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The intertidal benthic food web of the Jade Bay – a network approach

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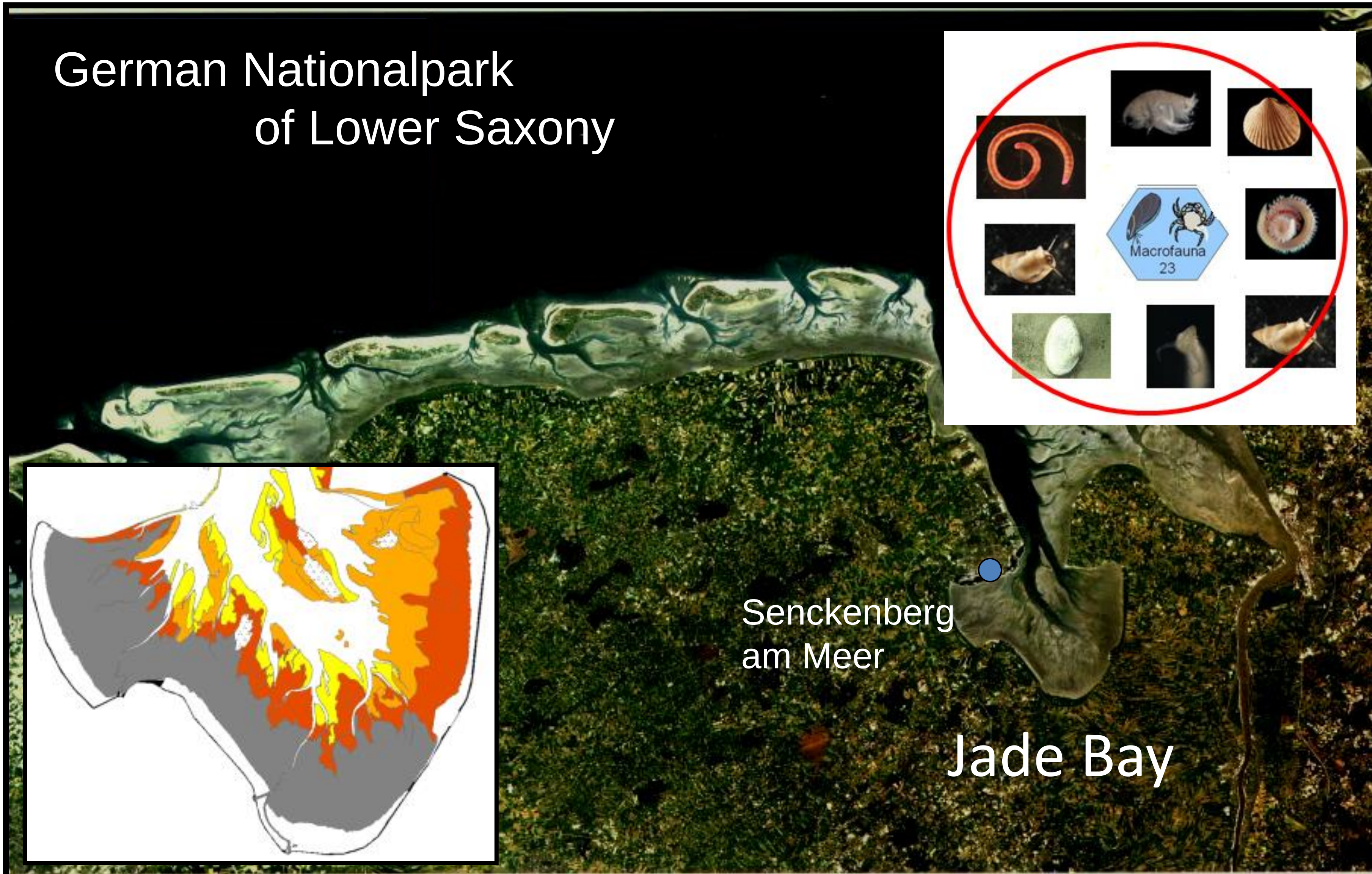
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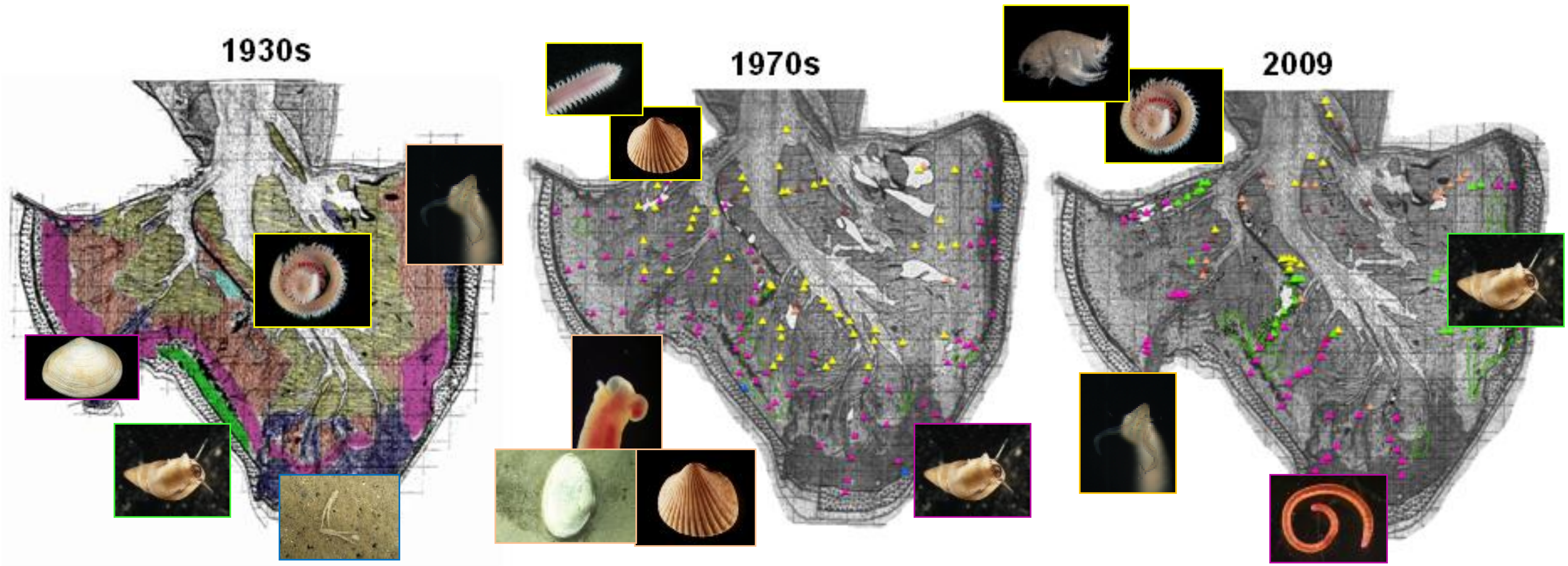
Jade Bay

Spatial distribution of the intertidal macrofauna communities in the Jade Bay in the 1930s, 1970s and 2009



1930s: pink, blue = mudflats; orange = mixed sediments; yellow = sandflats; turquoise = *Scolelepis squamata*-community; green = seagrass beds; black = mussel beds; 1970s and 2009: pink, blue = mudflats; green = *Hydrobia ulvae* community partially covered with seagrass beds; orange, brown = mixed sediments 1 & 2; yellow = sandflats; green bordered = seagrass beds (2009: data are given for 2008, Adolph, 2010); black spottet = mussel beds

Schückel & Kröncke 2013

Major changes that have been occurred were:

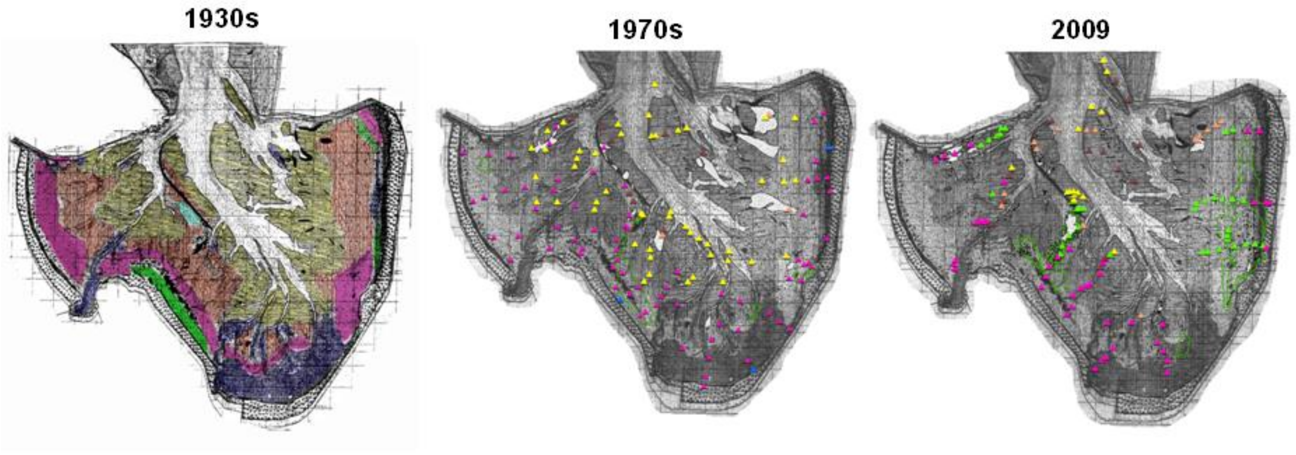
1930s-1970s	1970s-2009
• intertidal seagrass beds decreased between the 1930s and 1970s caused by increasing eutrophication • increasing abundances of opportunistic polychaetes • higher frequency of cold winters lead to increasing abundances of common bivalve species (e.g. *Macoma baltica, Mya arenaria, Cerastoderma edule*)	• decrease in intertidal bivalve species standing stocks between 1970s and 2009 caused by mild winters since 1997 due to lower recruitment success • increasing abundances of the oligochaete *Tubificoides benedii*, structural changes on the mudflats • tidal elevation and sediment volume transport increased, sediment net accumulation might indicate that Jade Bay can keep pace with rising sea level

Schückel & Kröncke 2013

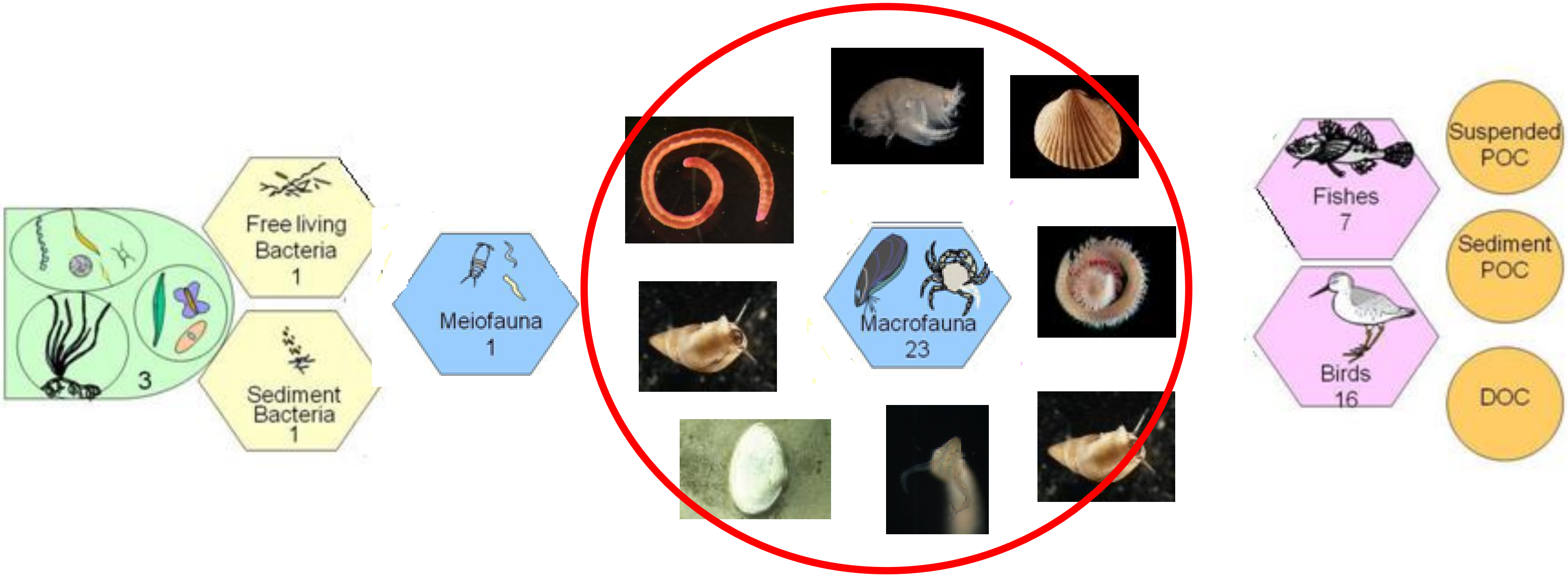
Ecological Network Analysis can be used…

• to describe energy flow models for ecosystems, to compare ecosystem and to **assess system responses to environmental or anthropogenic impacts**

• assess changes in biomass, rates of flows between the benthic living and non-living compartments as well as in the system-level properties in response to changing environmental conditions that have occurred in the Jade Bay during the past 80 years.



- build a model for each time period
- each model consists of 35 living and 3 non-living compartments



Benthic compartments

		1935-1937 Biomass	1975-1977 Biomass	2009 Biomass
6	*Hydrobia ulva* (2.12)	1496.3	2225.0	4949.1
7	*Littorina littorea* (2.13)	3026.4	540.0	128.2
8	*Arenicola marina* (2.50)	2055.3	1830.0	5359.8
9	*Scoloplos amiger* (2.50)	117.3	135.0	157.1
10	*Capitella capitata* (2.50)	0	20.0	40.4
11	*Eteone longa* (3.69)	24.9	8.5	8.6
12	*Heteromastus filiformis* (2.50)	392.5	295.0	55.1
13	*Hediste diversicolor* (2.27)	361.1	845.0	1141.1
14	*Pygospio elegans* (2.00)	107.8	9.5	120.4
15	*Corophium volutator* (2.12)	263.4	180.0	162.0
16	*Bathyporeia sarsi* (2.25)	463.9	15.1	67.9
17	Phyllodocidae (2.50)	24.9	8.5	15.0
18	*Microprotopus maculatus* (2.35)	0	0	2.5
19	*Urothoe poseidonis* (2.25)	0	29.0	206.5
20	*Cerastoderma edule* (2.00)	283.3	6345.0	3522.2
21	*Scrobicularia plana* (2.00)	430.0	597.5	276.5
22	*Caulleriella killariensis/Tharyx marioni* (2.50)	0	30.0	23.7
23	*Macoma baltica* (2.11)	211.8	1130.0	502.8
24	*Neanthes succinea* (2.29)	0	280.0	248.4
25	*Tubificoides benedii* (2.50)	24.1	72.0	268.5
26	*Ampharete acutifrons* (2.51)	73.1	167.9	66.9
27	*Crangon crangon* (3.07)	34.2	29.5	11.4
28	*Nepthys hombergii* (2.32)	464.4	100.0	124.5
29	*Mya arenaria* (2.00)	4.8	2515.0	1.5
30	*Mytilus edulis* (2.00)	150.2	544.0	204.0
31	Small polychaetes (*Polydora, Streblospio, Scolelepis*) (2.61)	17.5	188.4	57.1

Annual average conditions (mg C m^2)

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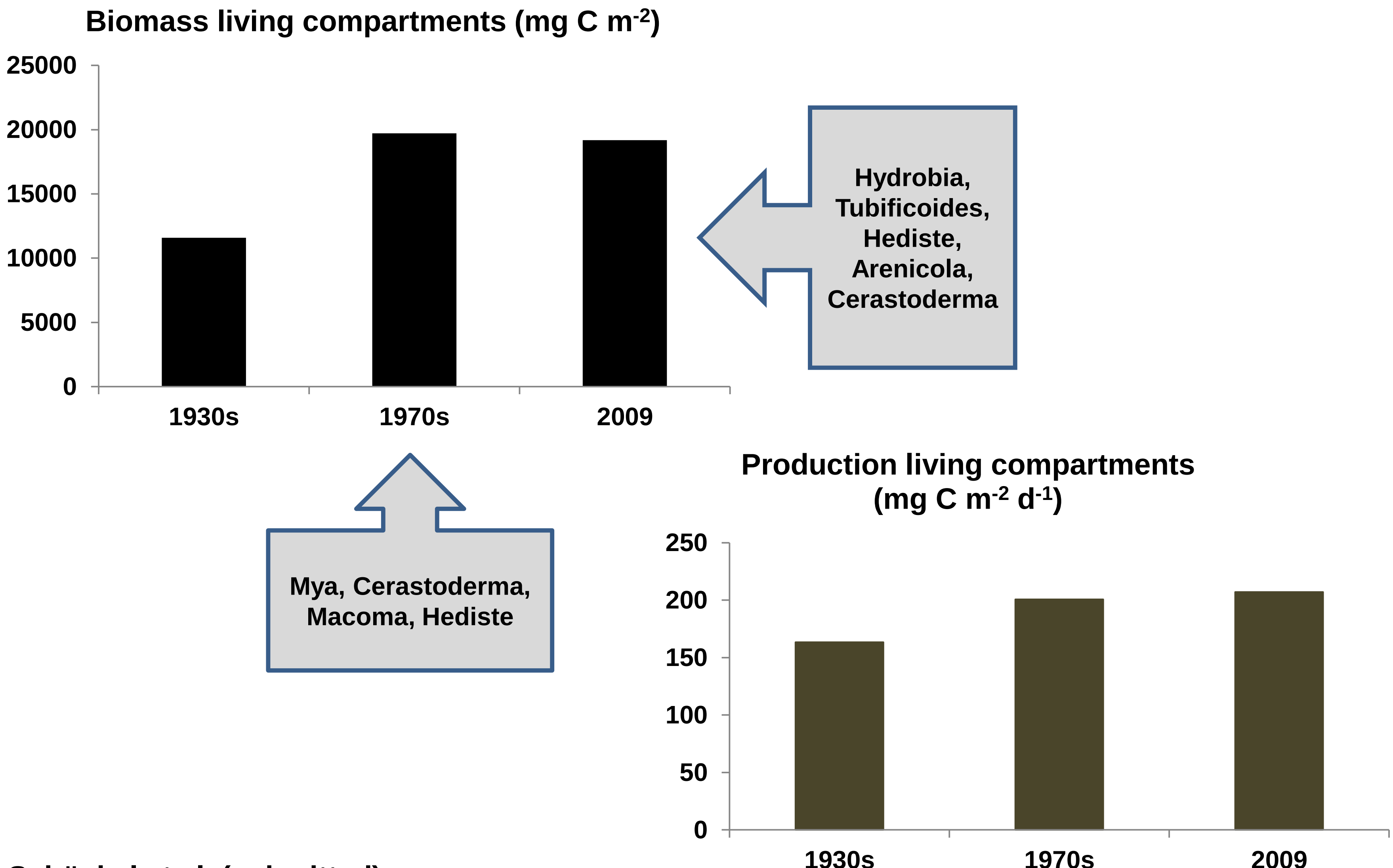

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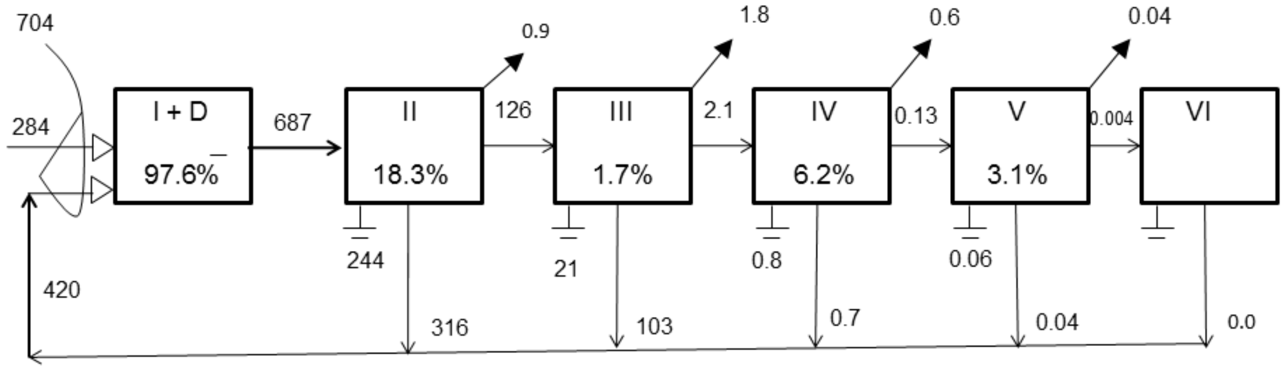
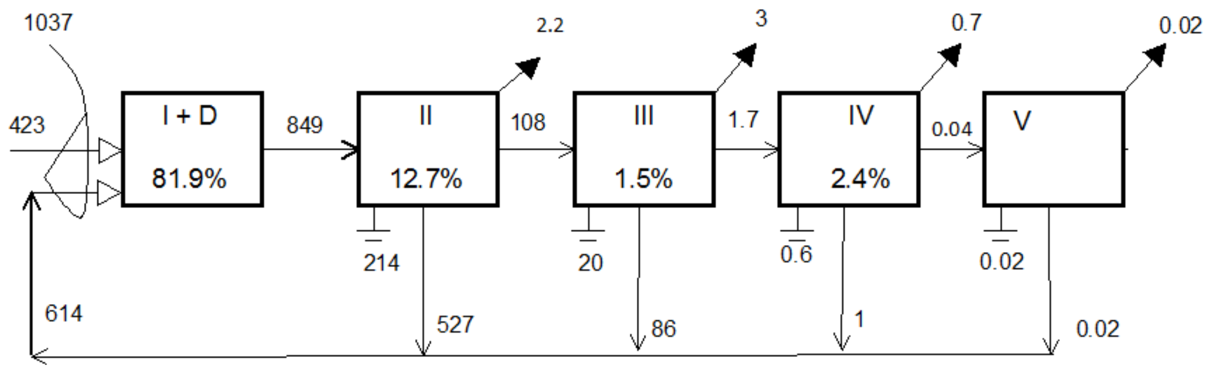
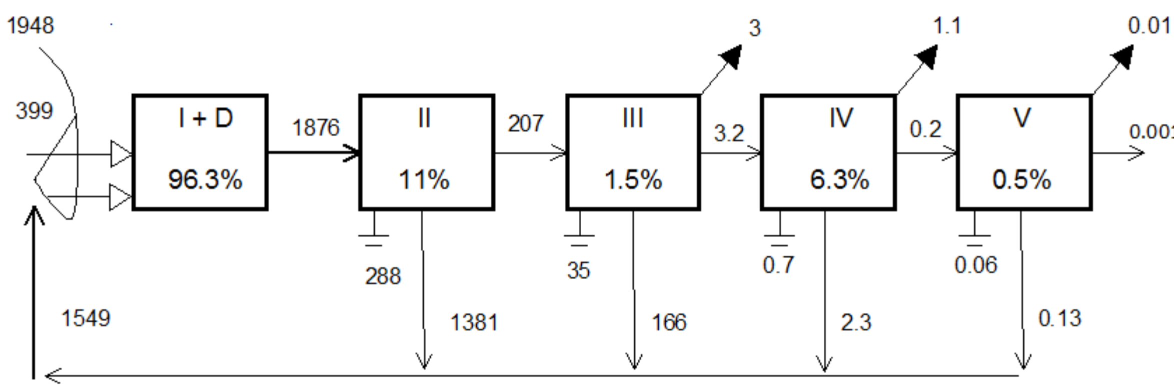
1930s



1970s



2009



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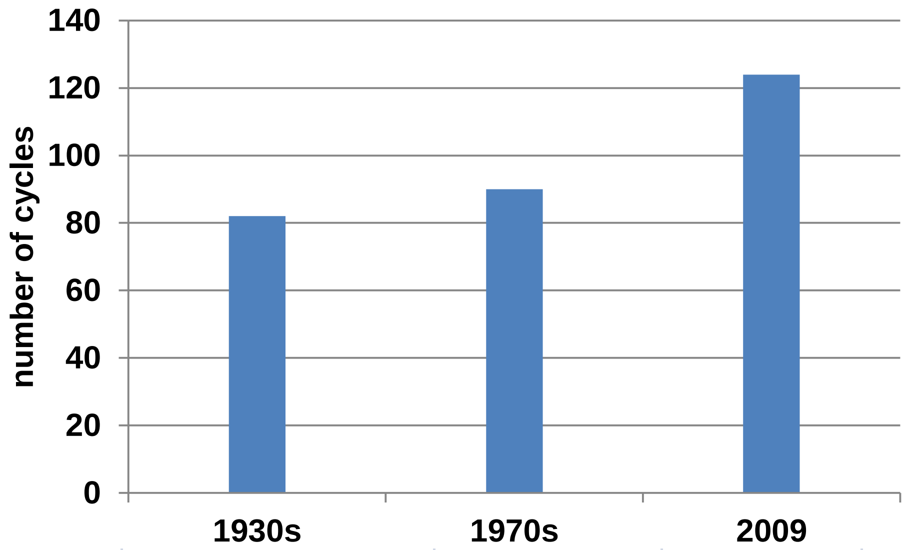

Number of cycles increased from the 1930s to 2009

% distribution of cycle per Nexus

Cycles per nexus	1930		1970		2009	
	No. of cycles	%	No. of cycles	%	No. of cycles	%
1	29	35.37	38	42.22	34	27.42
2	22	26.83	20	22.22	20	16.13
3	9	10.98	12	13.33	12	9.68
4	8	9.76	4	4.44	8	6.45
5	0	0.00	10	11.11	20	16.13
6	6	7.32	6	6.67	6	4.84
7	0	0.00	0	0.00	7	5.65
8	8	9.76	0	0.00	8	6.45
9	-	-	-	-	9	7.26

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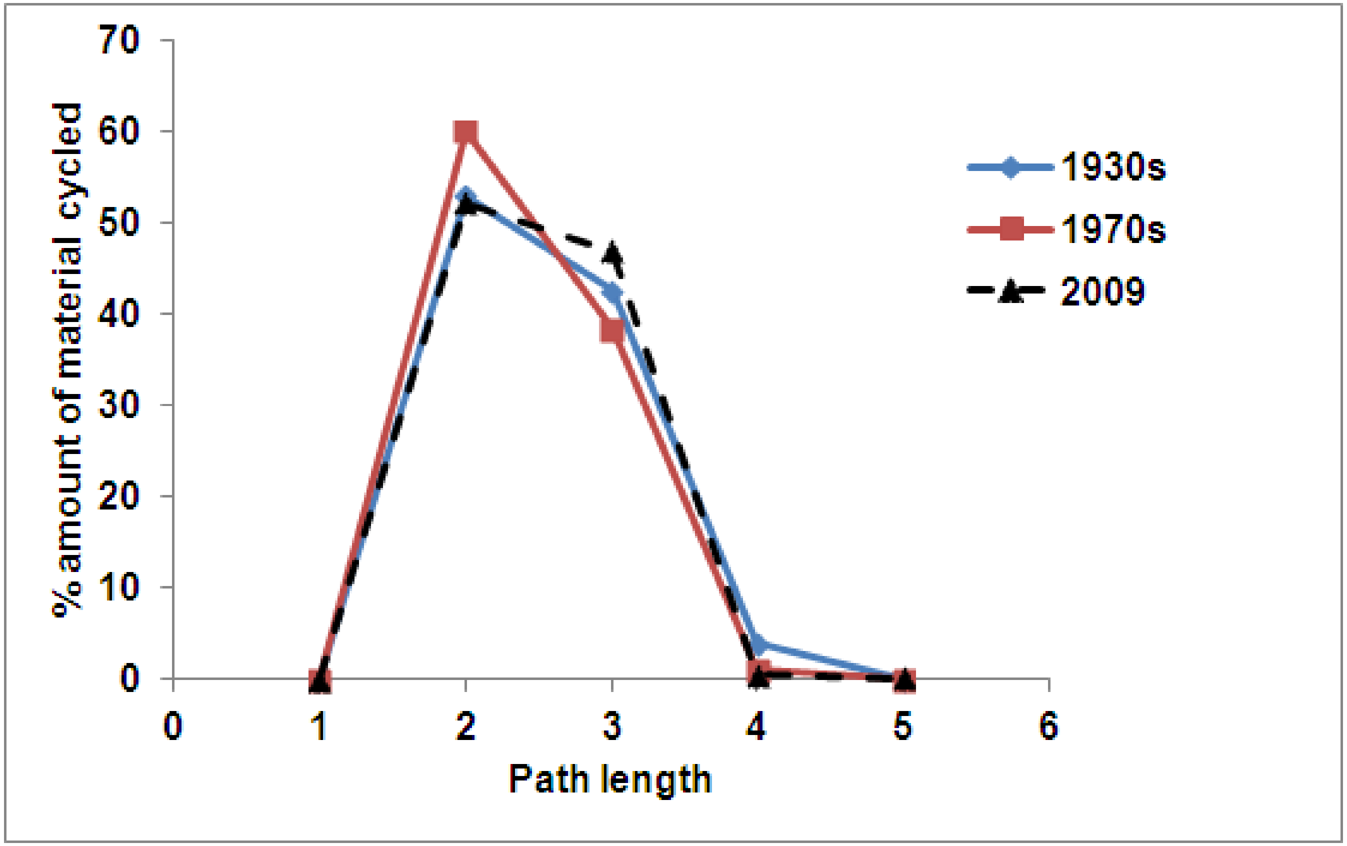
Material transport along the Jade Bay food webs



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Global system indices and attributes derived from ENA

System attributes	1935-37	1975-77	2009
Number of cycles	82	91	124
Finn cycling index (%)	40.9	29.7	30.6
Average Path Length (APL = TST - *Z* / *Z*)	6.08	4.27	9.9
Average Residence Time (ART; days)	43.66	68.9	59.61
Total system throughput (TST; g C m^{-2} yr^{-1})	1760.5	2229.8	3496.0
Relative Ascendency (A/DC; %)	35.19	38.77	42.03
Relative Redundancy (R/DC; %)	51.01	45.67	45.31
Detrivory:Herbivory ratio	1.88:1	1.31:1	4.21:1

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Conclusion

- detectable changes in key indices were found over time
- the period of eutrophication and cold winters is associated with an increase in total system biomass
- amount of material recycled decreased during the years of increasing eutrophication and cold winters but increased during the less stressed subsequent years of reduced eutrophication and mild winters
- increase in TST indicating an increase in the amount of energy flowing over time
- in 2009, it becomes apparent that the Jade Bay relies more heavily on the benthic layer than the pelagic ones

Thank you !

References

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