ADVISORY

We are pleased to provide a presentation that we hope will be useful to those who work, or plan to work, on spawning aggregations, do not have ready access to photographic material, or simply wish to learn more about aggregations. Please adjust format as you require.

PLEASE NOTE, however, that the photos provided must always include the embedded credit and cannot be used for commercial purposes, or for uses other than presentations.

The information provided and displayed in graphs is based on the database at **www.SCRFA.org** and on SCRFA's work. For more information on the data, for references, or for general information on spawning aggregations please refer to the website. Additional information may be obtained by contacting: **SCRFA@hku.hk**.
Full citations for indicated literature are available on the website.

SCRFA 2009

A Presentation on Reef Fish Spawning Aggregations

For more information:
www.SCRFA.org
SCRFA@hku.hk

SCRFA

Funded by the David and Lucile Packard Foundation

the David & Lucile Packard FOUNDATION

What is a spawning aggregation?

A group of fish that forms for the sole purpose of spawning (i.e. reproduction)

The photo shows a group of snappers that has formed for the purpose of spawning

The mixture of sperm and eggs is visible as a large white cloud in the photograph

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Why the growing interest in spawning aggregations?

- Spawning aggregations are heavily exploited in many fisheries because many commercial species spawn in aggregations
- For many species, aggregations are the only opportunities for reproduction
- Declines and losses of aggregations can seriously reduce fish populations and compromise the fishery, affecting both fish and people

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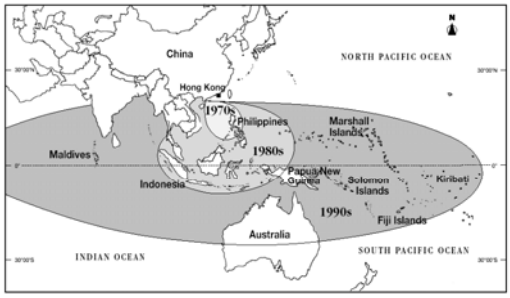


As just one example, the live reef food fish trade, centred in Hong Kong, sometimes takes groupers from spawning aggregations. This fishery began in the South China Sea in the 1970s but spread into the Pacific and Indian Oceans in the 2000s

Sadovy et al., 2003

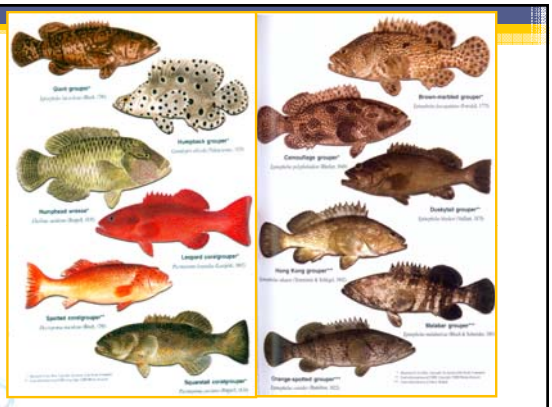
SCRFA

Snappers and groupers, including several aggregating species, in the live reef fish food trade, shown in a retail market in Hong Kong.

Indo-Pacific spawning aggregations are being fished for this large international market which expanded enormously between the 1960s and the 1990s

Live fish waiting to be selected for cooking by restaurants in Hong Kong; many of them come from the Pacific

Photo:
Upper right - live fish in tanks of restaurant;
Lower right – menu with live fish dishes



Major species in the live reef fish trade; many aggregate

Aggregating Fishes in Coastal Fisheries

- Many of the more valuable reef fish species taken by coastal communities aggregate to spawn
- Many of these aggregations are declining with implications for food supply and livelihoods

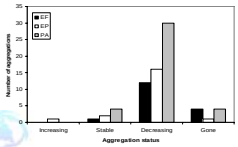
A wide range of commercially important reef fishes spawn in aggregations:

- rabbitfishes (Siganidae)
- mullets (Mugilidae)
- emperors (Lethrinidae)
- surgeonfishes (Acanthuridae)
- jacks (Carangidae)

among others…

Three grouper species that sometimes spawn in the same location are the camouflage (EP), the brown-marbled (EF) and the squaretail coral (PA) groupers

They are often fished in their aggregations for both live and chilled fish markets and many aggregations show declines



Two general types of spawning aggregation

- Resident aggregations form frequently, sometimes daily, close to home reefs and in many different locations (examples are found in surgeonfishes and some wrasses and parrotfishes)
- Transient aggregations form tens or hundreds of kilometers away from home reefs, for short periods each year and in relatively few places (examples are found in groupers, snappers, rabbitfishes, etc.)

Domeier and Colin, 1997

How are spawning aggregations identified?

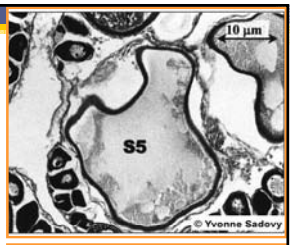
Spawning: determined from 'direct' or 'indirect' signs
Direct:
spawning observations and gravid (full of eggs) females
Indirect:
body colors and behavior known only to be associated with spawning; seasonally high landings of ripe fish

Aggregation:
determined from significant fish density increases, compared to the non-reproductive season

DIRECT indications of spawning

observation of spawning (upper right) or
hydrated eggs (lower right - inside bucket).

In histological sections 'S5' stage eggs are hydrated and ready for release (upper right), while
POFs (post-ovulatory follicles) remain after spawning for a short time and signal very recent spawning (lower right)



Ripe female grouper (red hind, *Epinephelus guttatus*), full of eggs (upper right)

Large numbers of red hind are caught before they have a chance to spawn
– if this is not controlled, the reproductive capacity of the population may be compromised

Ripe female *Lutjanus fulvus* showing eggs that filled her abdomen

BUT be careful, fat fish are not always full of eggs!

Fat bodies and large food items can also swell the abdomen and be misleading

As one example, the photo on the right shows juvenile snapper with large abdominal fat bodies (arrow)

INDIRECT indications of imminent spawning

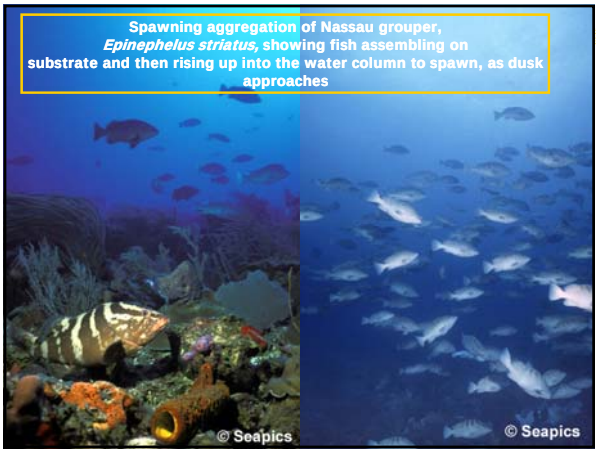
in males can include specific behaviours or colors known only be associated with spawning

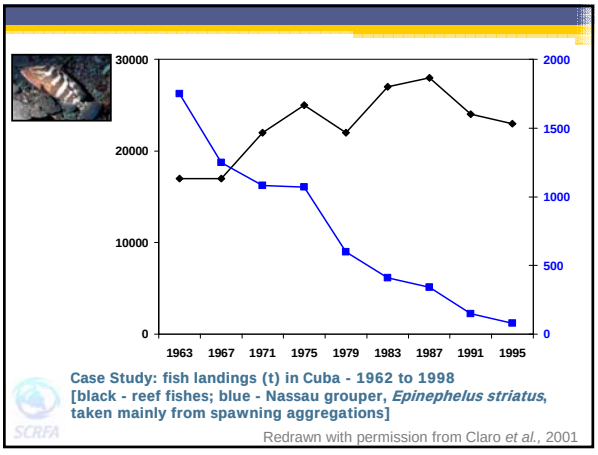
For example, the Tiger Grouper, *Mycteroperca tigris*, shows characteristic male-male display (right)

The Tiger Grouper also shows male colouration associated with spawning; see yellow head and white ventral area (upper right) whereas non-spawning coloration(lower right)

In 2003 the Nassau Grouper, *Epinephelus striatus* was listed as 'Endangered' on the IUCN Red List of Threatened Species and is a Species of Concern in relation to the U. S. Endangered Species List; largely because of aggregation-fishing

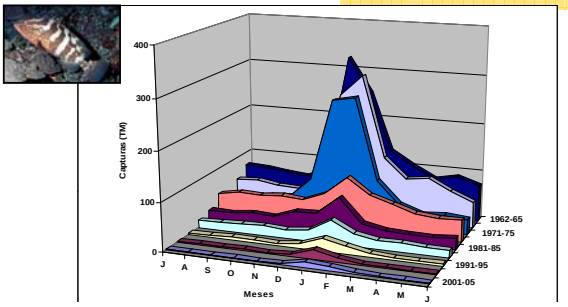
Spawning aggregation of Nassau grouper, *Epinephelus striatus*, showing fish assembling on substrate and then rising up into the water column to spawn, as dusk approaches





Case Study: fish landings (t) in Cuba - 1962 to 1998 [black - reef fishes; blue - Nassau grouper, *Epinephelus striatus*, taken mainly from spawning aggregations]

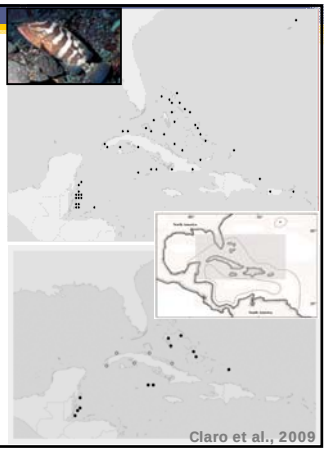
Redrawn with permission from Claro *et al.*, 2001



In Cuba, the Nassau grouper has been monitored since the early 1960s. Data shown in the graph were taken monthly until recently. Spawning months are December, January and February. It is noted (a) that most fishing usually occurred in the spawning months, and (b) that the fishery collapsed in the late 1970s. This collapse was mostly due to aggregation-fishing.

Claro et al., 2009

The number of aggregation sites of the Nassau grouper have declined to at least a third **(lower right)** of historic values **(upper right)** due to over-fishing, mainly on aggregations **(range of species shown in the middle diagram)**.



Claro et al., 2009

Healthy aggregations maintain fisheries. Aggregation-fishing at low and subsistence- only levels may be sustainable.

However, commercial level aggregation-fishing is typically not sustainable without management.

High seasonal landings may be an indication of a spawning aggregation. However, this should be validated by further work since changes in the fishery, unrelated to aggregating fishes, could also produce such patterns: examining the gonads would be a useful addition.

Conservation and Management of Reef Fish Spawning Aggregations

LEARNING ABOUT SPAWNING AGGREGATIONS

- To effectively understand, conserve and manage reef fish spawning aggregations and aggregating species, good scientific protocols must be developed for research and monitoring.
- Failure to adopt good science to validate reported aggregations or to collect the necessary information for management could lead to waste of time and money, or yield outcomes that are ineffective, or even detrimental to the fishery

SCRFA Mission Statement

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

...by building a strong scientific and social case for their protection and management

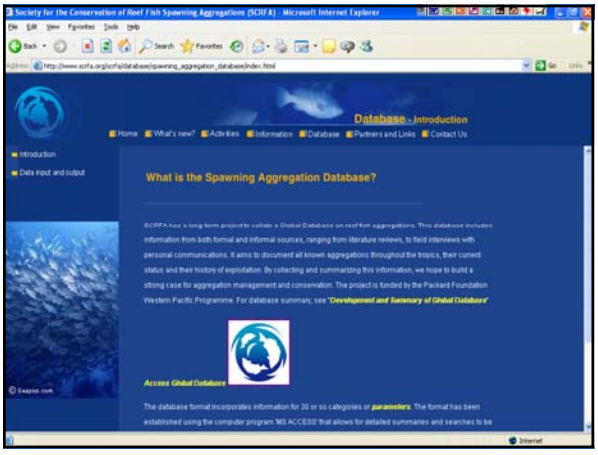
Information sources on spawning aggregations: interviews, field surveys, anecdotal information, un/published literature, etc...

Aggregation research

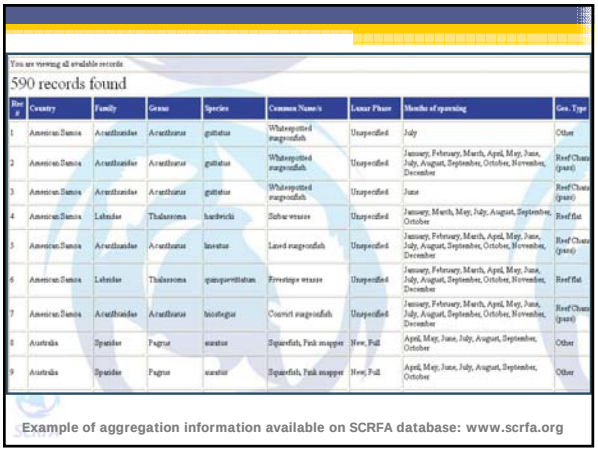
e.g., fish can be tracked to and from aggregation sites using coded or acoustic tags, and surveyed in aggregations using underwater visual census techniques. We can thereby learn how far they move and if they return to the same sites, year after year, and such information can help in management planning.

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

Locations of known aggregation sites globally (in red)



Example of aggregation information available on SCRFA database: www.scrfa.org



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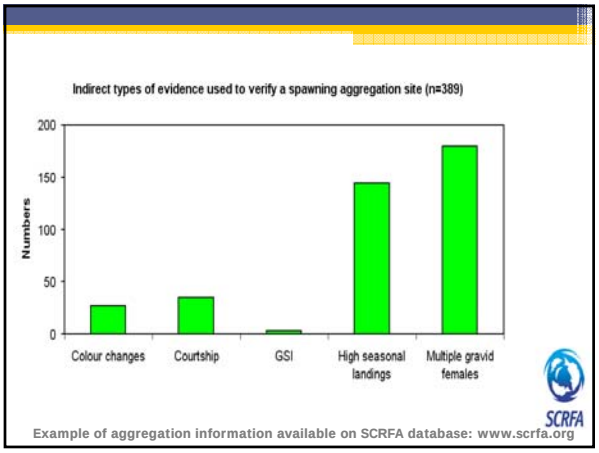

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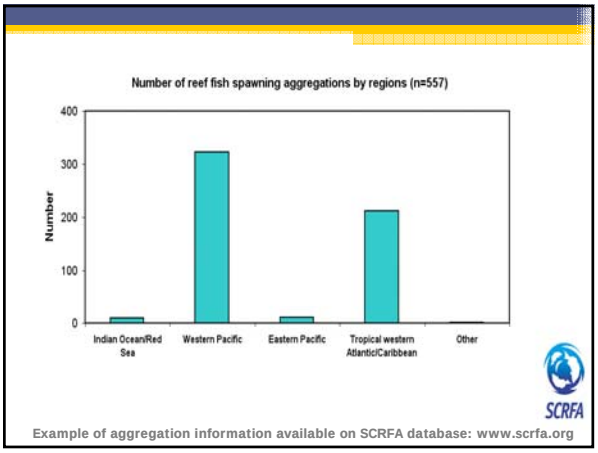

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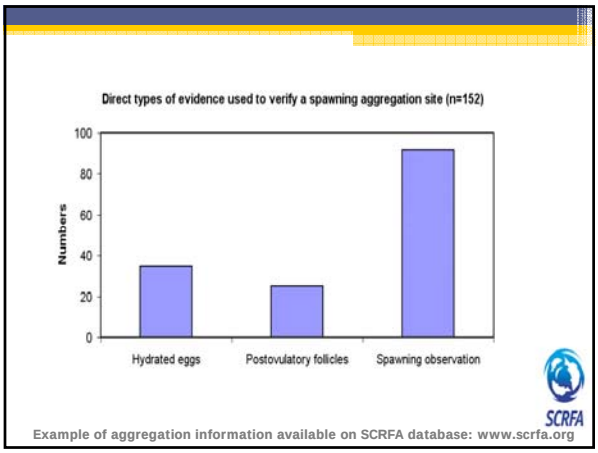

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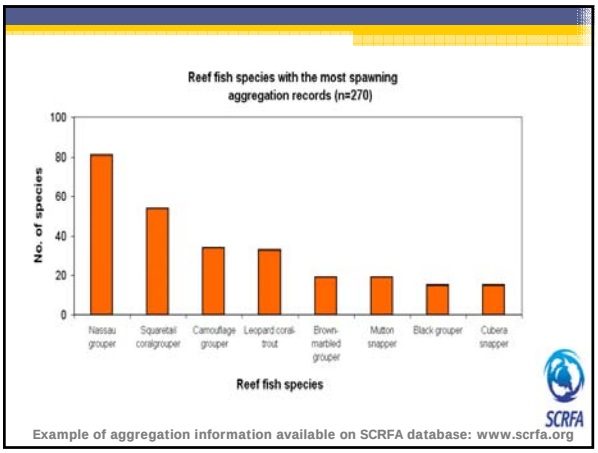

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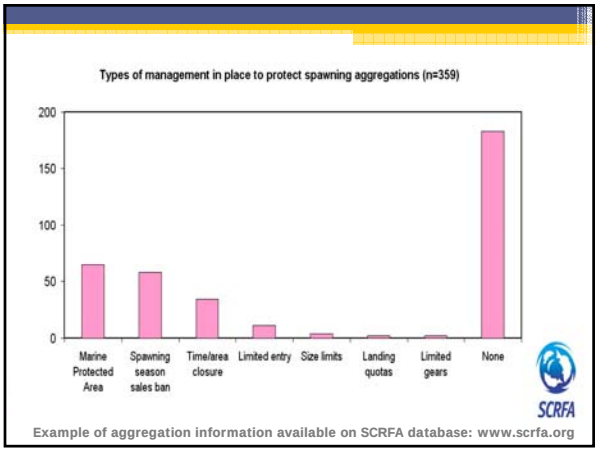

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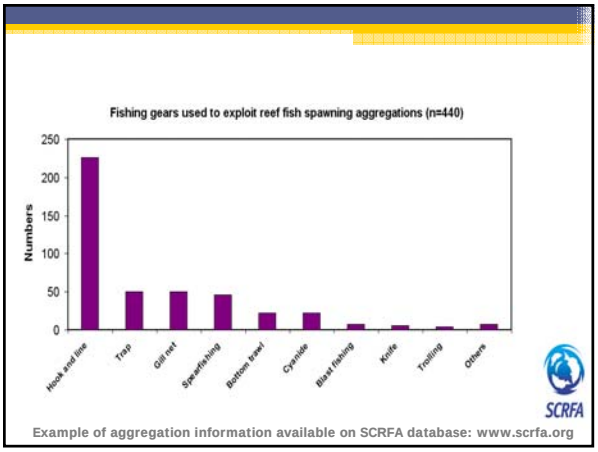

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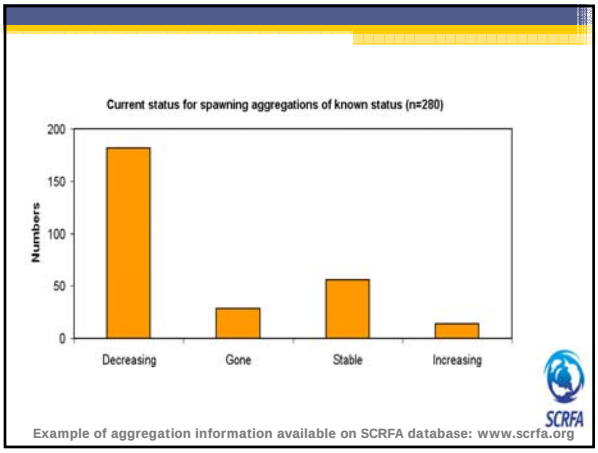

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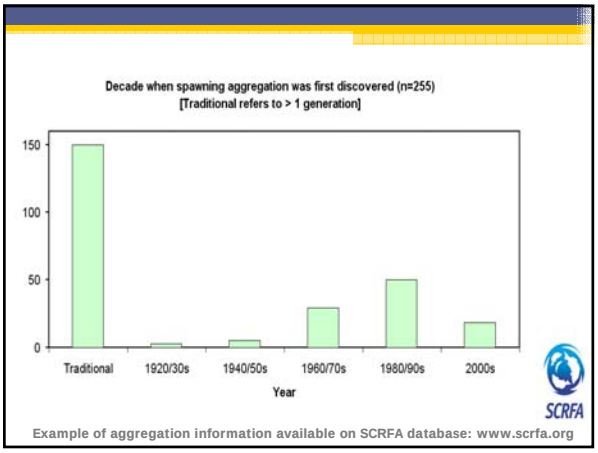

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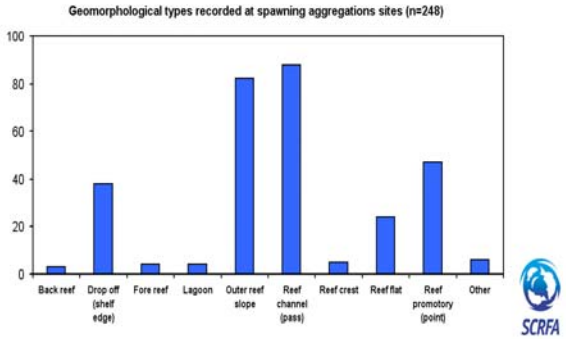

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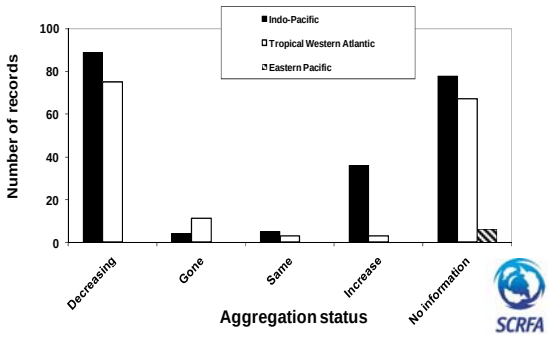

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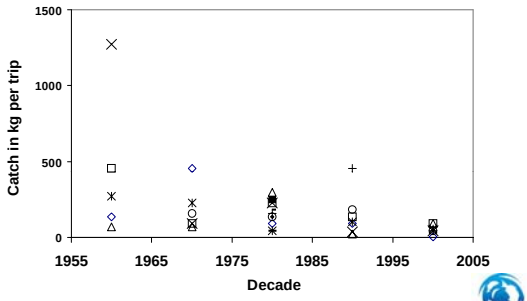


Groupers, Palau – aggregation catches from interview data showing marked declines since the 1950s

(Palau Conservation Society/SCRFA)
(Sadovy 2007; Sadovy et al., 2008)

Management options for aggregating species

1. Inclusion of spawning site in a marine protected area
2. Temporary closure of spawning site during spawning season
3. Seasonal ban on fishing during spawning season
4. Sales ban during spawning season
5. Conventional management (quota, size limits, etc.) throughout the year

When it may be best to protect aggregating species during the spawning season (rather than outside of the season)

1. When the price per fish is too cheap
2. When enforcement is easier
3. If the species changes sex; aggregations may be important for communicating information on sex ratios and sex change
4. If there is high wastage due to predation when hooked, or to mortalities in egg-bound fish when needed for the live fish trade
5. If fishing severely disrupts spawning activity
6. If most annual catch is during the spawning season and the species is over-fished

Specific concerns

- Illegal fishing (unpermitted and dynamite)
- Night diving with spear
- Compressor diving with spear
- Aggregation fishing
- Live reef food fish trade

H1 Why?

HKU, 27/10/2009

Possible actions identified

- Education and outreach
- Livelihood alternatives
- Government support for community management initiatives **(e.g. to reduce poaching)**
- Reduction of fishing effort
  (MPAs alone will not do this)
- Seasonal or area protection of aggregation sites
- Identify and protect threatened species
  (Napoleon fish is now on CITES Appendix II; species is protected in Palau and Fiji)

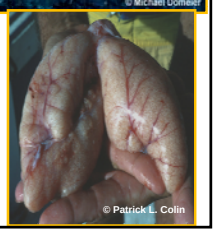
Changing perspectives on fish spawning aggregations

Protecting the next generation…

We do it for lobsters, seabirds and turtles… Why not for fish?

Many regulations protect berried (with eggs) lobsters

So why no similar protection for vulnerable fish?

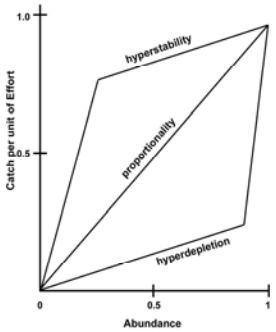


Hyperstability

A problem with detecting declines in aggregating species, if only the aggregations are monitored or targeted, is known as ‘Hyperstability’…

…declining fish numbers overall, are masked by the aggregating habit, resulting in continuing high catches of aggregating fish even as true abundance declines. This is called HYPERSTABILITY.

Therefore also need to monitor fish during non-aggregation periods.



Sadovy and Domeier, 2005

Changing perspectives on fish spawning aggregations

The large numbers of fish taken at some spawning aggregations give the impression that the species is abundant. This can hide the less obvious possibility that, for some species, one or a few large aggregations may represent all the adults in a population.

If those aggregations are lost, the FISH population, and hence the fishery may not persist.

Challenges of management: "Illusions of Plenty"

Bank
(ecotourism, capital in the bank; non-extractive benefit = eggs)

Bounty
(fish for now; the future looks after itself; does not matter if the aggregation and fishery disappear in the future)

YOUR CHOICE

© Seapics © Seapics

Why manage spawning aggregations?

Ripe adults are the capital and spawning aggregations produce interest (eggs)

(They are the source of fish for the future)

Spawning aggregations generate food and livelihoods during non-aggregation periods; if the spawning adults are not removed, the eggs they produce will sustain the fishery

Aggregations are often predictable in space- depending on the species and region, they regularly occur (clockwise) in reef channels, at promontories, or at specific outer reef areas close to deeper water

Such Areas Can Be Protected!

Fish	Area 1	Area 2	Area 3	Area 4
Grouper 1	Sep- Oct	-	Jul-Oct	Jun-Jul
Grouper 2	Sep-Nov	Variable	Jul-Oct	Jun-Jul
Surgeonfish	Sep-Nov	Sep-Nov	Aug-Nov	Jul-Oct
Snapper	Oct-Dec	-	Sep-Dec	Mar
Rabbitfish	Sep-Dec	-	Oct-Dec	Oct-Nov

Predictable spawning seasons by area and species within a country provide excellent opportunity for seasonal management, but might vary in different areas within the country

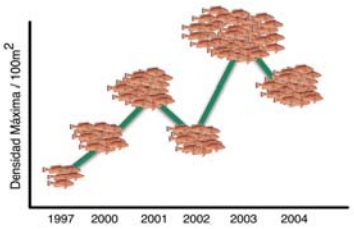
Management works!!

- **Contributed 70-90 % of finfish catch in U.S. Virgin Islands in the 1980's**
- **Dramatic declines in catch rates, sizes of landed fish**
- **Closures at spawning sites in the 1990s.....**

Red Hind
Epinephelus guttatus

Nemeth 2005

Density/100 sq.m.



... led to positive changes in the fishery

- **Spawning biomass increased by 60 %**
- **Spawning fish increased by 400 %**
- **Increase in commercial fishing landings**
- **Increase in average size of landed fish**

Statement of Concern adopted by the second Inter-Tropical Marine Ecosystem Management Symposium in March 2003 on aggregations

- **Spawning aggregations should be conserved, through judicious management or complete protection, to ensure persistence of the fish populations and species that form them, the integrity of reef ecosystems and the livelihoods and food supply of communities that depend on aggregating species**

IUCN Recommendation on aggregations

- **In November, 2004, a Recommendation to better protect and manage reef fish spawning aggregations was adopted by the 4th IUCN World Fisheries Congress. See Recommendation 3.100, on p. 127 of the Resolutions and Recommendations on Reef-Fish Spawning Aggregations**

FAO-WECAFC Recommendations
Cartagena, Oct. 2008

- Nassau grouper management is more effective at the national level when harmonized at the regional level
- Closed spawning seasons is one of the most effective ways of protecting spawning aggregations that are exploited