Belize Fisheries Project

Summary Report on Stakeholder Workshops and Meetings Held in Belize June 12 – June 16, 2023

July 13, 2023

Contents

Introduction

The Belize Fisheries Project brings together a team of local and international experts in healthy reefs and small-scale fisheries to evaluate new and existing information and facilitate discussions about the current status and management of fisheries in Belize. The team has analyzed publicly available information about Belize's fisheries and has shared and discussed their findings with stakeholders, including the Belizean government, fishers, managers, and others involved or interested in fisheries in Belize, to understand their perceptions as well as ideas for the future. The project has and will continue to implement a transparent and participatory process to engage all interested stakeholders. Our goal is to exchange knowledge and provide a forum for stakeholders to develop a shared, evidence-based view of the state of Belizean fisheries.

This project is taking place at the same time Belize is working to implement the 2020 Fisheries Resources Act, expand its Blue Economy, conduct various activities under the Blue Bond including development of a Belize Sustainable Ocean Plan, and engage in a marine and coastal Project Finance for Permanence Initiative. These efforts provide a unique opportunity to ensure and support healthy, resilient, and sustainable fisheries. For example, under the Blue Bonds Loan Act, 2021, Belize committed to implementing a fisheries governance framework "consistent with transparent, science based, socially responsible international best practices," which include "sustainable harvest of target species."[1] Findings shared and discussions facilitated by the Belize Fisheries Project provide further insights to support sustainable fisheries in Belize, supporting livelihoods and contributing to the well-being of coastal communities.

The Belize Fisheries Project team comprises experts from Comunidad y Biodiversidad (COBI), the Environmental Law Institute (ELI), Healthy Reefs for Healthy People Initiative (HRI), MRAG Americas, and The Sea Around Us (SAU). The team also includes two individual partners with experience in fisheries governance globally and Belize's fisheries specifically. The project partners have global experience in and a commitment to fisheries that are ecologically sustainable and provide good livelihoods for fishers, help to support coastal communities, and contribute to national economies.

More information about the project and team members is available on the project's webpage: https://www.eli.org/belize-fisheries-project.

[1] Belize. Blue Bonds Loan Act, 2021. Conservation Funding Agreement, Annex A: Conservation Commitments. Available on: https://www.nationalassembly.gov.bz/wp-content/uploads/2021/11/Act-No-28-of-2021-Blue-Bonds-Loan.pdf (last accessed on July 10, 2023).

Purpose of the Report

This report provides a summary of the results of a series of workshops and meetings held in Belize the week of June 12, 2023, which had a primary aim of meeting with fishers in Belize to exchange information and understand fishers' experiences. This report also contains a list of main topics discussed during the team's meetings with other stakeholders, with key takeaways. The team is in the process of preparing a Full Workshop Report covering the results of those workshops and meetings in more detail.

The Team's June Trip to Belize

The team held three workshops with the fishers in different parts of the country. The team shared its draft analysis of new and existing information about fisheries in Belize with fishers and sought the fishers' perspectives about the status and management of the fisheries on which they depend.

The day before the first workshop with fishers, the team met with Belizean government representatives from the Ministry of Blue Economy and Civil Aviation, including from the Fisheries Department, and from the Blue Bond and Project Finance for Permanence Unit in the Office of the Prime Minister. During the week the team also met with MPA co-managers and other NGOs in Belize, and had individual conversations with representatives of Belize University's Environmental Research Institute, the Wildlife Conservation Society, and The Nature Conservancy to discuss the team's findings further.

The objectives of these workshops and meetings were to:

- Present a compilation of existing information and new analyses of the state of fisheries, conservation, and management;
- Understand how the information presented compares with stakeholders' perspectives, knowledge, and experiences on the water;
- Understand stakeholders' experience with participation in the management process; and
- Discuss possible sustainable fishery management actions.

Meeting with Belizean Government Officials

On Monday, June 12, 2023, the project team met with Belizean government representatives, including representatives from the Ministry of Blue Economy and Civil Aviation, the Fisheries Department, and the Blue Bond and Project Finance for Permanence Unit in the Office of the Prime Minister. During this meeting, the team shared its analysis and draft findings and engaged in a discussion with government officials about the status of key invertebrate and fish stocks and their management. Topics discussed included the status of fisheries in Belize;

regulation of recreational and sport fishing; the need for the regular assessment and review of management measures; development of fishery management plans; potential ways to strengthen management and enforcement of fisheries in Belize; and potential next steps for continued discussion among the project team and the Government of Belize.

The possible next steps discussed during this meeting included having a follow-up meeting with the Fisheries Department's technical team to discuss the Sea Around Us assessment methodology in more detail, compare results with the Fisheries Department's own assessments, and share fisheries data for stock assessments, particularly with regard to lobster and queen conch. A possible future technical workshop and other technical collaboration, including training in stock assessment methods, was also discussed. The project team would be pleased to receive any additional data that the Fisheries Department can provide, which could be shared, for example, during the technical workshops or training sessions, to incorporate in our analysis.

For the full presentation delivered by the project team to the Belizean government, please see Appendix 1.

Workshops with Fishers

The team had three workshops with fishers. The goal of these workshops was to share the team's analysis of the existing and new information about fisheries in Belize and learn from fishers about their perceptions and experiences on the water.

Each workshop – organized with support from the Belize Federation of Fishers – was attended by fishers with various levels of experience, from a year to over 50 years. These fishers came from many communities across Belize. The project team conducted extensive outreach through various channels in Belize to ensure that workshops were attended by diverse and representative groups of fishers. Participants included members of fishing cooperatives, the Belize Federation of Fishers, and local fishing associations.

- Workshop 1 was held Tuesday, June 13 in Dangriga – Twenty-five fishers from Dangriga, Hopkins, Placencia, Seine Bight, Georgetown, and Riversdale attended the workshop. Participants included members of Northern, National, and Placencia co-ops as well as unaffiliated fishers.
- Workshop 2 was held Wednesday, June 14 in Belize City – Twenty-one fishers from the Vernon Street, North Front Street, Barracks, and Yabra communities attended the workshop. Participants included members of National and Northern co-ops as well as unaffiliated fishers.
- Workshop 3 was held Thursday, June 15 in Corozal – Twenty-six fishers from Sarteneja, Copper Bank, Chunox, and Corozal Town attended the workshop. Participants included members of National and Northern co-ops.

The workshops began with presentations from the project team about existing information and draft results of new analyses on the status of fish stocks and fisheries management in Belize. The presentations included sections on Belize Fishery Status, Reef Health Survey Results, and Key Management Responses and Examples of Successes. For the full presentation delivered by the project team to fishers, please see Appendix 2.

Following the presentation and question and comment sessions, participants engaged in small group discussions. There were four small groups in each workshop, each presenting the results of their discussions to the whole meeting.

The first small group discussion aimed to capture fishers' stories about their experience on the water. The team posed the following questions to the fishers:

- What is your experience on the water - is our draft stock analysis similar to what you, the fishers, are seeing? If not, how? Why? How has your experience changed over time?
- What is your experience in the management process?
- What are the management problems that need to be addressed to improve the fishery?

The second small group discussion aimed to capture the fishers' thoughts on the actions that could be taken to make fisheries more sustainable. The team asked the fishers the following questions:

- What are the priority actions you think the government should take?
- How can the fishing community help motivate better management?
- How can other groups (private sector, tourism, NGOs) take action to motivate better management?

Commonalities for all three workshops

The following observations summarize the main points heard from fishers during all three workshops, including during the small group discussions and the question and comment sessions that followed the team's presentations. As stated above, this report is a summary of the workshops. The team is preparing a more detailed report that will include the main points of discussion during each meeting.

There was general agreement among the fishers that the key fisheries resources are currently in a poor state and new management interventions of various kinds are needed. There was some divergence of opinions regarding specific details but almost all were in agreement with the broader conclusions of the scientific analyses presented. There was general agreement among the fishers that they were seeing the warning signs of overfishing and declines in stock size, and that fishery management processes and procedures set out in the 2020 Fisheries Act needed to be effectively implemented to achieve sustainability.

Generally speaking, fishers expressed their deep concern about the natural resources of Belize and the future of their livelihoods. They repeatedly expressed a heartfelt desire to be involved in every part of the process to improve management and sustainability of the fisheries in which they work and often expressed deep frustration about being excluded or marginalized from the information sharing, problem-solving, and decision-making that directly affects their jobs, income, families, communities, and the environment in which they work. The expressed desire of the fishing community was not to resist change, but to be an integral part of it.

The fishers spoke about five major topics throughout the workshops:

1. Risk to Fishery Resources. The presentations on the status of the fishery resources in Belize were of great interest to the fishers. There was a good understanding that fishers and scientists have different perspectives on the resources and bring important and complementary knowledge to the discussion. The critical point is that scientists, fishers and, ultimately, decision-makers recognize that the natural resources and the communities that depend on them are at risk. That risk is from multiple pressures, including overfishing, but also climate change, coastal development, potential foreign fishing, and other sources.

    · The fishing community shared the view that relying on deep water stocks of conch, lobster, and finfish to continually replenish shallow water stocks carried a high level of risk. Fishers with experience in deep water were very skeptical that these areas could continue to support shallow water fishing on immature individuals. Scientific knowledge and experience from around the world shows that the reliance on replenishment of stocks from assumed deep water refuges of adults is very risky, even when the exploitation of juveniles is strictly limited.

    · There was broad agreement about the risks to lobster and nearly all participants were in agreement about the significant risks to conch (the most valuable species). At the same time, it was clear that scientists' and fishers' perspectives on what "abundance" and "overexploited" mean may be different due to differences in scale. Scientists assess the status of whole stocks, while fishers rely on their direct observations on the water. Both can be an accurate representation of observations and complement each other. For example, many fishers said that their landings were reasonably stable over the last decade or so, particularly at the opening of the fishing season. But they also said the total number of fishers and the amount of Illegal, Unreported, and Unregulated (IUU) fishing, and therefore the total fishing effort, had increased enormously. In addition to noting declines in their average catch size, fishers said that with both conch and lobster, the animals they were catching had gotten smaller. Many fishers – with as few as five to more than fifty years of experience – noted

decreases in size. These observations of the fishers align with the scientific results showing declines in biomass and increases in exploitation rates.

· Fishers generally, and often strongly, commented on the problem of IUU fishing. They also noted their observations of impacts of climate change, increased recreational catch, coastal development, pollution, and other coastal issues. All of these negative impacts exacerbate the risks to the stocks shown by the scientific analysis. All of these issues, if more explicitly included in the analyses, would produce results showing even greater risk. No issues were raised that would improve the assessed condition of fishery resources.

· Fishers strongly expressed the view that the current licensing system is not effectively limiting fishing effort. It was widely described by fishers during the meetings as unfair, unworkable, and poorly administered. Fishers voiced their opinion that the license system needs to be significantly reformed to become a useful tool for fishery management.

· Many fishers were concerned that more fishing areas would be closed off to them with the establishment of additional MPAs. While not objecting to protected areas *per se*, fishers voiced their concern that some conservation zones of existing protected areas continue to be exploited either illegally or legally from recreational fishing, while legitimate commercial fishers are excluded. That feels unfair to the licensed fishers, and just as importantly, adds significantly to overexploitation. They wanted to see proper implementation of the existing MPAs before new ones were implemented. Most agreed with the concept and need for effective 'replenishment zones" that are not fished - recreationally or commercially.

· Fishers observed that the sizes of conch and lobsters were declining. For lobsters, some fishers specifically expressed that most of the animals have tail weights of less than 4.5 ounces. From a scientific perspective, this means that those lobsters are juveniles. This is a clear warning sign of overexploitation. While few fishers called for increased minimum landing sizes, except for preventing IUU landings of undersized conch, lobsters, and fish, they recognized the problem. Nevertheless, a switch to larger minimum sizes was of concern to many fishers due to expected economic hardship during the transition period between the change in regulation and the expected future benefits in terms of higher catches.

2. <u>Inclusion in Planning and Decision-Making.</u> The fishers expressed an urgent need for genuine consultation and inclusion of fishers and their communities in the process of

planning and implementing future management actions that affect the fisheries and the coastal areas of Belize.

· Currently, fishers do not feel included in the fisheries management process, or decision-making regarding efforts to conserve, manage, and potentially develop the Belizean coastal environment. When consultations do occur, they are cursory, not transparent, and limited to a small number of individuals rather than a broader representation from the community and fisher organizations in each area. This includes processes led by government departments, as well as those led by or including non-governmental organizations and private industry discussions. Fishers want to be included in consultations focused not only on fishery management, but also on the Blue Economy, coastal development, tourism, and other sectors, because decisions in all of these fast-moving sectors affect fishing communities and livelihoods.

· Fishers also noted that inclusion goes beyond just listening sessions; it means that fishing communities are true contributors to and partners in decision-making. The fishers understand that inclusion cannot mean that nothing moves forward without consensus, but they believe the opportunity to be a part of a transparent process to influence decisions is essential.

· Most of the participants were deeply frustrated by the lack of transparency in the process of planning and management, and the implementation of management actions. They expressed in open session and individually how hard it is to know what decisions are being considered, made, and implemented that affect them directly. This lack of transparency is a source of deep frustration and suspicion that results in a lack of trust in government and non-governmental actions happening in the coastal environment. Some noted that lists of licensed fishers in each zone are not publicly available.

3. <u>Enforcement.</u> Enforcement of existing rules repeatedly came up as a major issue during the meetings. Fishers voiced their concerns that enforcement was often spotty, misguided and misapplied, or almost completely absent. Enforcement was said to be generally unreliable and, if present at all, did not address major violators or significant sources of IUU fishing.

· The true extent of IUU fishing is difficult to know, and it is highly likely that it is not fully included in the scientific analyses presented by the project team so far, although it is partially and imprecisely included. If better estimates of the IUU catch and effort were available, it would likely show that the stocks are worse off

than the analysis currently shows. Hence the risk to sustainability is likely to be higher than currently estimated.

· Fishers shared their concerns that IUU fishing resulting from the lack of enforcement is taking away catch, income, and livelihoods directly from fishers who are trying to follow the rules and be "good" fishers/citizens. Examples were given included taking very small size lobsters, conch, and fish without regard for rules or sustainability, fishing in closed seasons and areas, and destructive practices such as smashing of small conch for pearls. Fishers noted that huge catches landed at co-ops on opening day were a clear indication of fishing before the season opened, depressing prices for those fishing legally.

4. Education. Education was a major topic for the fishing community. Fishers expressed a desire to employ elder fishers to mentor younger ones on safe and sustainable fishing practices, as young fishers may enter the fishery with little experience, particularly regarding issues of sustainability. Fishers also wanted to help educate enforcement agents in how the fisheries work, and the different types of IUU fishing. Some fishers suggested more public education about fishing and the marine environment by fishers for school children. Many others suggested building support for fishing as a sustainable occupation and important part of society.

   · There were more young fishers in the workshops than is often the case in other countries. This is an opportunity for younger generations to bring sustainable practices to the fore and for elders to mentor their fellow fishers.

   · Suggestions on education were voiced as part of a broader desire for fishers to have alternative employment in the closed season or as a move towards retirement.

   · Fishers feel forgotten and misunderstood. They want to help improve their image, the situation with fisheries resources, and their opportunities.

5. Need for Support. Fishers have expressed their willingness to support and contribute to management, enforcement, education, and coastal sustainability, but they need help. Many ideas were proposed at the workshops. Of particular note are the following:

   · Alternative employment for off-season or other periods. Training in a range of activities related to agriculture, tourism, boat engine repair, and more were mentioned. These are support activities, trainings, and opportunities that can be important transition efforts.

· Fishers expressed a desire for education for fisher families so as to expand opportunities for the next generation. Some wanted their children to continue the fishing tradition but recognized they also need more and diverse livelihood options.

· Some fishers wanted better market control, so that prices were not subject to the effects of oversupply at certain times (e.g., at the start of the season, with a clear connection to IUU landings).

· Many fishers wanted help in cost reduction for fuel and other supplies.

Meeting with MPA Co-Managers

On the morning of Friday, June 16, the team met with Marine Protected Area Co-Managers. Members of the following co-management organizations attended this meeting:

- Belize Audubon Society
- Sarteneja Alliance for Conservation and Development
- Southern Environmental Association
- Toledo Institute for Development and Environment
- Turneffe Atoll Sustainability Association

The meeting began with a project team's presentation about the status of fish stocks and fisheries management in Belize. For the full presentation delivered by the project team, please see Appendix 3.

After the presentation, meeting participants engaged in a discussion. Key topics discussed at the meeting included enforcement within managed access areas, IUU fishing, and the role of NGO co-managers. The co-managers voiced no disagreement with the team's findings regarding declining stocks. However, they wanted to learn more about the data used in the SAU methodology. The co-managers shared their concerns that current enforcement capacity is insufficient to address the problems of IUU fishing. They also suggested that law enforcement agencies in Belize should come together to develop a strategy to address IUU fishing – land-based as well as on the water – and that big IUU activity has its roots on land. With regard to the role co-managers can play, some shared their thoughts that co-managers should lead by example and take proactive action against big violators. There was also a discussion about licensing and the need for licensing reform.

Meeting with NGOs

On the afternoon of Friday, June 16, the project team met with a number of marine conservation NGOs. Members of the following organizations attended this meeting:

- Belize Fund for a Sustainable Future
- Belize Network of NGOs
- Bonefish Tarpon Trust
- Environmental Defense Fund

- Fragments of Hope
- MAR Alliance
- Oceana
- The Nature Conservancy
- Turneffe Atoll Sustainability Association
- Turneffe Atoll Trust
- Wild Tracks
- Wildlife Conservation Society
- World Wildlife Fund

The meeting began with the project team's presentation about the status of fish stocks and fisheries management in Belize. For the full presentation delivered by the project team to NGOs, please see Appendix 3.

After the presentation, meeting participants engaged in a discussion. There was general agreement among the NGO participants regarding the status of the fishery resources and associated risks identified in the presentation and the needs to address them. Topics discussed during the meeting included enforcement, monitoring, use of technology, training on the methodology used by the team, exchange of data, fishery management plans, implementation of the 2020 Fisheries Act, and consultations with the fishers about management decisions.

Next Steps

The Belize Project will release the Full Workshop Report which will include additional information and details from the meetings and workshops, as well as outline the next stages for the project. We will continue our efforts to schedule training and information exchange sessions with Belize Fisheries Department technical staff and NGO staff in the Sea Around Us stock assessment modeling tool.

Estamos traduciendo este informe preliminar a Español. Compartiremos el informe traducido cuando esté disponible. El informe final también estará disponible en español.

Appendix 1: Presentation to Belizean Government Representatives

Belize Fisheries Project

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

June 12, 2023

The Fisheries of Belize: Overview of Results

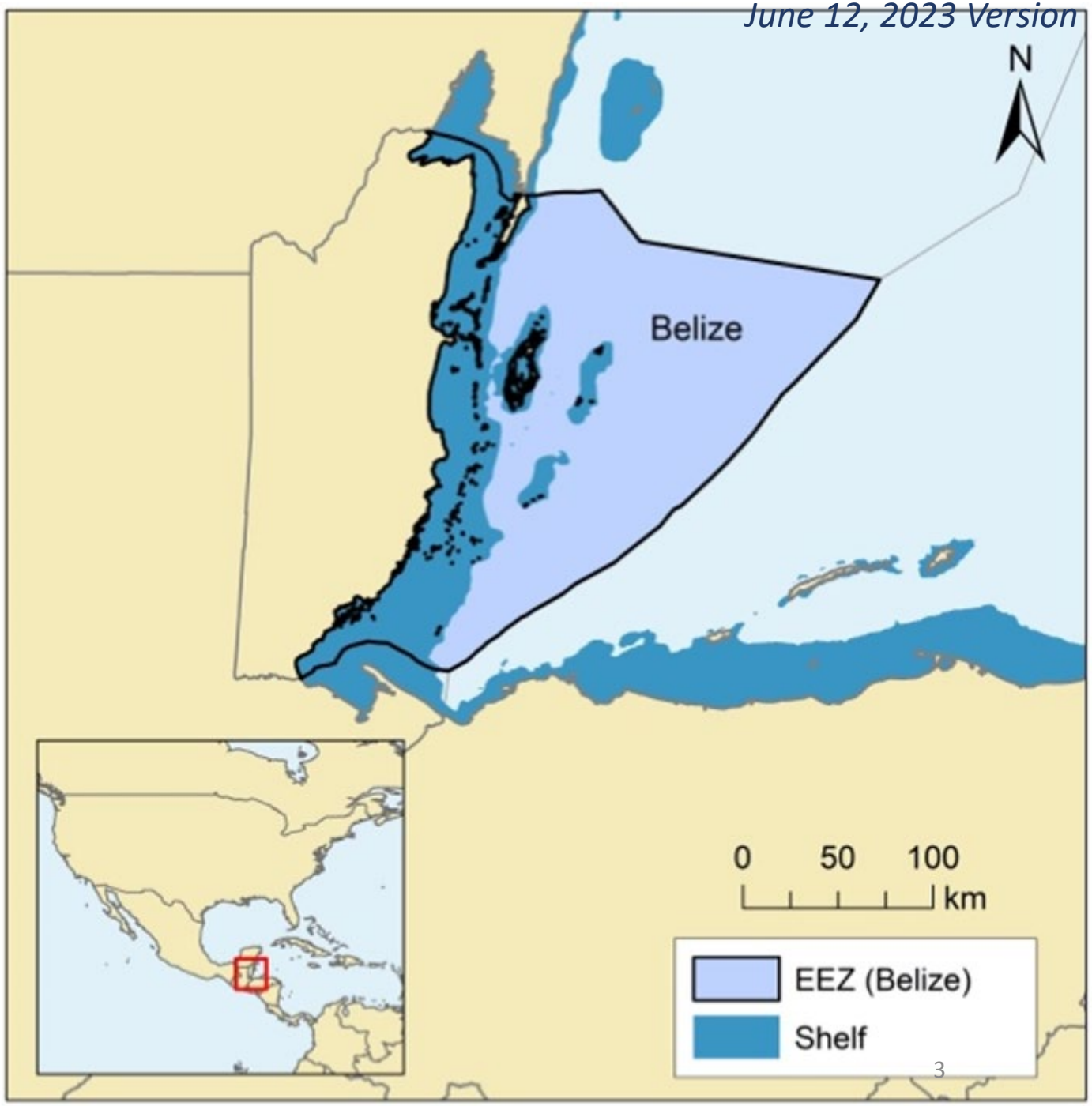
Daniel Pauly, M.L. 'Deng' Palomares, and Alexander Tewfik

Sea Around Us Research Initiative, IOF, UBC

Belize, 12 June 2023

- The Exclusive Economic Zone (EEZ) of Belize covers 36,182 km^2

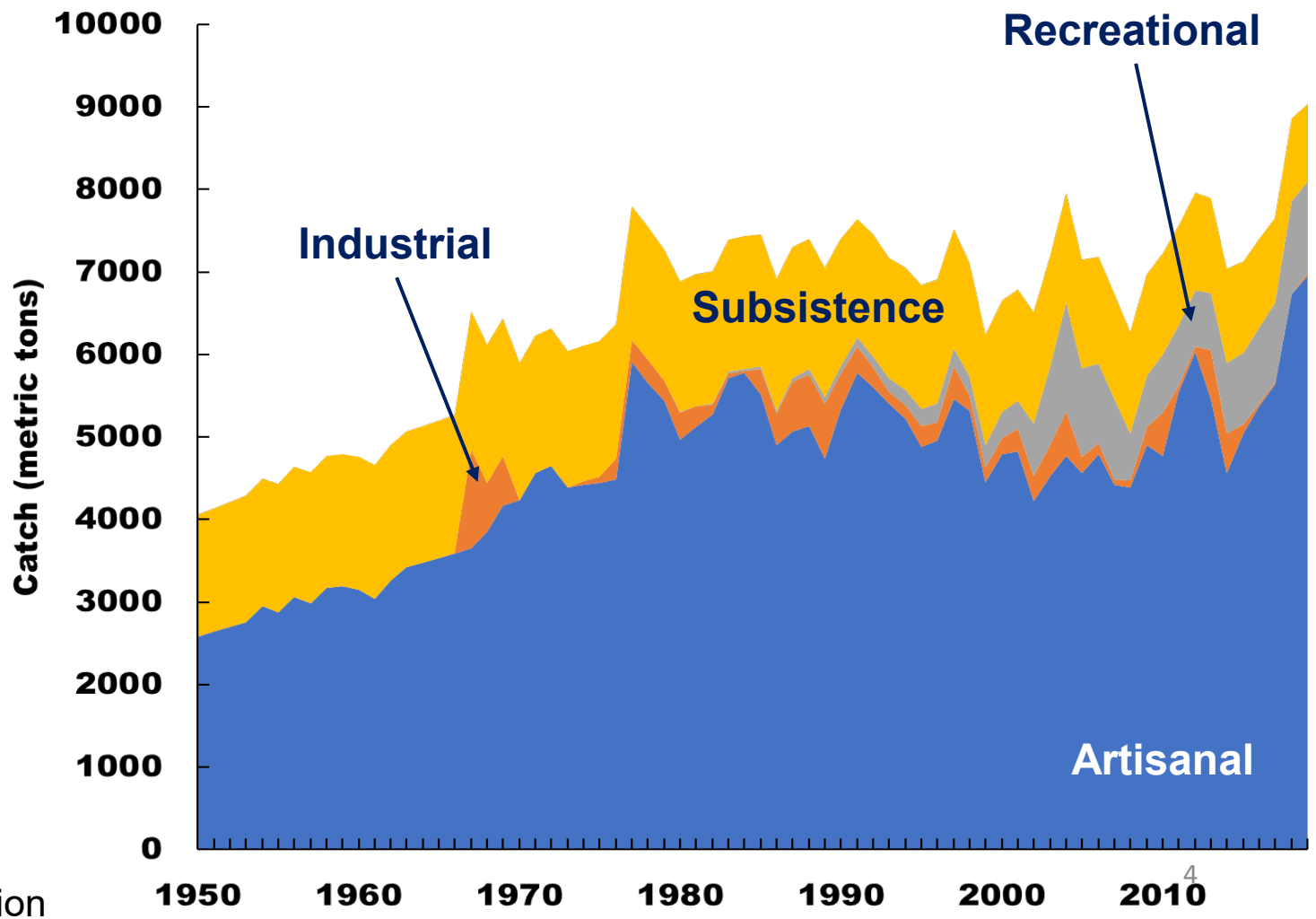
- The Territorial Sea includes three distinct atolls, Glover's Reef, Lighthouse Reef and Turneffe Atoll.



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
23 of 443 sources were used for this reconstruction

Belizean marine catch by species (I)

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

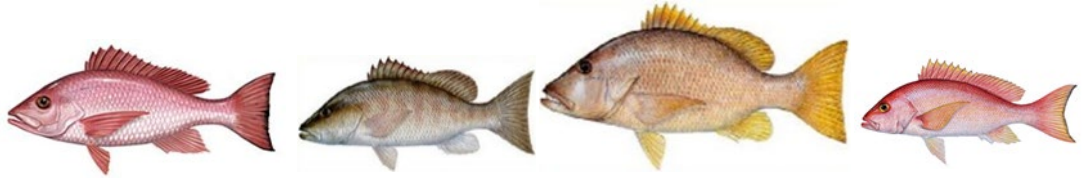
21% of the catch

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

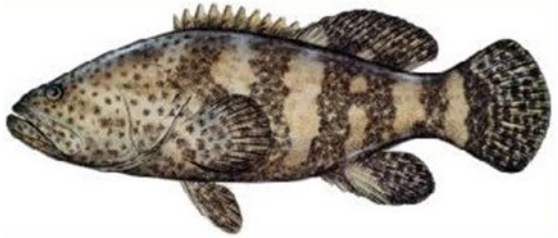
8% of the catch

Great barracuda

2% of the catch

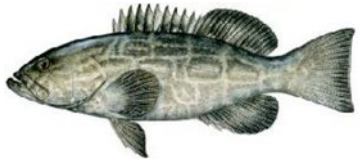
Snook

2% of the catch



Goliath grouper

Nassau Grouper



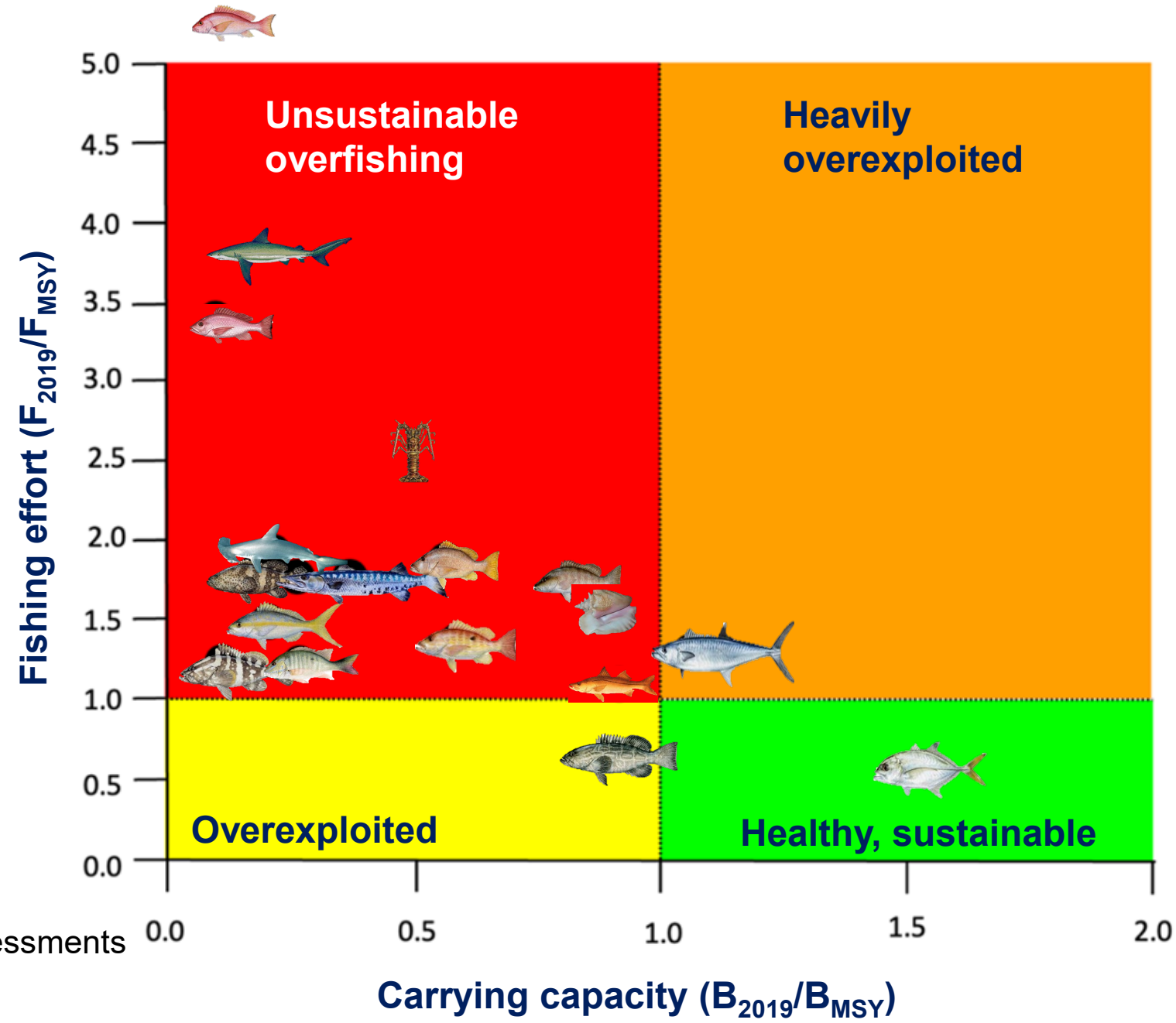
Black grouper

<1% of the catch

Sea Around Us stock analyses

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

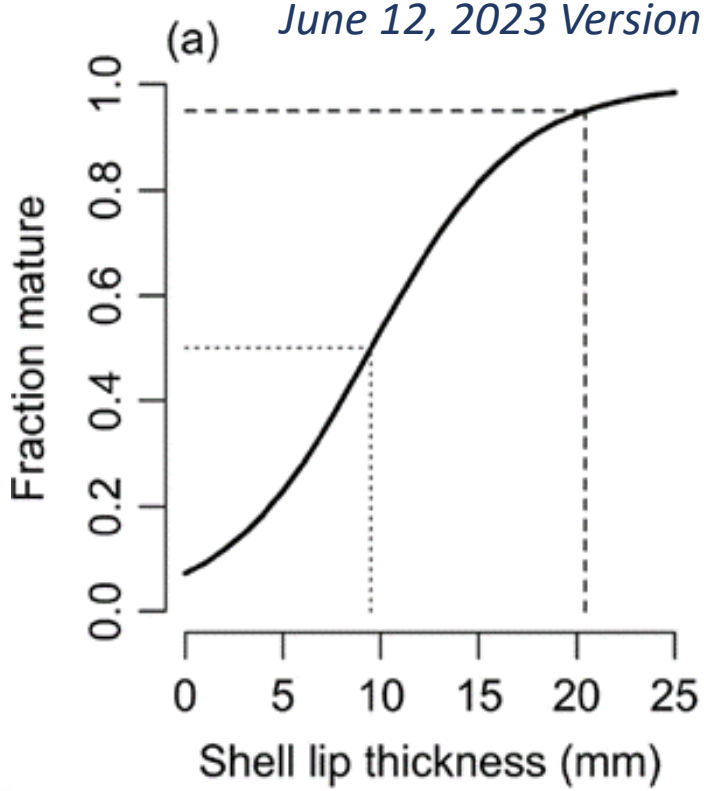
Low carrying capacity driven by high fishing effort.

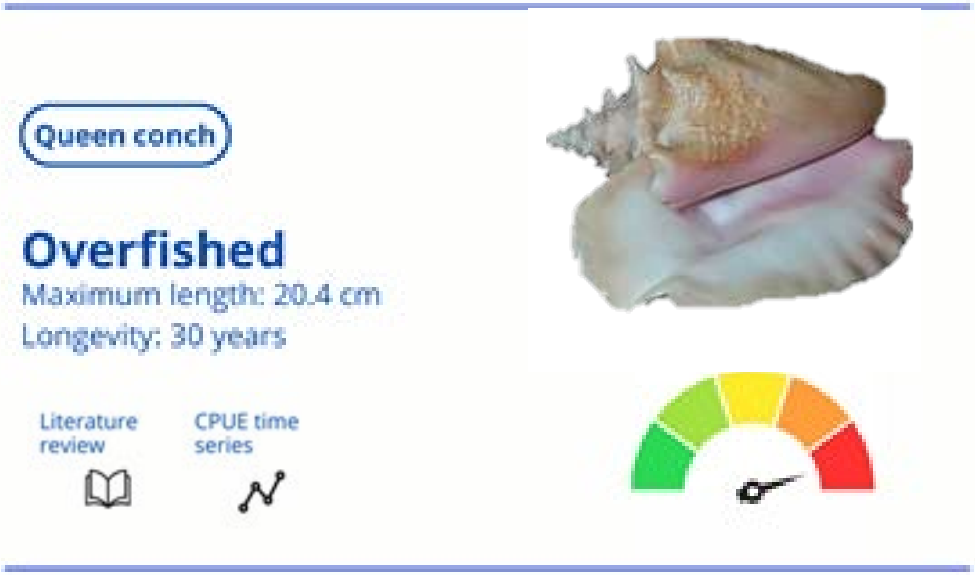


38 of 443 sources were used to inform these assessments

Review of existing knowledge: Queen conch

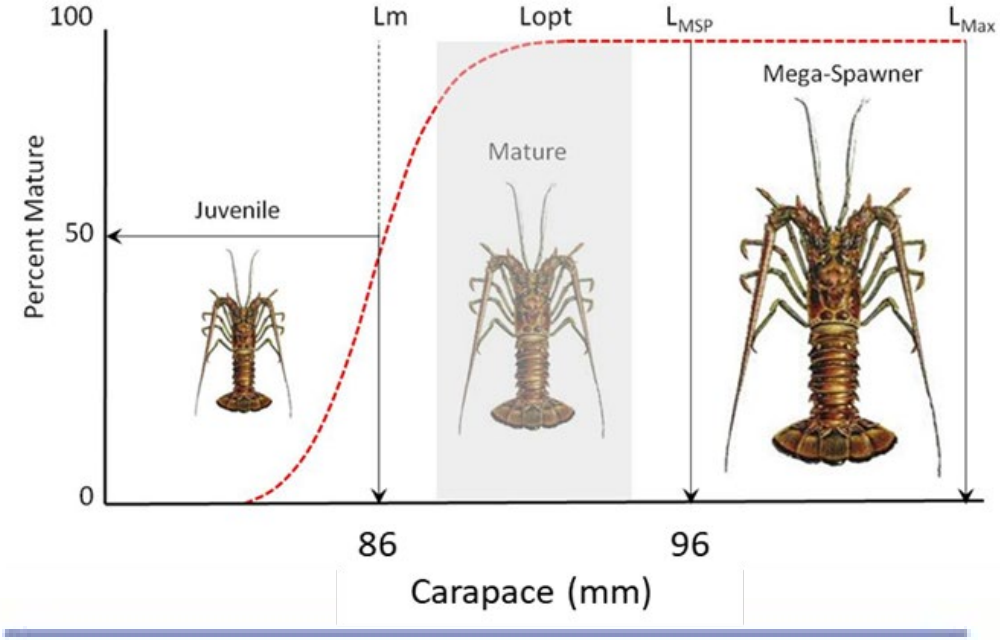
- Exploitation peaked in 2008-2013, which led to listing in Appendix II of CITES.
- Currently managed using size limits established in 1978 based on shell height and meat weight.
- Maturity is measured by thickness of shell lip (Tewfik et al. 2019).
- Bulk of catch is of immature individuals.





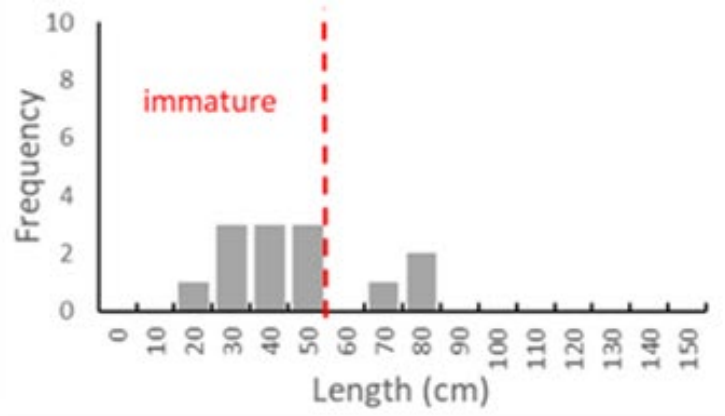
Review of existing knowledge: Spiny lobster

- 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.



Review of existing knowledge: Nassau Grouper

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

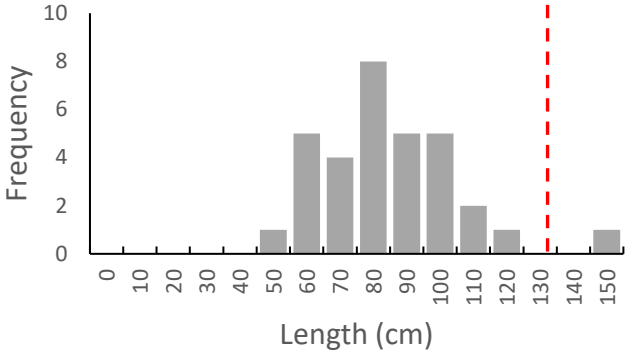


Review of existing knowledge: Goliath and Black Groupers

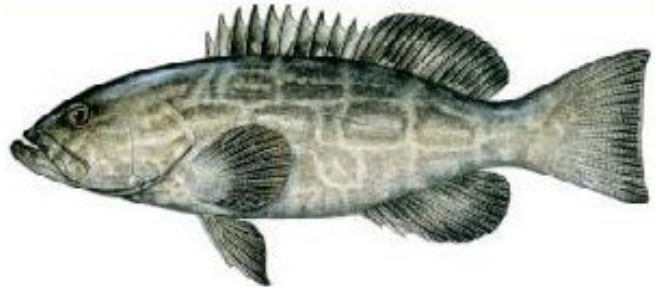
- In similar conditions as Nassau grouper

Goliath

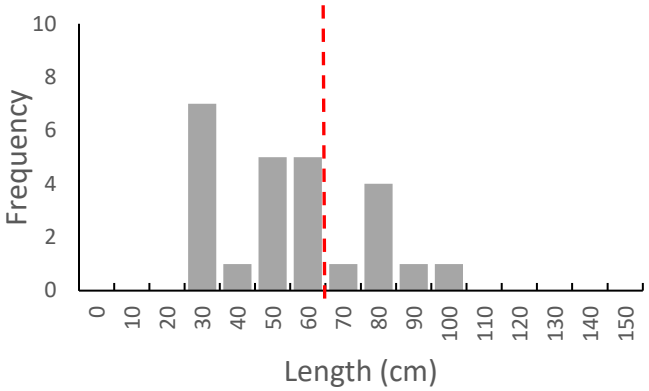
Max: 250 cm/360 kg



Black



Max: 150 cm/45 kg



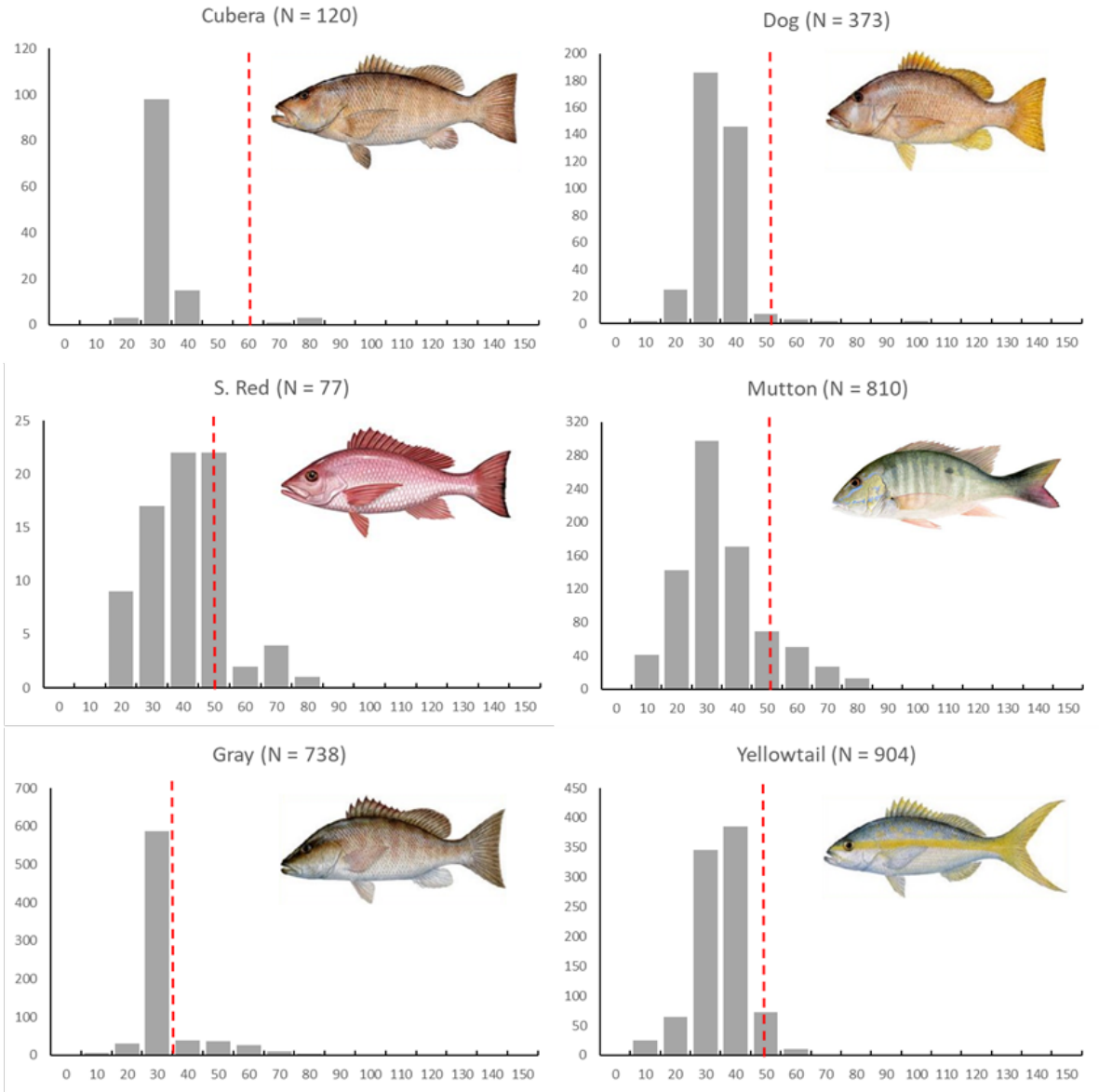
Review of existing knowledge: Snappers

Red

Cubera

Mutton

Lane



June 12, 2023 Version

Crevalle jack

Overfished
Length at maturity: 56 cm
Maximum length: 124 cm
Optimal length: 70 cm
Longevity: 8 years

Mutton snapper

Overfished
Length at maturity: 46 cm
Maximum length: 94 cm
Optimal length: 55.8 cm
Longevity: 18 years

Dog snapper

Overfished
Length at maturity: 47.6 cm
Maximum length: 128 cm
Optimal length: 58 cm
Longevity: 29 years

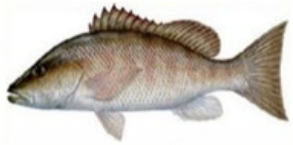
Common snook

Overfished
Length at maturity: 61.2 cm
Maximum length: 140 cm
Optimal length: 77.6 cm
Longevity: 10 years

Silk snapper

Overfished
Length at maturity: 34 cm
Maximum length: 83 cm
Optimal length: 39.9 cm
Longevity: 9 years

Grey snapper



Overfished
Length at maturity: 32.1 cm
Maximum length: 89 cm
Optimal length: 36.7 cm
Longevity: 12 years

Great barracuda

Overfished
Length at maturity: 75.7 cm
Maximum length: 200 cm
Optimal length: 99.3 cm
Longevity: 17 years

Northern red snapper

Overfished
Length at maturity: 49.5 cm
Maximum length: 100 cm
Optimal length: 60.6 cm
Longevity: 17 years

Lane snapper

Overfished
Length at maturity: 26.4 cm
Maximum length: 60 cm
Optimal length: 29.3 cm
Longevity: 10 years

Yellowtail snapper

Overfished
Length at maturity: 29.3 cm
Maximum length: 86.3 cm
Optimal length: 33 cm
Longevity: 10 years

Official assessment | Literature review | CPUE time series | Expert testimony

Scalloped hammerhead

Overfished
Length at maturity: 143.2 cm
Maximum length: 430 cm
Optimal length: 208.2 cm
Longevity: 32 years

Caribbean reef shark

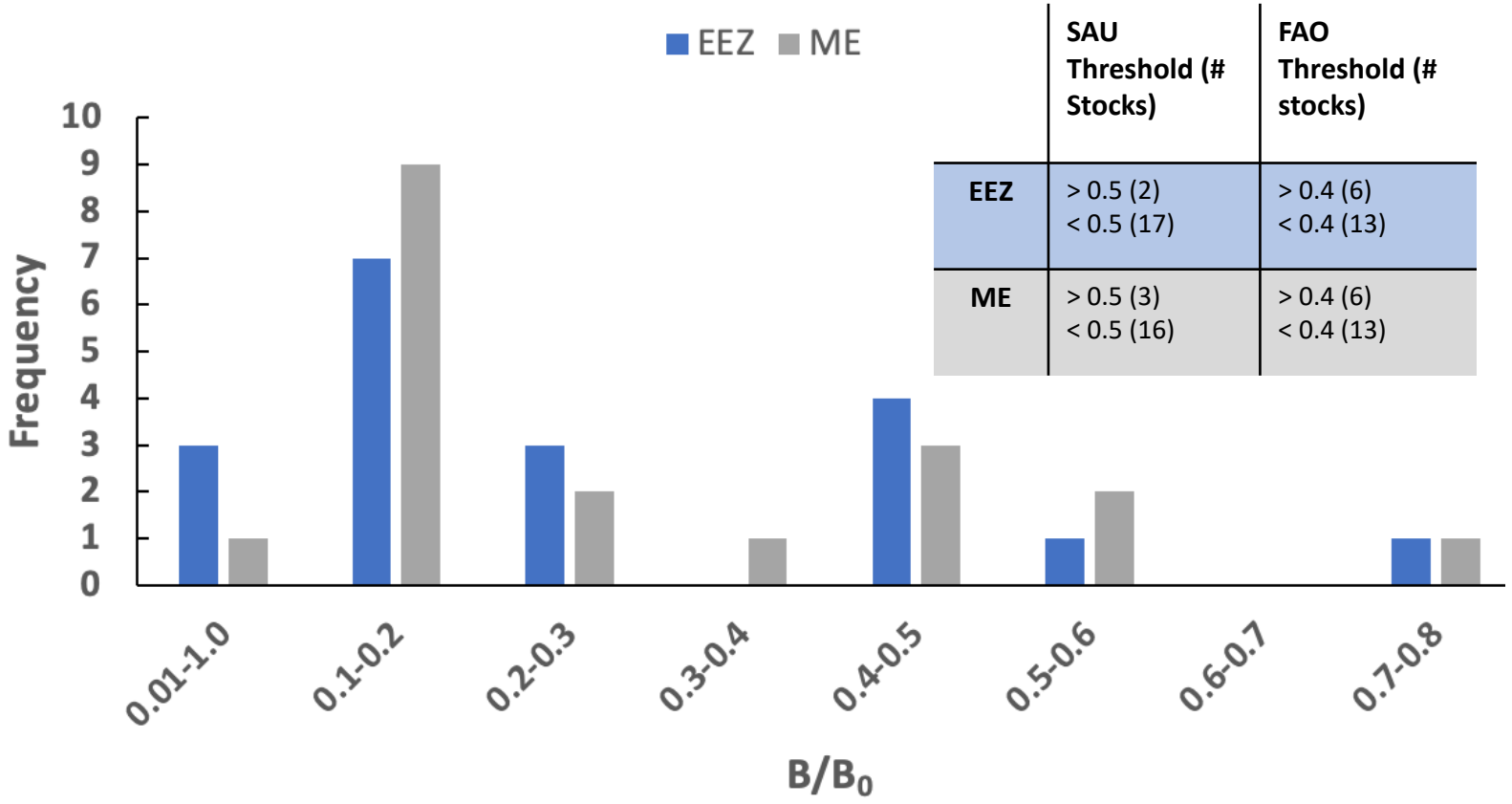
Overfished
Length at maturity: 141.1 cm
Maximum length: 300 cm
Optimal length: 205.1 cm
Longevity: 24 years

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**.

Current biomass relative to carrying capacity (B/B_0)



	SAU Threshold (# Stocks)	FAO Threshold (# stocks)
EEZ	> 0.5 (2) < 0.5 (17)	> 0.4 (6) < 0.4 (13)
ME	> 0.5 (3) < 0.5 (16)	> 0.4 (6) < 0.4 (13)

Stock status of 19 stocks assessed for the Belize EEZ and Western Caribbean Marine Ecoregion. 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, .

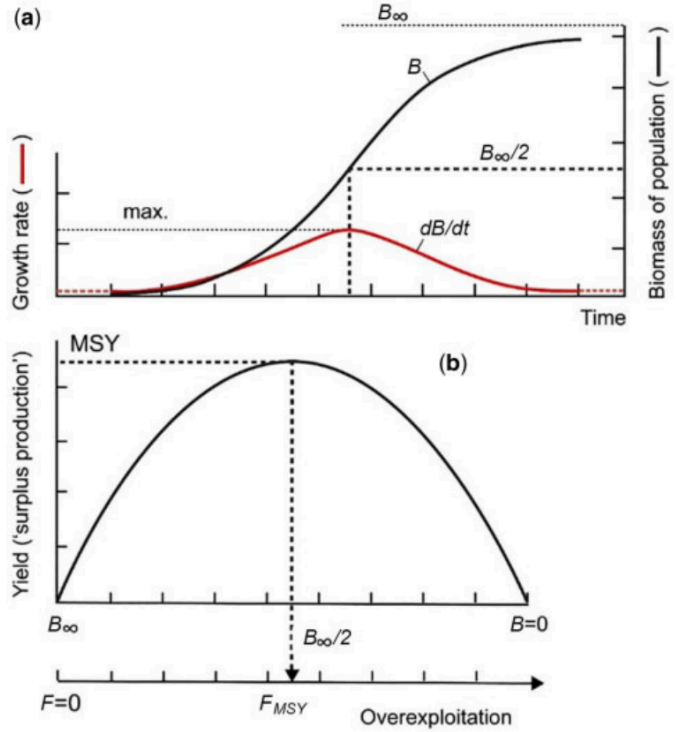


Figure 3. Basic elements of the Schaefer surplus production model. (a) A population invading an open space or recovering from a catastrophic decline will typically grow in sigmoid fashion, i.e. exponentially at first, then with at a declining rate as carrying capacity is approached. (b) The first derivative 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)

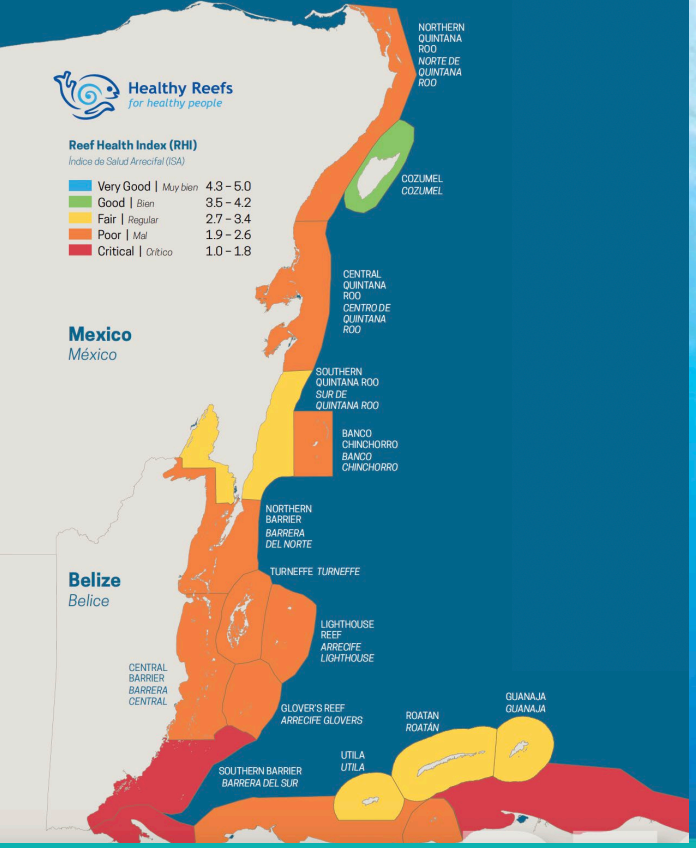
Reef Health Survey Results

Dr. Melanie McField

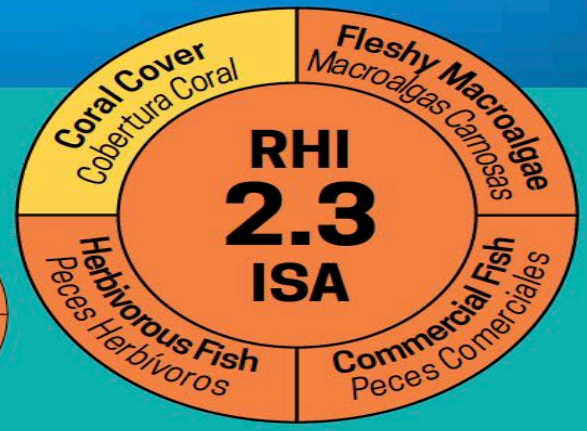
Healthy Reefs Initiative and Smithsonian Institution

June 12, 2023 Version

Mesoamerican Reef Health



5 is top Score

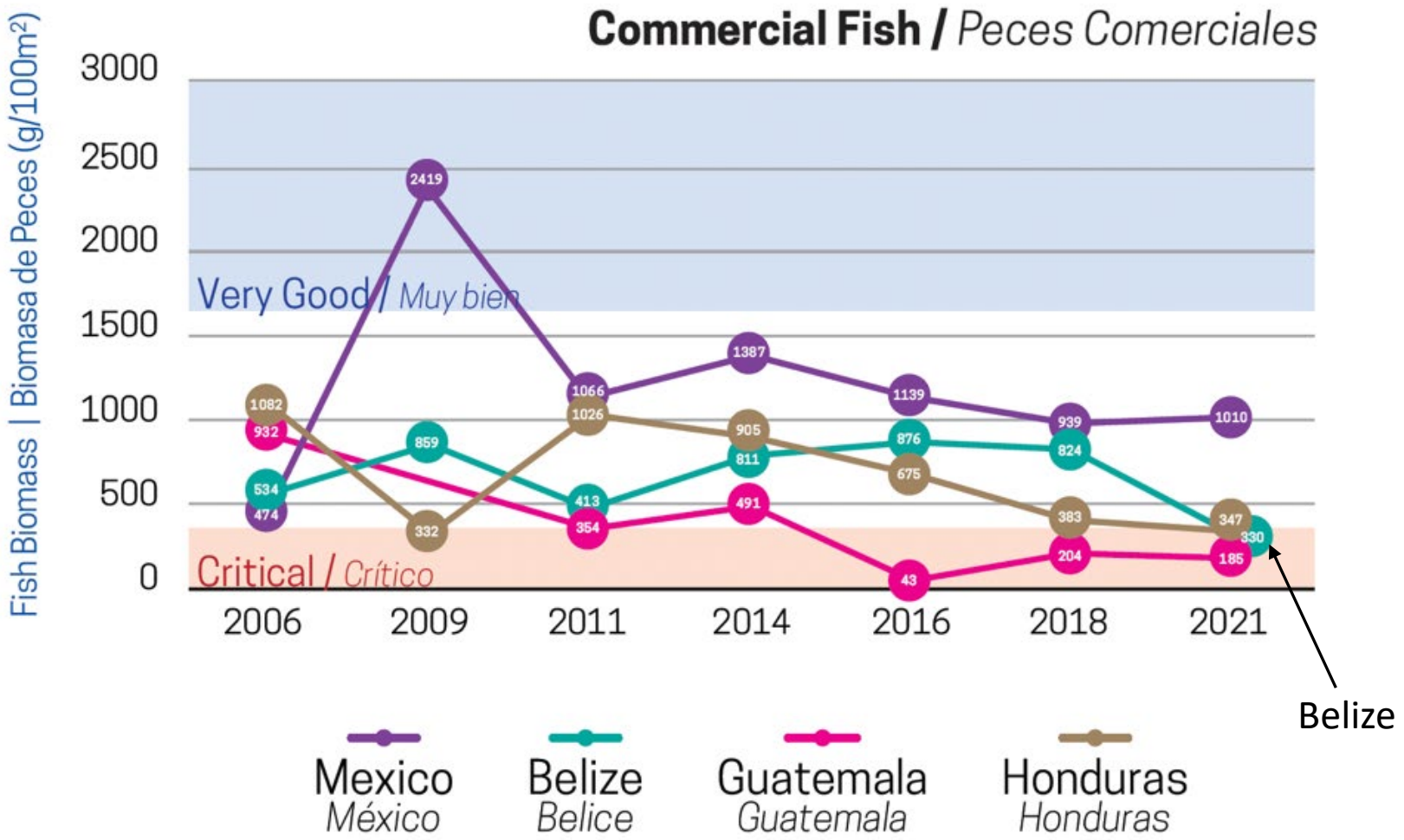


2006	2009	2011	2014	2016	2018	2021
2.3	2.3	2.5	2.8	2.8	2.5	
326 SITES SITIOS	130 SITES SITIOS	193 SITES SITIOS	249 SITES SITIOS	319 SITES SITIOS	286 SITES SITIOS	234 SITES SITIOS

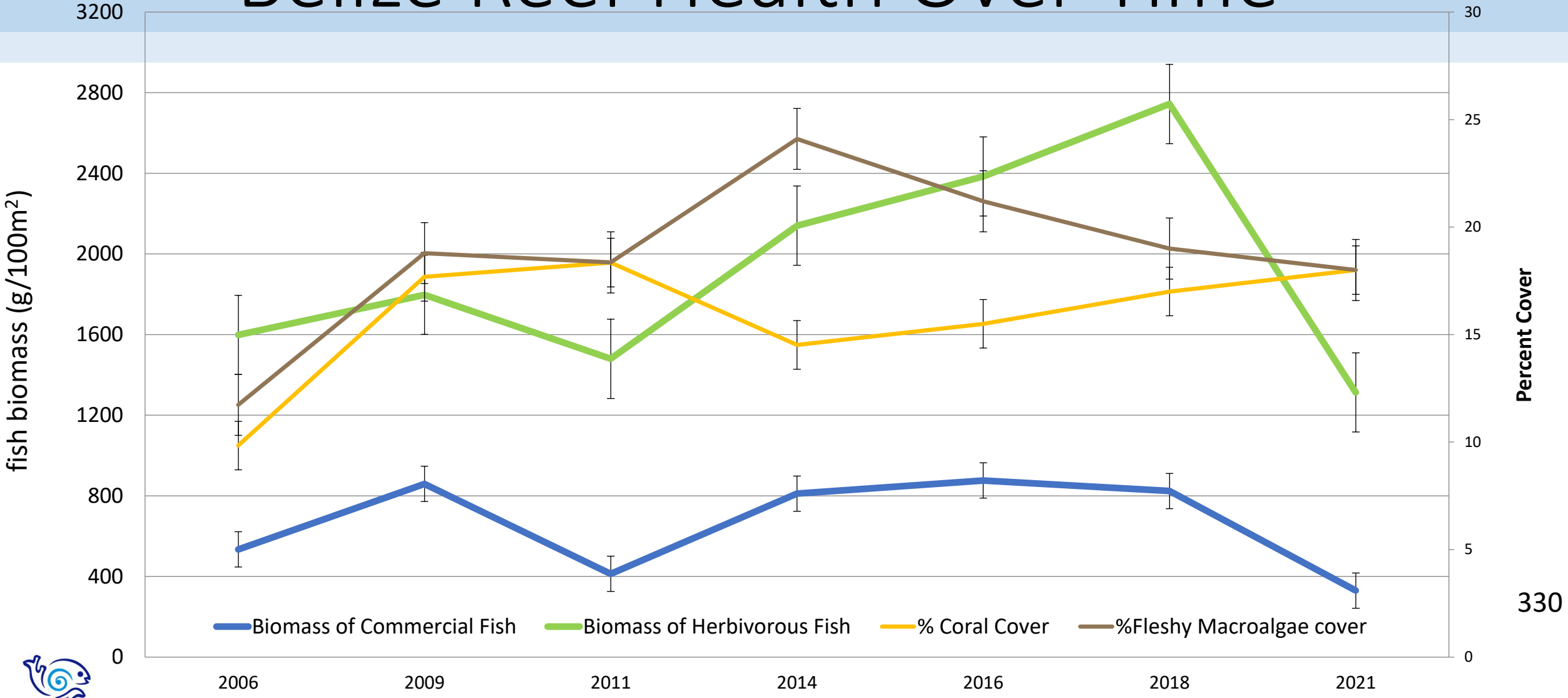
Years shown represent when data was collected not year report card was printed | *Los años que se muestran representan cuándo se colectaron los datos y no cuándo se imprimió el reporte.*

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.

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.



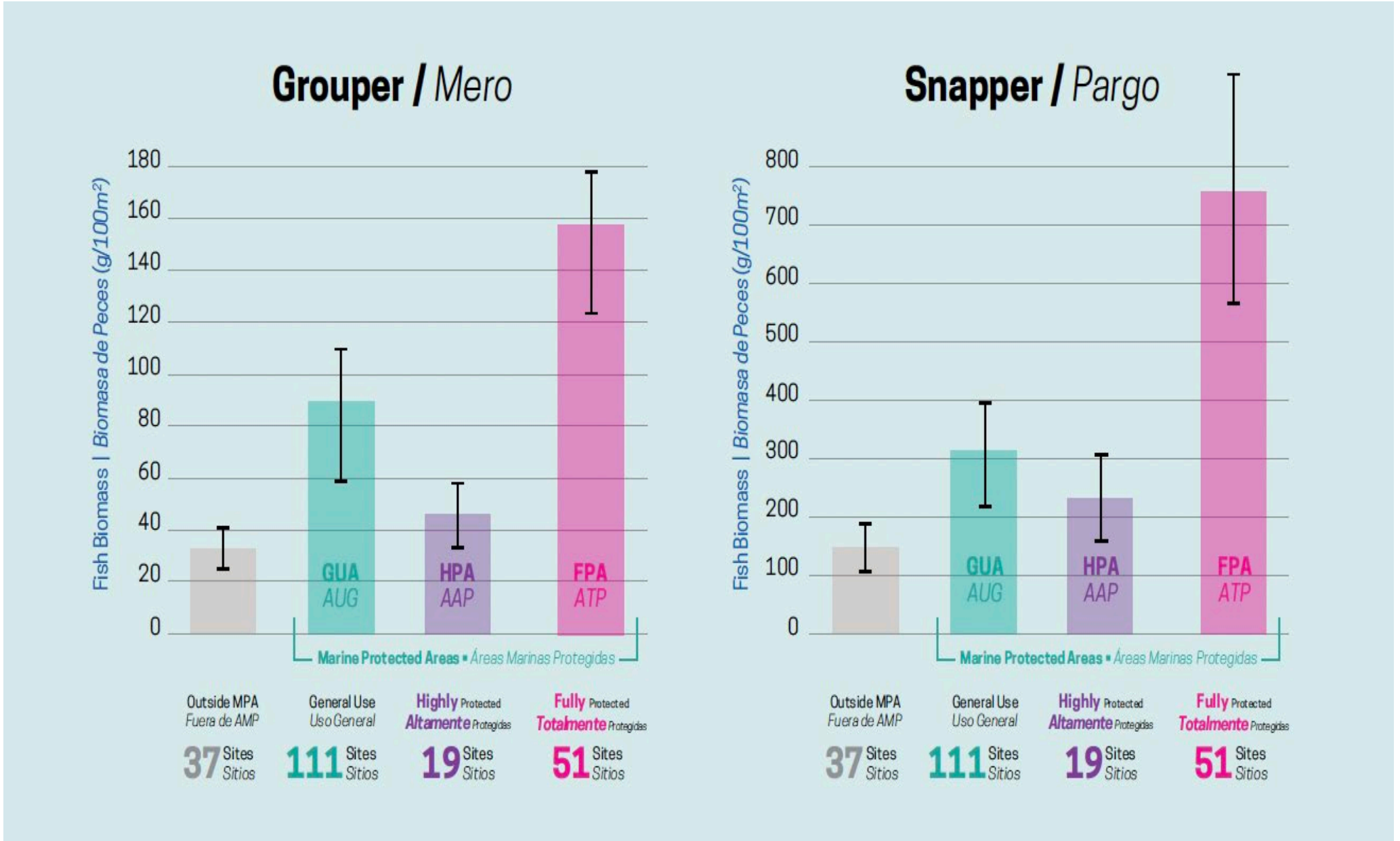
Belize Reef Health Over Time



330

Healthy Reefs
for healthy people

Only Fully Protected Zones Have Higher Fish Biomass



218 sites

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

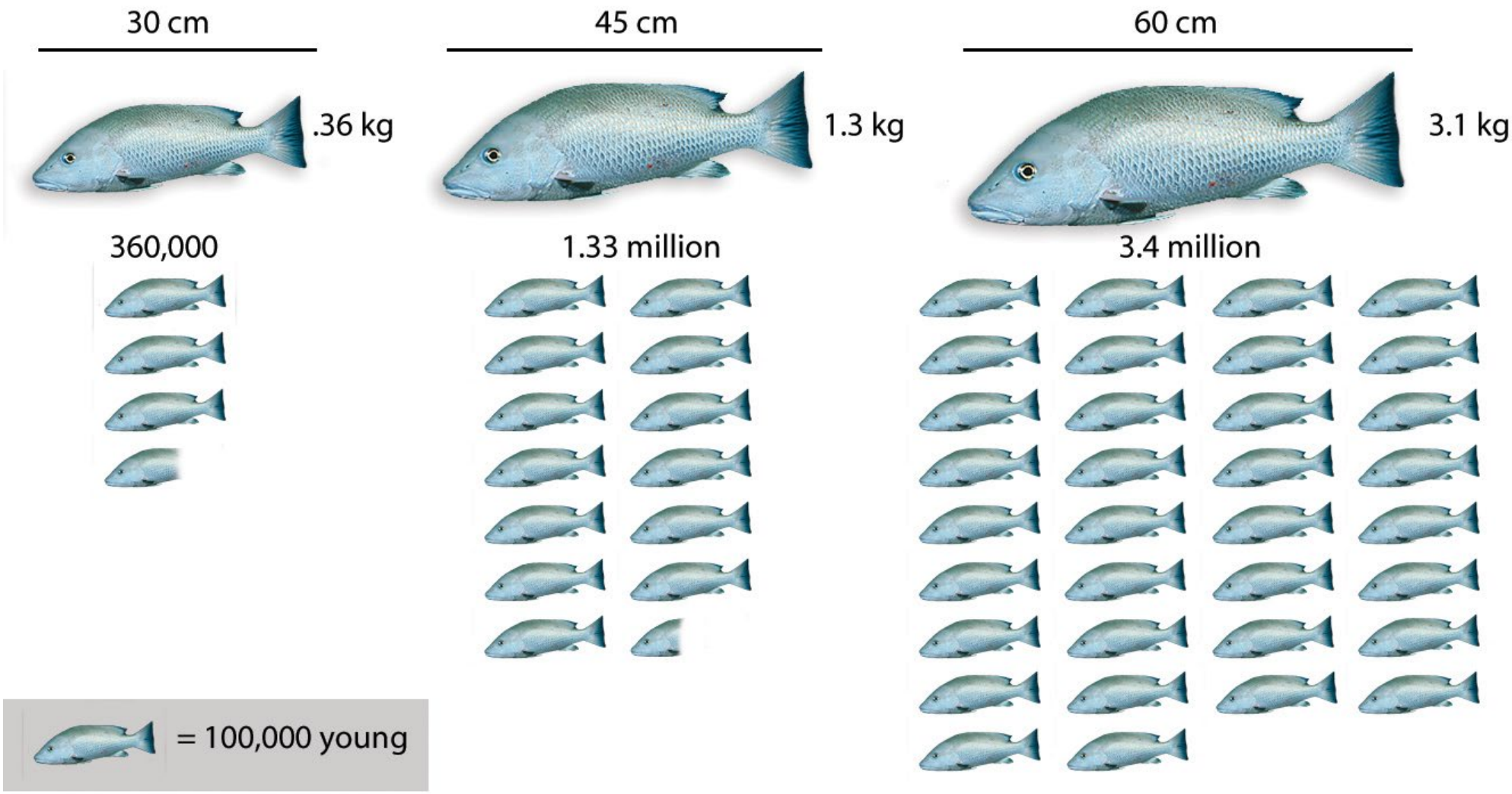
65cm **25% Mature** Maduro

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

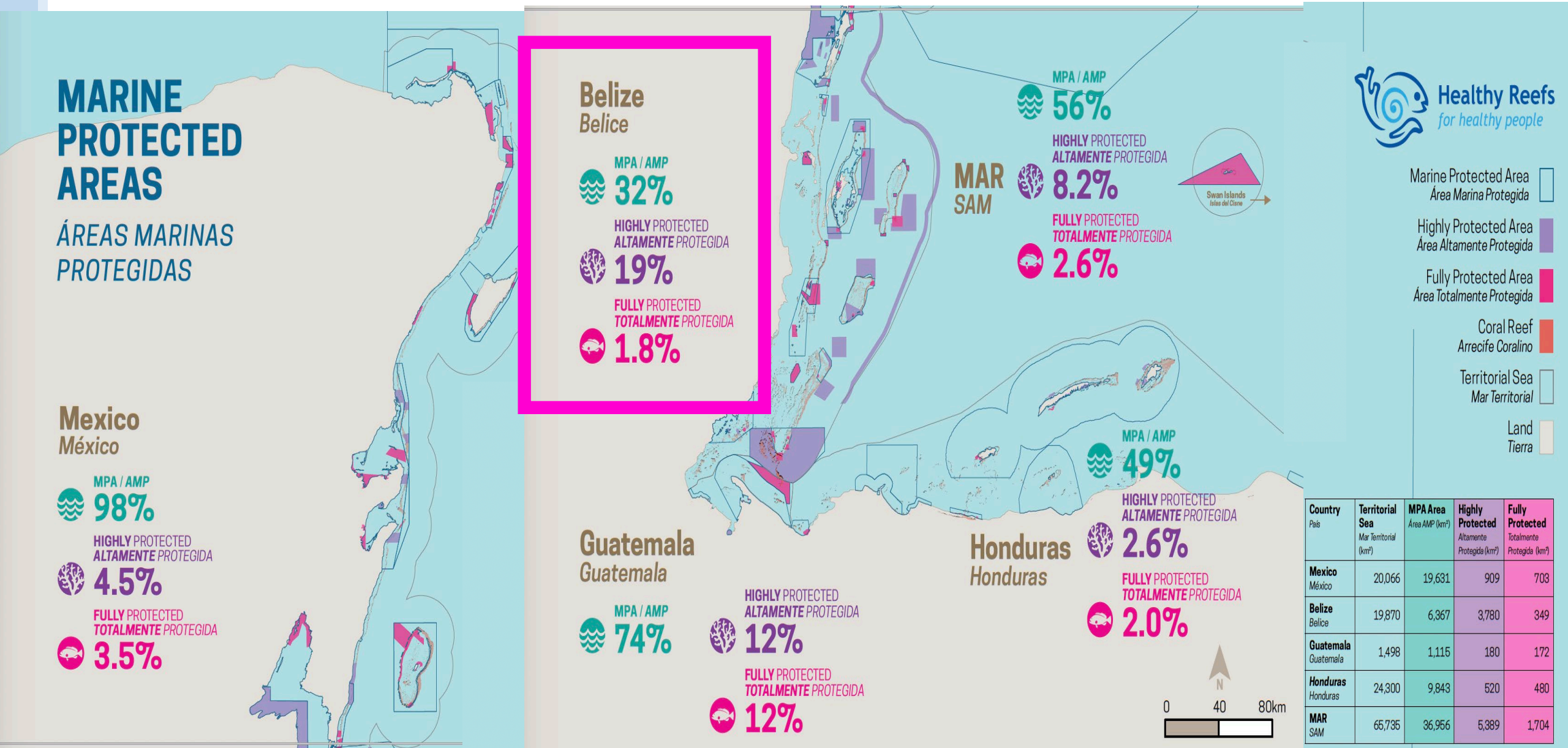


Average numbers of young produced by three different sizes of gray snapper.
Data: Bortone & Williams (1986) US Fish and Wildlife Service Biological Report

June 12, 2023 Version

Big Fish are in the FULLY PROTECTED zones of MPAs

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



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

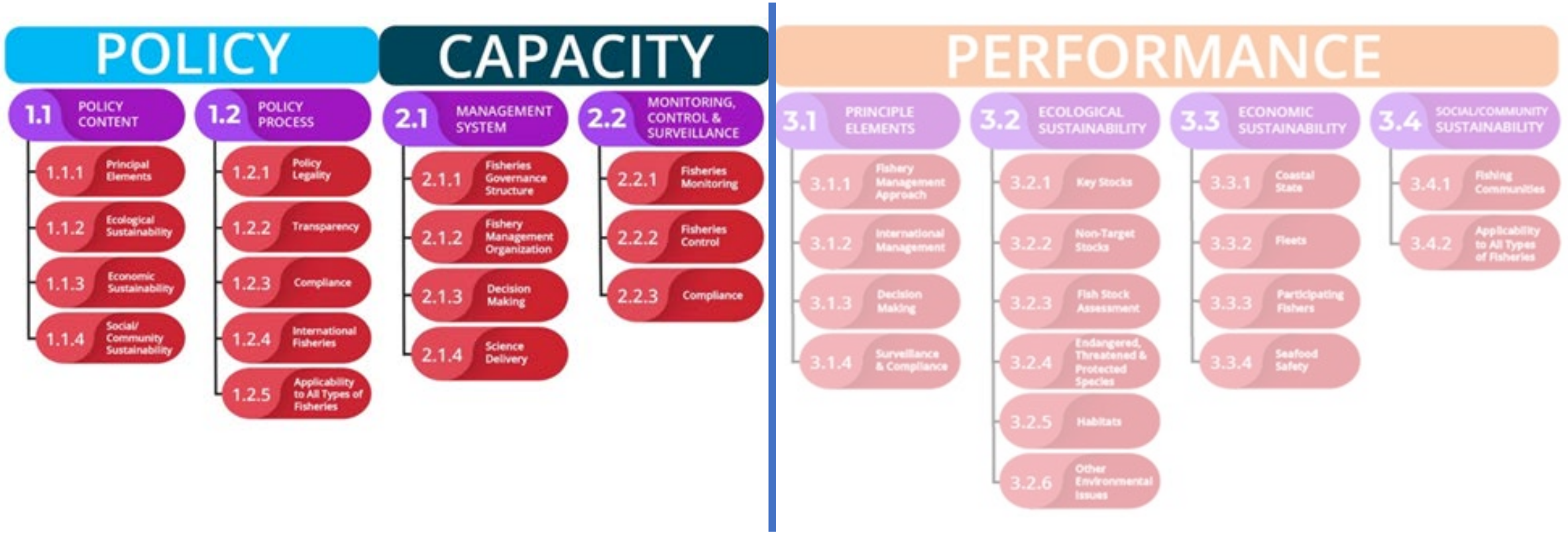
Fishery Management Opportunities

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

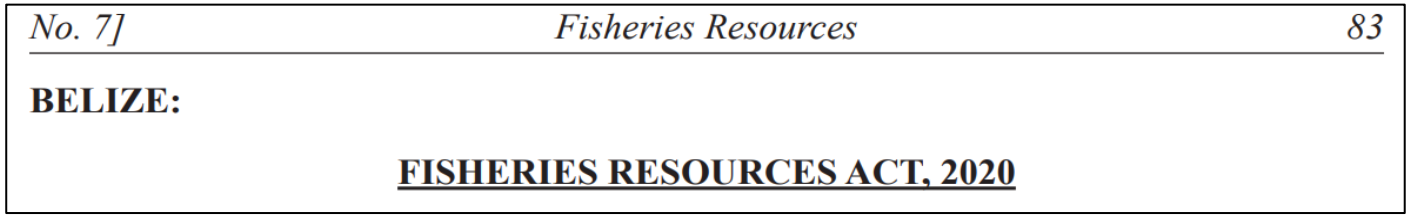
- Based on 40 source references, including 25 Belize Government documents
- Seeking feedback on our findings

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**



No. 7] *Fisheries Resources* *83*

BELIZE:

FISHERIES RESOURCES ACT, 2020

  - 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 (approximately 1000 additional fishing licenses in 2022);

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

Key Management Responses and Examples of Successes

Dr. Andrew Rosenberg

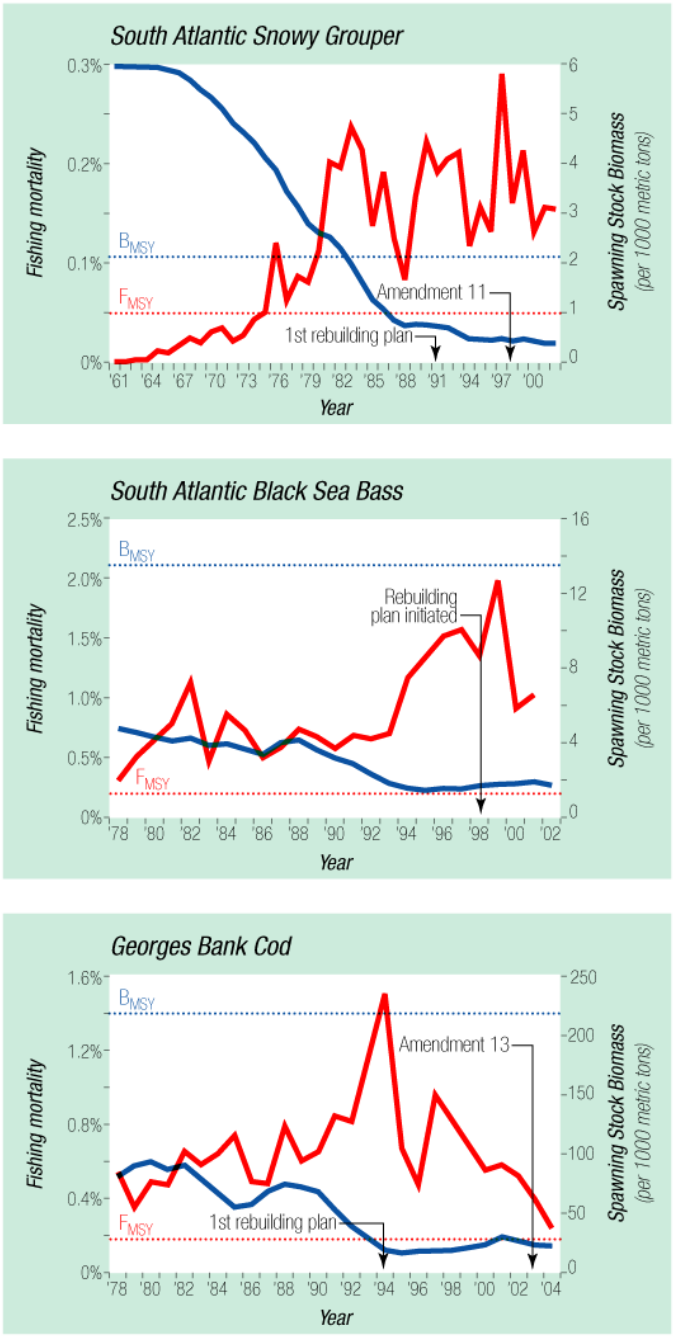
MRAG Americas, Inc.

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 businesses constantly adapt, so must management
- For key species and species assemblages exploitation rate and exploitation pattern (size, age, sex, maturity, etc) 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

LENFEST OCEAN PROGRAM

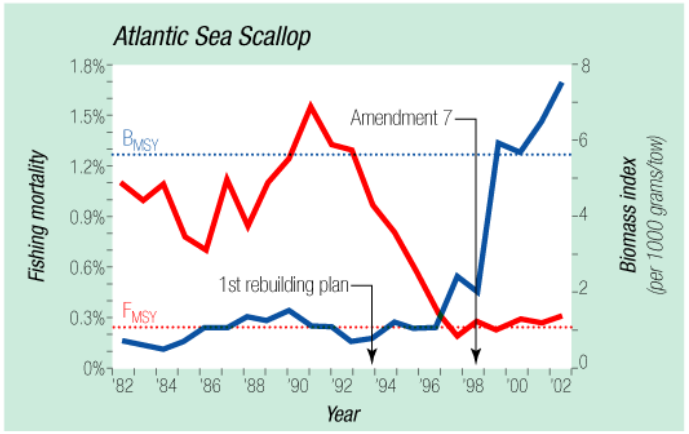
Figure 4:
Examples Of Stocks Showing Little Or No Rebuilding Progress

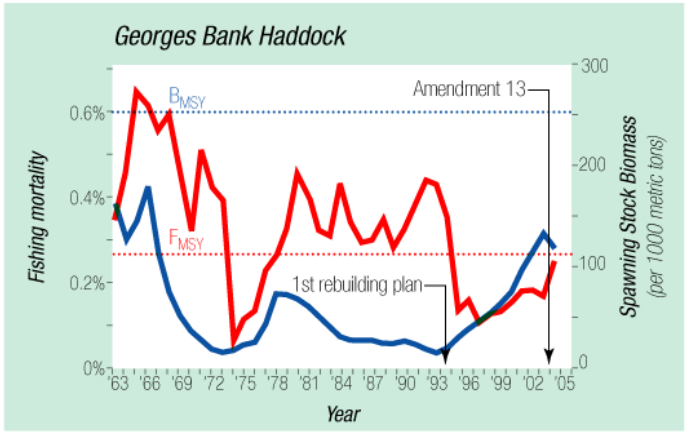


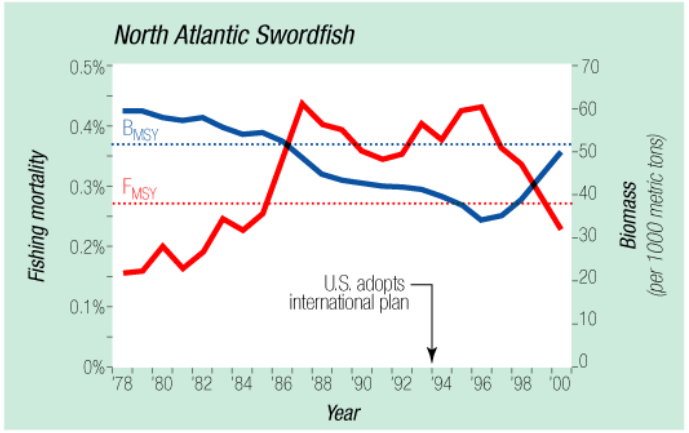
When fishing pressure remains high, stocks show little recovery

LENFEST OCEAN PROGRAM

Figure 5: Examples Of Stocks Showing Rebuilding Progress



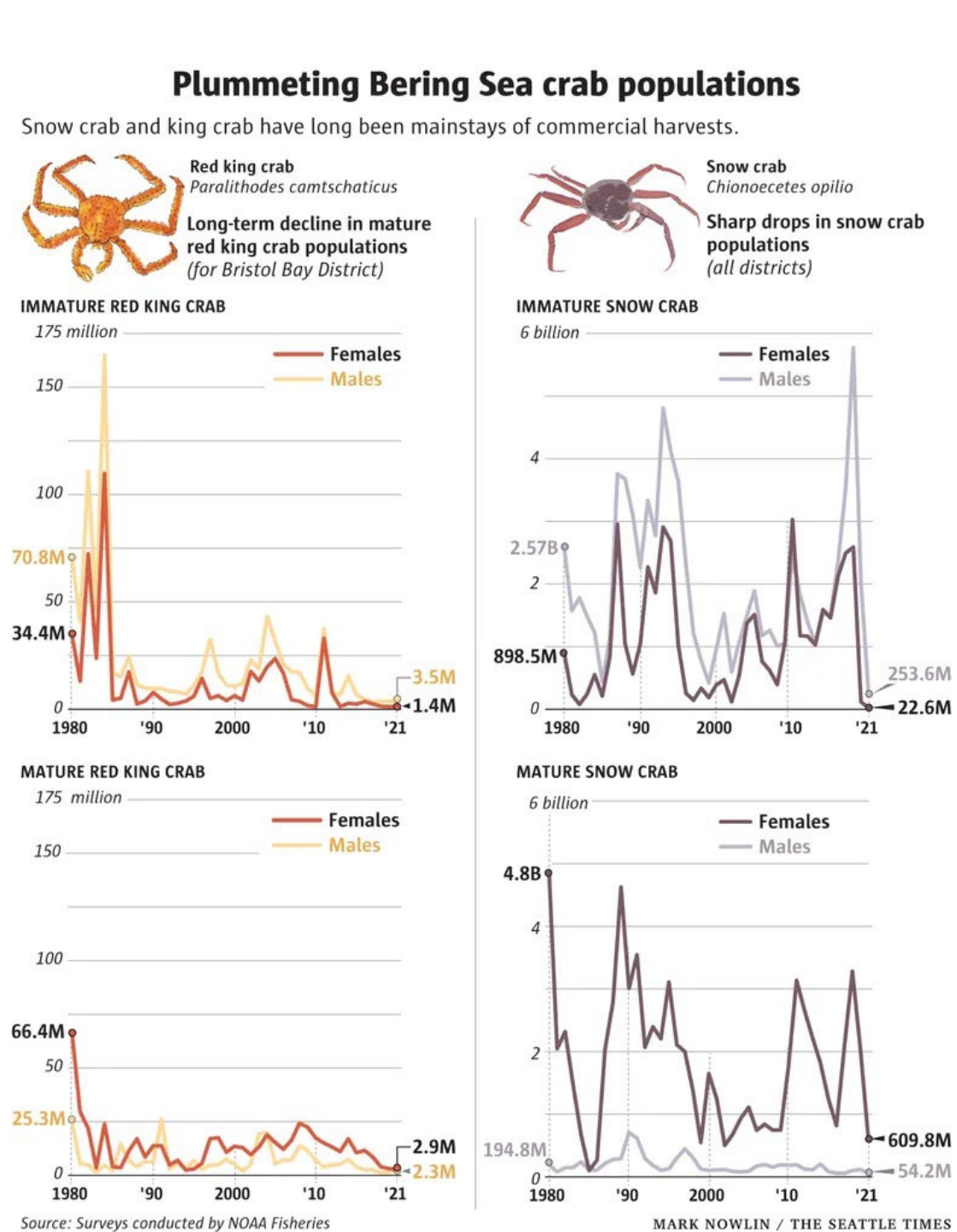


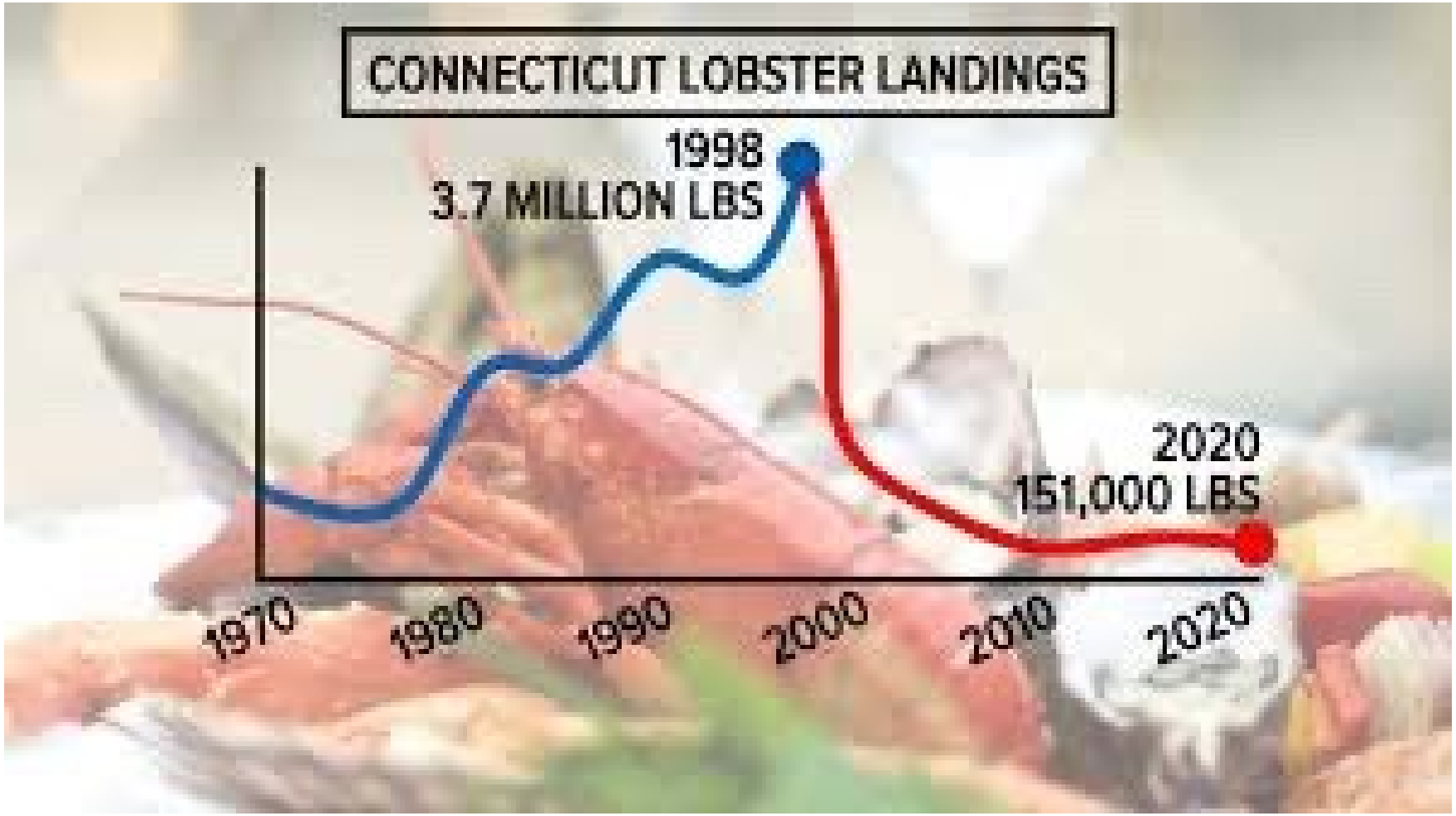


When fishing pressure is reduced, stocks can recover

:tps://www.eli.org/belize-fisheries-project

- 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)
Snow crab
Chionoecetes opilio
Sharp drops in snow crab populations
(all districts)
IMMATURE RED KING CRAB
175 million
150
100
70.8M
50
34.4M
0
Females
Males
3.5M
1.4M
1980
'90
2000
'10
'21
IMMATURE SNOW CRAB
6 billion
4
2.57B
2
898.5M
0
Females
Males
253.6M
22.6M
MATURE RED KING CRAB
175 million
150
100
66.4M
50
25.3M
0
Females
Males
2.9M
2.3M
MATURE SNOW CRAB
6 billion
4.8B
4
2
194.8M
0
Females
Males
609.8M
54.2M
Source: Surveys conducted by NOAA Fisheries
MARK NOWLIN / THE SEATTLE TIMES


CONNECTICUT LOBSTER LANDINGS
1998
3.7 MILLION LBS
2020
151,000 LBS
1970
1980
1990
2000
2010
2020

Fishing for certainty

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

Andrew A. Rosenberg

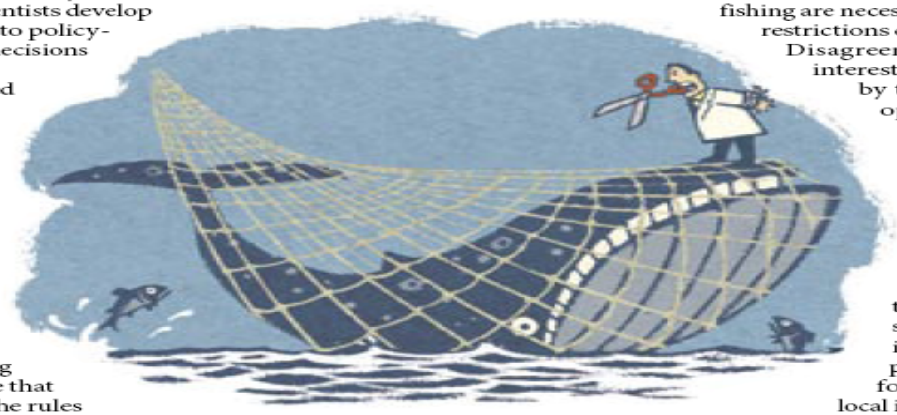
Policy-makers receive formal and informal advice from all quarters: scientific, legal, political and public. Each piece of advice is considered mandatory by the giver, and it often conflicts with other advisers' points of view. Uncertainty is a feature of all advice, but is usually only acknowledged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

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

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. ■

Andrew A. Rosenberg is professor of natural resources at the Institute for the Study of Earth, Oceans and Space, Morse Hall 142, Durham, New Hampshire 03824, USA.

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

Thank You

- Questions and discussion

Appendix 2: Presentation to Fishers

Belize Fisheries Project

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

June 13-15, 2023

The Fisheries of Belize: Overview of Results

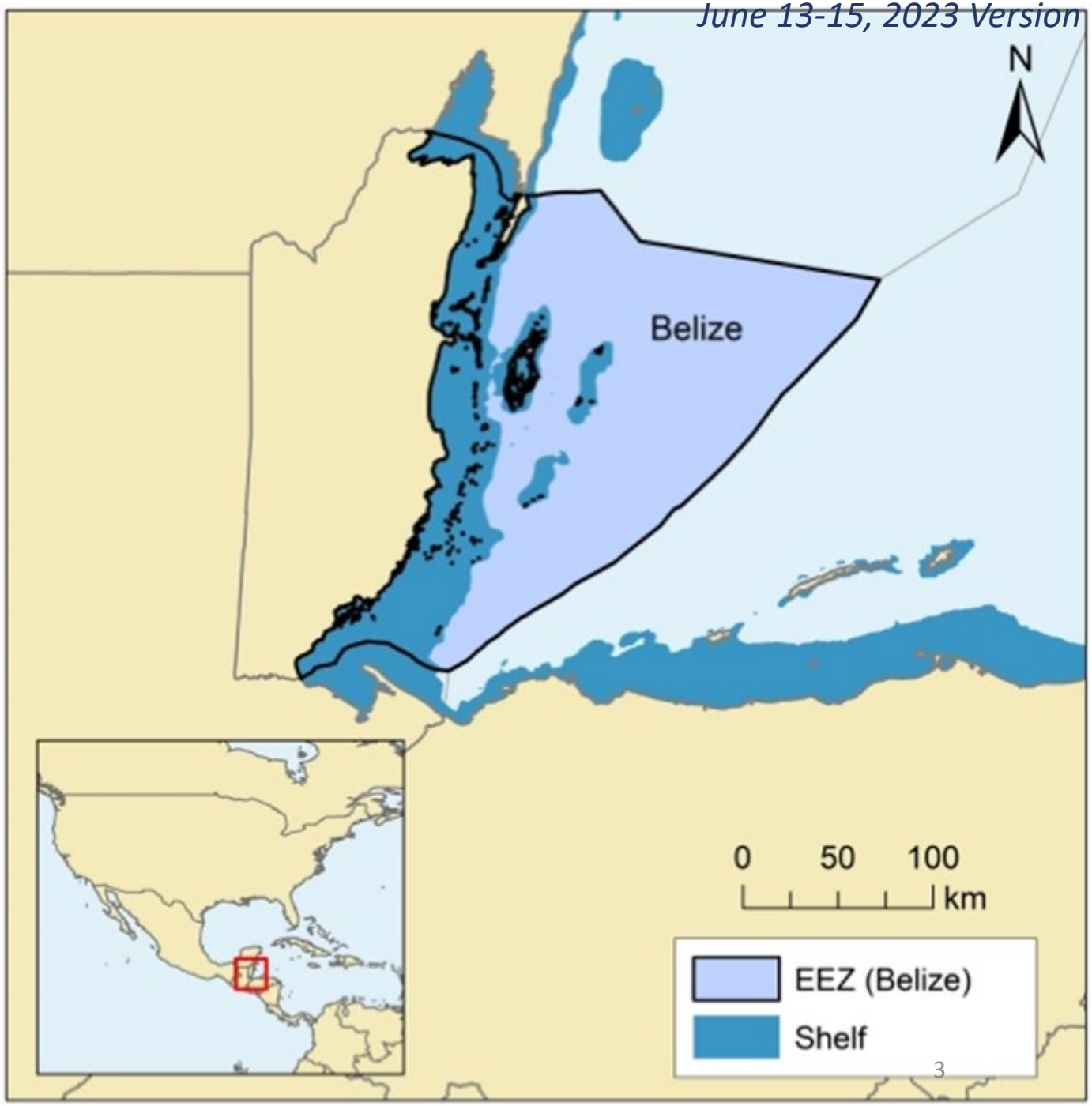
Daniel Pauly, M.L. 'Deng' Palomares, and Alexander Tewfik

Sea Around Us Research Initiative, IOF, UBC

Belize, 12 June 2023

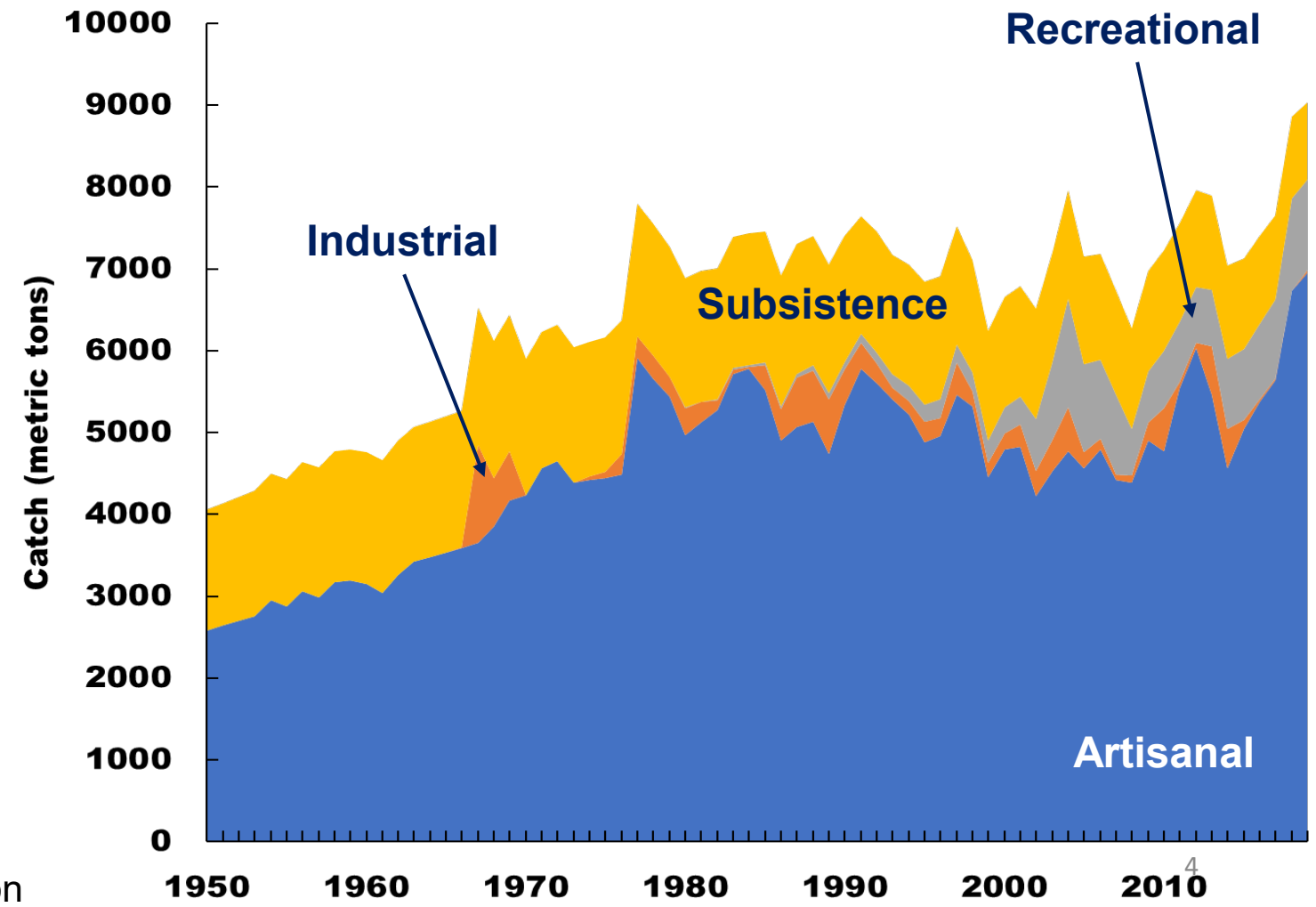
- The Exclusive Economic Zone (EEZ) of Belize covers 36,182 km^2

- The Territorial Sea includes three distinct atolls, Glover's Reef, Lighthouse Reef and Turneffe Atoll.



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
23 of 443 sources were used for this reconstruction

Belizean marine catch by species (I)

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

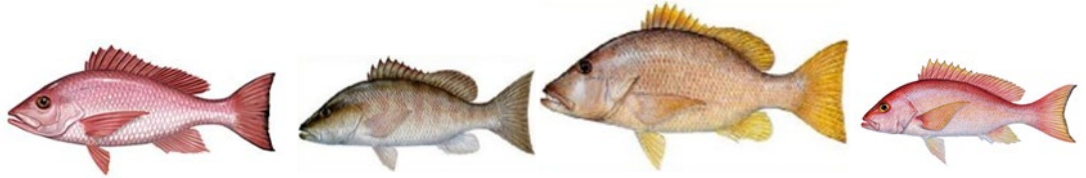
21% of the catch

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

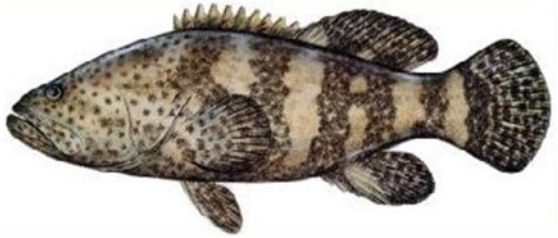
8% of the catch

Great barracuda

2% of the catch

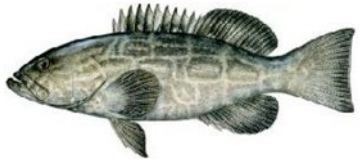
Snook

2% of the catch



Goliath grouper

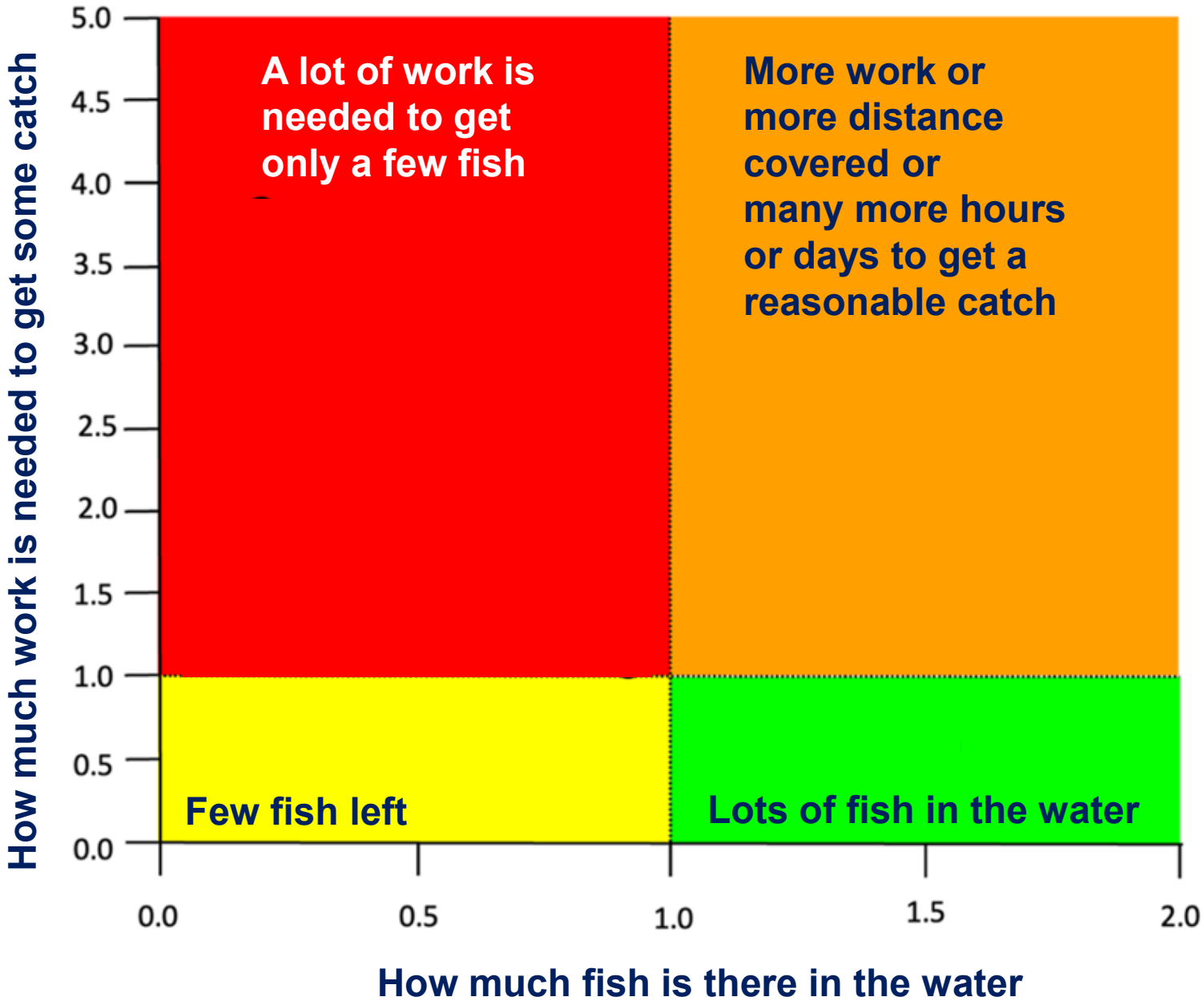
Nassau Grouper



Black grouper

<1% of the catch

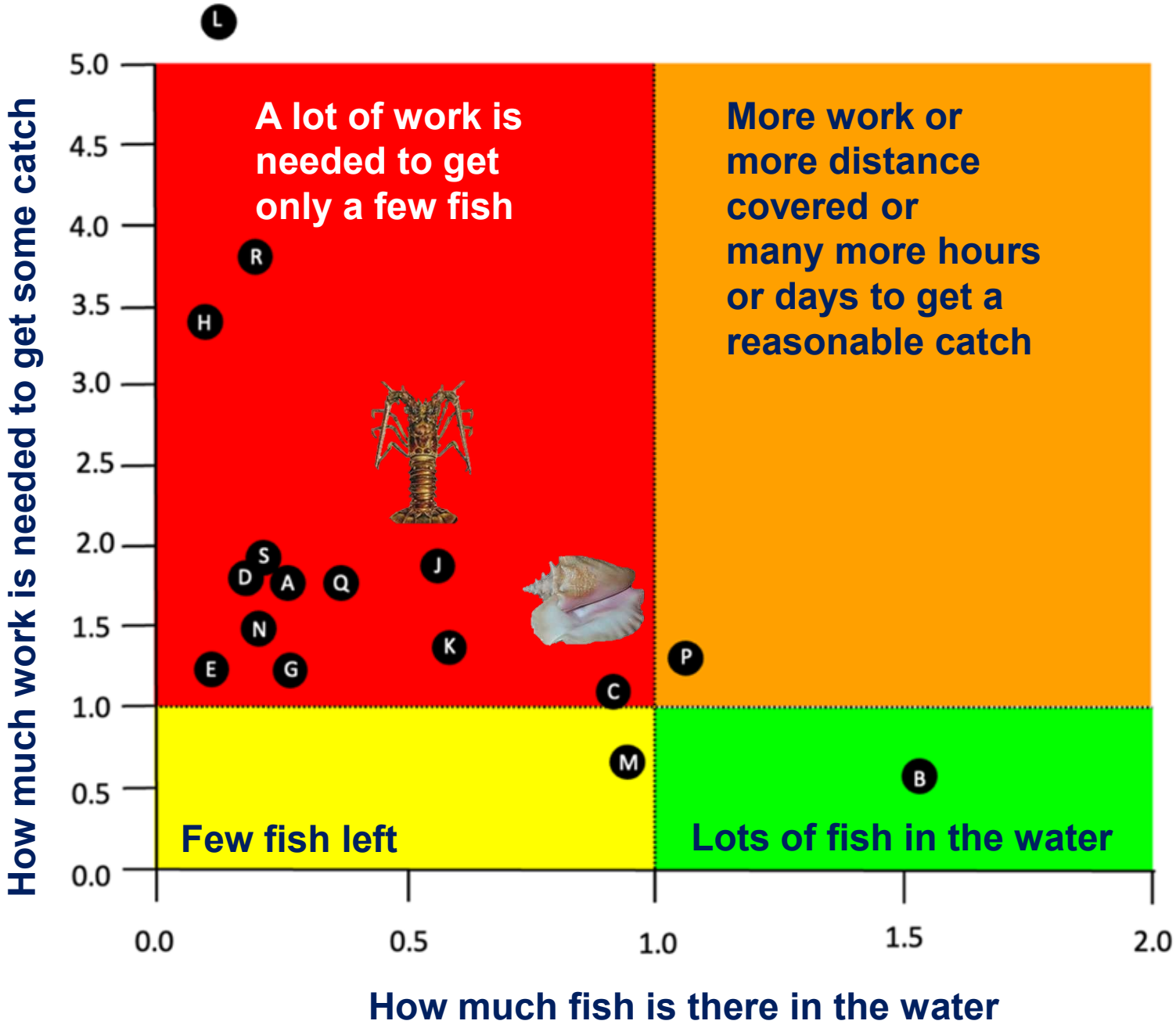
Sea Around Us stock analyses



Sea Around Us stock analyses

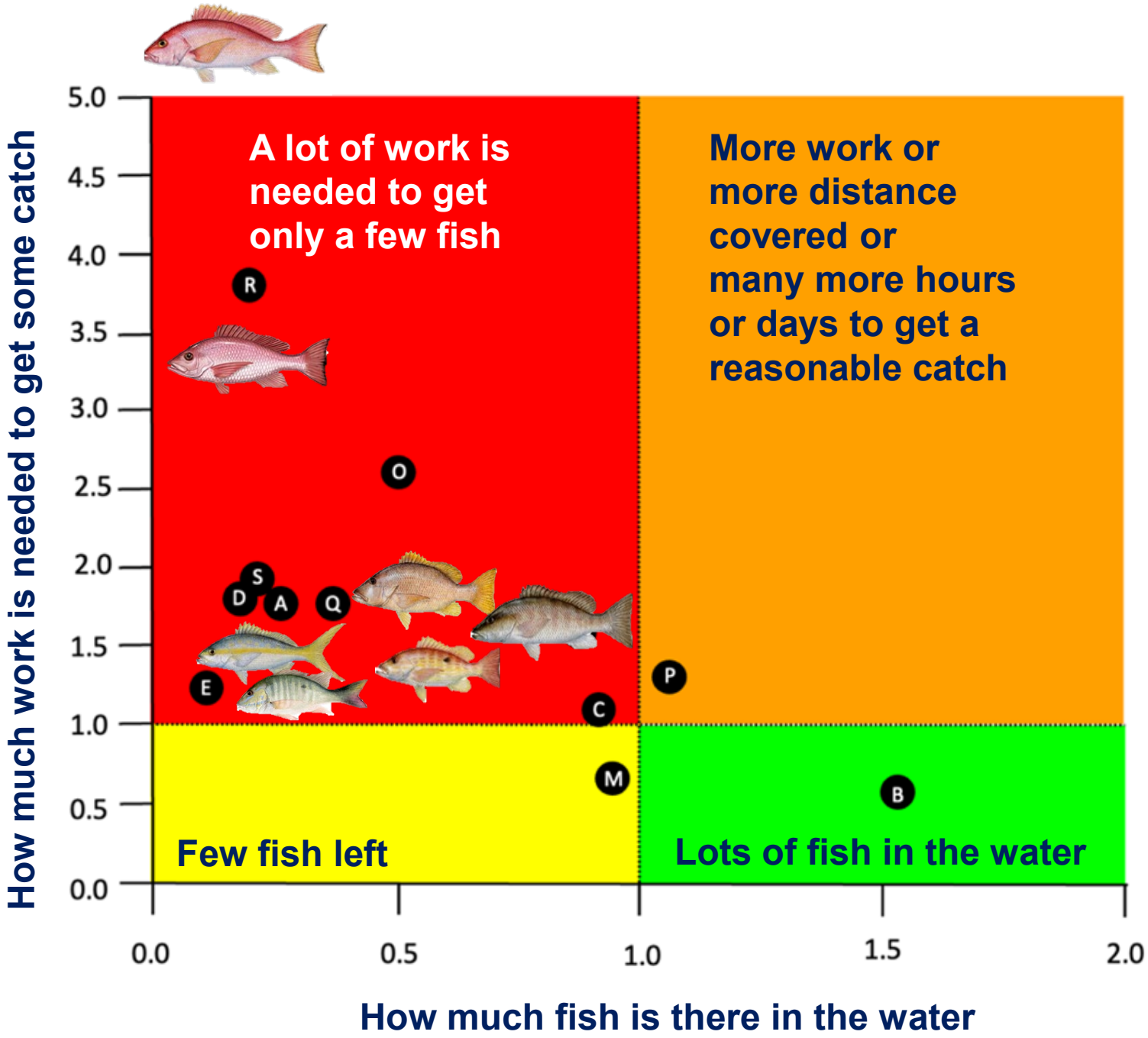
In general, the most commercially important species are in the red:

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



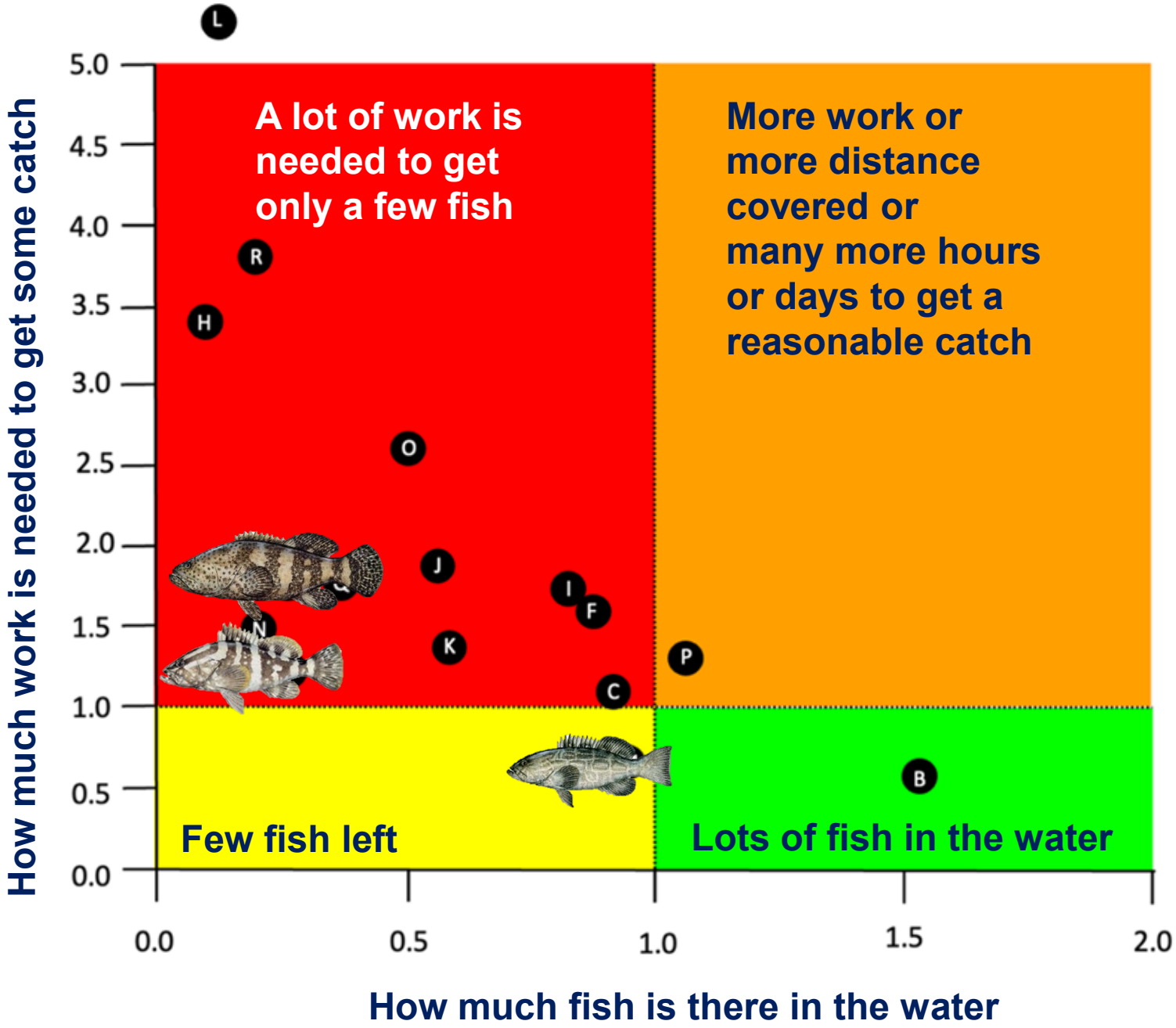
Sea Around Us stock analyses

Snappers are less abundant, and a lot work of 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.

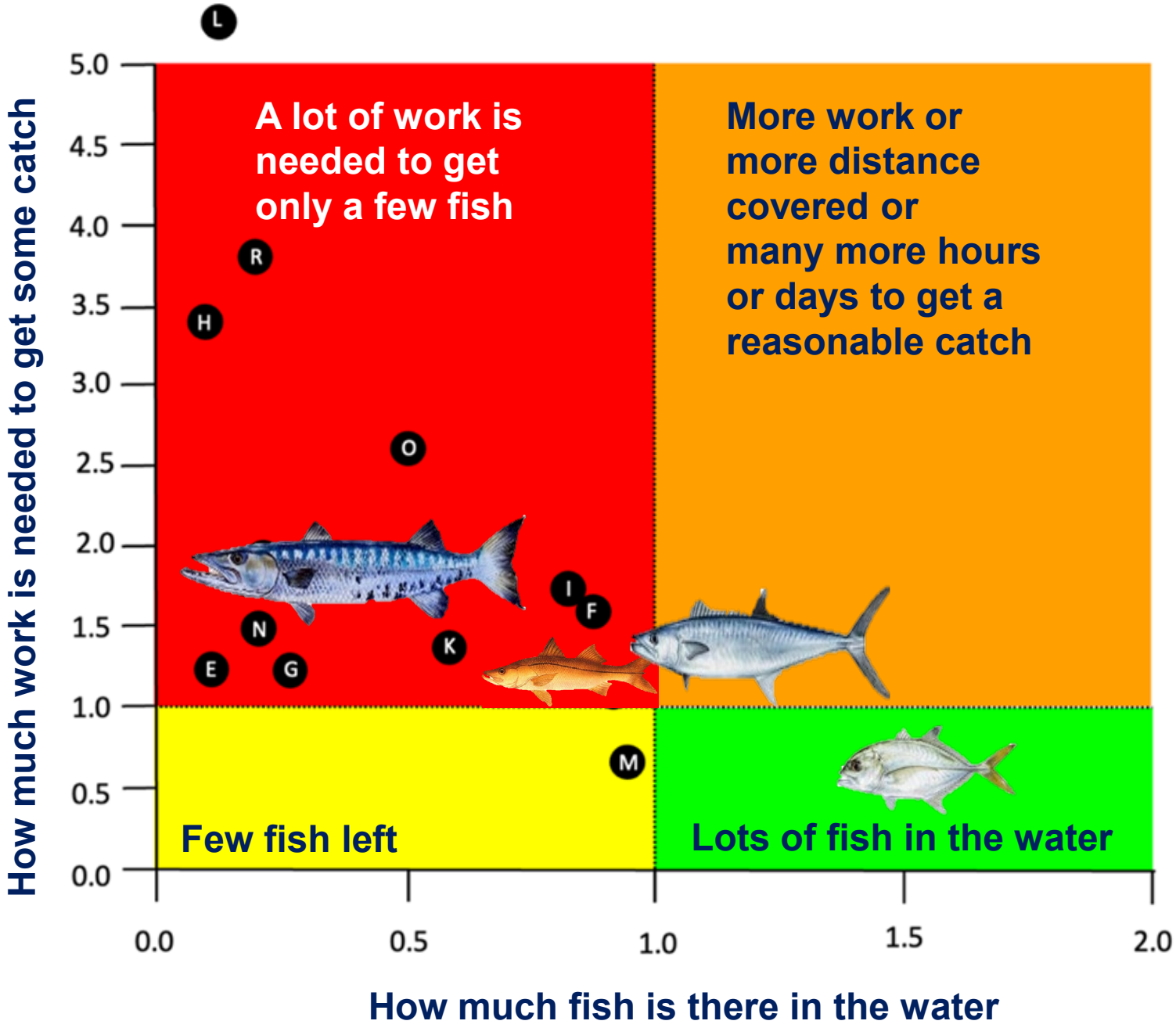


Sea Around Us stock analyses

The horse eye jack is abundant.

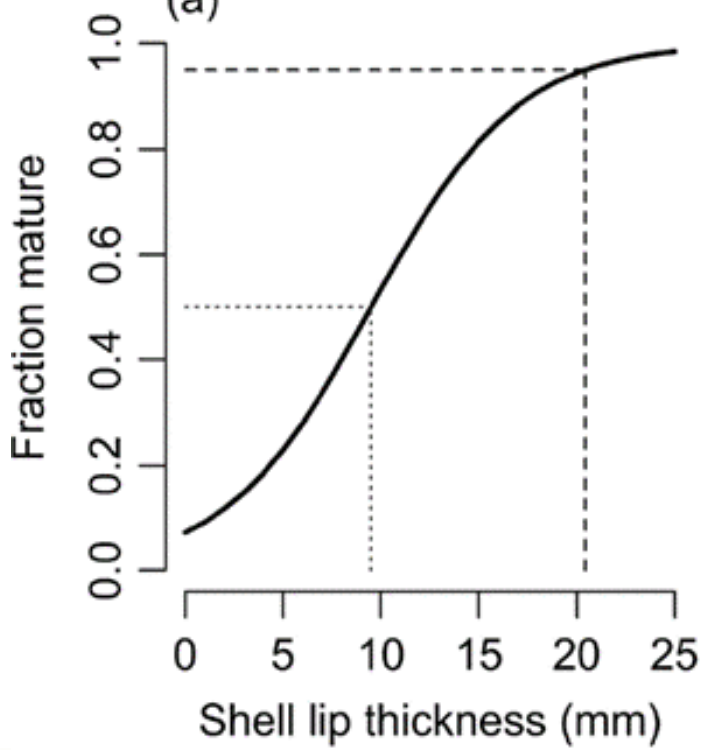
Although there is enough king mackerel, it is now taking more work to catch them.

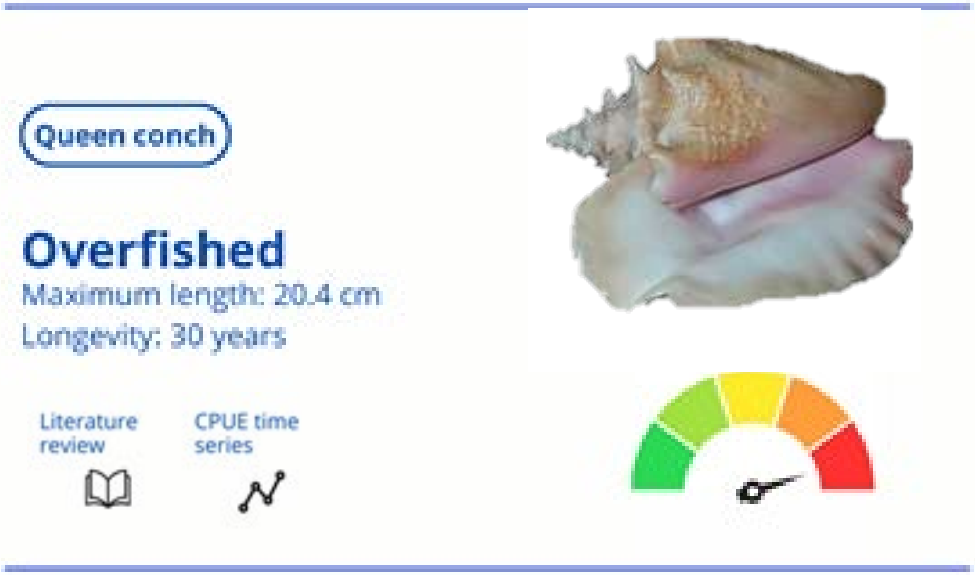
The barracuda and snook are less abundant and takes a lot more work catch them.



Review of existing knowledge: Queen conch

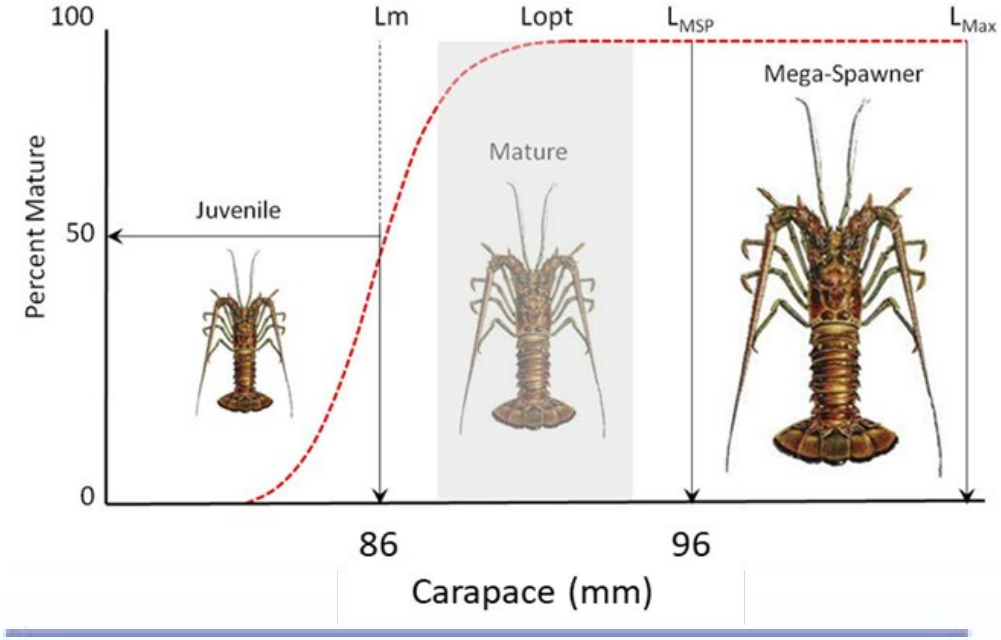
- Exploitation peaked in 2008-2013, which led to listing in Appendix II of CITES.
- Currently managed using size limits established in 1978 based on shell height and meat weight.
- Maturity is measured by thickness of shell lip (Tewfik et al. 2019).
- Bulk of catch is of immature individuals.





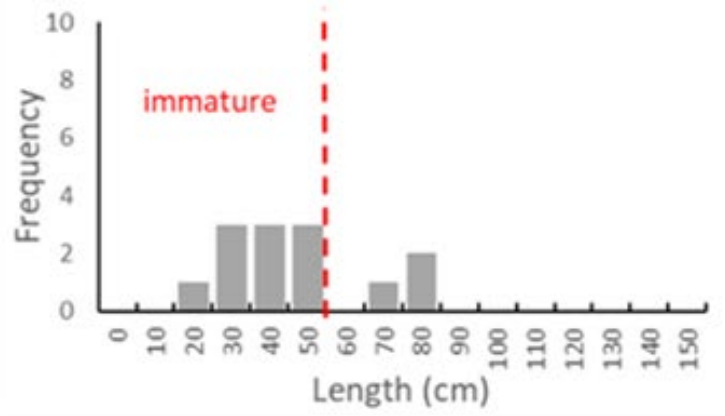
Review of existing knowledge: Spiny lobster

- 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.



Review of existing knowledge: Nassau Grouper

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

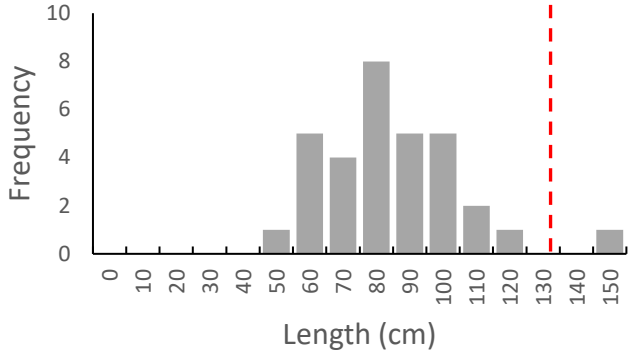


Review of existing knowledge: Goliath and Black Groupers

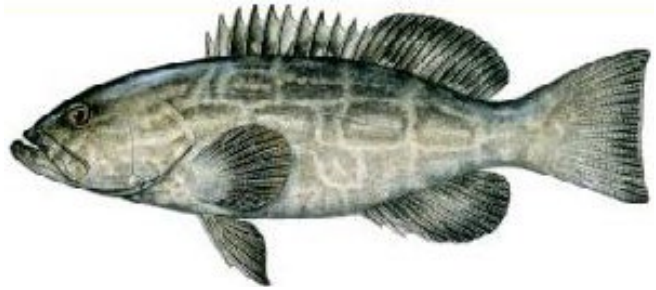
- In similar conditions as Nassau grouper

Goliath

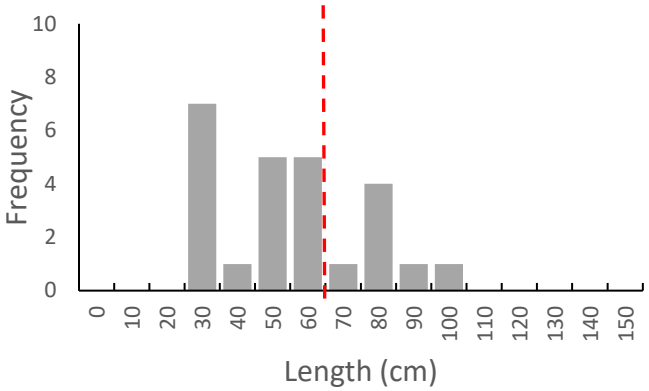
Max: 250 cm/360 kg



Black



Max: 150 cm/45 kg



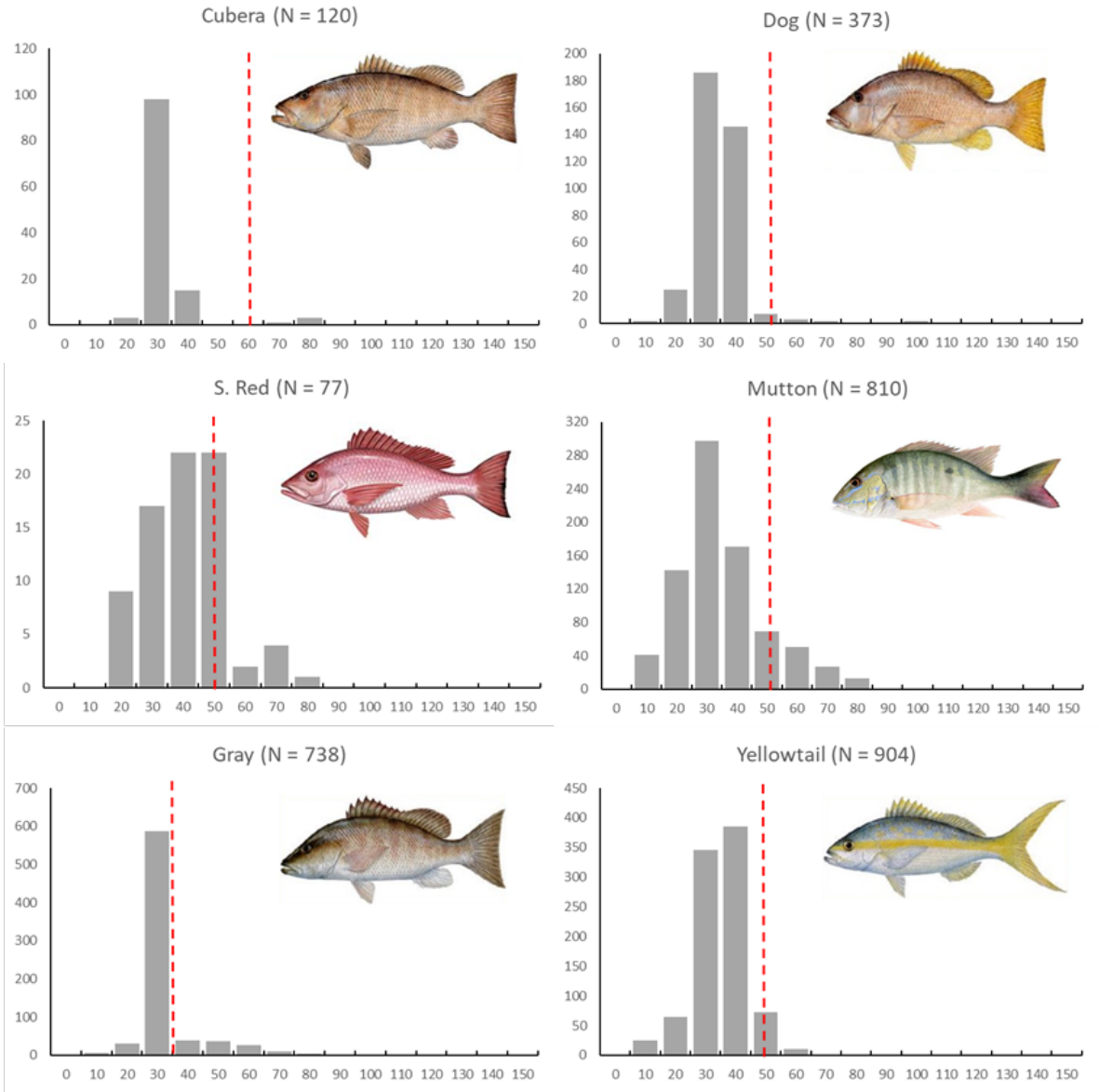
Review of existing knowledge: Snappers

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**.

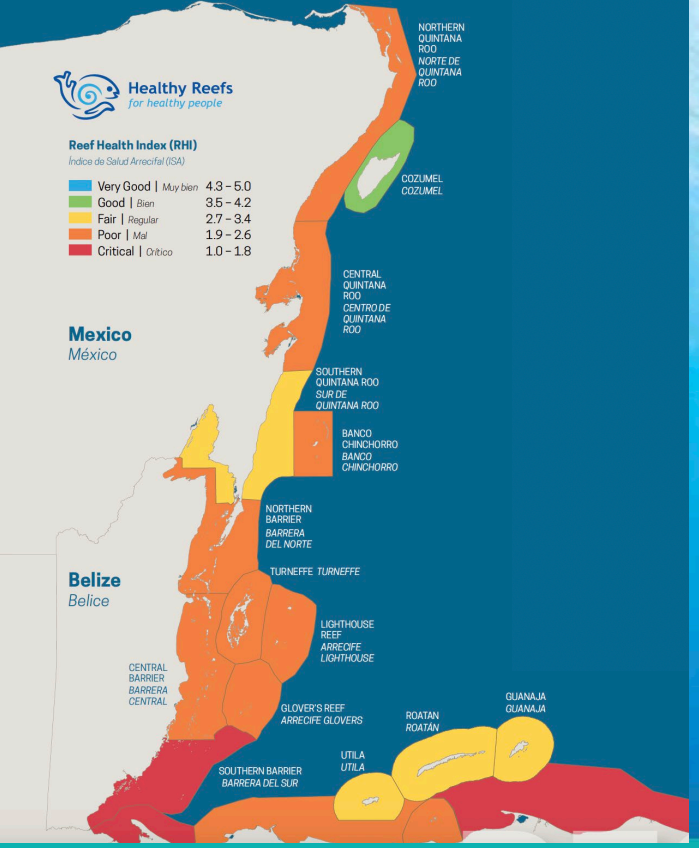
Reef Health Survey Results

Dr. Melanie McField

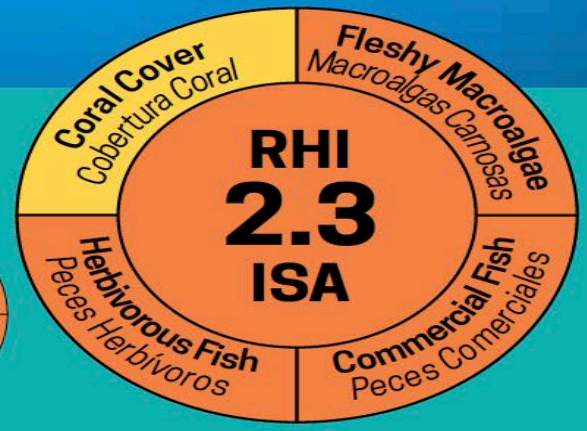
Healthy Reefs Initiative and Smithsonian Institution

June 13-15, 2023 Version

Mesoamerican Reef Health



5 is top Score

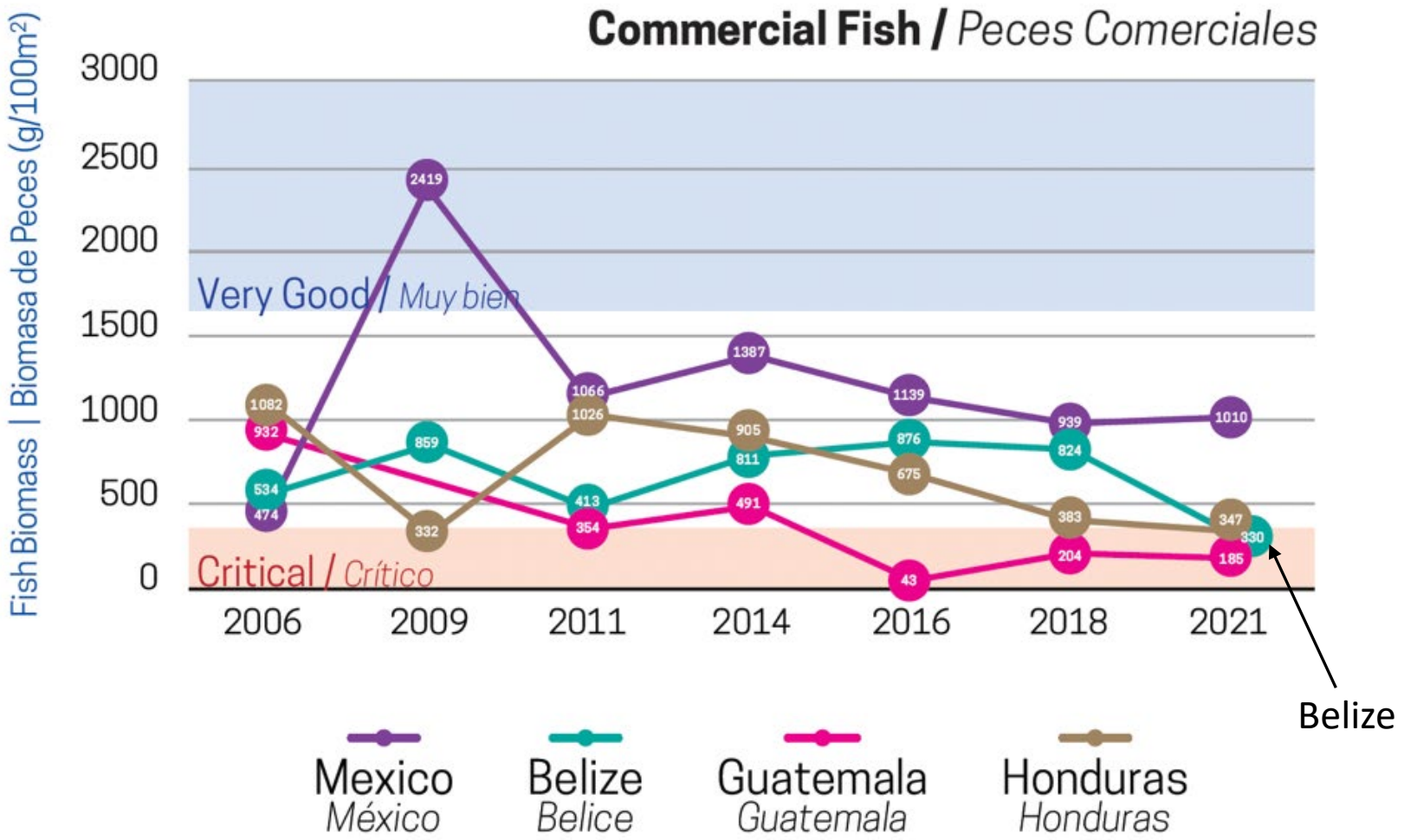


2006	2009	2011	2014	2016	2018	2021
2.3	2.3	2.5	2.8	2.8	2.5	
326 SITES SITIOS	130 SITES SITIOS	193 SITES SITIOS	249 SITES SITIOS	319 SITES SITIOS	286 SITES SITIOS	234 SITES SITIOS

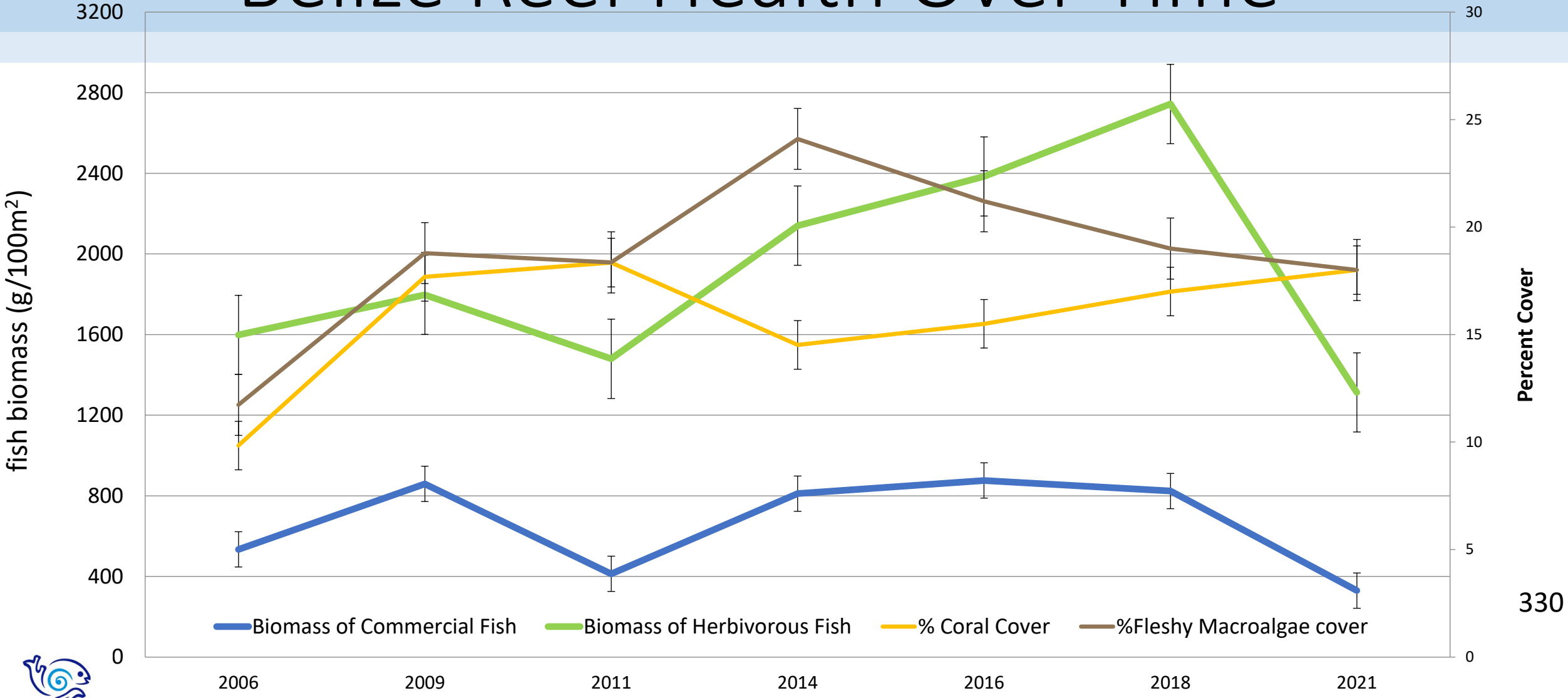
Years shown represent when data was collected not year report card was printed | *Los años que se muestran representan cuándo se colectaron los datos y no cuándo se imprimió el reporte.*

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.

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.



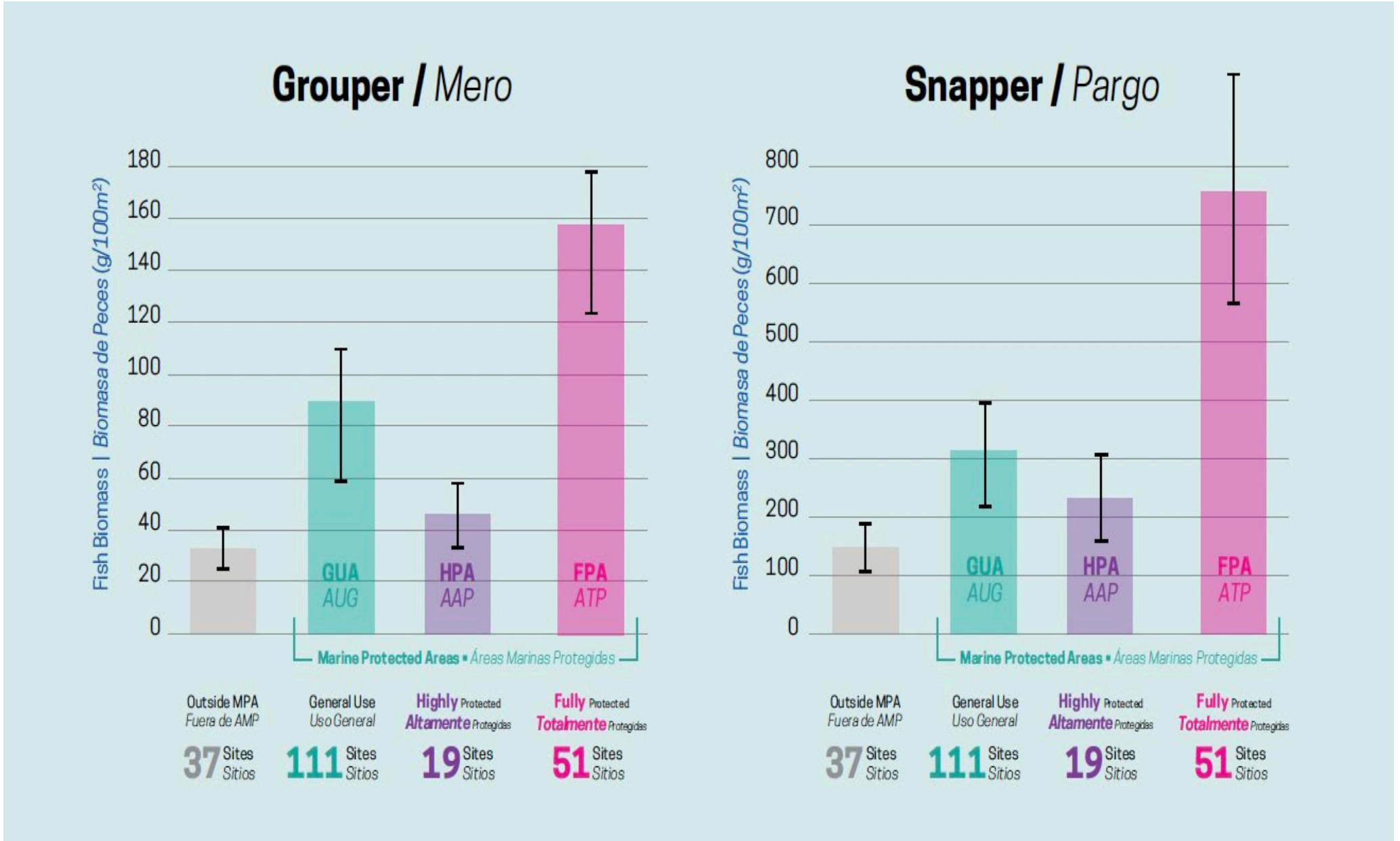
Belize Reef Health Over Time



330

Healthy Reefs
for healthy people

Only Fully Protected Zones Have Higher Fish Biomass



218 sites

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

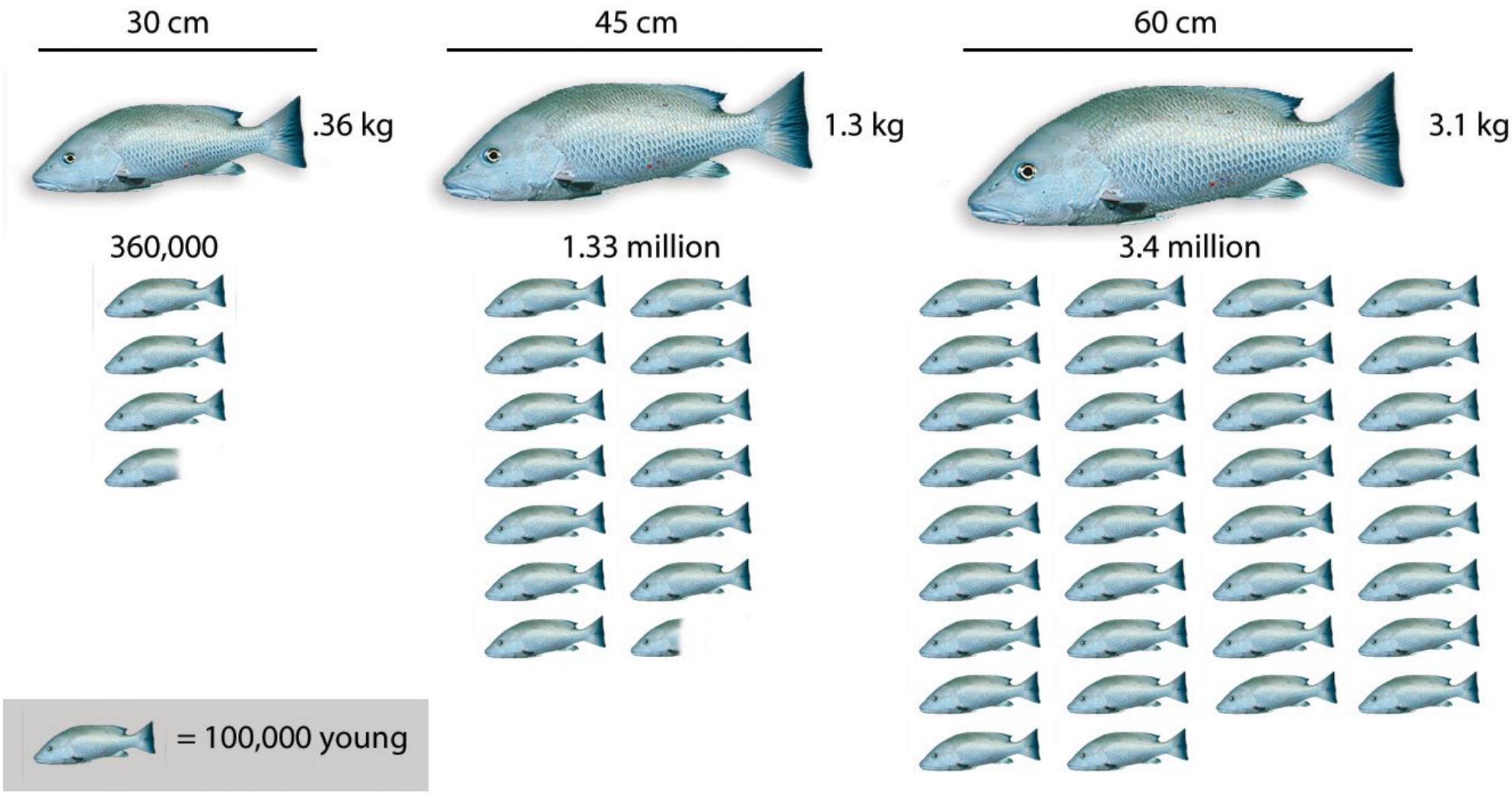
65cm **25%** Mature Maduro

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

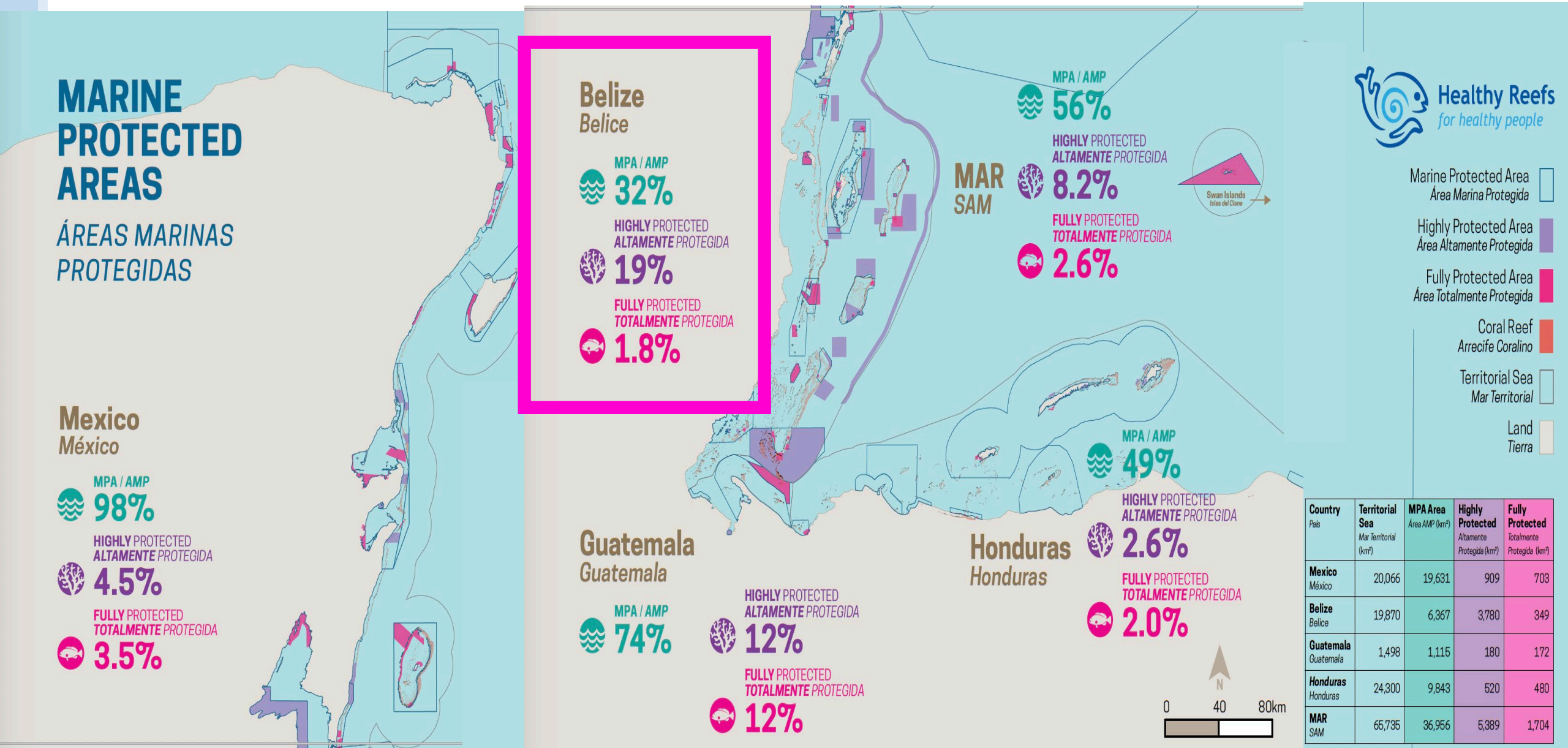


Average numbers of young produced by three different sizes of gray snapper.
Data: Bortone & Williams (1986) US Fish and Wildlife Service Biological Report

June 13-15, 2023 Version

Big Fish are in the FULLY PROTECTED zones of MPAs

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



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

Management Responses and Examples of Successes

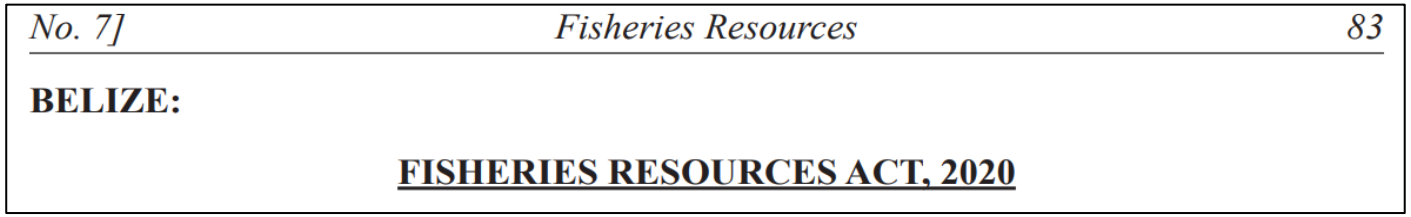
Dr. Andrew Rosenberg

MRAG Americas, Inc.

Governance Analysis

POLICY

- **Policy Mandate**



No. 7] *Fisheries Resources* *83*

BELIZE:

FISHERIES RESOURCES ACT, 2020

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

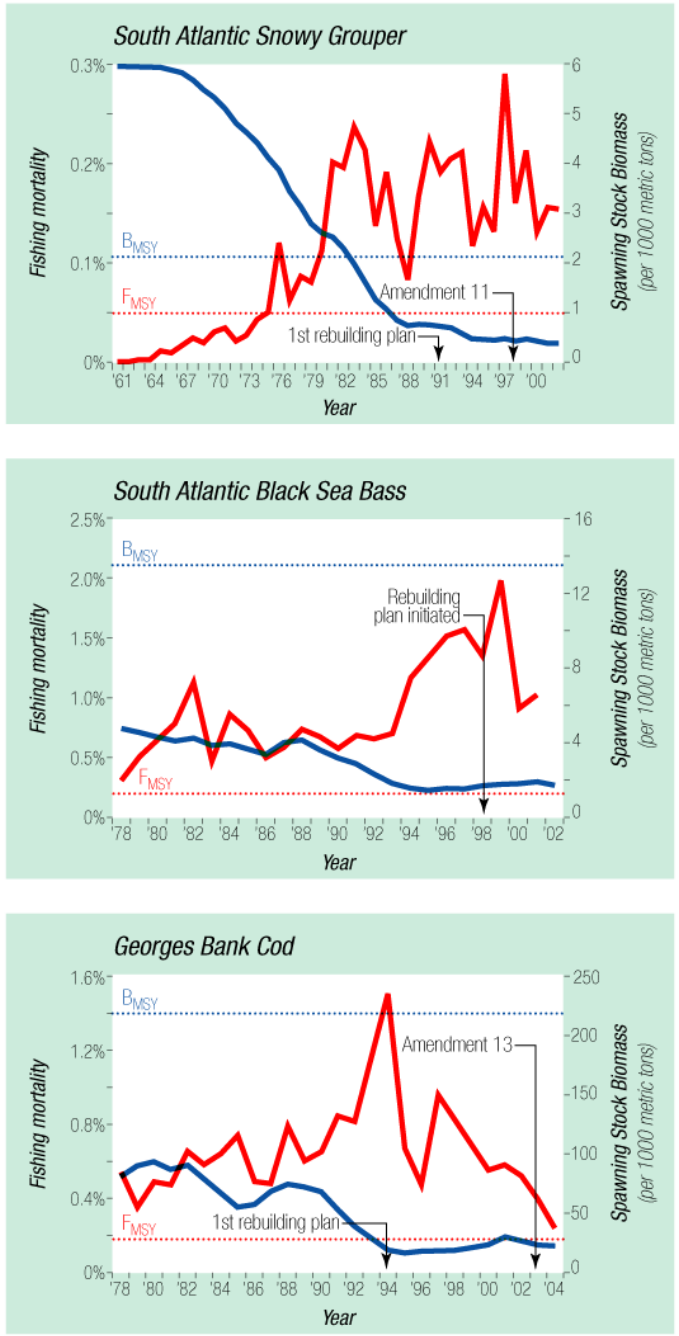
- **Policy Implementation**
  - laws, regulations, decrees, orders, and guidance.

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

LENFEST OCEAN PROGRAM

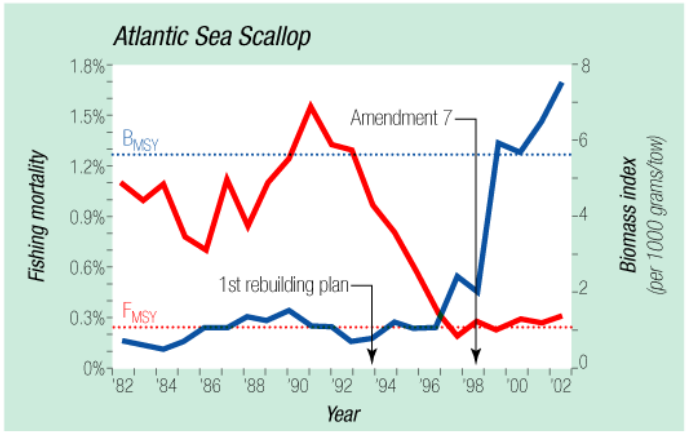
Figure 4:
Examples Of Stocks Showing Little Or No Rebuilding Progress

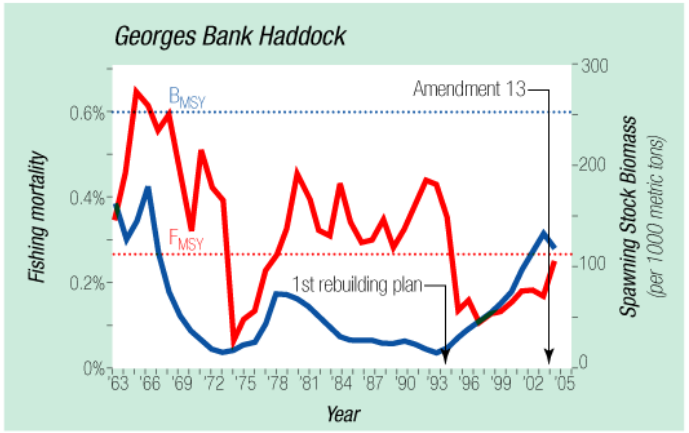


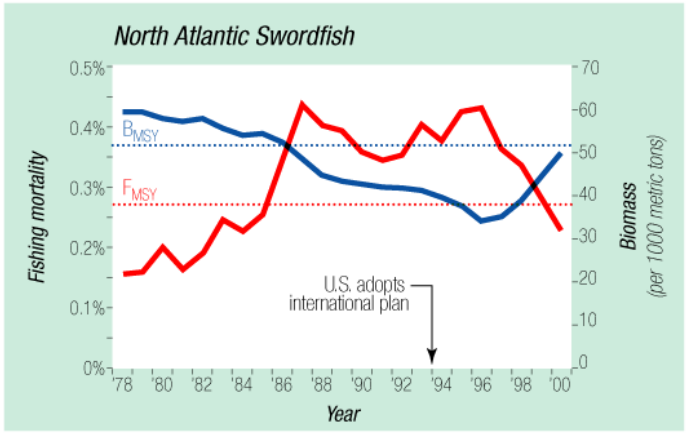
When fishing pressure remains high, stocks show little recovery

LENFEST OCEAN PROGRAM

Figure 5: Examples Of Stocks Showing Rebuilding Progress



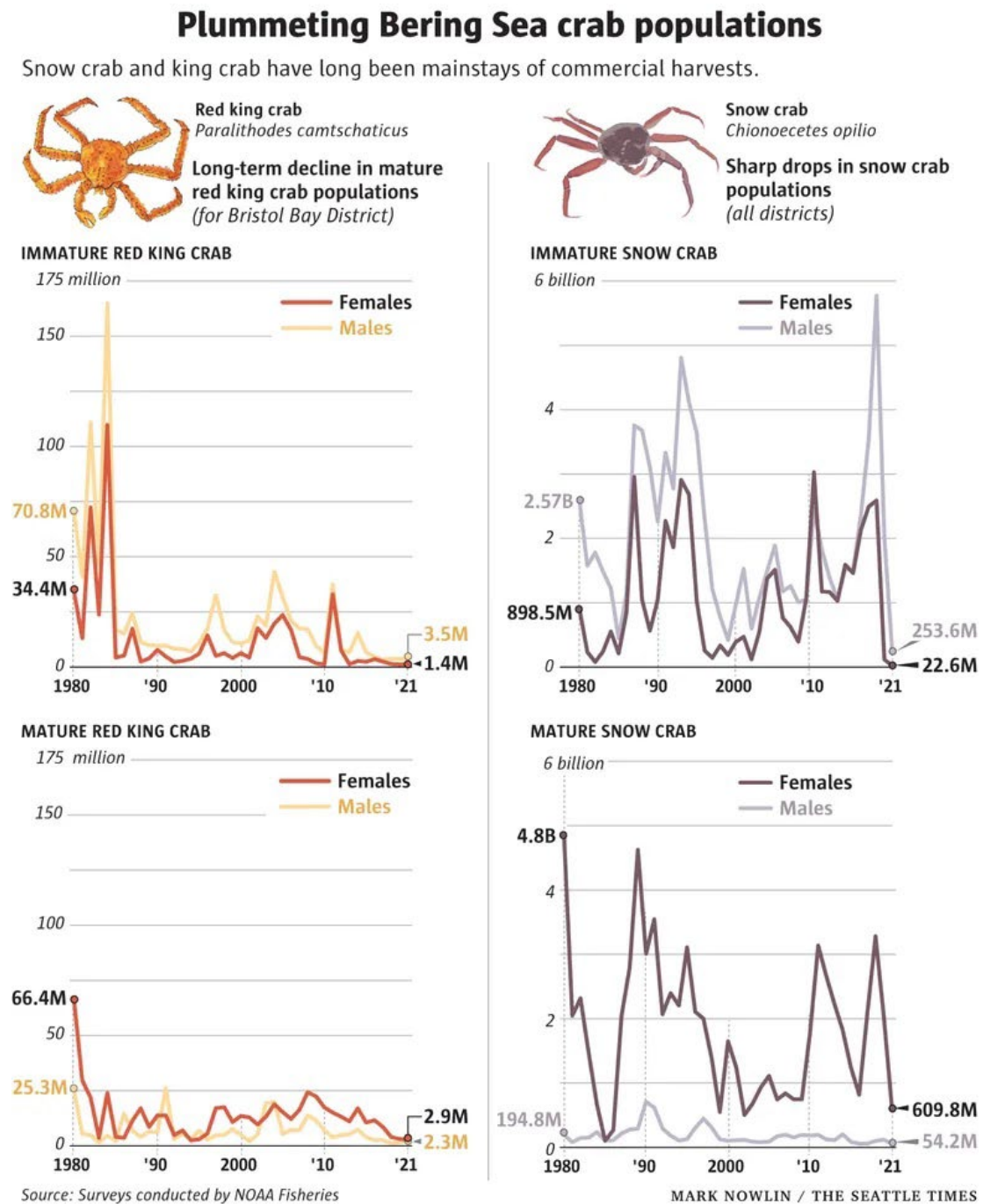


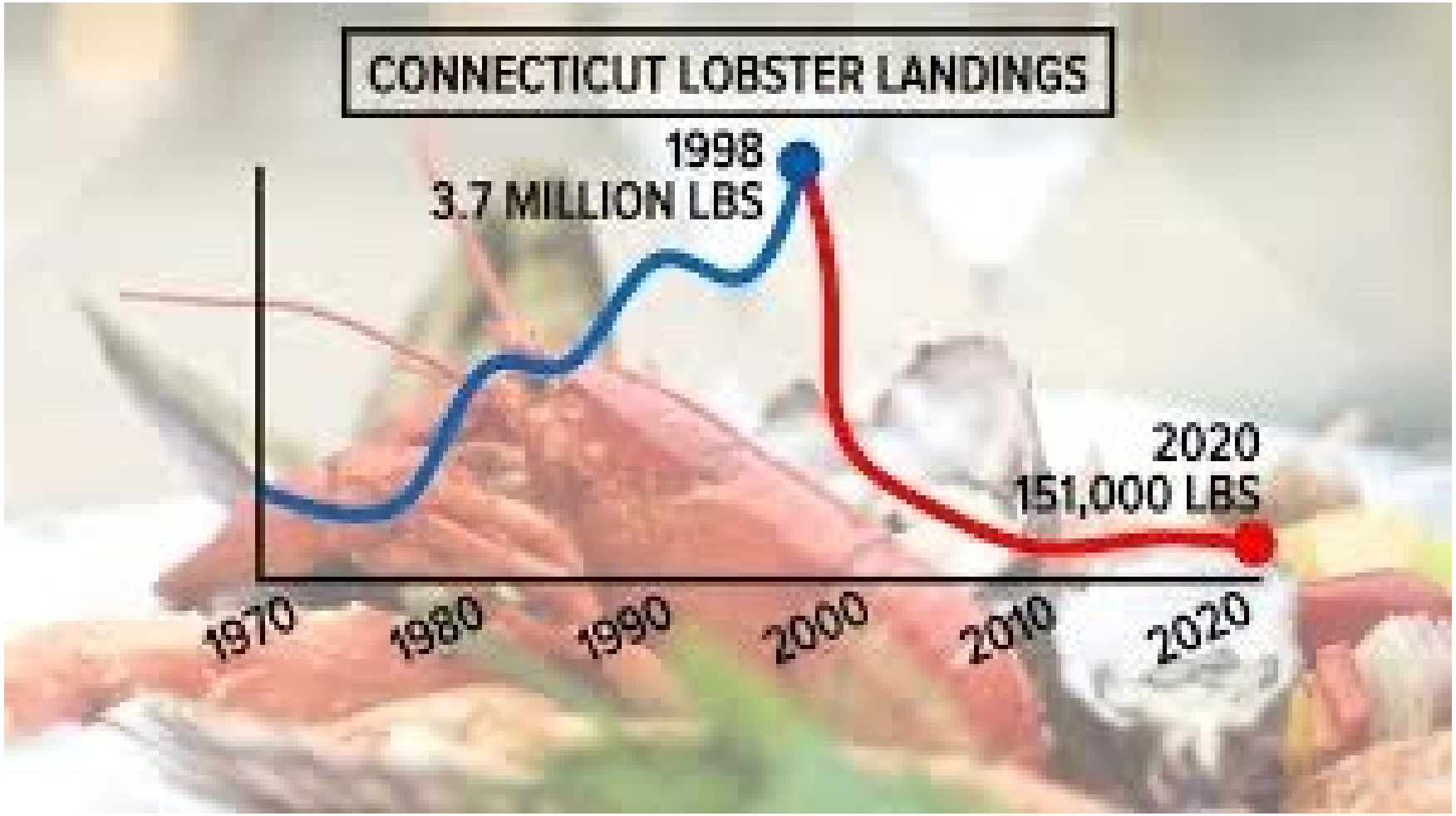


When fishing pressure is reduced, stocks can recover

:tps://www.eli.org/belize-fisheries-project

- Warning signs of unsustainability are well known
    - Continuing declines in average size
    - Continuing loss of range/fishing grounds
    - Continuing loss of yield
- A control/enforcement strategy is essential


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)
Snow crab
Chionoecetes opilio
Sharp drops in snow crab populations
(all districts)
IMMATURE RED KING CRAB
175 million
150
100
70.8M
50
34.4M
0
Females
Males
3.5M
1.4M
1980
'90
2000
'10
'21
IMMATURE SNOW CRAB
6 billion
4
2.57B
2
898.5M
0
Females
Males
253.6M
22.6M
1980
'90
2000
'10
'21
MATURE RED KING CRAB
175 million
150
100
66.4M
50
25.3M
0
Females
Males
2.9M
2.3M
1980
'90
2000
'10
'21
MATURE SNOW CRAB
6 billion
4.8B
4
2
194.8M
0
Females
Males
609.8M
54.2M
1980
'90
2000
'10
'21
Source: Surveys conducted by NOAA Fisheries
MARK NOWLIN / THE SEATTLE TIMES


CONNECTICUT LOBSTER LANDINGS
1998
3.7 MILLION LBS
2020
151,000 LBS
1970
1980
1990
2000
2010
2020

Thank You

- Questions and discussion

Appendix 3: Presentation to MPA Co-Managers and NGOs

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

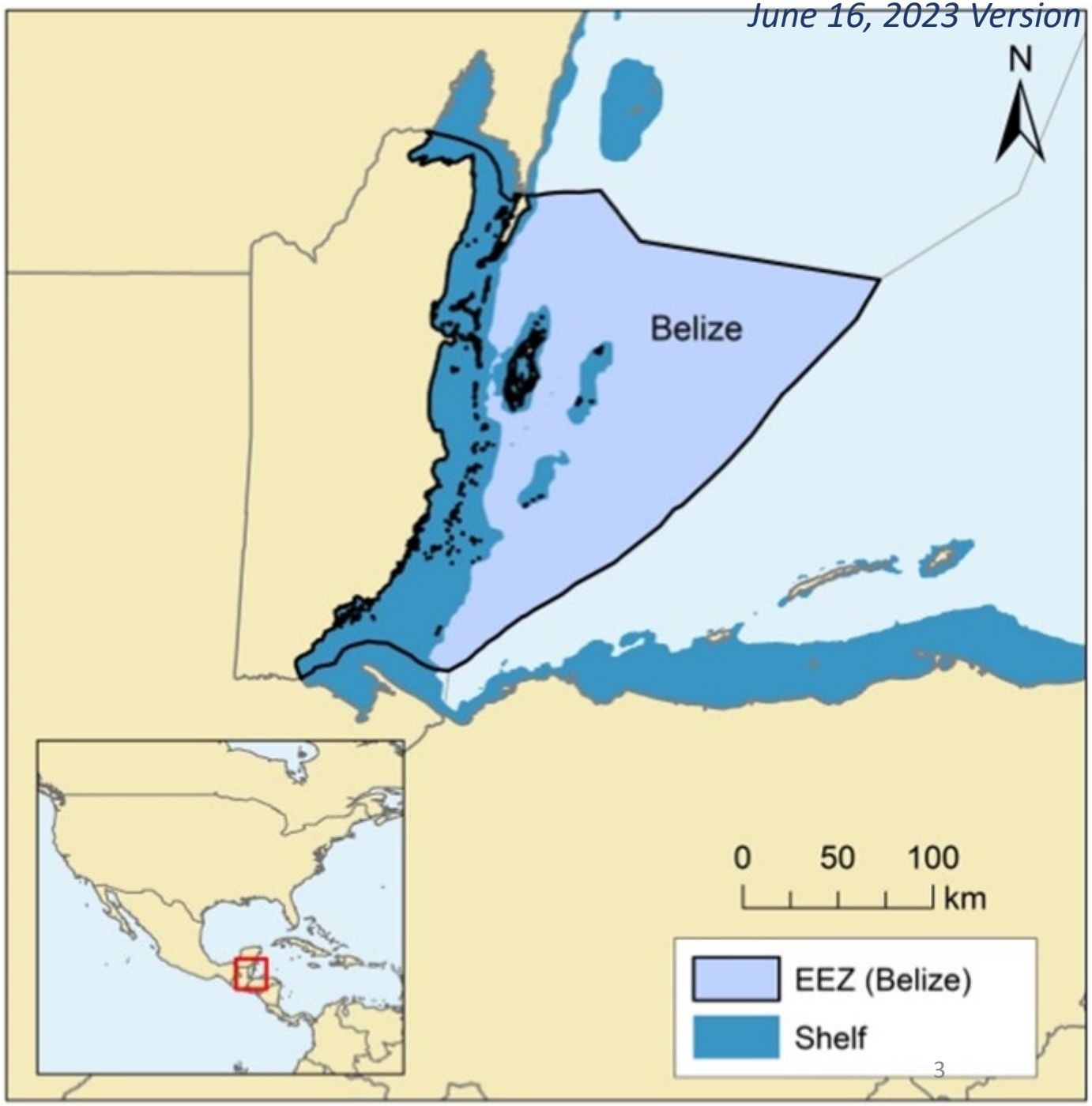
Daniel Pauly, M.L. 'Deng' Palomares, and Alexander Tewfik

Sea Around Us Research Initiative, IOF, UBC

Belize, 16 June 2023

- The Exclusive Economic Zone (EEZ) of Belize covers 36,182 km^2

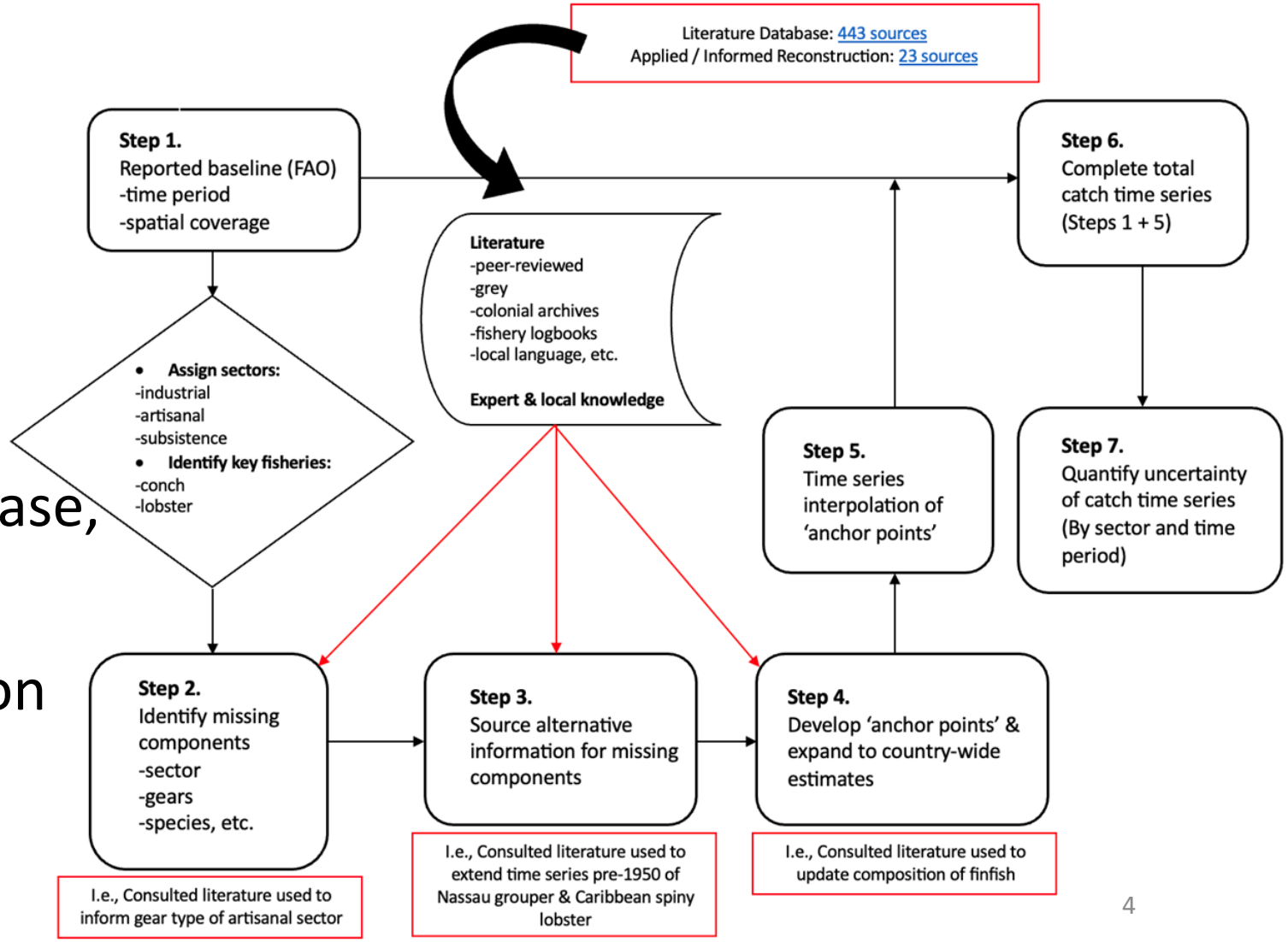
- The Territorial Sea includes three distinct atolls, Glover's Reef, Lighthouse Reef and Turneffe Atoll.



The reconstruction of the fisheries catches of Belize

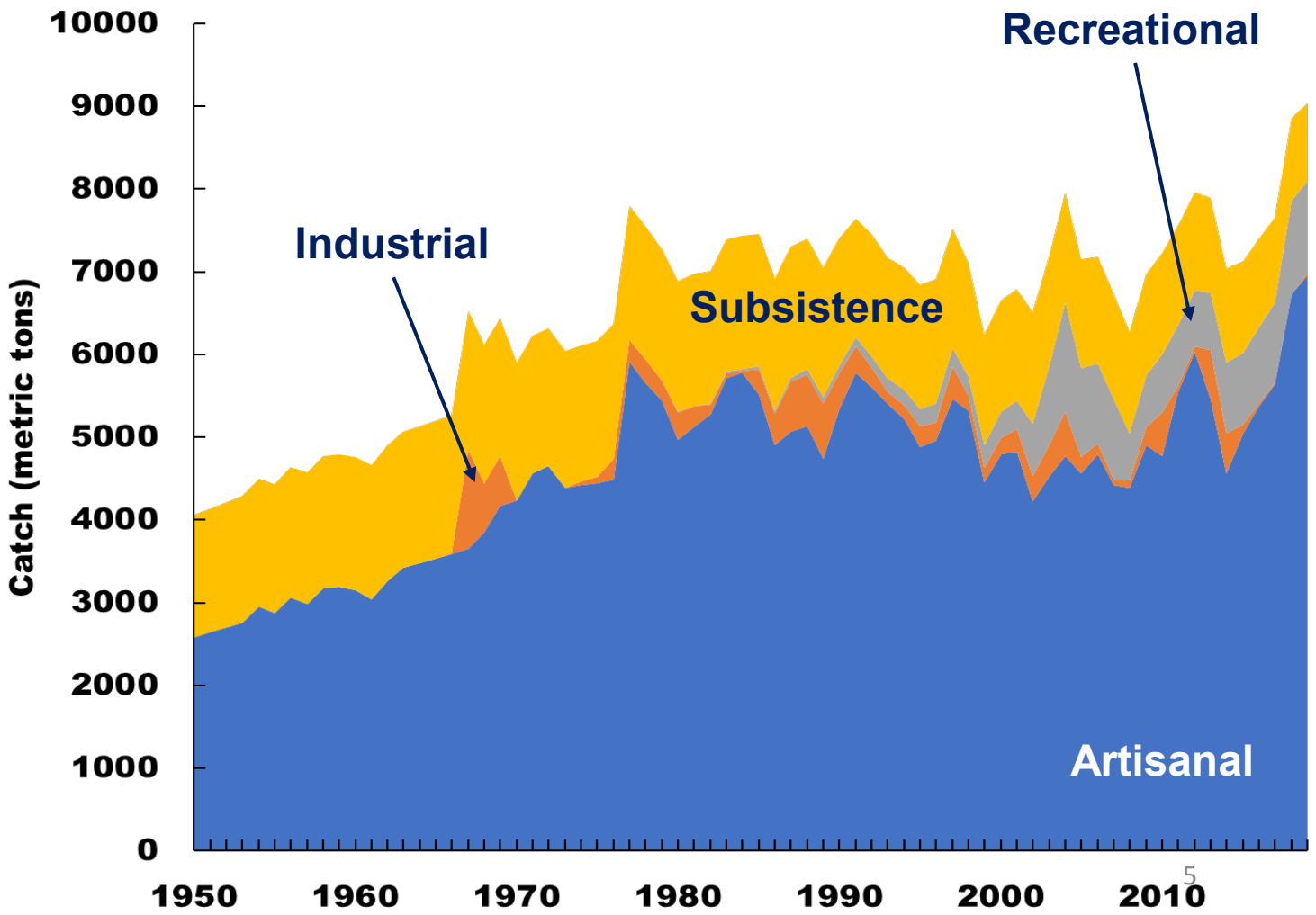
- Flowchart illustrating the 7-step fisheries catch data reconstruction approach.

- 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.

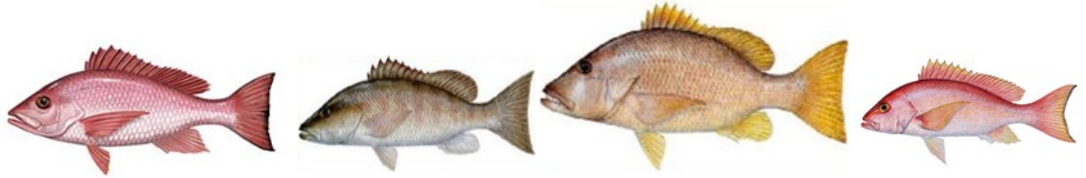
21% of the catch

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

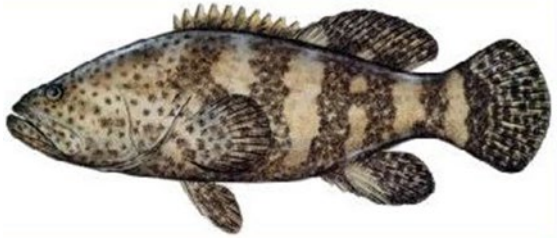
8% of the catch

Great barracuda

2% of the catch

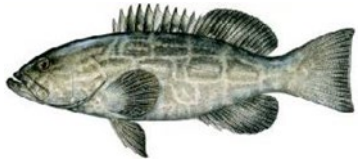
Snook

2% of the catch



Goliath grouper

Nassau Grouper

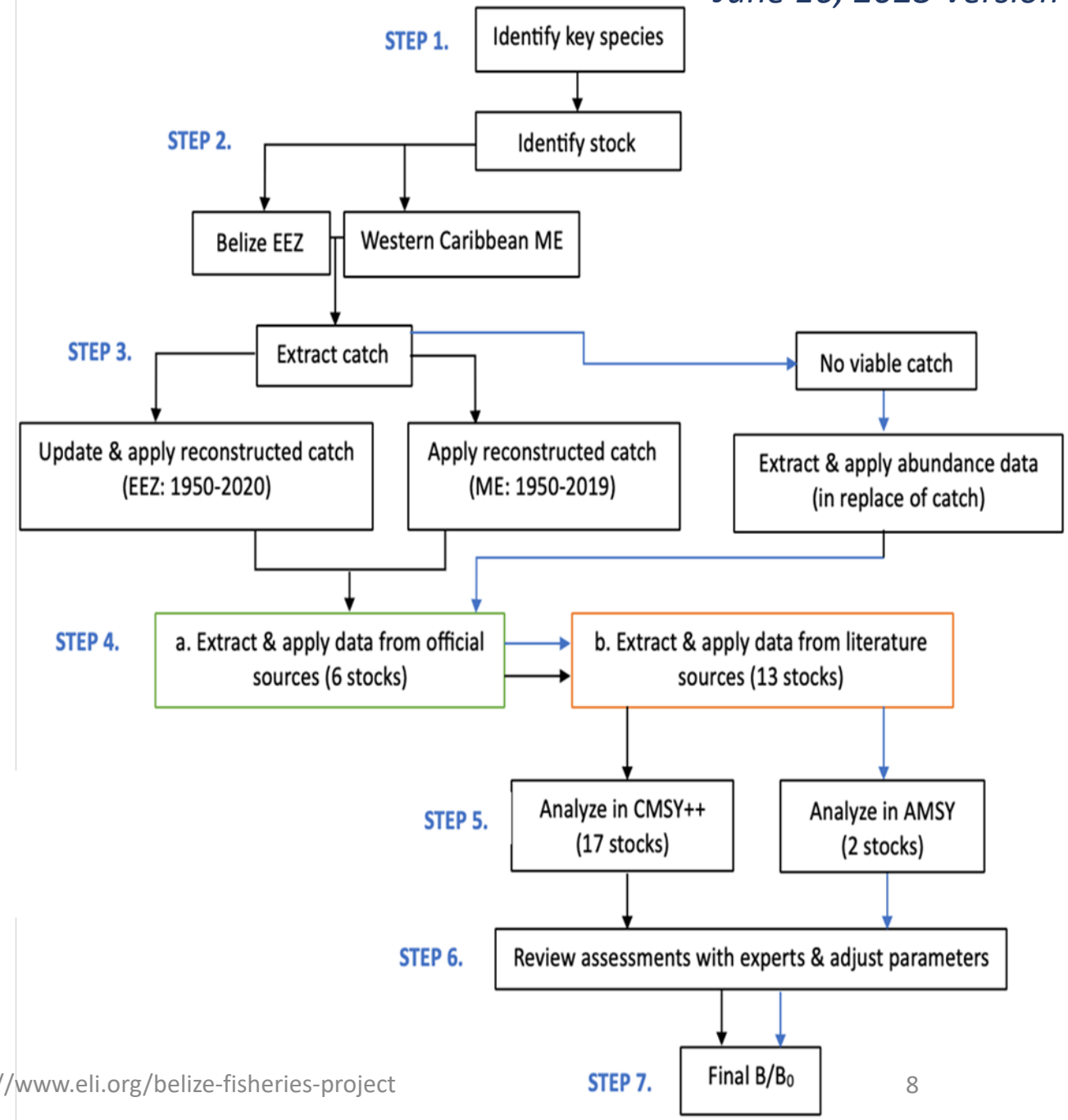


Black grouper

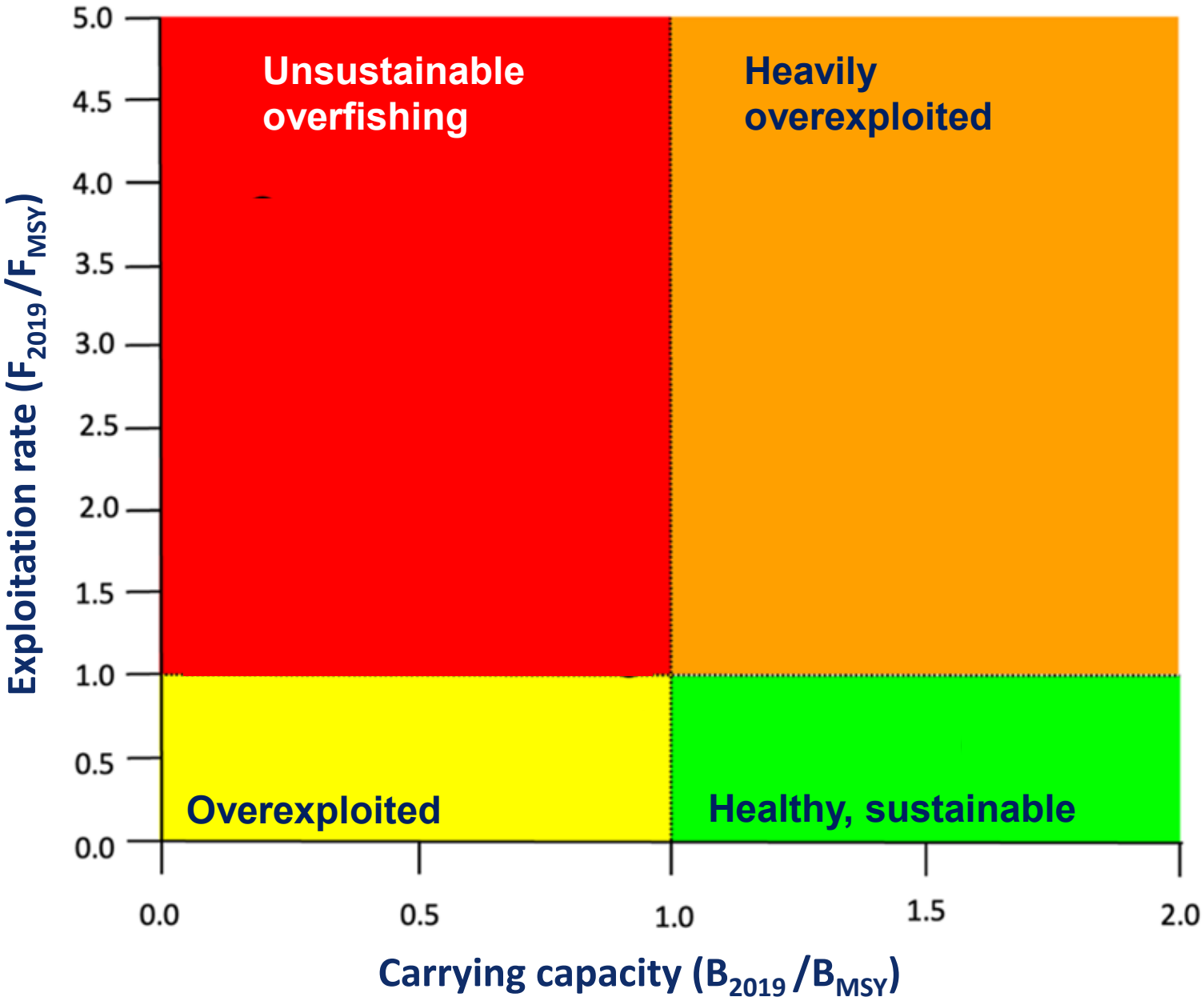
<1% of the catch

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.



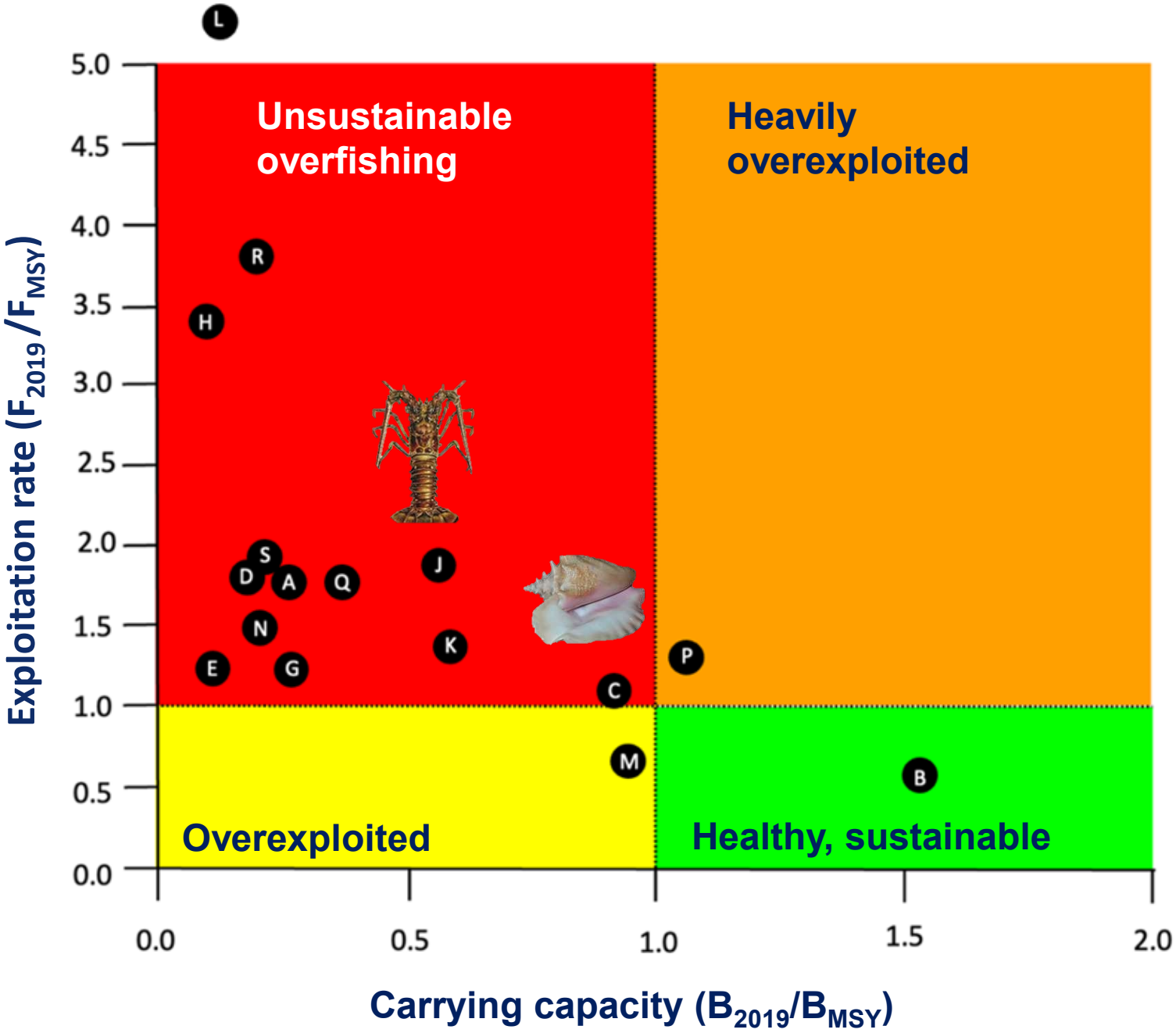
Sea Around Us stock analyses



Sea Around Us stock analyses

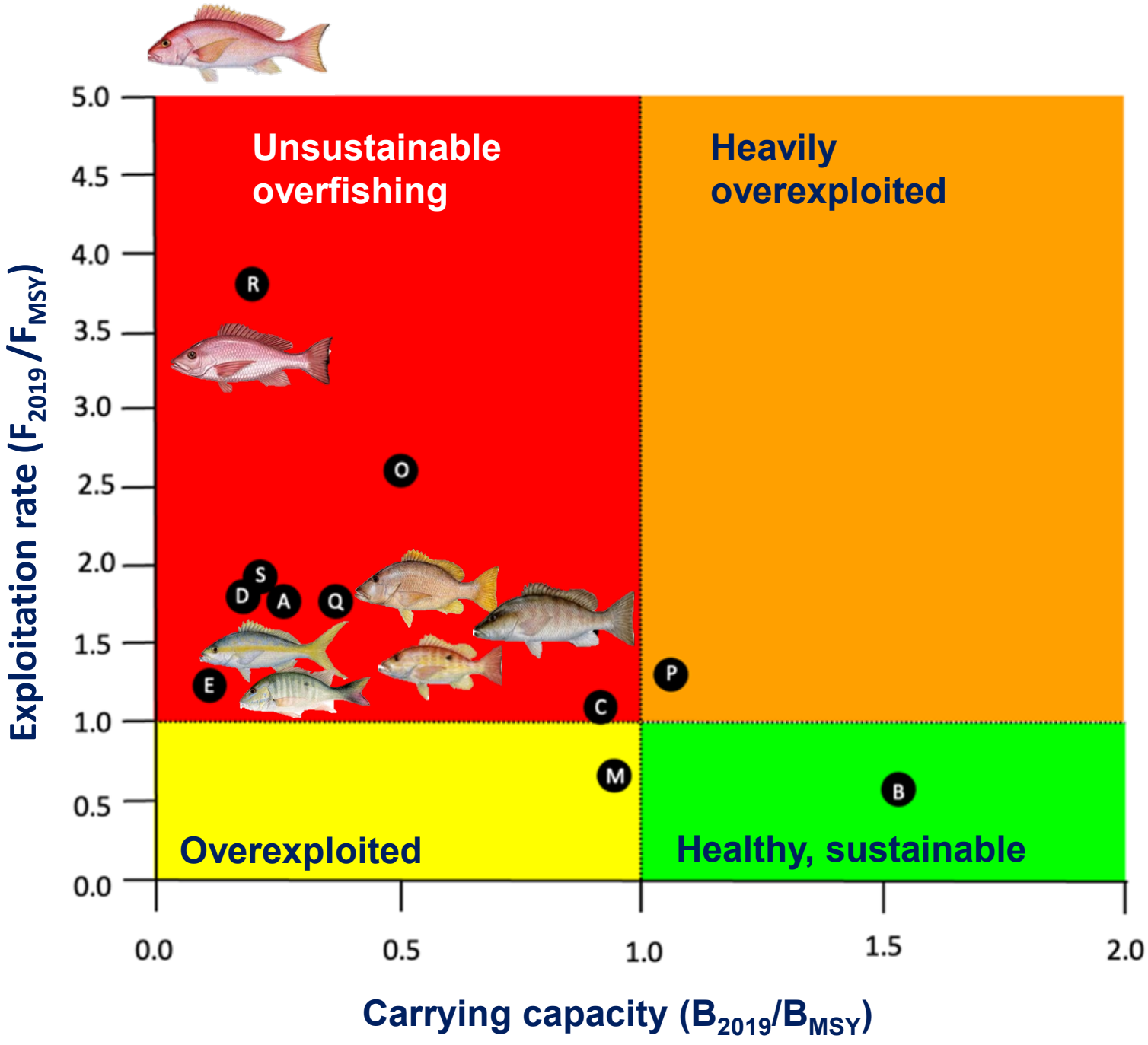
In general, the most commercially important species are in the red:

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



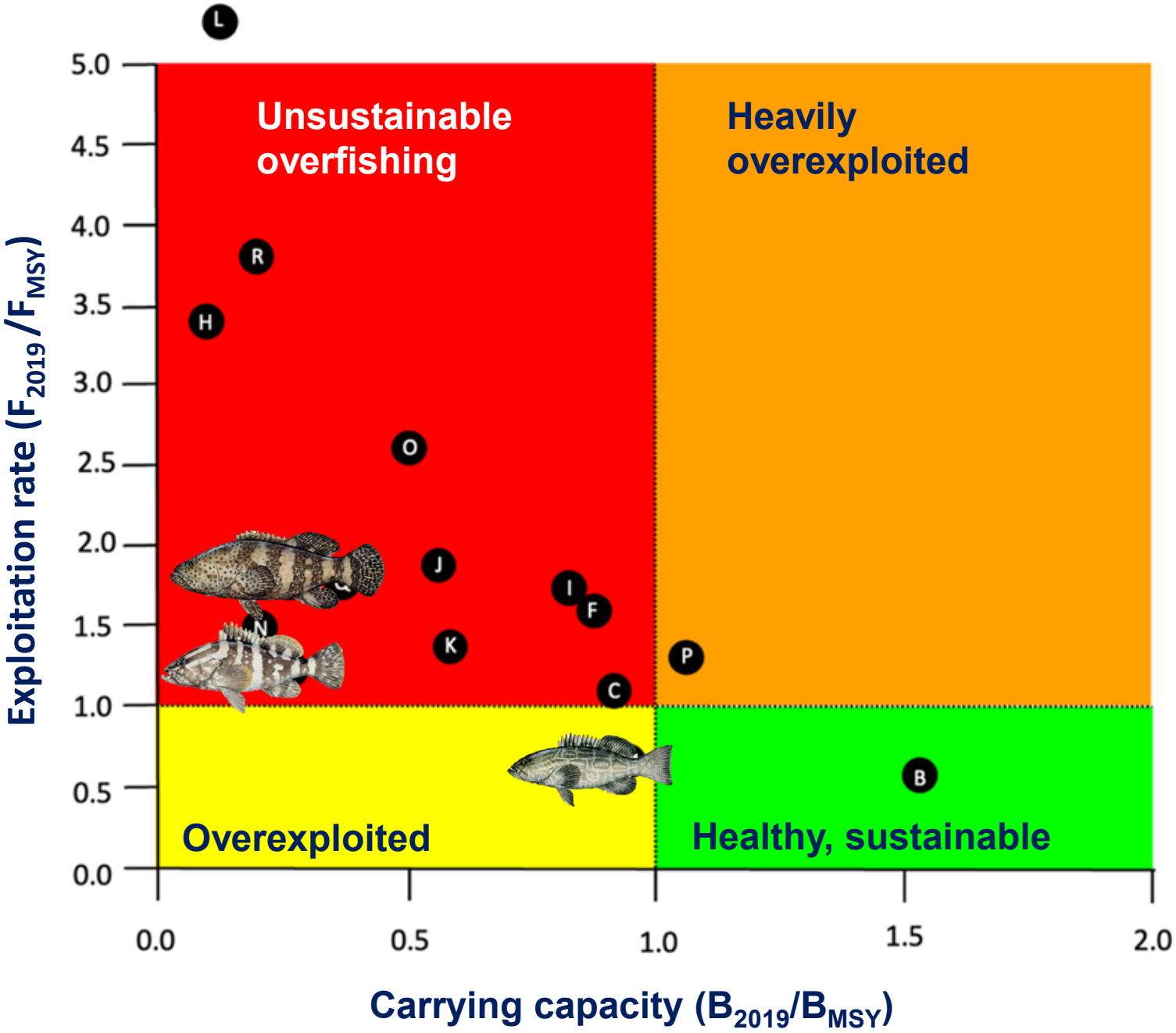
Sea Around Us stock analyses

Snappers are less abundant, and a lot work of 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.

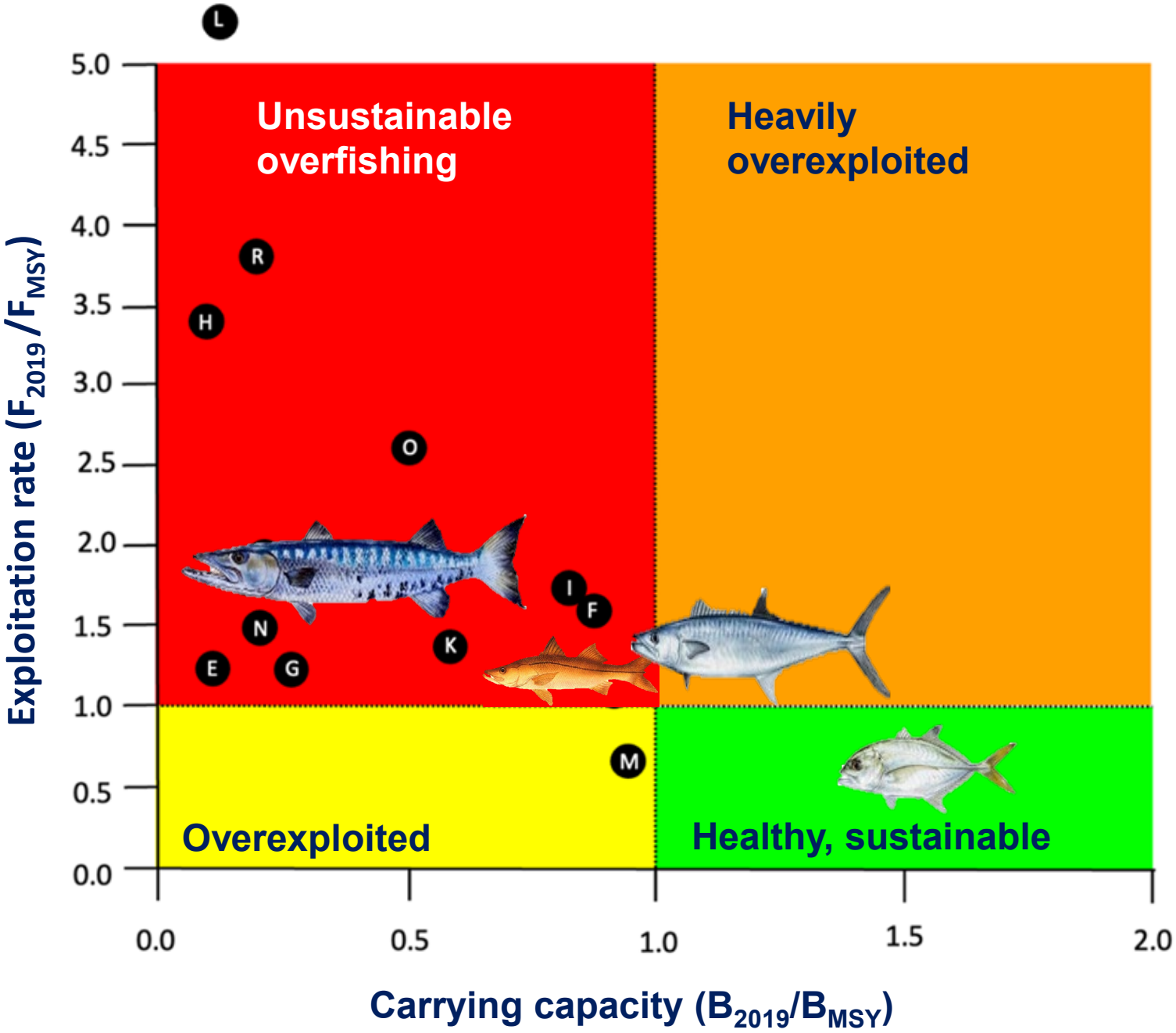


Sea Around Us stock analyses

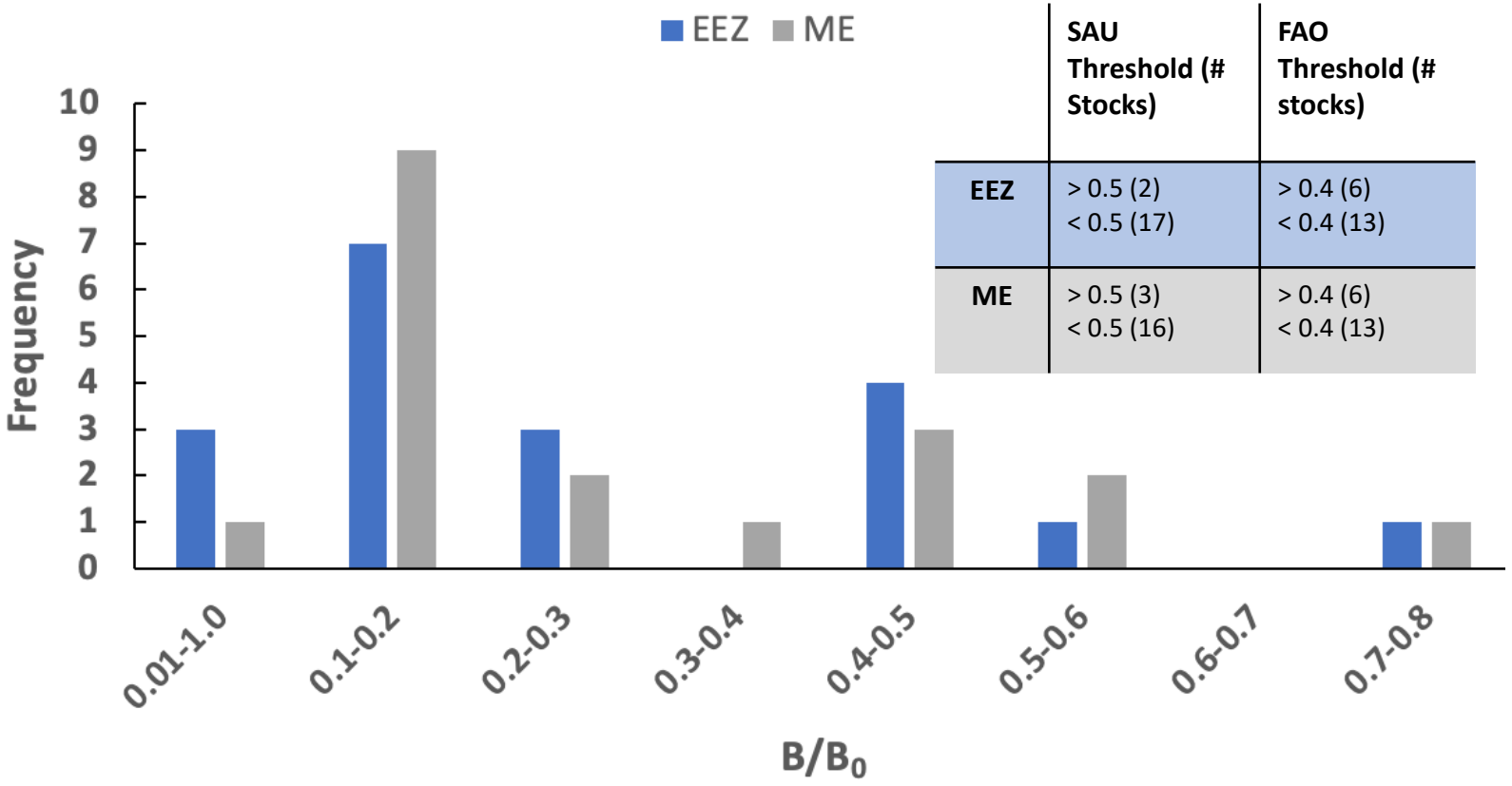
The horse eye jack is abundant.

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)



	SAU Threshold (# Stocks)	FAO Threshold (# stocks)
EEZ	> 0.5 (2) < 0.5 (17)	> 0.4 (6) < 0.4 (13)
ME	> 0.5 (3) < 0.5 (16)	> 0.4 (6) < 0.4 (13)

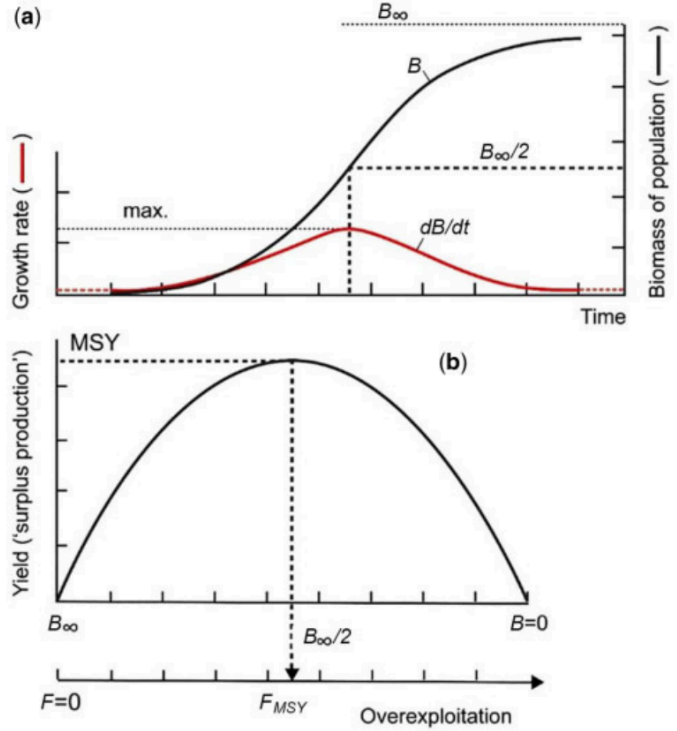


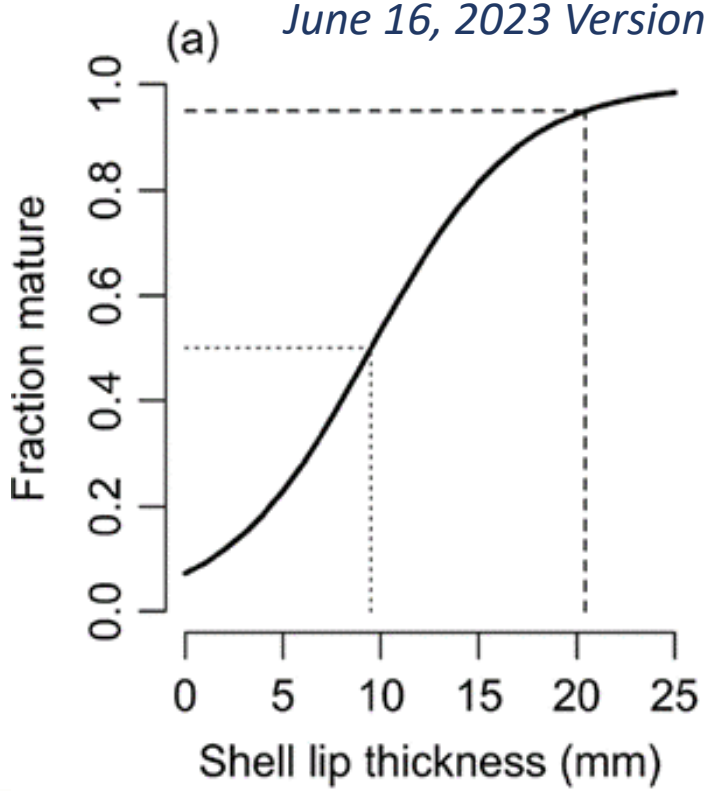
Figure 3. Basic elements of the Schaefer surplus production model. (a) A population invading an open space or recovering from a catastrophic decline will typically grow in sigmoid fashion, i.e. exponentially at first, then with at a declining rate as carrying capacity is approached. (b) The first derivative 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).

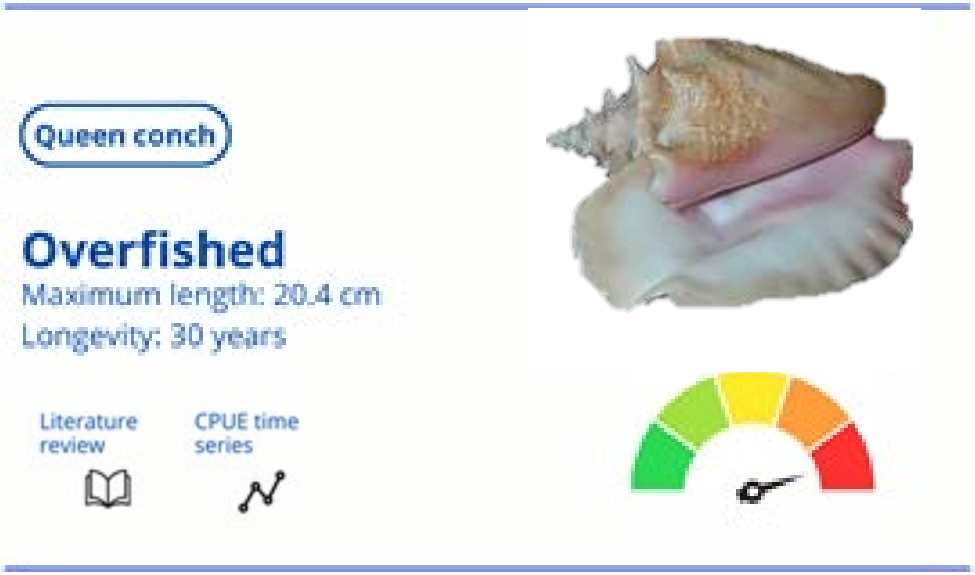
Pauly & Froese (2020)

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,

Review of existing knowledge: Queen conch

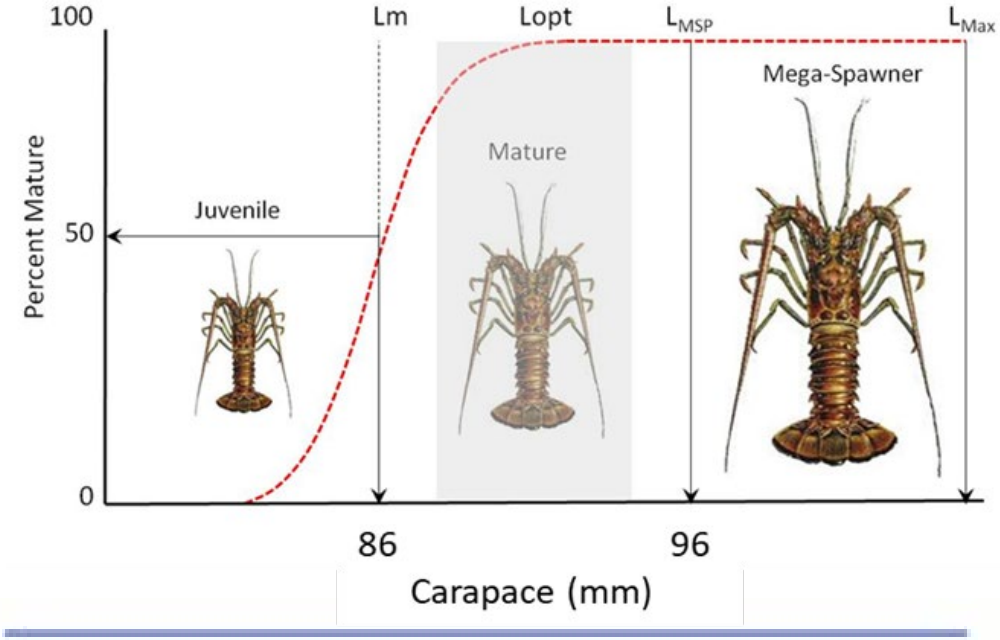
- Exploitation peaked in 2008-2013, which led to listing in Appendix II of CITES.
- Currently managed using size limits established in 1978 based on shell height and meat weight.
- Maturity is measured by thickness of shell lip (Tewfik et al. 2019).
- Bulk of catch is of immature individuals.





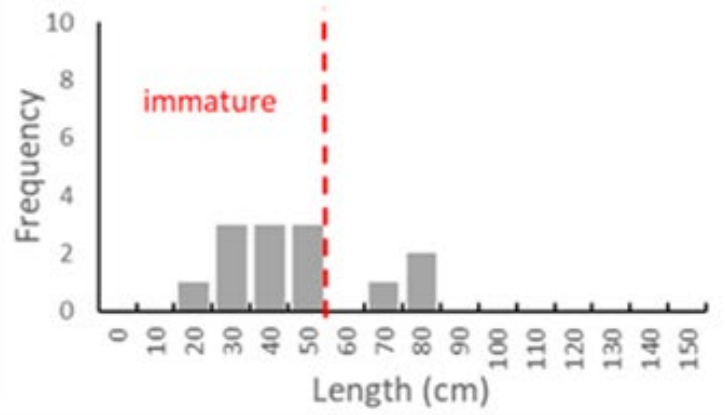
Review of existing knowledge: Spiny lobster

- 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.



Review of existing knowledge: Nassau Grouper

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

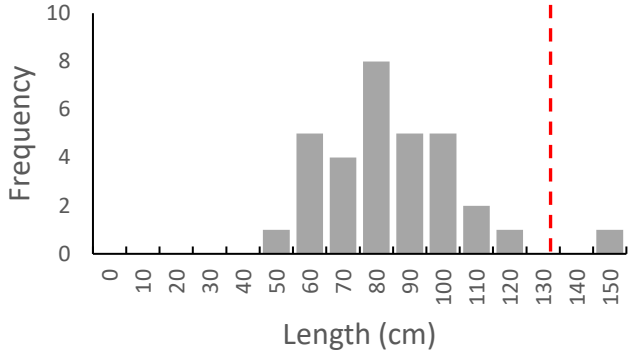


Review of existing knowledge: Goliath and Black Groupers

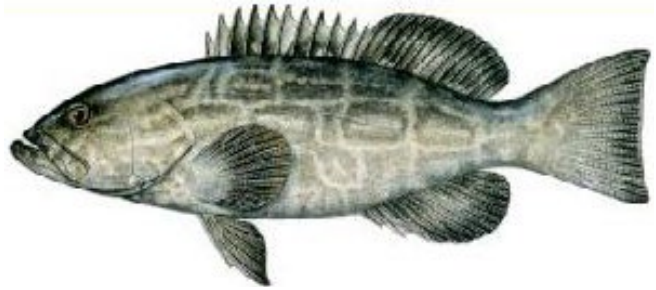
- In similar conditions as Nassau grouper

Goliath

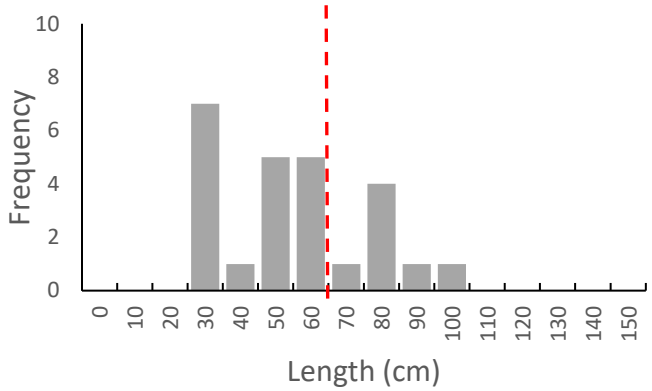
Max: 250 cm/360 kg



Black



Max: 150 cm/45 kg



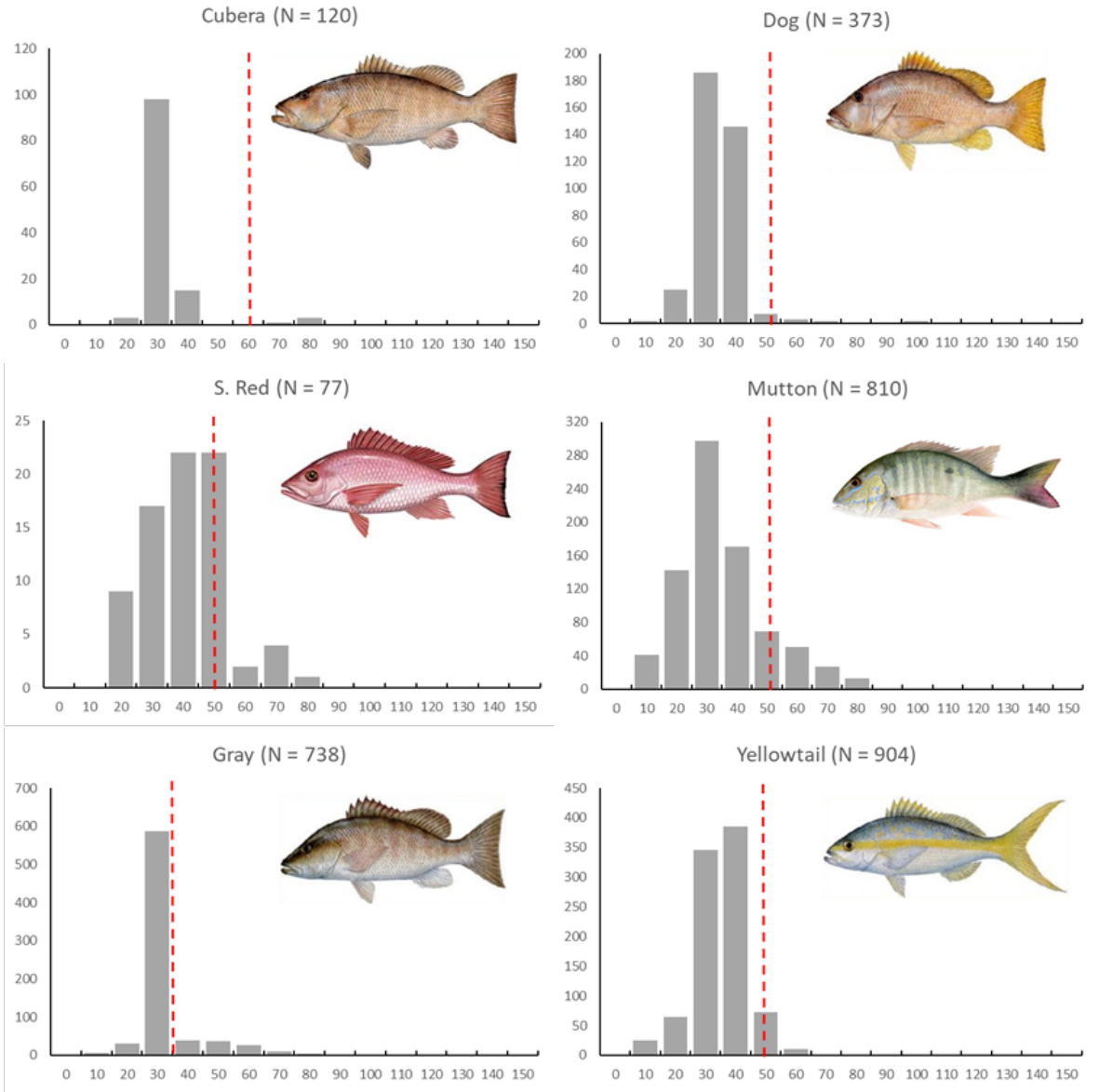
Review of existing knowledge: Snappers

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**.

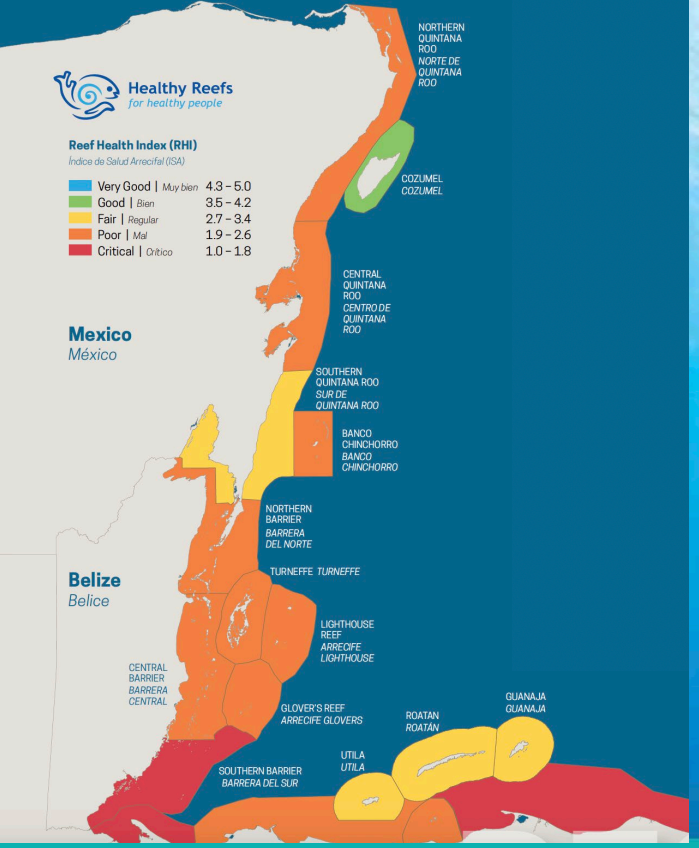
Reef Health Survey Results

Dr. Melanie McField

Healthy Reefs Initiative and Smithsonian Institution

June 16, 2023 Version

Mesoamerican Reef Health



5 is top Score

2006
326 SITES
SITIOS

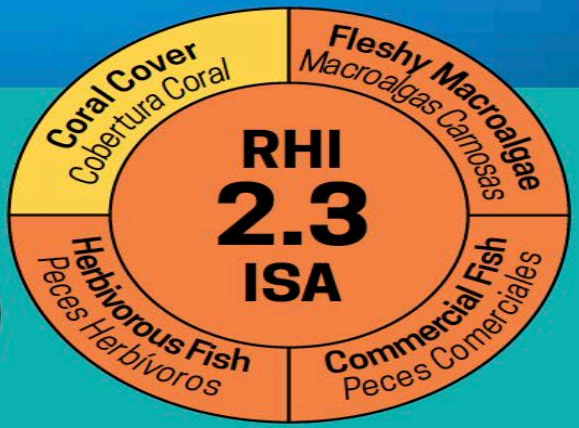
2009
130 SITES
SITIOS

2011
193 SITES
SITIOS

2014
249 SITES
SITIOS

2016
319 SITES
SITIOS

2018
286 SITES
SITIOS

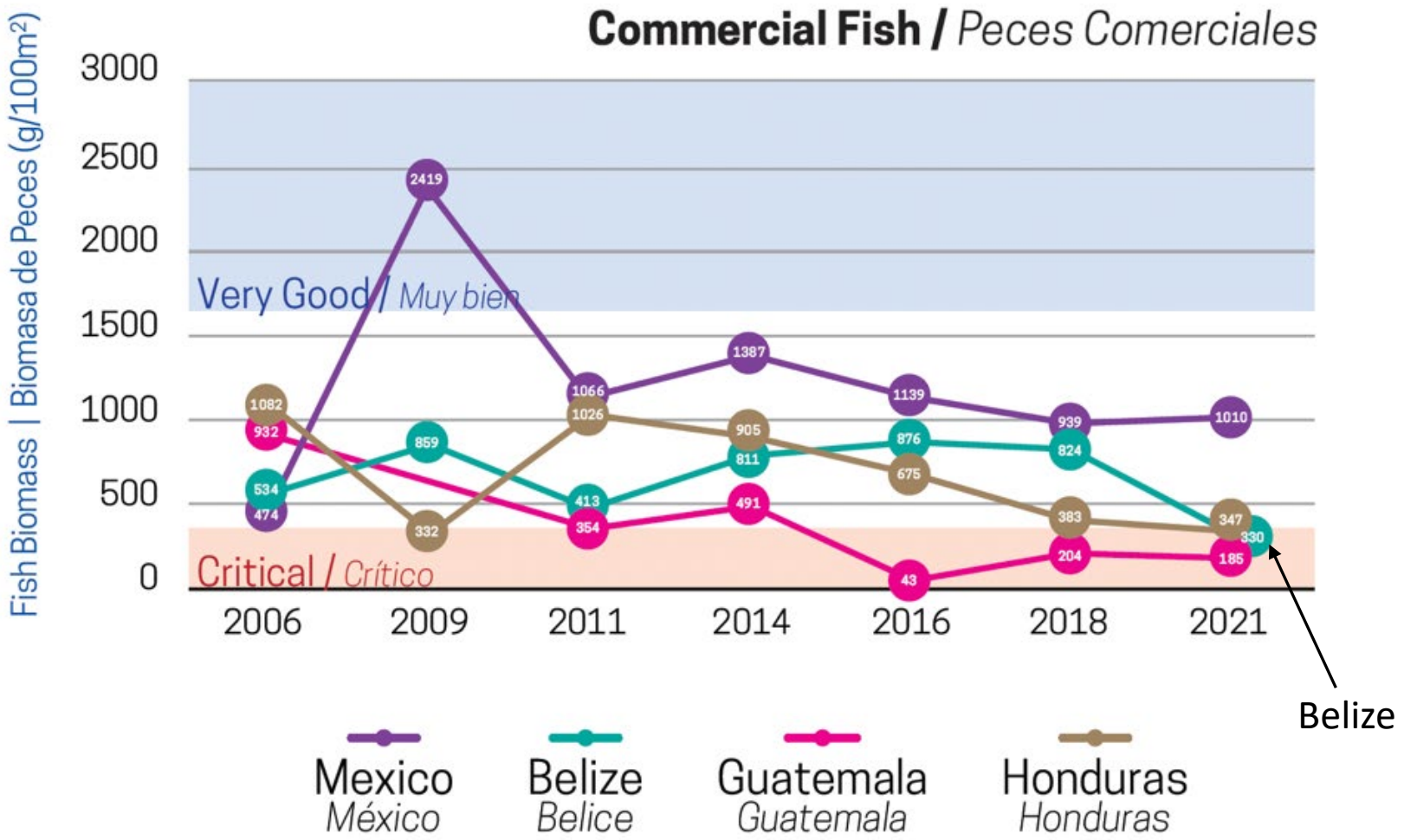


2021
234 SITES
SITIOS

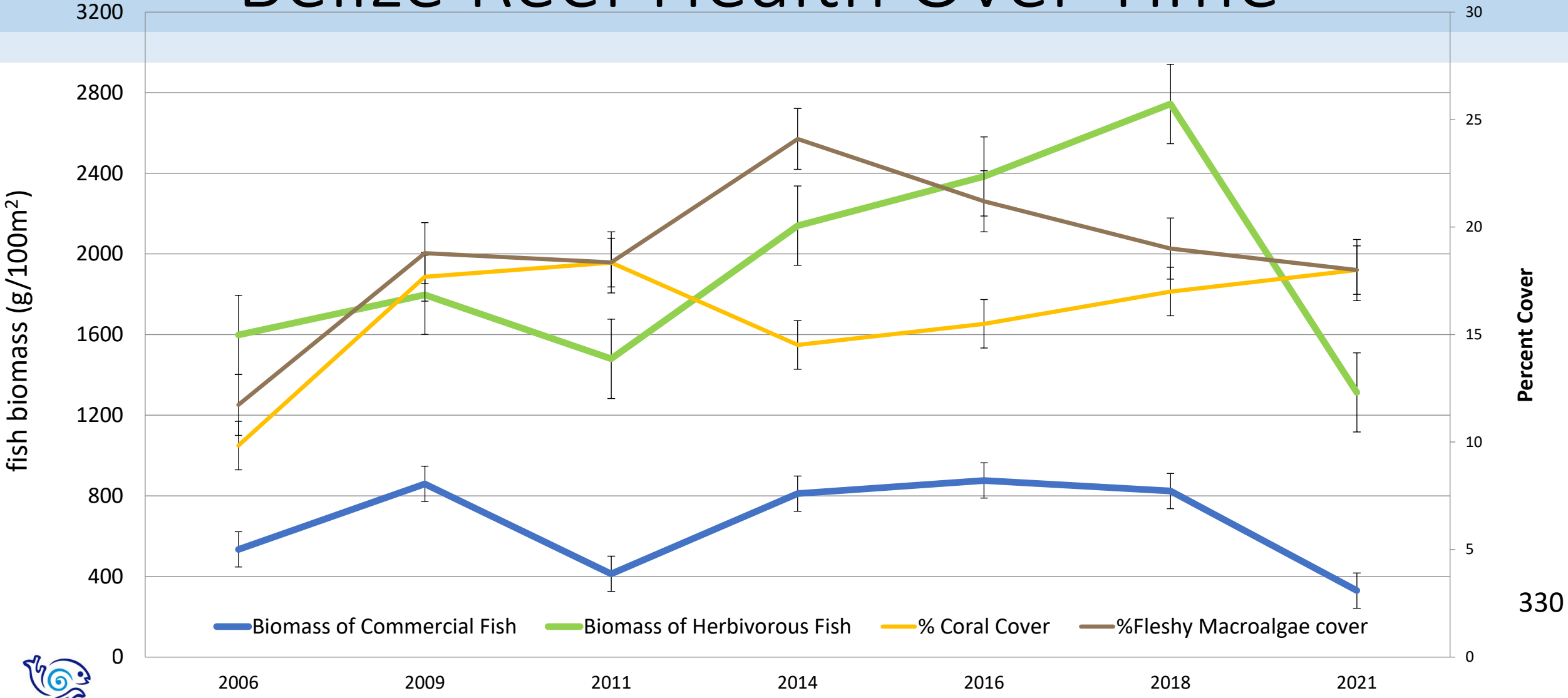
Years shown represent when data was collected not year report card was printed | *Los años que se muestran representan cuándo se colectaron los datos y no cuándo se imprimió el reporte.*

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.

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.



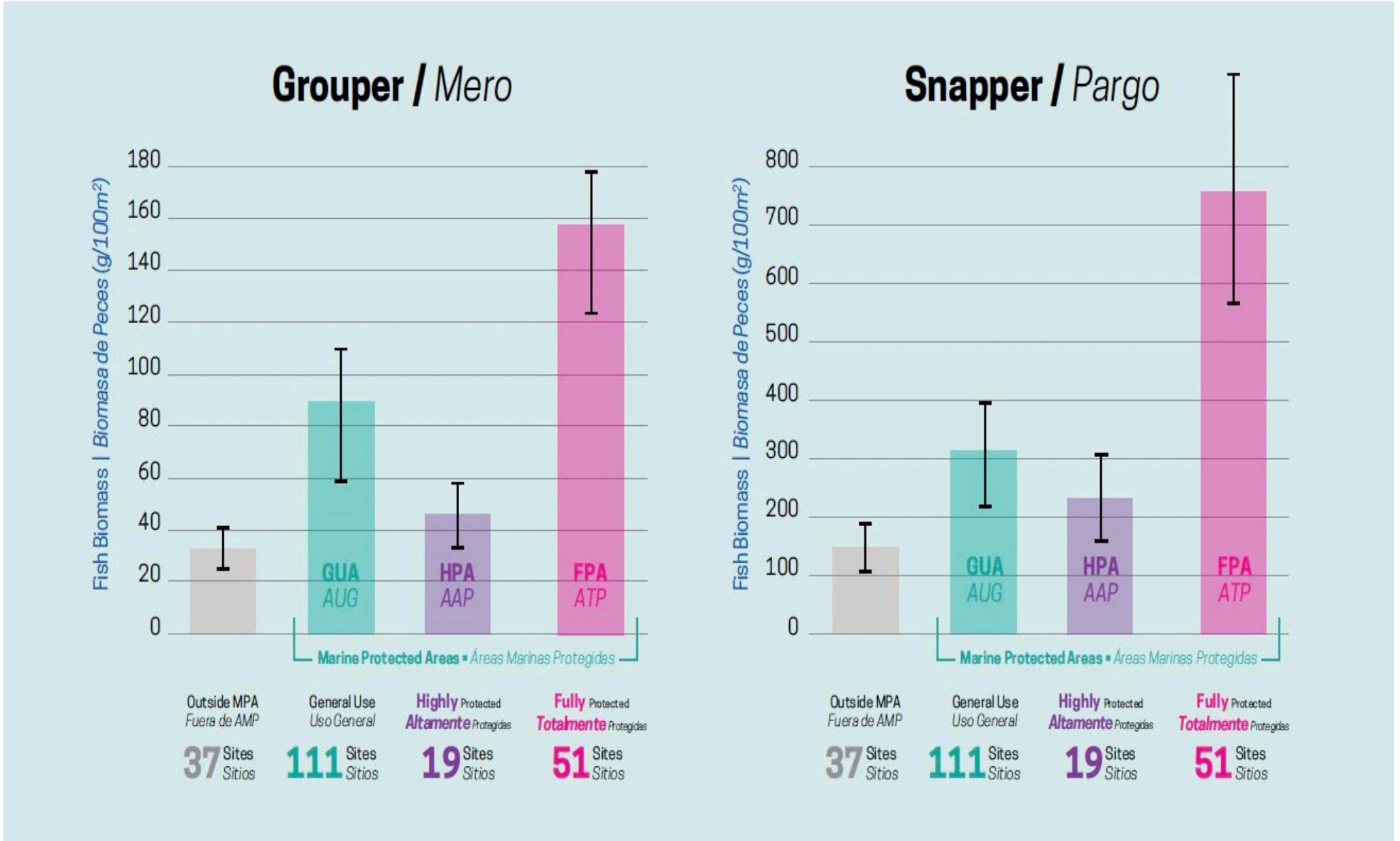
Belize Reef Health Over Time



330

Healthy Reefs
for healthy people

Only Fully Protected Zones Have Higher Fish Biomass



218 sites

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

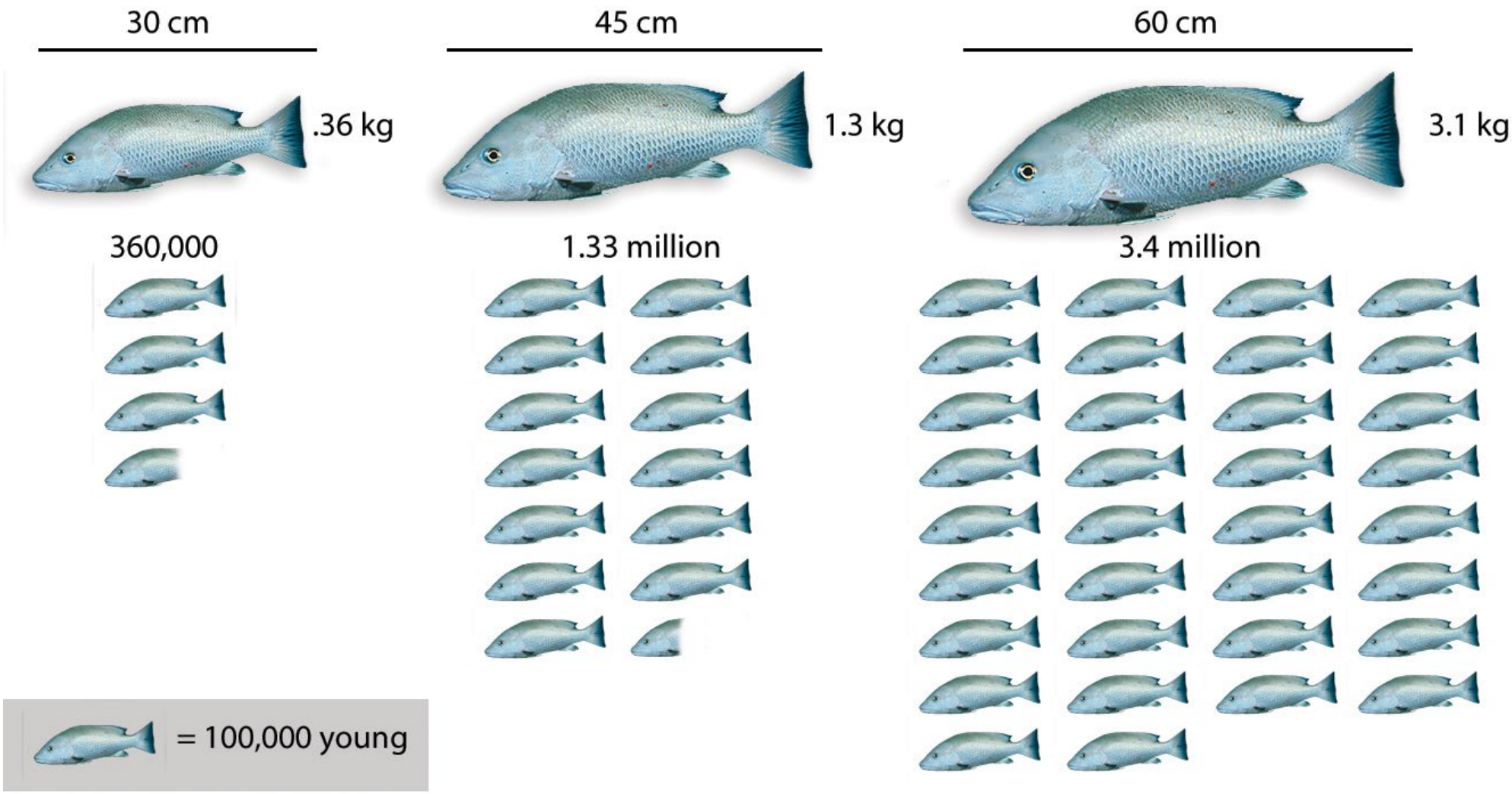
65cm **25%** Mature Maduro

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

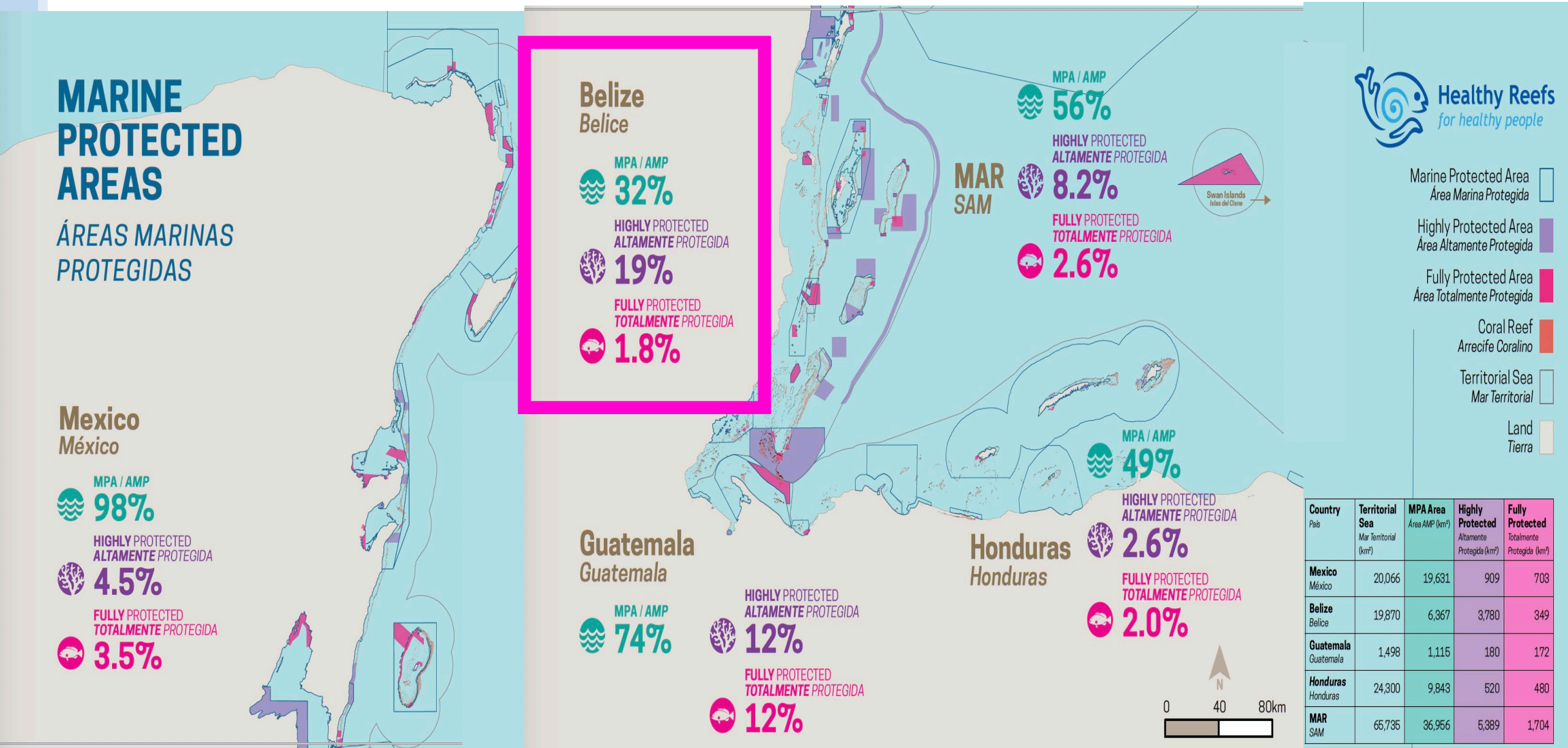


Average numbers of young produced by three different sizes of gray snapper.
Data: Bortone & Williams (1986) US Fish and Wildlife Service Biological Report

June 16, 2023 Version

Big Fish are in the FULLY PROTECTED zones of MPAs

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



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

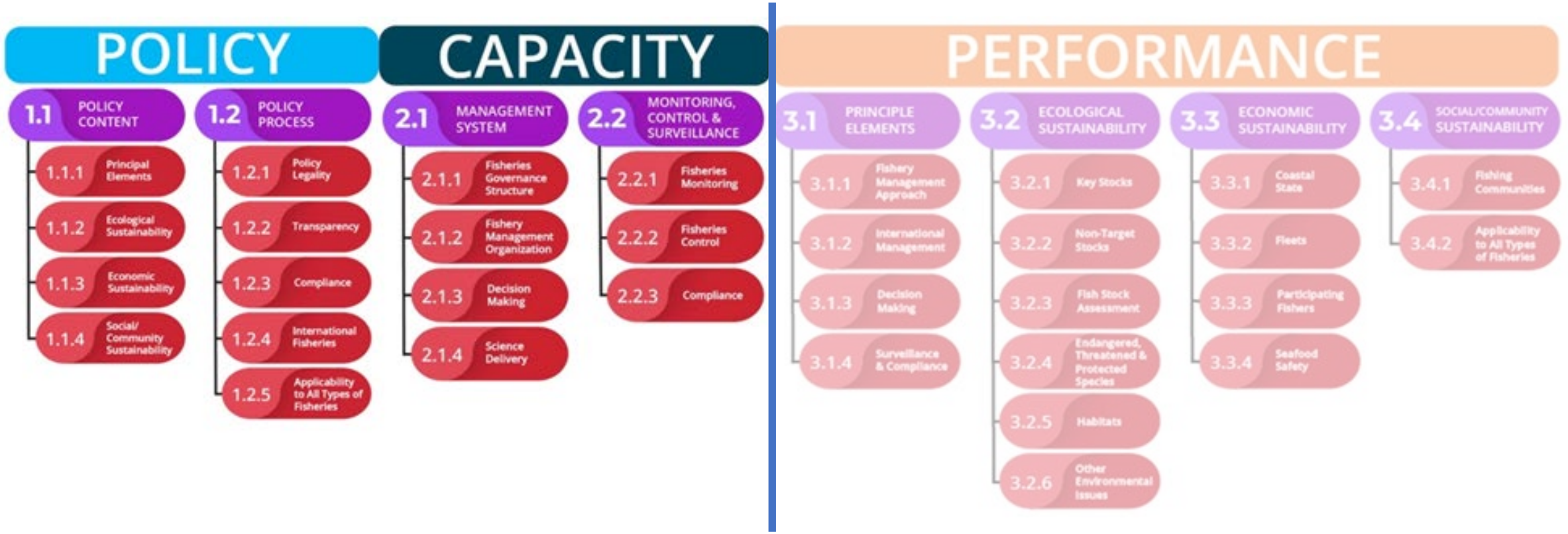
Fishery Management Opportunities

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

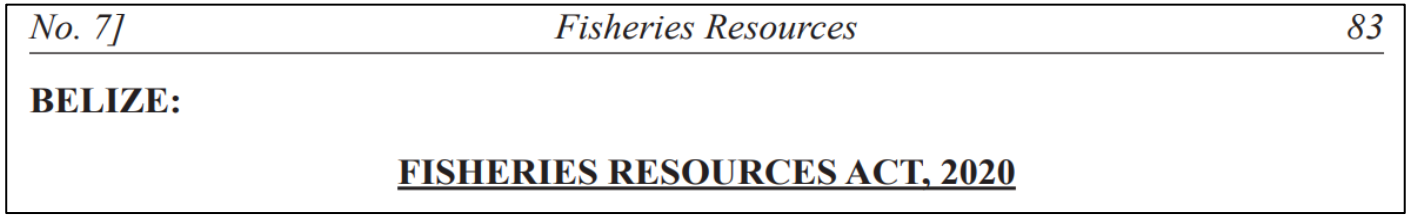
- Based on 40 source references, including 25 Belize Government documents
- Seeking feedback on our findings

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**



No. 7] *Fisheries Resources* *83*

BELIZE:

FISHERIES RESOURCES ACT, 2020

  - 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

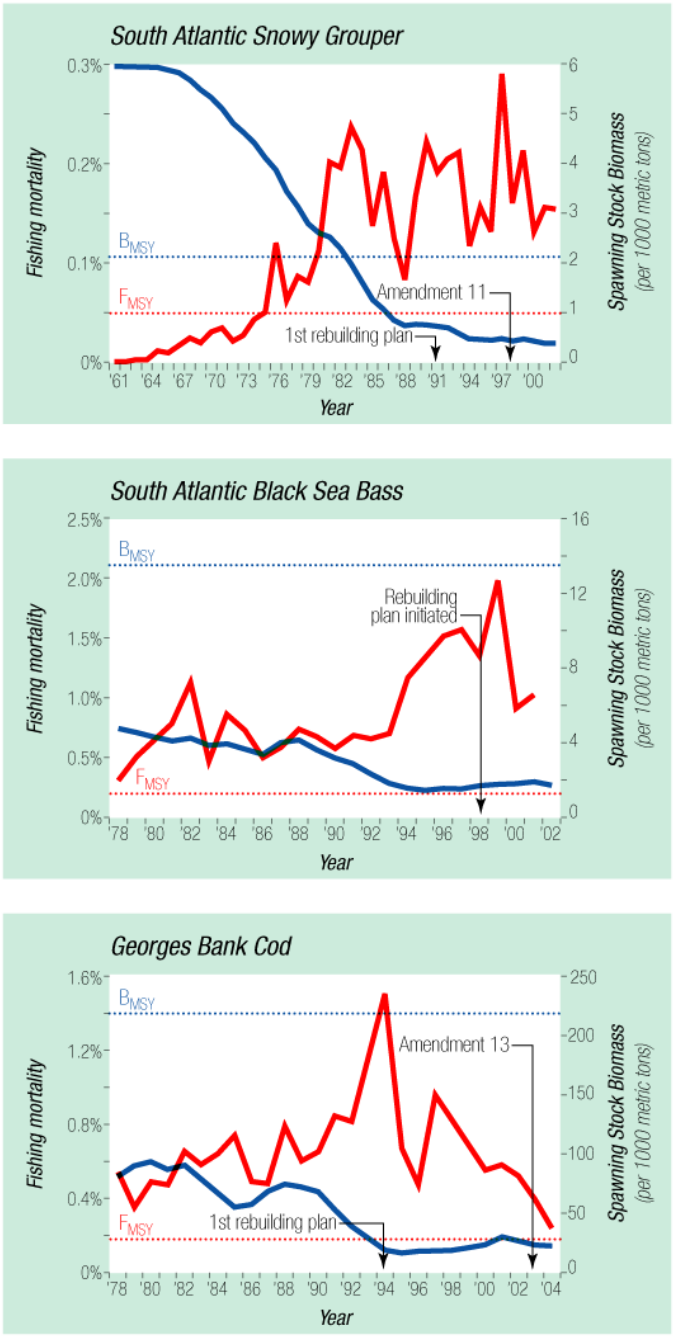
MRAG Americas, Inc.

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

LENFEST OCEAN PROGRAM

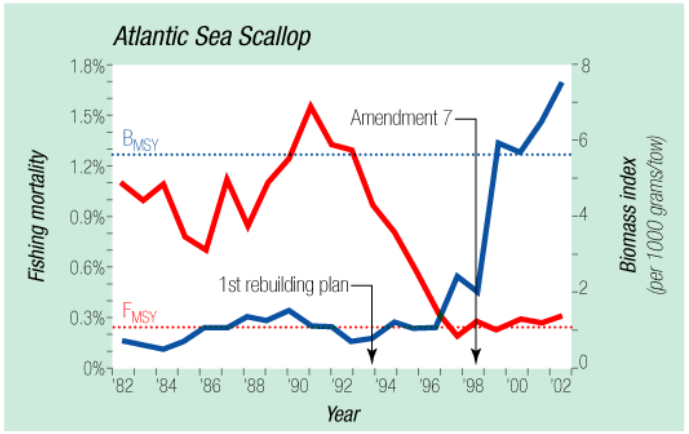
Figure 4:
Examples Of Stocks Showing Little Or No Rebuilding Progress

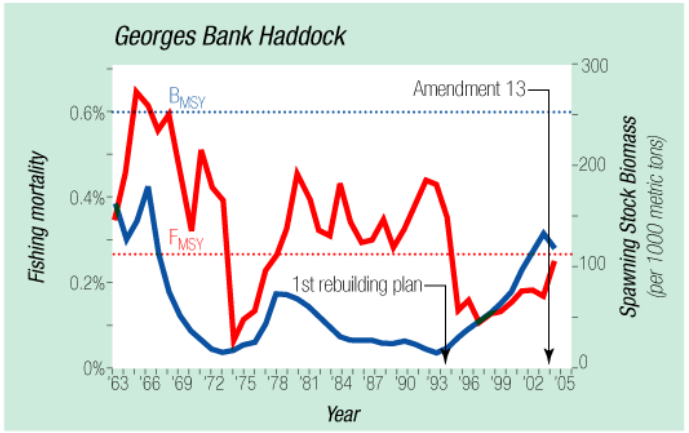


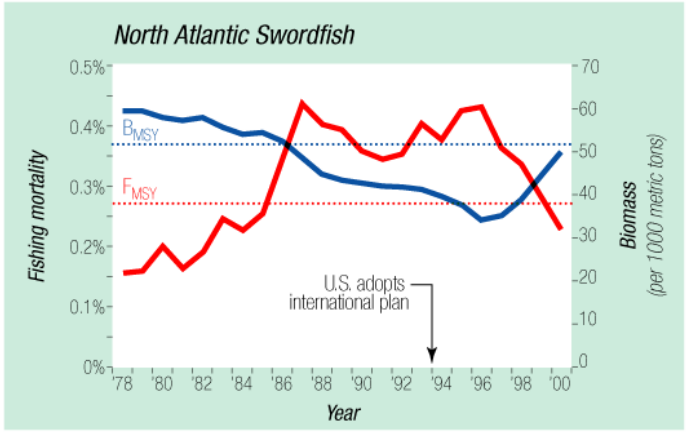
When fishing pressure remains high, stocks show little recovery

LENFEST OCEAN PROGRAM

Figure 5: Examples Of Stocks Showing Rebuilding Progress



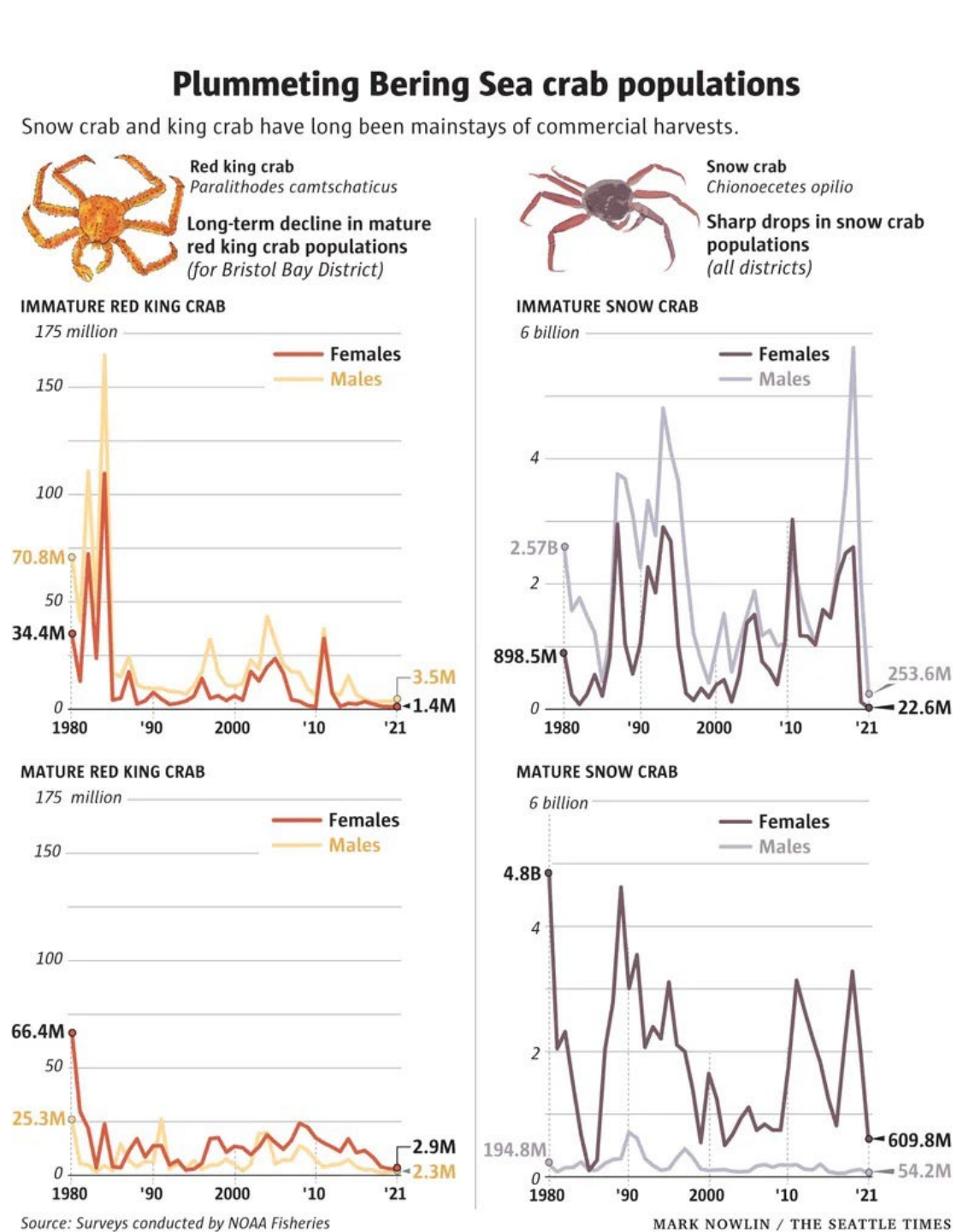


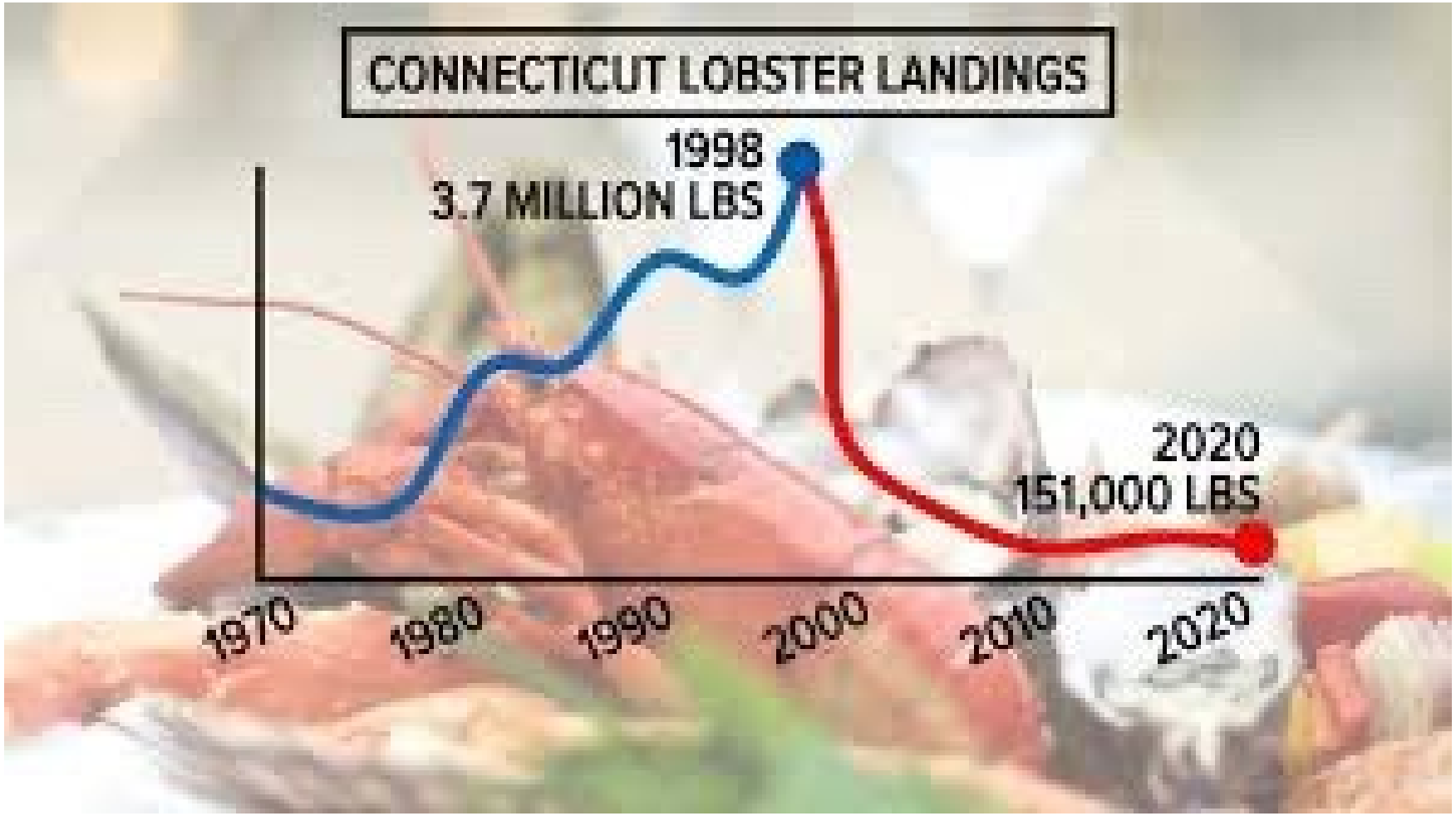


When fishing pressure is reduced, stocks can recover

:tps://www.eli.org/belize-fisheries-project

- 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)
Snow crab
Chionoecetes opilio
Sharp drops in snow crab populations
(all districts)
IMMATURE RED KING CRAB
175 million
150
100
70.8M
50
34.4M
0
Females
Males
3.5M
1.4M
1980
'90
2000
'10
'21
IMMATURE SNOW CRAB
6 billion
4
2.57B
2
898.5M
0
Females
Males
253.6M
22.6M
1980
'90
2000
'10
'21
MATURE RED KING CRAB
175 million
150
100
66.4M
50
25.3M
0
Females
Males
2.9M
2.3M
1980
'90
2000
'10
'21
MATURE SNOW CRAB
6 billion
4.8B
4
2
194.8M
0
Females
Males
609.8M
54.2M
1980
'90
2000
'10
'21
Source: Surveys conducted by NOAA Fisheries
MARK NOWLIN / THE SEATTLE TIMES


CONNECTICUT LOBSTER LANDINGS
1998
3.7 MILLION LBS
2020
151,000 LBS
1970
1980
1990
2000
2010
2020

Fishing for certainty

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

Andrew A. Rosenberg

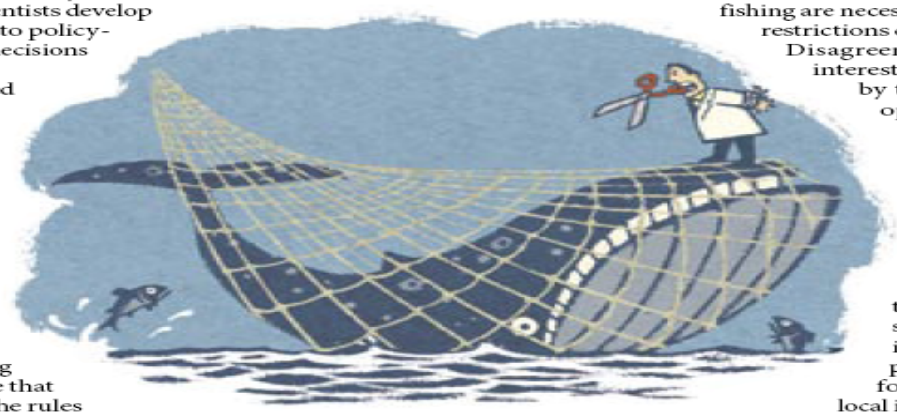
Policy-makers receive formal and informal advice from all quarters: scientific, legal, political and public. Each piece of advice is considered mandatory by the giver, and it often conflicts with other advisers' points of view. Uncertainty is a feature of all advice, but is usually only acknowledged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

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

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.

SCIENCE & POLITICS

Thank You

- Questions and discussion