Spawning Aggregations of Reef Fishes: Myths, Methods and MPA's

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Caesio teres at Enewetak Atoll



Spawning aggregations of coral reef fishes are fascinating and widespread biological and oceanographic phenomena found on Atlantic, Pacific and Indian Ocean coral reefs



Large numbers (10’s to 1000’s) of reef fishes come together at specific times and places for purposes of reproduction. The predictable nature of aggregations makes for easy exploitation and resultant disturbance of reproduction.

Platax orbicularis – possible spawning aggregation?

Bert Yates

Sometimes deciding what is (and is not) a spawning aggregation is not so simple!

Epinephelus polyphekedion

Is this a spawning aggregation? Yes!

Is this a spawning aggregation? Probably not!

Priacanthus hamrur

Is this a spawning aggregation? Maybe?

Fishes which aggregate include the larger commercial and food fishes. They have pelagic eggs which drift away with the current.

Knowledge of spawning aggregations is important for sustainable management of large reef fish populations and coral reefs in general. Knowledge of where and when they spawn is the basis of being able to monitor their status over time for management.

There are two basic types of spawning aggregations:

RESIDENT and **TRANSIENT**

RESIDENT aggregations form frequently, sometimes daily, over much of the year. Fishes migrate only short distances to spawn.

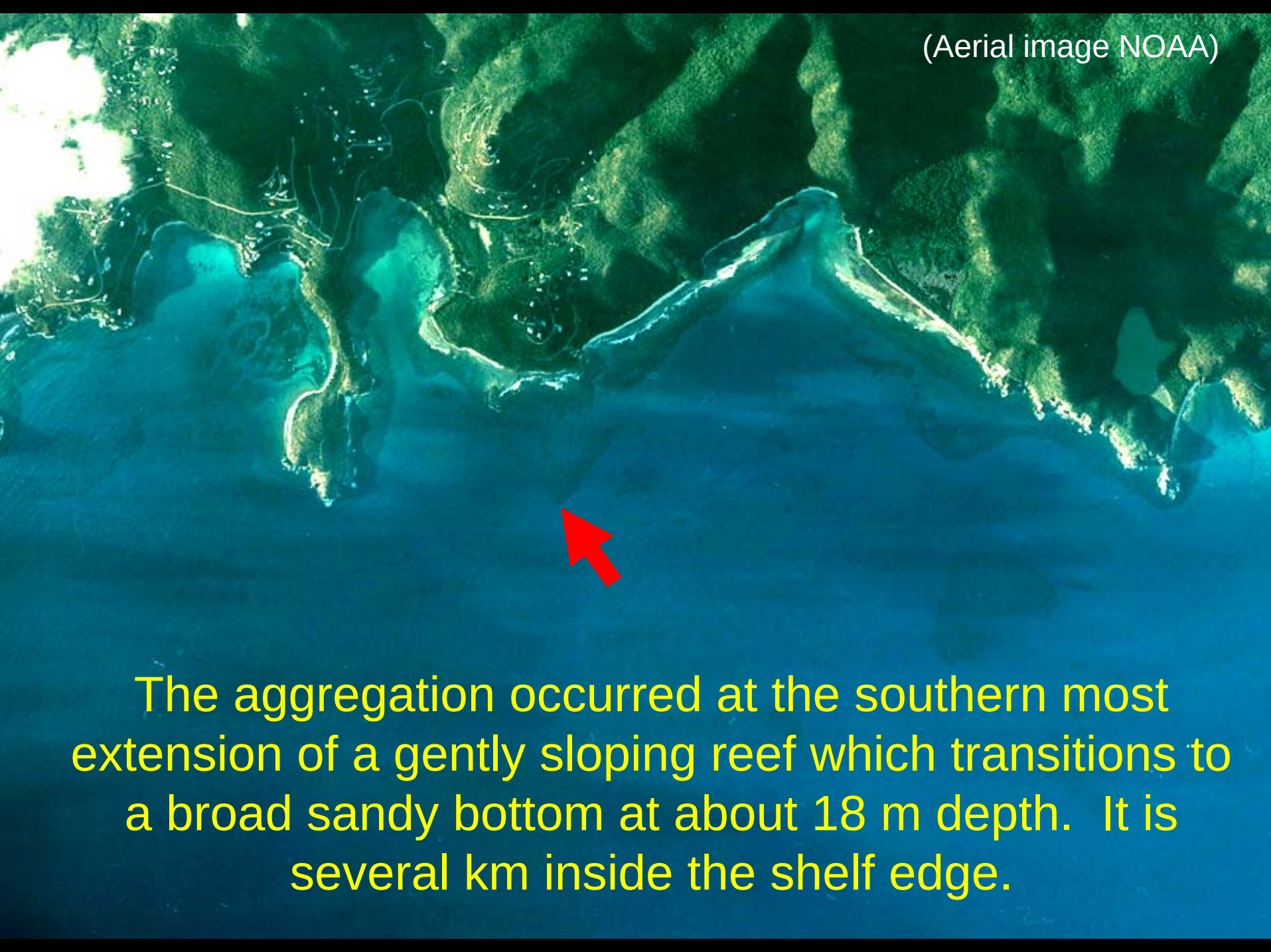
TRANSIENT aggregations occur only part of the year (seasonally), often with a strong lunar component. Fishes may migrate tens or hundreds of kilometers from home reefs to spawn.

THE SPAWNING AND EARLY DEVELOPMENT OF THE ATLANTIC PARROT FISH, *Sparisoma rubripinne*, WITH NOTES ON OTHER SCARID AND LABRID FISHES

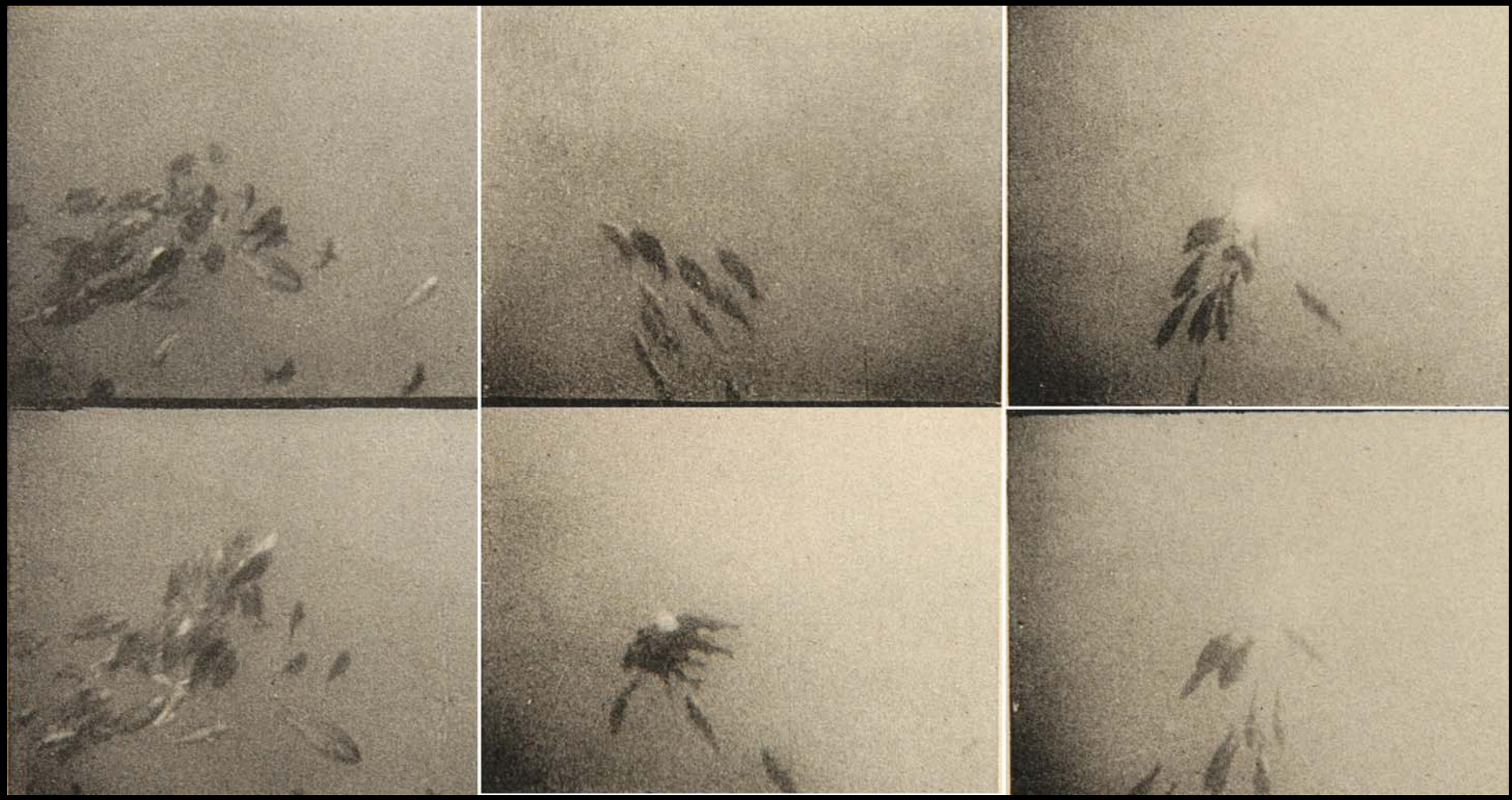
JOHN E. RANDALL & HELEN A. RANDALL

University of Puerto Rico, Mayaguez, Puerto Rico

The first scientific study of a spawning aggregation was by Jack and Helen Randall for the parrotfish *Sparisoma rubripinne* in the US Virgin Islands in 1960-61.



The aggregation occurred at the southern most extension of a gently sloping reef which transitions to a broad sandy bottom at about 18 m depth. It is several km inside the shelf edge.



Randall and Randall studied the behavior and dynamics of this aggregation of a few hundred fish over several months. They took movies and still photos, collected eggs and specimens; things that we are still doing today.

I visited the site in 1977 and again in 1988 and on these two occasions (the second 28 years after Randall and Randall's original observations) the aggregation still occurred in approximately equal numbers at the same location.

As far as I know, no one has checked on it since!

Although the conservation and management importance of spawning aggregations is becoming more generally realized, there is still a general lack of accurate information on the occurrence, and biological and physical relationships of spawning aggregations.

Lutjanus bohar – possible spawning aggregation Bert Yates

This was the impetus for the formation of the Society for the Conservation of Reef Fish Aggregations (SCRFA) in 2000

Funded by the David and Lucile Packard Foundation

SCRFA Mission Statement

To promote and facilitate the conservation and management of reef fish spawning aggregations….

….by building a strong case for their protection and management

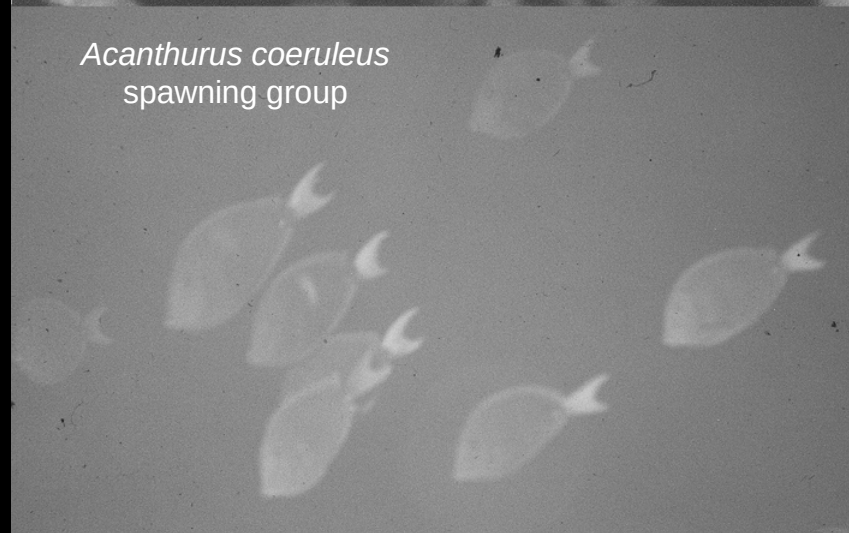
There are still huge gaps in knowledge of spawning aggregations as biological and oceanographic phenomena.

Many abundant and ecologically critical herbivorous and planktivorous reef fishes spawn in RESIDENT aggregations and also as pairs of fish on a daily basis.

For example, two of the three species of western Atlantic surgeonfishes (Acanthuridae) can form spawning aggregations in late afternoons numbering in the 1000’s of fishes.

Acanthurus bahianus

Acanthurus coeruleus



Acanthurus coeruleus
spawning group

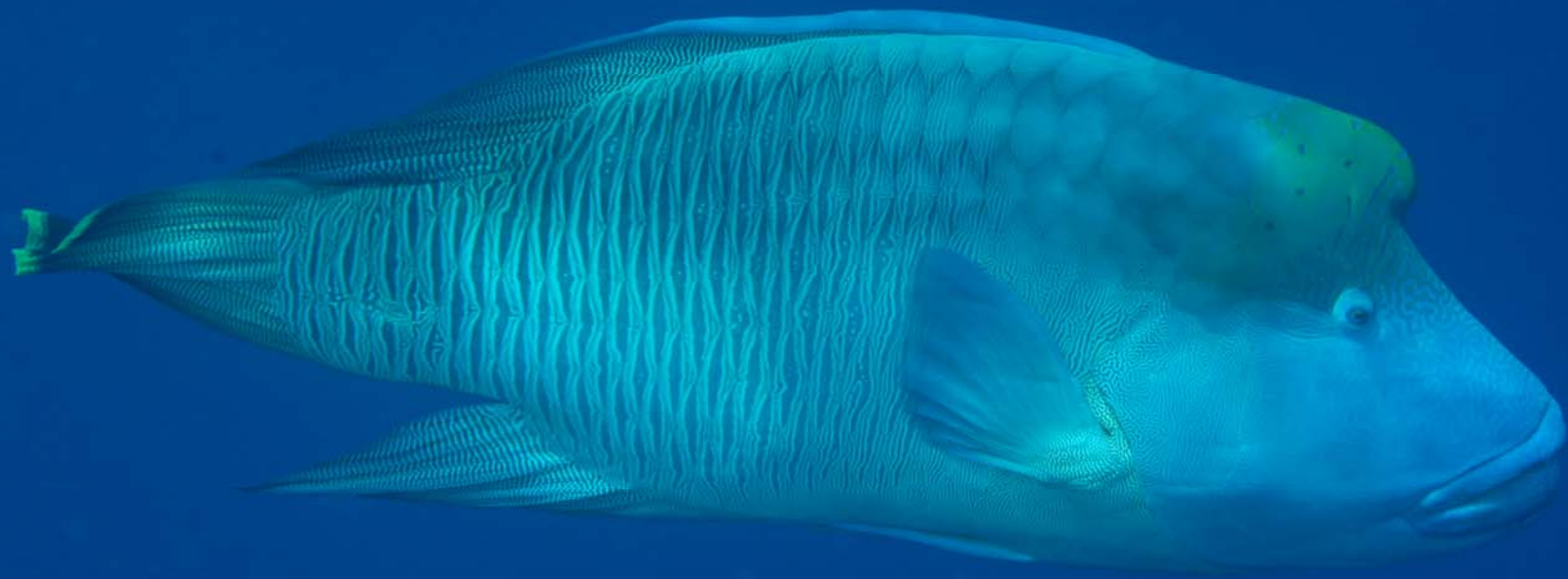
Many Indo-Pacific surgeonfishes also form spawning aggregations. Such spawning is usually related to tides.

The common fusillier, *Caesio teres*, spawns in large groups just after high tide at Enewetak in the Marshall Islands.

They spawn on a reef promontory inside in a major reef channel.

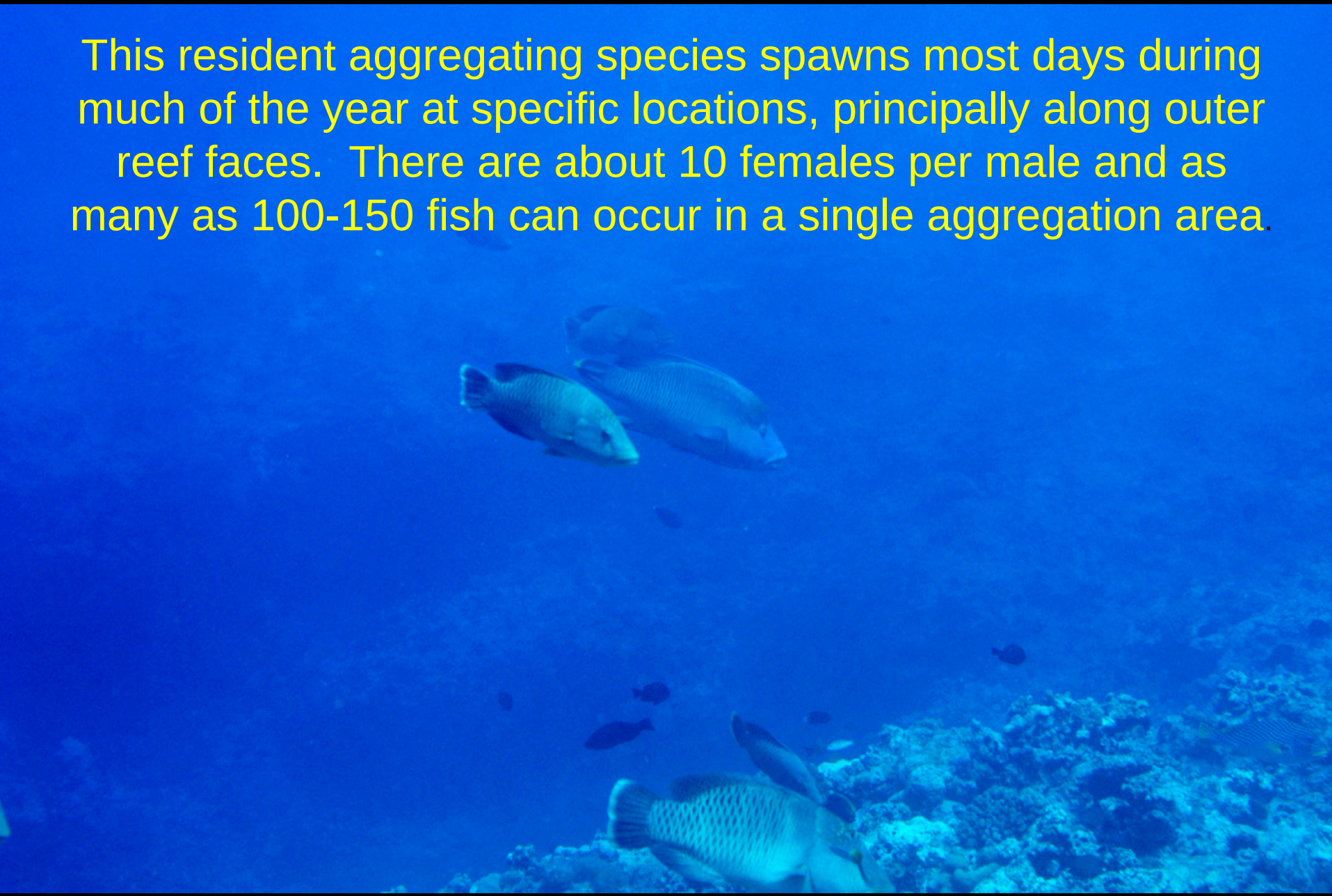
Spawning starts about 30 minutes after high tide in the late afternoon. Beyond this, we know little about the seasonality or lunar components of their spawning.

RESIDENT aggregations are not just restricted to the smaller species!

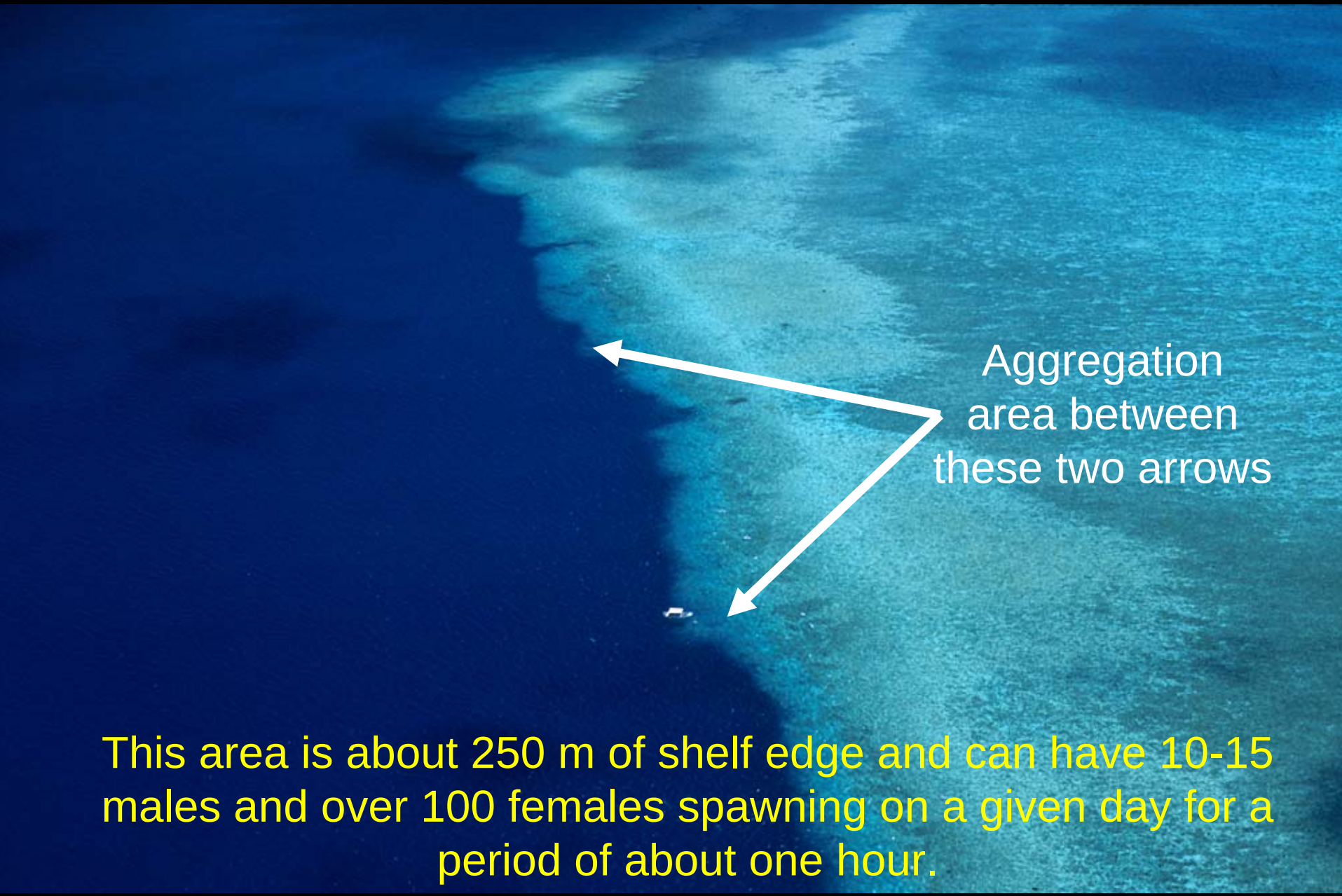


Cheilinus undulatus – humphead wrasse - male.

The World's Largest Wrasse!

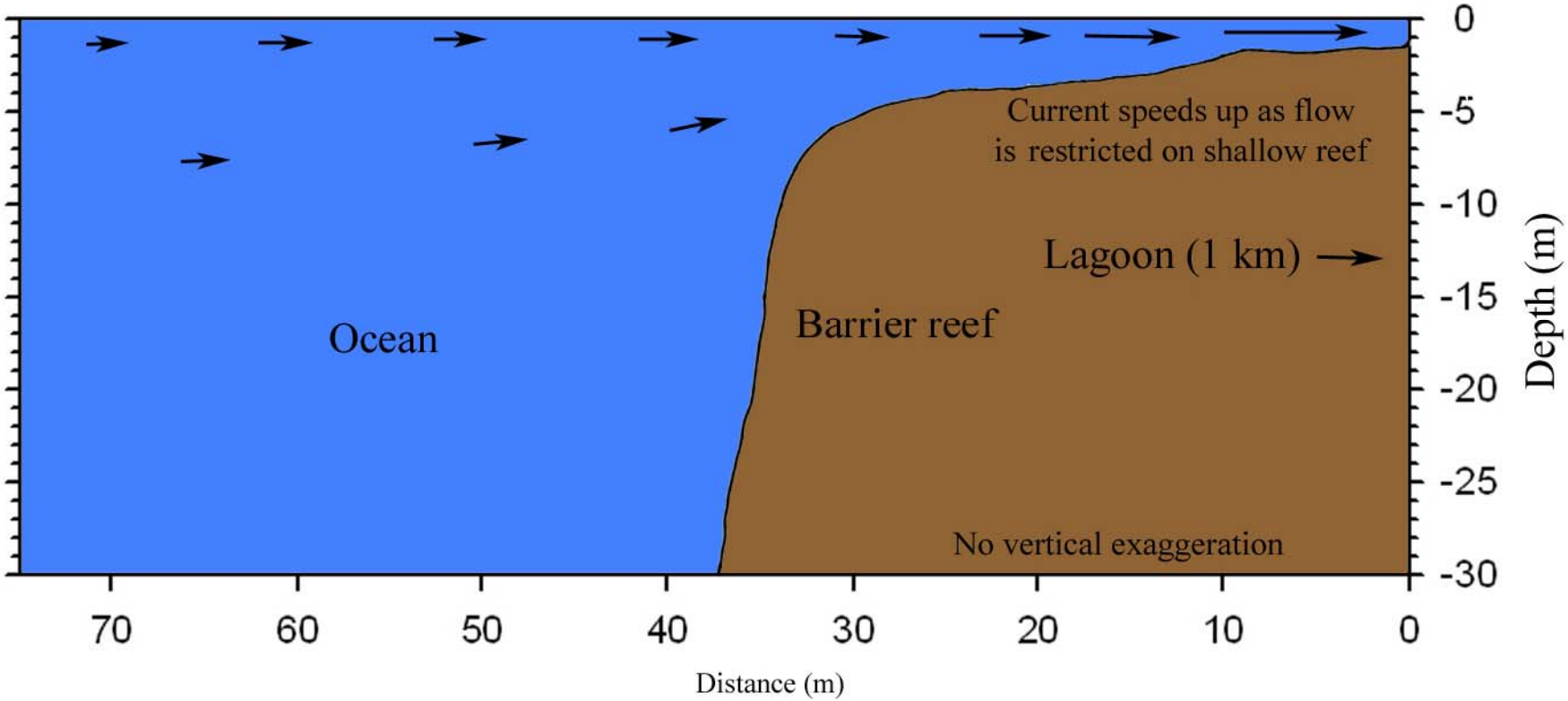


This resident aggregating species spawns most days during much of the year at specific locations, principally along outer reef faces. There are about 10 females per male and as many as 100-150 fish can occur in a single aggregation area.



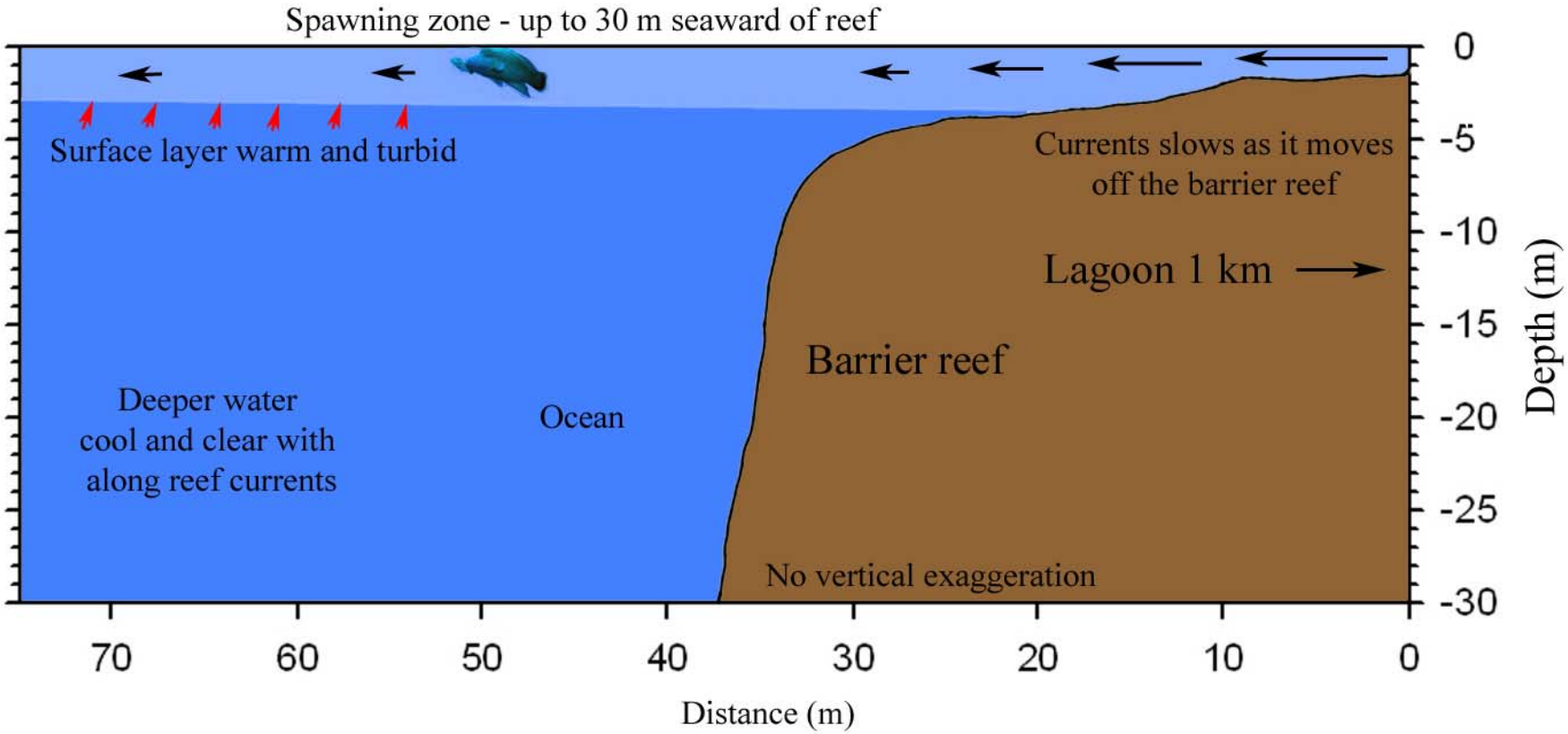
This area is about 250 m of shelf edge and can have 10-15 males and over 100 females spawning on a given day for a period of about one hour.

Incoming (rising) tide - water moves from ocean to lagoon across barrier reef



Oceanic water is brought in across the barrier reef on the rising tide

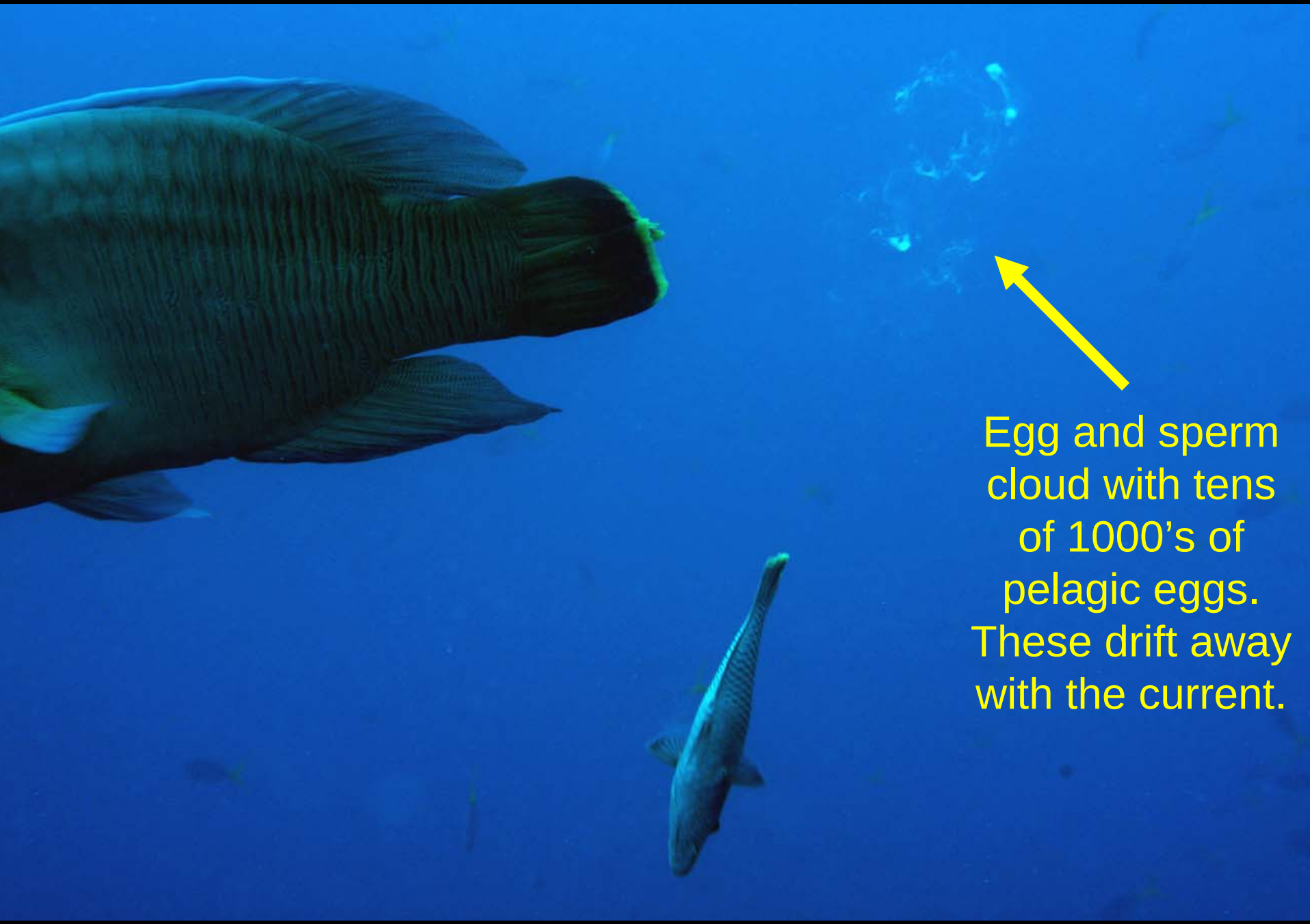
Outgoing (falling) tide - water moves from lagoon to ocean



Fish spawn as pairs at surface up to 30 m seward of the shallow reef

Male in normal swimming attitude


Male in courtship posture


Egg and sperm cloud with tens of 1000’s of pelagic eggs. These drift away with the current.

For TRANSIENT aggregations, the first scientific report for any species was by C. L. Smith in 1972 for the Nassau grouper, *Epinephelus striatus*.

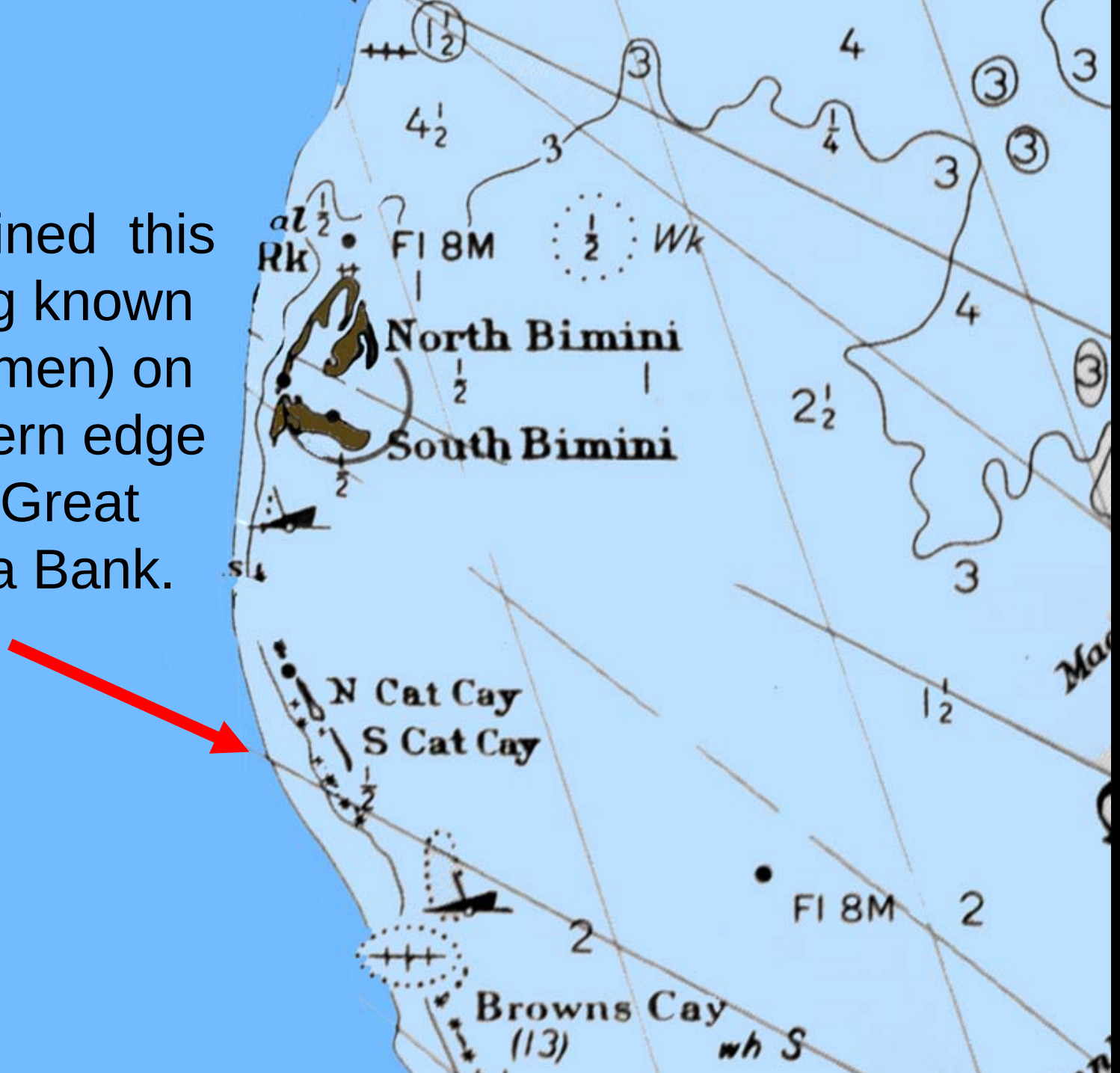
A Spawning Aggregation of Nassau Grouper, *Epinephelus striatus* (Bloch)

C. Lavett Smith
The American Museum of Natural History
Central Park West at 79th St., New York, N. Y. 10024

ABSTRACT

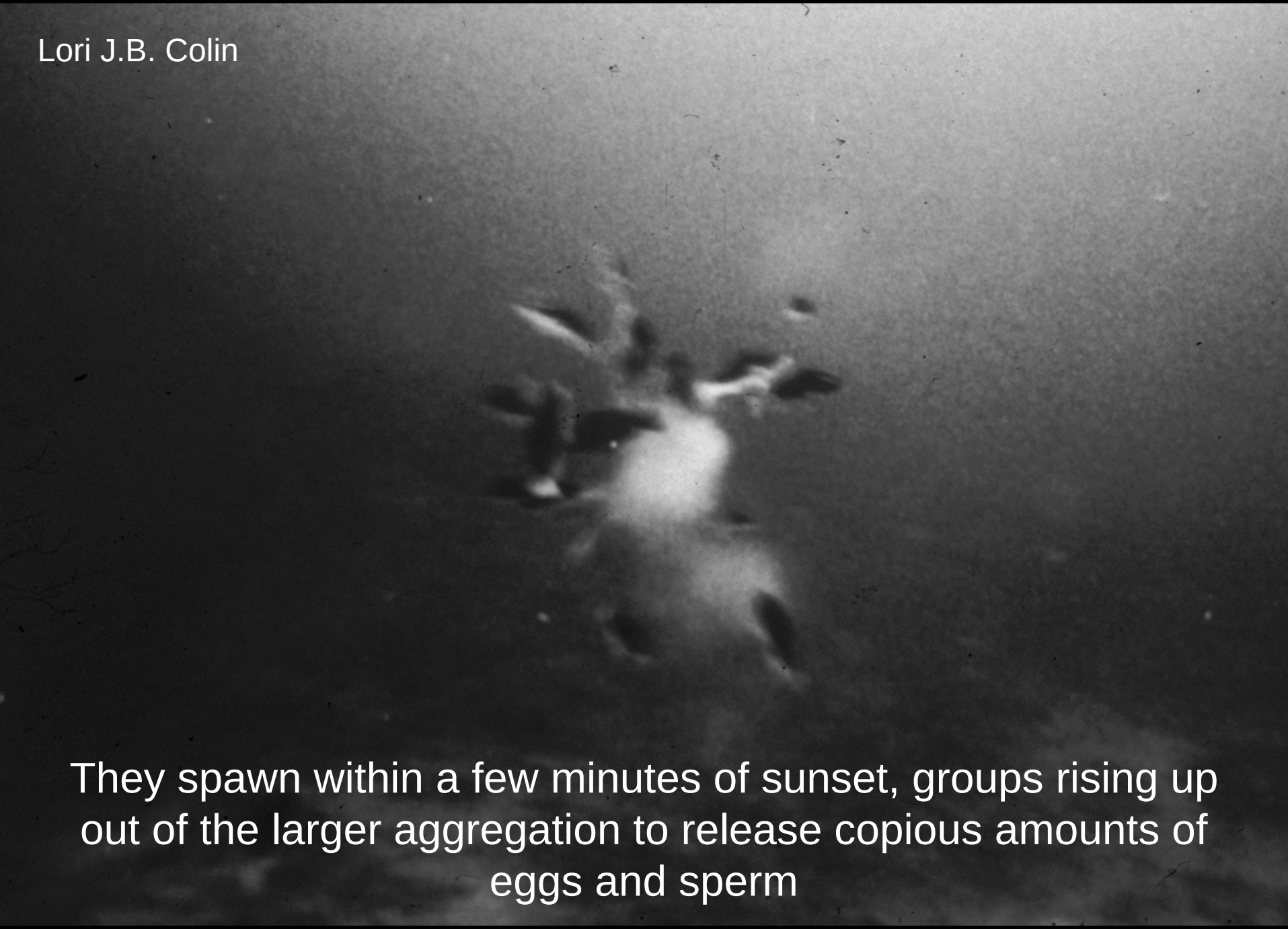
A spawning aggregation, estimated to consist of 30,000 to 100,000 Nassau groupers, occurred during the third week of January 1971 off Cat Cay in the Bahamas. The fish congregated near the edge of deep water and about one-third were in an unusual color pattern—dark above and light below with some of the usual head markings reversed. Histological sections revealed that both sexes were sexually active; one female had ovulated eggs in the ovary, another had ripe eggs in the ovarian follicles. Fishermen report similar spawning aggregations at selected localities throughout the Bahamas.

He examined this site (long known to fishermen) on the western edge of the Great Bahama Bank.



Nassau grouper aggregate around winter full moons at discrete locations, many long known to and exploited by fishermen.


As spawning approaches many fish enter the distinctive
“bicolor” phase.


Lori J.B. Colin
They spawn within a few minutes of sunset, groups rising up out of the larger aggregation to release copious amounts of eggs and sperm

After release and fertilization, the slightly buoyant eggs drift away with the currents.

Nassau grouper had the largest aggregations (up to many 1,000's) of any western Atlantic grouper. This is no longer the case.

It is unknown whether Nassau groupers can successfully reproduce outside of spawning aggregations. Present evidence indicates they probably do not!

Unfortunately most known aggregations have been largely fished out or heavily impacted. On the positive side, many of the remaining aggregations are now receiving protection!

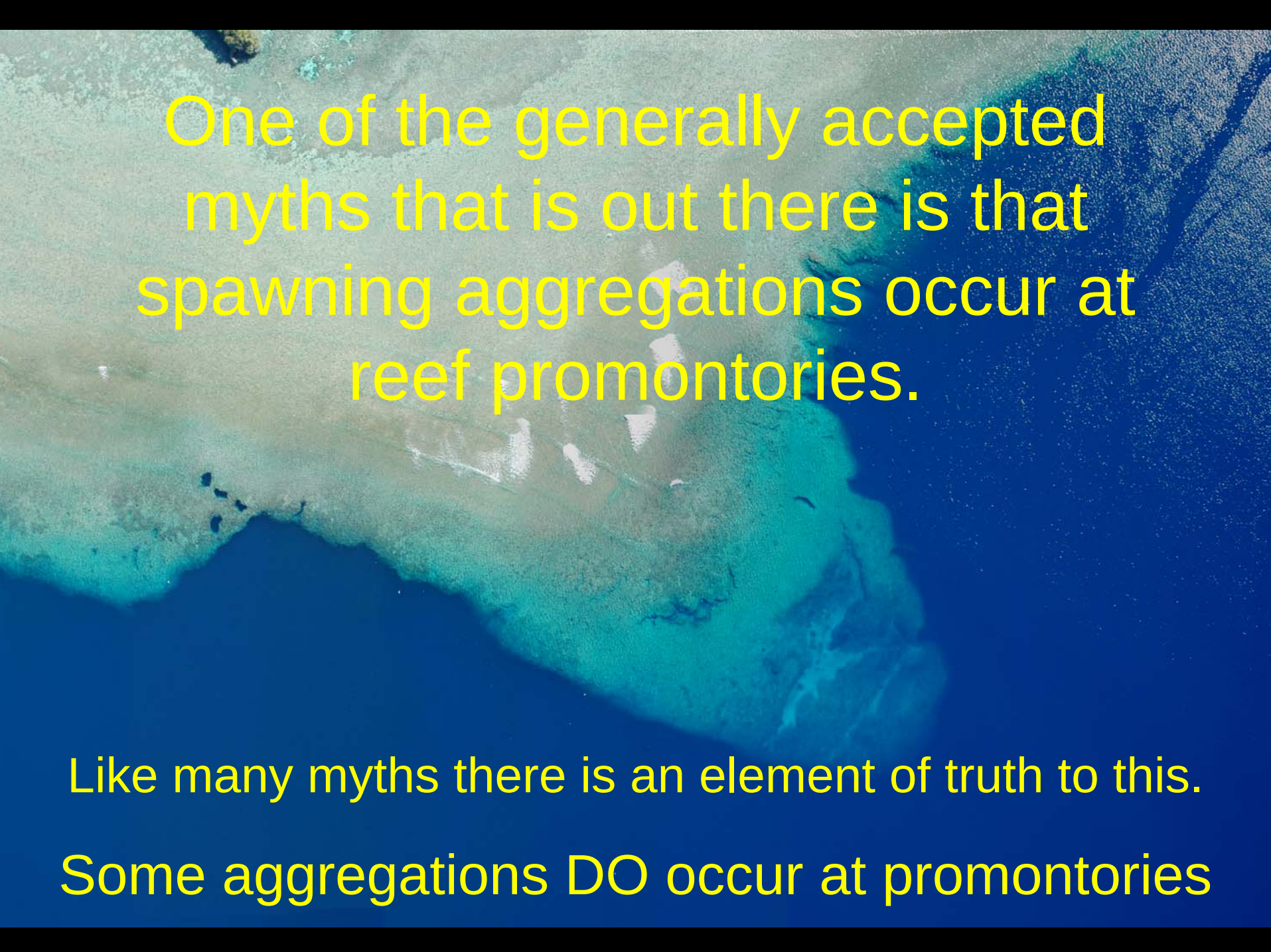
Many TRANSIENT aggregators use the same sites, often simultaneously. These “MULTI-SPECIES” aggregation sites have been known to fishermen for decades.



In the western Atlantic, Nassau, yellowfin, and tiger groupers (plus species in other families) aggregate at the same sites, but may have different peak months.

MULTI-SPECIES aggregations also occur in the western Pacific.

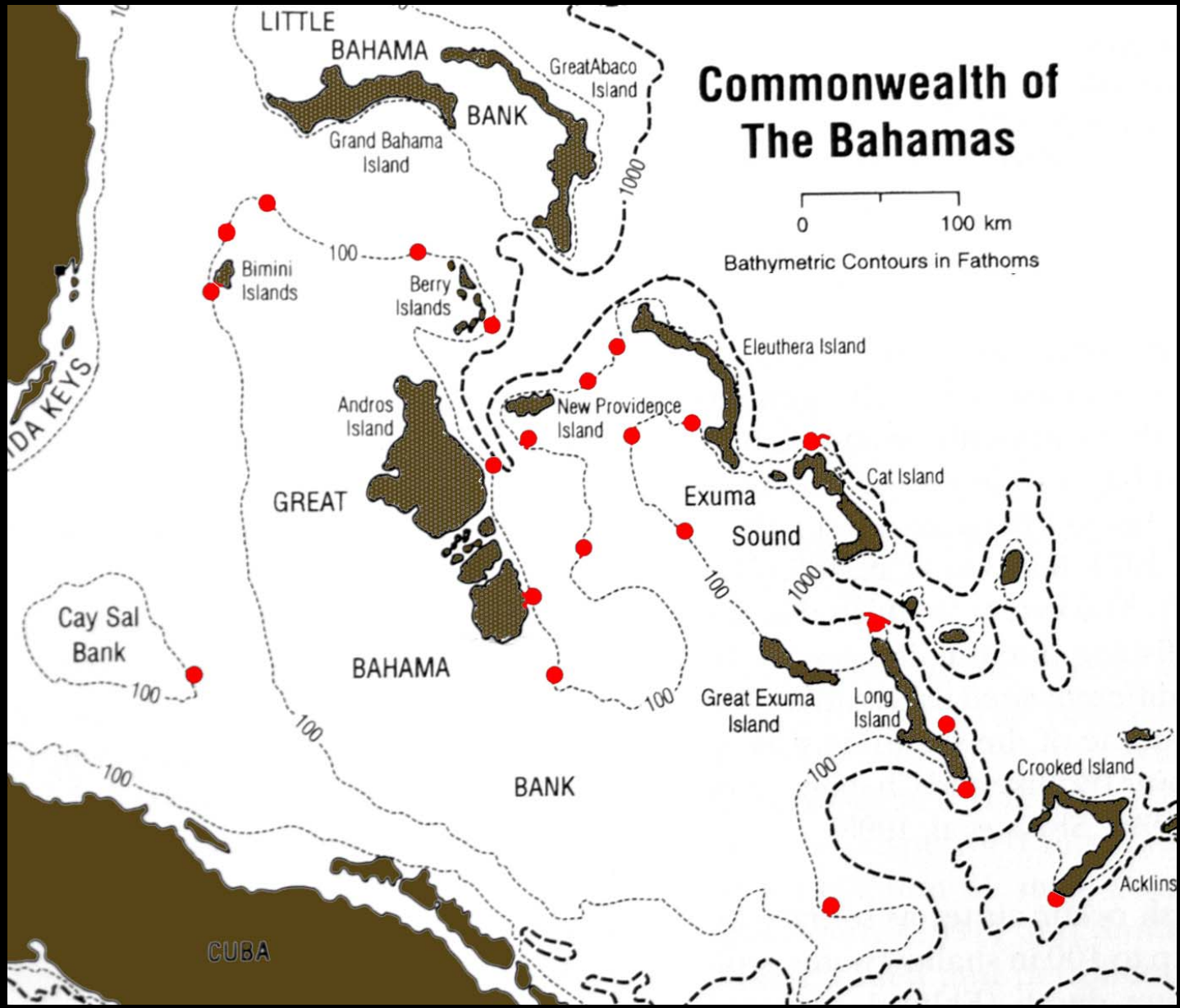
For example, three species of groupers, *Plectropomus areolatus* (A), *Epinephelus fuscoguttatus* (B) and *E. polyphekedion* (C), (AKA – "The Trio") aggregate together, again with slightly different seasonal peaks.


One of the generally accepted myths that is out there is that spawning aggregations occur at reef promontories.
Like many myths there is an element of truth to this.
Some aggregations DO occur at promontories

Others are found near channels or along linear areas of reef without distinctive features.

A given species may have variation in the types of aggregation site.
For example, Nassau grouper aggregations occur at **BOTH** promontory and non-promontory areas.

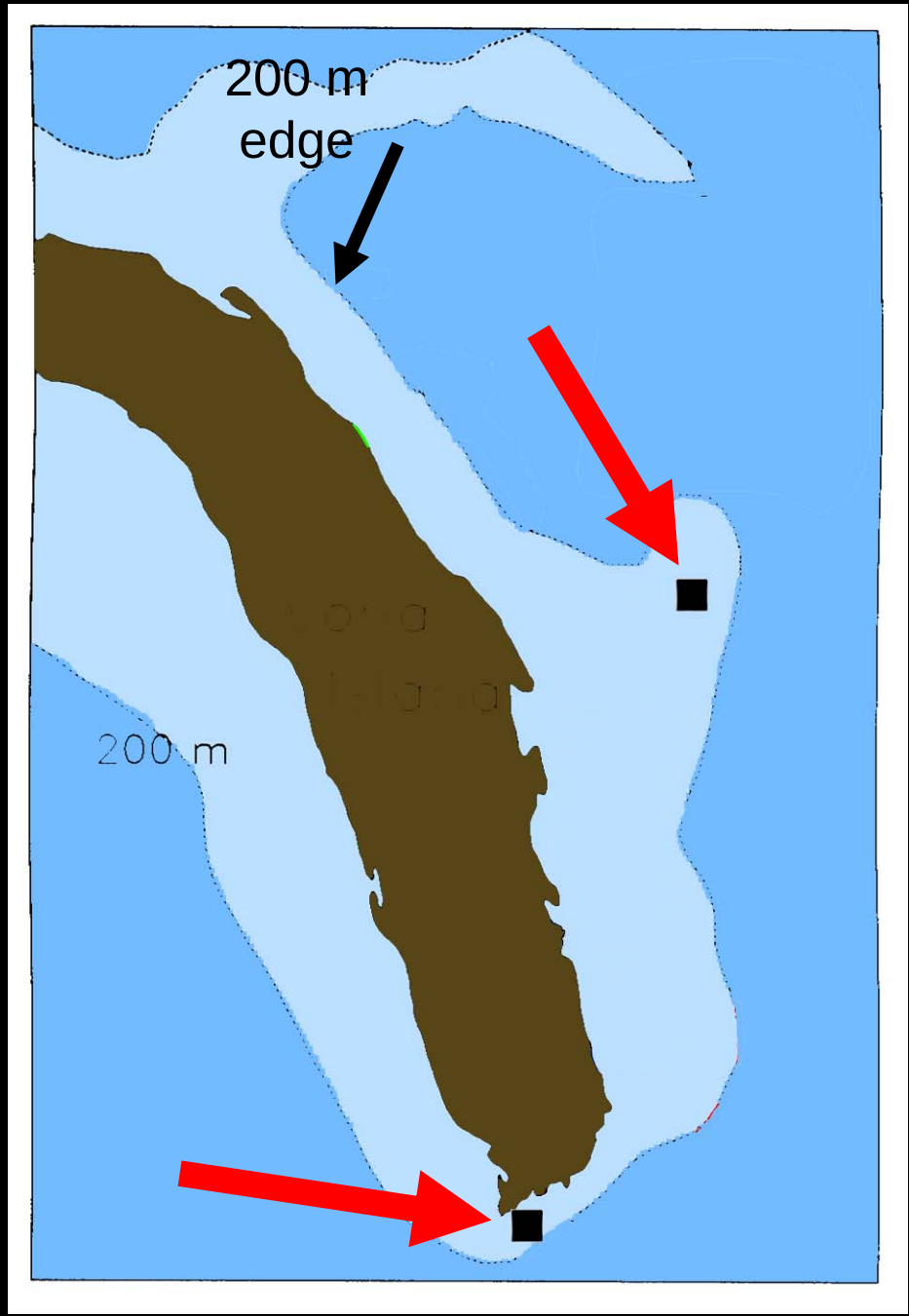
Most Nassau grouper aggregation sites (red dots) in the Bahamas are not promontories.



It has been suggested satellite images can be used to locate unknown aggregation sites.

Using the locations of well known aggregation sites, we can assess the value of satellite images to "discover" unknown aggregation sites.

If we look for these two Nassau grouper aggregation sites in southern Long Island, Bahamas……



.. the bottom is not even visible for these areas in a Landsat Image!

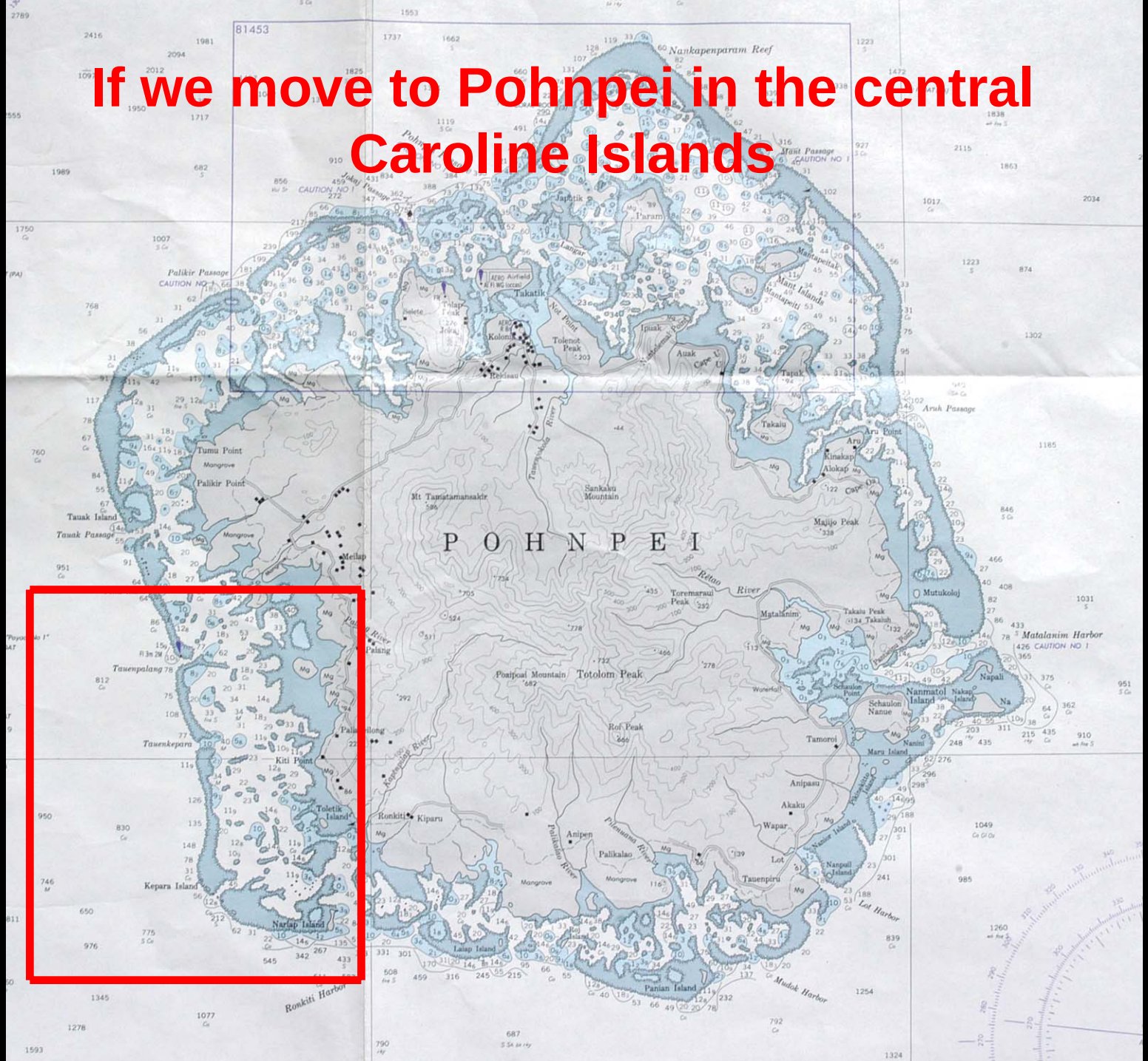
Variability in site utilization also occurs commonly in the Pacific

Spawning aggregation area

Ngermakaol (Ulong Channel) – Palau

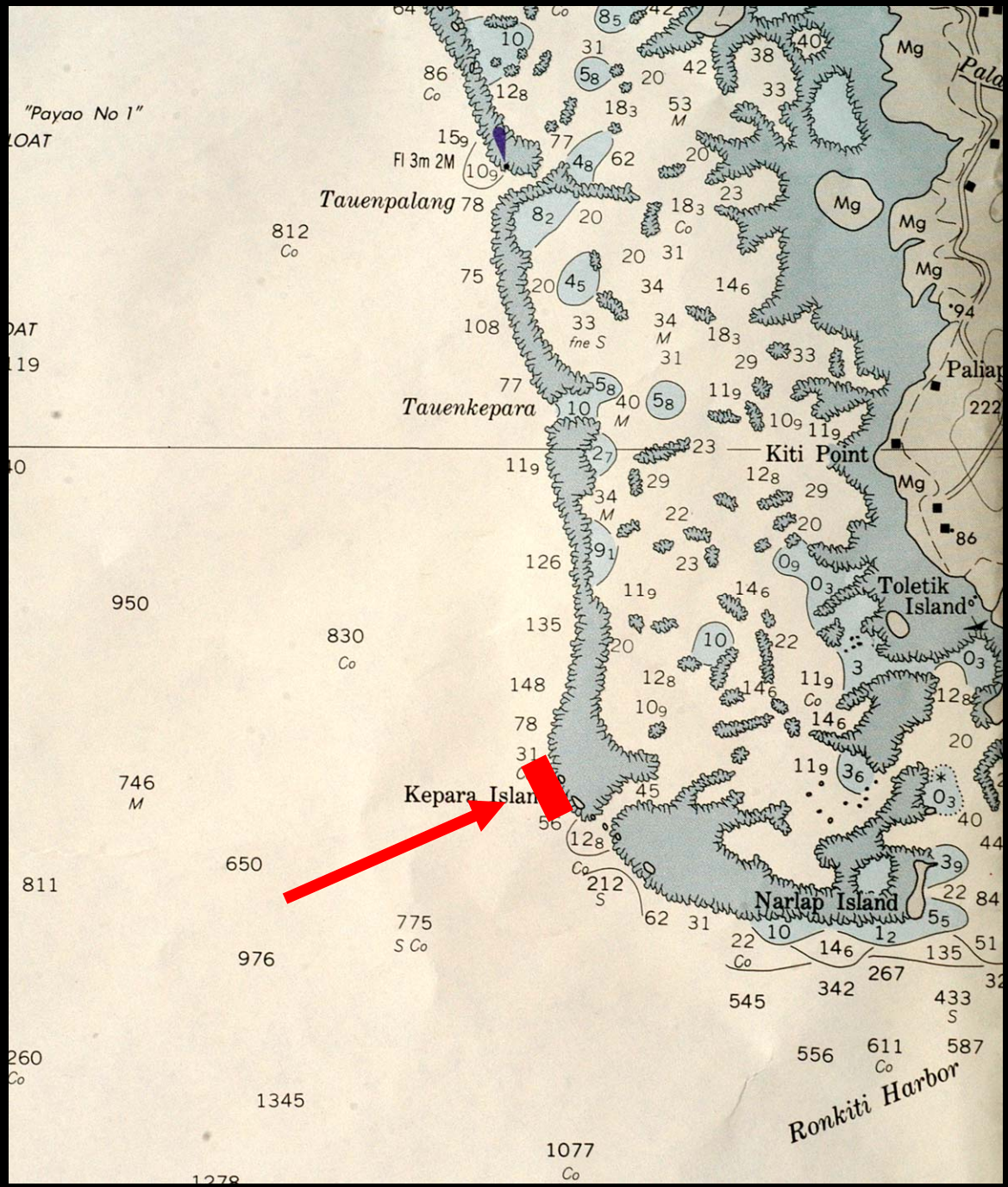
Epinephelus polyphekedion (A), *Epinephelus fuscoguttatus* (B) and *Plectropomus areolatus* (C).

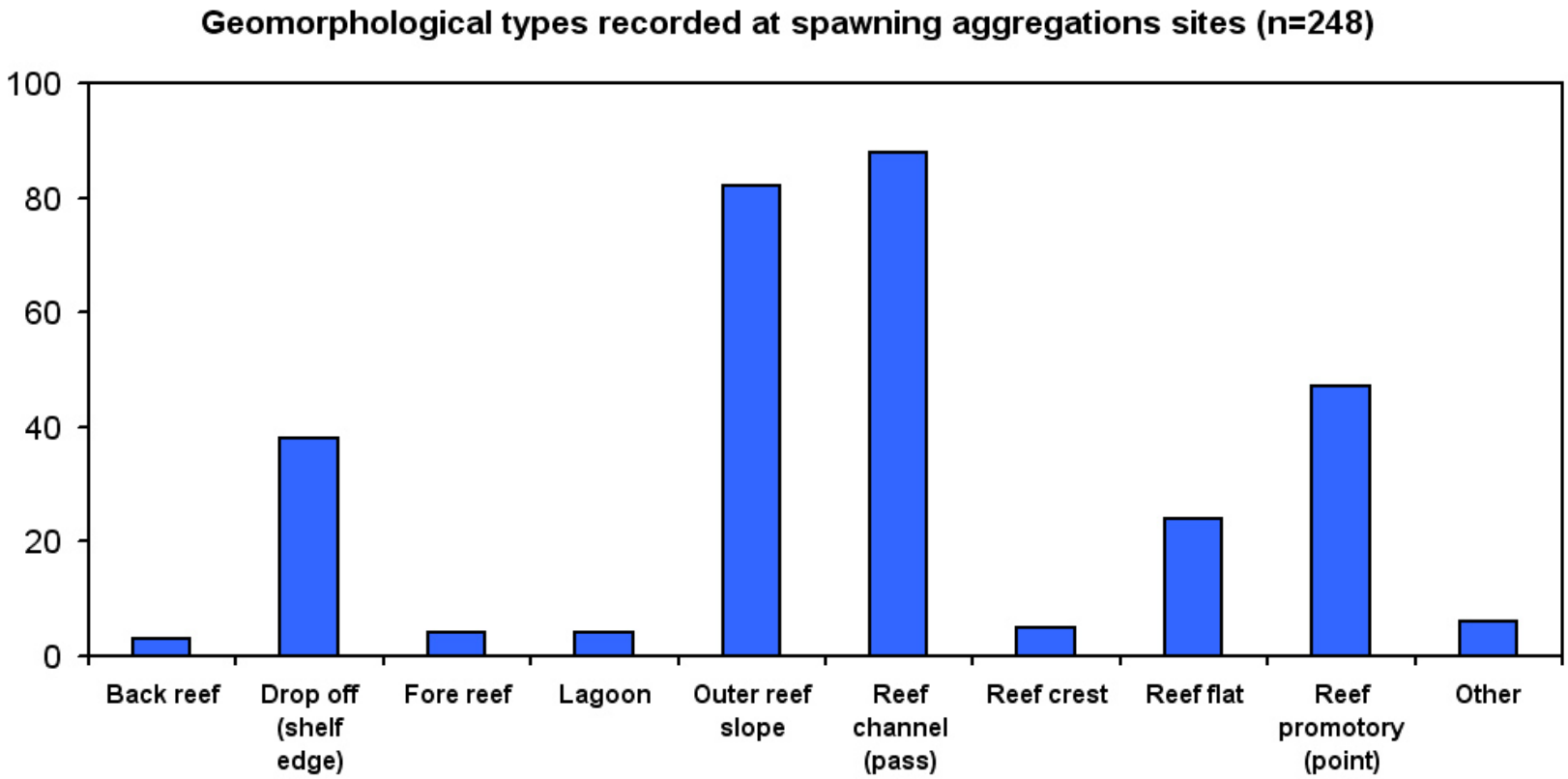
If we move to Pohnpei in the central Caroline Islands



In Pohnpei, the same trio of grouper species aggregate on the outer reef slope at a corner of the island, despite channels being nearby!

Why? We don't know

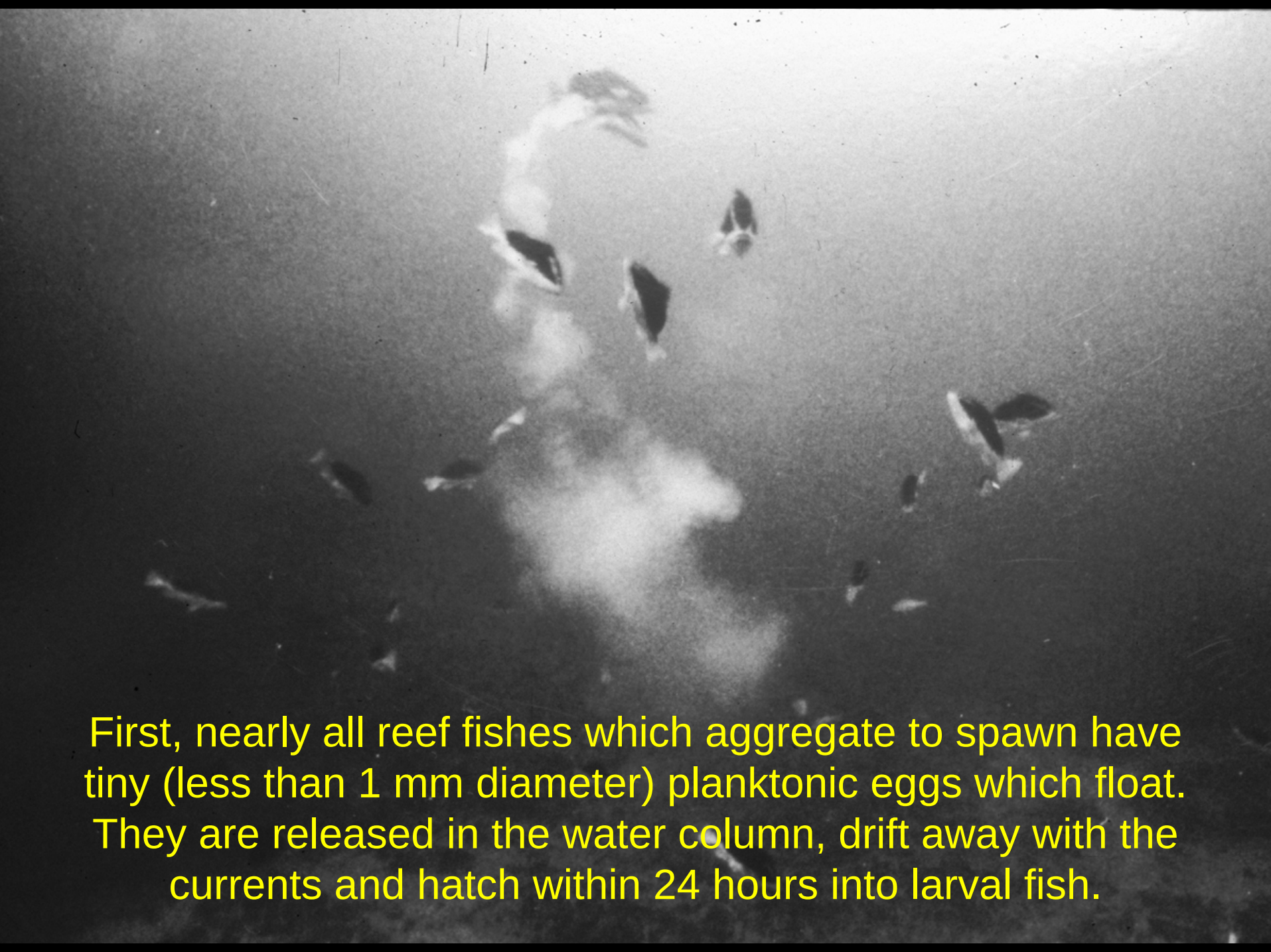



Geomorphological types recorded at spawning aggregations sites (n=248)
100
80
60
40
20
0
Back reef
Drop off (shelf edge)
Fore reef
Lagoon
Outer reef slope
Reef channel (pass)
Reef crest
Reef flat
Reef promotory (point)
Other

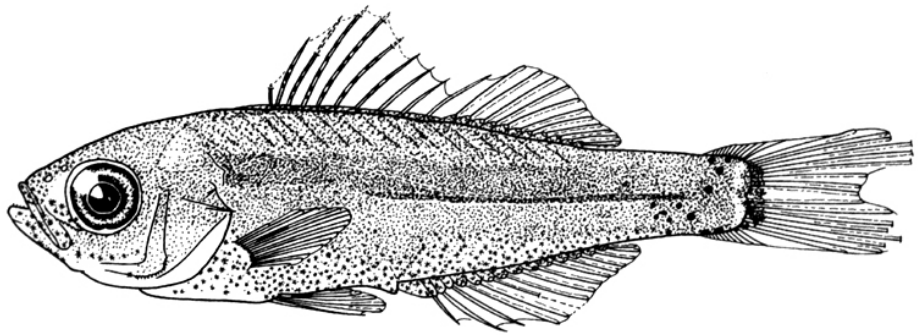
SCRFA

What does this mean for MPA’s?

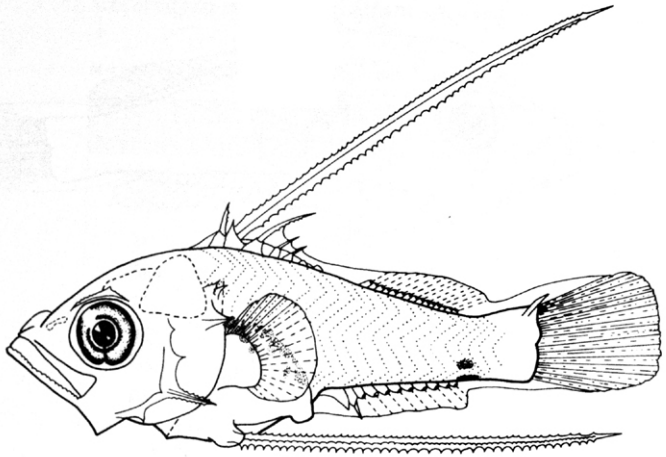
First you need to know a little bit about reef fish life history.

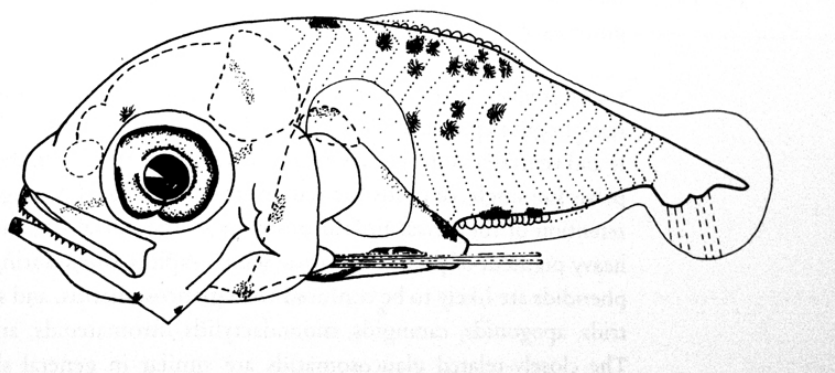


First, nearly all reef fishes which aggregate to spawn have tiny (less than 1 mm diameter) planktonic eggs which float. They are released in the water column, drift away with the currents and hatch within 24 hours into larval fish.



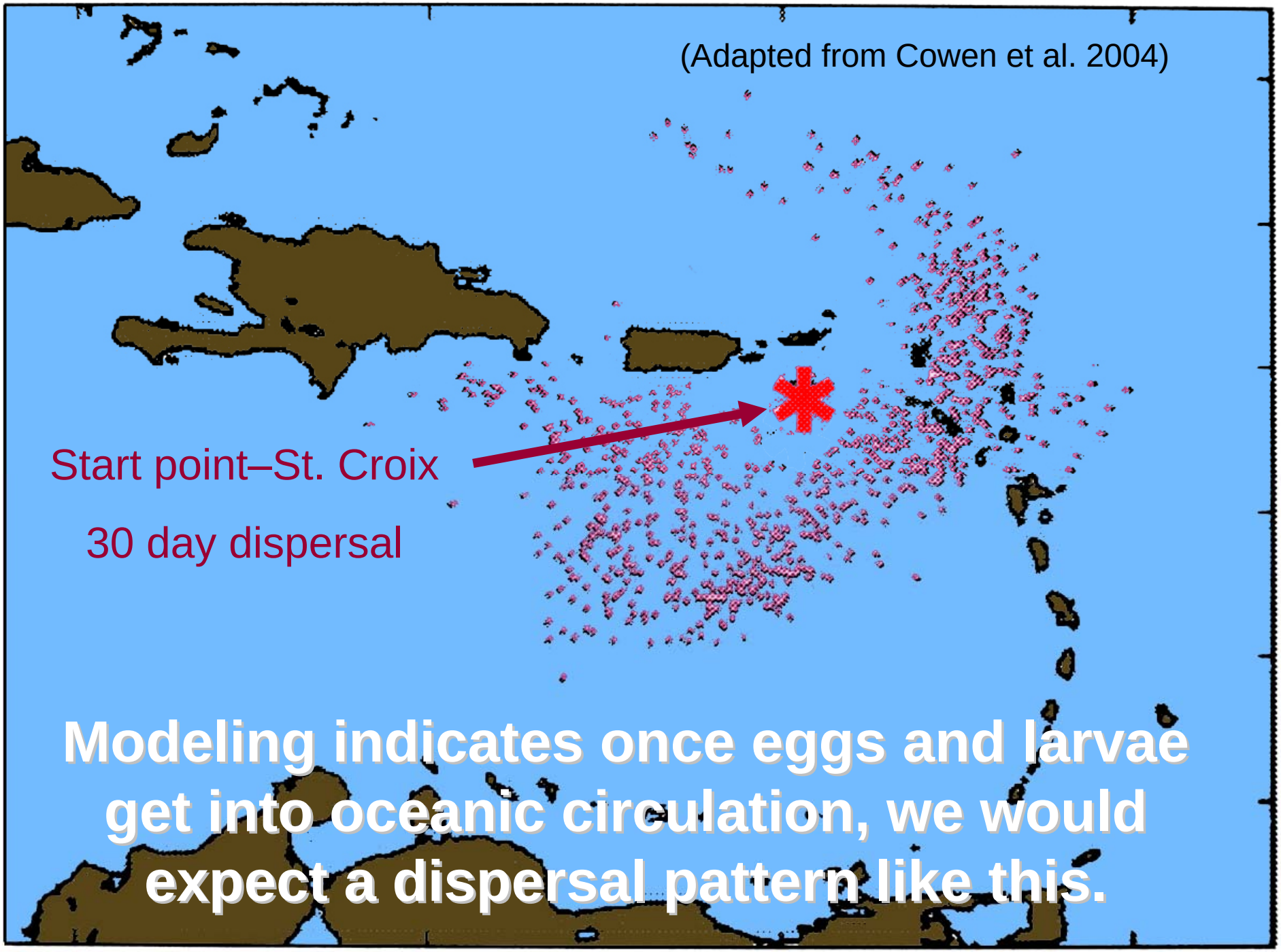
The larval fish spend a few weeks to several months living in the water column





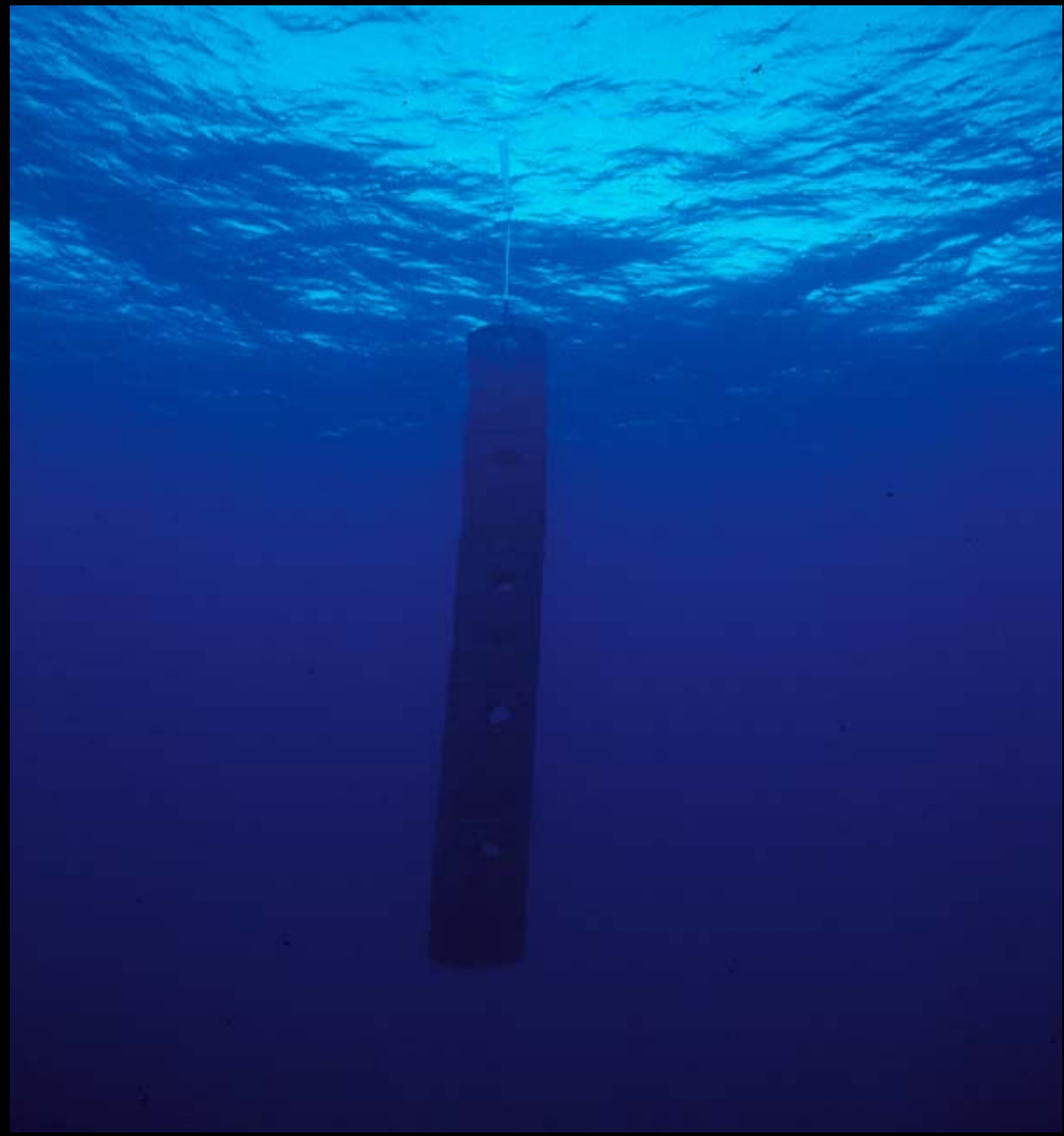
That the conclusion of their planktonic lives they take up residence on the bottom as juveniles, eventually growing into adult fishes which complete the process.

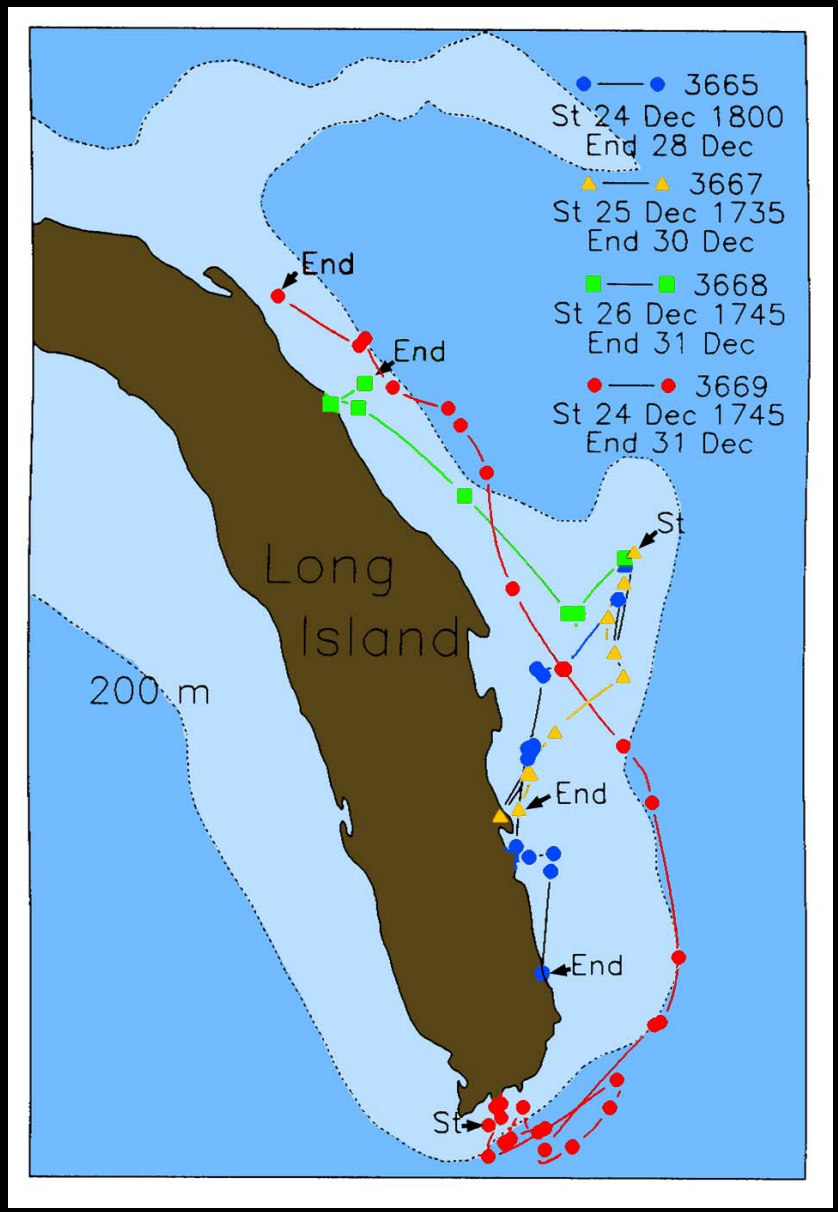
So, where do eggs and larvae go after spawning?

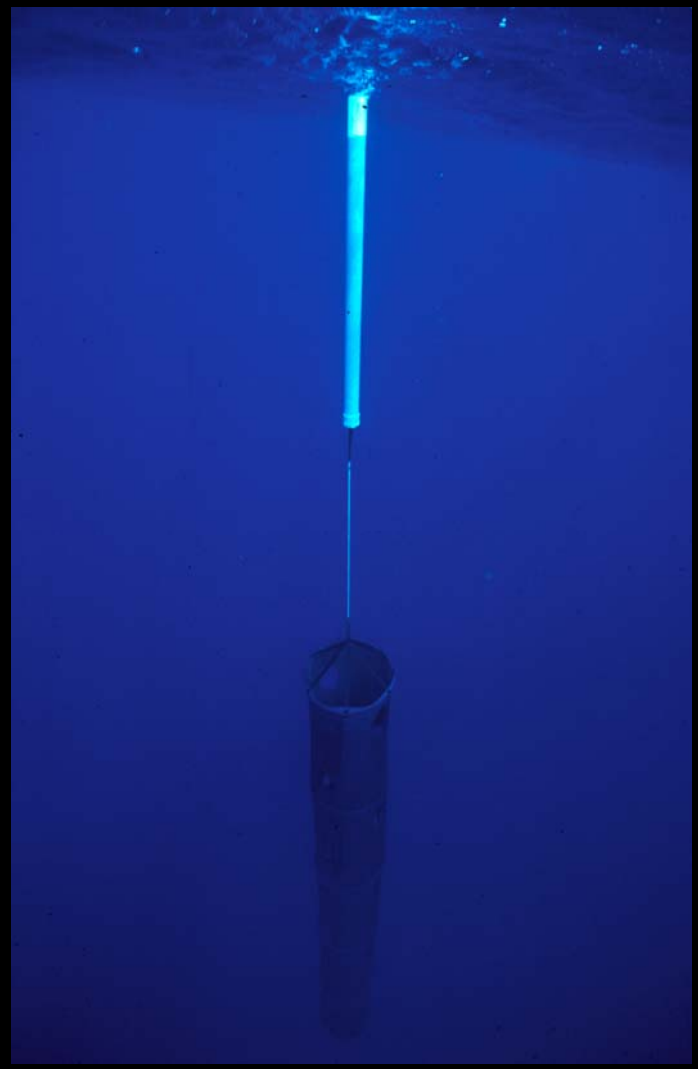

(Adapted from Cowen et al. 2004)
Start point–St. Croix
30 day dispersal
Modeling indicates once eggs and larvae get into oceanic circulation, we would expect a dispersal pattern like this.

But, do eggs and larvae move into oceanic circulation easily? This is a great “nearly unknown”.

One way to approach this question is to use current following drifters.

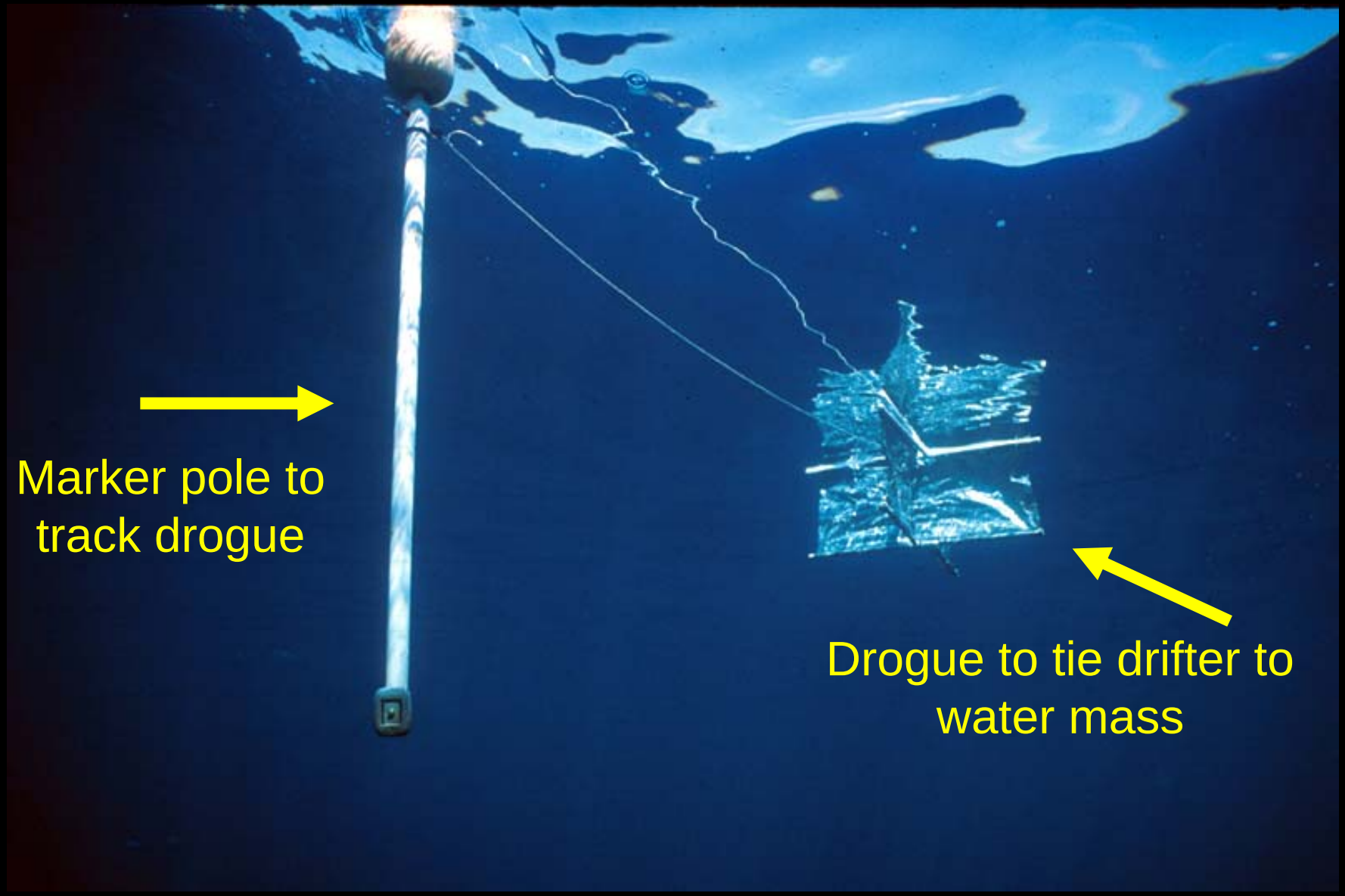






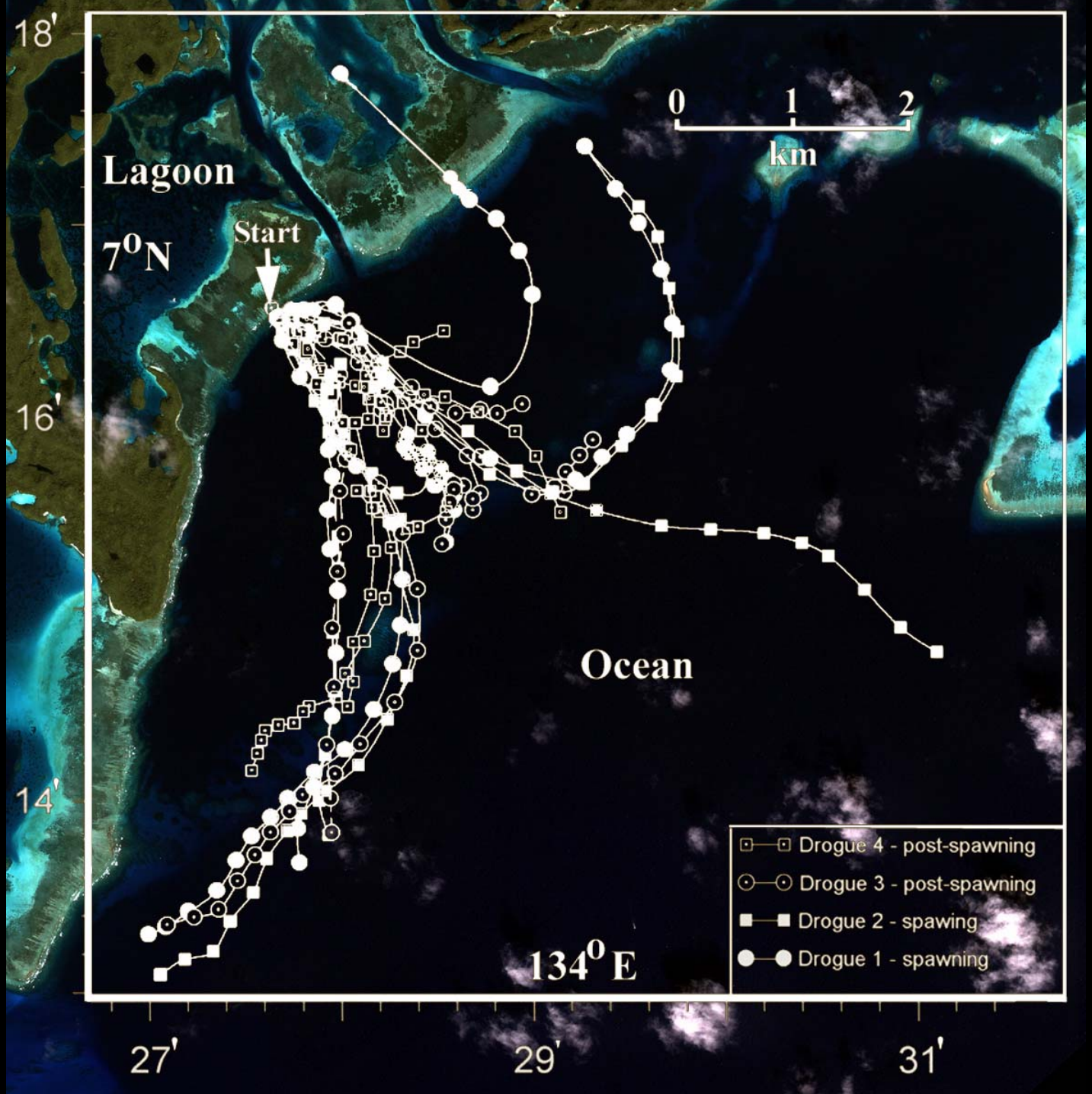
Tracks of satellite drifters released at Nassau grouper spawning sites at the time of spawning

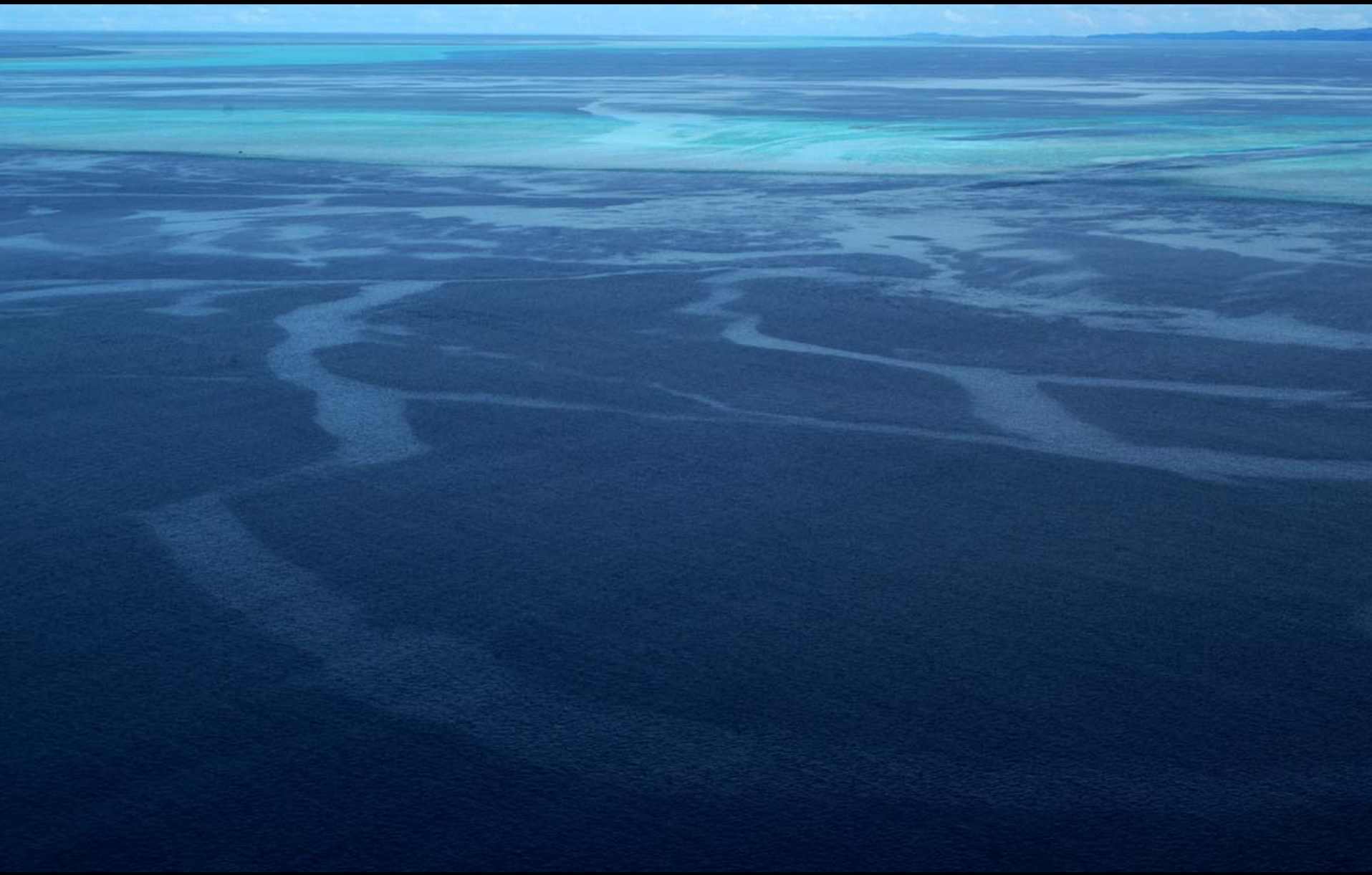
Drifters from spawning sites do not necessarily move easily into oceanic circulation



Simple GPS logging drifters can be used to track local currents from spawning sites to assess the transport of eggs (and larvae) over periods up to a few days.

Drifter from surface. GPS unit logs position at selected intervals. Drifter is recovered later (hopefully!).

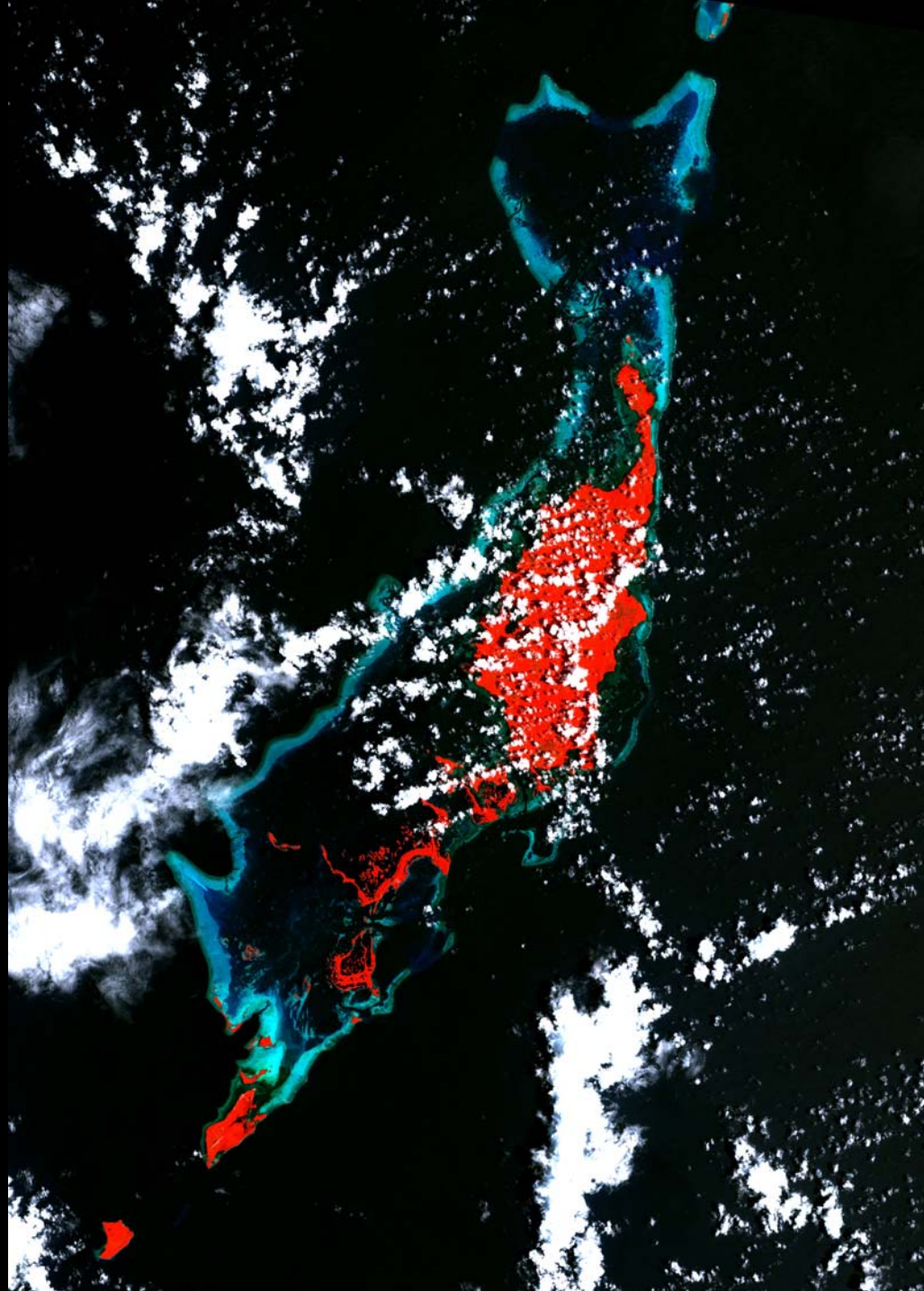

18'
16'
14'
27'
29'
31'
0
1
2
km
Lagoon
Start
7°N
Ocean
134° E
Drogue 4 - post-spawning
Drogue 3 - post-spawning
Drogue 2 - spawing
Drogue 1 - spawning



Ocean areas near reefs are often dominated by surface slicks.

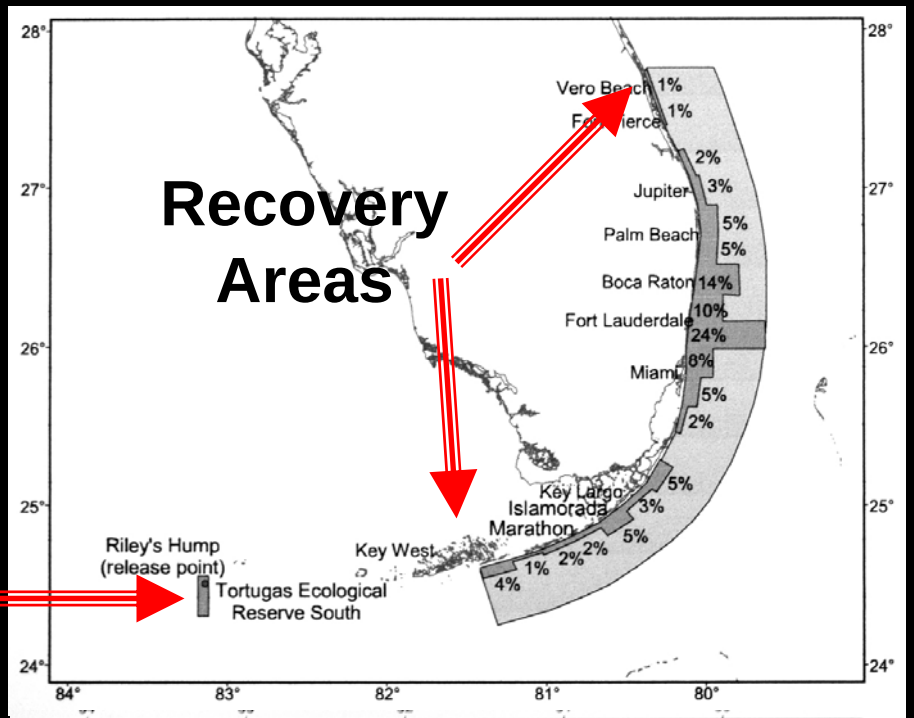
Within just a few hours drifters started at a spawning site at 30 min intervals often end up close together along slick lines due to convergent circulation (Langmuir cells). The same happens with planktonic fish eggs since they float.

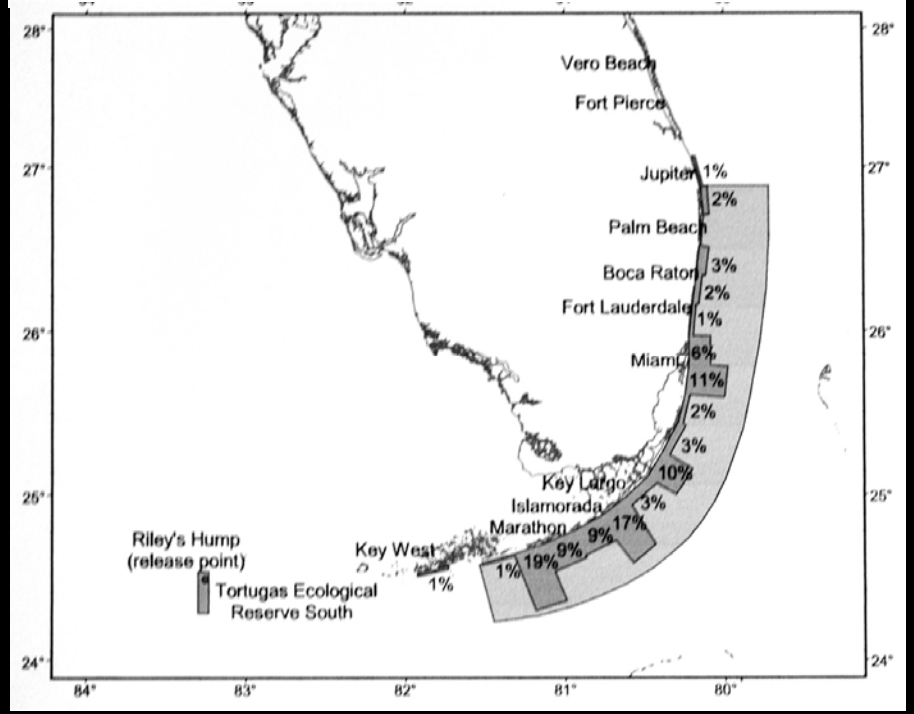
Overall it can be said that an island like Palau has “sticky water”. Water with larvae from the lagoon and inshore areas can remain around the archipelago for a prolonged period of time.

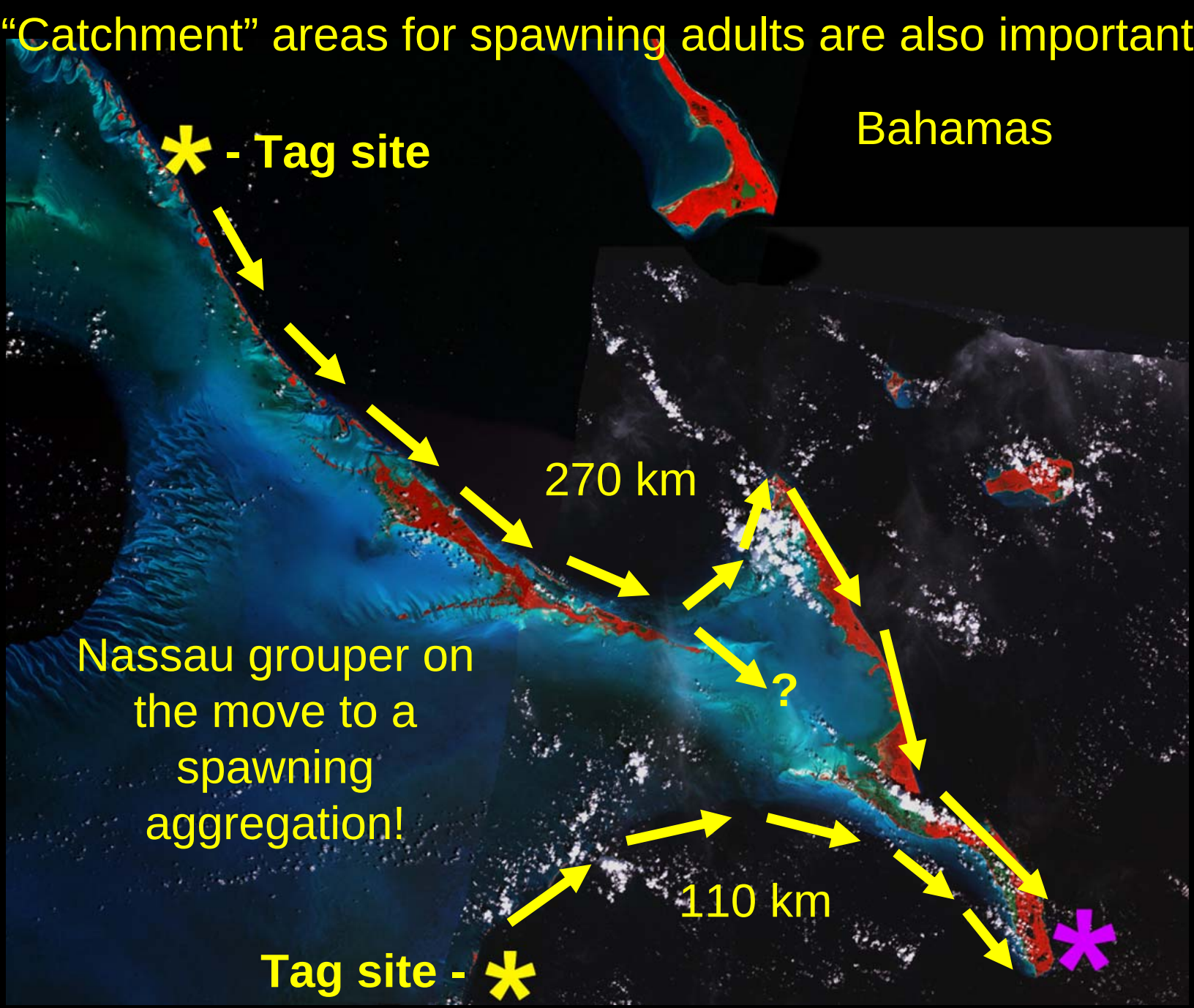


There's always an exception to this general rule. At "Riley's Hump", a MPA part of the Tortugas Reserve drift vials were carried far away from the isolated bank where there is nothing to stop general currents from sweeping eggs away after spawning.

Start site






"Catchment" areas for spawning adults are also important
Bahamas
* - Tag site
270 km
?
Nassau grouper on the move to a spawning aggregation!
110 km
Tag site - *

Benefits that inclusion of spawning aggregations in MPA's has to offer marine conservation?

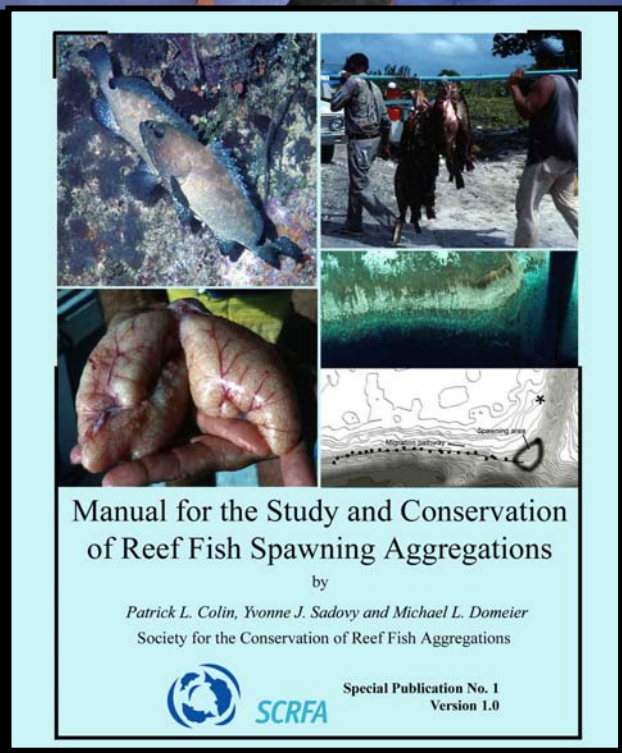
- Protection of aggregating fish allows undisturbed reproduction.
- Limited protection of populations during their migration to and from the site.
- Little to no protection to eggs, larvae and recruits because of wide dispersal of eggs and larvae.

Information

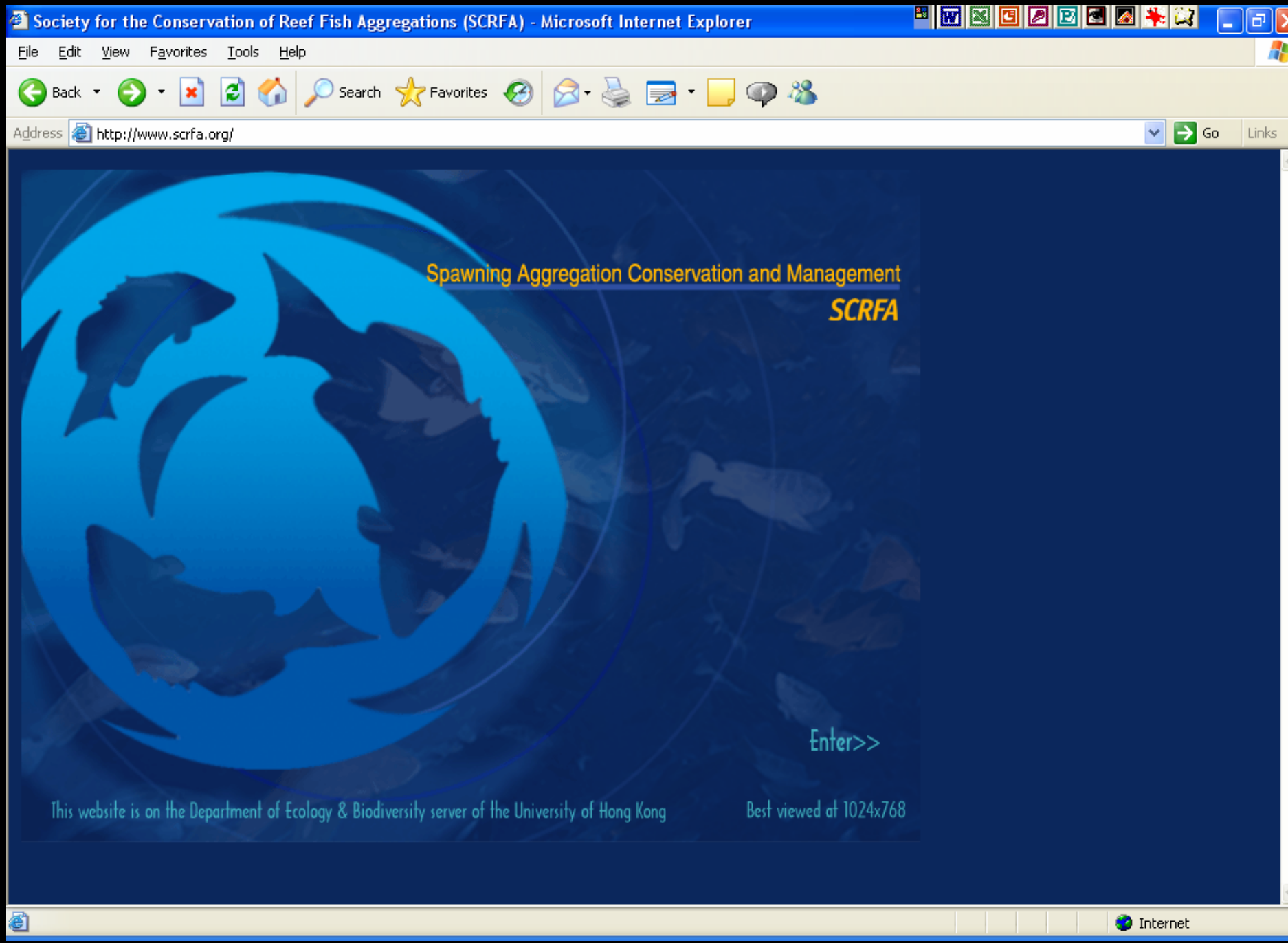
- Website www.scrfa.org
- newsletters
- pamphlets / posters
- western Pacific surveys
- centralized database
- methodologies
- presentations etc.

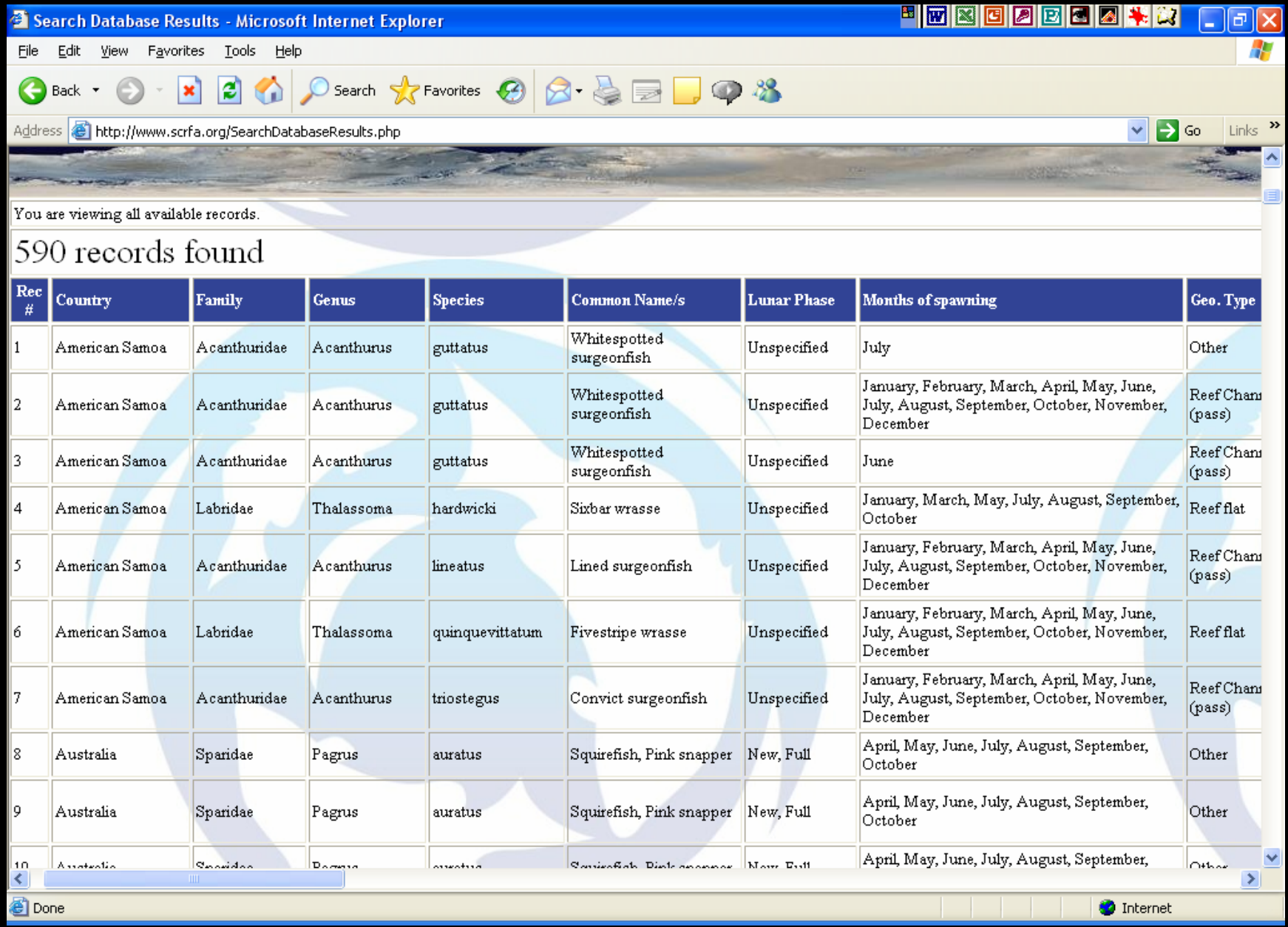
Network

- feedback / advice
- consensus
- support letters
- advocacy



Interviews with fishers can reveal much about the current status and history of exploited spawning aggregations


Society for the Conservation of Reef Fish Aggregations (SCRFA) - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://www.scrfa.org/
Go Links
Spawning Aggregation Conservation and Management
SCRFA
Enter>>
This website is on the Department of Ecology & Biodiversity server of the University of Hong Kong
Best viewed at 1024x768
Internet



Rec #	Country	Family	Genus	Species	Common Name/s	Lunar Phase	Months of spawning	Geo. Type
1	American Samoa	Acanthuridae	Acanthurus	guttatus	Whitespotted surgeonfish	Unspecified	July	Other
2	American Samoa	Acanthuridae	Acanthurus	guttatus	Whitespotted surgeonfish	Unspecified	January, February, March, April, May, June, July, August, September, October, November, December	Reef Chan (pass)
3	American Samoa	Acanthuridae	Acanthurus	guttatus	Whitespotted surgeonfish	Unspecified	June	Reef Chan (pass)
4	American Samoa	Labridae	Thalassoma	hardwicki	Sixbar wrasse	Unspecified	January, March, May, July, August, September, October	Reef flat
5	American Samoa	Acanthuridae	Acanthurus	lineatus	Lined surgeonfish	Unspecified	January, February, March, April, May, June, July, August, September, October, November, December	Reef Chan (pass)
6	American Samoa	Labridae	Thalassoma	quinquevittatum	Fivestripe wrasse	Unspecified	January, February, March, April, May, June, July, August, September, October, November, December	Reef flat
7	American Samoa	Acanthuridae	Acanthurus	triostegus	Convict surgeonfish	Unspecified	January, February, March, April, May, June, July, August, September, October, November, December	Reef Chan (pass)
8	Australia	Sparidae	Pagrus	auratus	Squirefish, Pink snapper	New, Full	April, May, June, July, August, September, October	Other
9	Australia	Sparidae	Pagrus	auratus	Squirefish, Pink snapper	New, Full	April, May, June, July, August, September, October	Other
10	Australia	Sparidae	Pagrus	auratus	Squirefish, Pink snapper	New, Full	April, May, June, July, August, September,	Other

Example of information available on SCRFA database

Live Reef Food Fish Trade

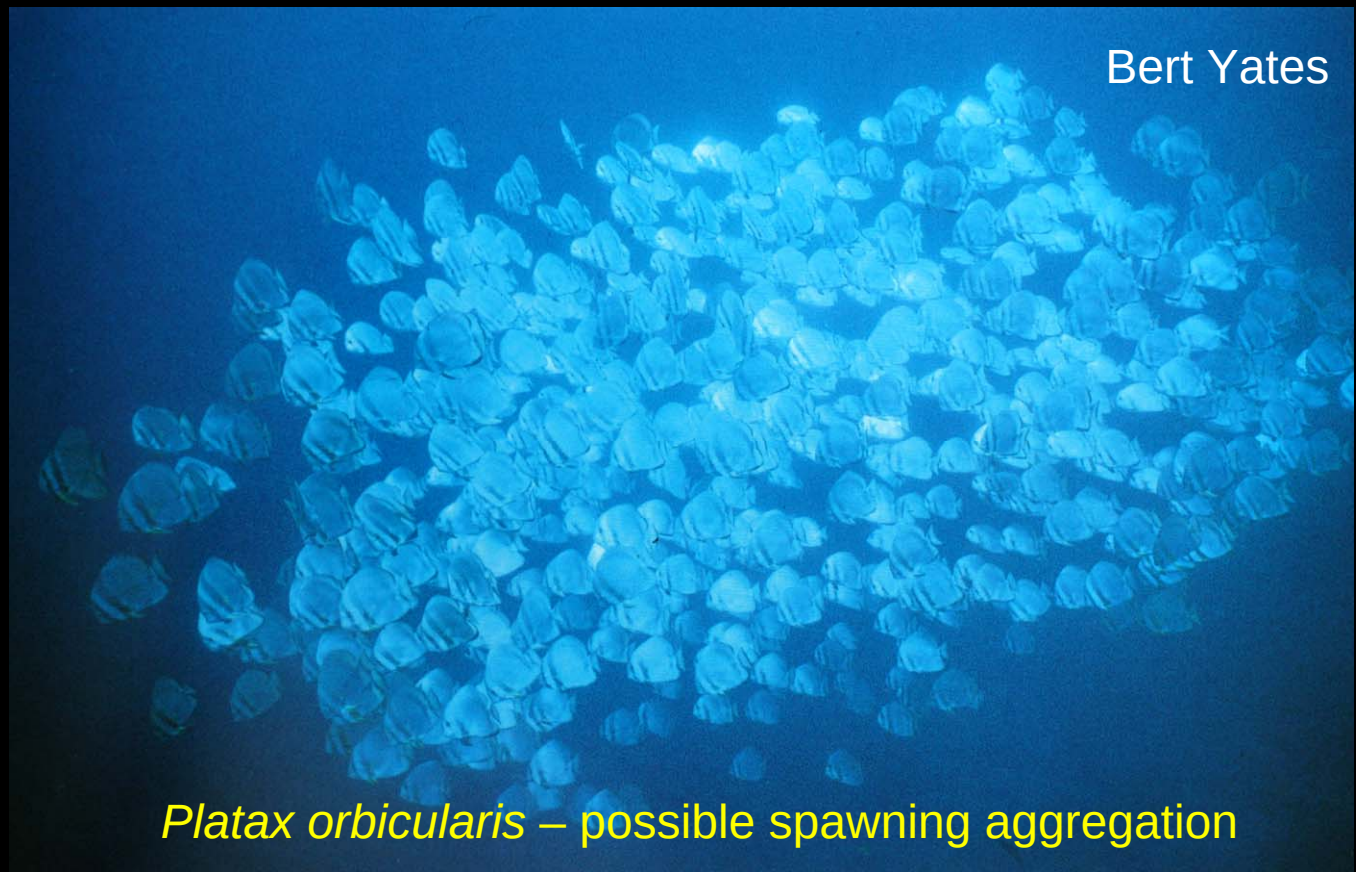
Live reef food fish trade

- Groupers, snappers, wrasses
- 30-50,000 mt annually retailed
- US$1 billion annually
- Retailing at US$20-150/kg

What's needed now?

1 - Continued investigation of the basic biology and oceanography of spawning by reef fishes, particularly those with aggregations.

2 - More information on the dispersal and fate of eggs and larvae, particularly from MPA's.



Platax orbicularis – possible spawning aggregation

This is

THE END

of this talk

Thank you for listening!

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