ELECTRONIC SUPPLEMENTARY MATERIAL

OCEAN RESOURCES & MARINE CONSERVATION

Combining ecosystem indicators and life cycle assessment for environmental assessment of demersal trawling in Tunisia

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Appendix 1. Names of unit processes (from ecoinvent 3.0) used to model seafood production by demersal trawling in the Gulf of Gabes. Detailed Life Cycle Inventory and quantities could not be provided due to confidentiality.

Seafood production by demersal trawling

Materials

1. Construction of trawling vessel

Materials

Engine

- Cast iron {GLO}| market for | Alloc Def, U
- Steel, chromium steel 18/8 {GLO}| market for | Alloc Def, U
- Aluminium alloy, AlMg3 {GLO}| market for | Alloc Def, U

Sawnwood, azobe from sustainable forest management, planed, air dried {GLO}| market for | Alloc Def, U

Steel, low-alloyed {GLO}| market for | Alloc Def, U

Copper {GLO}| market for | Alloc Def, U

Aluminium alloy, AlMg3 {GLO}| market for | Alloc Def, U

Electricity/heat

Transport, freight, lorry 16-32 metric ton, EURO3 {GLO}| market for | Alloc Def, U

Transport, freight, sea, transoceanic ship {GLO}| market for | Alloc Def, U

2. Construction of trawling net

Materials

- Polyethylene, high density, granulate {GLO}| market for | Alloc Def, U
- Nylon 6-6 {GLO}| market for | Alloc Def, U
- Lead {GLO}| market for | Alloc Def, U
- Steel, chromium steel 18/8 {GLO}| market for | Alloc Def, U

Electricity/heat

- Transport, freight, lorry 28 metric ton, vegetable oil methyl ester 100% {GLO}| market for | Alloc Def, U
- Transport, freight, sea, transoceanic ship {GLO}| market for | Alloc Def, U

3. Antifouling paint

Zinc oxide {GLO}| market for | Alloc Def, U

Copper oxide {GLO}| market for | Alloc Def, U

Xylene {GLO}| market for | Alloc Def, U

Solvent, organic {GLO}| market for | Alloc Def, U

4. Paint for trawler
5. Diesel, low-sulfur {RoW}| market for | Alloc Def, U
6. Lubricating oil {GLO}| market for | Alloc Def, U

Electricity/heat

Transport, freight, sea, transoceanic ship {GLO}| market for | Alloc Def, U

Transport, freight, lorry 16-32 metric ton, EURO3 {GLO}| market for | Alloc Def, U

Heat, central or small-scale, other than natural gas {RoW}| heat production, light fuel oil, at boiler 10kW, non-modulating | Alloc Def, U

Emissions to air

Carbon monoxide

Sulfur dioxide

Carbon dioxide

Volatile organic compounds

Nitrogen oxides

Emissions to water

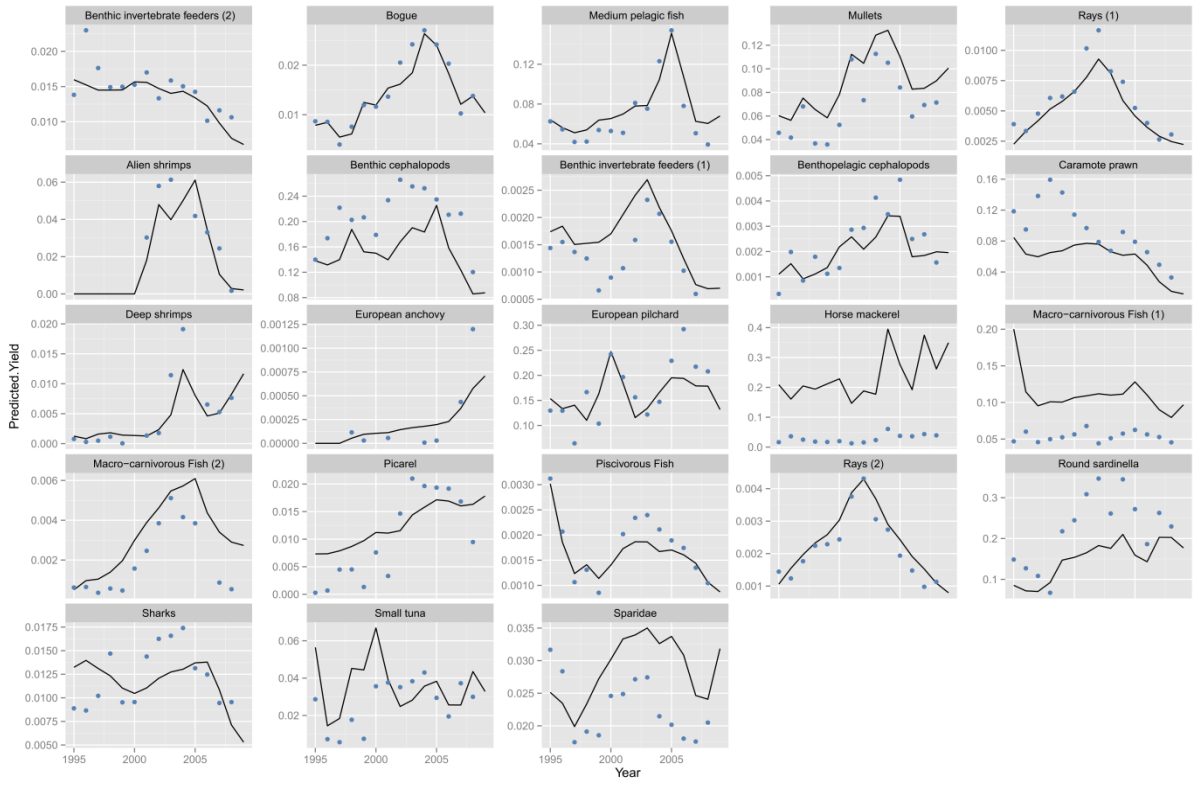
Xylene

Copper oxide

Zinc compounds

Appendix 2: Parameters of the Ecopath model of the Gulf of Gabes ecosystem (Hattab et al. 2013)

Functional group	Trophic level	Biomass ($t.km^{-2}$)	Production / biomass ($.year^{-1}$)	Consumption / biomass ($.year^{-1}$)	Ecotrophic efficiency	Production / consumption
Phytoplankton	1.000	7.650	160.000	0.000	0.309	
Macro-algae	1.000	2.188	13.400	0.000	0.950	
Posidonia oceanica	1.000	0.046	15.033	0.000	0.950	
Micro and mesozooplankton	2.105	8.460	32.395	51.069	0.950	0.634
Macrozooplankton	3.093	3.463	22.650	56.570	0.950	0.400
Foraminifera	2.000	0.368	7.844	23.532	0.950	0.333
Invertebrate suspension feeders	2.725	7.382	1.647	9.904	0.950	0.166
Polychaetes	2.361	4.416	3.502	19.723	0.950	0.178
Amphipoda and Isopoda	2.000	5.464	2.405	26.199	0.950	0.092
Echinoderms	2.327	4.526	0.570	2.460	0.950	0.232
Benthic molluss	2.353	4.258	1.886	9.386	0.950	0.201
Crabs	3.211	2.089	2.555	4.953	0.950	0.516
Benthic cephalopods	3.701	0.552	2.800	5.642	0.968	0.496
Benthopelagic cephalopods	4.225	0.065	2.712	31.640	0.885	0.086
Mantis shrimp	3.716	0.560	1.590	4.854	0.884	0.328
Caramote prawn	3.279	0.131	2.260	7.665	0.994	0.295
Alien shrimp	2.868	0.125	3.800	7.665	0.996	0.496
Deep shrimp	3.270	0.036	2.796	7.665	0.952	0.365
Horse mackerel	3.663	1.550	0.716	9.044	0.997	0.079
European pilchard	3.122	3.829	1.116	11.403	0.927	0.098
Round sardinella	3.125	1.850	0.853	9.635	0.953	0.089
European anchovy	3.081	0.700	1.089	10.505	0.882	0.104
Picarel	3.104	0.618	0.882	27.280	0.791	0.032
Bogue	3.200	0.538	0.772	19.813	0.782	0.039
Benthic invertebrate feeders (1)	3.537	0.210	0.608	6.834	0.997	0.089
Benthic invertebrate feeders (2)	3.391	0.049	0.723	8.529	0.946	0.085
Mullets	3.305	0.085	1.310	6.587	0.990	0.199
Piscivorous fish	4.213	0.067	0.359	4.335	0.788	0.083
Sparidae	3.313	0.216	0.779	7.832	0.959	0.099
Macro-carnivorous fish (1)	4.026	0.189	0.639	9.380	0.999	0.068
Macro-carnivorous fish (2)	4.056	0.052	0.571	8.529	0.949	0.067
Rays (1)	4.060	0.363	0.239	3.277	0.095	0.073
Rays (2)	3.780	0.133	0.342	3.736	0.267	0.092
Sharks	4.355	0.193	0.544	4.233	0.220	0.128
Small tuna	4.419	0.074	0.591	8.193	0.950	0.072
Medium pelagic fish	4.118	1.462	0.111	1.306	0.891	0.085
Atlantic bluefin tuna	4.381	0.230	0.313	3.513	0.899	0.089
Dolphins	4.339	0.080	0.075	14.361	0.000	0.005
Sea birds	3.772	0.002	0.200	62.751	0.000	0.003
Discards	1.000	0.381			0.447	
Detritus	1.000	30.000			0.280	



Appendix 3: Comparison of the time series of landings (points) and model outputs (lines) for the period 1995-2008

Appendix 4: Input parameters applied to each group in the Gulf of Gabes Ecospace model (Abdou et al. 2016)

Functional group	Trophic level	Base dispersal rate (km year^{-1})	Relative dispersal rate in bad habitat	Relative vulnerability to predation in bad habitat	Relative feeding rate in bad habitat
Phytoplankton	1.00	3	1	2	0.95
Macro-algae	1.00	3	1	2	0.95
Posidonia oceanica	1.00	3	1	2	0.95
Micro and mesozooplankton	2.10	3	1	2	0.01
Macrozooplankton	3.09	3	1	2	0.01
Foraminifera	2.00	3	1	2	0.01
Invertebrate suspension feeders	2.72	3	1	2	0.01
Polychaetes	2.36	3	1	2	0.01
Amphipoda and Isopoda	2.00	3	1	2	0.01
Echinoderms	2.32	3	1	2	0.01
Benthic mollusks	2.35	3	2	2	0.01
Crabs	3.21	3	2	2	0.01
Benthic cephalopods	3.70	3	2	2	0.30
Benthopelagic cephalopods	4.22	3	2	2	0.60
Mantis shrimp	3.71	30	2	2	0.30
Caramote prawn	3.27	30	2	2	0.01
Alien shrimp	2.86	30	2	2	0.01
Deep shrimp	3.27	30	2	2	0.01
Horse mackerel	3.71	300	3	2	0.30
European pilchard	3.12	300	3	2	0.01
Round sardinella	3.12	300	3	2	0.01
European anchovy	3.08	300	3	2	0.01
Picarel	3.10	300	3	2	0.01
Bogue	3.20	300	3	2	0.01
Benthic invertebrate feeders (1)	3.53	300	3	2	0.30
Benthic invertebrate feeders (2)	3.39	300	3	2	0.01
Mullets	3.30	300	2	2	0.01
Piscivorous fish	4.21	300	3	2	0.60
Sparidae	3.35	300	4	2	0.01
Macro-carnivorous fish (1)	4.02	300	4	2	0.60
Macro-carnivorous fish (2)	4.05	300	4	2	0.60
Rays (1)	4.06	30	4	2	0.60
Rays (2)	3.78	30	4	2	0.30
Sharks	4.35	300	5	2	0.60
Small tuna	4.45	300	5	2	0.60
Medium pelagic fish	4.12	300	5	2	0.60
Atlantic bluefin tuna	4.43	300	5	2	0.60
Dolphins	4.34	300	5	2	0.60
Sea birds	3.77	300	5	2	0.30

Appendix 5: Preferred habitat of functional groups in the model. (+) sign indicates the habitat assigned to a specific functional group (Abdou et al. 2016)

Functional group	Habitat type									
	All	Deep mud	Offshore muddy sand and gravel	Circalittoral bioclastic muddy sand				*Posidonia* high density	*Posidonia* medium density	*Posidonia* low density
Depth range (m)		>100	>100	>100	50-100	35-50	20-35	20-35	35-50	20-35
Phytoplankton	+									
Macro-algae						+	+	+	+	+
Posidonia oceanica								+	+	+
Micro and mesozooplankton	+									
Macrozooplankton	+									
Foraminifera	+									
Invertebrate suspension feeders	+									
Polychaetes	+									
Amphipoda and Isopoda	+									
Echinoderms	+									
Benthic mollusks	+									
Crabs	+									
Benthic cephalopods	+									
Benthopelagic cephalopods	+									
Mantis shrimp					+	+	+	+	+	+
Caramote prawn					+	+	+	+	+	+
Alien shrimp					+	+	+	+	+	+
Deep shrimp		+	+	+	+					
Horse mackerel	+									
European pilchard	+									
Round sardinella	+									
European anchovy	+									
Picarel	+									
Bogue	+									
Benthic invertebrate feeders (1)	+									
Benthic invertebrate feeders (2)	+									
Mullets	+									
Piscivorous fish	+									
Sparidae					+	+	+	+	+	+
Macro-carnivorous fish (1)	+									
Macro-carnivorous fish (2)	+									
Rays (+)	+									
Rays (2)	+									
Sharks	+									
Small tuna	+									
Medium pelagic fish	+									
Atlantic bluefin tuna	+									
Dolphins	+									
Sea birds	+									

Appendix 6: Distribution of fleets among habitat types. (+) sign indicates fishable habitat per fleet (Abdou et al. 2016)

Fleet	Habitat type								
	Deep mud	Offshore muddy sand and gravel	Circalittoral bioclastic muddy sand				*Posidonia* high density	*Posidonia* medium density	*Posidonia* low density
Depth range (m)	>100	>100	20-35	35-50	50-100	>100	20-35	35-50	20-35
Coastal fishing			+	+	+		+	+	+
Fishing with lights fishing	+	+		+	+	+		+	
Small seine	+	+	+	+	+	+	+	+	+
Tuna purse seine	+	+		+	+	+		+	
Demersal trawling	+	+			+	+			
Sponge fishing			+				+		+