Longevity overfishing

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- Theory of fishing is that all populations produce a surplus that is available for harvest.
- Fisheries science attempts to determine the surplus and maintain stable commercial fisheries.

Two considerations in managing fisheries are

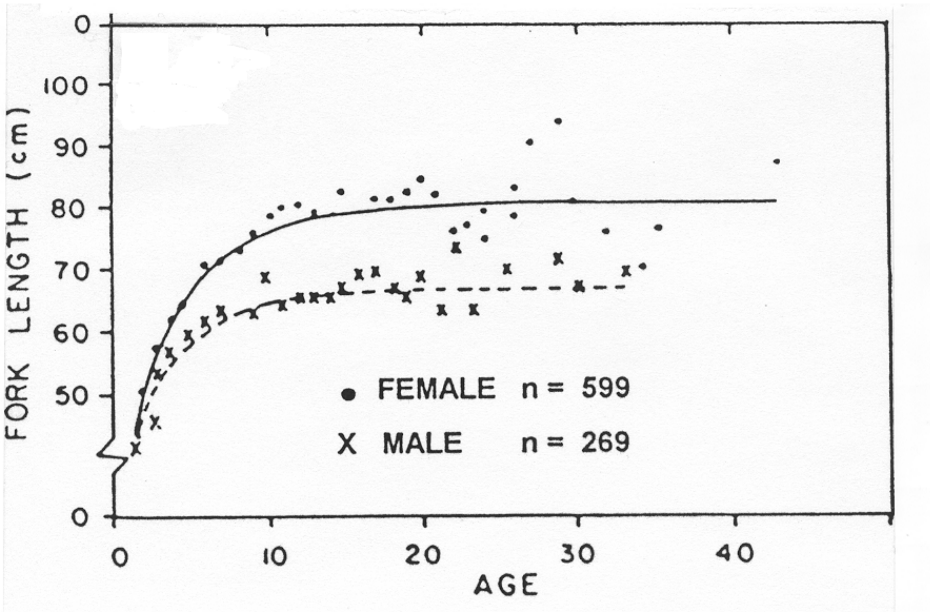
1. **Avoid growth overfishing**
   - Growth overfishing: fish are caught so young that they are not being given a chance to grow to a decent size. Though increased fishing will increase “number” of fish caught, their average weight will steadily decrease and, so, ultimately, will the total weight.
2. **Avoid recruitment overfishing**
   - Recruitment overfishing: the spawning stock is reduced to too low a level to ensure adequate production of young fish………the recruits to the fishing.

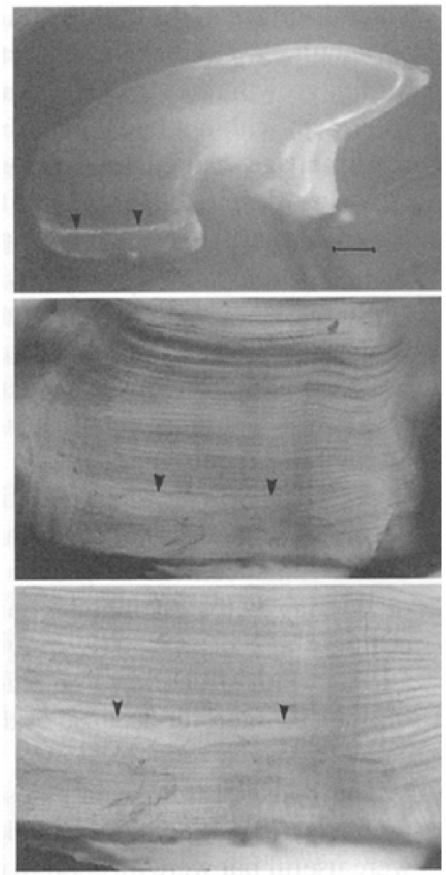
Gulland, J.A. 1983. Fish Stock Assessment. John Wiley and sons, Toronto, New York. 223 pg.

We propose that there is a third major consideration that we call “Longevity overfishing”.

- Longevity overfishing is the virtual elimination of a large number of older age classes from a population impairing the species and population from adapting to long periods of ocean conditions that are unsuitable for reproduction.

Longevity overfishing was not considered important in the past primarily because most species of fish were not recognized to be very old until the mid-1980s.





- A species is considered to be longlived when its maximum age exceeds three standard regimes (ie $\geq$ 30 years).

- Fish 11 to 29 years can also be considered to be old, relative to the maximum ages of commercially caught species in some areas such as off the Pacific coast of Asia.

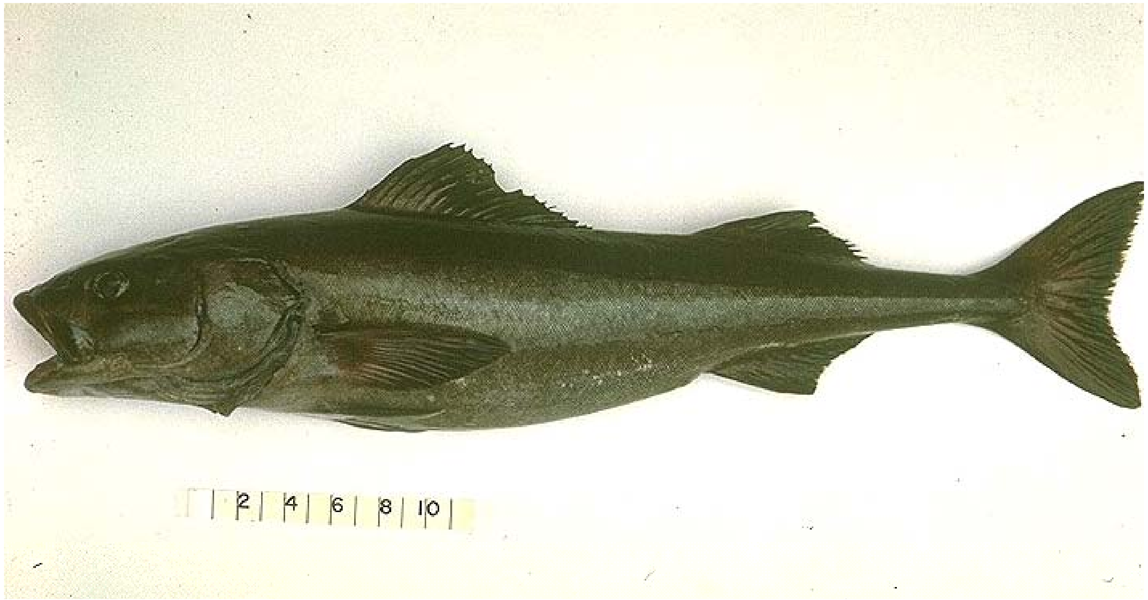
Maximum ages of all fish caught off the Pacific coast of Canada (more than 1(t) landed and sold in 2000)

Species	Maximum age	Total weight (t)
Rougheye rockfish	205	848
Shortraker rockfish	120	234
Yelloweye rockfish	118	292
Sablefish	113	3947
Pacific ocean perch	100	6179
Yellowmouth rockfish	100	2050
Shortspine thornyhead	100	732
Spiny dogfish	100	244
Redbanded rockfish	93	556
Quillback rockfish	90	197
Rosethorn rockfish	87	17
Splitnose rockfish	86	92
Canary rockfish	84	662
Silvergray rockfish	81	1579
China rockfish	79	30
Tiger rockfish	69	7
Yellowtail rockfish	64	4124
Widow rockfish	60	1971
Vermilion rockfish	60	7
Sharpchin rockfish	58	401
Dover sole	57	3040
Redstripe rockfish	55	1193
Pacific halibut	55	6096
Greenstriped rockfish	54	35
Bocaccio	52	282
Longspine thornyhead	50	723
Copper rockfish	50	48
Black rockfish	50	25
Darkblotched rockfish	48	56
Harlequin rockfish	47	9
Petrale sole	35	405
Walleye pollock	33	1044

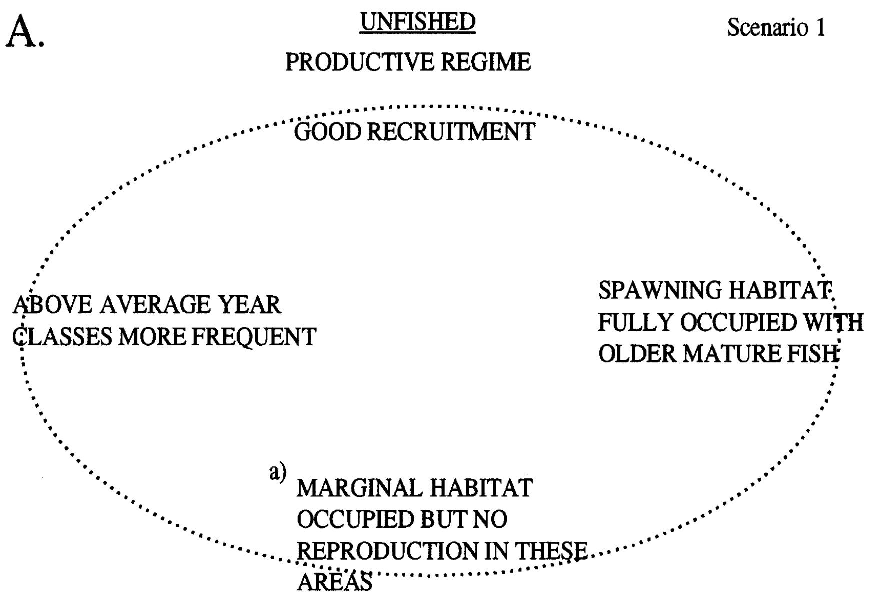
Maximum ages of all fish caught off the Pacific coast of Canada (more than 1(t) landed and sold in 2000)

Species	Maximum age	Total weight (t)
Big skate	30	1152
Longnose skate	30	208
Rex sole	27	393
Flathead sole	27	40
Arrowtooth flounder	25	4285
Rock sole	25	1229
Lingcod	25	1984
Pacific cod	25	708
Starry flounder	24	38
English sole	23	710
Pacific hake	23	22347
Slender sole	20	2
Wolf eel	~20	2
Kelp greenling	18	18
Pacific herring	15	27725
Sandpaper skate	~15	4.2
Spotted ratfish	~15	13
Sardine	13	800
Butter sole	11	19
Tuna Albacore	10	233
Sand sole	10	19
Curlfin sole	~10	18
Chinook	8	510
Sockeye	7	8670
Chum	7	2780
Coho	4	30
Pink	3	7160

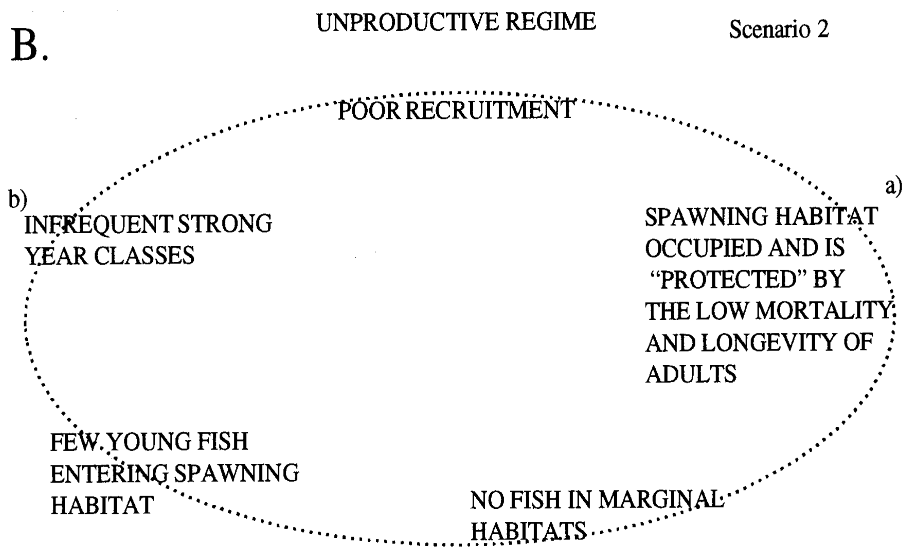
- Long-lived species have evolved a natural life history strategy where fish occupy specific habitats and essentially wait for good ocean conditions to arrive.
- Basic fishing theory needs to be re-thought for long-lived species. Sablefish is an example.



Sablefish



a) -MARGINAL HABITAT OCCUPIED WITH JUVENILES AND YOUNG ADULTS



a) -SELECTION FOR LONG LIVED FISH THAT PROTECT THE NICHE.

b) -EVEN IN UNPRODUCTIVE REGIME - NATURAL VARIABILITY CAN PRODUCE STRONG YEAR CLASSES - BUT THESE YEAR CLASSES ARE RARE.

Sablefish

C.

FISHED

PRODUCTIVE REGIME

Scenario 3

GOOD RECRUITMENT
OF YOUNG ADULTS

ABOVE AVERAGE
YEAR CLASSES
MORE FREQUENT

SPAWNING HABITAT
FULLY OCCUPIED

MAY BE LESS
USE OF MARGINAL
HABITATS

LARGE STANDING
BIOMASS

YOUNG ADULTS FILL UP THE
SPACES LEFT BY REMOVALS
FROM FISHING IN PREFERRED
HABITAT

- FISHING REMOVES VIRTUALLY ALL THE OLDER FISH
- EASIER TO MANAGE BECAUSE SPAWNING HABITAT IS NOT UNDERUTILIZED AND RECRUITMENT IS GOOD.

D.

UNPRODUCTIVE REGIME

Scenario 4

POOR RECRUITMENT

FISHING MAY SELECT FISH THAT
GROW FASTER, MATURE EARLIER

FISHING REMOVES VIRTUALLY
ALL THE OLDER FISH

EXPLOITABLE BIOMASS
DECLINING NATURALLY
AND THROUGH FISHING

NO FISH IN MARGINAL
HABITAT

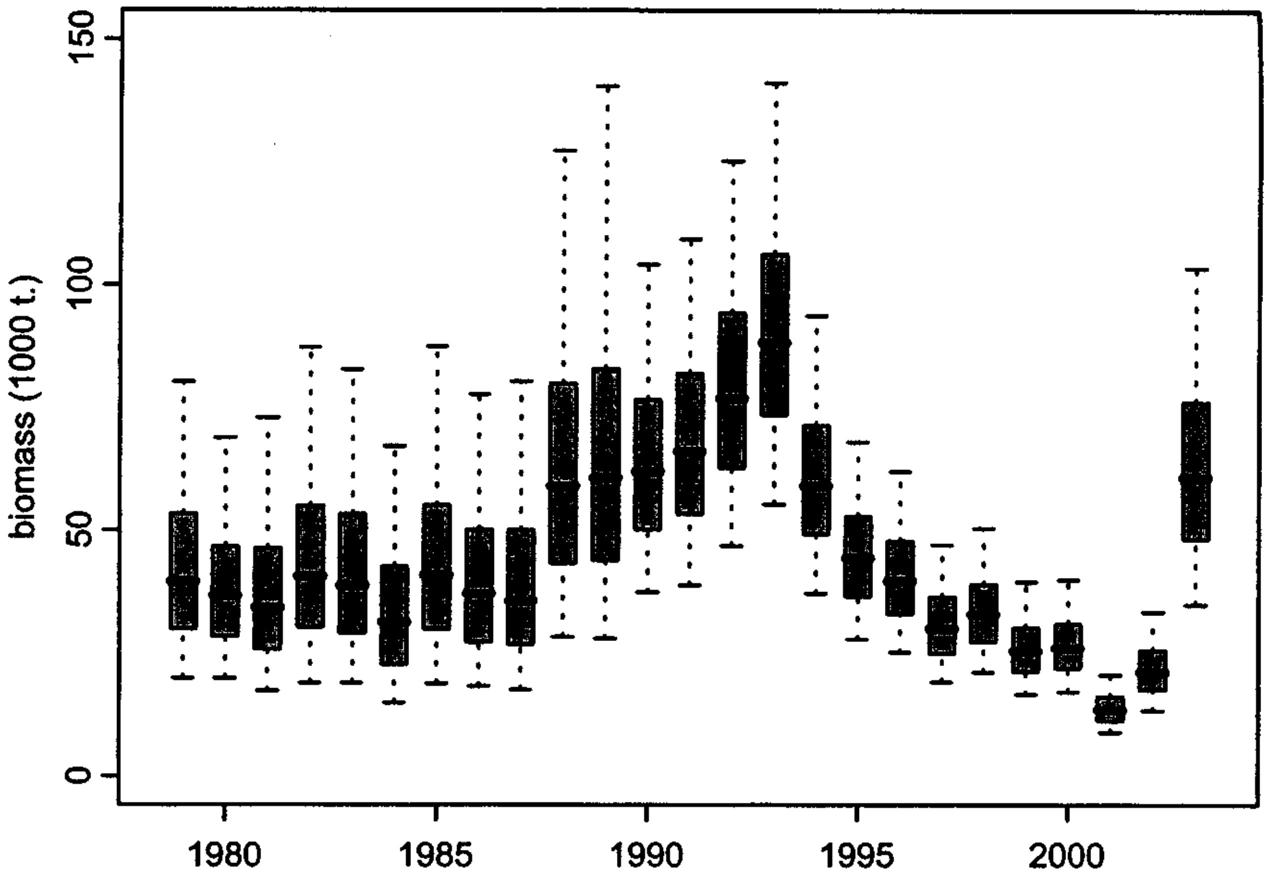
SPAWNING HABITAT IS NOT PROTECTED
AND FEWER EGGS ARE PRODUCED.

FEWER FISH IN SPAWNING
HABITAT

- EXPLOITABLE BIOMASS IN SPAWNING HABITAT IS DECREASING
- MANAGEMENT DOES NOT KNOW THE LENGTH OF UNPRODUCTIVE PERIOD IN ADVANCE
- MANAGEMENT DETERMINES MINIMUM CRITICAL SPAWNING BIOMASS (AT WHICH FISHERY SHUTS DOWN)
- DOUBLE MATCH-MISMATCH MANAGEMENT

Fishing is a top down impact that we suggest can profoundly affect long-lived species if the number of age classes are greatly reduced and the ocean habitat becomes unfavourable for reproduction for long periods.

Biomass



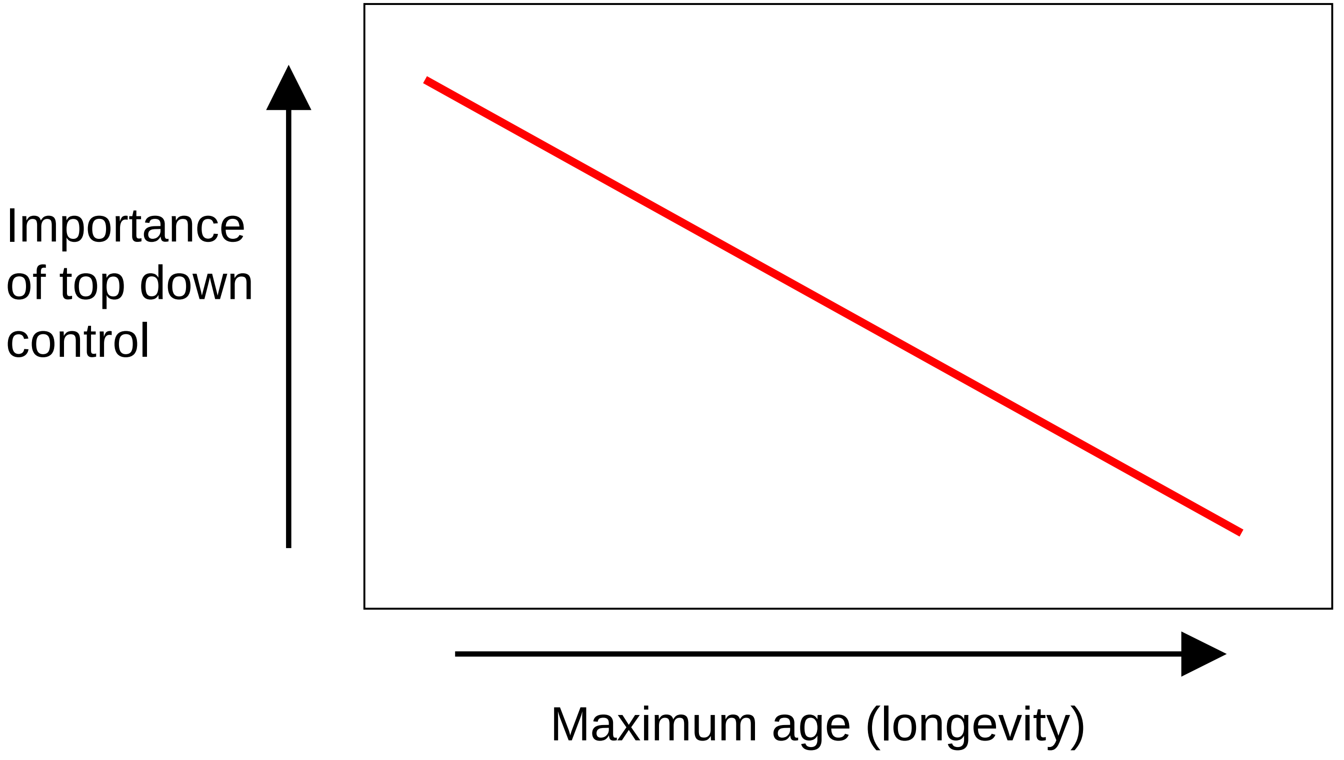
Considerations

- There are age related differences in time, and location of spawning.
- Older fish produce larger larvae which are important in poor ocean conditions.
- In truncated age distributions, the younger fish are smaller as well as younger and in poor ocean conditions their growth rate is reduced with the result is increased natural mortality especially in the winter.

Longevity management

1. Accept that there is no S/R relationship.
2. Accept that young and old fish in a population may not be equal.
3. Accept that the consequences of error are not easily detected in the time frame of the career of a biologist – may be 50-100 or 200 years to realize impact.
4. Ability to survive starvation is the key to marine survival and natural mortality can be physiologically based.
5. Preserve longevity by permanently closing areas as these old fish rarely move.

The relevance to this symposium is that we are also proposing that longevity is inversely related to the importance of bottom up control.



Management strategy

"Fishery objectives, in the sense of the specific elements of the management system that allow the goals to be achieved, are not defined for sablefish".

(A goal is "To ensure conservation and protection of sablefish stocks through the application of scientific management principles applied in a risk adverse and precautionary manner based on the best scientific advice available".)