Fish Population indicators – an example of sprat from Bulgarian marine area

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Which key-stock indicators are of primary importance?

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- **1 .What is "Indicator"?** - Measurable criteria that are easy to operate with and to compare between different time periods and/or between different areas,.
- Indices frame the biological limits of the stocks that are accepted as safe.
- Fishing dynamics has been influenced by two main factors: fish stock and fishing quota.
- Indicators are to be related to the reference levels - target reference points (TRP) and limit reference points (LRP).
- LRP should never be reached, and if they were to be reached severe and corrective management actions should be implemented.

- Fish stock indicators have to be the policy/science interface, in other words the 'bridge' between scientists and policy-decision-makers.

- Ranking among indicators should be based on the rule that the most appropriate indicators shall describe the given attribute best while requiring the least elaborate data.

Elaborated indicators system in the frame of AG FOMLR, Black Sea Commission could serve as a starting point for region/s indicator system elaboration. GFCM Task force 1

I. Biological and technical indicators:

1.Catches
2. Effort
3. CPUE
4. Stock biomass
5. Population parameters
6. Changing of fish behaviour – migration routes
7. Other exotic fish species recorded and which of them became resource
8. List of species under extinction and recovering
9. Gears: mesh size and minimal admissible length of fish
10. By catch of fish and mammals, strandings
11. Aquaculture development - production, number of farms. Restocking activities
12. Illegal fishery - IUU fishing, number of penalties

II. Economic indicators: fuel consumption, average age of the fleet, seafood consumption, employment, subsidy programs and type.

13. Legislation, Strategies, Policies
14. Historical stocks
15. Landings
16. By-catch
17. Fishing fleet
18. Catches per month and quarter
19. Fish processing
20. Fish Ports Landing Facilities
21. Employment in Fishery
22. Fishing seasons selected
23. Fishing grounds
24. Gears reporting
25. Impact of Aquaculture
26. Environmental Norms for Aquaculture
27. Regulations

Background

- "Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock"
- Descriptor for determining Good Environmental Status (GES) under the MSFD defined as (Directive 2008/56/EC, Annex I).

In the Commission Decision 2010/477/EU three criteria including methodological standards were described for this descriptor.

Criterion 1: Level of pressure of the fishing activity

- Fishing mortality (F)
- Ratio between catch and biomass index (hereinafter‘catch/biomass ratio’)

Criterion 2: Reproductive capacity of the stock

- Spawning Stock Biomass (SSB)
- Biomass indices

Criterion 3: Population age and size distribution

- Proportion of fish, larger than the mean size of first sexual maturation
- Mean maximum length across all species found in research vessel surveys
- 95% percentile of the fish length distribution observed in research vessel surveys
- Size at first sexual maturation, which may reflect the extent of undesirable genetic effects of exploitation

Type of indicators:

- **Biological indicators:** measure the status of the stock.
- **Biological reference points (BRP)** present fishing mortality rate (F) and/or a level of stock biomass (B).
- BRPs can be targets or thresholds.
- A threshold specifies the upper limit of fishing mortality.
- Maximum Sustainable yield (MSY) presents the largest catch that can be taken from a fish stock over an indefinite period without harming it.

- **Yield and Social indicators** measure the outputs of fishery, namely the recreational and commercial landings. The most important yield indicator is the landed catch (landings) averaged over some period of time.

- **Uncertainty indicators** (**performance indicators**) measures the rate in with analysis can learn about uncertain population parameters.

Pressure, state, impact and response indicators.

- **Pressure**:

Biological disturbance: selected or non-selected extraction (by-catch), microbial pathogens, introduction of invasive species

Oil spills, industrial leakages or any other accidental pollution

Physical loss and physical damage of substratum

Climate change

Changes of hydrological regime due to human activities

Other physical disturbance (marine litter, noise)

Introduction of contaminants (non-accidental)

Nutrient and organic matter enrichment

- **Driving Forces** (‘driving force’ is a need)

FE: Agriculture,sewage systems etc

- **Impacts:**
- C1. On habitats

Spawning, nursery and feeding grounds

- C2. On species/populations

e.g. decimation of migratory predator components, changes in migratory routes

- **Responses**

A ‘response’ by society or policy makers is the result of an undesired impact and can affect any part of the chain between driving forces and impacts.

Some new indicators

- **Ratio catch/biomass**.
- **Log (abundance)**. The log-transformed population abundance is used because it is considered to provide a better signal to noise ratio.
- 5. **95% percentile of the population length distribution** - The general consensus is that the health of the stock increases as the age and size distribution consists of more, older fish.
- The indicator that probably captures this best is the 95% percentile of the population length distribution which, according to literature, provides a good summary of the size distribution of fish with an emphasis on the large fish and is expected to be sensitive to fishing and other human impacts.
- The indicator can be based on any standard survey that provides a length-frequency distribution.

The choice:

(1) Identification of the appropriate area ; (2) Match of existing spatial units to that area;
(3) Choice of data source;
(4) Choice of time period;
(5) Selection criteria.

For the overall assessment
of Descriptor 3, three approaches were considered in the case studies: (1) no aggregation across criteria; (2) application of the one-out-all-out aggregation rule or "assessment by worst case"; or (3) application of weights for the different criteria. A higher proportion of assessed stocks increases the quality of the GES assessment;
species/taxa for which no information is available decreases the quality;
length of the time-series (with/without Reference levels);

Stocks for which analytical stock assessments are conducted

F, SSB

the populations for which only information from monitoring programs is available.

Proportion of fish larger than the mean size of first sexual maturation

Mean maximum length across all species found in research vessel surveys

95% percentile of the fish length distribution observed in research vessel surveys

Size at first sexual maturation, which may reflect the extent of undesirable genetic effects of exploitation

'catch/biomass ratio';

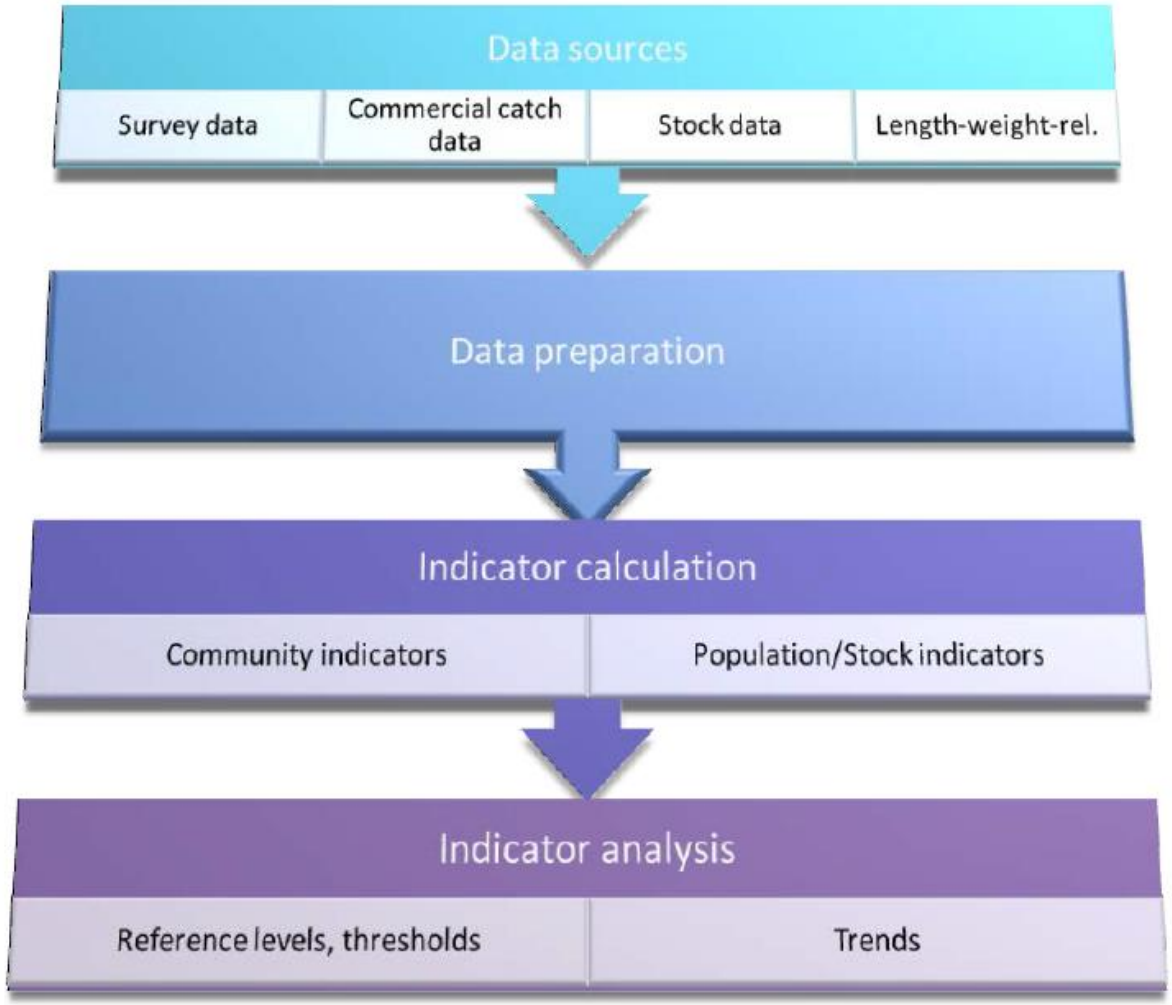
Biomass indices

Issues to be considered

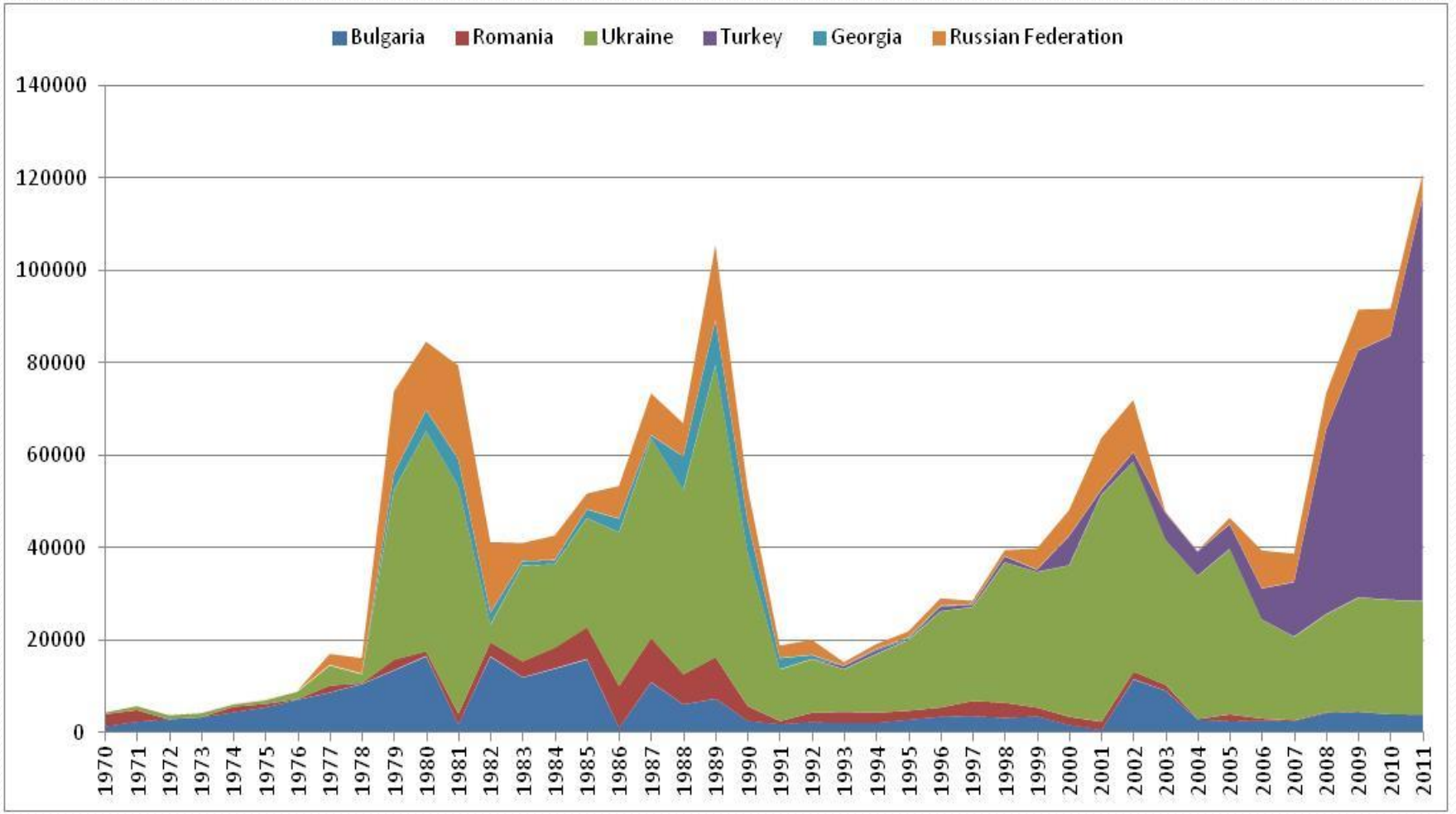
- Appropriate areas – divisions/subdivisions?
- The time period over which the landings data are considered determines the relative importance of species or species groups;

Threshold for inclusion of species – 1% but in Baltic Sea 0.5% as a threshold for salmon – important but with low catches;

Indicators calculation



LANDINGS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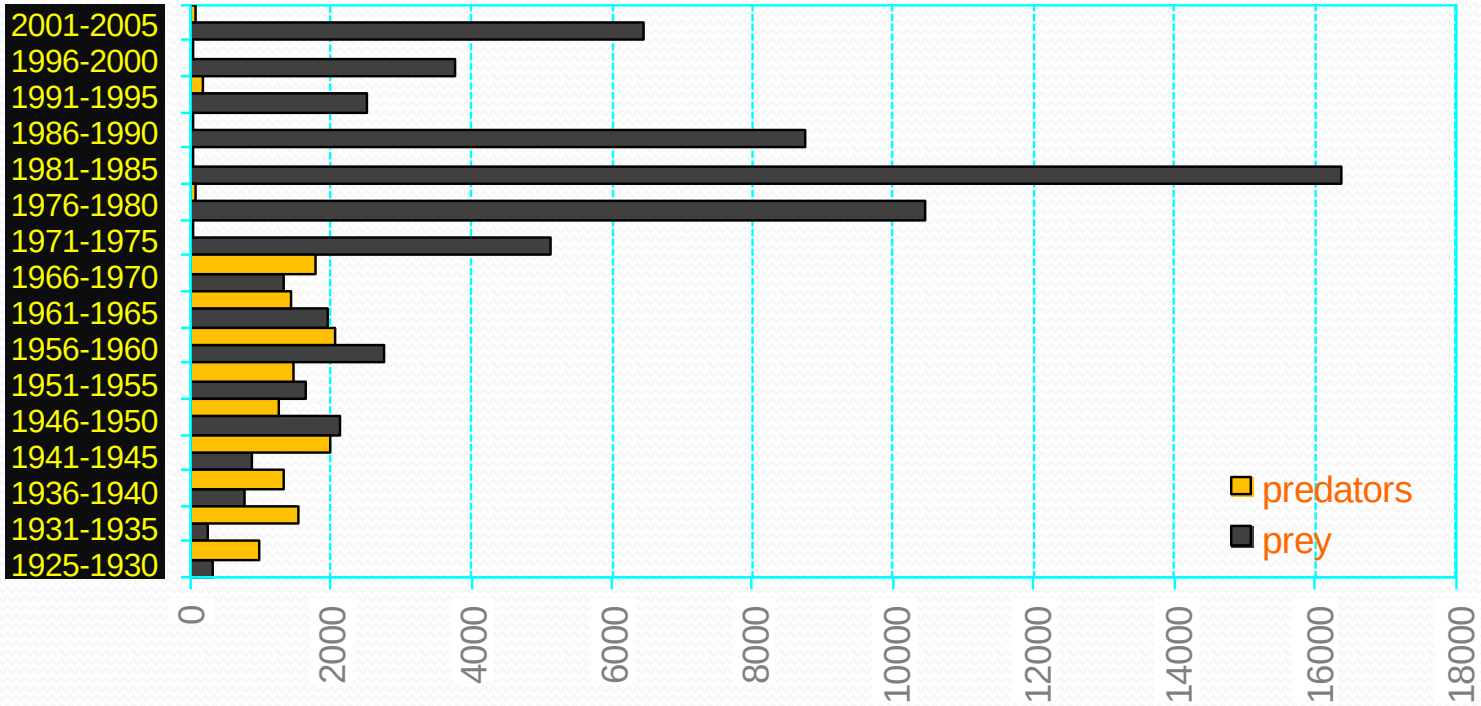
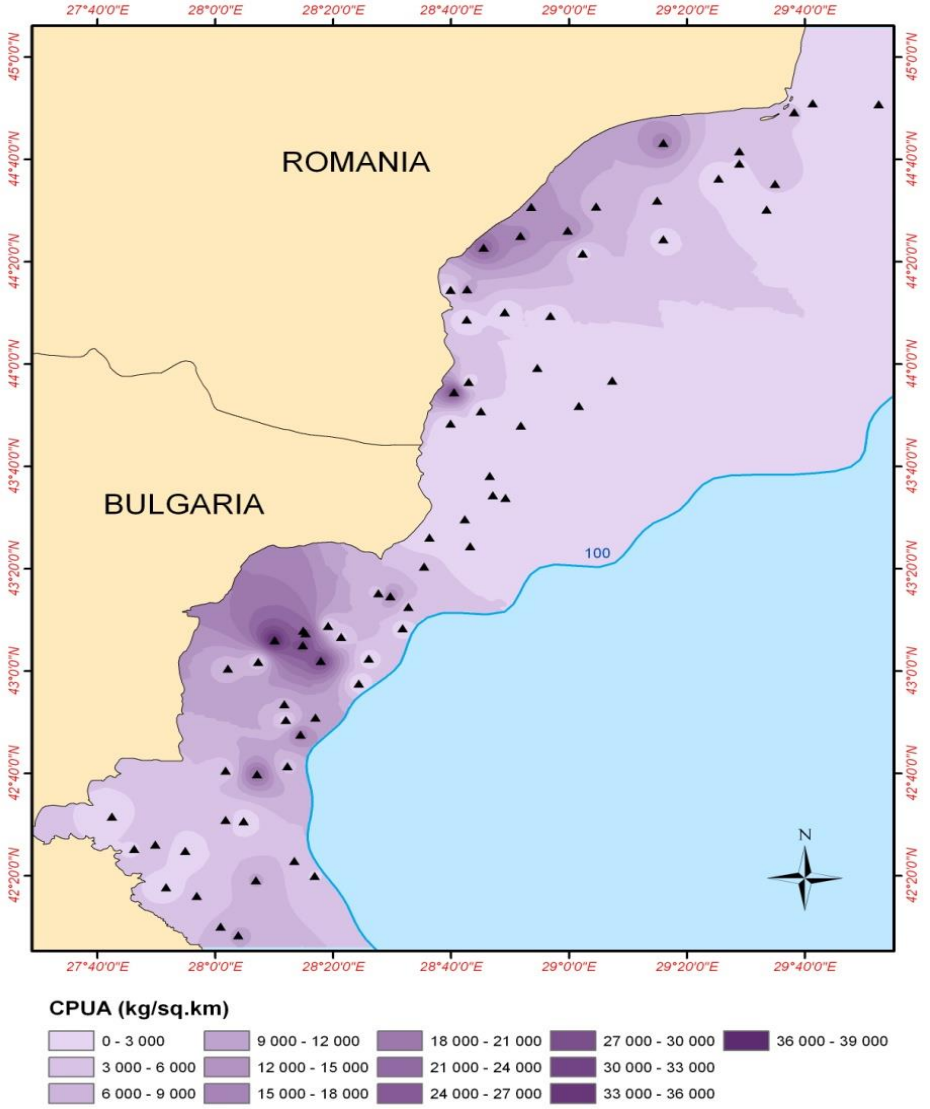
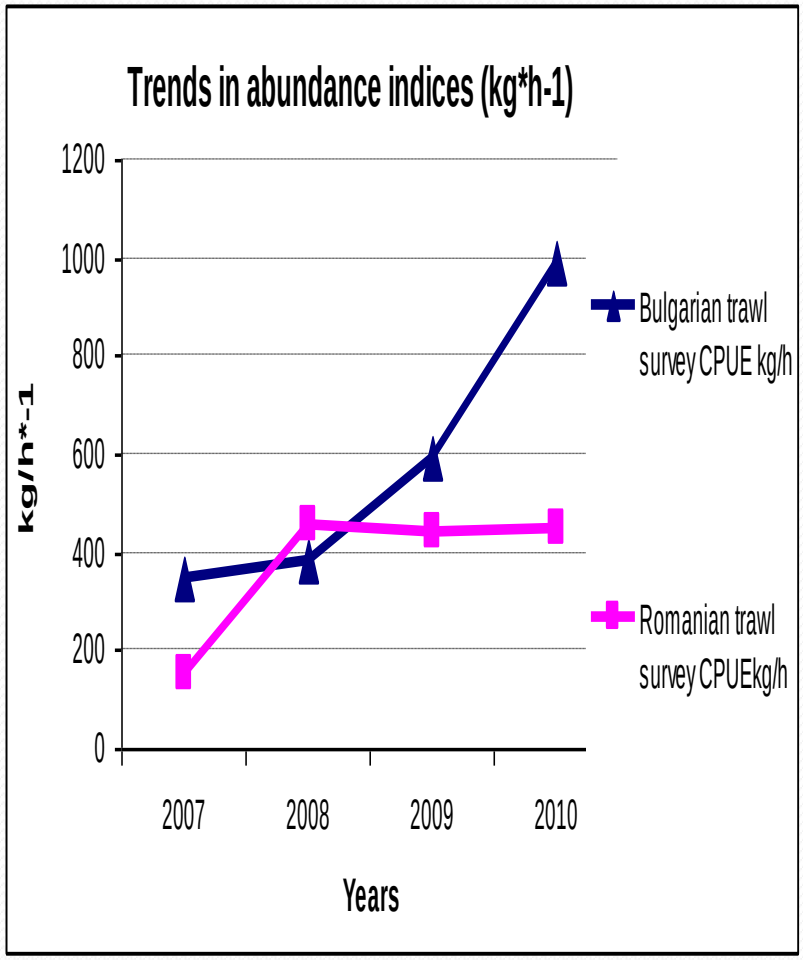
Predator-prey ratio



Trend in abundance from scientific surveys

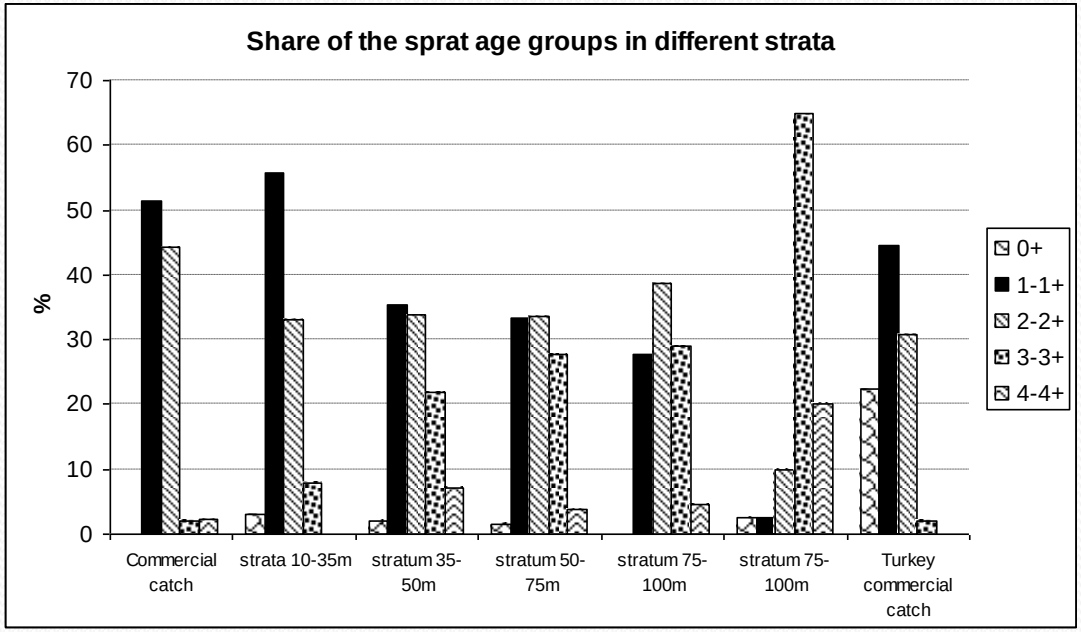
GFCM Working Group on stock assessment of pelagic fish in Med&BS, 5-9 Nov,Split

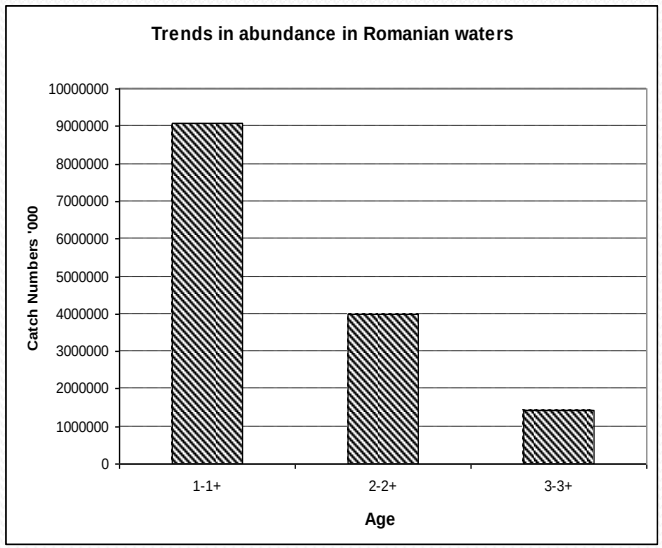


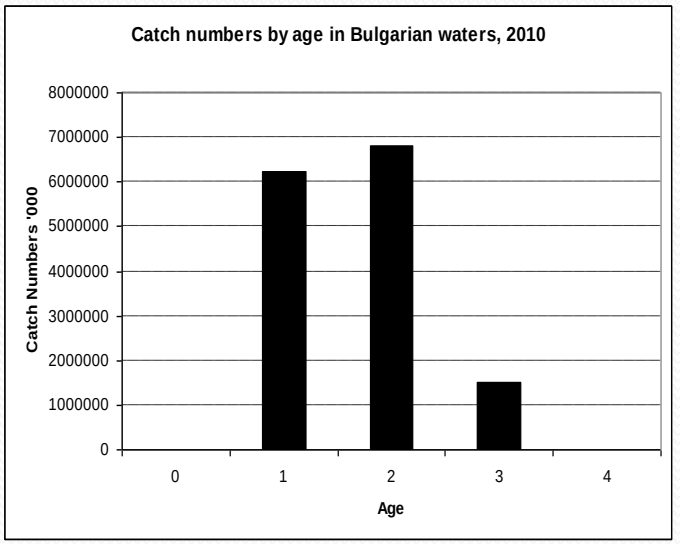


Daskalov et al., 2011

Trends in abundance at length or age

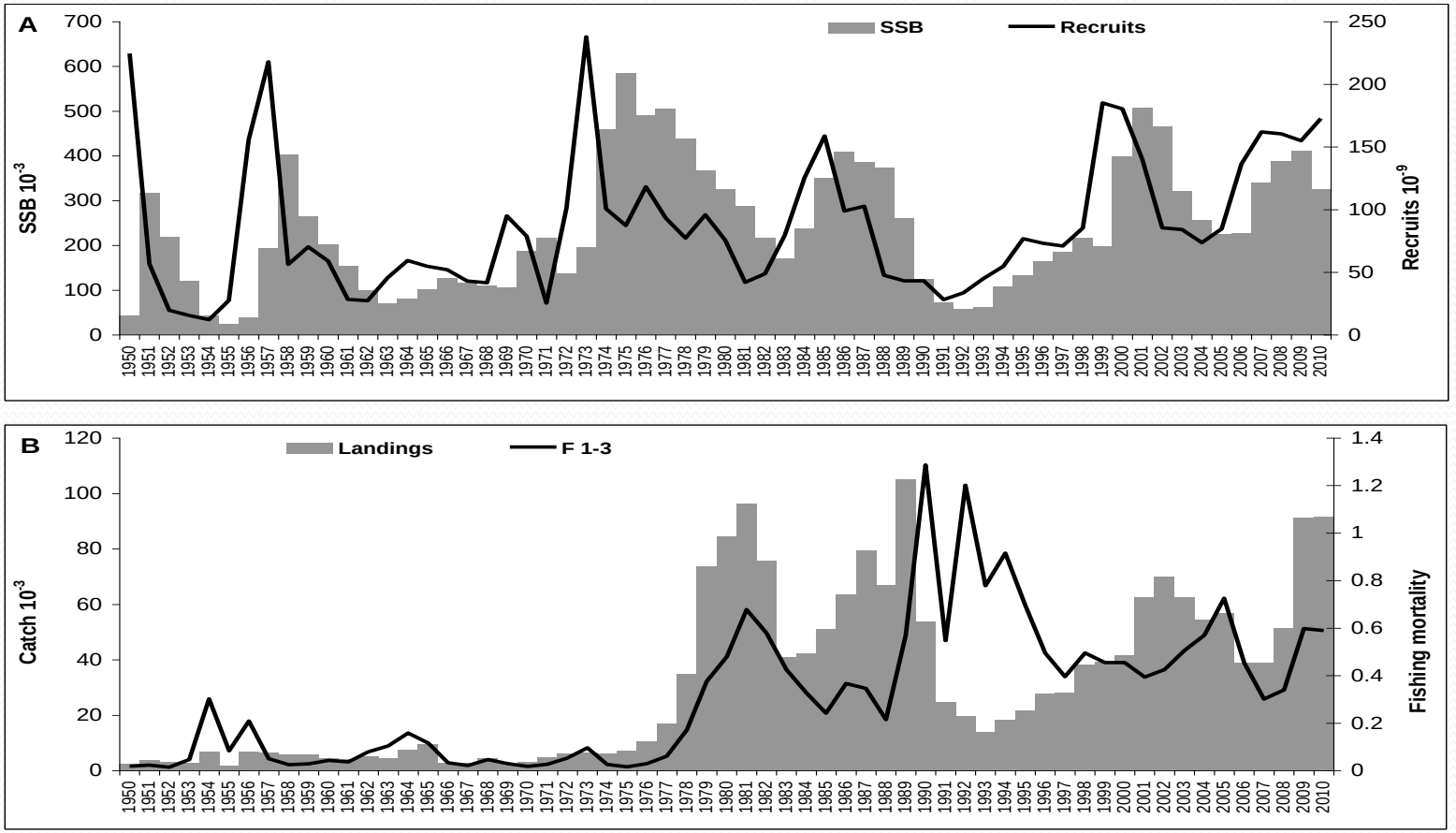






Daskalov et al., 2011

Time-series of sprat population estimates – present results combined with historical estimates from Daskalov 1998: A. recruitment (line) and SSB (grey); B. landings (grey) and average fishing mortality (ages 2–4, line).



Daskalov et al., 2011

Management regulations applicable in 2010 and 2011

~~Year~~ / *National data*	*2008*	*2009*	*2010*	*2011*
Spicies	*Sprat (SPR)*	*Sprat (SPR)*	*Sprat (SPR)*	*Sprat (SPR)*
Quota. t	15 000[2]	12 750[2]	12 750[2]	8 032.5[1] 11475[1+]
Total catch. t	4 300.0363	4541	4 039.966	3 957.895
Biomass. t	32 718.3[3]	41 761.398[3]	75 080.20[4]	48 201.70[3,4]
Recommended TAC	13747	11470	12 500[4]	-
Days at sea	2320	2598	2548	3106

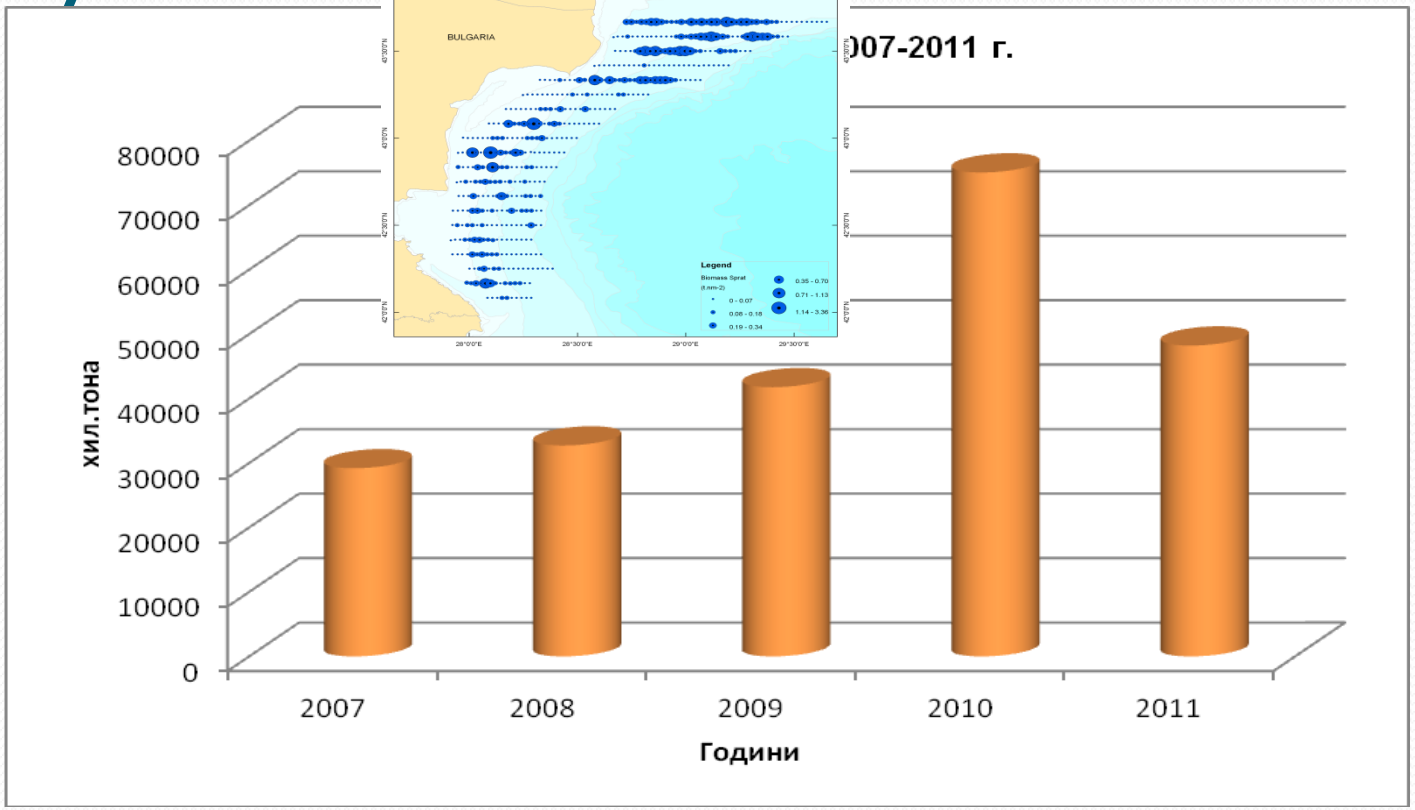
Year	Russian Federation	Ukraine
2005	42 000	60 000
2006		70 000
2007		40 000
2008	21 000	50 000
2009	21 000	50 000
2010	21 000	50 000
2011		60 000

Minimum landing size of sprat in the Black sea region

	BG	GE	RO	RU	TR	UA
Sprattus sparttus	TL=7cm	SL=6cm	TL=7cm	SL= 6cm	NO	SL=6cm

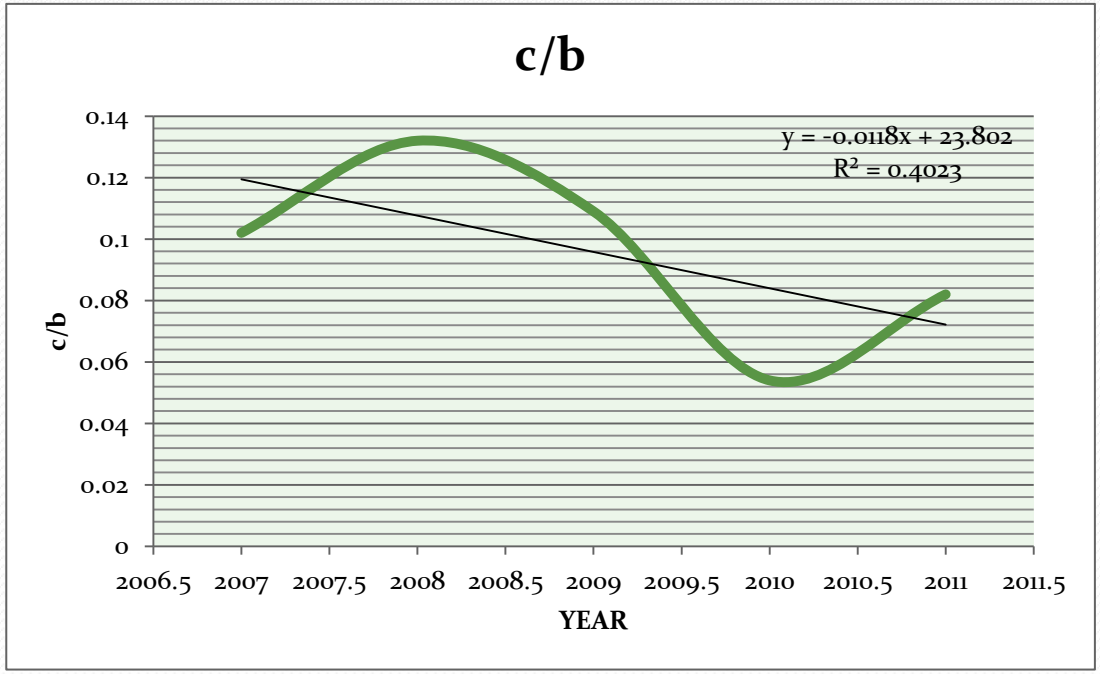
Daskalov et al., 2011

Biomass from scientific surveys



Catch/Biomass ratio

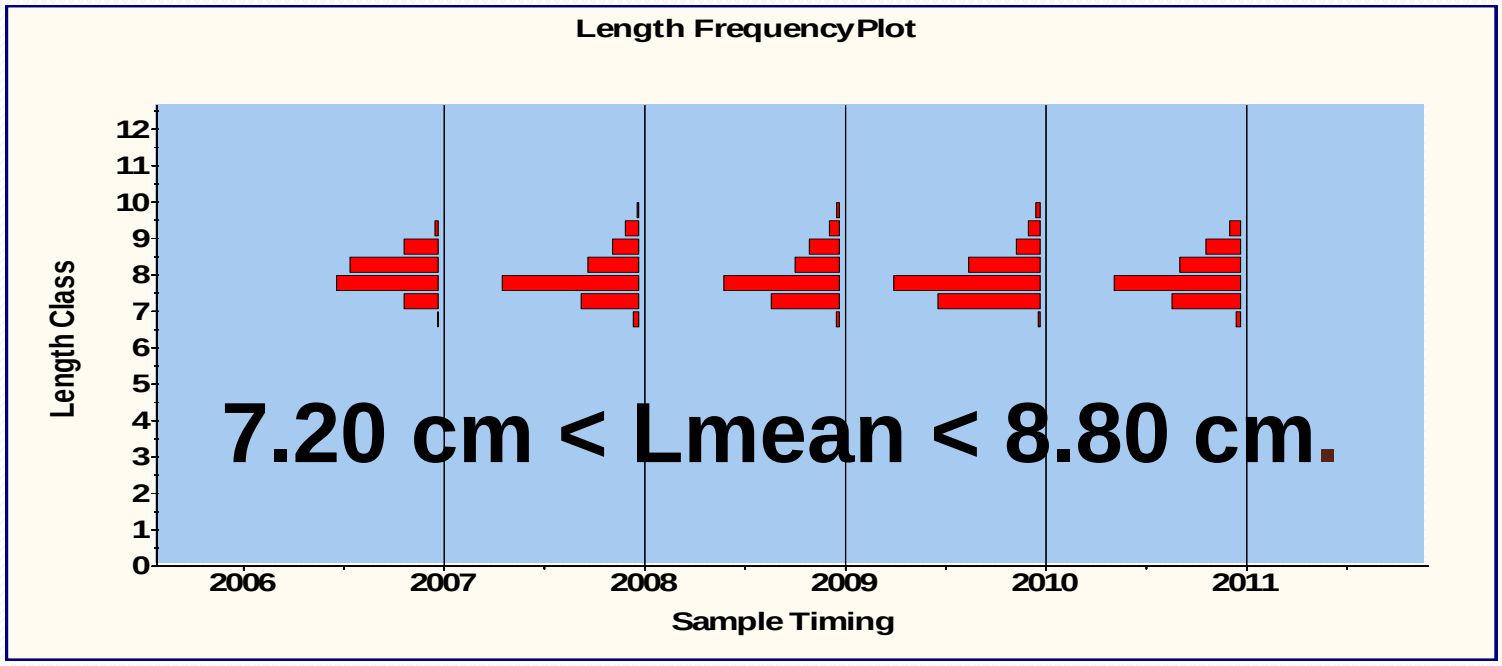
year	Index of Biomass (t)	Catch (t)	Ratio C/B
2007	29190	2984,6	0,102
2008	32718	4309,4	0,132
2009	41761	455,32	0,109
2010	75080	4041,4	0,054
2011	48202	3939	0,082



- L_{mean} Reference level for the given period of "healthy stock" condition
- Holt (1958), Lopt – which assure max Y/R if all specimen were caught at the Lopt.
- Froese et al. (2008) - Yield of the individuals reached Lopt, won't affect negatively age structure of the population;
- Froese and Sampang (2012) – the stock will have proportion of older individuals,if the mean length in the catch is within the interval : L_{opt} +/- 10%, i.e. 0.9 L_{opt} < L_{mean} < 1.1 L_{opt}.
- For L_{opt} calculation the following equations is used:
- $\log L_{opt} = 1.0421 * \log L_{\infty} - 0.2742$ (Froese and Binohlan, 2000).
- where: L_{∞} - asymtotic lenght, L_{opt} – length at max Y/R

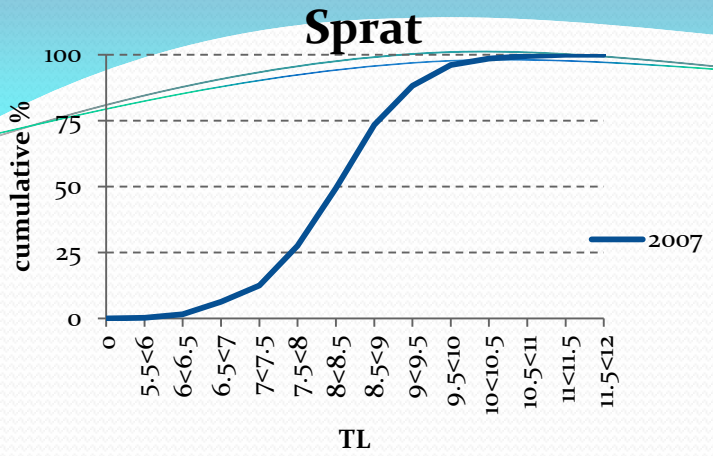
Classification of the state of Sprat population according to Lmean

State of population	S.sprattus (L_{opt}=8.0 cm)	
	good	bad
mean	8	<7.2
Border values	$7.2 \leq L_{mean} \leq 8.8$	$L_{mean} < 7.2$
EQR	0.9	



Long-term Lmean

Station	Lmean,cm	min	max	CI (95%)	Zone
2007	8,33	5,76	11,55	0,4451	
2008	8,45	5,88	11,62	0,5477	
2009	7,94	4,99	12,46	0,8122	**Shelf**
2010	7,99	4,92	11,72	0,2531	
2011	8,33	5	10,6	0,546	
Average	**8,21**				


Sprat
cumulative %
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7.5<8
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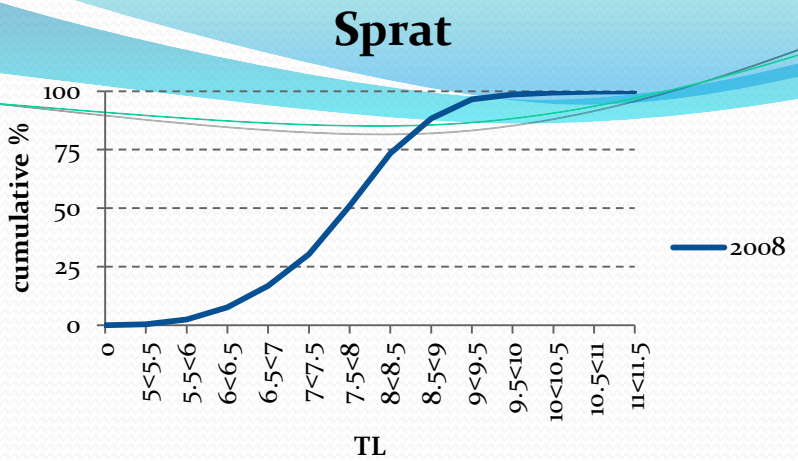
9<9.5
9.5<10
10<10.5
10.5<11
11<11.5
11.5<12
TL
2007


Sprat
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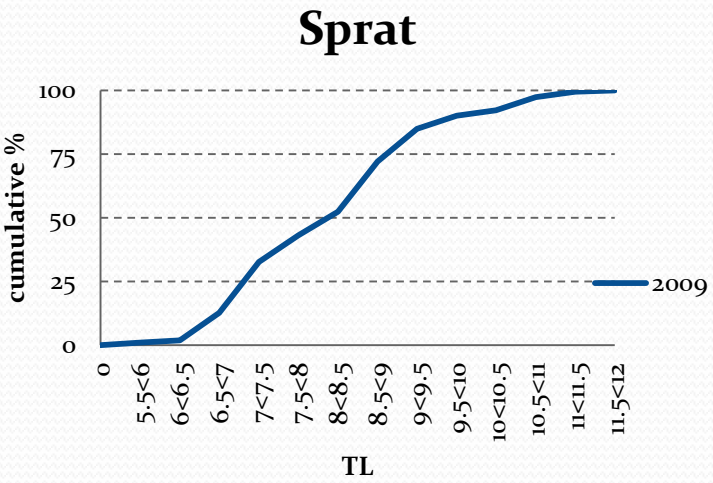
Sprat
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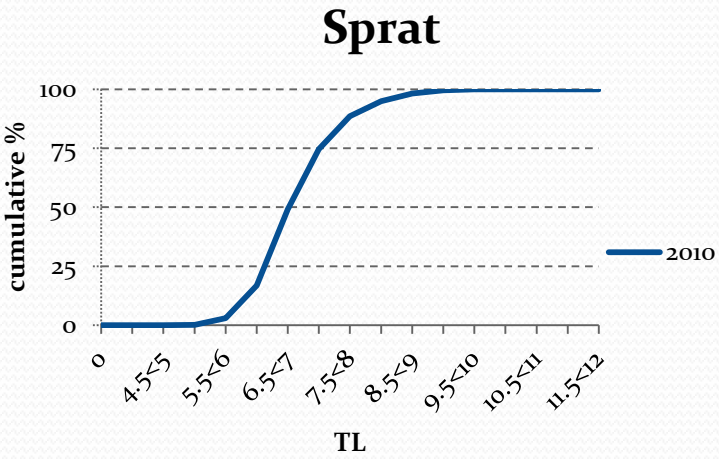
2009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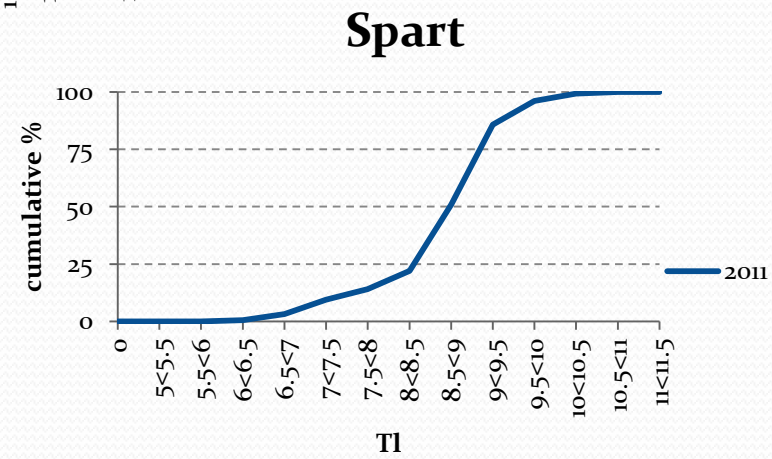
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2011

95% Percentile from L

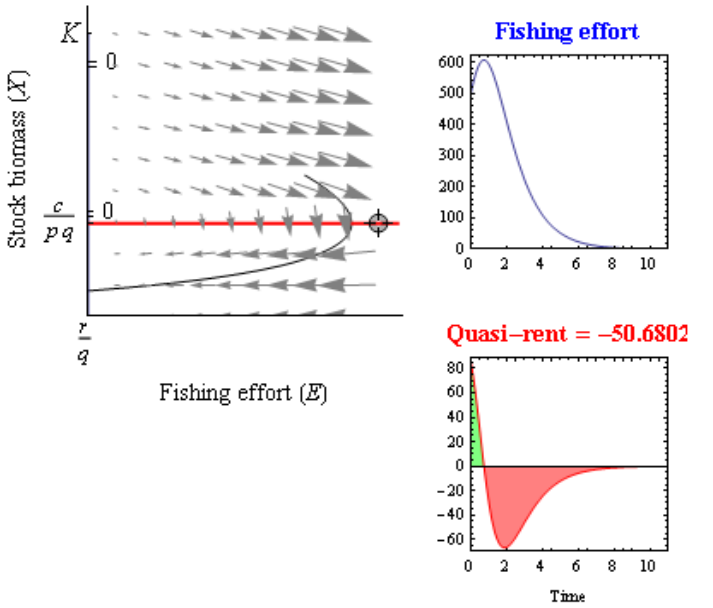
species	year	percentile 95%	Mean lenght,cm	min	max	SD	CI (95%)	zone
Whiting	2012	14.08	10.89	6.00	17.70	1.42	0.01	**Coastal**
Sprat	2012	10.23	8.38	6.80	11.20	1.09	0.01	
N.mel.	2012	14.11	11.28	6.00	17.70	1.70	0.28	
Bluefish	2012	12.91	11.49	9.00	13.50	1.12	0.01	
R.mullet	2012	12.60	9.37	5.00	14.40	1.62	0.01	
H.mackerel	2012	13.20	9.58	5.50	14.50	2.06	0.01	
Turbot	2006	62.90	44.81	26.00	76.50	9.94	1.69	**Shelf**
	2007	58.48	46.19	26.50	74.00	6.77	0.70	
	2008	57.00	46.28	15.00	71.00	9.26	0.92	
	2009	63.00	50.92	24.00	74.00	7.55	0.76	
	2010	67.25	52.44	15.00	73.00	12.18	2.11	
	2011	65.75	44.34	10.00	68.00	15.72	3.72	
Sprat	2012	10.08	8.22	6.00	11.50	1.37	0.01	
Whiting	2012	13.92	10.91	5.90	17.00	1.50	0.01	
N.melanos	2012	14.36	11.73	6.00	17.00	1.39	0.01	
R.mullet	2012	13.03	10.96	9.50	17.00	1.21	0.02	

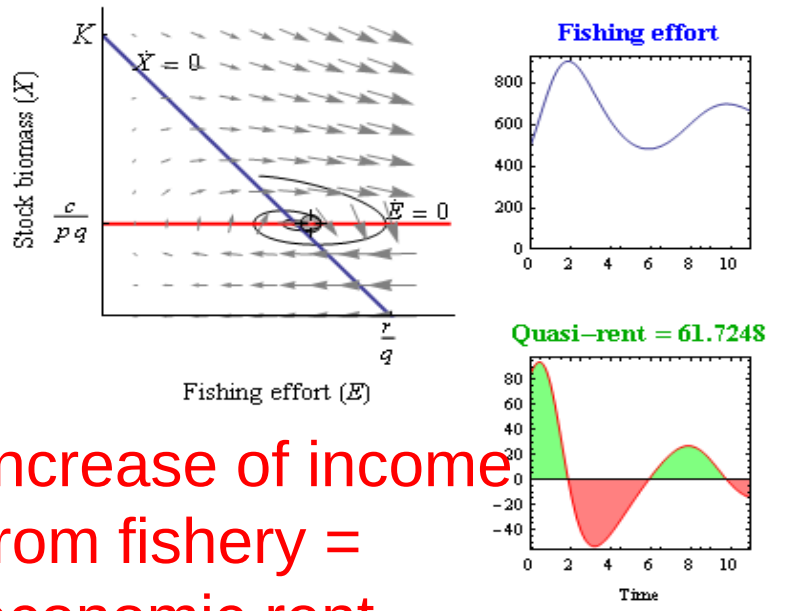
Lmax (mean values) across all species caught in surveys

year	No of species (S)	$\bar{L}_{max}$	zone
2012	8.6	21.00	coastal
2012	6.33	22.96	shelf

Age distribution

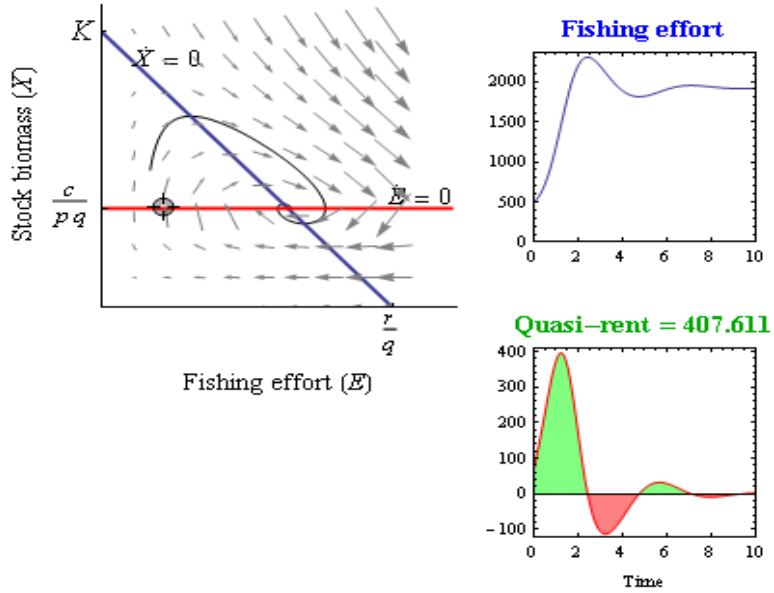
Quasi-Rent in Open Access Fisheries





Increase of income from fishery = economic rent

The concept of "economic rent" is a subset of factor markets that helps explain why some factors of production receive more income than others. Economic rent applies not just to land but to any scarce resource.



Conclusions:

Before adopting indicators from legal/policy point of view a relevant framework should be in place, taking into consideration:

- At the national and regional level - policy priorities, environmental and management targets
- Legal foundations to provide for the needed data (monitoring and information systems), including new types of data if needed to collect and for the use of indicators

PROBLEMS TO BE SOLVED

Management

- Lack of common management
- Lack of management plans

Resources

- Overexploitation and eutrophication
- Unknown state of the resources

Economy

- Lack of bio-economic analyses
- Loss of revenue
- Unsustainable development

Thank You!!!