POSSIBLE NEGATIVE EFFECT OF STOMATOPOD (MANTIS SHRIMP) DISCARDS FROM SHRIMP TRAWLERS IN INDIA

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Introduction

- Major concern on bycatch and discards from trawlers in global fisheries
- Non-target (40%)fishery groups play crucial roles in ecosystems
- Stomatopods -mantis shrimps, squilla-major discards-carnivorous and predators
- Works regarding their ecological niche is nil
- Ecosystems are balanced by nature-each component role in the sustenance of others

Shrimp trawler

C.smithii formed major discards in post monsoon

Fate of discards

Original catch

Bycatch after target groups sorted out

Onboard discarding
of non-edible biota and
low value ground fishes &
juveniles of commercially
important fishes after
segregating the Target catch

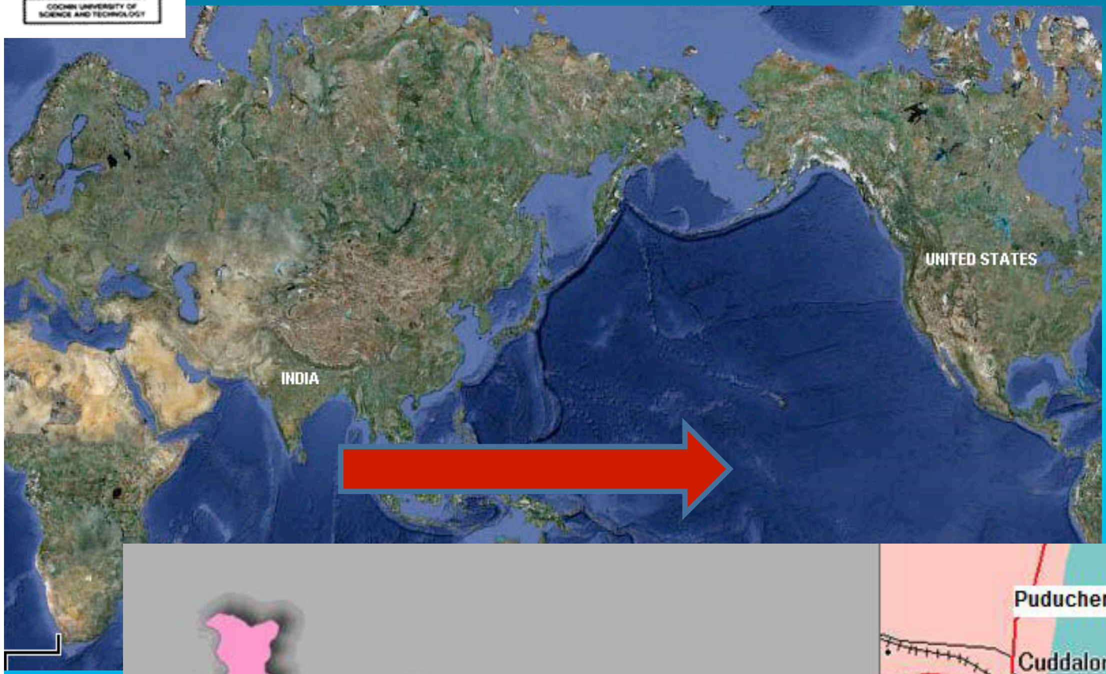
Fate of discards other than stomatopods

Discarded stomatopods impact

Objectives

- Model a marine trophic ecosystem
  - Evaluate the trophic niche overlaps
  - To assess trophic impacts & trophic interactions in the ecosystem
  - Simulate the impacts of stomatopods discard by increasing their biomass in the ecosystem and fisheries

Study area


UNITED STATES
INDIA


India
Tamil Nadu
Porto Novo
Puducherry
11° 50'N
Cuddalore
FL W 5S
Porto Novo
Mudasalodai
Pazhayar
Poompukhar
10° 50'N

Bycatch from trawlers

Stomatopod – *Miyakea nepa*

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Materials and methods

- **Ecopath with Ecosim version 5 software**

Polovina(1984)

$$B_i\,(P/B)_i\,EE_i = Y_i\,\sum B_j\,(Q/B)_j\,DC_{ij} + Ex_i$$

- *Bi* = the biomass of prey group *i*; *P*/*Bi* = production/biomass ratio of group *i*; EE*i* = ecotrophic efficiency; *Yi* = its yield (=fishery catch); *Bj* = the biomass of predator group *j*; *Q*/*Bj* = the food consumption per unit biomass of *j*, DC*ji* = the fraction of *i* in the diet of *j* and Ex_i = the export of group *i*

- **Mass balancing:Production of any given prey=Bimass consumed by predators +fisheries+any exports from the system**
- **Entered basic inputs**
- **Ecopath parametrisation**
- **Ecosim simulation**

EwE - data requirements

1. Biomass (B): For fishery groups B=Y/F (Catch/Fishing mortality) expressed in tonnes/km^2
2. Production per biomass (P/B) ratio: P/B = Z (Total mortality)= fishery yield + predation + net migration + biomass change + other mortality
3. Consumption per biomass (Q/B) ratio

   $\log Q/B = 7.964 - 0.204 \log W\alpha - 1.965\, T + 0.083\, A + 0.532\, h + 0.398\, d$ (Pauly et al. 1998)

   where Wα = asymptotic weight, T = temperature, A = Aspect ratio, h and d are binary variables (0 for carnivores and 1 for herbivores and detritivores)

4. Ecotrophic efficiency (EE) – proportion of production that is utilized in the ecosystem (predation or harvest)

- Catch data
  - Multi-stage stratified random sampling
  - 3 landing centres covered (Nov. 2004 – Oct. 2005)
  - 17 functional groups defined
- F, Z, Q/B and diet composition data
  - secondary data available from the study area
- Stomatopod - single functional group
  - Parameters were directly estimated
  - length frequency data - FiSAT software
  - diet composition - gut content analysis)

Functional groups

- Marine mammals
- Elasmobranchs
- Large pelagic
- Tunas
- Benthopelagic fishes
- Cephalopods
- Benthic carnivore fishes
- Mackerel
- Clupeids
- Stomatopods
- Crabs and Lobsters
- Shrimps
- Macrobenthos
- Meiobenthos
- Zooplankton
- Phytoplankton
- Detritus

- Basic input entered
- Mass balancing by automatic parameterization
- Evaluated the various outputs
- Ecosim simulation run
- Fishing mortality increased from the present level of 2.5 $year^{-1}$ to 5.0$year^{-1}$ in the initial two years, and decreased gradually to 0.25 $year^{-1}$ in 10 years

Results

Group name	TL	B (t km^{-2})	P/ B (/ year)	Q/ B (/ year)	EE	OI
Marine mammals	4.49	0.007	0.250	11.230	0.000	0.343
Elasmobranchs	4.47	0.024	2.600	8.900	0.980	0.375
Large pelagic	3.91	0.015	4.200	6.820	0.974	0.584
Tunas	4.29	0.024	5.020	11.860	0.980	0.332
Benthopelagic fishes	3.92	0.104	4.350	14.300	0.979	0.624
Cephalopods	4.04	0.292	4.500	28.000	0.953	0.159
Benthic carnivore fishes	4.06	0.359	4.523	21.200	0.969	0.312
Mackerel	2.07	0.409	6.240	31.560	0.906	0.088
Clupeids	2.69	1.049	8.200	55.120	0.966	0.623
Stomatopods	3.49	0.284	4.600	15.000	0.980	0.794
Crabs and Lobsters	3.35	0.343	5.700	21.000	0.976	0.771
Shrimps	3.06	0.774	7.621	13.600	0.879	0.666
Macrobenthos	3.17	16.192	4.500	11.140	0.489	0.492
Meiobenthos	2.45	11.546	14.600	34.600	0.646	0.375
Zooplankton	2.28	17.844	78.000	300.000	0.972	0.281
Phytoplankton	1.00	71.000	82.000	-	0.735	0.000
Detritus	1.00	9.200	-	-	0.087	0.484

Mass balancing results

- Trophic level of the groups ranged from 1 (phytoplankton) to 4.49 (marine mammals)
- EE values for all the groups were less than 1
- Stomatopods occupied trophic level 3.49, indicates the carnivorous habit
- The exceptionally high value of omnivory index in stomatopods indicated their large feeding spectrum, carnivorous behaviour and wide distribution in the system

Diet matrix

	Prey \ Predator	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Marine mammals															
2	Elasmobranchs															
3	Large pelagic	0.005	0.062													
4	Tunas															
5	Benthopelagic s	0.115	0.101	0.061	0.073						0.022	0.015				
6	Cephalopods	0.193	0.207	0.070	0.162	0.164		0.088								
7	Benthic carnivore	0.215	0.182	0.135	0.108	0.103	0.075	0.048			0.016	0.021				
8	Mackerel			0.296		0.302		0.129								
9	Clupeids	0.254	0.279	0.213	0.266	0.104	0.305	0.073		0.048	0.083	0.119				
10	Stomatopods			0.004	0.018	0.010	0.028	0.030		0.001	0.002	0.006				
11	Crabs & Lobsters			0.007	0.034	0.027	0.066	0.051			0.013	0.018	0.000			
12	Shrimps	0.099	0.057	0.032	0.084	0.061	0.137	0.142		0.015	0.049	0.074	0.008			
13	Macrobenthos	0.119	0.087	0.107	0.191	0.102	0.312	0.360		0.076	0.355	0.191	0.189	0.114		
14	Meiobenthos		0.025	0.071	0.064	0.024	0.077	0.079		0.035	0.183	0.165	0.221	0.561		
15	Zooplankton					0.103			0.057	0.281	0.045	0.135	0.244	0.082	0.354	0.220
16	Phytoplankton								0.881	0.458					0.153	0.780
17	Detritus			0.003					0.062	0.085	0.230	0.255	0.338	0.243	0.493	
18	Import															
	Sum	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

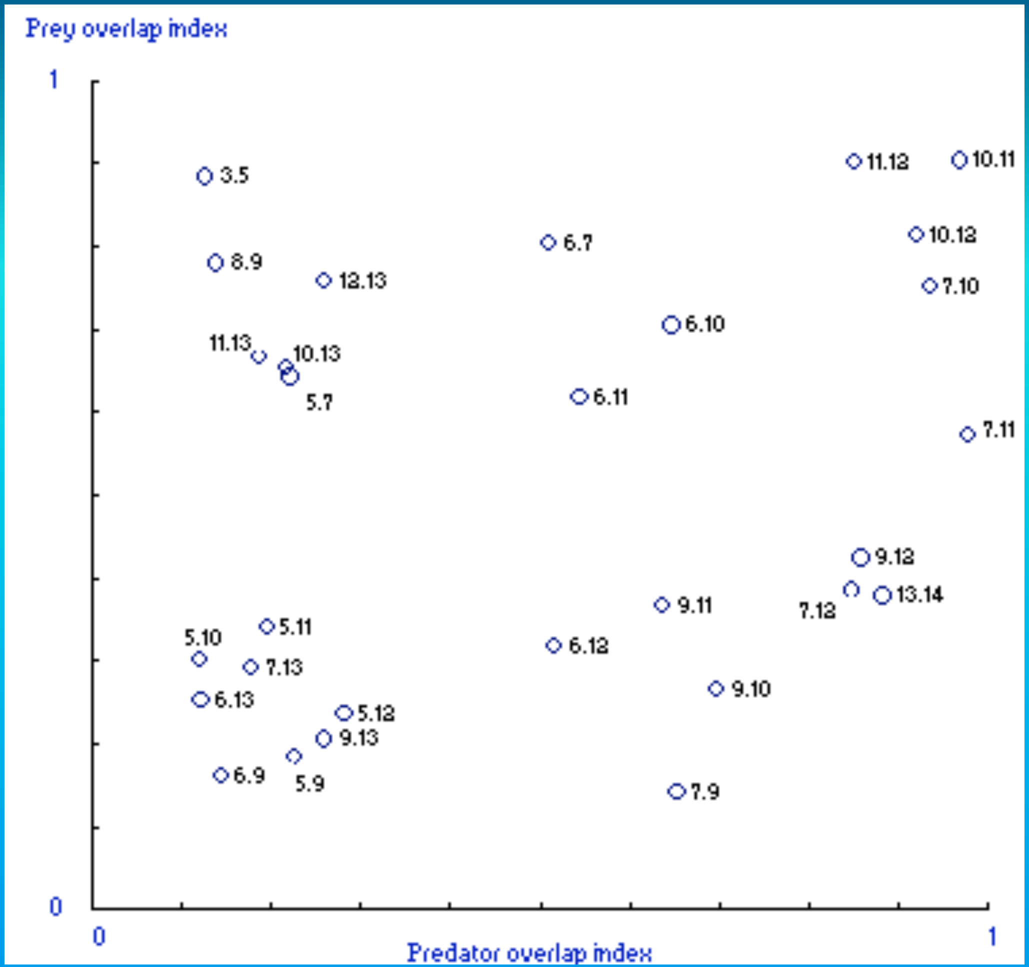
Estimated group-wise split mortality rates

Group name	Production/Biomass (=Z)	Fishing mortality	Predation mortality	Other mortality
Marine mammals	0.250	0.000	0.000	0.250
Elasmobranchs	2.600	2.548	0.000	0.052
Large pelagic	4.200	3.186	0.907	0.108
Tunas	5.020	4.920	0.000	0.100
Benthopelagic fishes	4.350	1.740	2.519	0.091
Cephalopods	4.500	0.774	3.515	0.210
Benthic carnivore fishes	4.523	0.324	4.060	0.139
Mackerel	6.240	2.091	3.564	0.585
Clupeids	8.200	0.884	7.034	0.282
Stomatopods	4.600	2.459	2.048	0.094
Crabs and Lobsters	5.700	2.171	3.393	0.136
Macrobenthos	4.500	0.021	2.180	2.299
Meiobenthos	14.600	0.000	9.427	5.173
Zooplankton	78.000	0.000	75.797	2.203
Phytoplankton	82.000	0.000	60.240	21.760

Estimated predation mortality rates of different groups

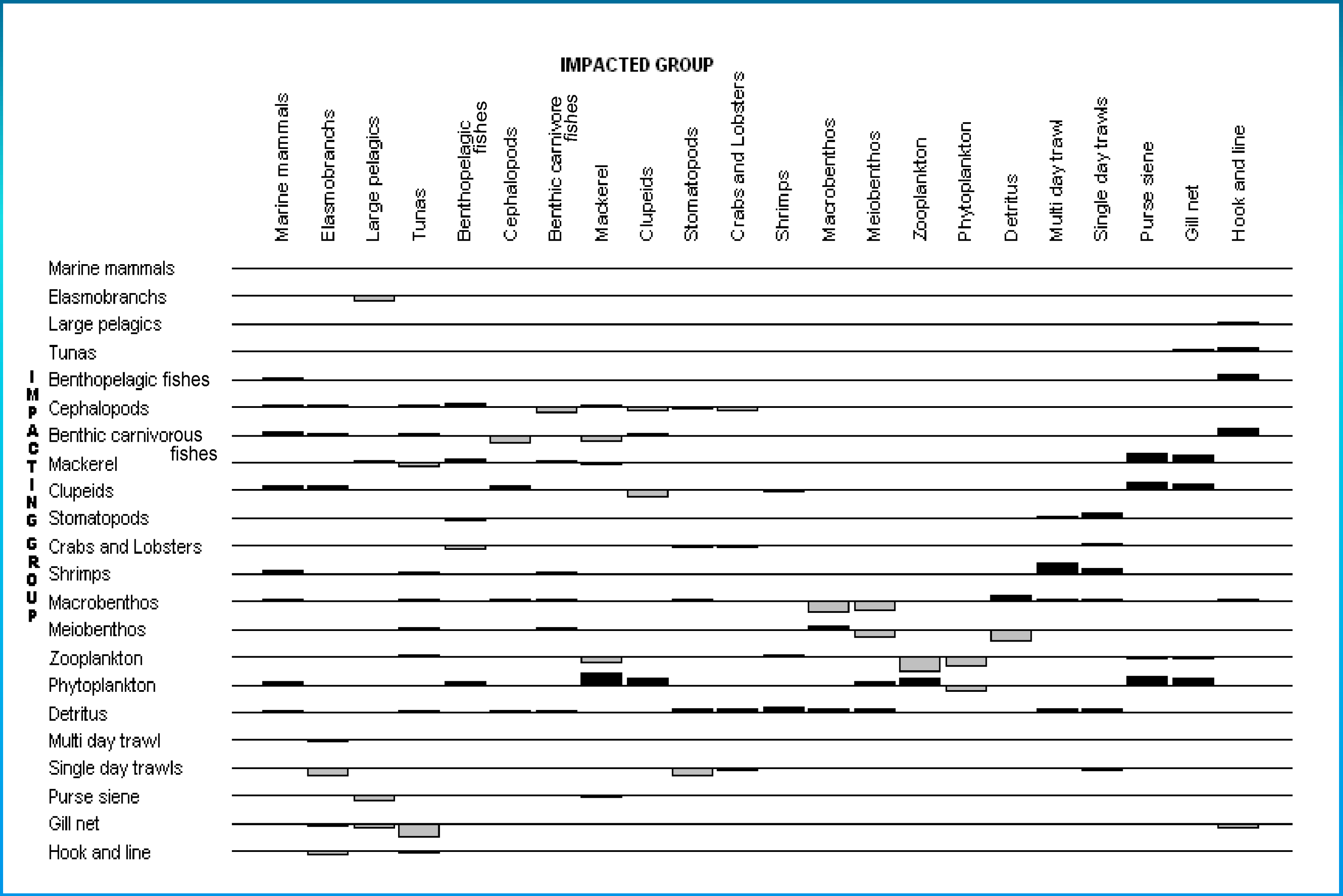
	Prey \ Predator	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Marine mammals	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	Elasmobranchs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	Large pelagic	0.026	0.881	-	-	-	-	-	-	-	-	-	-	-	-	-
4	Tunas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	Benthopelagic s	0.084	0.204	0.059	0.200	-	-	-	-	-	0.917	1.055	-	-	-	-
6	Cephalopods	0.050	0.148	0.024	0.158	0.835	-	2.301	-	-	-	-	-	-	-	-
7	Benthic carnivore	0.045	0.106	0.038	0.085	0.428	1.717	1.027	-	-	0.196	0.418	-	-	-	-
8	Mackerel	-	-	0.073	-	1.097	-	2.394	-	-	-	-	-	-	-	-
9	Clupeids	0.018	0.056	0.020	0.072	0.147	2.377	0.527	-	2.663	0.338	0.815	-	-	-	-
10	Stomatopods	-	-	0.001	0.018	0.055	0.792	0.793	-	0.203	0.026	0.159	-	-	-	-
11	Crabs and Lobsters	-	-	0.002	0.028	0.116	1.576	1.128	-	-	0.167	0.370	0.004	-	-	-
12	Shrimps	0.010	0.015	0.004	0.031	0.118	1.449	1.394	-	1.092	0.272	0.688	0.112	-	-	-
13	Macrobenthos	0.001	0.001	0.001	0.003	0.009	0.157	0.169	-	0.271	0.093	0.085	0.123	1.266	-	-
14	Meiobenthos	-	0.000	0.001	0.002	0.003	0.054	0.052	-	0.177	0.068	0.103	0.201	8.766	-	-
15	Zooplankton	-	-	-	-	0.009	-	-	0.041	0.912	0.011	0.055	0.144	0.833	7.926	65.87
16	Phytoplankton	-	-	-	-	-	-	-	0.160	0.373	-	-	-	-	0.862	58.84

Niche overlap



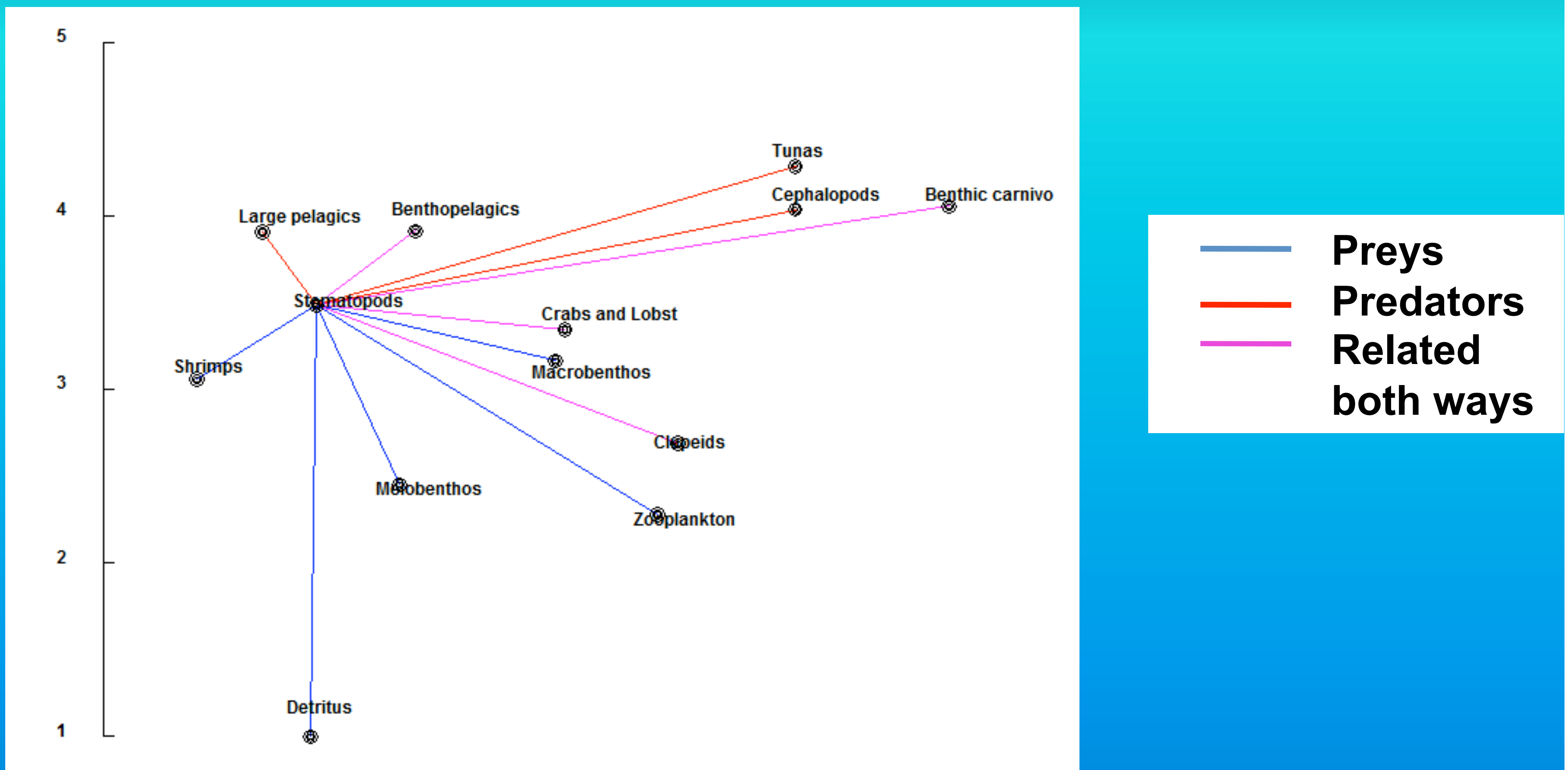
Prey and predators of group 10 (stomatopods) have very good overlap with the prey and predators of groups 11 (crabs and lobsters), 12 (shrimps) and 7 (benthic carnivores)

Mixed trophic impact

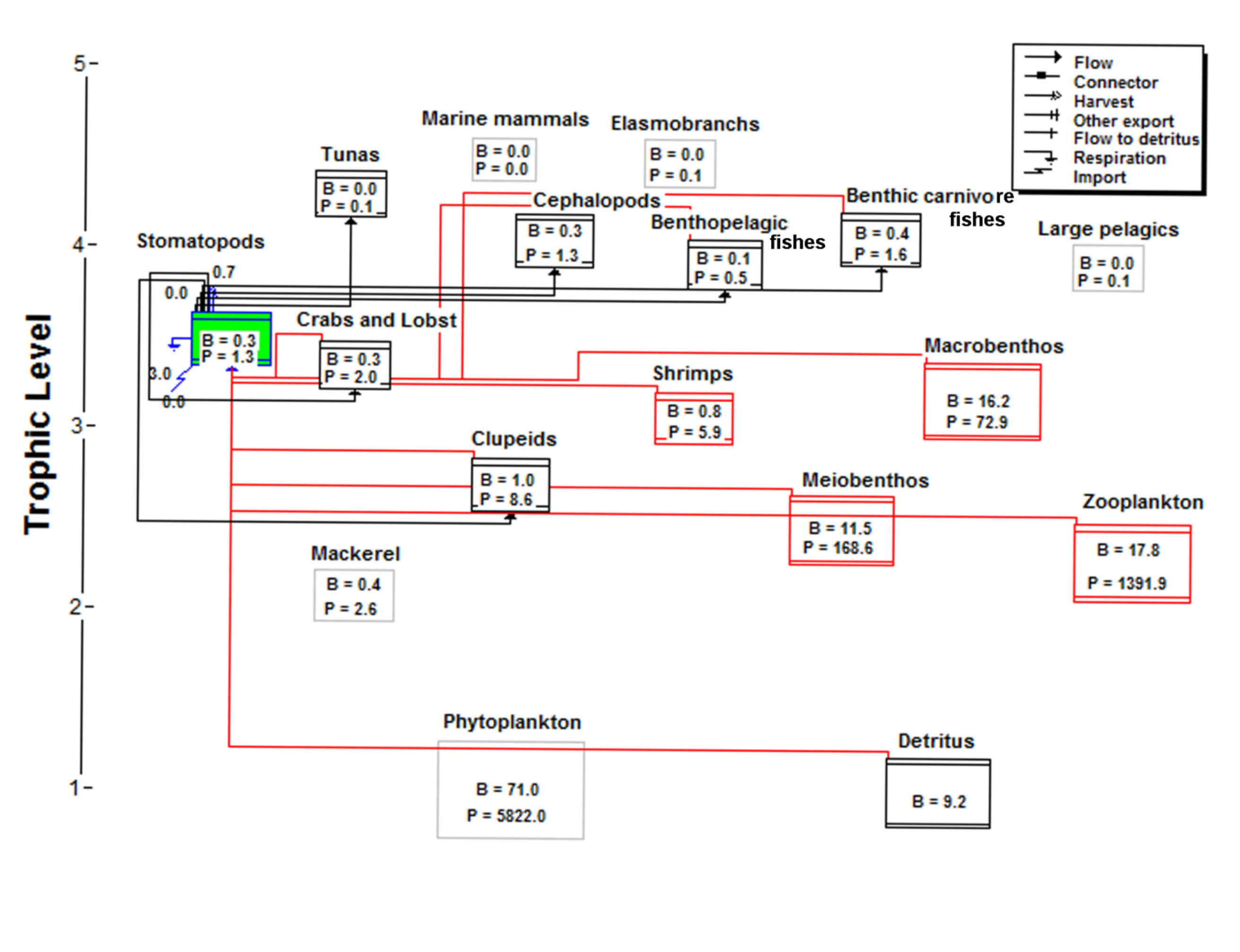


Stomatopods showed negative impact on benthopelagic fishes

Trophic level connectance plot

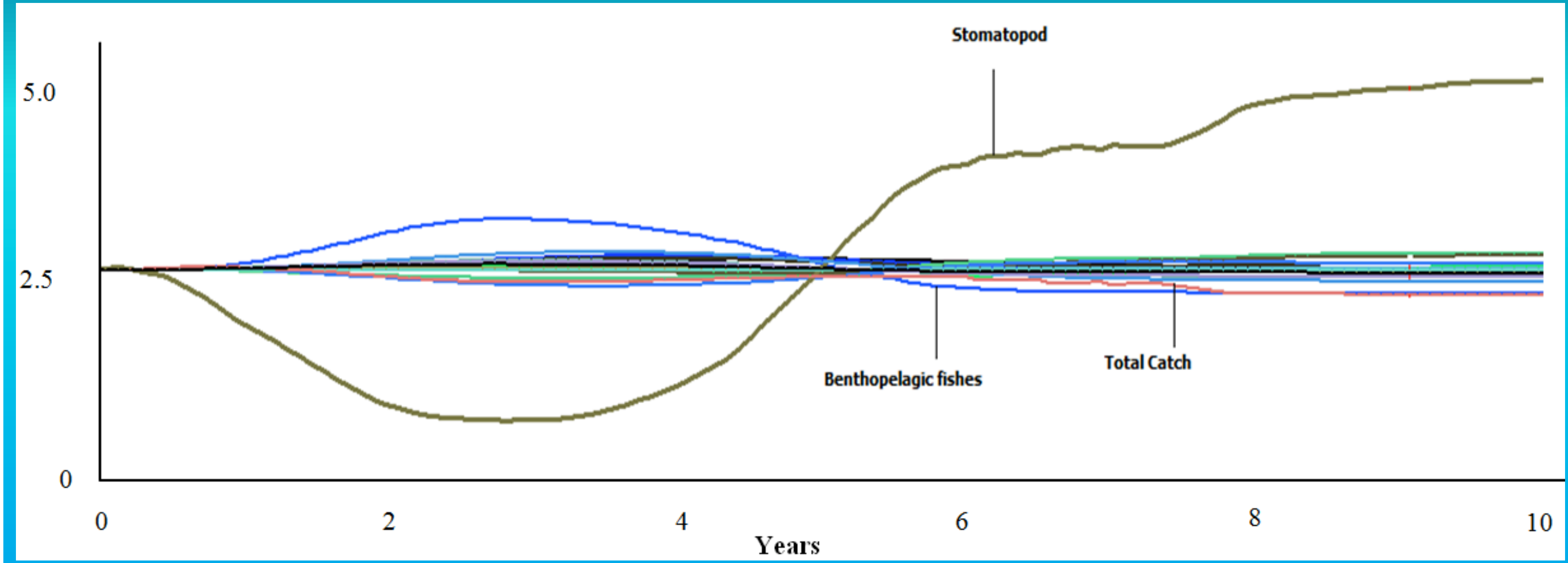


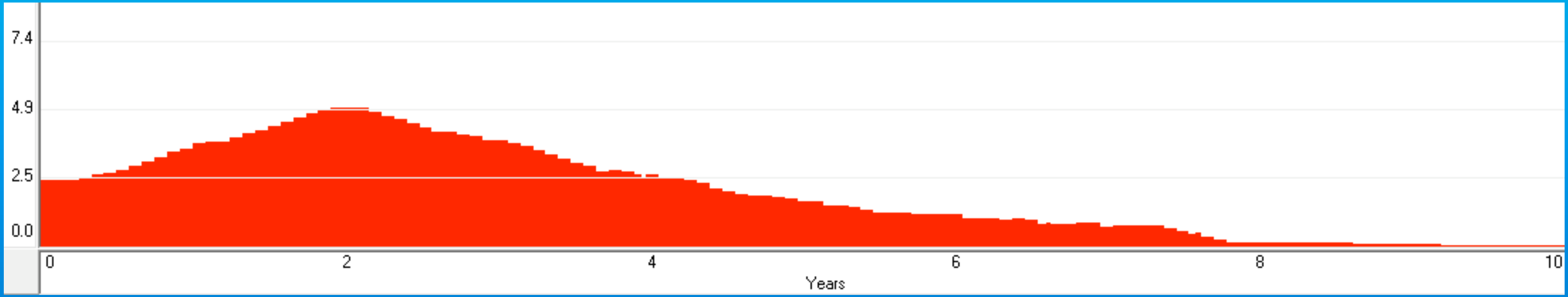
Trophic flows from stomatopods



Inflows in red lines and outflows in black lines

Simulated change in biomass





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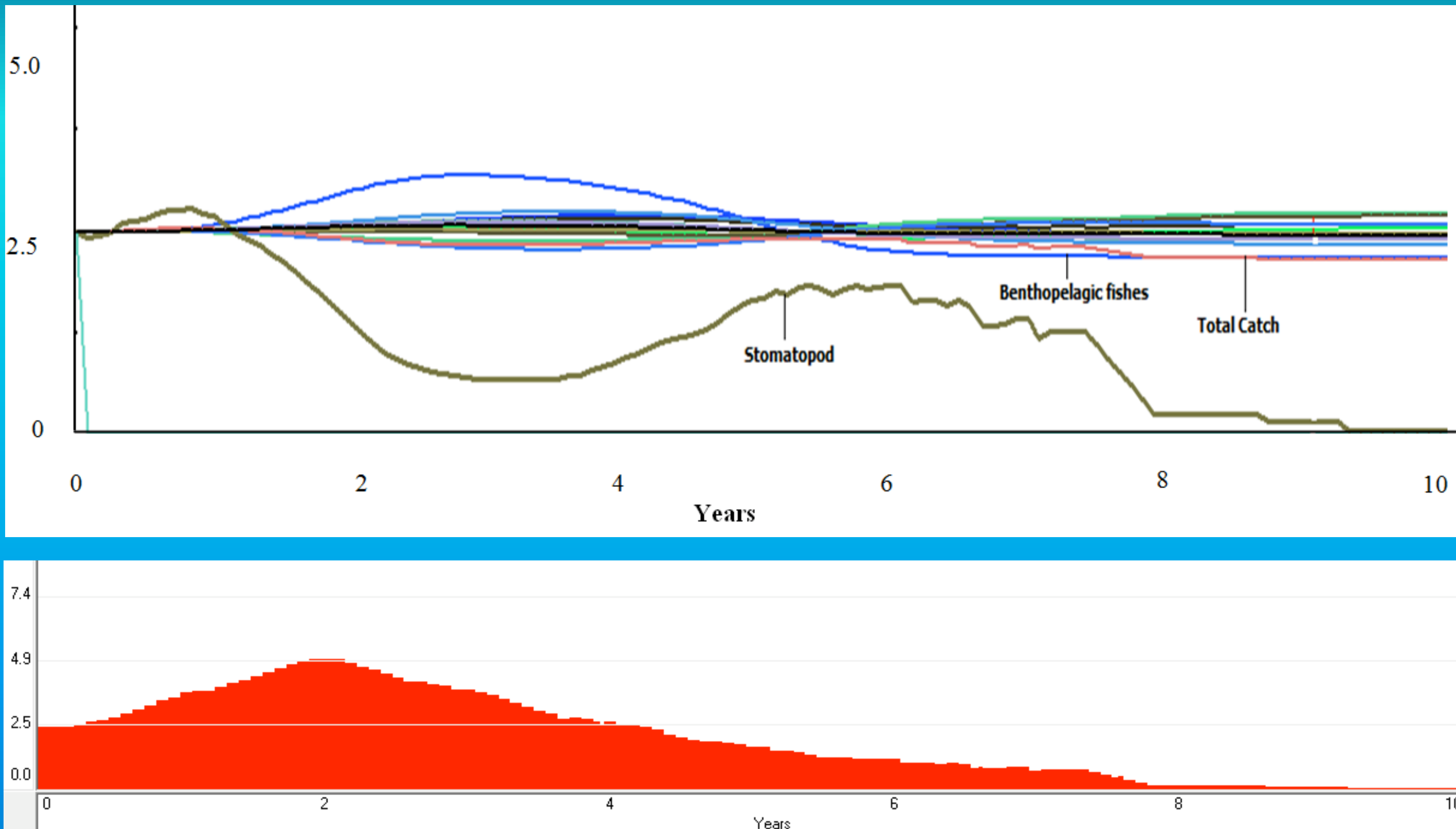
Ecosim results

Group name	SB	EB	EB/SB
Marine mammals	0.007	0.007	1.00
Elasmobranchs	0.024	0.023	0.99
Large pelagic	0.015	0.015	1.01
Tunas	0.024	0.025	1.03
Benthopelagic fishes	0.104	0.090	0.87
Cephalopods	0.292	0.317	1.09
Benthic carnivore fishes	0.359	0.385	1.07
Mackerel	0.409	0.424	1.04
Clupeids	1.049	1.007	0.96
Stomatopods	0.284	0.570	2.00
Crabs and Lobsters	0.343	0.320	0.93
Shrimps	0.774	0.742	0.96
Macrobenthos	16.192	16.063	0.99
Meiobenthos	11.546	11.59	1.00
Zooplankton	17.843	17.848	1.00
Phytoplankton	70.994	70.999	1.00
Detritus	60.127	60.112	1.00
Total	180.384	180.536	1.00

Simulated changes in yield



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Conclusion

- Discard of juveniles fishes in live condition is found very essential in trawl fishery
- Increase of the biomass of Stomatopods is having negative impact on ecosystem and fisheries
- Ecosystem overfishing(Pauly,1994) due to live discards of stomatopods in live condition
- Impact is mostly on commercial groups including benthopelagic fishes, shrimps, crabs and lobsters and macrobenthos
- Competition for food, increased predation

cosystem based fisheries management is advocated for better management of fish stocks

- Better understand the ecosystem, their components, interlinks and niche are essential for sustenance of the stock
- Increase awareness for an optimum exploitation and utilization of stomatopods
- Utilisation of squilla as fishery products and biproducts needs to be investigated

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Thank you
for your kind attention……