

Belize Fisheries Project

*Developing a Shared View of the Status of Belize's
Fishery Resources*

June 16, 2023



The Fisheries of Belize: Overview of Results

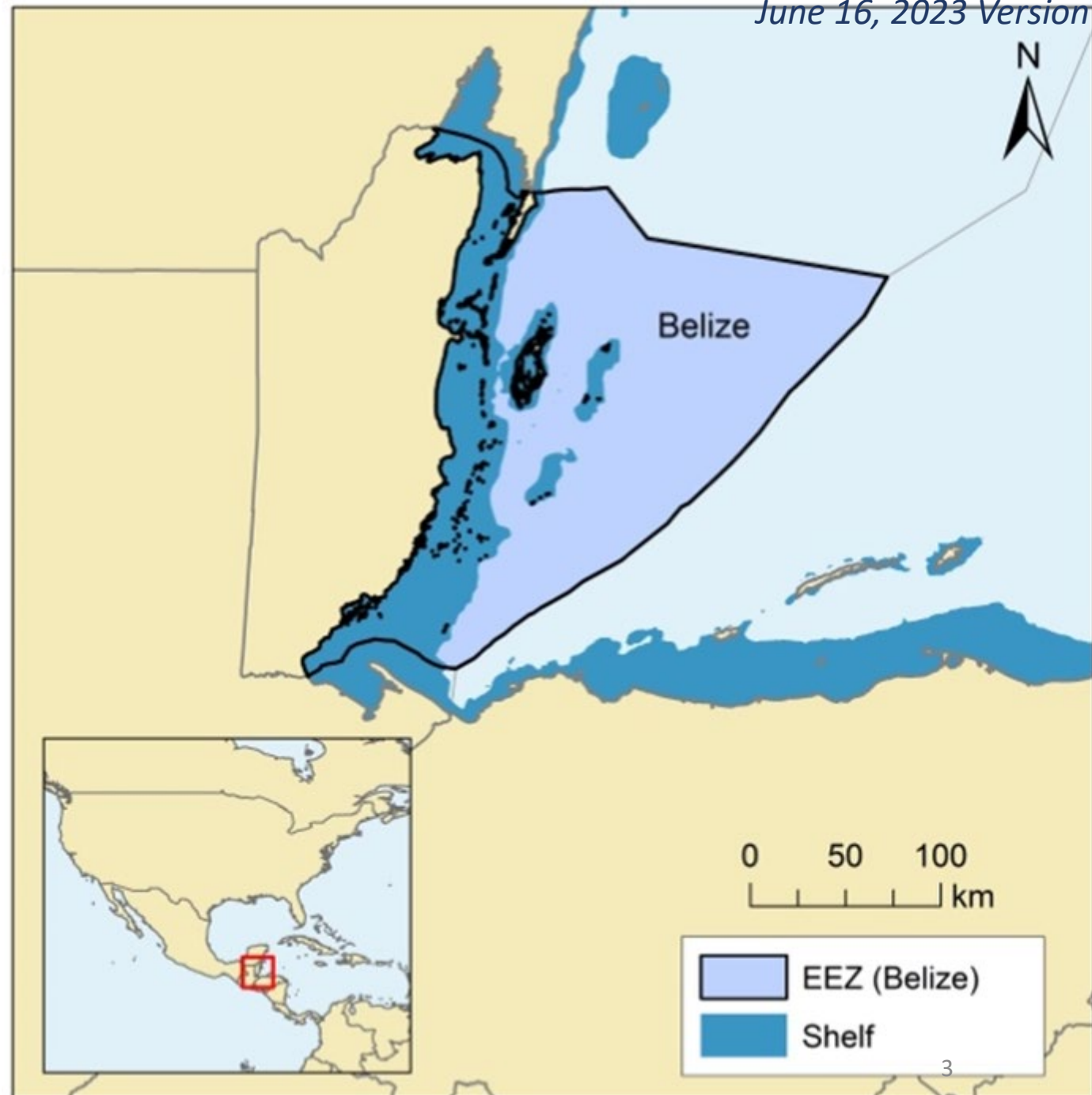
Daniel Pauly, M.L. 'Deng' Palomares, and Alexander Tewfik

Sea Around Us Research Initiative, IOF, UBC

Belize, 16 June 2023

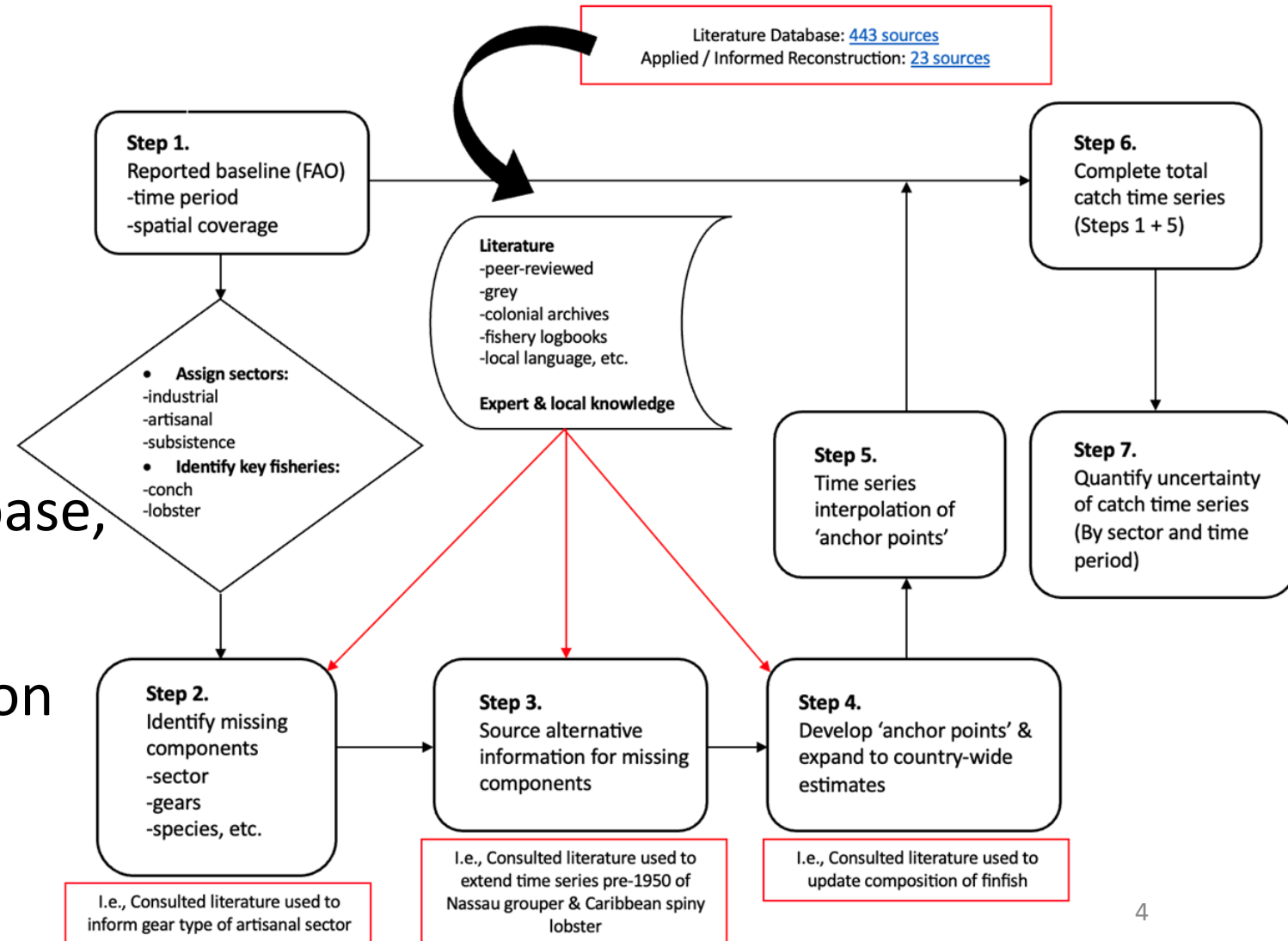


- The Exclusive Economic Zone (EEZ) of Belize covers 36,182 km²
- The Territorial Sea includes three distinct atolls, Glover's Reef, Lighthouse Reef and Turneffe Atoll.



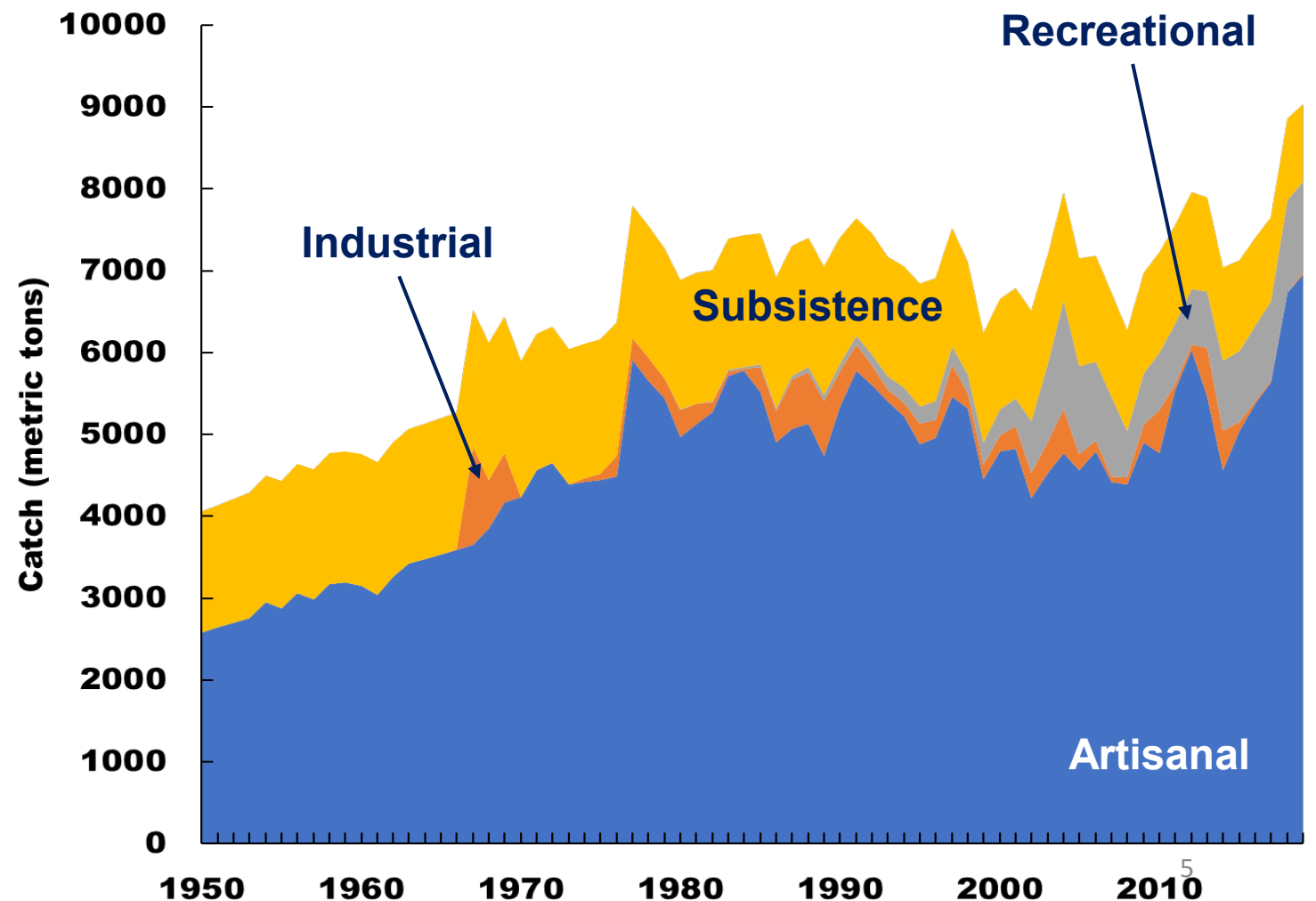
The reconstruction of the fisheries catches of Belize

- Flowchart illustrating the 7-step fisheries catch data reconstruction approach.
- Red boxes refer to the complete literature database, of which 23 sources were applied or used to inform the updated reconstruction of Belize EEZ to 2020.



Reconstructed Belizean marine fisheries catches*

- Catches within the EEZ of Belize are dominated by artisanal (67%) and subsistence (22%) fisheries.
- Industrial and recreational fisheries made up only 11%, with the former currently absent.



* See: www.seaaroundus.org

Belizean marine catch by species (I)

Queen conch and spiny lobster make up a third of these catches.



21% of the catch



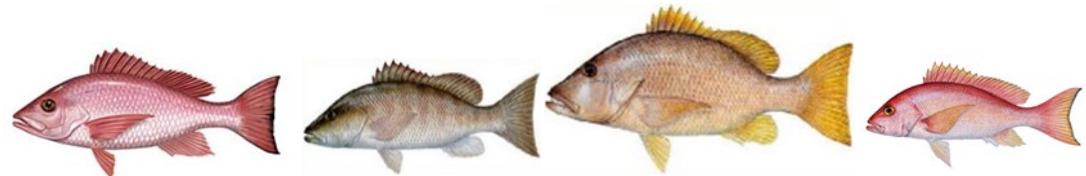
10% of the catch

Snappers make up a quarter of these catches



Yellowtail Mutton Lane

23% of the catch



Red Grey Dog Silk

3% of the catch

Belizean marine catch by species (II)

- Other species included in these assessments:



Crevalle jack



Horse-eye jack



King mackerel

8% of the catch



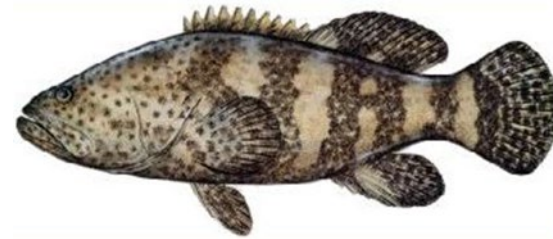
Great barracuda

2% of the catch



Snook

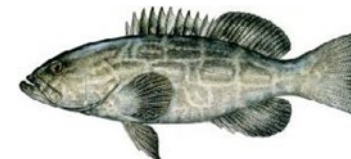
2% of the catch



Goliath grouper



Nassau Grouper

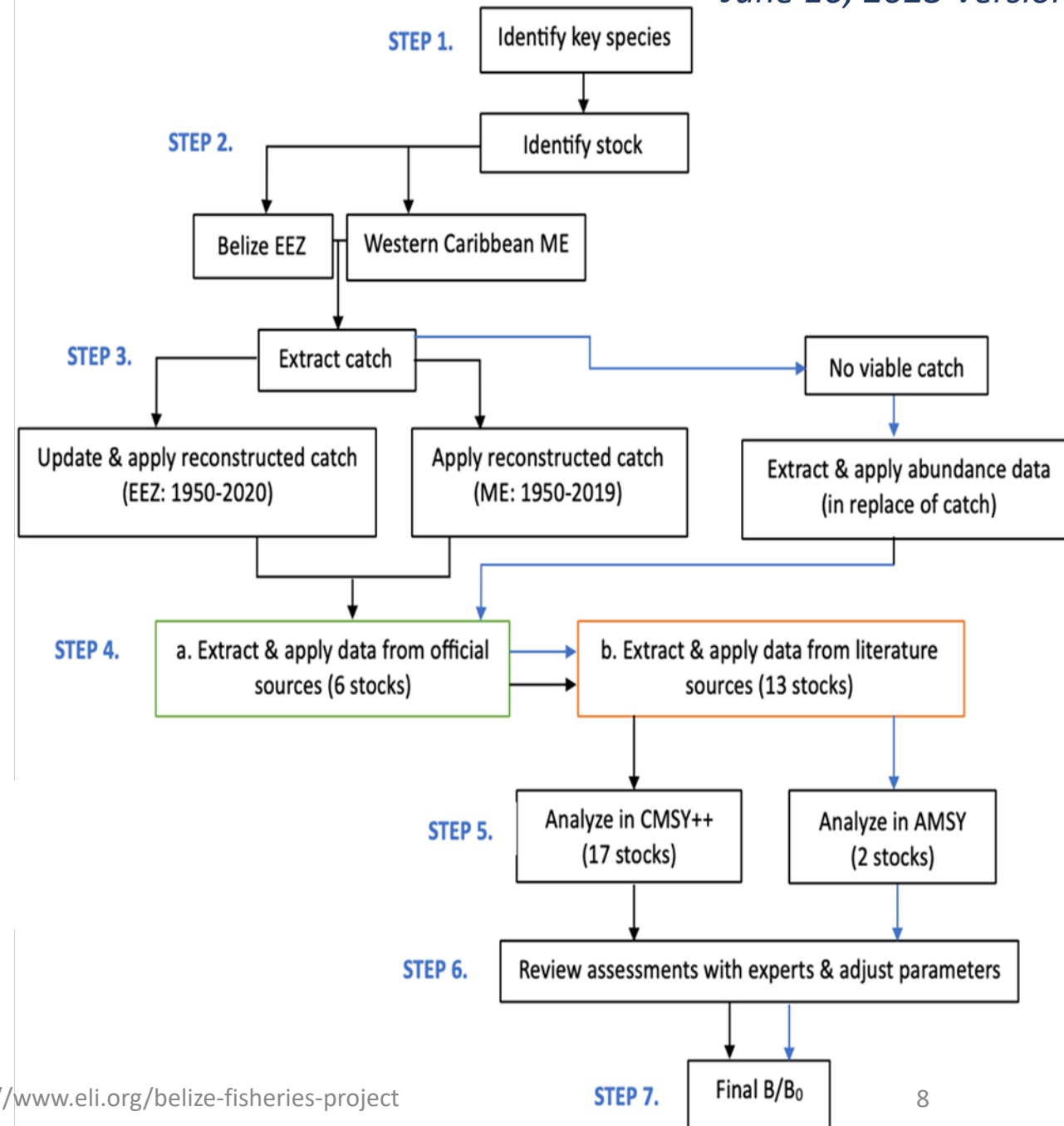


Black grouper

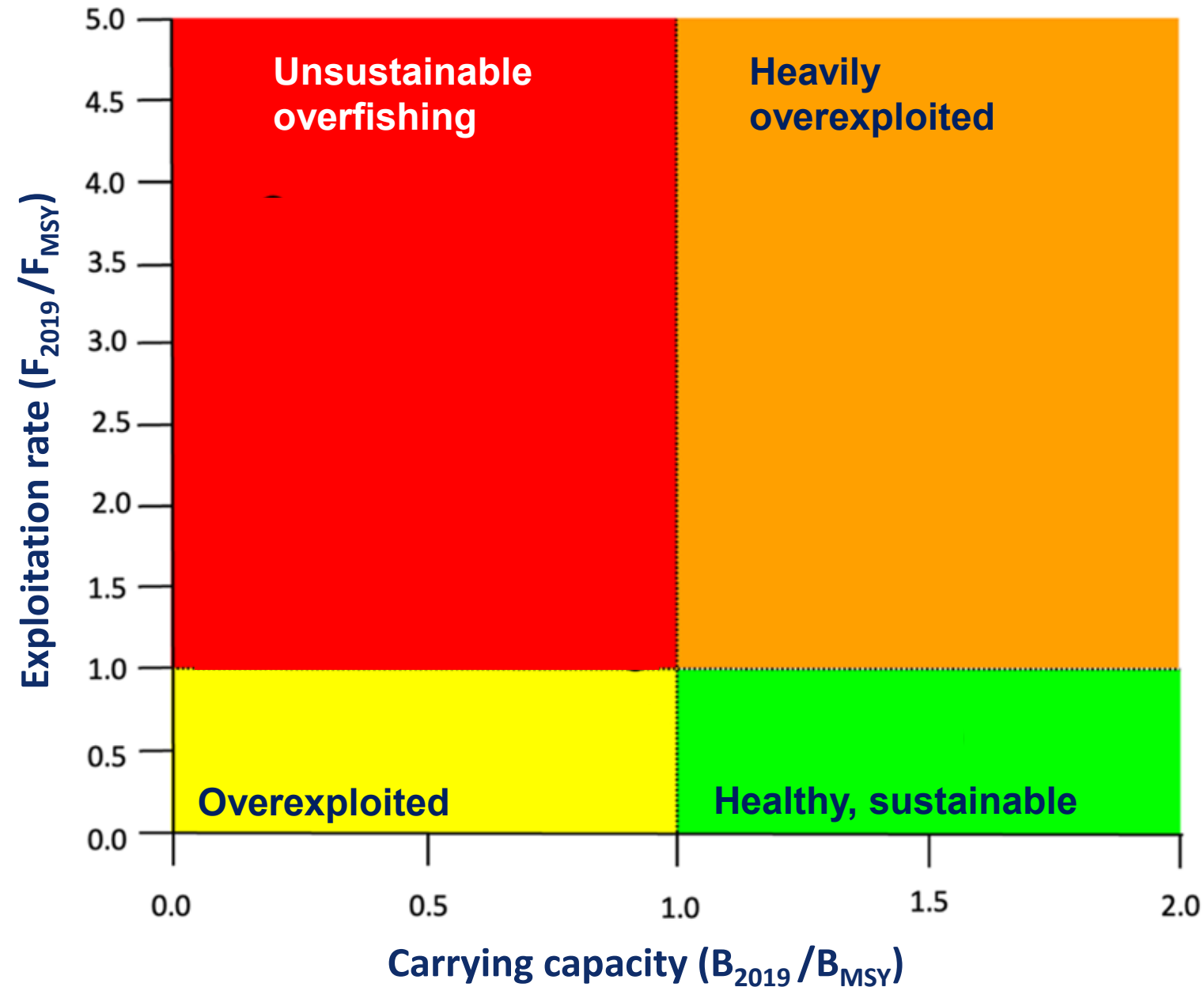
<1% of the catch

Assessing the top 20 species

- Flowchart for the stock assessment process.
- Green box indicates higher reliability of data.
- Orange box indicates lower reliability.
- Black arrows refer to stocks assessed using the CMSY++ method.
- Blue arrows refer stocks assessed using AMSY method.
- 38 sources were used to inform these assessments.



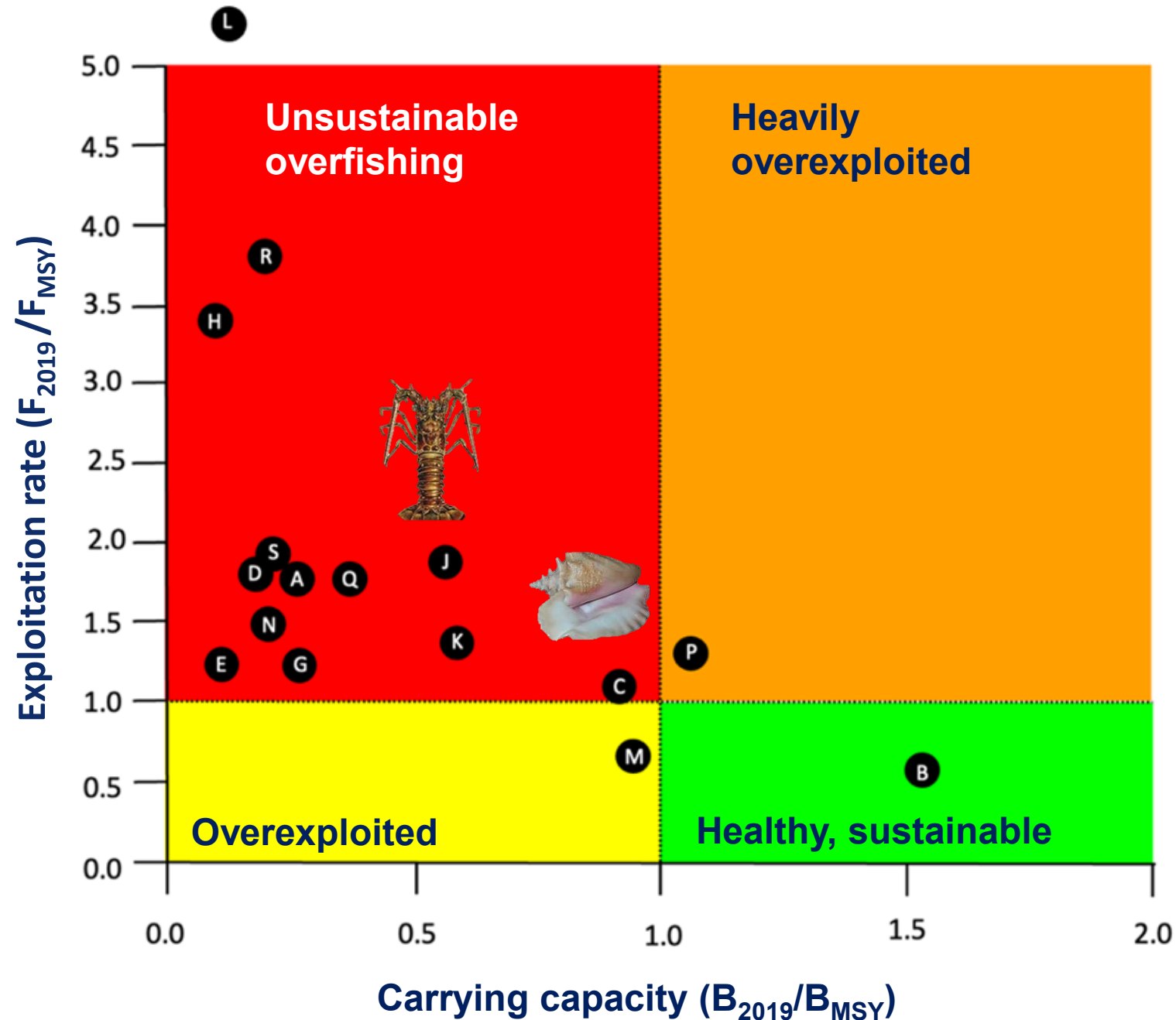
Sea Around Us stock analyses



Sea Around Us stock analyses

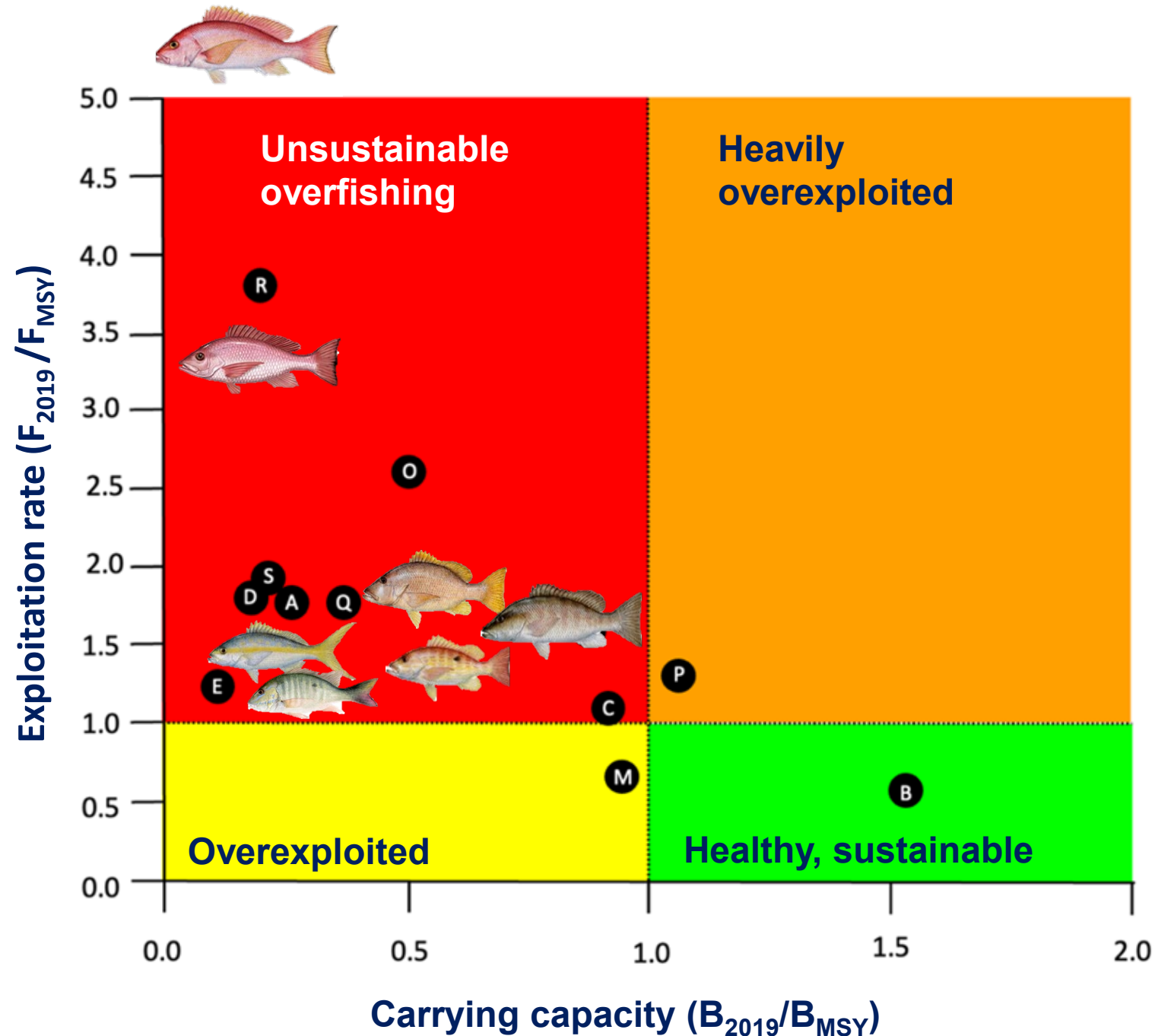
In general, the most commercially important species are in the red:

There are not enough fish left in the water, and it takes more work to catch them.



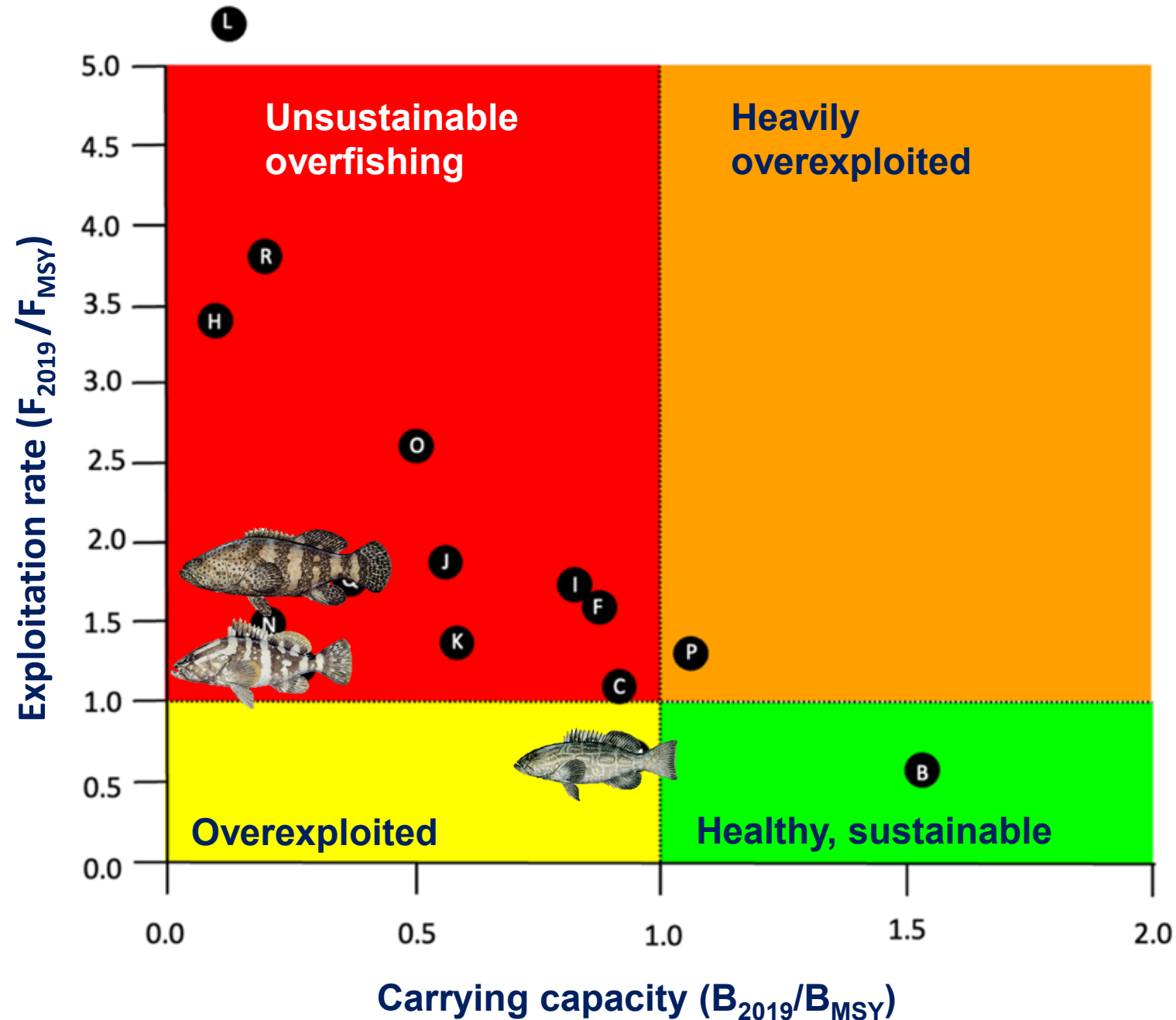
Sea Around Us stock analyses

Snappers are less abundant, and a lot of work is needed to catch the few of them left in the water.



Sea Around Us stock analyses

There are few groupers left and it now takes much more work to catch them.

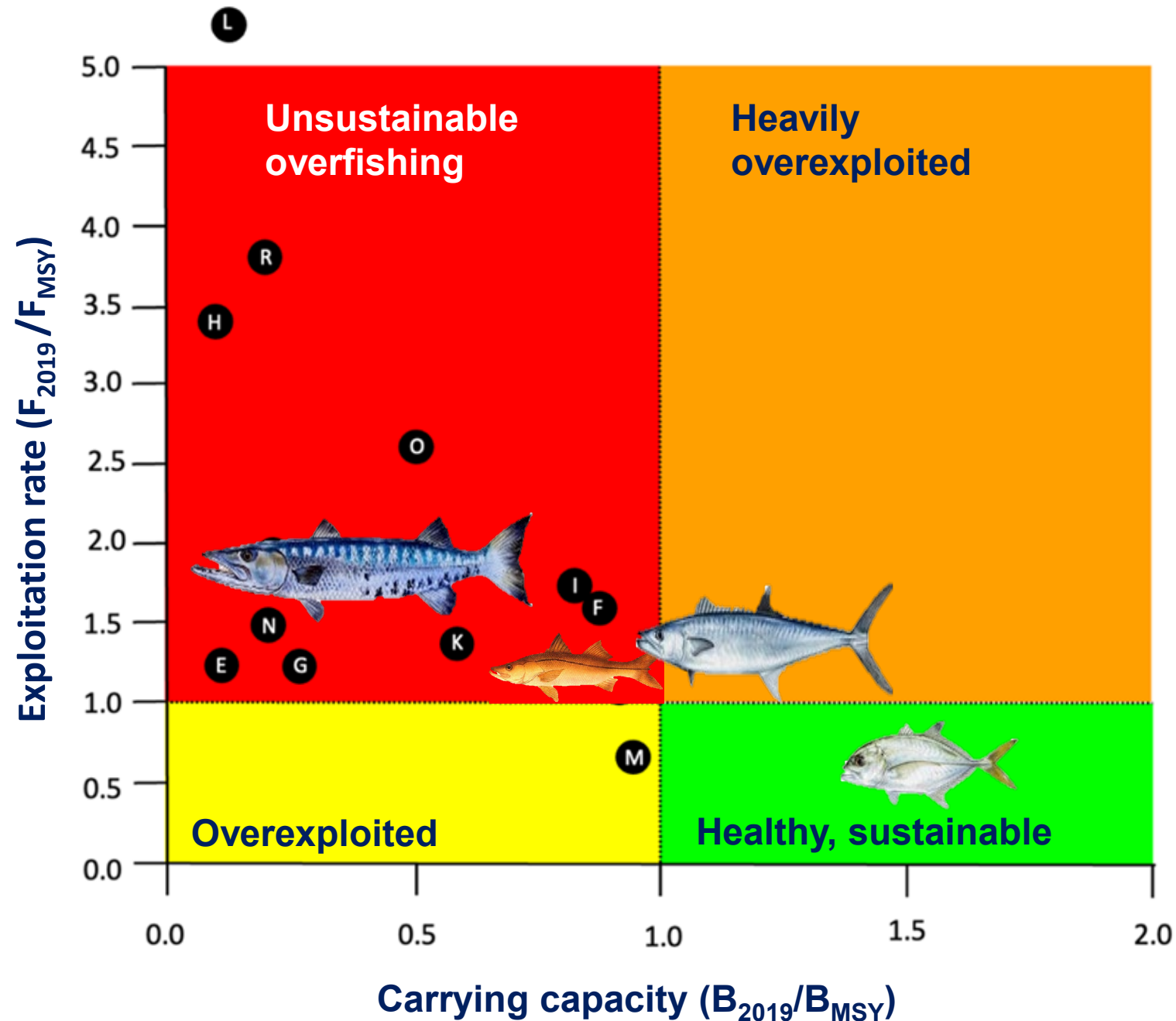


Sea Around Us stock analyses

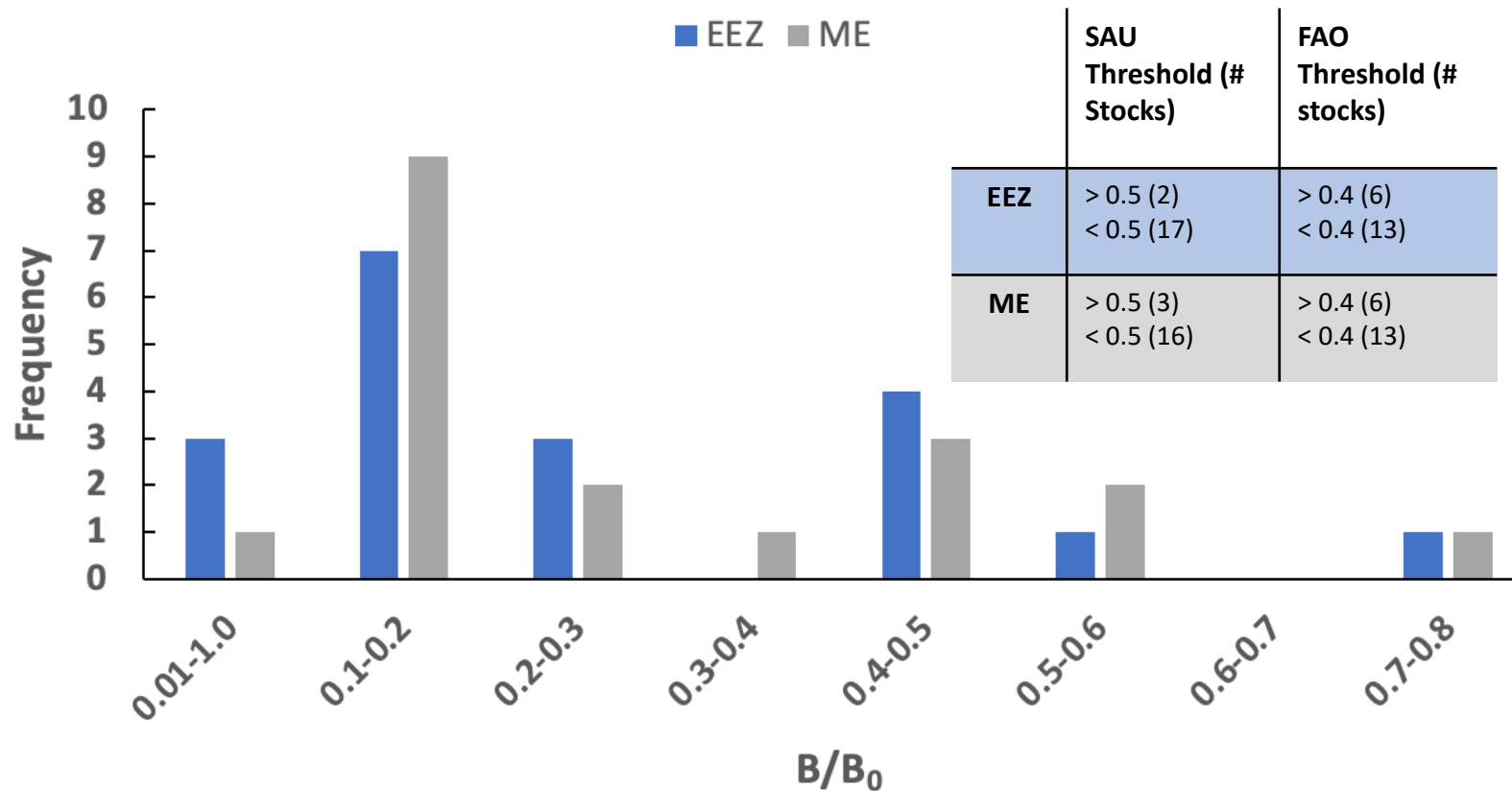
The horse eye jack is abundant.

Although there is enough king mackerel, it is now taking more work to catch them.

The barracuda and snook are less abundant and it takes a lot more work catch them.



Current biomass relative to carrying capacity (B/B_0)



Stock status of 19 stocks assessed for the Belize EEZ and Western Caribbean ME. Final year $B/B_0 = 2020$ (EEZ) and 2019 (ME). This suggests that the biomass left of 89% (at EEZ-level) and 84% (at ME-level) of the 19 stocks assessed are below half of carrying capacity,

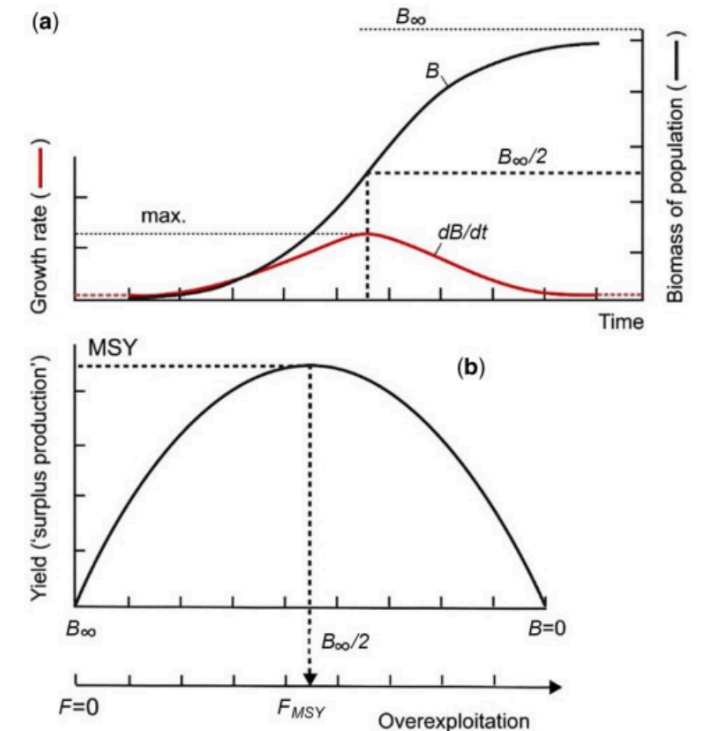
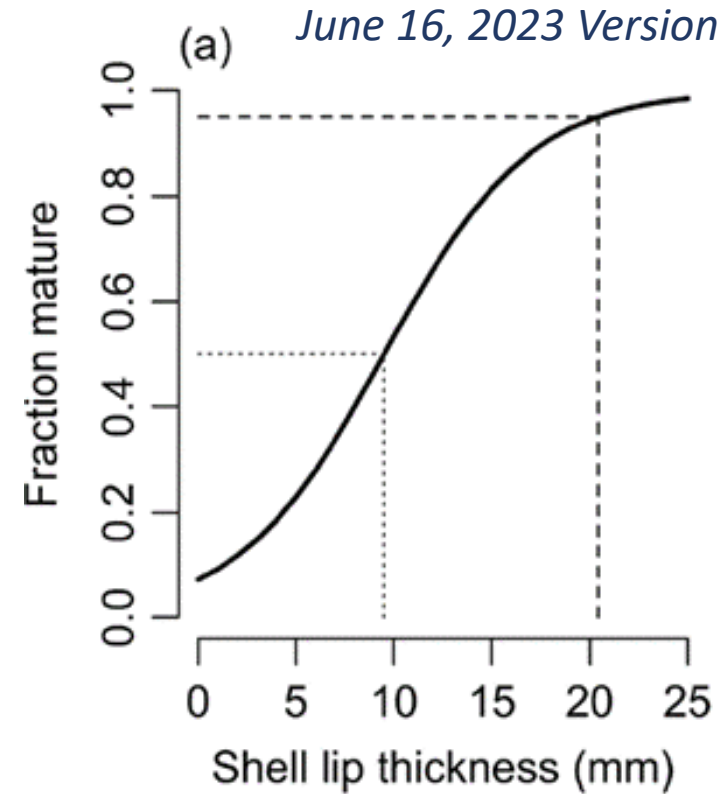


Figure 3. Basic elements of the Schaefer surplus production model. (a) A population invading an open space or recovering from a catastrophic decline will typically grow in sigmoid fashion, i.e. exponentially at first, then with at a declining rate as carrying capacity is approached. (b) The first derivative of the population growth curve [red line in (a)] plotted against the biomass from a parabola of surplus production vs. biomass, whose maximum occurs at $B_0/2$ (see text).

[Pauly & Froese \(2020\)](#)

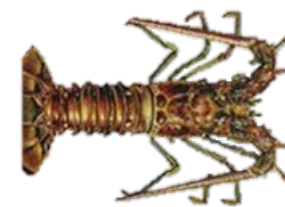
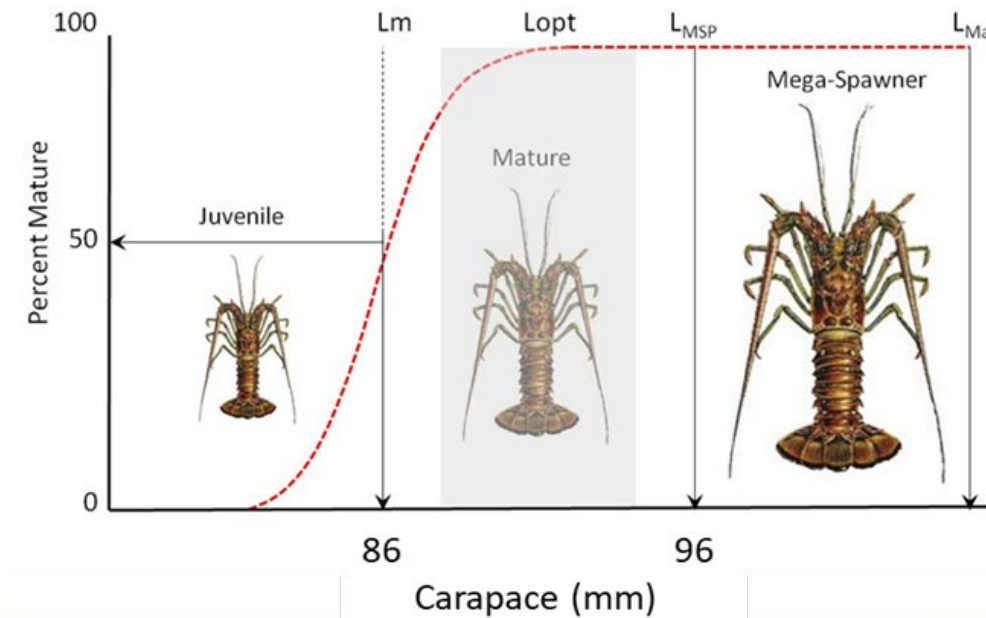
Review of existing knowledge: Queen conch

- Exploitation peaked in 2008-2013, which led to listing in Appendix II of CITES.
- Currently managed using size limits established in 1978 based on shell height and meat weight.
- Maturity is measured by thickness of shell lip (Tewfik et al. 2019).
- Bulk of catch is of immature individuals.



Review of existing knowledge: Spiny lobster

- 100 years of commercial fishery;
- Depletion of northern populations and expansion to the south and to atolls (Tewfik *et al.* 2020);
- Dramatic increases in catch in 21st century with all fishing grounds fully utilized for some time;
- Replenishment zones help but overfishing continues with landing of immature individuals;
- Belizean catches in the AVOID and NOT RECOMMENDED lists of Seafood Watch and Ocean Wise.



Caribbean spiny lobster

Overfished

Length at maturity: 8.2 cm

Maximum length: 45 cm

Longevity: 15 years



Literature
review



CPUE time
series

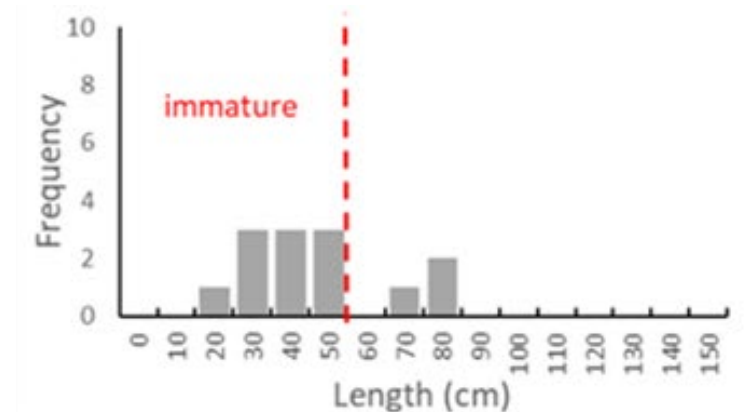


Review of existing knowledge: Nassau Grouper

- Heavily exploited since the 1920s. Management intervention, although with adequate size limits, came too late.
- Stock is depleted.



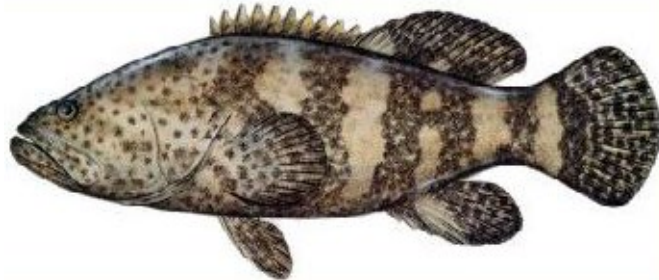
Max: 122 cm/25 kg



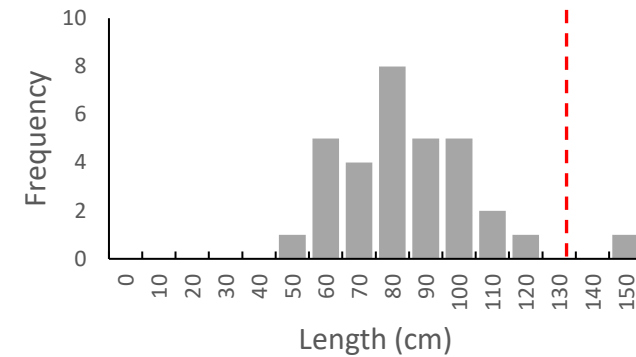
Review of existing knowledge: Goliath and Black Groupers

- In similar conditions as Nassau grouper

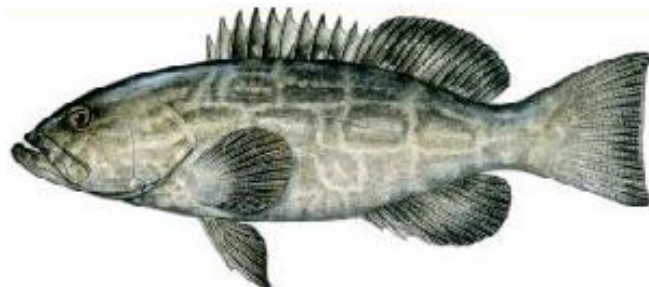
Goliath



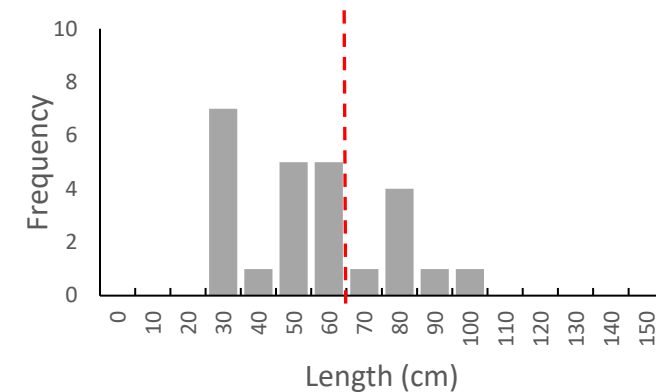
Max: 250 cm/360 kg



Black



Max: 150 cm/45 kg



Review of existing knowledge: Snappers



Red



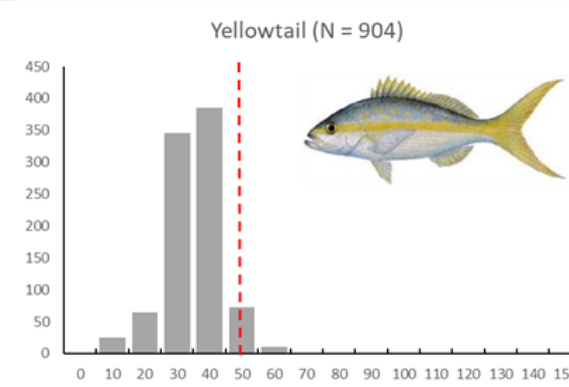
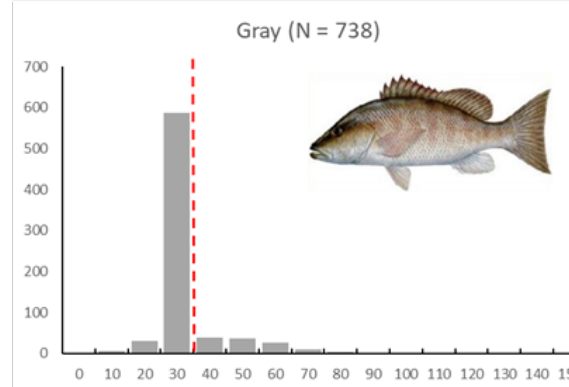
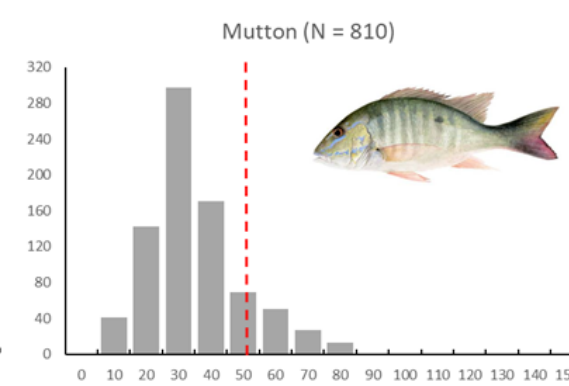
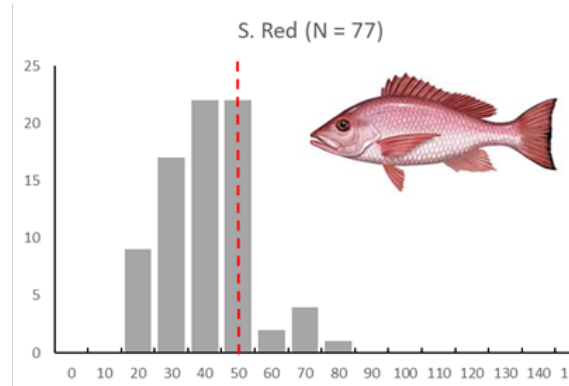
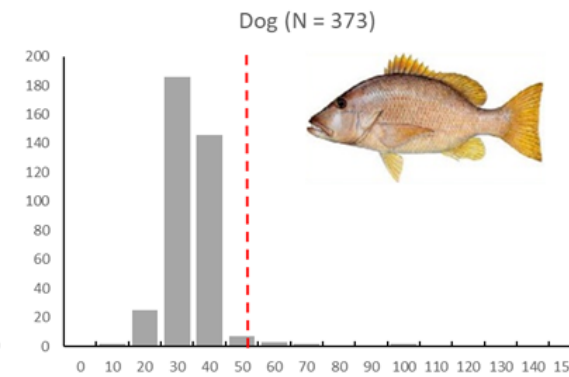
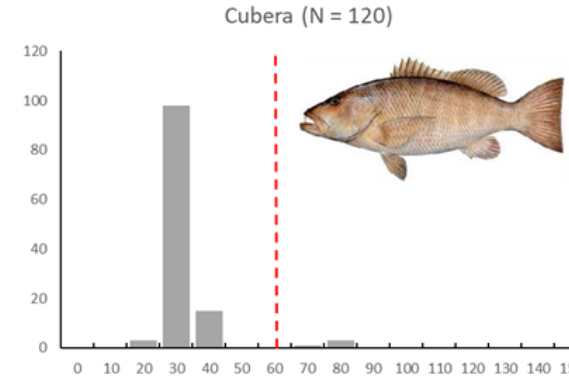
Cubera



Mutton



Lane



Status of stocks

- Review of existing knowledge conducted by Tewfik *et al.* (2020, 2022) suggest **growth overfishing**
 - Groupers, snappers, jacks and mackerels
 - Much of the catch consist of fish lengths $<$ length at maturity, that is, the bulk of the catch are immature individuals.
- *Sea Around Us* stock analyses based on reconstructed catches point to the same conclusion: most of these species are **overexploited**.

Reef Health Survey Results

Dr. Melanie McField

Healthy Reefs Initiative and Smithsonian Institution

Mesoamerican Reef Health

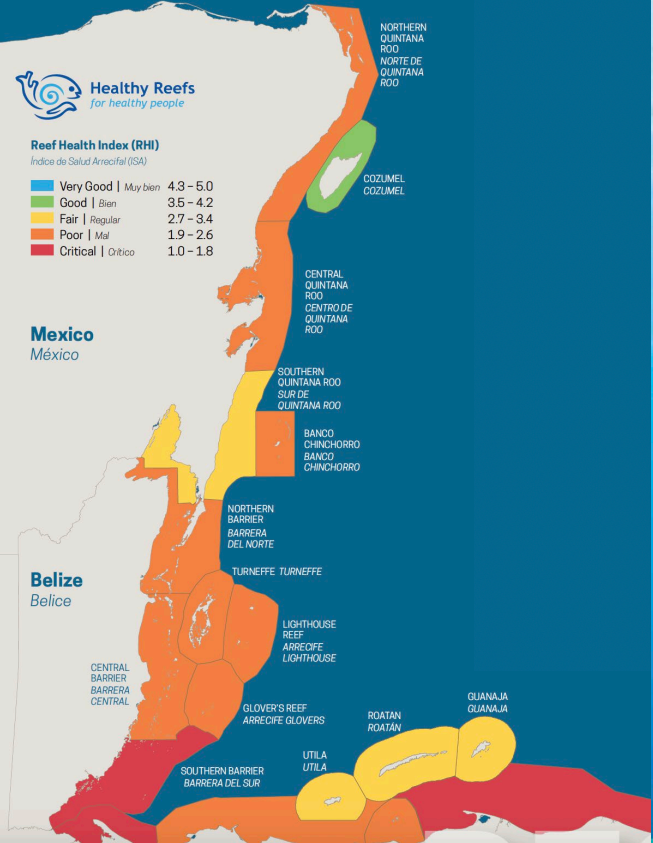


Reef Health Index (RHI)
Índice de Salud Arrecifal (ISA)

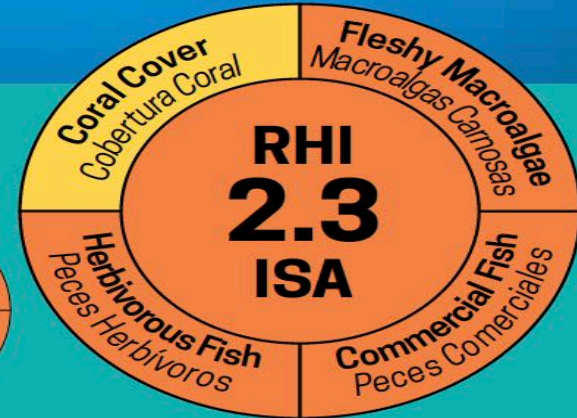
- Very Good | Muy bien 4.3 - 5.0
- Good | Bien 3.5 - 4.2
- Fair | Regular 2.7 - 3.4
- Poor | Mal 1.9 - 2.6
- Critical | Crítico 1.0 - 1.8

Mexico
México

Belize
Belice



5 is top Score



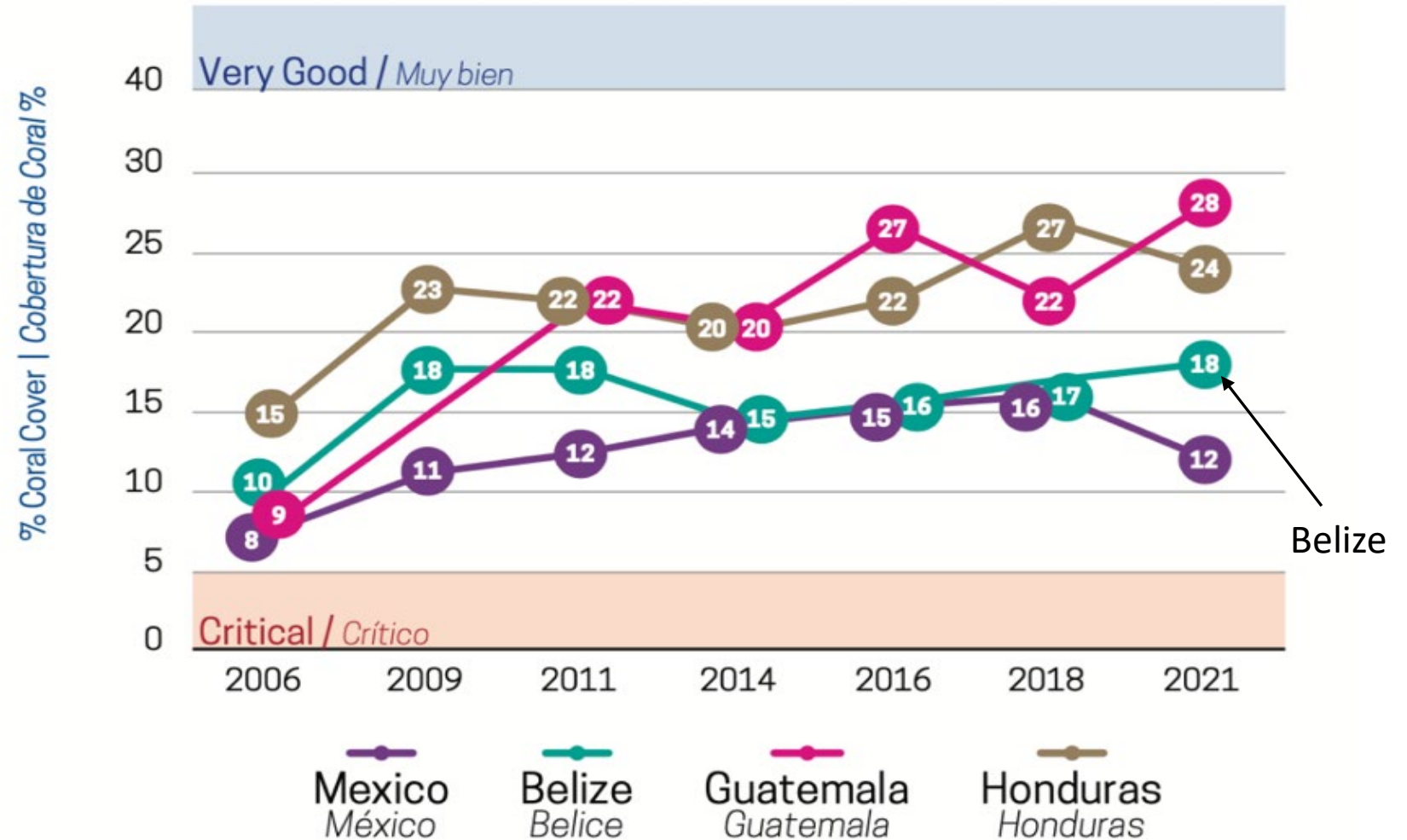
| Year | Sites |
|------|------------------|
| 2006 | 326 SITES SITIOS |
| 2009 | 130 SITES SITIOS |
| 2011 | 193 SITES SITIOS |
| 2014 | 249 SITES SITIOS |
| 2016 | 319 SITES SITIOS |
| 2018 | 286 SITES SITIOS |
| 2021 | 234 SITES SITIOS |

Years shown represent when data was collected not year report card was printed | Los años que se muestran representan cuándo se colectaron los datos y no cuándo se imprimió el reporte.

Living coral cover has slowly increased over the last 15 years, but diseases and bleaching are starting to have an impact. MAR average is 19%. A 5% increase is needed to attain a "Good" score.



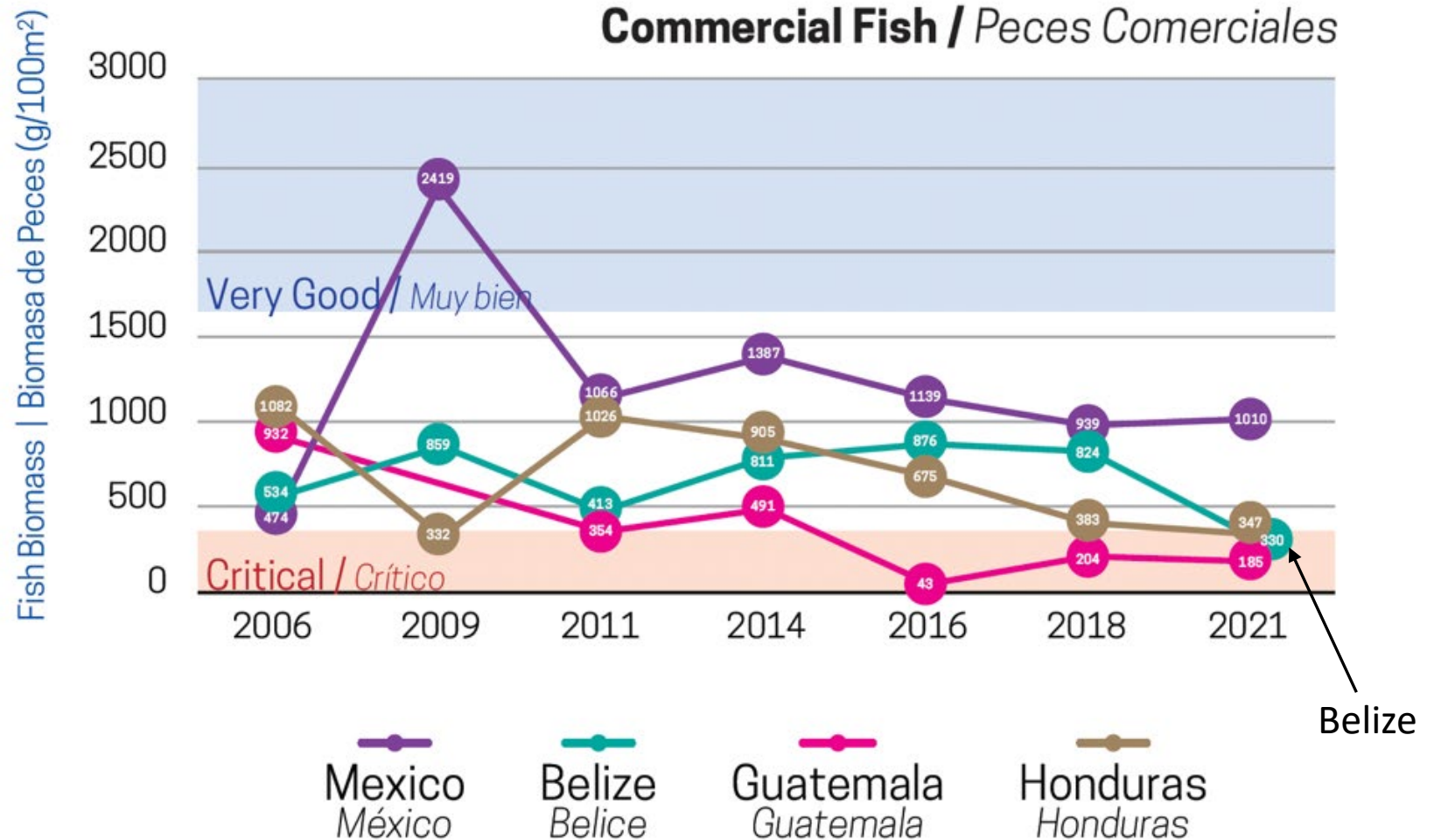
Coral Cover / Cobertura de Coral



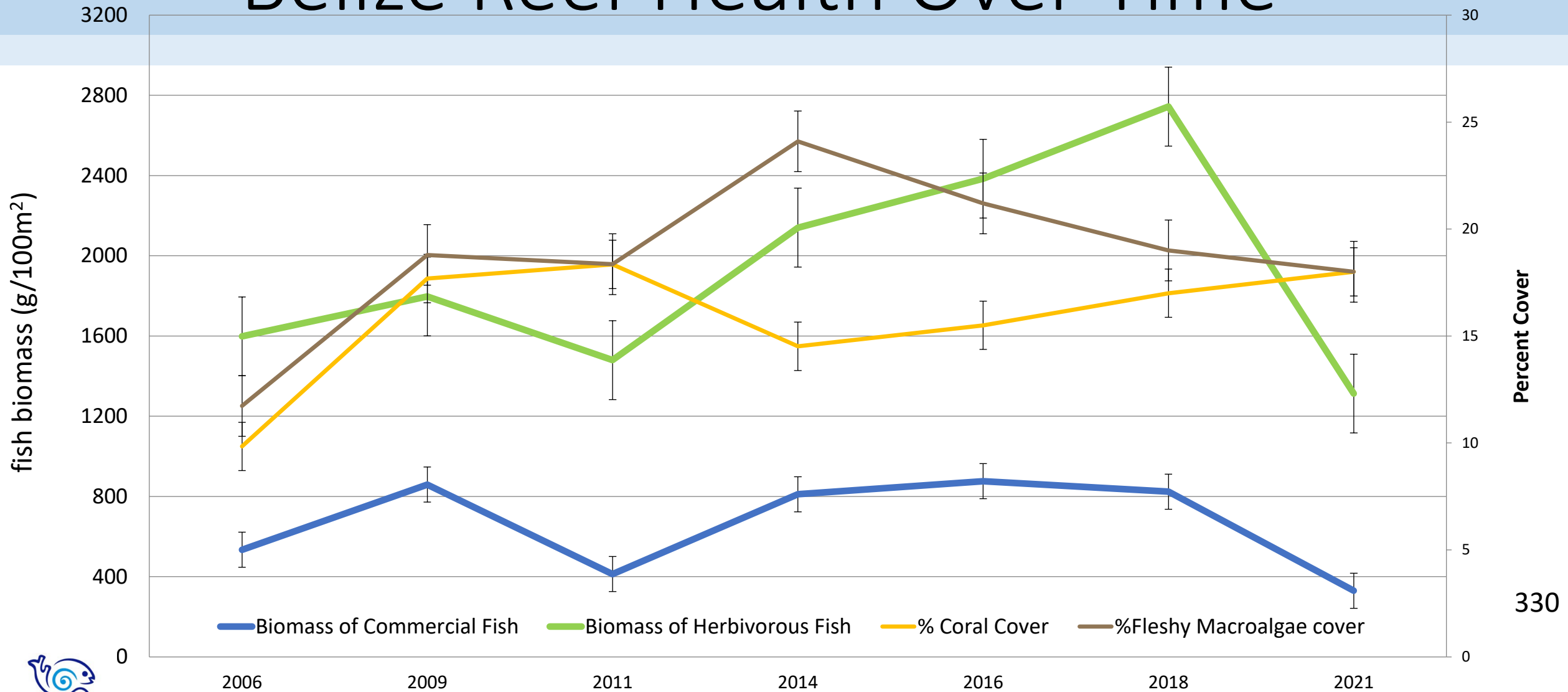
Belize



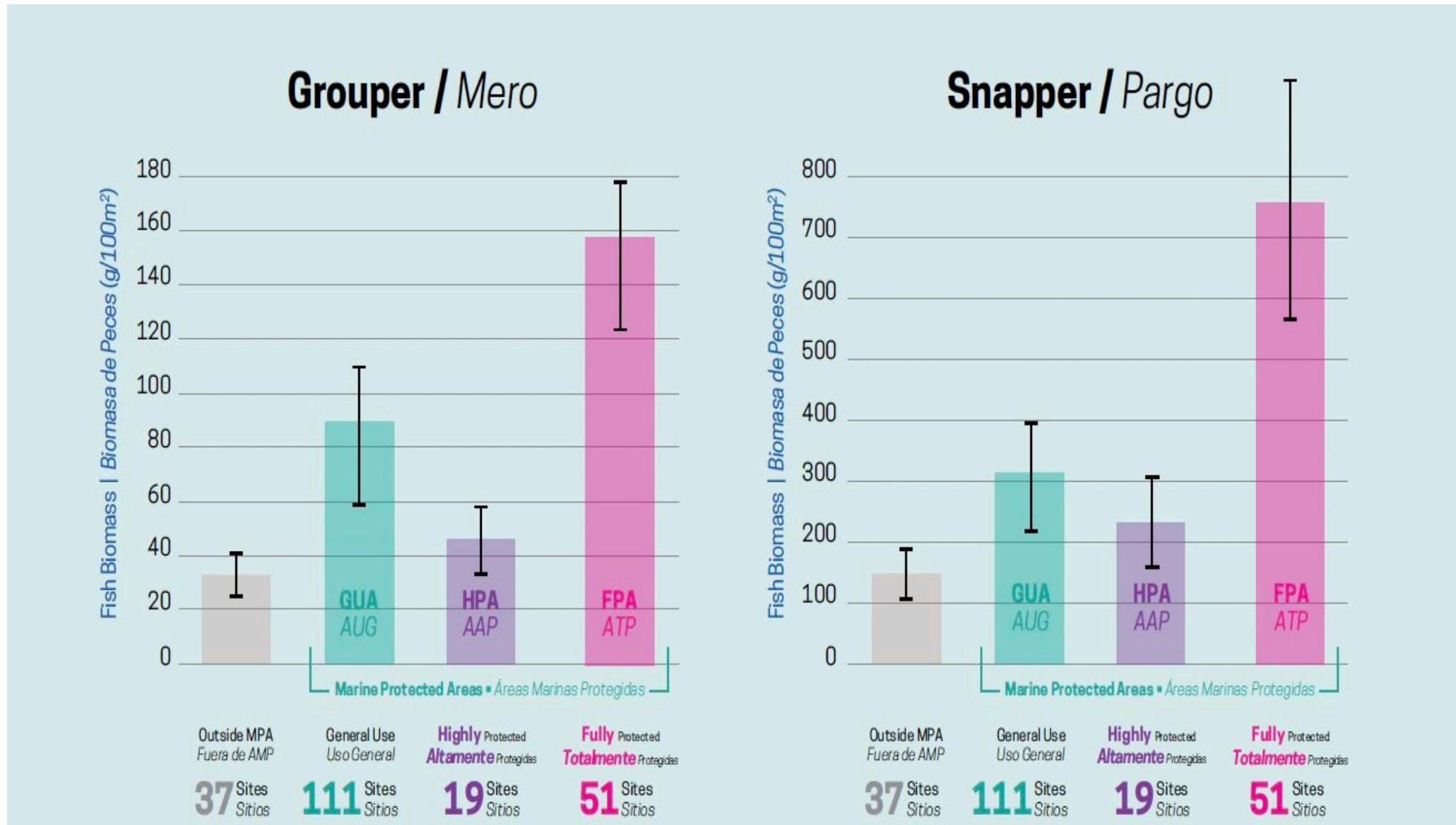
Critical Commercial fish biomass (snappers & groupers) indicates the extent of overfishing, critical habitat loss, potential biodiversity loss, and dire ecological consequences. MAR average is 499 g/100m². A 142% increase is needed to attain a “Good” score.



Belize Reef Health Over Time



Only Fully Protected Zones Have Higher Fish Biomass



Most fish that were counted were immature

Nassau Grouper
Epinephelus striatus



48cm **24%** Mature
Maduro



29 fish ▪ Avg 35 cm
29 peces ▪ Prom 35 cm

Black Grouper
Mycteroperca bonaci



67.7cm **14%** Mature
Maduro



7 fish ▪ Avg 33 cm
7 peces ▪ Prom 33 cm

Yellowtail
Ocyurus chrysurus



15cm **24%** Mature
Maduro



1046 fish ▪ Avg 17 cm
1046 peces ▪ Prom 17 cm

Cubera
Lutjanus cyanopterus



65cm **25%** Mature
Maduro

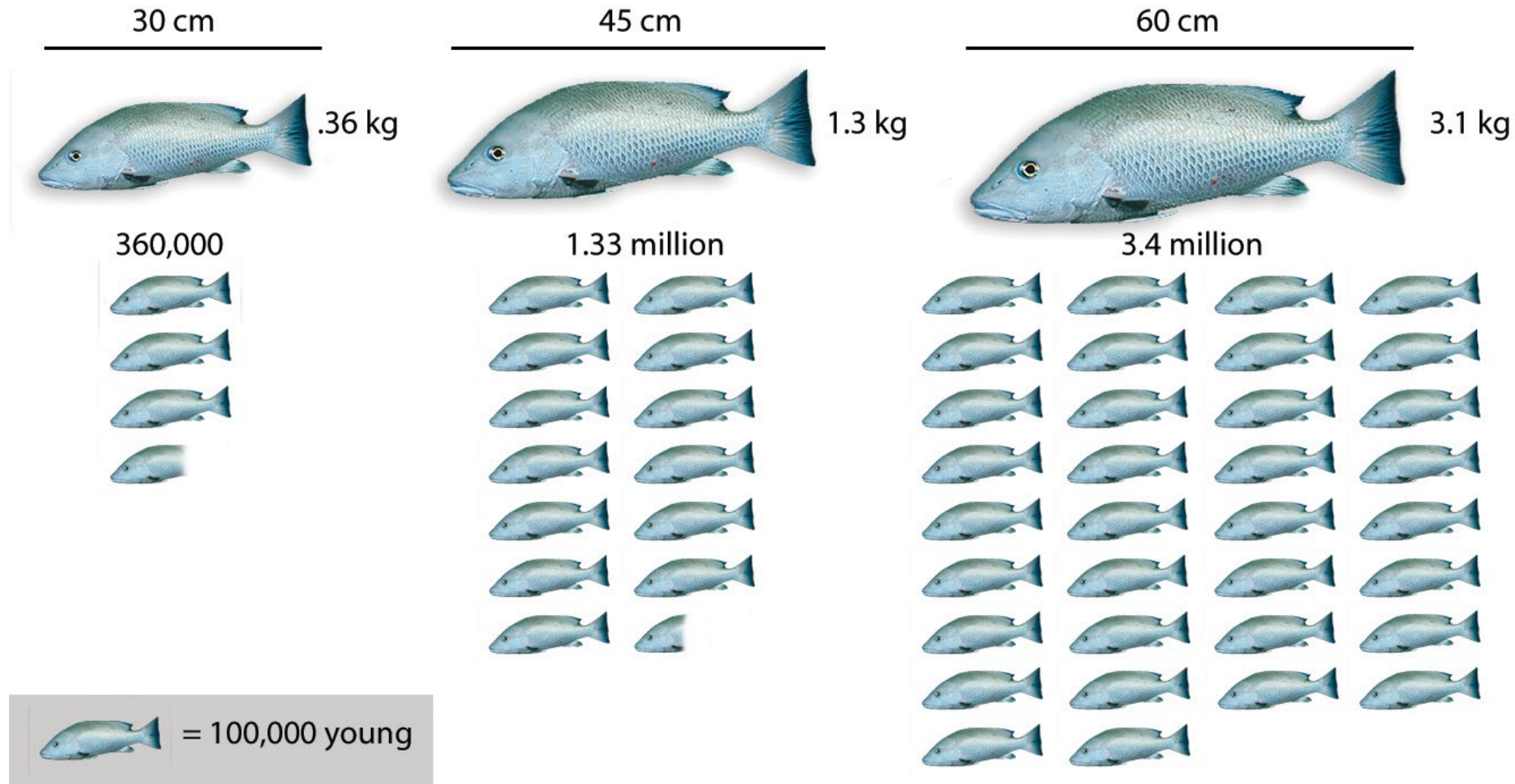


4 fish ▪ Avg 34 cm
4 peces ▪ Prom 34 cm

**THESE DATA COME FROM 2,160 FISH TRANSECTS
COVERING 129,600m² AND COUNTING 64,447 FISH IN 2021***

Size Matters – Bigger fish make more young

June 16, 2023 Version



Average numbers of young produced by three different sizes of gray snapper.
Data: Bortone & Williams (1986) US Fish and Wildlife Service Biological Report

Big Fish are in the FULLY PROTECTED zones of MPAs

Now only <2% of Belize Sea; ~ 7% of the coral reef area

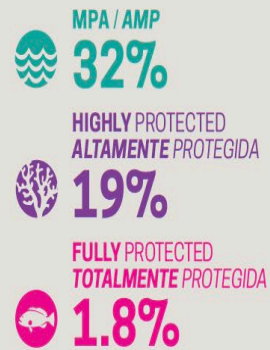
MARINE PROTECTED AREAS

ÁREAS MARINAS PROTEGIDAS

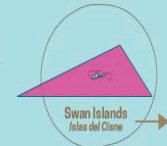
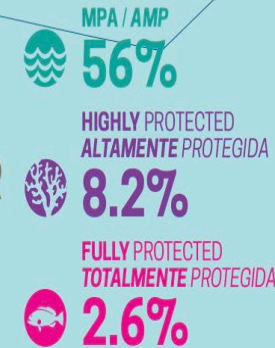
Mexico México



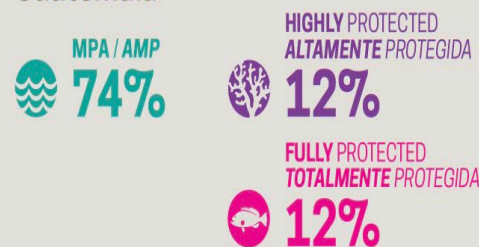
Belize Belice



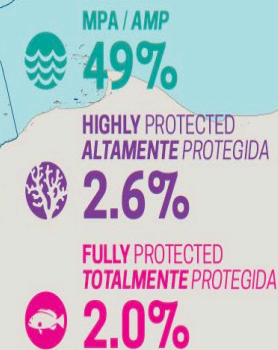
MAR SAM



Guatemala Guatemala

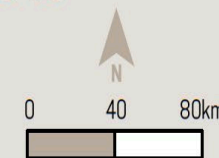


Honduras Honduras



- Marine Protected Area
Área Marina Protegida
- Highly Protected Area
Área Altamente Protegida
- Fully Protected Area
Área Totalmente Protegida
- Coral Reef
Arrecife Coralino
- Territorial Sea
Mar Territorial
- Land
Tierra

| Country País | Territorial Sea Mar Territorial (km²) | MPA Area Área AMP (km²) | Highly Protected Altamente Protegida (km²) | Fully Protected Totalmente Protegida (km²) |
|------------------------|--|----------------------------|---|---|
| Mexico México | 20,066 | 19,631 | 909 | 703 |
| Belize Belice | 19,870 | 6,367 | 3,780 | 349 |
| Guatemala Guatemala | 1,498 | 1,115 | 180 | 172 |
| Honduras Honduras | 24,300 | 9,843 | 520 | 480 |
| MAR SAM | 65,735 | 36,956 | 5,389 | 1,704 |



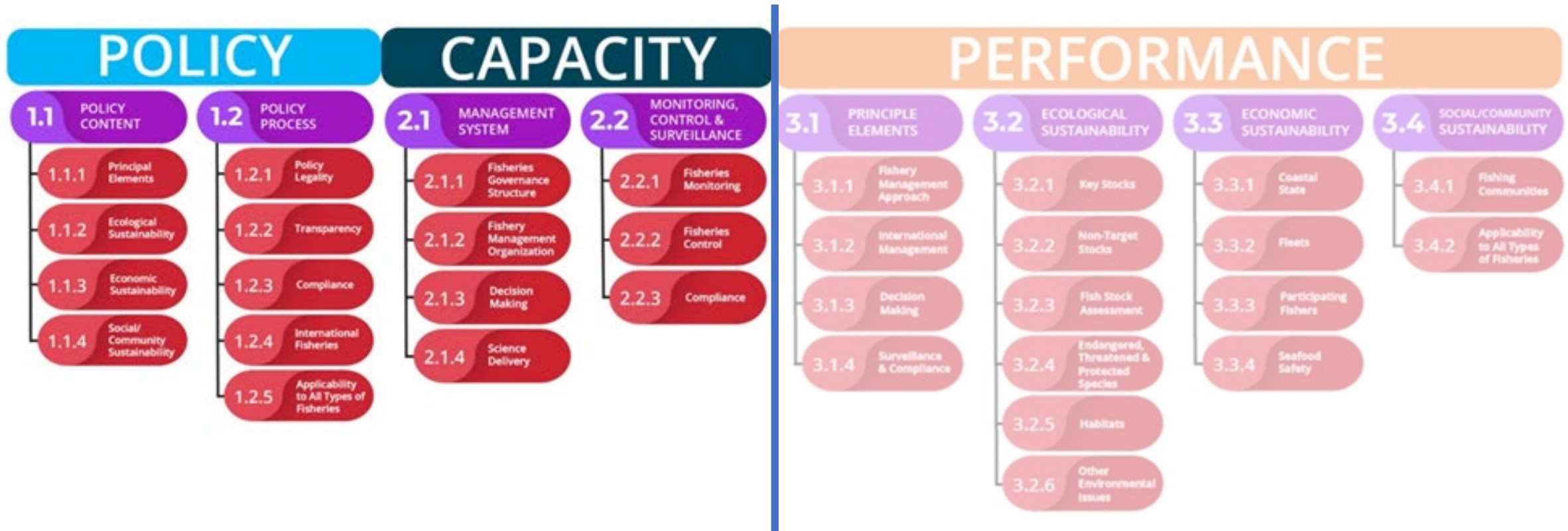
Fishery Management Opportunities

Dr. Graeme Parkes

MRAG Americas, Inc.

Governance Analysis

Structured analysis using the Fisheries Governance Tool

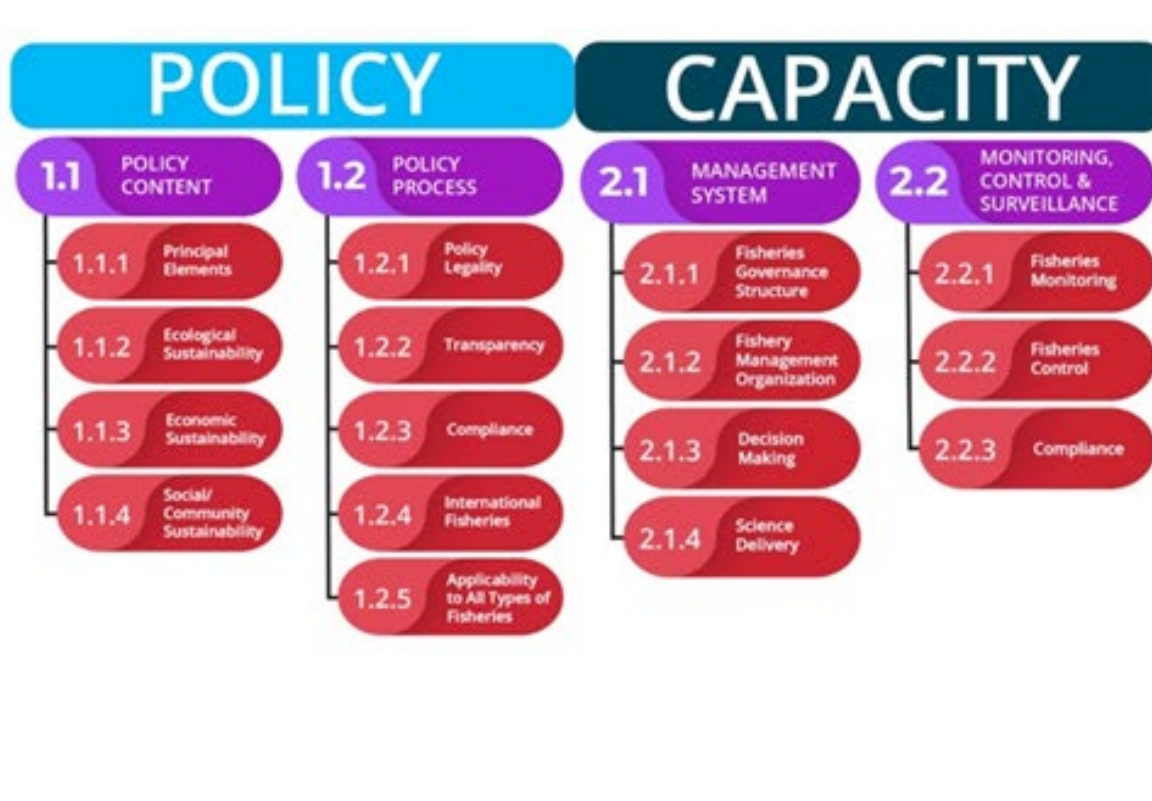


<https://fishgovtool.com/>

Swasey JH, Iudicello S, Parkes G, Trumble R, Stevens K, Silver M, et al. (2021) The fisheries governance tool: A practical and accessible approach to evaluating management systems. PLoS ONE 16(7): e0253775. <https://doi.org/10.1371/journal.pone.0253775>

Governance Analysis

Structured analysis using the Fisheries Governance Tool



Implemented in:

- Mexico
- Peru
- Chile
- Indonesia
- USA

<https://fishgovtool.com/>

Swasey JH, Iudicello S, Parkes G, Trumble R, Stevens K, Silver M, et al. (2021) The fisheries governance tool: A practical and accessible approach to evaluating management systems. PLoS ONE 16(7): e0253775. <https://doi.org/10.1371/journal.pone.0253775>

Governance Analysis

- Based on 40 source references, including 25 Belize Government documents
- Seeking feedback on our findings

| Government Documents | Published and Public Literature |
|-------------------------------------|--|
| Constitution | Peer reviewed journal articles |
| Laws | Audits and assessments by NGOs |
| Regulations | Reviews by international and regional agencies |
| FMPs: draft, planned, in progress | Academic publications |
| Government Reports | NGO Reports |
| Ministry announcements and speeches | Papers produced by this project |
| Government News releases | Belizean news media |
| Agency Budgets | Workshop reports |

Governance Analysis

POLICY

• Policy Mandate

| | | |
|---|----------------------------|-----------|
| <i>No. 7]</i> | <i>Fisheries Resources</i> | <i>83</i> |
| BELIZE: | | |
| <u>FISHERIES RESOURCES ACT, 2020</u> | | |

- Coastal Zone Management Act, National Protected Areas System Act, Trade in Endangered Species (CITES) Act, High Seas Fishing Act, Environmental Protection Act

• Policy Implementation

- laws, regulations, decrees, orders, and guidance.

Governance Analysis

POLICY



Fisheries Law follows international best practice:

- Precautionary Approach
- Best information available
- Stakeholder consultation
- Transparency

Governance Analysis

POLICY IMPLEMENTATION

Transparency is key

- Review Fishery Council meetings
- Review Fishery Management Plans
- Reviewed document “Towards a climate resilient multispecies finfish management plan for Belize”

Governance Analysis

POLICY IMPLEMENTATION



- Adaptive Management Framework
- Target and Limit Reference Points
- Risk tolerance and uncertainty
- Harvest Control Rule
- FMP Amendments
- Contains many ideas for an FMP, but requires implementation

Governance Analysis

CAPACITY

Policy Implementation requires a strong **capacity**, including:

- institutions,
- statutory bodies,
- human resources,
- equipment,
- expertise,
- stakeholder participation,
- stable funding, and
- continuity.



Governance Analysis

CAPACITY

- Authority to manage fisheries is established
- Management organizations with regional focus exist
- Control and Compliance mechanisms exist

But

- Human resources needed, e.g. enforcement personnel and presence
- Sufficient and consistent budget allocation for management and science needed
- Vessel license limits raised

Opportunities

New Fisheries Act and other policy instruments provide sound basis for management

Limit licenses/effort/access to match fishing capacity with fishing opportunities

Develop FMPs to focus on fisheries sustainability in addition to MPAs

Enhanced MCS capacity with clear presence and enforcement results

Mandate use of science in management: Harvest Control Rules

Regular review of management measures to support long-term resilience

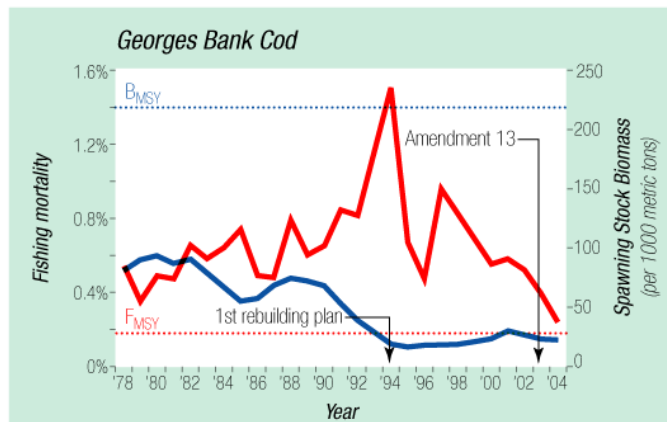
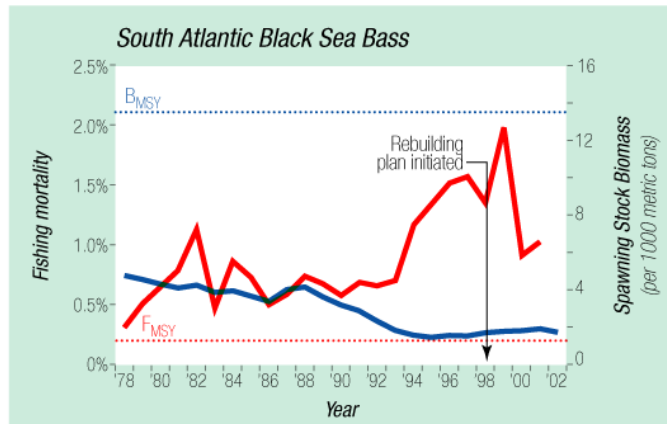
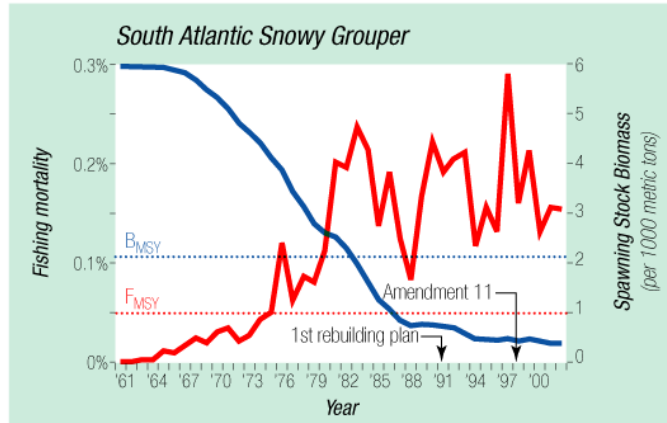
Management Responses and Examples of Successes

Dr. Andrew Rosenberg
MRAG Americas, Inc.

Fishery Policy Key Lessons

- Policies must change as the fishery and environment changes
 - Holding regulations constant doesn't work
 - Responding to new evidence is essential
- Fishing Pressure and Catch size, age, sex, maturity is fundamental
 - If exploitation is too high stock and yields will decline
 - If exploitation pattern doesn't allow sufficient reproduction, stock and yields will decline

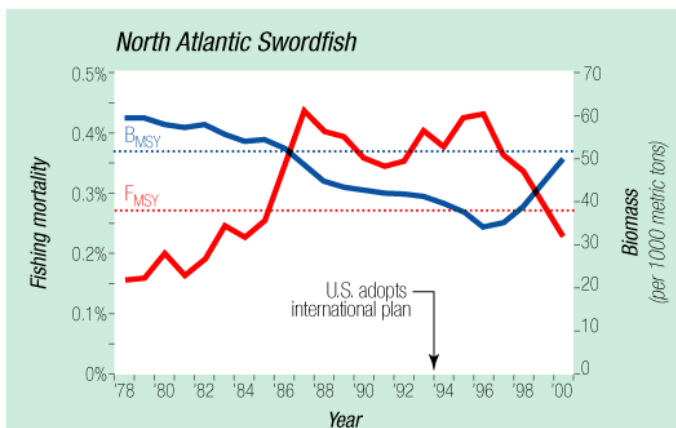
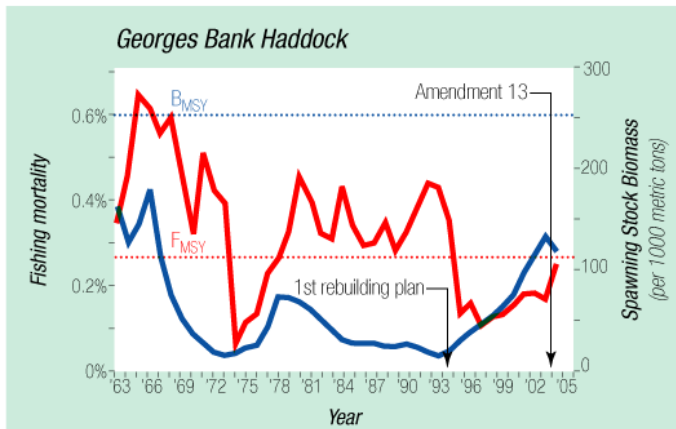
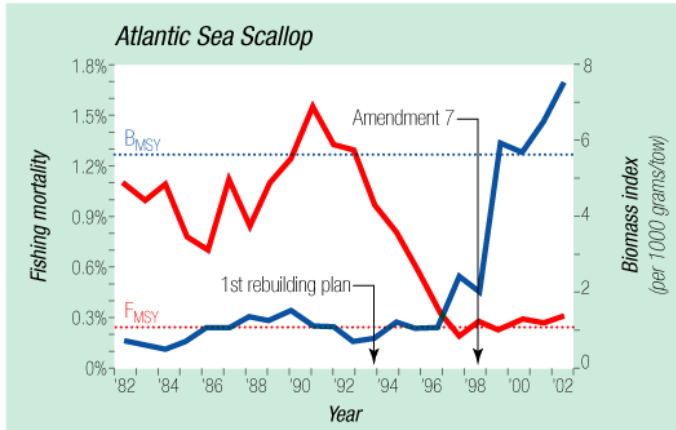
Figure 4:
Examples Of Stocks Showing Little Or No Rebuilding Progress



When fishing pressure remains high, stocks show little recovery



Figure 5: Examples Of Stocks Showing Rebuilding Progress



When fishing pressure is reduced, stocks can recover



- Warning signs of unsustainability are well known
 - Continuing declines in average size
 - Continuing loss of range/fishing grounds
 - Continuing loss of yield
 - Continuing denial
 - Demands for greater and greater scientific precision
- A control/enforcement strategy that focuses on major violations is essential to give confidence to the community

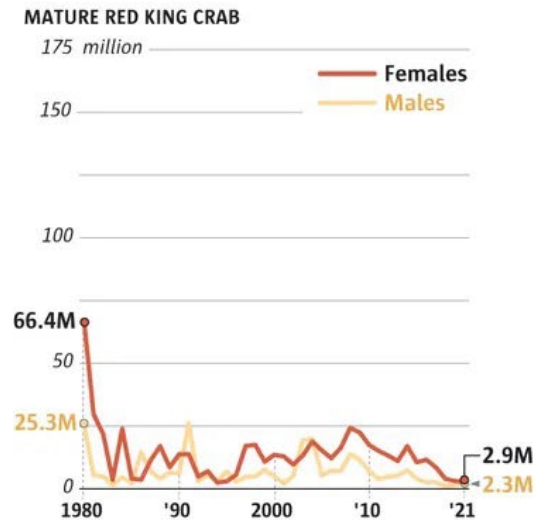
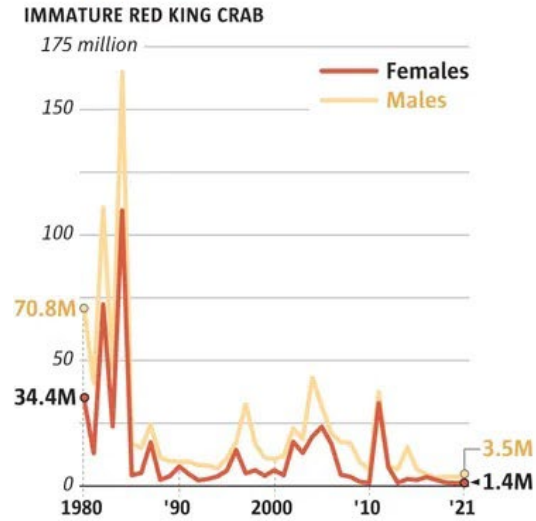
Plummeting Bering Sea crab populations

Snow crab and king crab have long been mainstays of commercial harvests.



Red king crab
Paralithodes camtschaticus

Long-term decline in mature red king crab populations (for Bristol Bay District)

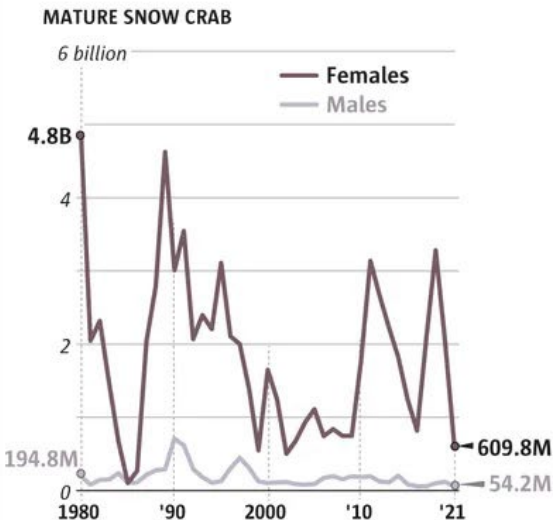
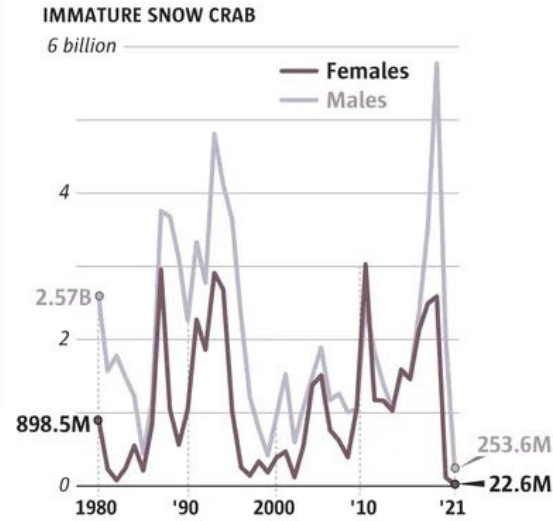


Source: Surveys conducted by NOAA Fisheries

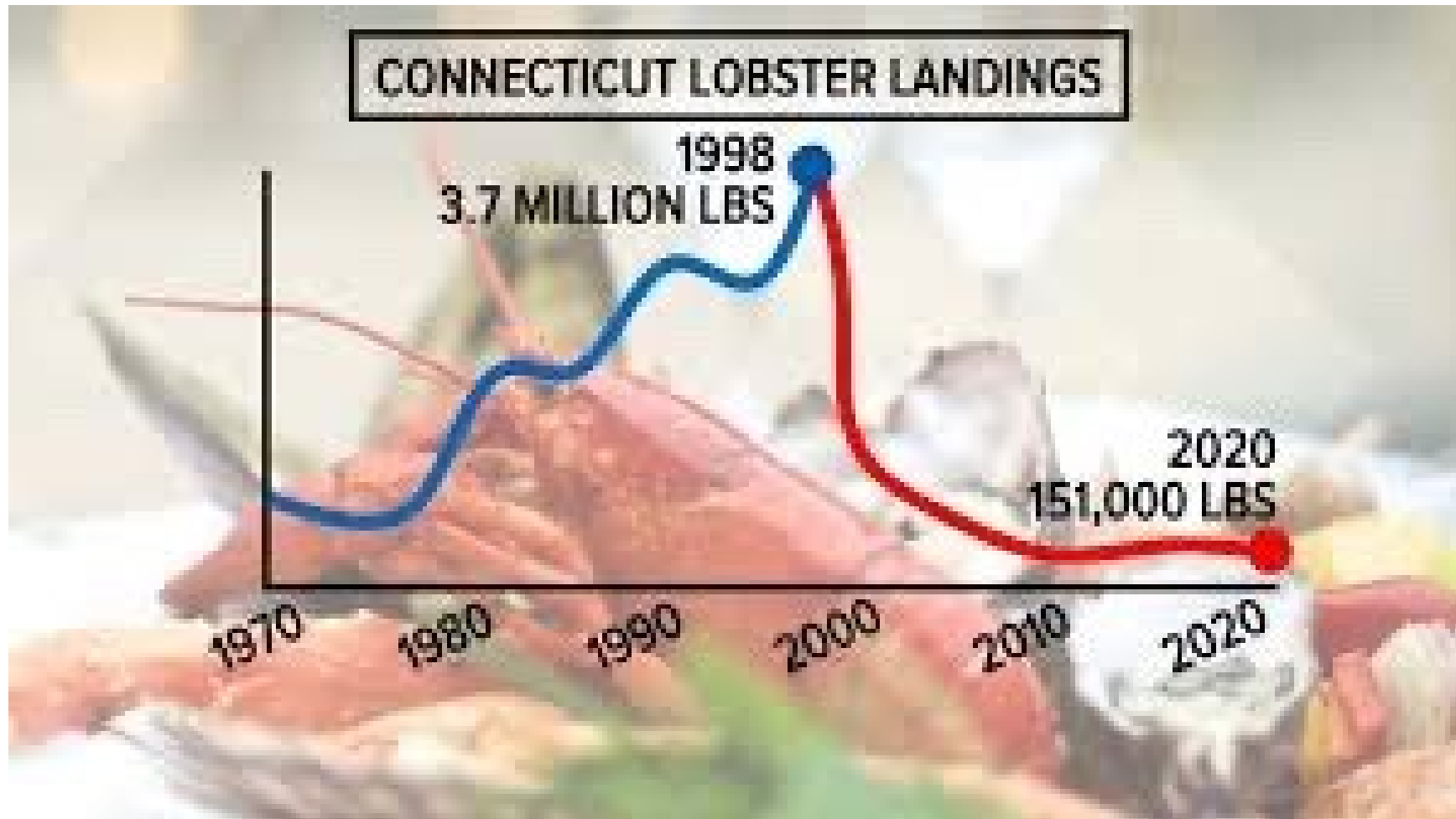


Snow crab
Chionoecetes opilio

Sharp drops in snow crab populations (all districts)



MARK NOWLIN / THE SEATTLE TIMES



Fishing for certainty

Science advisers should have confidence in their data, or risk being drowned-out by more dogmatic stakeholders.

Andrew A. Rosenberg

Policy-makers receive formal and informal advice from all quarters: scientific, legal, political and public. Each piece of advice is considered mandatory by the giver, and it often conflicts with other advisers' points of view. Uncertainty is a feature of all advice, but is usually only acknowledged by the scientific adviser.

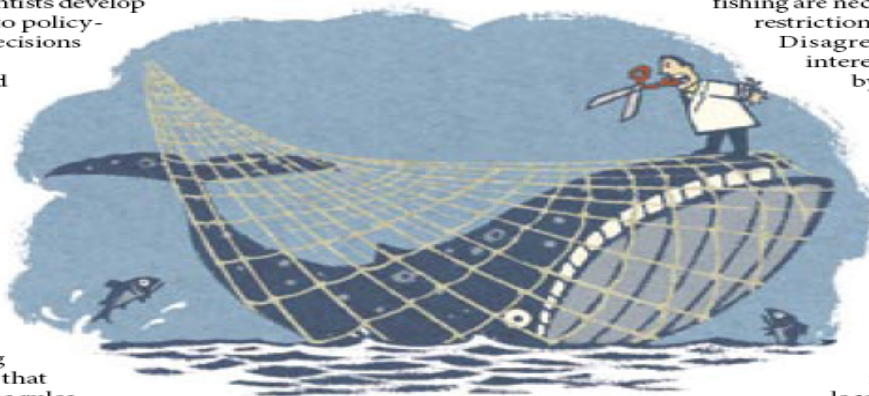
I have worked as a scientist, policy-maker and adviser, mostly managing marine resources. As an ecologist specializing in fisheries population dynamics, I naively assumed that scientists develop advice that is passed on to policy-makers who then make decisions in the light of it.

When in 1995 I moved into the policy-making side of things, managing fisheries in the northeastern United States, I learned that advice comes from all directions. Scientists would present data with many caveats; others would give advice based mainly on opinion. Fishermen coming to the microphone in a public meeting might categorically state that the science was wrong, the rules wouldn't work and everyone would go out of business. Scientists tended to emphasize their uncertainty, and would be unwilling to speculate.

As scientists, we learn to analyse uncertainty and we explore decision-making in the light of that uncertainty. This is important, but we must also recognize that the precautionary approach will be adopted only slowly in policy-making. Uncertainty undermines political will in environmental decision-making. Officials are more likely to support a vociferous interest group that is apparently certain of the dire economic consequences of new restrictions, than scientists who advocate caution and prioritize the environment.

Over time, I learned that the solution for an adviser is not to hide careful analyses of uncertainty, but to distinguish the almost certain from the less certain. For example, it became clear in the 1980s that overfishing in New England, the North Sea and

many other areas was critically depleting resources. Exploitation of species such as cod was removing 60–70% of the standing stock every year. Unfortunately, the debates were too often about whether the sustainable exploitation rate should be 20 or 25%. The conclusion drawn by many in industry and politics was that the science was uncertain. Hearing people say in debates, “fisheries science is not an exact science,” made me wonder which other field they were comparing fisheries to, and indeed what an exact science is.



There is little uncertainty that overfishing was, and in many cases still is, occurring and that exploitation needed to be reduced by half or more. Emphasizing what we don't know often drowns out what we do know. In the event, strong action in New England reduced exploitation rates on some stocks, such as haddock, down to reasonable levels. As scientists predicted, the stocks began to recover. On other stocks such as cod, exploitation has remained relatively high, and they have not recovered. There is little mystery, and very slow progress is being made. Unfortunately, the fish may not wait for us to learn our lesson.

Statements of policy are still a far cry from implementing policy. It is easier to agree to the general principle of ending overfishing and rebuilding resources than it is to put the principle into effect. Few

argue that overfishing and resource depletion is a good thing; many argue about whether their fishing activity, their business or their recreation really contributes to overfishing.

For example, the United States' Marine Mammal Protection Act of 1972 is a strong mandate to protect all marine mammals; its reauthorization in 1994 was passed unanimously by the US Senate. But in the northeastern United States, protection of whales from entanglement in fishing gear — one of the main causes of death in whales in coastal waters — means that restrictions on fishing are necessary. Implementing these restrictions caused huge controversy.

Disagreement between different interest groups was exemplified by the elected official who opposed the restriction, telling me to, “go save the whales somewhere else”.

Political decision-making inevitably leans towards minimizing the impacts of policies on constituents who are most affected.

The public cares about the general outcome, such as saving whales, but is unlikely to change its political view or support for an official because of

local issues such as catch quotas or protected areas; fishermen will because the issue is immediate and vital to them.

In the 1990s, when I was a senior manager of the US National Marine Fisheries Service, I viewed my job as maximizing conservation without someone higher in the policy-making structure taking away my authority. Each decision was a judgement call about how far I could go, and without a doubt my judgment was imperfect. Science led my logic. I would start by asking: what do we know, and what does that mean we should do? In every case, I would then have to consider: what can be done, given the forces at play? As an adviser, I learned that adhering closely to the scientific advice is always the best course — as long as you can save some fish in the process. ■

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For more essays and information see <http://nature.com/nature/focus/arts/scipol/index.html>.

“Emphasizing what we don't know often drowns out what we do know.”

SCIENCE & POLITICS

Thank You

- Questions and discussion