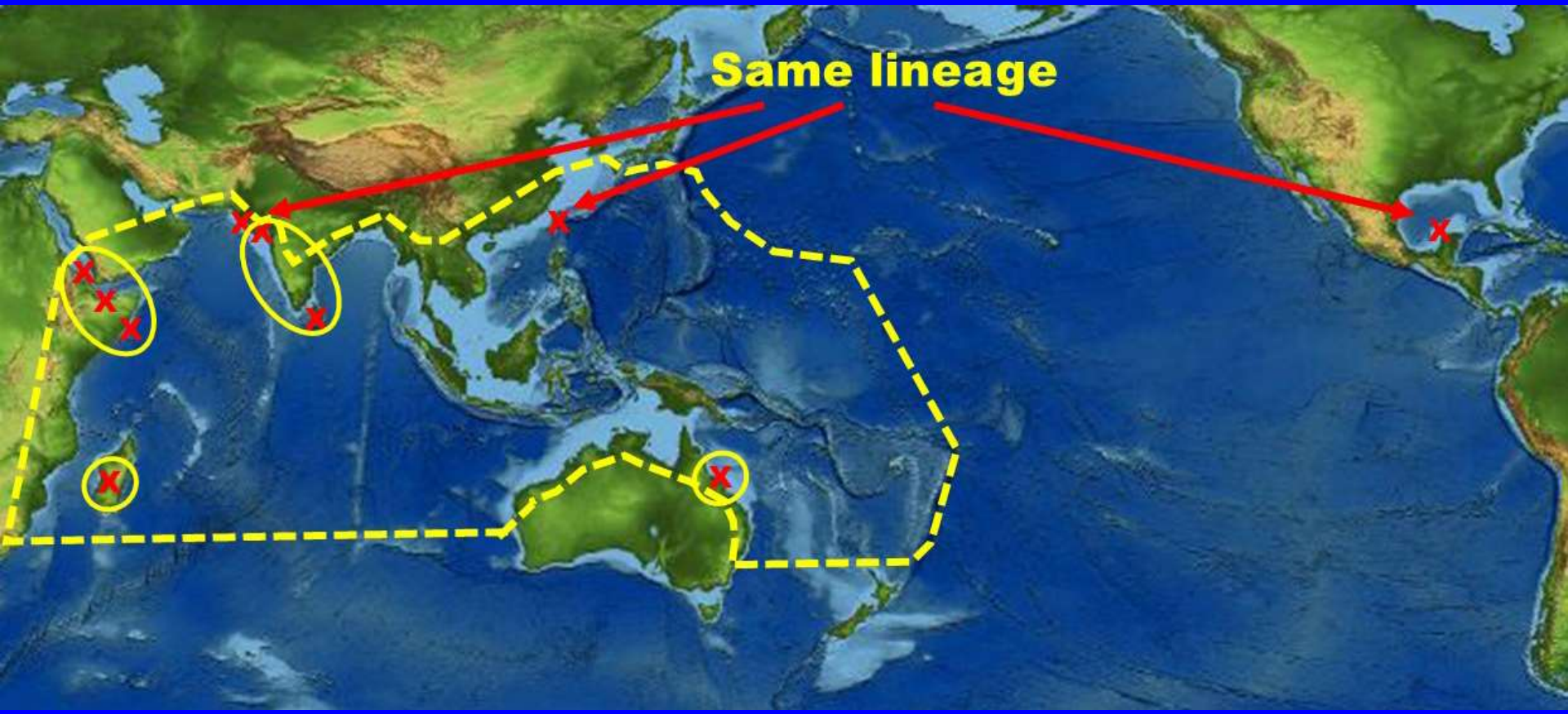


Relationships within the *N cyanomos* lineage

Barcode relationships: BOLD TaxonID Tree
N cyanomos lineage



GoMx from a widespread lineage:



Aquarium-industry *"N cyanomos"* from Philippines wrongly identified by industry…… based on morphology it probably is *N taeniurus*

Two look-alike *Neopomacentrus spp*

N cyanomos:
Hidden suborbital edge

N taeniurus
Exposed suborbital edge

Philippines aquarium trade
"N cyanomos"
has exposed suborbital
most likely is N taeniurus

Question 1: where did *N cyanomos* in the GoMx come from and how did it get there?

Potential Introduction modes:

1…….Commercial shipping
2…… Aquarium release
3……Oil-rig translocation

Commercial Shipping hypothesis: in or on a ship

PROS

Some fish do it

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CONS

Damselfishes don’t do it

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Ships clean, fast …not conducive externally

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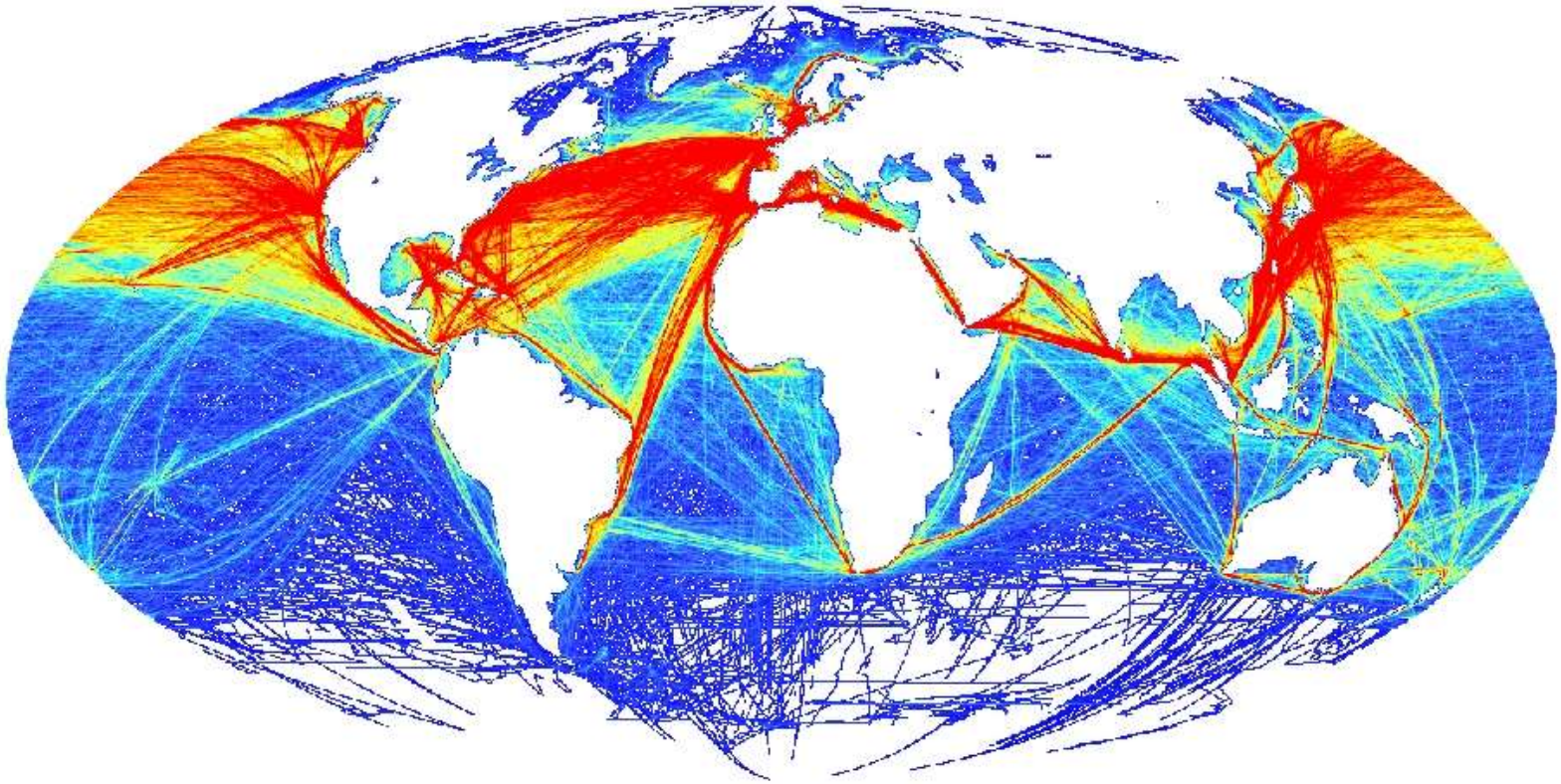
Ships clean, fast…not conducive

SW GoMx not major international shipping endpoint

World shipping patterns (NCEAS)



Commercial Shipping Hypothesis: In or on a ship

PROS

Some fish do it

CONS

Damselfishes don't do it
Ships clean, fast moving
SW GoMx not major international shipping endpoint

Panama is MAJOR choke point for shipping; only shipping intro is Omobranchus (from S America?)

Aquarium-release hypothesis:

PROS

Lots other examples, Florida

e.g. Lionfish

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1st barcode match indicated possible aquarium-trade connection

Aquarium-release hypothesis:

CONS

Nc bland fish, tiny component of aquarium trade

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Few salt-water aquarists in Mexico

Aquarium-release hypothesis:

CONS

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Few aquarists in Mexico

Imports to US (likely source of fish to Mexico) not GoMx lineage (not right species)

Aquarium-release hypothesis:

CONS

Nc bland fish, tiny component of aquarium trade

Few aquarists in Mexico

Imports to US not GoMx lineage

Most aquarium releases don't take…too few fish

Oil-rig translocation hypothesis:

PROS

Rigs = artificial reefs….lots of species, with large populations

slow moving, good for planktivores

….ideal for transport & establishment

Oil-rig translocation hypothesis:

PROS

Involved in reef fish transport:

Offshore Rig: GoMx to Mediterranean -> 2 spp reef fish

Offshore Rig: 2006.. enroute Brazil (22^0S) to Singapore, wrecked Tristan de Cunha (37^0S), with 2 Brazilian fishes

Canary Islands = Rig maintenance center:

...various W Atlantic arrivals (from Venezuela & Brazil)

***** one IWP damselfish that is not in aquarium trade

Oil-rig translocation hypothesis:

PROS

N cyanomos abundant on rig in GoMx…small, near-substrate, shelters in fouling growth, planktivore

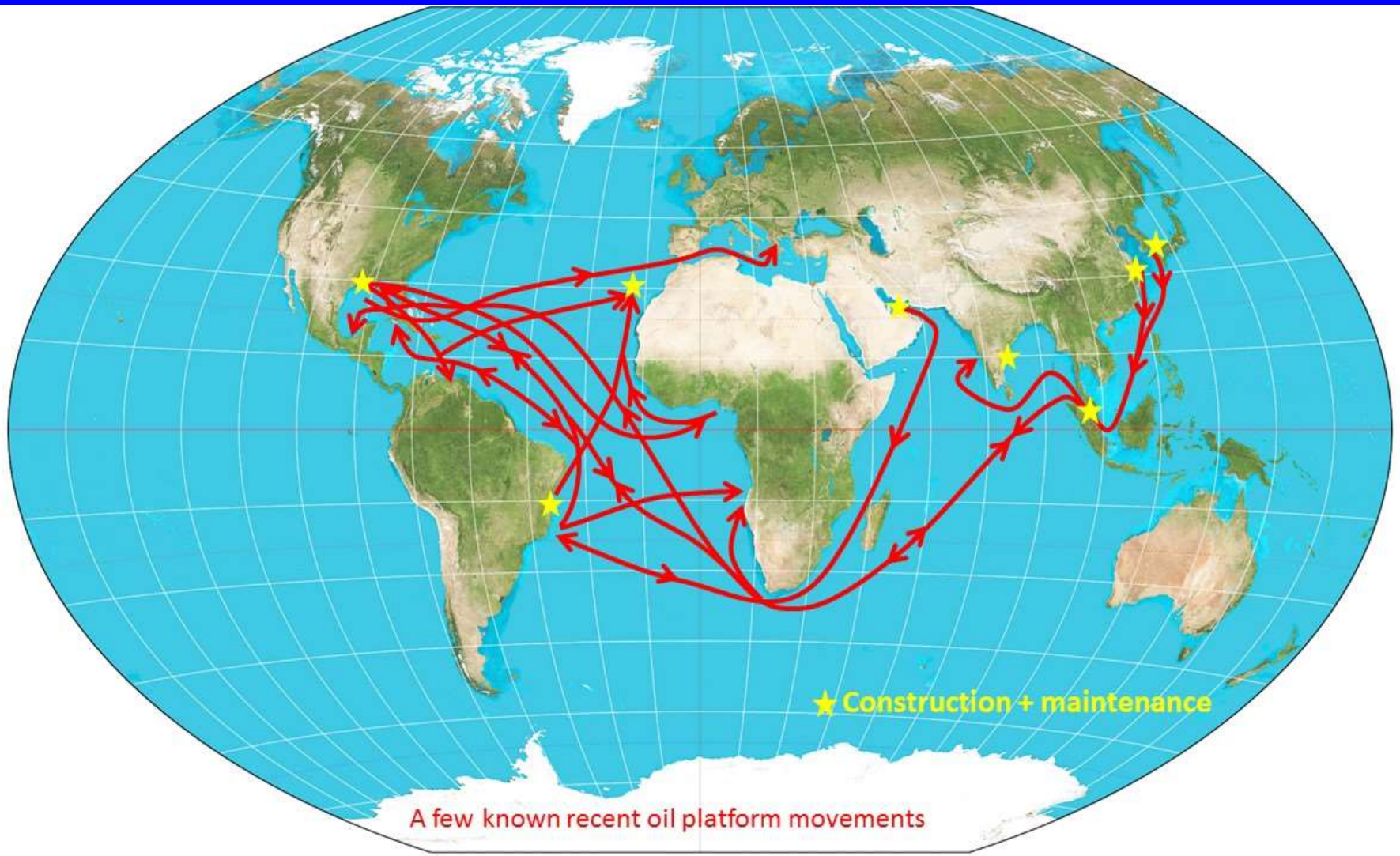
N violascens likely taken by towed, fouled US drydocks: Philippines -> Guam (1980s)..abundant on fouled mooring chains

Myers 1996 Micronesica 28:207

Oil-rig translocation hypothesis:

PROS

Towed offshore rigs do have IWP -> GoMx movements

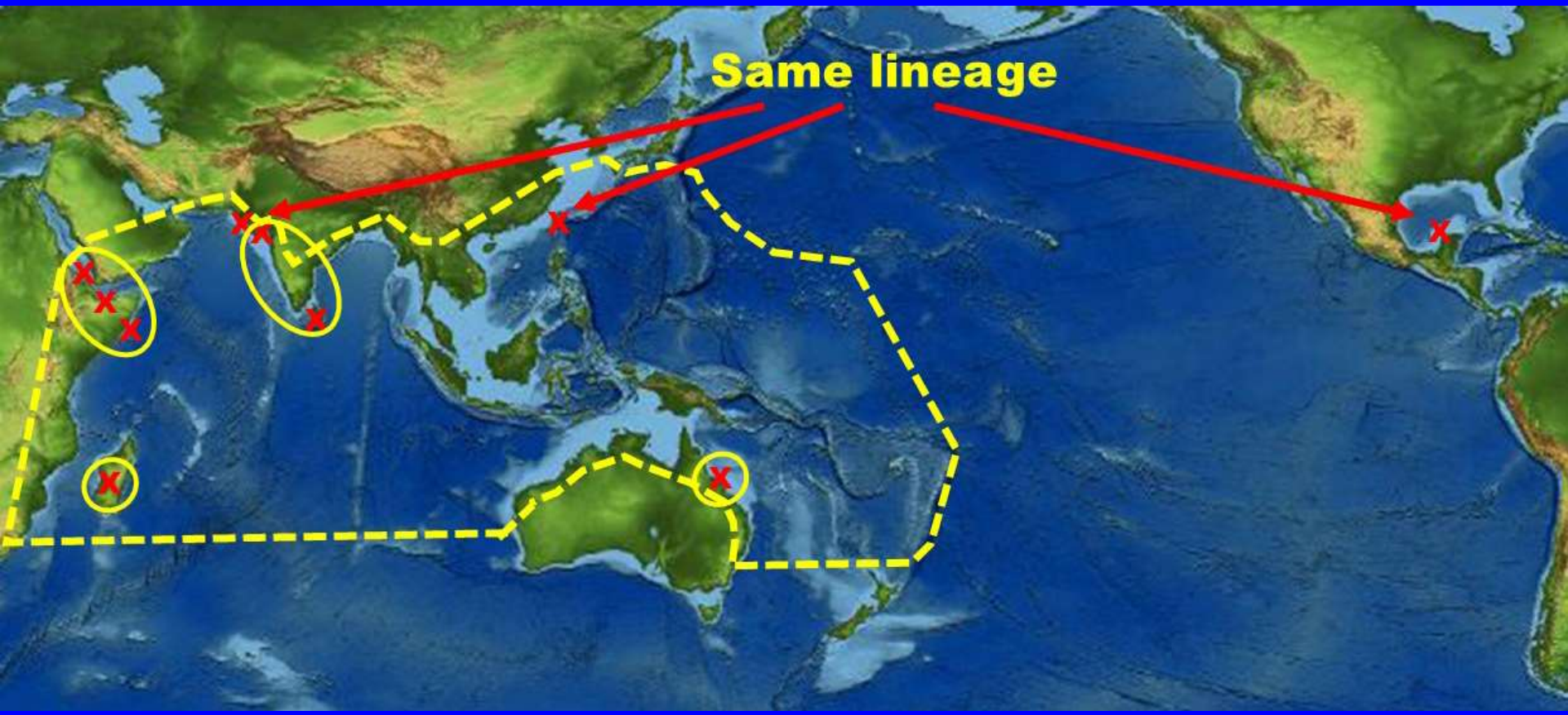


A few known recent oil platform movements

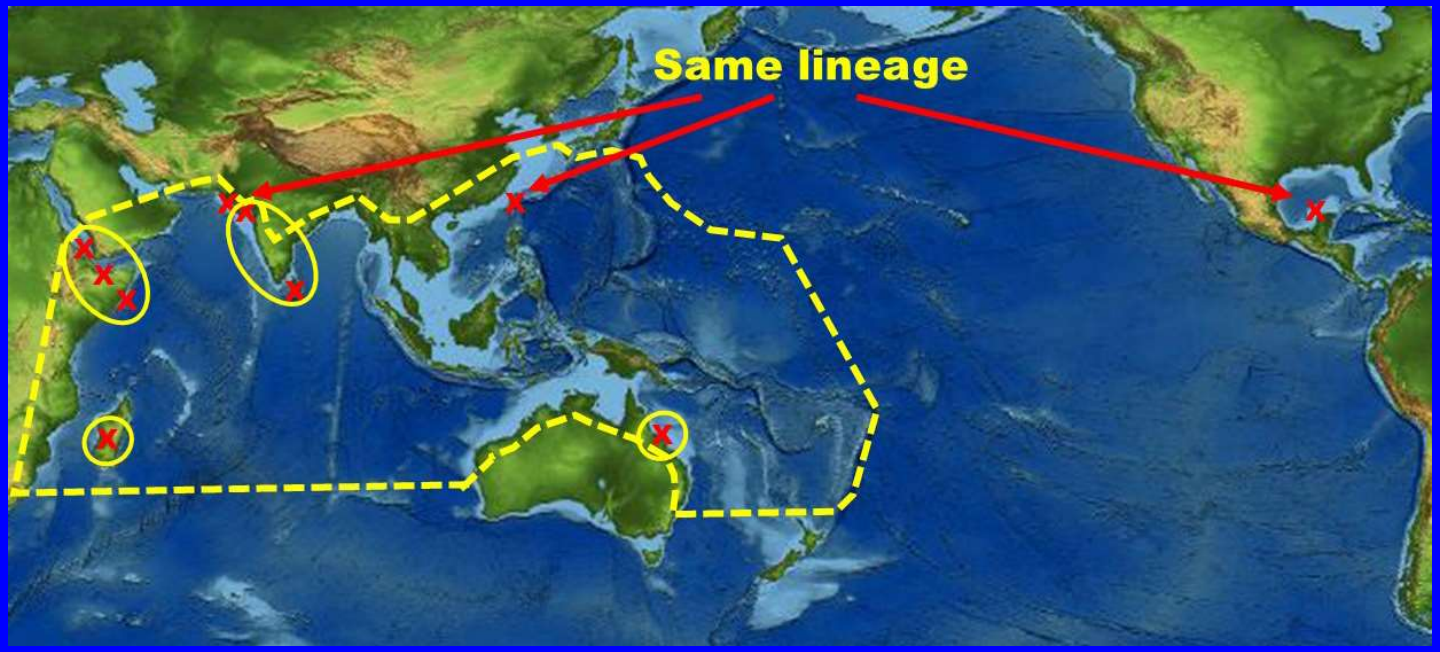
Oil-rig translocation hypothesis:

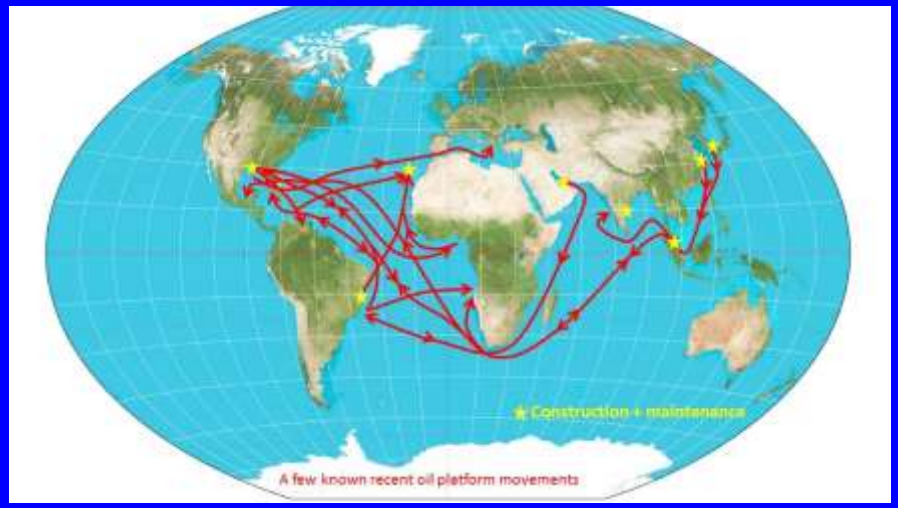
PROS

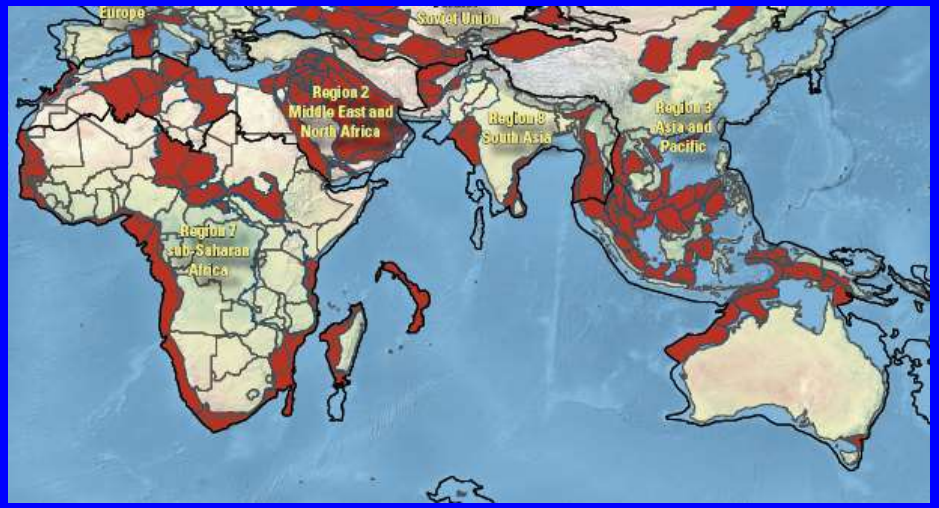
GoMx lineage is the only widespread, interoceanic native lineage, others localized



A plausible combination:
Genes, Rig movements & IWP Oilfields



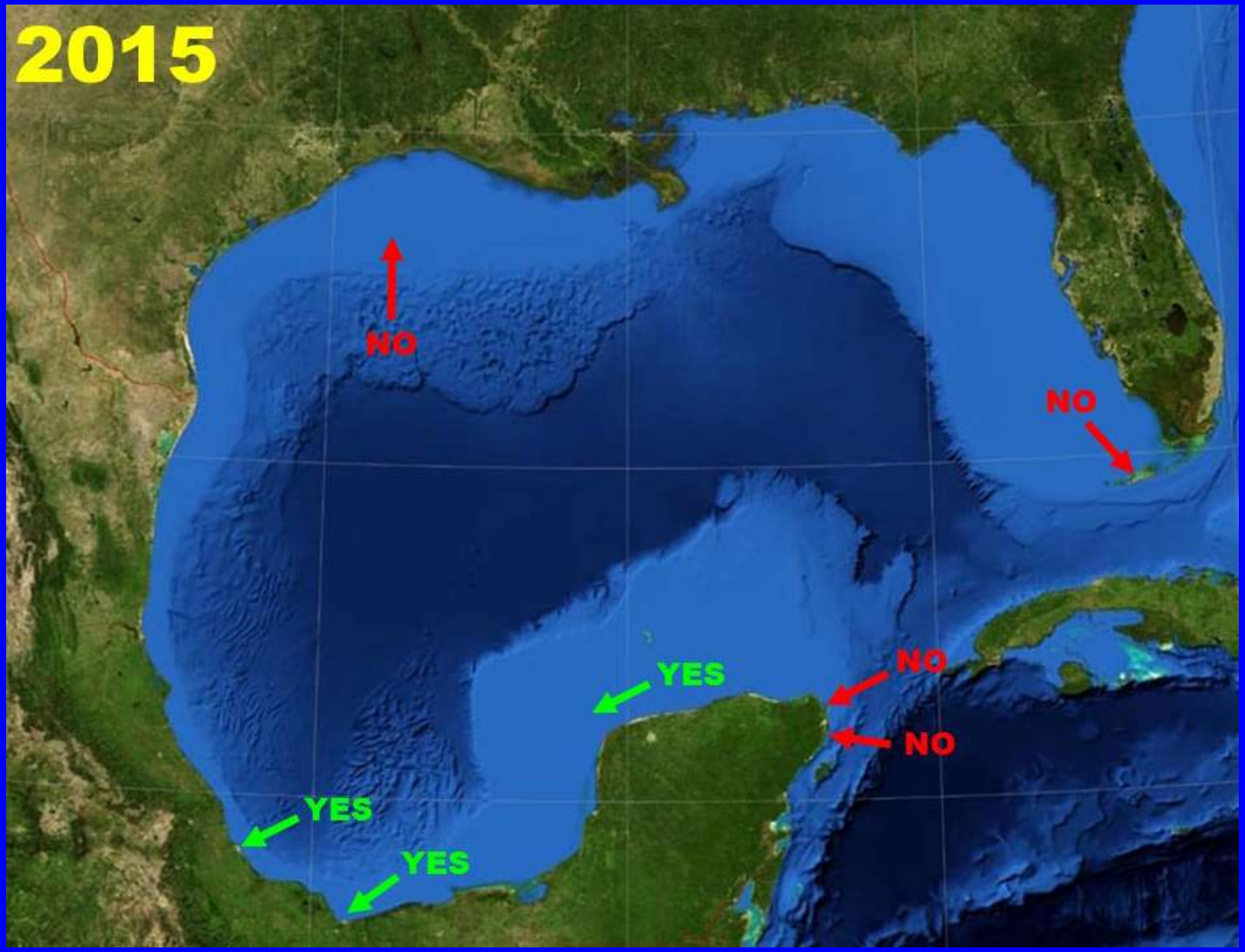




The current range of

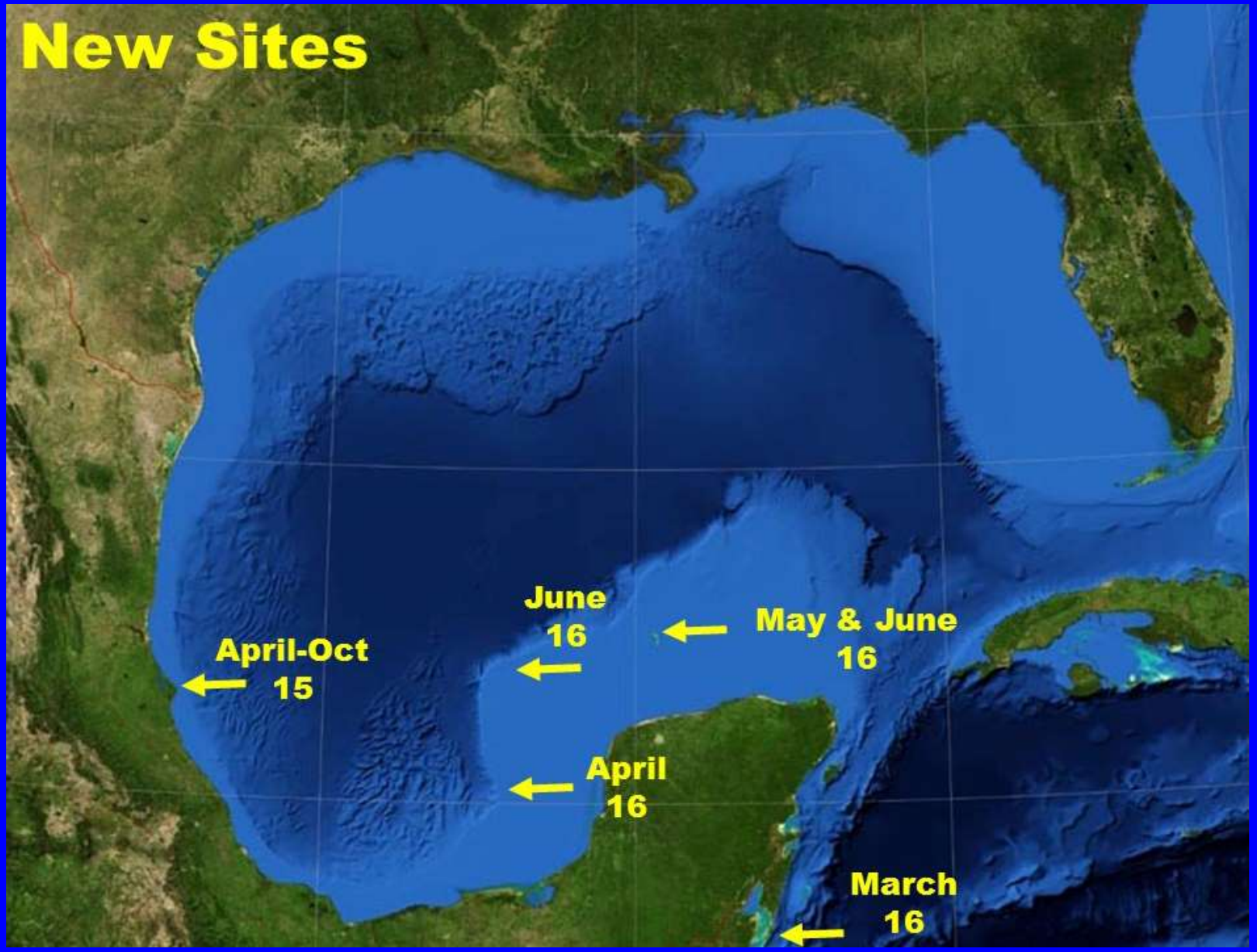
N cyanomos in the GoMx

2015 information on *N cyanomos'* range

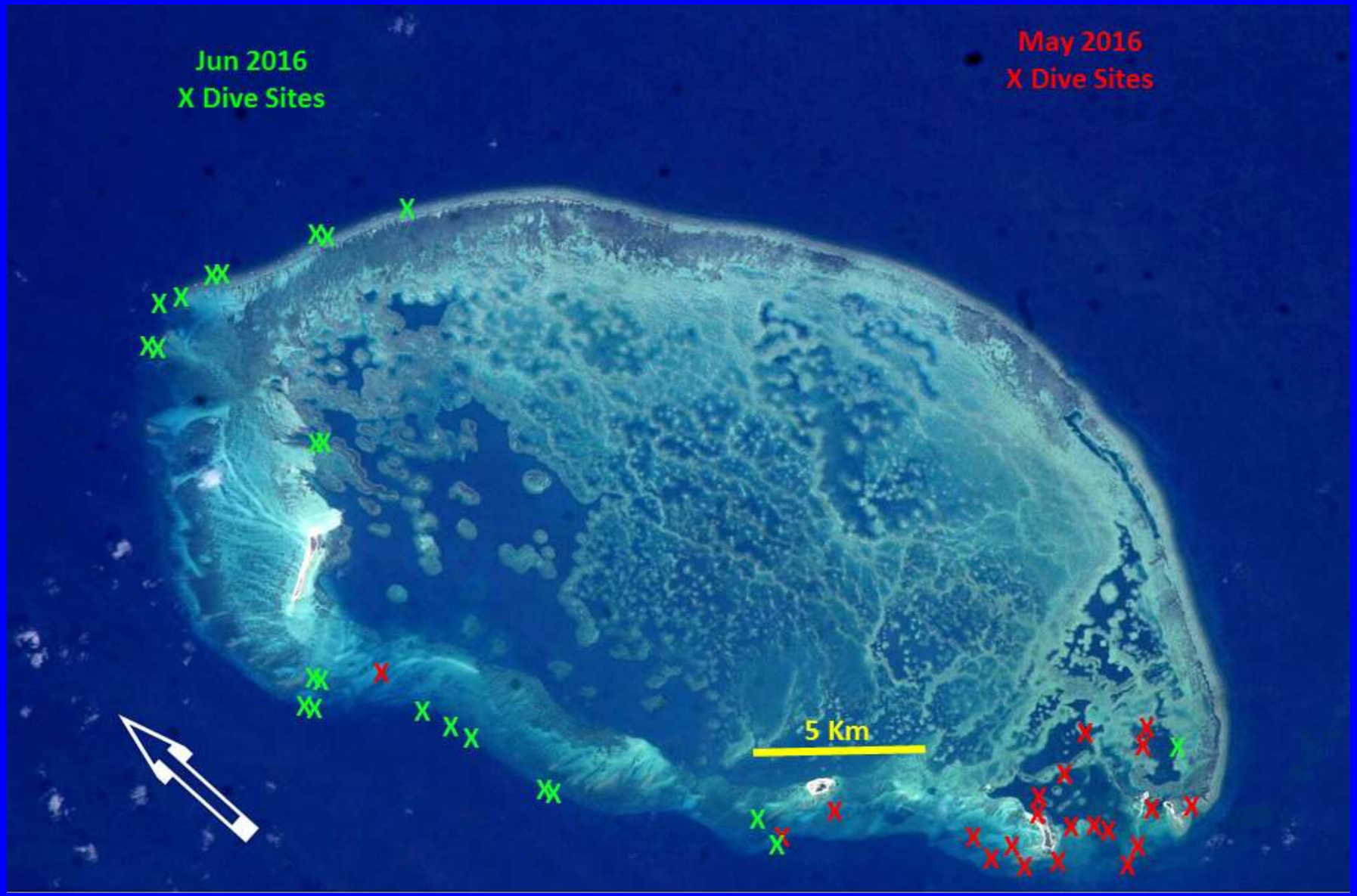


2016 New Data on *N cyanomos'* range

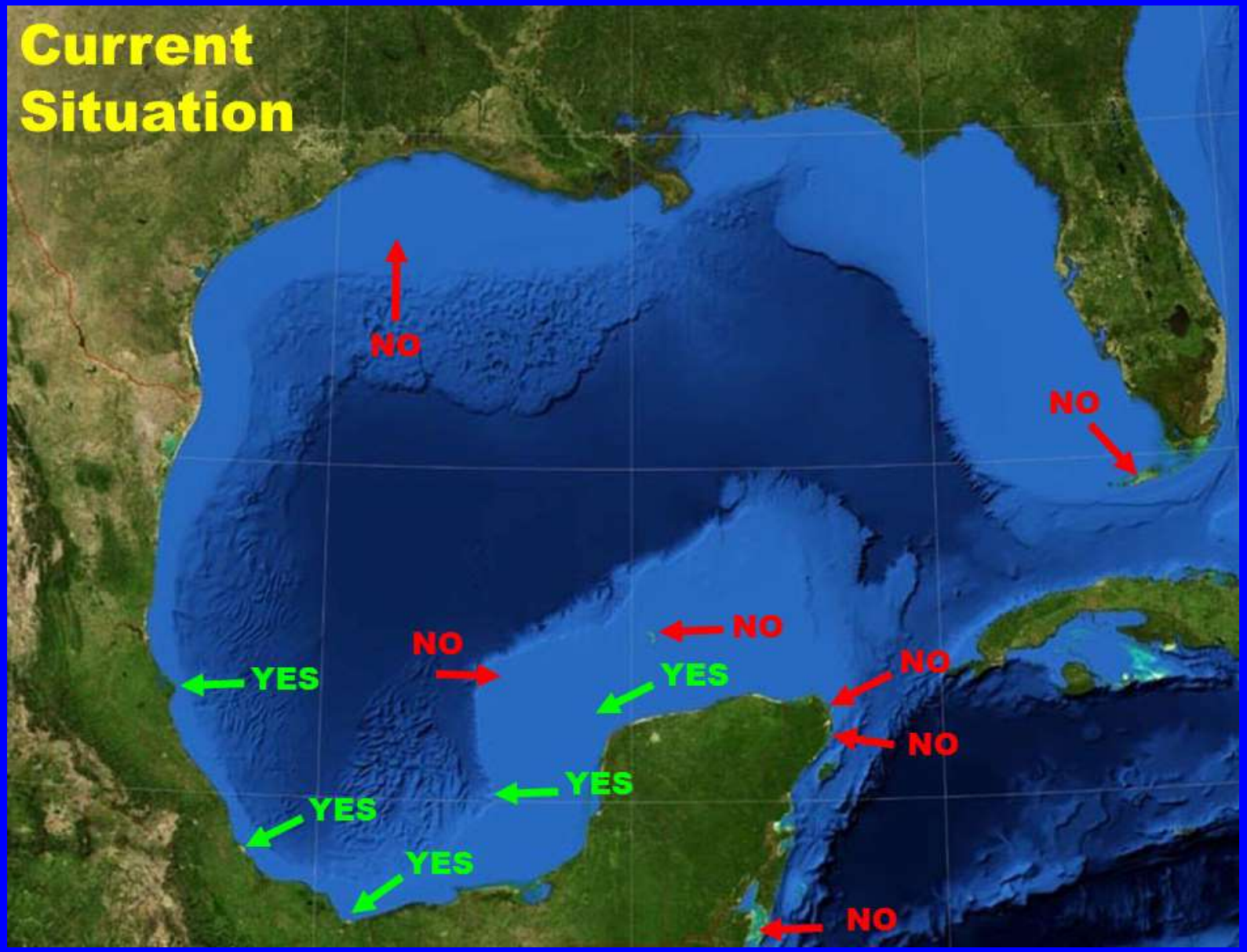
Tuxpan: Cruz-Francisco et al 2016: Rev Investig Mar 35:101



Alacran Reef Surveys: May & June 2016



2016 state of info on *N cyanomos'* range



Prospects for a wider, adverse Invasion?

Suitable environmental conditions widely distributed

N. cyanomos: Native & Potential ranges

Actual Native Range

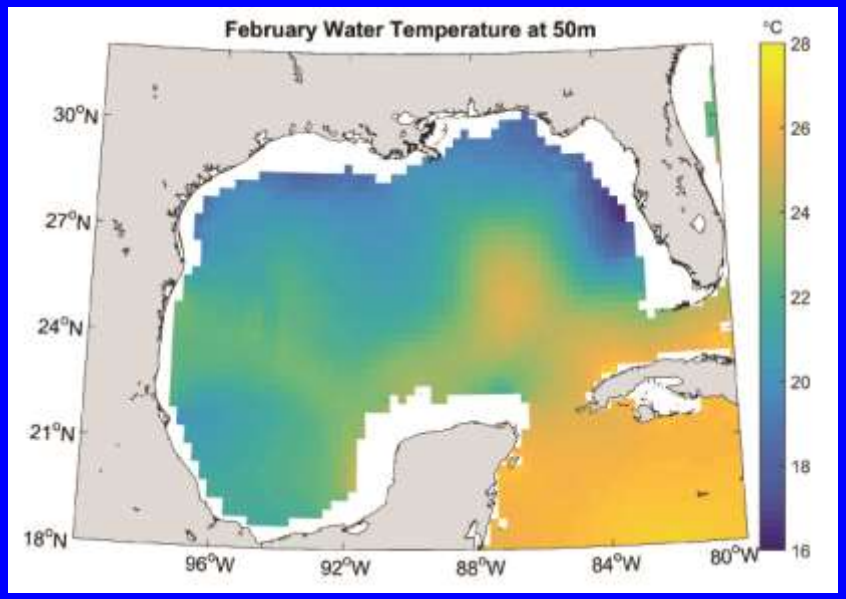
Potential Range:

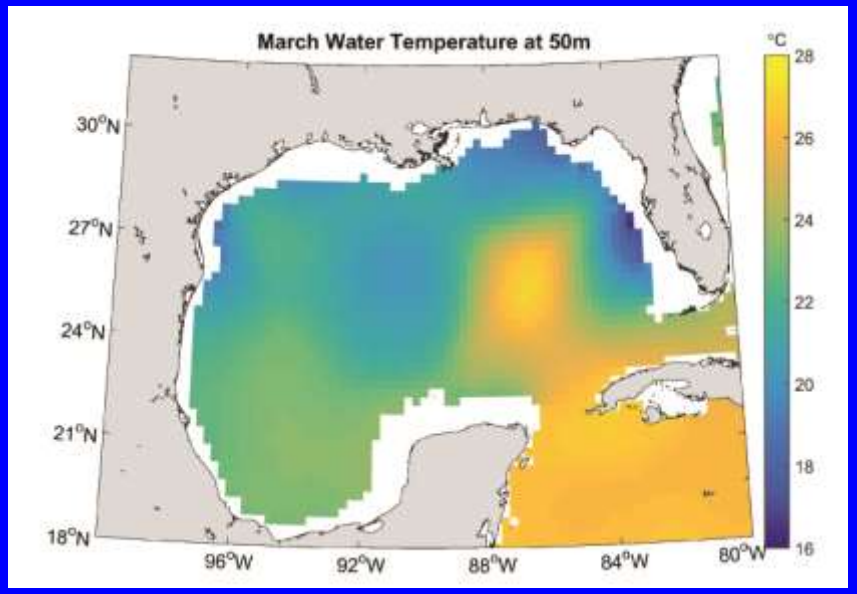
Fishbase Aquamap:

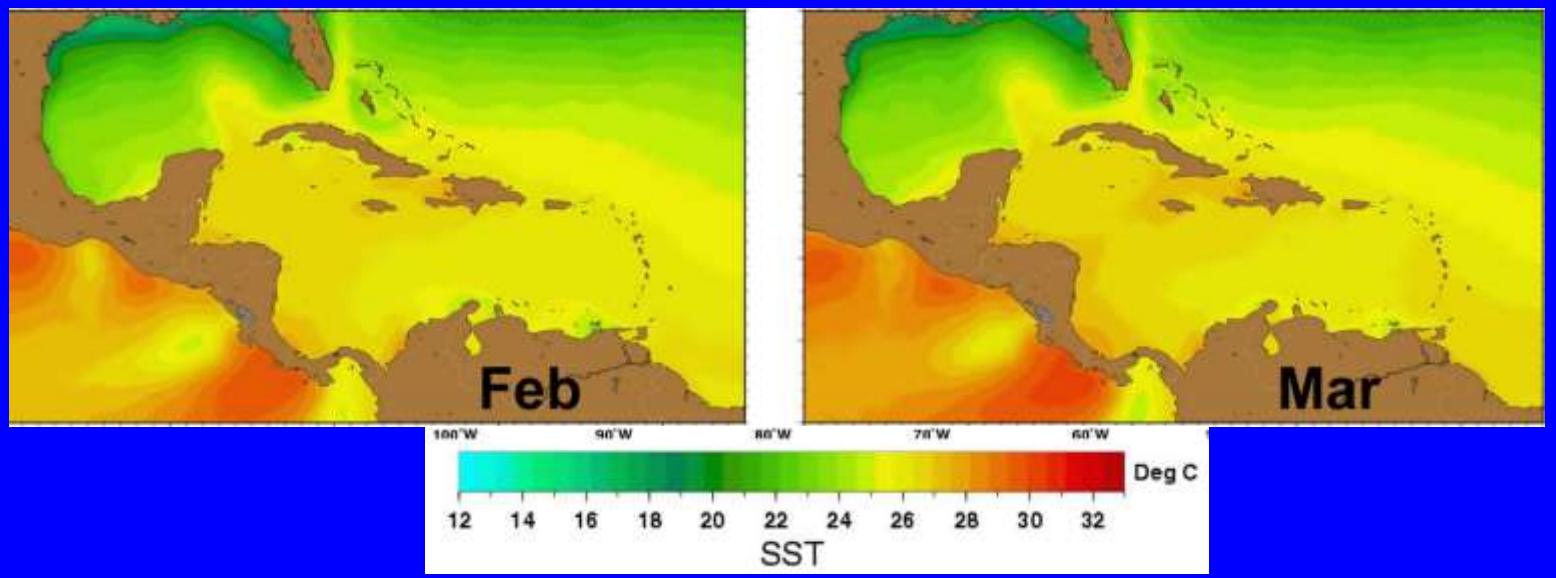
Extrapolated from combination of depth, SST, productivity & salinity in native range

Potential for occurrence throughout GoMx

Winter temperature at 50m (Brian Grieve, NOAA) vs surface







Prospects for a wider, adverse Invasion?

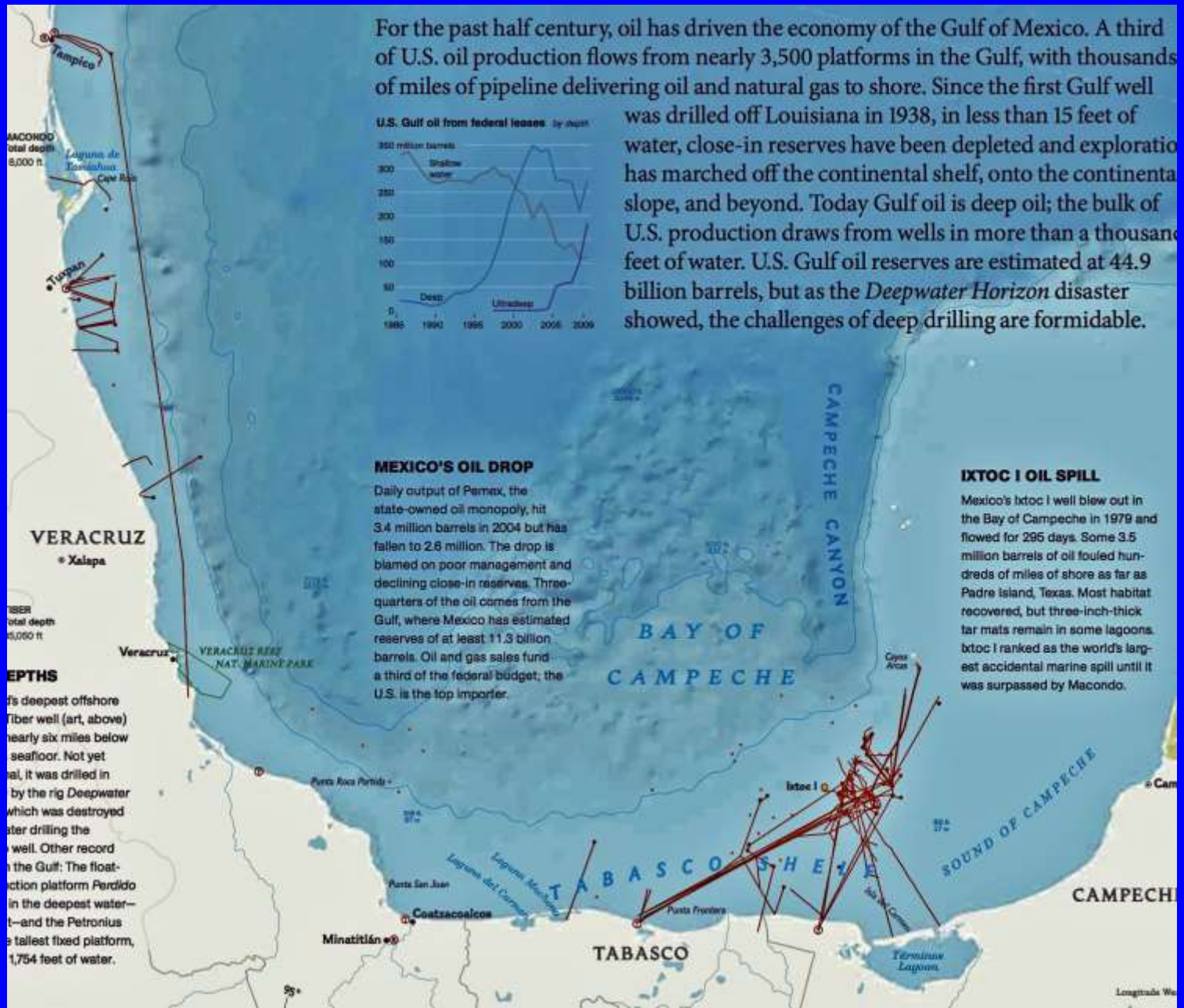
PROS:

Well established over large area of SW GoMx

Lots of oil installations = high-quality habitat

as well as sunken ships

Suitable habitat: SW GoMx oil installations



Prospects for a wider, adverse Invasion?

PROS:

Well established over large area

Can be locally highly successful

Prospects for a wider, adverse Invasion?

PROS:

Well established over large area

Can be highly successful (one habitat)

Knows about lionfish: evolved with it

Prospects for a wider, adverse Invasion?

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Genus not in Atlantic, similar native planktivores don't seem directly equivalent

Prospects for a wider, adverse Invasion?

PROS:

Well established over large area
Can be highly successful (one habitat)
Knows about lionfish
Genus not in Atlantic, similar native planktivores don't seem directly equivalent

N miryae apparently has cohesive larval dispersal

Ben-Tzi et al 2012 Plos One

..if general for *N spp* it might enhance spread & establishment at new sites by assisting mate finding

Prospects for a wider, adverse Invasion?

CONS:

Ecologically not highly unusual

(ie not as unusual as lionfish)?

Prospects for a wider, adverse Invasion?

CONS:

Ecologically not unusual?

Morphologically similar to natives….no protection from native predators?

Prospects for a wider, adverse Invasion?

CONS:

Ecologically not unusual?

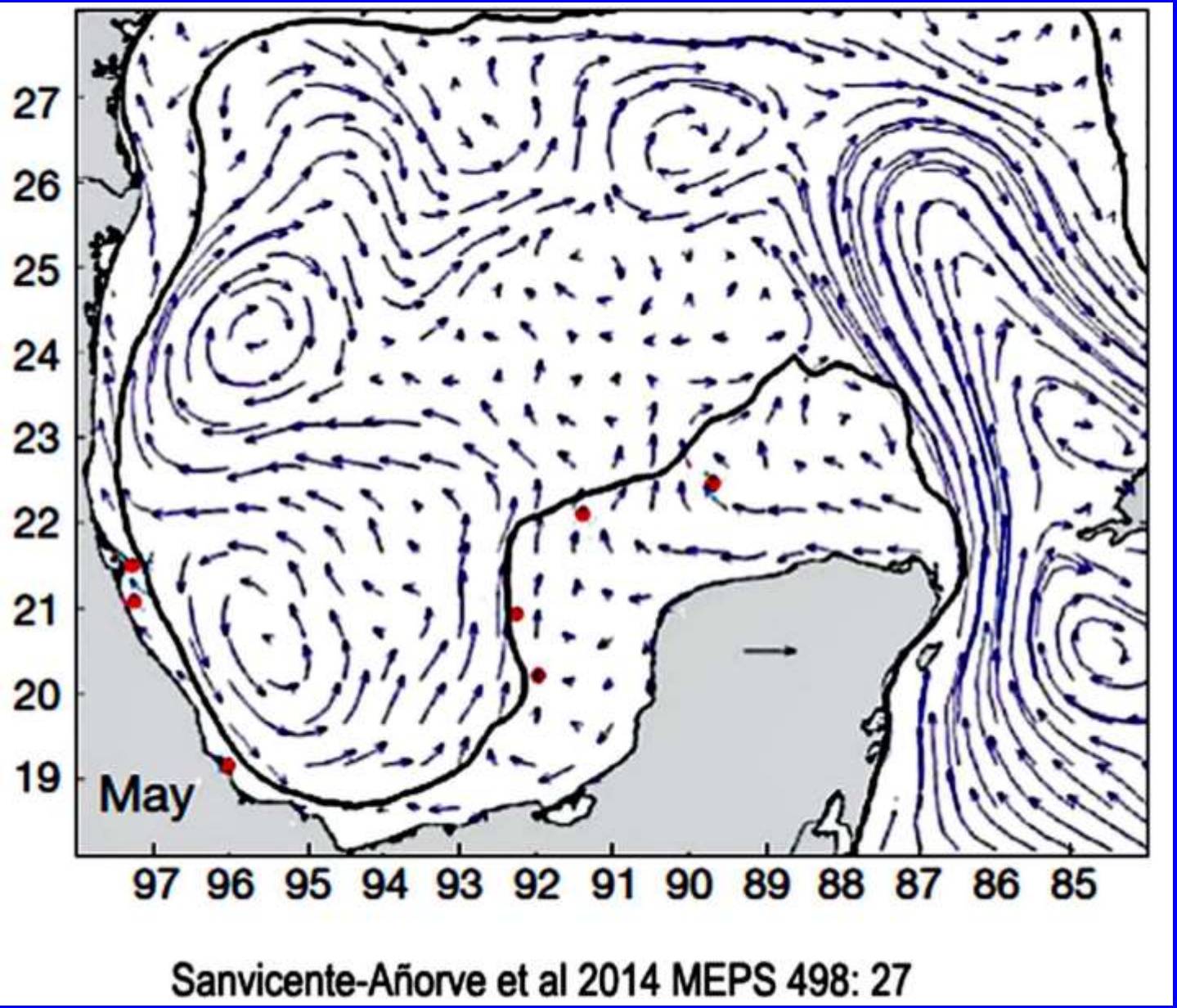
Morphologically similar to natives….no protection from native predators?

Currents in SW could slow spread out of GoMx

Sanvicente-Añorve et al 2014 MEPS 498:27

Johnston & Akins 2016, Mar Biol 163: 12

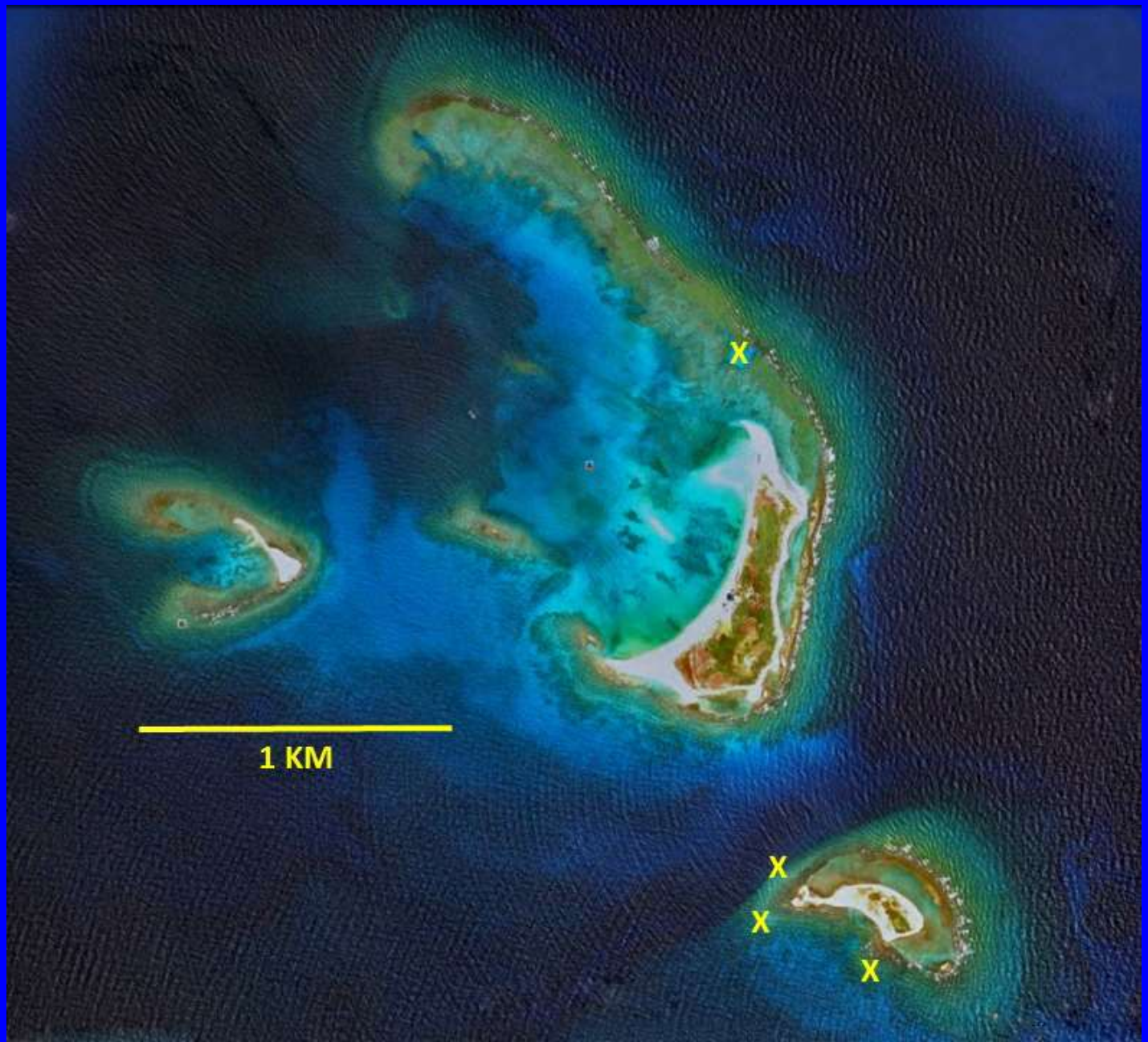
Alacran isolated from rest?



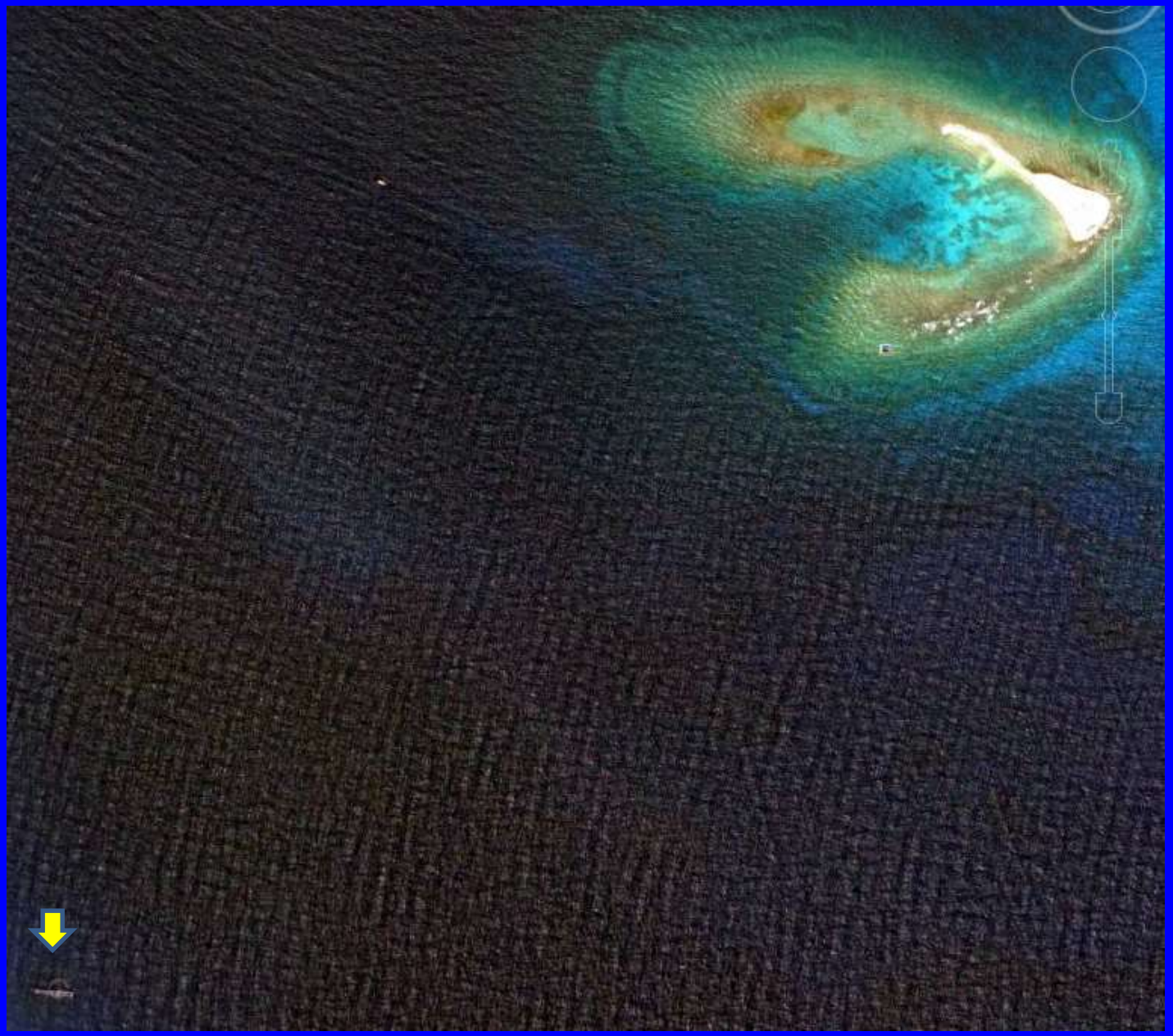
Sanvicente-Añorve et al 2014 MEPS 498: 27

How abundant can *N cyanomos* get in GoMx?

Cayo Arcas Survey: NS April 2016



Cayo Arcas loading platform



Cayo Arcas loading platform

Cayo Arcas Petro-Platform 3km from reefs

N. cyanomos on oil-loading platform at Cayo Arcas, Campeche Bank

Video by Nuno Simoes, April 2016

Adverse Invasion Potential?

Can reach very high density…but in one particular artificial habitat: 60 m high, high-current drop-off, with dense small-scale shelter

Native range: abundant on natural drop-offs (high relief habitat on reef edges)

In GoMx uses small- & large-scale drop-offs

Adverse Invasion Potential?

Can reach very high density…but in one particular artificial habitat: 60 m high, high-current drop-off, with dense small-scale shelter
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In GoMx uses small- & large-scale drop-offs

Lower densities in natural habitats:

Offshore reefs…aggregations to 50+

Inshore reefs….aggregations 1-30, not all local sites

Adverse Invasion Potential?

Can reach very high density…but in one particular artificial habitat: 60 m high, high-current drop-off, with dense small-scale shelter
Native range: abundant on natural drop-offs
In GoMx uses small- & large-scale drop-offs

Low densities in other habitats on inshore & offshore reefs.

→ Any adverse effects likely strongly habitat limited