“Piloting of eco-innovative fishery supply–chains to market added–value Adriatic fish products”

Priority Axis: Blue innovation

1.1 - Enhance the framework conditions for innovation in the relevant sectors of the blue economy within the cooperation area

D3.3.3: Report of the pre-assessment of relevant fisheries in Croatia

WP3 - Piloting of sustainable and eco-certified fishery productions/ A3.3. Piloting of selected fisheries production

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1. Introduction

This report is deliverable 3.3.3 under *Work Package 3 of Prizefish: Piloting of sustainable and eco-certified fishery production*. It presents the results of a pre-assessment of four Croatian fisheries (involving five species):

Table 1 Croatian Fisheries undergoing ARFM pre-assessment

Species	Latin name	Gear	Stock extent
Sardine Anchovy	*Sardina pilchardus* *Engraulis encrasicolus*	Purse seine	Adriatic (Shared)
Common sole	*Solea solea*	Trammel net	Adriatic (Shared)
Queen scallop	*Aequipecten opercularis*	Beam trawl (rampon)	Croatian waters
Deep-water rose shrimp	*Parapenaeus longirostris*	Bottom otter trawl	Adriatic (Shared)

The above fisheries are assessed against the Adriatic Responsible Fisheries Management (ARFM) standard (deliverable 3.2.3) based on the approach set out in standard developed under deliverable 3.3.1.

1.1. Governance

Legislation

An effective legal and administrative framework is in place, comprising international measures adopted by the General Fisheries Commission for the Mediterranean (GFCM) and for the EU Member States in the Adriatic, under the EU legal framework (mainly the EU Common Fisheries Policy (CFP)[1], the EU 'Mediterranean Regulation'[2]) as well as by national legislation and regulations adopted by the Adriatic Sea Countries.

The main document that defines conservation and management measures applied to fisheries is Marine Fisheries Act and Ordinances (Official Gazette 62/17, 130/17, 14/19), which follow the EU Common Fisheries Policy.

The Directorate of fisheries within the Ministry of agriculture is the main administrative body with responsibility for fisheries management and marine environmental protection in Croatia.

A GFCM Recommendation sets a multi-annual management plan in place for the Adriatic small pelagics fishery in subareas 17 and 18[3].

[1] EU Reg1380/2013: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R1380&qid=1625494412652
[2] EU Reg 1967/2006: https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32006R1967
[3] http://www.fao.org/gfcm/data/fleet/adriaticseasmallpelagics/en/

In 2019, a Recommendation GFCM/43/2019/5 on a multiannual management plan for sustainable demersal fisheries in the Adriatic Sea (geographical subareas 17 and 18) was adopted, listing common sole (sub-area 17) and deep-water rose shrimp (sub-areas 17 & 18) as key stocks. This sets a Minimum Conservation Reference Size (MCRS) for deep-water rose shrimp (20 mm carapace length) and common sole (20 cm), specifies the establishment of fisheries restricted areas, spatial and temporal closures and the requirement for fishing nations to manage fleet capacity so as not to exceed 2015 levels. Various improved control measures also form part of the plan.

The remaining fishery, rampon trawl for queen scallop, operates under Croatia's Marine Fisheries Act (2017), the main legislation implementing EU CFP and Med. Reg. requirements, along with additional national specifications.

Under the EU Control Regulation all fishing vessels over 12m in length are required to have an operational Vessel Monitoring System (VMS) onboard and maintain daily logbooks. This applies to all the fisheries under assessment other than the trammel net for sole, which involves smaller inshore vessels, where fishing activities are recorded through official logbooks.

The Directorate of Fisheries, with the assistance of academic institutions such as the Croatian Institute of Oceanography and Fisheries (IZOR), collate fisheries-dependent data. All data on fisheries are collected according to DCF rules, which are in line with current CFP rules. Data collected on fishing vessels include information on catch, by-catch, discards and socio-economic data.

Although fishermen are required by law to participate in data collection, most do so on a voluntary basis. Refusals to accept the observers are negligible.

Stock assessment

Stock assessment procedures vary depending on the geographical extent of the stock:

a) *Purse seine for anchovy & sardine*: GFCM assessment process with benchmarking procedures

b) *Trammel net for common sole*: GFCM assessment process with benchmarking procedures

c) *Rampon for queen scallop*: An assessment was carried out under the framework of European project DRUMFISH

d) *Bottom trawl for deep-water rose-shrimp*: GFCM & STECF stock assessment, no benchmark as yet.

There is no direct involvement of fishermen in the assessment process, but after the assessment there is consultation with stakeholders regarding any resulting management measures.

The following table describes the institutional structure in Croatian fisheries and responsible bodies[4]:

Responsibilities	***Responsible bodies***
Central	
• Overall legislation, regulation and implementation in accordance with the EU *acquis communautaire*; • Management of the European Maritime and Fisheries Fund (EMFF) in Croatia, 2014-2020; • Management of the EMFF Operational Programme; • Sustainable development of the Croatian fisheries sector; • Promotion of innovation and partnerships between fishermen and scientists; • Aquaculture, research and development; • Implementation of Common Fisheries Policy, and collection and management of data. Fisheries Inspection, Coast Guard, State Inspectorate are responsible for: - Inspection; - Surveillance; - Control.	• Ministry of Agriculture (Directorate of Fisheries), • Fisheries Inspection, • Coast Guard, • State Inspectorate, • Paying Agency for Agriculture, • Fisheries and Rural Development, • State Port Authorities
Regional	
Counties, in cooperation with local authorities, are responsible for: • Ensuring that ports are organised for fish discharging; • Ensuring berth-spots for fishery ships; • Proposing (to the Ministry of Agriculture, Directorate of Fisheries) areas for fish and shellfish farming; • Ensuring the necessary infrastructure for fish markets; • Proposing fishery regulation concerning County area to the ministry. • Managing and coordinating EMFF projects.	• Regional authorities - counties (županije) • Administrative Department for Agriculture, Rural Development and Forestry, Regional Port Authorities
Local	
• Cooperation with counties (see regional level). • Promotion of local producers. • Support of individual applicants to EMFF	• Local authorities (općine i gradovi)

[4] https://portal.cor.europa.eu/divisionpowers/Pages/Croatia-Fisheries.aspx

funding in liaison with the national managing authority.	

1.2. Environment

Regulations

As a member state of the EU, Croatia is obliged to implement all necessary environmental regulations and requirements under the Marine Strategy Framework Directive (MSFD), Marine Spatial Planning (MSP), the Water Framework Directive (WFD). For Croatia, the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention) plays a significant role in achieving the goals required by the Marine Strategy Framework Directive. An EU review of Member State implementation of environmental legislation found that Croatian legislation has conformed to the Marine Strategy Framework Directive since June 2017[5].

Croatia's Ministry of Environment and Protection is responsible for the implementation of environmental policies, which are consistent with EU requirements:

- Environment Protection Act (OG 80/13, 153/13, 78/15, 12/18, 118/18)
- Regulation on development and implementation of the documents of the Marine and Coastal Management Strategy (OG 112/14, 39/17: transposition of MSFD)
- Regulation on EIA (OG 61/14, 3/17)
- Nature Protection Act (OG 80/13, 15/18)

The EU's Habitats and Birds Directives require the development of the Natura 2000 network of protected sites. Croatia's Natura 2000 Framework, the 2nd largest in the EU by Member State area, is now largely complete[6].

Croatia has introduced rules governing public participation. These include the 'Code of Consultations with Concerned Public in Lawmaking and Other Regulatory Procedures'[7] and the 'Regulatory Impact Assessment Act[8] on Obligatory Public Consultations on New Regulations'. These rules are complemented by access to information rules and some sector-specific legislation, particularly on public participation in environmental decision-making. Moreover, a central internet portal, e-Consultations[9], help ensuring that authorities, as a minimum:

(i) publish relevant information on their websites and in the media;
(ii) organise public hearings and presentations and

[5] https://ec.europa.eu/environment/eir/pdf/report_hr_en.pdf
[6] https://ec.europa.eu/environment/eir/pdf/factsheet_hr_en.pdf
[7] Kodeks savjetovanja sa zainteresiranom javnošću u postupcima donošenja zakona, drugih propisa i akata, OJ 140/2009.
[8] Zakon o pravu na pristup informacijama — pročišćeni tekst, OJ 25/13 and 85/15.
[9] Government of the Republic of Croatia, e-Consultations.

(iii) respond to direct information requests.[10]

Through the EU structural funding for the fisheries sector (EMFF from 2013-2020 and EMFAF from 2021 onwards) the National Operational Program for Maritime Affairs and Fisheries co-finance

voluntary transitions to more selective forms of fishing, increasing the size of fishing nets, diversifying fishing activities, collecting fishing gear and garbage from the sea, buying less powerful engines and better energy efficiency.

Ecosystem

The assessment of ecosystem and food web aspects benefits from an Adriatic ecosystem model developed by Prizefish project partners the National Institute of Oceanography and Applied Geophysics (OGS). This has enabled a quantitative approach to be adopted. A complex ecosystem model describing the renewable resources from plankton to top predators in the Adriatic Sea (GSA17-18) was adapted to also include the disaggregated description of species/gears under assessment. The model defines the marine ecosystem with 75 functional groups, including plankton and non-living organic groups (detrital pools) integrating the best information available from stock assessment, trawl surveys, literature and experimental data. All fisheries in the area are categorized through 34 fleets representing a combination of vessel size, main gear used and country using landing data from official sources (STECF, DCF, GFCM data, FishstatJ) and incorporating estimates of discards.

Ecosystem impacts of fisheries (2.4.1) considers *the overall negative impact of the fleet on the ecosystem*. This is determined by summing of all negative impacts produced by a fleet (*total ecosystem impact by fleet*) on the living nodes of the food web (i.e., excluding impacts on detrital forms). The calculation of this value for each fleet allows ranking all the fleets in the model and to identify the relative position of the fisheries under assessment in relation to all fisheries impacts on the ecosystem, resulting from a combination of magnitude of the flows of matter (i.e., catches) and the importance of impacts. It should be note that potential positive effects (e.g., removal of competitors) are not considered.

The total impacts of fisheries are calculated to inform the CoE scoring for 2.4.1, while the relative impact of individual fleets are used to score the CoA in terms of fleet impact on the ecosystem.

The role of a target species in the food web is identified by the model to inform the CoA score for 2.4.2. Species with high impacts (positive or negative) on the food web are considered key elements: small changes of their biomass will have large effects on the ecosystem (Libralato et al., 2006). The sum of positive and negative impacts produced by a species node on all other living nodes of the food web (using absolute values to avoid eliciting negative and positive effects) is considered a measure of the overall impact of a species in the food web and can be used to define

[10] https://ec.europa.eu/environment/eir/pdf/report_hr_en.pdf

its role in the food web. The overall raking of species in relation to how key it is within the food web allows for CoA scoring of the target species.

Further details on this model and how it has been applied in this pre-assessment are presented in **Annex 1**.

1.3. Socio-economic aspects

Baseline

The socio-economic survey conducted as part of Prizefish (deliverable D3.4.1) provides the following socio-economic baseline:

Economic importance of fisheries. In Croatia, the share of fisheries in the total gross value added of the economy (GVA) was 0.31% in 2017. In the same year, fisheries accounted for only 0.054% of the GVA of the EU-28 economy. Apart from the fact that the share of fishery in the Croatian economy is several times higher than in the EU, this share is growing in the period 2015-2018. GVA is not available for the fishery sector by county. In Istria County, which has the fourth largest GVA in Croatia, the Agriculture, Forestry and Fishing sector (Section A) has a share of 1.3% of the total GVA, and in Zadar County of 5.3%. We estimate that the share of fishery in GVA is about 0.12% in Istria and about 0.48% in Zadar County.

Employment and wages in fishery. Fishery employs about 0.30% of all employees in Croatia, while this percentage is 3.7 times lower in the EU-28 and amounts to 0.08% (2018, EUROSTAT). The percentage of employees in Croatian fishery has been gradually decreasing from 2011 to 2019. In fisheries, the share of self-employed in total employment is significantly higher than in the economy as a whole: 66% compared to 13%. According to the Croatian Central Bureau of Statistics (CBS), at the end of March 2019, 2.23% of employees in Istria County were in Section A and 4.46% in Zadar County. The total remuneration per employee in fisheries in Croatia in 2018 was EUR 8,994, which is 66.5% of the average remuneration per employee in the economy. The average remuneration per worker is 33.5% lower than at the EU-28 level.

Economic characteristics of the fishing fleet according to the STECF AER report. Croatian fleet as a proportion of the EU fleet represents in tonnage (3%) and propulsion power (6%). The largest part of the Croatian fleet consists of small vessels for coastal fishing, which is not always for commercial purposes. Among 23 countries, the Croatian fishing fleet rank is 13th in terms of landing value, 12th in terms of GVA and 21st in terms of net profit margin. The total number of crew members in 2018 was 7,820, of which 40% were FTE. In the same year, the growth trend in the number of crew declined, but the growth in the number of FTE in the crew structure is steady. Since the largest part of the fleet consists of small vessels, it is not surprising that the number of crew per vessel is only 1 person on average.

The average remuneration to the crew members is growing annually so that in 2018 it was 12.65% higher than in 2017. The total annual revenue of the fleet is growing, and in 2018 it was 11.66% higher than the average for the period 2014-2017. However, revenue per vessel does not have such distinct growth. The gross added value of the Croatian fleet has a growth trend and in 2018 amounted to EUR 51.4 MM. Gross profit margin was 25.4%, which is less than a previous year, but significantly higher than the average for the period 2014-2017. Net profit margin rose from negative values by 2016 up to 5.4% in 2018.

Method for socio-economic assessment of the fisheries.

The DCF data collection process includes the collection of socio-economic data related to Croatian fisheries. For the assessment of SI 3.1.1 (economic conditions[11]) an objective evaluation has been attempted based on data for the Croatian fleet segments of relevance to the fisheries under assessment. To evaluate the balance between the environmental and socio-economic sustainability of the fisheries, two socio-economic indicators have been used:

- the CR/BER (Current Revenue/Break Even Revenue) and
- the RoFTA (Return on Fixed Tangible Assets)

These indicators are provided in the STECF Balance assessment (latest version, STECF 20-11), which was used for this assessment with data on the Croatian fleet to 2018. RoFTA represents the unit return on capital invested in the fisheries sector. The RoFTA was compared to the arithmetic average of the long-term harmonised interest rate of the previous five years (2014-2018). As far as CR/BER is concerned, break-even revenues (BER) correspond to the revenues necessary to cover both fixed and variable costs, such as neither to result in losses nor to generate profits. Current revenues (CR) are the total operating revenues of the fleet segment, which consists of profits from landings and non-fishing activities.

To assess the ability of the fishery (and the related management) to provide full and productive employment, the labour productivity indicator (GVA per FTE) has been used, in line with the STECF approach. The scoring scheme used for the evaluation of SI 3.1.1 is the following:

Socio-economic Indicators	**Unbalanced in 2018**	**Balanced in 2018**	**Balanced in 2018 with a decreasing trend**	**Balanced in 2018 with an increasing trend**
CR/BER	2	3	2	4
RoFTA	2	3	2	4
Intermediate score	average between score CR/BER and RoFTA			
GVA/FTE	+2 if GVA/FTE of the fishery is above the GVA/FTE of the fishery at national level			

[11] The economic conditions under which fishing industries operate shall contribute to a fair standard of living for those who depend on fishing activities. Fisheries under assessment shall promote sustained and sustainable economic growth, full and productive employment.

Final score	Final score: a value ranging from 4 to 10

This results in a total score out of 10 for 3.1.1 at CoE level. CoA is not scored for the fishers under assessment as no additional data is available specific to the fishers themselves. The socio-economic dimension is also evaluated considering how the fisheries are managed in terms of balance between the productive structures, hence **capacity**, and resources. The main source of information is, again, DCF indicators and for each fleet segment, the possible structural overcapacity.

The *SHI (Sustainable Harvest Indicator)* index is used to identify fleet segments in excess capacity, determined by the economic reliance on stocks that are considered overfished (F/Fmsy >1)[12]. To select fleet segments showing an imbalance, segments with SHI indicator values above 1 and threshold above 40% for at least two out of three years in the period 2016 - 2018 are generally considered. The assessments of the state of resources are those carried out in the GFCM working groups, other than for queen scallop where the assessment reported by Armelloni et al (2021) is used.

To assess fleet utilisation intensity, hence overcapacity, the Guidelines for Balance Indicators (COM 2014, 545), propose two different indicators aimed at measuring the Inactive Vessel Indicator (IVI)and the Vessel Use Indicator (VUI). IVI is not available for these fleets and therefore VUI is used in the assessment, which considers the activity levels of vessels that have fished at least once during the year, considering the seasonal nature of fishing activities and other restrictions. It is given, for each fleet segment, by the ratio between the observed fishing effort (the average of the days at sea per vessel) and the maximum effort found (the maximum days at sea observed in a fleet segment). According to the "traffic light" system, an indicator above 0.9 is observed only for fleet segments with a broadly homogeneous activity level, which can be assigned a green light. Values below 0.7 were considered potentially as indicators of under-utilisation which in turn may indicate technical overcapacity (red light). The indicators included among the limit values indicated are highlighted in yellow and indicate a situation of relative stability, underlining that the technical capacity available is overall moderately exploited. The scoring scheme used for the evaluation of SI 3.1.2 is the following:

Capacity Indicators	**Unbalanced in 2018**	**Balanced in 2018**	**Balanced in 2018 with a decreasing trend**	**Balanced in 2018 with an increasing trend**
SHI	2	3	2	4
VUI	2	3	2	4
Intermediate score	average between score SHI and VUI			
capacity containment	+2 if there is clear evidence of capacity containment policies			
Final score	Final score: a value ranging from 4 to 10			

[12] A detailed description and discussion of the methodology can be found in the STECF report 15-02

A full score out of 10 is given at CoE level as this data at fisher level is not available.

Reduction of Croatian fleet capacity and effort are in line with EU regulations 508/2014; 1380/2013; and supported by the European Maritime and Fisheries Fund (EMFF) National Operational Program for Maritime Affairs and Fisheries of the Republic of Croatia for the programming period 2014-2020[13]. Detailed information on fleet capacity is available in the annual fleet capacity report[14].

[13] https://euribarstvo.hr/operativni-program-za-pomorstvo-i-ribarstvo-rh-za-programsko-razdoblje-2014-2020/
[14] *https://ec.europa.eu/oceans-and-fisheries/system/files/2020-09/2019-fleet-capacity-report-croatia_en.pdf*

Table 2 Socio-economic indicators used in scoring socio-economic assessment of Croatian fisheries

			3.1.1. indicators & scores				3.2.1 indicators & scores		
Fleet Segment name	gear	vessel_length	CR/BER	RoFTA	GVA/FTE	3.1.1 score	SHI	VUI	3.2.1 score
Small pelagics PS:			Av. Score: 4	Av score: 3	Av. 20,641	+2 for GVA/FTE above national average. Overall score: **9**	Av. Score 2	Av. Score 3	+2 due to effort reduction measures. Overall score: **7**
HRV MBS PS 1218 NGI	PS	VL1218	In balance, Increasing trend	In balance	14,265		out of balance, decreasing trend	out of balance, no trend	
HRV MBS PS 1824 NGI	PS	VL1824	In balance, Increasing trend	Not sufficiently profitable	18,785		out of balance, decreasing trend	in balance, no trend	
HRV MBS PS 2440 NGI	PS	VL2440	In balance, Increasing trend	Not sufficiently profitable	28,875		out of balance, decreasing trend	in balance, no trend	
Sole Trammel net:			Score: 3	Score: 3		+2 for GVA/FTE above national average. Overall score: **8**	Score: 2	Score: 2	+2 as demersal MAP proposes effort reduction Overall score: **6**
HRV MBS DFN0612 NGI	DFN	VL0612	In balance, no trend	In balance, no trend	24,784		Out of balance No trend	out of balance, no trend	
Rampon Queen. Scallop:			Score: 2	Score:2		GVA/FTE below national average Overall score: **4**	Score: 2	Score: 3	No identification of effort reduction measures Overall score: **5**
HRV MBS DRB1218 NGI*	DRB	VL1218	out of balance, no trend	out of balance, no trend	2,777		Out of balance No trend	in balance, no trend	
HRV MBS DRB1824 NGI*	DRB	VL1824							
DW rose shrimp trawl:			Av. Score: 3	Av. Score: 2	Av. 17,699	+2 for GVA/FTE above national average. Overall score: **7**	Av. Score: 2	Av. Score: 2	+2 due to new MP with limitation + effort reduction from 2020 onwards. Overall score: **6**
HRV MBS DTS1218 NGI*	DTS	VL1218	In balance, No trend	Not sufficiently profitable	13,605		Out of balance No trend	Out of balance No trend	
HRV MBS DTS1824 NGI	DTS	VL1824	In balance, Increasing trend	In balance, Increasing trend	26,390		Out of balance No trend	Out of balance No trend	
HRV MBS DTS2440 NGI	DTS	VL2440	out of balance, increasing trend	out of balance, increasing trend	13,102		Out of balance No trend	In balance, Increasing trend	

Source: STECF 20-11 & 20-06 (national average GVA/FTE = 16,500)

Safety and working conditions (SI 3.3.1) on board of ships are an important part of the socio-economic dimension in the fisheries and maritime fields and, in Croatia, the general framework is well established. Croatia has been a member of the International Labour Organisation since 1992 and has ratified 61 acts and 1 protocol, including the forced labour convention (C029) and the Maritime Labour Convention (MLC, 2006).

Council Directive (EU) 2017/159 of 19 December 2016 on the implementation of the Agreement on the Implementation of the 2007 International Labor Organization Convention on Fisheries concluded on 21 May 2012 between the General Association of Agricultural Cooperatives in the European Union (COGECA), European Transport Workers' Union (ETF) and Associations of national organizations of fishing enterprises in the European Union (Europêche) (Text relevant to the EGP) (SL L 206, 29. 7. 1991.).

All workers on vessels have an employment contract, in accordance with the regulations on labour and safety at work (Istra PO pers. comm.). All fishermen that employ crew members enter an employment contract. In the Zadar region, all fishermen have employed persons, and in Istria 55% of them are employed. The only other way to hire workers is through seasonal contracts that are supervised and managed by special regulations. One third of fishermen do not have employees, but most of them are obliged to contribute to health and pension insurance.

Croatia has not yet ratified the ILO C.188 Working in Fishing Convention but follows EU Directive 2017/159/EU implements the ILO Work in fishing Convention (C188) agreement concerning its implementation in the EU[15].

Croatian National acts and ordinances of relevance are:

- Workers rights (Official gazette 71/14, 118/14, 154/14, 94/18, 96/18),
- Maritime law and ordinances (OG 181/04, 76/07, 146/08, 61/11, 56/13, 26/15, 17/19),
- Labor Act, NN 93/14, NN 127/2017, NN 98/2019
- Ordinance on working hours, vacations and holidays of workers on marine fishing vessels, NN 3/2016, 109/2019,
- Ordinance on the registration procedure and content of the register of employment contracts of seafarers and workers on marine fishing vessels, NN 32/2015, 109/2019, 13/2020,
- Occupational Safety and Health Act NN 71/14, NN 118/14, NN 154/14, NN 94/18, NN 96/18,
- Ordinance on the preparation of risk assessments, NN 112/14, NN 129/19

[15] https://osha.europa.eu/en/legislation/directive/directive-2017159eu-work-fishing-convention

2. ARFM Marking system

The evaluation of a fishery within the ARFM process is organized at two levels. Considering each Specific Indicator separately, a first assessment of the fishery is carried-out at the level of the entire fleet operating in the area (CoE: Component of Evaluation). A second, separate assessment is made at the level of the single actor (individual or producer organization) applying for the ARFM certification programme (CoA: Component of Accreditation).

An overall mark between 4 and 10 is assigned to the fishery, by summing the scores given for the CoE and for the CoA, as per the following grid:

Table 2 – ARFM Marking system

ARFM marking grid				
CoE	2	3	4	5
CoA	2	3	4	5
Final mark (CoE + CoA)	4	6	8	10
Level of compliance	Low Confidence Rating	Medium Confidence Rating	Medium/High Confidence Rating	High Confidence Rating

For each Specific Indicator, the final mark shall be based on the sum of the two individual scores given separately for the CoE and for the CoA. Where only CoE or CoA is scored, it is scored directly on the scale 4, 6, 8, 10.

To be certified, a fishery must score ≥ 6 (CoE + CoA) for each of the 14 Specific Indicators as well as an average of 8 out of 10 (CoE + CoA) across all Specific Indicators under each of the three key components. Indeed, a Specific Indicator can score, for instance:
3(CoE level) + 2 (CoA level) = 5 (Final mark). 5 < 6 so the fishery fails in this Specific Indicator.
or
4(CoE level) + 3 (CoA level) = 7 (Final mark). 7 > 6 so the minimum threshold is achieved in this Specific Indicator.

If the fishery is scored between 6 and 7 for any Specific Indicator, the Applicant is required to improve the fishery's performance against that Indicator by means of an action plan, so that it will get 8 or above within 5 years. This leads the fishery being certified ARFM 'subject to an action plan' (see paragraph 2.4. above).

2.1 Main outputs of the scoring by fishery

Table 3 below summarises the scoring of each fishery at CoE and CoA level and average scores for each main area of governance, environment, and socioeconomics. Details for each indicator are given in the scoring tables in section 3.

Table 3 Summary of pre-assessment scoring for the four Croatian fisheries

		Fishery 1	Fishery 2	Fishery 3	Fishery 4
		Purse seine anchovy sardine	**Trammel net for common sole**	**Rampon for Queen scallop**	**Bottom trawl for d- w rose shrimp**
Governance					
1.1.1 Legislation	CoE	4	4	4	4
	CoA	4	4	3	4
	Total	8	8	7	8
1.1.2 Cooperation	CoE	4	4	4	4
	CoA	5	5	5	5
	Total	9	9	9	9
1.2.1 Environmental policies	CoE	7	7	7	7
	CoA				
	Total	7	7	7	7
1.2.2 Management plan or a set of	CoE	4	4	3	4
	CoA	5	5	3	5
	Total	9	9	6	9
Average for Governance		**8.3**	**8.3**	**7.3**	**8.3**
Environment					
2.1.1 Data collection and statistics	CoE	5	4	3	4
	CoA	5	3	4	3
	Total	10	7	7	7
2.2.1 Institutional framework	CoE	10	8	6	8
	CoA				
	Total	10	8	6	8
2.2.2 Data limited approach	CoE	n/a	n/a	8	n/a
	CoA				
	Total	n/a	n/a	8	n/a
2.3.1 Precautionary approach	CoE	5	4	4	4
	CoA				
	Total	10	8	8	8
2.3.2 Absence of information	CoE	n/a	n/a	8	n/a
	CoA				
	Total	n/a	n/a	8	n/a
2.4.1 Ecosystem impacts	CoE	4	4	5	3
	CoA	3	4	3	4
	Total	7	8	8	7
2.4.2 Food web	CoE	6	10	10	8
	Total	6	10	10	8
Average for Environment		**8.6**	**8.2**	**7.9**	**7.6**
Socio-economics					
3.1.1 Economic conditions	CoE	9	8	4	7
	CoA				
	Total	9	8	4	7
3.2.1 Fishing capacity	CoE	7	6	5	6
	CoA				
	Total	7	6	5	6
3.3.1 Human rights and safety on board	CoE	4	4	4	4
	CoA	4	4	4	4
	Total	8	8	8	8
Average for Socio-economics		**8.0**	**7.3**	**5.7**	**7.0**

Purse seine for sardine and anchovy has an average score of 8 or above across all main components and currently passes the ARFM standard.

Only the rampon fishery fails a specific indicator (3.1.1., economic conditions). However, two of the other selected fisheries (trammel net for sole and trawl for deep water rose shrimp) would require

some additional actions before they can be certified under the ARFM standard as they do not achieve an average score of 8 or above under the main components.

A summary of the scoring for each fishery is given in the sections below, with full scoring tables provided in the Annex). Actions are proposed to enable the fisheries to address the shortcomings identified. There is also opportunity to improve information related to fishers and their positive management actions to support scoring some scoring indicators at CoA level and to increase confidence levels.

2.2. Sardine and anchovy fished by purse seines

The small pelagic fishery fished by purse seine in the Adriatic has some of the best stock information and management effort in the Adriatic. There is also a good level of international co-operation through the GFCM shown in the development of the management plan. This is particularly important due to the important role of the species in the food web and the relatively high impact of the fishery on these two species.

The lack of management measures to implement marine environmental policies is a weakness. Specifically for the purse seine fishery for small pelagics, the information emerging from the Medbycatch project should be acted on to minimize interaction and impact on vulnerable species. Despite the management plan, management authorities have to date failed to fully address over-capacity, leading to resource over-exploitation and so poorer socio-economic outcomes.

The tables below give the overall score obtained by the fishery, whether passing the ARFM assessment (table 4). Table 5 indicates areas of improvement for those SIs where overall score <=7).

Table 4 Summary score for small pelagic purse seine fishery

Fishery	Components	Average score	Overall result
Purse seine for small pelagics (anchovy & sardine)	**GOVERNANCE (1)**	8.3	**Passing ARFM pre-assessment** with conditions for 3 SIs (1.2.1, 2.4.2, 3.2.1)
	ENVIRONMENT (2)	8.6	
	SOCIO-ECONOMIC (3)	8.0	

Table 5 – Small Pelagic Purse Seine SIs scoring <=7 and proposed action to improve the score.

Supporting Articles (SA)	Specific Indicators (SI)	Score	Actions needed (to be defined under the action plan)
1.2. A clear decision-making process is part of the management system to achieve the objectives foreseen by international, national, and local fishery laws and has an appropriate approach to avoid conflicts.	1.2.1. Environmental policies	7	Include more environmental aspects into management strategies and implement management measures for MPAs/designated sites.
2.4.2. The role of the stock under consideration in the food web shall be considered, and if it is a key prey species in the ecosystem, management objectives and measures shall be in place to avoid severe adverse impacts on dependent preys and predators.	2.4.2. Food web	6	Ensure harvest strategies and management fully recognises the key role target species play in the food web.

3.2.1. Based on the data available and the most recent assessments and advice from relevant scientific bodies on stock status and their exploitation rates, estimates indicators to judge about fleet overcapacity.	3.2.1 Fishing capacity	7	Reduce effort in the fishery to improve stock status leading to improvements in the sustainable harvest indicator (SHI).

2.3. Sole by trammel net

The trammel net fishery for common sole achieves a score of 8 or more on average across the three main standard components of governance, environment and socio-economic. There is a good level of scientific knowledge on the stock and a GFCM recommendation has been developed for a multi-annual plan for the fishery, although the assessment remains data limited and more reliable information could be sought, particularly on discards and information from the small-scale vessels operating in this fishery. The overall environmental and ecosystem impact of the fishery is estimated to be relatively low.

Table 6 Summary score for sole trammel net fishery

Fishery	Components	Average score	Overall result
Trammel net for sole	**GOVERNANCE (1)**	8.3	**Failing ARFM pre-assessment** with conditionality for 3 SIs (1.2.1, 2.1.1, 2.3.2)
	ENVIRONMENT (2)	8.2	
	SOCIO-ECONOMIC (3)	7.3	

Table 7 – Sole Trammel net fishery SIs scoring <=7 and proposed action to improve the score.

Supporting Articles (SA)	Specific Indicators (SI)	Score	Actions needed (to be defined under the action plan)
1.2.1 A clear decision-making process is part of the management system to achieve the objectives foreseen by international, national, and local fishery laws and has an appropriate approach to avoid conflicts.	1.2.1. Environmental policies	7	include more environmental aspects into management strategies
2.1.1. All significant fishery removals and mortality of the target species shall be considered by management. Specifically, reliable and accurate data required for assessing the status of fishery and ecosystems, including data on retained catch and discards shall be collected. These data shall be collected, at an appropriate time and level of	2.2.1. Institutional framework	7	Improve data collection in the fishery to ensure all removals can be fully considered in management plan

aggregation, by relevant management organizations and provided to relevant fisheries organizations.			
3.2.1. Based on the data available and the most recent assessments and advice from relevant scientific bodies on stock status and their exploitation rates, estimates indicators to judge about fleet overcapacity.	3.2.1 Fishing capacity	6	Reduce effort in the fishery to improve stock status leading to improvements in the sustainable harvest indicator (SHI).

2.4. Queen scallop by rampon trawl

This fishery is the only one of the four that is not managed as a shared Adriatic stock. The level of information on the fishery has improved, but this has only been assessed very recently as part of a project, not a regular arrangement and a specific management plan for the fishery is lacking. This can negatively impact the environment (as this is mobile bottom gear) and socioeconomics if resources are not managed at a sustainable level.

Table 8 Summary score for rampon scallop fishery

Fishery	Components	Average score	Overall result
Rampon for queen scallop	**GOVERNANCE (1)**	7.3	**Failing ARFM pre-assessment** 3.1.1 direct fail with conditionality for 6 SIs (1.1.1, 1.2.1, 1.2.2, 2.1.1, 2.2.1, 3.2.1)
	ENVIRONMENT (2)	7.9	
	SOCIO-ECONOMIC (3)	5.7	

Table 9 – Rampon queen scallop fishery SIs scoring <=7 and proposed action to improve the score.

Supporting Articles (SA)	Specific Indicators (SI)	Score	Actions needed (to be defined under the action plan)
1.1.1 An effective legal and administrative framework at international, European, national and local levels appropriate for fishery resource conservation and management. The management system and the fishery operate in compliance with the requirements of international, national, and local laws, regulations and agreements.	1.1.1 Legislation	7	Improve the evidence base on compliance with the management system, which can then show an effective harvest strategy.
1.2.1 A clear decision-making process is part of the management system to achieve the objectives foreseen by international, national, and local fishery laws and has an appropriate approach to avoid conflicts.	1.2.1. Environmental policies	7	Include more environmental aspects into management strategies
1.2.2 Long-term management objectives shall be translated into a plan or other management document and be subscribed to by all interested parties.	1.2.2 Management plan	6	Develop a long-term management plan for the fishery
2.1.1. All significant fishery removals and mortality of the target species shall be considered by management. Reliable and	2.2.1. Institutional	7	Introduce regular data collection and in the fishery to

accurate data for assessing the status of fishery and ecosystems, including on retained catch and discards shall be collected at an appropriate time and level of aggregation and provided to relevant fisheries organizations.	framework		ensure all removals can be fully considered to inform a management plan.
2.2.1 An appropriate institutional framework shall be established to determine the applied research required and its proper use (i.e., assess/evaluate stock assessment model/practices) for fishery management purposes.	2.2.1 Institutional framework	6	Introduce regular stock assessment to ensure all removals are fully considered to inform a management plan.
3.1.1 The economic conditions under which fishing industries operate shall contribute to a fair standard of living for those who depend on fishing activities. Fisheries under assessment shall promote sustained and sustainable economic growth, full and productive employment.	3.1.1 Economic conditions	4	All socio-economic indicators are currently out of balance. Management and data collection in the fishery need to be improved to illustrate the fishery is in balance.
3.2.1. Based on the data available and the most recent assessments and advice from relevant scientific bodies on stock status and their exploitation rates, estimates indicators to judge about fleet overcapacity.	3.2.1 Fishing capacity	6	Reduce effort in the fishery to improve stock status leading to improvements in the sustainable harvest indicator (SHI).

2.5 Deep water rose shrimp by demersal trawl

International co-operation and the legislative framework for this fishery is well-established through GFCM and the level of information on the deep-water rose shrimp has improved in recent years. However, environmental management has not been found to be effective and more management is needed to ensure this fishery does not impact vulnerable habitats and species. There is uncertainty over that the impact of the fishery on the ecosystem due to limited discard information which should be improved. Over-capacity is identified in the fishery and this has resulted in resource over-exploitation.

Table 10 Summary score for deep water rose shrimp fishery

Fishery	Components	Average score	Overall result
Deep water rose shrimp trawl fishery	**GOVERNANCE (1)**	8.3	**Failing ARFM pre-assessment** with conditionality for 5 SIs (1.2.1, 2.1.1, 2.4.1, 3.1.1., 3.2.1)
	ENVIRONMENT (2)	7.6	
	SOCIO-ECONOMIC (3)	7.0	

Table 11 – Deep water rose shrimp trawl fishery SIs scoring <=7 and proposed action to improve the score.

Supporting Articles (SA)	Specific Indicators (SI)	Score	Actions needed (to be defined under the action plan)

1.2.1 A clear decision-making process is part of the management system to achieve the objectives foreseen by international, national, and local fishery laws and has an appropriate approach to avoid conflicts.	1.2.1. Environmental policies	7	include more environmental aspects into management strategies
2.1.1. All significant fishery removals and mortality of the target species shall be considered by management. Reliable and accurate data for assessing the status of fishery and ecosystems, including on retained catch and discards shall be collected at an appropriate time and level of aggregation and provided to relevant fisheries organizations.	2.1.1. Data collection	7	Improve data collection in the fishery to ensure all removals can be fully considered in management plan
2.4.1 The most probable adverse impacts of fishery on the ecosystem/environment, shall be assessed and, where appropriate, addressed and/or corrected, taking into account available scientific information.	2.4.1 Ecosystem impacts	7	Reduce bycatch and discarding. Improve information on discards to better inform ecosystem assessment.
3.1.1 The economic conditions under which fishing industries operate shall contribute to a fair standard of living for those who depend on fishing activities. Fisheries under assessment shall promote sustained and sustainable economic growth, full and productive employment.	3.1.1 Economic conditions	7	Management to improve stock condition and data collection in the fishery need to be improved to illustrate the fishery is in balance.
3.2.1. Based on the data available and the most recent assessments and advice from relevant scientific bodies on stock status and their exploitation rates, estimates indicators to judge about fleet overcapacity.	3.2.1 Fishing capacity	6	Reduce effort in the fishery to improve stock status leading to improvements in the sustainable harvest indicator (SHI).

4. References

(see Annex 2 for references related to ecosystem modelling by Librato et al)

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STECF (2018) Mediterranean Stocks Assessments part 1 (18-12), part 2 (18-16)

STECF (2020a) Annual Economic Report of the European Fishing Fleet (20-06)

STECF (2020b) Balance between fishing capacity and fishing opportunities (20-11)

Annex 1: ARFM scoring tables

1. Sardine and anchovy fished by purse seines

ARFM marking grid_Governance					
	Evaluation level	Level of compliance			
		Low confidence rating	Medium Confidence Rating	Medium/High Confidence Rating	High Confidence Rating
Supporting article 1.1	**There shall be a structured and legally mandated management system based upon and respecting international, national, and local fishery laws, for the responsible utilization of the target stock and conservation of the marine environment. FAO CCRF3 (1995) 7.1.3/7.1.4/7.1.9/7.3.1/7.3.2/7.3.4/7.6.8/7.7.1/**				

SI 1.1.1 Legislation There shall be an effective legal and administrative framework established at international, European, national and local levels appropriate for fishery resource conservation and management. The management system and the fishery operate in compliance with the requirements of international, national, and local laws and regulations, including the requirements of any regional and/or international fisheries management agreement.	**CoE 1.1.1 evaluation**	*There is a comprehensive international management framework under the EU's CFP and the Med Regulation as well as through the GFCM. However the European Environment Agency (EEA) reported in 2020 that the CFP objective of fishing all stocks within MSY levels by 2020 was unlikely to be met. The STECF's review of CFP progress shows that progress in the Mediterranean is relatively poor compared to other sea areas.*			
	CoE 1.1.1 score			4	
	CoA level 1.1.1 evaluation	The fishers are aware and are reported to be compliant with the management system, although low levels of enforcement effort is reported by ECA)			
	CoA 1.1.1 score			4	
	Final mark 1.1.1 (CoE+CoA)			**8**	
SI 1.1.2 Cooperation Where transboundary, shared, straddling, highly migratory, or high seas fish stocks are exploited by two or more countries (neighboring or not), the	**CoE 1.1.2 evaluation**	The GFCM is the regional fisheries management organisation responsible for shared stocks in the Adriatic. There is evidence of good co-operation between relevant parties, as exemplified in the Adriamed project on scientific cooperation to support sustainable fisheries in the Adriatic.			
	CoE 1.1.2 score			4	

applicant and appropriate management organizations concerned shall cooperate and take part in the formal fishery commission or arrangements appointed to ensure effective conservation and management of the stock(s) in question and their environment.	**CoA level 1.1.2 evaluation**	Croatia's Ministry of Agriculture is the main administrative body involved in fisheries management. Fisheries inspection and coastguard are also responsible for inspection and control duties. Croatia is a full participant in GFCM matters, including the application of multi-annual plans (MAP).			
	CoA 1.1.2 score				5
	Final mark 1.1.2 (CoE+CoA)				**9**
Supporting article 1.2	**A clear decision-making process is part of the management system to achieve the objectives foreseen by international, national, and local fishery laws and has an appropriate approach to avoid conflicts. FAO CCRF (1995) 10.1.1, 10.1.2, 10.1.4, 10.2.1, 10.2.2, 10.2.4**				
SI 1.2.1 Environmental policies Within the fisheries management organization's jurisdiction, an appropriate policy, legal, and institutional framework shall be adopted in order to achieve sustainable and integrated use of living marine resources, allowing for determination of the possible uses of resources and	**CoE 1.2.1 evaluation**	Croatia's Ministry of Environment and Protection is responsible for the implementation of environmental policies, which are consistent with EU requirements. A 2020 EEA audit of Marine Protection found that: EU protection rules have not led to the recovery of significant ecosystems and habitats. The network of marine protected areas was not representative of the EU's diverse seas and sometimes provided little protection. In practice, the provisions to coordinate fisheries policy with environmental policy had not worked as intended, and the species and habitats protected by birds and habitats directives were based on outdated threat assessments. Croatia's Natura 2000 Framework, the 2nd largest in the EU by Member State area, is now largely complete. However, the latest Environmental Implementation Review (EIR) of 2019 identified that conservation objectives and accompanying management measures within Natura 2000 sites is still to be done. The Med by catch project has now been expanded to include Croatia, which is an important step for this fishery that has the potential to interact with vulnerable species.			

governing access to them.	CoE 1.2.1 score		7		
	CoA level 1.2.1 evaluation				
	CoA 1.2.1 score				
	Final mark 1.2.1 (CoE+CoA)		**7**		
SI 1.2.2 Management plan or a set of management measures Long-term management objectives shall be translated into a plan or other management document and be subscribed to by all interested parties.	CoE 1.2.2 evaluation	A Multi-Annual Plan (MAP) is in place for small pelagic fisheries in the Adriatic.			
	CoE 1.2.2 score			4	
	CoA level 1.2.2 evaluation	Croatia is a full participant in GFCM matters, including the application of multi-annual plans (MAP). Croatian fishers are reported to be compliant with requirements of the MAP, including the effort limitation measures. All fishing activities are monitored by the Fisheries Monitoring Centre of the Directorate of Fisheries through VMS data, digital logbook, inspection at sea, landing site or market, and fishing vessels are also supervised by trained and licenced Coast Guard officers.			

	CoA 1.2.2 score				5
	Final mark 1.2.2 (CoE+CoA)				**9**

ARFM marking grid_Environment					
	Evaluation level	Level of compliance			
		Low confidence rating	Medium Confidence Rating	Medium/High Confidence Rating	High Confidence Rating
Supporting article 2.1	**There shall be an effective fishery data (dependent and independent) collection and analysis system for stock management purposes.**				

2.1.1 Data collection and statistics All significant fishery removals and mortality of the target species shall be considered by management. Specifically, reliable and accurate data required for assessing the status of fishery and ecosystems, including data on retained catch and discards shall be collected. These data shall be collected, at an appropriate time and level of aggregation, by relevant management organizations and provided to relevant fisheries organizations. FAO CCRF (1995) 7.3.1, 7.4.6, 7.4.7, 12.4 FAO Eco (2009) 29.1-29.3	**CoE 2.1.1 evaluation**	*Stock assessments are conducted for both species in Adriatic (priority commercial species). Data on catches, retained and discards are collected via logbooks. Reference points for F and SSB are established. A benchmark process on the stock assessment (latest was in 2015).*			
	CoE 2.1.1 score				5
	CoA level 2.1.1 evaluation	Vessel logbook data that is completed and provided by Croatian vessels operating in the fishery. VMS and e-logbook are required for: - all vessels over 15 m in length, as well as vessels over 12 m in length if they operate outside the territorial sea or for more than 24 hours - all vessels working with tools that are under management plans and have an Authorization (authorization) issued: bottom trawls, sardine swimmers, small swimmers (mullet, bonito, locardar, needlefish, lizard), tuna traps. (Istra PO pers. comm.)			
	CoA 2.1.1 score				5
	Final mark 1.1.1 (CoE+CoA)				**10**
Supporting article 2.2	**To support its optimum utilization, there shall be regular stock assessment activities appropriate for the fishery resource—its range, the species biology, and the ecosystem—all undertaken in accordance with acknowledged scientific standards.**				

2.2.1 Institutional framework An appropriate institutional framework shall be established to determine the applied research required and its proper use (i.e., assess/evaluate stock assessment model/practices) for fishery management purposes. FAO CCRF 12.2, 12.6	**CoE 2.2.1 evaluation**	GFCM coordinates the process across all 5 participating nations (Croatia, Italy, Serbia, Montenegro and Albania. Croatian authorities collect the logbook data from Croatian vessels and share information with stock assessment scientists.			
	CoE 2.2.1 score				10
	CoA level 2.2.1 evaluation				
	CoA 2.2.1 score				
	Final mark 2.2.1 (CoE+CoA)				**10**
2.2.2 Data limited approach Less elaborate stock assessment methods are frequently used for small-scale, data poor stocks or low-value capture fisheries resulting in greater uncertainty about the status of the stock under consideration. A more	**CoE 2.2.2 evaluation**	n/a			
	CoE 2.2.2 score				

precautionary approach to managing fisheries on such resources shall be required, including, where appropriate, a lower level of resource utilization. A record of good management performance may be considered as supporting evidence of the adequacy of the management system.	**CoA level 2.2.2 evaluation**	n/a			
	CoA 2.2.2 score				
	Final mark 2.2.2 (CoE+CoA)	n/a			
Supporting article 2.3	**Management actions and measures for the conservation of stock and the aquatic environment shall be based on the precautionary approach. Where information is deficient, a suitable method using risk assessment shall be adopted to take into account uncertainty**				
2.3.1 Precautionary approach The precautionary approach shall be applied widely to conservation, management, and exploitation of ecosystems to protect and preserve them. This should take due account of fishery enhancement procedures, where appropriate. Absence	**CoE 2.3.1 evaluation**	Stock assessment advice is based on the PA. A Bpa reference point is set for SSB. Croatian fisheries management increased the temporary cessation period above that proposed in the MAP.			
	CoE 2.3.1 score				5
	CoA level 2.3.1 evaluation				
	CoA 2.3.1 score				

of scientific information shall not be used as a reason for postponing or failing to take conservation and management measures. Relevant uncertainties shall be taken into account through a suitable method of risk management, including those associated with the use of introduced or translocated species. FAO CCRF (1995) 7.5.2	**Final mark 2.3.1 (CoE+CoA)**				**10**
2.3.2 Absence of information In the absence of adequate scientific information, appropriate research shall be initiated in a timely fashion. FAO CCRF (1995) 7.5.1, 12.3	**CoE 2.3.2 evaluation**	Mediterranean International Acoustic Survey (MEDIAS) undertaken along with MEDITS.			
	CoE 2.3.2 score			4	
	CoA level 2.3.2 evaluation	Vessels participate in additional sampling operations associated with closed areas			
	CoA 2.3.2 score			4	
	Final mark 2.3.2 (CoE+CoA)			**8**	
Supporting Article 2.4	**Considerations of fishery interactions and their effects on the ecosystem shall be based on best available science, local knowledge where it can be objectively verified, and a risk-based management approach to determine the most probable adverse impacts. Adverse impacts on the fishery on the ecosystem shall be appropriately assessed and effectively addressed.**				

2.4.1 Ecosystem impacts The most probable adverse impacts of fishery on the ecosystem/environment, shall be assessed and, where appropriate, addressed and/or corrected, taking into account available scientific information. This may take the form of an immediate management response or a further analysis of the identified risk. In the absence of specific information on the ecosystem impacts of fishery under assessment, generic evidence based on similar fishery situations can be used for fisheries with low risk of severe adverse impact. However, the greater the risk, the more specific evidence shall be necessary to ascertain the adequacy of mitigation measures. FAO Eco (2009) 30.4, 31, 31.4 FAO Eco (2011) 41.4	**CoE 2.4.1 evaluation**	See Annex for graphs detailing ecosystem modelling results. Low overall negative impact of the fleet on the ecosystem			
	CoE 2.4.1 score			4	
	CoA level 2.4.1 evaluation	See Annex for graphs detailing ecosystem modelling results. Medium-high impact of the fleet on the target species			
	CoA 2.4.1 score			3	
	Final mark 2.4.1 (CoE + CoA)			**7**	
2.4.2 Food web The role of the stock under	**CoE 2.4.2 evaluation**	See Annex for graphs detailing ecosystem modelling results. Medium-high overall impact of the species in the food web			

consideration in the food web shall be considered, and if it is a key prey species in the ecosystem, management objectives and measures shall be in place to avoid severe adverse impacts on dependent preys and predators. FAO Eco (2009) 31.2	CoE 2.4.2 score			6	
	CoA level 2.4.2 evaluation	n/a			
	CoA 2.4.2 score				
	Final mark 2.4.2 (CoE+CoA)			**6**	

ARFM marking grid_Socio-economics					
	Evaluation level	**Level of compliance**			
		Low confidence rating	**Medium Confidence Rating**	**Medium/High Confidence Rating**	**High Confidence Rating**

Supporting article 3.1	**Economic, social, and cultural value of resources shall be assessed by the appropriate fisheries management organization in order to assist decision making on their use and the fishing activities should be managed in coherence with the objectives of achieving economic, social and employment benefits.** FAO CCRF (1995) 10.2.2 Art. 2, point 1 of the EU Common Fishery Policy Basic Regulation – Reg. (EU) No 1380/2013				
3.1.1 Economic conditions The economic conditions under which fishing industries operate shall contribute to a fair standard of living for those who depend on fishing activities. Fisheries under assessment shall promote sustained and sustainable economic growth, full and productive employment. Art. 2, point 5 f) of the EU Common Fishery Policy Basic Regulation – Reg. (EU) No 1380/2013	**CoE 3.1.1 evaluation**	*STECF Annual Economic Report (AER) shows employment and personnel costs in Croatian fisheries have increased over time (2008-2017), indicating socio-economic improvements over this period. Unfortunately, fishermen's average income per month is significantly below the average salary. Budget support in fisheries increased by 254% from 2007-2016 with EU accession and access to structural funding (Mikus et al, 2018).* *See table 2 for socio-economic indicators & resulting score.*			
	CoE 3.1.1 score			9	
	CoA level 3.1.1 evaluation	CoA not scored as fisher-specific data not available			
	CoA 3.1.1 score				
	Final mark 3.1.1 (CoE+CoA)			**9**	

Supporting article 3.2	**Excess fishing capacity shall be avoided and exploitation of the stocks shall remain economically viable.** Art. 22 of the EU Common Fishery Policy Basic Regulation – Reg. (EU) No 1380/2013				
3.2.1 Fishing capacity Based on the data available and the most recent assessments and advice from relevant scientific bodies on stock status and their exploitation rates, estimates indicators to judge about fleet overcapacity.	**CoE 3.2.1 evaluation**	Adriatic fleets targeting small pelagics are over-capacity. PS fleet remains out of balance due to reliance on over-fished stocks (SHI). Effort reduction measures have been introduced. DCF derived data gives medium/high confidence level.			
	CoE 3.2.1 score			7	
	CoA level 3.2.1 evaluation	CoA not scored as no fisher-specific data			
	CoA 3.2.1 score				
	Final mark 3.2.1 (CoE+CoA)			**7**	
Supporting article 3.3.	**The fishery activity shall work in full compliance with international laws on labor, human rights and safety.**				

3.3.1 Human rights and safety on board International norm shall clearly be followed in fishing fleet under assessment, such as fisheries should not participate in slavery or other human rights abuses and shall promote decent work for all.	**CoE 3.3.1 evaluation**	Croatia has ratified ILO fundamental conventions on workers rights, but not yet C.188 Work in Fishing.			
	CoE 3.3.1 score			4	
	CoA level 3.3.1 evaluation	Vessel operators in the fishery undertake employment consistent with national requirements. Croatia's EU structural funding programmes in fisheries (EMFF) has sought to improve safety and work conditions onboard vessels.			
	CoA 3.3.1 score			4	
	Final mark 3.3.1 (CoE+CoA)			**8**	

2. Common sole fished by trammel nets

ARFM marking grid_Governance					
	Evaluation level	**Level of compliance**			
		Low confidence rating	**Medium Confidence Rating**	**Medium/High Confidence Rating**	**High Confidence Rating**
Supporting article 1.1	**There shall be a structured and legally mandated management system based upon and respecting international, national, and local fishery laws, for the responsible utilization of the target stock and conservation of the marine environment. FAO CCRF3 (1995) 7.1.3/7.1.4/7.1.9/7.3.1/7.3.2/7.3.4/7.6.8/7.7.1/**				
SI 1.1.1 Legislation There shall be an effective legal and administrative framework established at international, European, national and local levels appropriate for fishery resource conservation and management. The management system and the fishery operate in compliance with the requirements of international,	**CoE 1.1.1 evaluation**	*There is a comprehensive international management framework under the EU's CFP and the Med Regulation as well as through the GFCM. More specifically there is a GFCM recommendation for a multiannual management plan for demersal stocks (GFCM/43/2019/5). Common sole is a named species for the fleets to be managed under the plan. These illustrate a comprehensive legal and administrative framework for fishery resource management. The European Environment Agency (EEA) reported in 2020 that the CFP objective of fishing all stocks within MSY levels by 2020 was unlikely to be met. The STECF's review of CFP progress shows that progress in the Mediterranean is relatively poor compared to other sea areas.*			
	CoE 1.1.1 score			4	

national, and local laws and regulations, including the requirements of any regional and/or international fisheries management agreement.	**CoA level 1.1.1 evaluation**	The fishers are aware and are reported to be compliant with the management system, although low levels of enforcement effort is reported by ECA.			
	CoA 1.1.1 score			4	
	Final mark 1.1.1 (CoE+CoA)			**8**	
SI 1.1.2 Cooperation Where transboundary, shared, straddling, highly migratory, or high seas fish stocks are exploited by two or more countries (neighboring or not), the applicant and appropriate management organizations concerned shall cooperate and take part in the formal fishery commission or arrangements appointed to ensure effective conservation and management of the stock(s) in question and their environment.	**CoE 1.1.2 evaluation**	The GFCM is the regional fisheries management organisation responsible for shared stocks in the Adriatic. There is evidence of good co-operation between relevant parties, as exemplified in the Adriamed project on scientific cooperation to support sustainable fisheries in the Adriatic.			
	CoE 1.1.2 score			4	
	CoA level 1.1.2 evaluation	Croatia's Ministry of Agriculture is the main administrative body involved in fisheries management. Fisheries inspection and coastguard are also responsible for inspection and control duties. Croatia is a full participant in GFCM matters, including the application of multi-annual plans (MAP).			
	CoA 1.1.2 score				5
	Final mark 1.1.2 (CoE+CoA)				**9**

Supporting article 1.2	**A clear decision-making process is part of the management system to achieve the objectives foreseen by international, national, and local fishery laws and has an appropriate approach to avoid conflicts. FAO CCRF (1995) 10.1.1, 10.1.2, 10.1.4, 10.2.1, 10.2.2, 10.2.4**				
SI 1.2.1 Environmental policies Within the fisheries management organization's jurisdiction, an appropriate policy, legal, and institutional framework shall be adopted in order to achieve sustainable and integrated use of living marine resources, allowing for determination of the possible uses of resources and governing access to them.	**CoE 1.2.1 evaluation**	Croatia's Ministry of Environment and Protection is responsible for the implementation of environmental policies, which are consistent with EU requirements. A 2020 EEA audit of Marine Protection found that: EU protection rules have not led to the recovery of significant ecosystems and habitats. The network of marine protected areas was not representative of the EU's diverse seas and sometimes provided little protection. In practice, the provisions to coordinate fisheries policy with environmental policy had not worked as intended, and the species and habitats protected by birds and habitats directives were based on outdated threat assessments. Croatia's Natura 2000 Framework, the 2nd largest in the EU by Member State area, is now largely complete. However, the latest Envrionmental Implementation Review (EIR) of 2019 identified that conservation objectives and accompanying management measures within Natura 2000 sites is still to be done.			
	CoE 1.2.1 score		7		
	CoA level 1.2.1 evaluation				
	CoA 1.2.1 score				

	Final mark 1.2.1 (CoE+CoA)		**7**		
SI 1.2.2 Management plan or a set of management measures Long-term management objectives shall be translated into a plan or other management document and be subscribed to by all interested parties.	**CoE 1.2.2 evaluation**	A Multi-Annual Plan (MAP) is in place for demersal fisheries in the Adriatic.			
	CoE 1.2.2 score			4	
	CoA level 1.2.2 evaluation	Croatia is a full participant in GFCM matters, including the application of multi-annual plans (MAP). Croatian fishers are reported to be compliant with requirements of the MAP, including the effort limitation measures. All fishing activities are monitored by the Fisheries Monitoring Centre of the Directorate of Fisheries through digital logbook (some vessels below 12m so not with VMS), inspection at sea, landing site or market, and fishing vessels are also supervised by trained and licenced Coast Guard officers.			
	CoA 1.2.2 score				5
	Final mark 1.2.2 (CoE+CoA)				**9**

ARFM marking grid_Environment		
	Evaluation	**Level of compliance**

	level	Low confidence rating	Medium Confidence Rating	Medium/High Confidence Rating	High Confidence Rating
Supporting article 2.1	**There shall be an effective fishery data (dependent and independent) collection and analysis system for stock management purposes.**				
2.1.1 Data collection and statistics All significant fishery removals and mortality of the target species shall be considered by management. Specifically, reliable and accurate data required for assessing the status of fishery and ecosystems, including data on retained catch and discards shall be collected. These data shall be collected, at an appropriate time and level of aggregation, by relevant management organizations and provided to relevant fisheries organizations. FAO CCRF (1995) 7.3.1, 7.4.6, 7.4.7, 12.4 FAO Eco (2009) 29.1-29.3	**CoE 2.1.1 evaluation**	Stock assessments are conducted for common sole (priority commercial species). Data on catches, retained and discards are collected via logbooks. The fundamental idea of this stock assessment is to use the integrated approach of stock synthesis (lastversion SS3.3) to model the size structure data available for the common sole. SS3 uses a forward projection of the population in the "statistical catch-at-age" approach. Benchmarking process conducted in 2021.			
	CoE 2.1.1 score			4	
	CoA level 2.1.1 evaluation	Vessel logbook data is completed and provided by Croatian vessels operating in the fishery. VMS and e-logbook are required for: - all vessels over 15 m in length, as well as vessels over 12 m in length if they operate outside the territorial sea or for more than 24 hours - all vessels working with tools that are under management plans and have an Authorization (authorization) issued: bottom trawls, sardine swimmers, small swimmers (mullet, bonito, locardar, needlefish, lizard), tuna traps (Istra PO pers. comm.) As the trammel net fishery is mainly small-scale vessels below 12m, the collection of data is less comprehensive than for vessels over 12m. More information on data collection and provision in the fishery is needed.			

	CoA 2.1.1 score		3		
	Final mark 1.1.1 (CoE+CoA)		**7**		
Supporting article 2.2	**To support its optimum utilization, there shall be regular stock assessment activities appropriate for the fishery resource—its range, the species biology, and the ecosystem—all undertaken in accordance with acknowledged scientific standards.**				
2.2.1 Institutional framework An appropriate institutional framework shall be established to determine the applied research required and its proper use (i.e., assess/evaluate stock assessment model/practices) for fishery management purposes. FAO CCRF 12.2, 12.6	**CoE 2.2.1 evaluation**	GFCM coordinates the process across all 5 participating nations (Croatia, Italy, Serbia, Montenegro and Albania. Croatian authorities collect the logbook data from Croatian vessels and share information with stock assessment scientists. Mediterranean International Acoustic Survey (MEDIAS) undertaken along with MEDITS to provide data for common sole, which is not considered data limited. A benchmark on the assessment was carried out in 2021.			
	CoE 2.2.1 score			8	
	CoA level 2.2.1 evaluation				
	CoA 2.2.1 score				

	Final mark 2.2.1 (CoE+CoA)			**8**	
2.2.2 Data limited approach Less elaborate stock assessment methods are frequently used for small-scale, data poor stocks or low-value capture fisheries resulting in greater uncertainty about the status of the stock under consideration. A more precautionary approach to managing fisheries on such resources shall be required, including, where appropriate, a lower level of resource utilization. A record of good management performance may be considered as supporting evidence of the adequacy of the management system.	**CoE 2.2.2 evaluation**	n/a			
	CoE 2.2.2 score				
	CoA level 2.2.2 evaluation	n/a			
	CoA 2.2.2 score				
	Final mark 2.2.2 (CoE+CoA)	n/a			

Supporting article 2.3	**Management actions and measures for the conservation of stock and the aquatic environment shall be based on the precautionary approach. Where information is deficient, a suitable method using risk assessment shall be adopted to take into account uncertainty**				
2.3.1 Precautionary approach The precautionary approach shall be applied widely to conservation, management, and exploitation of ecosystems to protect and preserve them. This should take due account of fishery enhancement procedures, where appropriate. Absence of scientific information shall not be used as a reason for postponing or failing to take conservation and management measures**.** Relevant uncertainties shall be taken into account through a suitable method of risk management, including those associated with the use of introduced or translocated species. FAO CCRF (1995) 7.5.2	**CoE 2.3.1 evaluation**	Stock assessment advice is based on the PA. Results suggested that the stock is in low overexploitation with relatively low biomass. Reduction of fishing mortality was recommended in lastest stock assessment.			
	CoE 2.3.1 score			4	
	CoA level 2.3.1 evaluation				
	CoA 2.3.1 score				
	Final mark 2.3.1 (CoE+CoA)			**8**	
2.3.2 Absence of information	**CoE 2.3.2 evaluation**				

In the absence of adequate scientific information, appropriate research shall be initiated in a timely fashion. FAO CCRF (1995) 7.5.1, 12.3	**CoE 2.3.2 score**				
	CoA level 2.3.2 evaluation				
	CoA 2.3.2 score				
	Final mark 2.3.2 (CoE+CoA)				
Supporting Article 2.4	**Considerations of fishery interactions and their effects on the ecosystem shall be based on best available science, local knowledge where it can be objectively verified, and a risk-based management approach to determine the most probable adverse impacts. Adverse impacts on the fishery on the ecosystem shall be appropriately assessed and effectively addressed.**				
2.4.1 Ecosystem impacts The most probable adverse impacts of fishery on the ecosystem/environment, shall be assessed and, where appropriate, addressed and/or corrected, taking into account available scientific information. This may take the form of an immediate management response or a further analysis of the identified risk. In the absence of specific information on the ecosystem impacts of fishery	**CoE 2.4.1 evaluation**	See Annex for graphs detailing ecosystem modelling results. low overall negative impact of the fleet on the ecosystem			
	CoE 2.4.1 score			4	
	CoA level 2.4.1 evaluation	See Annex for graphs detailing ecosystem modelling results. low impact of the fleet to the target species			
	CoA 2.4.1 score			4	
	Final mark 2.4.1 (CoE+CoA)			**8**	

under assessment, generic evidence based on similar fishery situations can be used for fisheries with low risk of severe adverse impact. However, the greater the risk, the more specific evidence shall be necessary to ascertain the adequacy of mitigation measures. FAO Eco (2009) 30.4, 31, 31.4 FAO Eco (2011) 41.4					
2.4.2 Food web The role of the stock under consideration in the food web shall be considered, and if it is a key prey species in the ecosystem, management objectives and measures shall be in place to avoid severe adverse impacts on dependent preys and predators. FAO Eco (2009) 31.2	**CoE 2.4.2 evaluation**	See Annex for graphs detailing ecosystem modelling results. outputs of the trophic level analyses for common sole using N/C ratio isotopes indicates it is not a key prey species in the Adriatic. Confirmed by low overall impact of the species in the food web			
	CoE 2.4.2 score			5	
	CoA level 2.4.2 evaluation	n/a			
	CoA 2.4.2 score				
	Final mark 2.4.2 (CoE+CoA)			**10**	

ARFM marking grid_Socio-economics					
	Evaluation level	**Level of compliance**			
		Low confidence rating	**Medium Confidence Rating**	**Medium/High Confidence Rating**	**High Confidence Rating**
Supporting article 3.1	**Economic, social, and cultural value of resources shall be assessed by the appropriate fisheries management organization in order to assist decision making on their use and the fishing activities should be managed in coherence with the objectives of achieving economic, social and employment benefits.** FAO CCRF (1995) 10.2.2 Art. 2, point 1 of the EU Common Fishery Policy Basic Regulation – Reg. (EU) No 1380/2013				
3.1.1 Economic conditions The economic conditions under which fishing industries operate shall contribute to a fair standard of living for those who depend on fishing activities. Fisheries under assessment shall promote sustained and sustainable economic growth, full and productive employment.	**CoE 3.1.1 evaluation**	*Both indicators are in balance (no increasing trend identified) and the GVA/FTE is above the national average.*			
	CoE 3.1.1 score			8	

Art. 2, point 5 f) of the EU Common Fishery Policy Basic Regulation – Reg. (EU) No 1380/2013	**CoA level 3.1.1 evaluation**	CoA is not scored			
	CoA 3.1.1 score				
	Final mark 3.1.1 (CoE+ CoA)			**8**	
Supporting article 3.2	**Excess fishing capacity shall be avoided and exploitation of the stocks shall remain economically viable.** Art. 22 of the EU Common Fishery Policy Basic Regulation – Reg. (EU) No 1380/2013				
3.2.1 Fishing capacity Based on the data available and the most recent assessments and advice from relevant scientific bodies on stock status and their exploitation rates, estimates indicators to judge about fleet overcapacity.	**CoE 3.2.1 evaluation**	Croatian DFN are considered out of balance for both indicators, but a demersal MP is now in place to address overcapacity.			
	CoE 3.2.1 score			6	
	CoA level 3.2.1 evaluation	CoA is not scored as no specific fisher data.			

	CoA 3.2.1 score				
	Final mark 3.2.1 (CoE+ CoA)			**6**	
Supporting article 3.3.	**The fishery activity shall work in full compliance with international laws on labor, human rights and safety.**				
3.3.1 Human rights and safety on board International norm shall clearly be followed in fishing fleet under assessment, such as fisheries should not participate in slavery or other human rights abuses and shall promote decent work for all.	**CoE 3.3.1 evaluation**	Croatia has ratified ILO fundamental conventions on workers rights, but not yet C.188 Work in Fishing.			
	CoE 3.3.1 score			4	
	CoA level 3.3.1 evaluation	Vessel operators in the fishery undertake employment consistent with national requirements. Croatia's EU structural funding programmes in fisheries (EMFF) has sought to improve safety and work conditions onboard vessels.			

	CoA 3.3.1 score			4	
	Final mark 3.3.1 (CoE+ CoA)			**8**	

3. Rampon fishery for queen scallop

ARFM marking grid_Governance					
	Evaluation level	Level of compliance			
		Low confidence rating	Medium Confidence Rating	Medium/High Confidence Rating	High Confidence Rating

Supporting article 1.1	**There shall be a structured and legally mandated management system based upon and respecting international, national, and local fishery laws, for the responsible utilization of the target stock and conservation of the marine environment. FAO CCRF3 (1995) 7.1.3/7.1.4/7.1.9/7.3.1/7.3.2/7.3.4/7.6.8/7.7.1/**				
SI 1.1.1 Legislation There shall be an effective legal and administrative framework established at international, European, national and local levels appropriate for fishery resource conservation and management. The management system and the fishery operate in compliance with the requirements of international, national, and local laws and regulations, including the requirements of any regional and/or international fisheries management agreement.	**CoE 1.1.1 evaluation**	*There is a comprehensive management framework under the Croatian Marine Fisheries Act (2017) implementing the EU's CFP and the Med Regulation. More specifically there is a GFCM recommendation for a multiannual management plan for demersal stocks (GFCM/43/2019/5). While queen scallop is not a named species, beam trawling is one of the gears managed under the plan. These illustrate a comprehensive legal and administrative framework for fishery resource management. the European Environment Agency (EEA) reported in 2020 that the CFP objective of fishing all stocks within MSY levels by 2020 was unlikely to be met. The STECF's review of CFP progress shows that progress in the Mediterranean is relatively poor compared to other sea areas.*			
	CoE 1.1.1 score			4	
	CoA level 1.1.1 evaluation	The fishers are aware of the management system and regulations, but levels of enforcement effort an compliance is unknown			
	CoA 1.1.1 score		3		
	Final mark 1.1.1 (CoE+CoA)		**7**		

SI 1.1.2 Cooperation Where transboundary, shared, straddling, highly migratory, or high seas fish stocks are exploited by two or more countries (neighboring or not), the applicant and appropriate management organizations concerned shall cooperate and take part in the formal fishery commission or arrangements appointed to ensure effective conservation and management of the stock(s) in question and their environment.	**CoE 1.1.2 evaluation**	The rampon fishery operates in Croatian waters. There is good co-operation between relevant parties and well-defined roles for national bodies, regional and local authorities.			
	CoE 1.1.2 score			4	
	CoA level 1.1.2 evaluation	Croatia's Ministry of Agriculture is the main administrative body involved in fisheries management. Fisheries inspection and coastguard are also responsible for inspection and control duties.			
	CoA 1.1.2 score				5
	Final mark 1.1.2 (CoE+CoA)				**9**
Supporting article 1.2	**A clear decision-making process is part of the management system to achieve the objectives foreseen by international, national, and local fishery laws and has an appropriate approach to avoid conflicts. FAO CCRF (1995) 10.1.1, 10.1.2, 10.1.4, 10.2.1, 10.2.2, 10.2.4**				
SI 1.2.1 Environmental policies Within the fisheries management organization's jurisdiction, an appropriate	**CoE 1.2.1 evaluation**	Croatia's Ministry of Environment and Protection is responsible for the implementation of environmental policies, which are consistent with EU requirements. A 2020 EEA audit of Marine Protection found that: EU protection rules have not led to the recovery of significant ecosystems and habitats. The network of marine protected areas was not representative of the EU's diverse seas and sometimes provided little protection. In practice, the provisions to coordinate fisheries policy with			

policy, legal, and institutional framework shall be adopted in order to achieve sustainable and integrated use of living marine resources, allowing for determination of the possible uses of resources and governing access to them.		environmental policy had not worked as intended, and the species and habitats protected by birds and habitats directives were based on outdated threat assessments. Croatia's Natura 2000 Framework, the 2nd largest in the EU by Member State area, is now largely complete. However, the latest Envrionmental Implementation Review (EIR) of 2019 identified that conservation objectives and accompanying management measures within Natura 2000 sites is still to be done.			
	CoE 1.2.1 score		7		
	CoA level 1.2.1 evaluation				
	CoA 1.2.1 score				
	Final mark 1.2.1 (CoE+CoA)		**7**		
SI 1.2.2 Management plan or a set of management measures Long-term management objectives shall be translated	**CoE 1.2.2 evaluation**	Long term objectives set out in Marine Fisheries Act, consistent with CFP. However these are not translated into a plan specifically for the rampon fishery			
	CoE 1.2.2 score		3		

into a plan or other management document and be subscribed to by all interested parties.	**CoA level 1.2.2 evaluation**	General rules applying to trawl fisheries (out with 3 miles), but limited fishery-specific management evident.			
	CoA 1.2.2 score		3		
	Final mark 1.2.2 (CoE+CoA)		**6**		

ARFM marking grid_Environment					
	Evaluation level	**Level of compliance**			
		Low confidence rating	**Medium Confidence Rating**	**Medium/High Confidence Rating**	**High Confidence Rating**

Supporting article 2.1	**There shall be an effective fishery data (dependent and independent) collection and analysis system for stock management purposes.**				
2.1.1 Data collection and statistics All significant fishery removals and mortality of the target species shall be considered by management. Specifically, reliable and accurate data required for assessing the status of fishery and ecosystems, including data on retained catch and discards shall be collected. These data shall be collected, at an appropriate time and level of aggregation, by relevant management organizations and provided to relevant fisheries organizations. FAO CCRF (1995) 7.3.1, 7.4.6, 7.4.7, 12.4 FAO Eco (2009) 29.1-29.3	**CoE 2.1.1 evaluation**	*Fishery removals are recorded in e-logbooks and reported. Discards of target species are limited. However the data input used in Armelloni et al (2021) for queen scallop was 2004-2008, which is older and a shorter time frame than other species suggesting survey data is limited.*			
	CoE 2.1.1 score		*3*		
	CoA level 2.1.1 evaluation	E-logbook data from all vessels is provided to authorities. Vessel logbook data that is completed and provided by Croatian vessels operating in the fishery. VMS and e-logbook are required for: - all vessels over 15 m in length, as well as vessels over 12 m in length if they operate outside the territorial sea or for more than 24 hours - all vessels working with tools that are under management plans and have an Authorization (authorization) issued: bottom trawls, sardine swimmers, small swimmers (mullet, bonito, locardar, needlefish, lizard), tuna traps (Istra PO pers. comm.)			
	CoA 2.1.1 score			4	
	Final mark 1.1.1 (CoE+CoA)			**7**	

Supporting article 2.2	**To support its optimum utilization, there shall be regular stock assessment activities appropriate for the fishery resource—its range, the species biology, and the ecosystem—all undertaken in accordance with acknowledged scientific standards.**				
2.2.1 Institutional framework An appropriate institutional framework shall be established to determine the applied research required and its proper use (i.e., assess/evaluate stock assessment model/practices) for fishery management purposes. FAO CCRF 12.2, 12.6	**CoE 2.2.1 evaluation**	Assessment was carried out in the framework of European project DRUMFISH (http://drumfish.org/), addressing methods of assessment for data poor stocks. This shows an ad-hoc assessment approach rather than an institutional framework delivering research and regular assessment for the fishery.			
	CoE 2.2.1 score		6		
	CoA level 2.2.1 evaluation				
	CoA 2.2.1 score				
	Final mark 2.2.1 (CoE+CoA)		**6**		
2.2.2 Data limited approach Less elaborate stock assessment methods are frequently used for small-	**CoE 2.2.2 evaluation**	Assessment was carried out in the framework of European project DRUMFISH (http://drumfish.org/), addressing methods of assessment for data poor stocks. This shows an ad-hoc assessment approach rather than a regular assessment. A paper by Armelloni et al (2021) reports on this process and the status of queen scallop stocks.			

scale, data poor stocks or low-value capture fisheries resulting in greater uncertainty about the status of the stock under consideration. A more precautionary approach to managing fisheries on such resources shall be required, including, where appropriate, a lower level of resource utilization. A record of good management performance may be considered as supporting evidence of the adequacy of the management system.	**CoE 2.2.2 score**			8	
	CoA level 2.2.2 evaluation	n/a			
	CoA 2.2.2 score				
	Final mark 2.2.2 (CoE+CoA)			**8**	
Supporting article 2.3	**Management actions and measures for the conservation of stock and the aquatic environment shall be based on the precautionary approach. Where information is deficient, a suitable method using risk assessment shall be adopted to take into account uncertainty**				
2.3.1 Precautionary approach The precautionary approach shall be applied widely to conservation, management, and exploitation of ecosystems to protect and preserve	**CoE 2.3.1 evaluation**	Croatia has implemented the CFP which requires PA to be applied. Armelloni has derived MSY levels for queen scallop			
	CoE 2.3.1 score			4	
	CoA level 2.3.1	n/a			

them. This should take due account of fishery enhancement procedures, where appropriate. Absence of scientific information shall not be used as a reason for postponing or failing to take conservation and management measures**.** Relevant uncertainties shall be taken into account through a suitable method of risk management, including those associated with the use of introduced or translocated species. FAO CCRF (1995) 7.5.2	**evaluation**				
	CoA 2.3.1 score				
	Final mark 2.3.1 (CoE+CoA)			**8**	
2.3.2 Absence of information In the absence of adequate scientific information, appropriate research shall be initiated in a timely fashion. FAO CCRF (1995) 7.5.1, 12.3	**CoE 2.3.2 evaluation**	Projects have been commissioned (DRUMFISH) to help fill the information gaps due to a regular assessment lacking.			
	CoE 2.3.2 score			8	
	CoA level 2.3.2 evaluation				
	CoA 2.3.2 score				
	Final mark 2.3.2 (CoE+CoA)			**8**	

Supporting Article 2.4	**Considerations of fishery interactions and their effects on the ecosystem shall be based on best available science, local knowledge where it can be objectively verified, and a risk-based management approach to determine the most probable adverse impacts. Adverse impacts on the fishery on the ecosystem shall be appropriately assessed and effectively addressed.**				
2.4.1 Ecosystem impacts The most probable adverse impacts of fishery on the ecosystem/environment, shall be assessed and, where appropriate, addressed and/or corrected, taking into account available scientific information. This may take the form of an immediate management response or a further analysis of the identified risk. In the absence of specific information on the ecosystem impacts of fishery under assessment, generic evidence based on similar fishery situations can be used for fisheries with low risk of severe adverse impact. However, the greater the risk, the more specific evidence shall be necessary to ascertain the adequacy of	**CoE 2.4.1 evaluation**	See Annex for graphs detailing ecosystem modelling results. very low overall negative impact of the fleet on the ecosystem; need to improve data on discards			
	CoE 2.4.1 score			5	
	CoA level 2.4.1 evaluation	See Annex for graphs detailing ecosystem modelling results. low impact of the fleet to the target species, but precautionary value due to poorly quantified discards			
	CoA 2.4.1 score			3	
	Final mark 2.4.1 (CoE+CoA)			**8**	

mitigation measures. FAO Eco (2009) 30.4, 31, 31.4 FAO Eco (2011) 41.4					
2.4.2 Food web The role of the stock under consideration in the food web shall be considered, and if it is a key prey species in the ecosystem, management objectives and measures shall be in place to avoid severe adverse impacts on dependent preys and predators. FAO Eco (2009) 31.2	**CoE 2.4.2 evaluation**	See Annex for graphs detailing ecosystem modelling results. Low overall impact of the species in the food web			
	CoE 2.4.2 score			10	
	CoA level 2.4.2 evaluation	n/a			
	CoA 2.4.2 score				
	Final mark 2.4.2 (CoE+CoA)			**10**	

ARFM marking grid Socio-economics		
	Evaluation	**Level of compliance**

	level	Low confidence rating	Medium Confidence Rating	Medium/High Confidence Rating	High Confidence Rating
Supporting article 3.1	**Economic, social, and cultural value of resources shall be assessed by the appropriate fisheries management organization in order to assist decision making on their use and the fishing activities should be managed in coherence with the objectives of achieving economic, social and employment benefits.** FAO CCRF (1995) 10.2.2 Art. 2, point 1 of the EU Common Fishery Policy Basic Regulation – Reg. (EU) No 1380/2013				
3.1.1 Economic conditions The economic conditions under which fishing industries operate shall contribute to a fair standard of living for those who depend on fishing activities. Fisheries under assessment shall promote sustained and sustainable economic growth, full and productive employment. Art. 2, point 5 f) of the EU Common Fishery Policy Basic Regulation – Reg. (EU) No 1380/2013	**CoE 3.1.1 evaluation**	*Both indicators out of balance and GVA/FTE is significantly below national average. See Table 2.*			
	CoE 3.1.1 score			4	
	CoA level 3.1.1 evaluation	CoA not scored as no fisher specific data.			
	CoA 3.1.1 score				

	Final mark 3.1.1 (CoE+CoA)			**4**	
Supporting article 3.2	**Excess fishing capacity shall be avoided and exploitation of the stocks shall remain economically viable.** Art. 22 of the EU Common Fishery Policy Basic Regulation – Reg. (EU) No 1380/2013				
3.2.1 Fishing capacity Based on the data available and the most recent assessments and advice from relevant scientific bodies on stock status and their exploitation rates, estimates indicators to judge about fleet overcapacity.	**CoE 3.2.1 evaluation**	VUI in balance but SHI reported to be out of balance. Armelloni et al (2021) report some improvement in stocks (from a low level) but no identification of effort reduction measures. DCF derived data gives med/high confidence level.			
	CoE 3.2.1 score			5	
	CoA level 3.2.1 evaluation				
	CoA 3.2.1 score				
	Final mark 3.2.1 (CoE+CoA)			**5**	

Supporting article 3.3.	**The fishery activity shall work in full compliance with international laws on labor, human rights and safety.**				
3.3.1 Human rights and safety on board International norm shall clearly be followed in fishing fleet under assessment, such as fisheries should not participate in slavery or other human rights abuses and shall promote decent work for all.	**CoE 3.3.1 evaluation**	Croatia has ratified ILO fundamental conventions on workers rights, but not yet C.188 Work in Fishing.			
	CoE 3.3.1 score			4	
	CoA level 3.3.1 evaluation	Vessel operators in the fishery undertake employment consistent with national requirements. Croatia's EU structural funding programmes in fisheries (EMFF) has sought to improve safety and work conditions onboard vessels.			
	CoA 3.3.1 score			4	
	Final mark 3.3.1 (CoE+CoA)			**8**	

3.4. Trawl fishery for deep-water rose shrimp

ARFM marking grid_Governance					
	Evaluation level	**Level of compliance**			
		Low confidence rating	**Medium Confidence Rating**	**Medium/High Confidence Rating**	**High Confidence Rating**
Supporting article 1.1	**There shall be a structured and legally mandated management system based upon and respecting international, national, and local fishery laws, for the responsible utilization of the target stock and conservation of the marine environment. FAO CCRF3 (1995) 7.1.3/7.1.4/7.1.9/7.3.1/7.3.2/7.3.4/7.6.8/7.7.1/**				
SI 1.1.1 Legislation There shall be an effective legal and administrative framework established at international, European, national and local levels appropriate for fishery resource conservation and management. The management system and the fishery operate in compliance with the requirements of international,	**CoE 1.1.1 evaluation**	There is a comprehensive international management framework under the EU's CFP and the Med Regulation as well as through the GFCM. More specifically there is a GFCM recommendation for a multiannual management plan for demersal stocks (GFCM/43/2019/5). DW rose shrimp is a named species for the fleets to be managed under the plan. These illustrate a comprehensive legal and administrative framework for fishery resource management. However the European Environment Agency (EEA) reported in 2020 that the CFP objective of fishing all stocks within MSY levels by 2020 was unlikely to be met. The STECF's review of CFP progress shows that progress in the Mediterranean is relatively poor compared to other sea areas.			
	CoE 1.1.1 score			4	

national, and local laws and regulations, including the requirements of any regional and/or international fisheries management agreement.	**CoA level 1.1.1 evaluation**	The fishers are aware and are reported to be compliant with the management system, although low levels of enforcement effort is reported by ECA.			
	CoA 1.1.1 score			4	
	Final mark 1.1.1 (CoE+CoA)			**8**	
SI 1.1.2 Cooperation Where transboundary, shared, straddling, highly migratory, or high seas fish stocks are exploited by two or more countries (neighboring or not), the applicant and appropriate management organizations concerned shall cooperate and take part in the formal fishery commission or arrangements appointed to ensure effective conservation and management of the stock(s) in question and their environment.	**CoE 1.1.2 evaluation**	The GFCM is the regional fisheries management organisation responsible for shared stocks in the Adriatic. There is evidence of good co-operation between relevant parties, as exemplified in the Adriamed project on scientific cooperation to support sustainable fisheries in the Adriatic.			
	CoE 1.1.2 score			4	
	CoA level 1.1.2 evaluation	Croatia's Ministry of Agriculture is the main administrative body involved in fisheries management. Fisheries inspection and coastguard are also responsible for inspection and control duties. Croatia is a full participant in GFCM matters, including the application of multi-annual plans (MAP).			
	CoA 1.1.2 score				5
	Final mark 1.1.2 (CoE+CoA				**9**

	)				
Supporting article 1.2	**A clear decision-making process is part of the management system to achieve the objectives foreseen by international, national, and local fishery laws and has an appropriate approach to avoid conflicts. FAO CCRF (1995) 10.1.1, 10.1.2, 10.1.4, 10.2.1, 10.2.2, 10.2.4**				
SI 1.2.1 Environmental policies Within the fisheries management organization's jurisdiction, an appropriate policy, legal, and institutional framework shall be adopted in order to achieve sustainable and integrated use of living marine resources, allowing for determination of the possible uses of resources and governing access to them.	**CoE 1.2.1 evaluation**	Croatia's Ministry of Environment and Protection is responsible for the implementation of environmental policies, which are consistent with EU requirements. A 2020 EEA audit of Marine Protection found that: EU protection rules have not led to the recovery of significant ecosystems and habitats. The network of marine protected areas was not representative of the EU's diverse seas and sometimes provided little protection. In practice, the provisions to coordinate fisheries policy with environmental policy had not worked as intended, and the species and habitats protected by birds and habitats directives were based on outdated threat assessments. Croatia's Natura 2000 Framework, the 2nd largest in the EU by Member State area, is now largely complete. However, the latest Environmental Implementation Review (EIR) of 2019 identified that conservation objectives and accompanying management measures within Natura 2000 sites is still to be done.			
	CoE 1.2.1 score		7		
	CoA level 1.2.1 evaluation				

	CoA 1.2.1 score				
	Final mark 1.2.1 (CoE+CoA)		**7**		
SI 1.2.2 Management plan or a set of management measures Long-term management objectives shall be translated into a plan or other management document and be subscribed to by all interested parties.	**CoE 1.2.2 evaluation**	A Multi-Annual Plan (MAP) is in place for demersal fisheries in the Adriatic.			
	CoE 1.2.2 score			4	
	CoA level 1.2.2 evaluation	Croatia is a full participant in GFCM matters, including the application of multi-annual plans (MAP). Croatian fishers are reported to be compliant with requirements of the MAP, including the effort limitation measures. All fishing activities are monitored by the Fisheries Monitoring Centre of the Directorate of Fisheries through digital logbook (some vessels below 12m so not with VMS), inspection at sea, landing site or market, and fishing vessels are also supervised by trained and licenced Coast Guard officers.			
	CoA 1.2.2 score				5
	Final mark 1.2.2 (CoE+CoA)				**9**

ARFM marking grid_Environment					
	Evaluation level	Level of compliance			
		Low confidence rating	Medium Confidence Rating	Medium/High Confidence Rating	High Confidence Rating
Supporting article 2.1	**There shall be an effective fishery data (dependent and independent) collection and analysis system for stock management purposes.**				
2.1.1 Data collection and statistics All significant fishery removals and mortality of the target species shall be considered by management. Specifically, reliable and accurate data required for assessing the status of fishery and ecosystems, including data on retained catch and discards shall be collected.	**CoE 2.1.1 evaluation**	*Stock assessments are conducted for deep water rose shrimp (priority commercial species). Data on catches, retained and discards are collected via logbooks. Fishery removals are recorded in e-logbooks and reported. Data on discards of target and bycatch species are limited.* *The data input used in Armelloni et al (2021) for queen scallop was 2004-2008, which is older and a shorter time frame than other species suggesting survey data is limited.*			
	CoE 2.1.1 score		*3*		

These data shall be collected, at an appropriate time and level of aggregation, by relevant management organizations and provided to relevant fisheries organizations. FAO CCRF (1995) 7.3.1, 7.4.6, 7.4.7, 12.4 FAO Eco (2009) 29.1-29.3	**CoA level 2.1.1 evaluation**	Vessel logbook data that is completed and provided by Croatian vessels operating in the fishery. Vessel logbook data that is completed and provided by Croatian vessels operating in the fishery. VMS and e-logbook are required for: - all vessels over 15 m in length, as well as vessels over 12 m in length if they operate outside the territorial sea or for more than 24 hours - all vessels working with tools that are under management plans and have an Authorization (authorization) issued: bottom trawls, sardine swimmers, small swimmers (mullet, bonito, locardar, needlefish, lizard), tuna traps (Istra PO pers. comm.)			
	CoA 2.1.1 score			4	
	Final mark 1.1.1 (CoE+CoA)		**7**		
Supporting article 2.2	**To support its optimum utilization, there shall be regular stock assessment activities appropriate for the fishery resource—its range, the species biology, and the ecosystem—all undertaken in accordance with acknowledged scientific standards.**				
2.2.1 Institutional framework An appropriate institutional framework shall be established to determine the applied research required and its proper use (i.e., assess/evaluate stock	**CoE 2.2.1 evaluation**	GFCM coordinates the process across all 5 participating nations (Croatia, Italy, Serbia, Montenegro and Albania. Croatian authorities collect the logbook data from Croatian vessels and share information with stock assessment scientists. Mediterranean International Acoustic Survey (MEDIAS) undertaken along with MEDITS to provide data for common sole, which is not considered data limited.			
	CoE 2.2.1 score			8	

assessment model/practices) for fishery management purposes. FAO CCRF 12.2, 12.6	**CoA level 2.2.1 evaluation**				
	CoA 2.2.1 score				
	Final mark 2.2.1 (CoE+CoA)			**8**	
2.2.2 Data limited approach Less elaborate stock assessment methods are frequently used for small-scale, data poor stocks or low-value capture fisheries resulting in greater uncertainty about the status of the stock under consideration. A more precautionary approach to managing fisheries on such resources shall be required, including, where appropriate, a lower level of resource utilization. A record of good management performance may be considered as supporting evidence of the adequacy of the	**CoE 2.2.2 evaluation**	n/a			
	CoE 2.2.2 score				
	CoA level 2.2.2 evaluation	n/a			
	CoA 2.2.2 score				

management system.	**Final mark 2.2.2 (CoE+CoA)**	n/a			
Supporting article 2.3	**Management actions and measures for the conservation of stock and the aquatic environment shall be based on the precautionary approach. Where information is deficient, a suitable method using risk assessment shall be adopted to take into account uncertainty**				
2.3.1 Precautionary approach The precautionary approach shall be applied widely to conservation, management, and exploitation of ecosystems to protect and preserve them. This should take due account of fishery enhancement procedures, where appropriate. Absence of scientific information shall not be used as a reason for postponing or failing to take conservation and management measures**.** Relevant uncertainties shall be taken into account through a suitable method of risk management, including those associated with the use of introduced or translocated species.	**CoE 2.3.1 evaluation**	Stock is considered to be over-exploited.			
	CoE 2.3.1 score			4	
	CoA level 2.3.1 evaluation				
	CoA 2.3.1 score				
	Final mark 2.3.1 (CoE+CoA)			**8**	

FAO CCRF (1995) 7.5.2					
2.3.2 Absence of information In the absence of adequate scientific information, appropriate research shall be initiated in a timely fashion. FAO CCRF (1995) 7.5.1, 12.3	**CoE 2.3.2 evaluation**				
	CoE 2.3.2 score				
	CoA level 2.3.2 evaluation				
	CoA 2.3.2 score				
	Final mark 2.3.2 (CoE+CoA)				
Supporting Article 2.4	**Considerations of fishery interactions and their effects on the ecosystem shall be based on best available science, local knowledge where it can be objectively verified, and a risk-based management approach to determine the most probable adverse impacts. Adverse impacts on the fishery on the ecosystem shall be appropriately assessed and effectively addressed.**				
2.4.1 Ecosystem impacts The most probable adverse impacts of fishery on the ecosystem/environment, shall be assessed and, where appropriate, addressed and/or corrected, taking into account available	**CoE 2.4.1 evaluation**	See Annex for graphs detailing ecosystem modelling results. medium-high overall negative impact of the fleet on the ecosystem; a precautionary value also due to uncertainties on discards			
	CoE 2.4.1 score		3		
	CoA level 2.4.1 evaluation	See Annex for graphs detailing ecosystem modelling results. low impact of the fleet to the target species			

scientific information. This may take the form of an immediate management response or a further analysis of the identified risk. In the absence of specific information on the ecosystem impacts of fishery under assessment, generic evidence based on similar fishery situations can be used for fisheries with low risk of severe adverse impact. However, the greater the risk, the more specific evidence shall be necessary to ascertain the adequacy of mitigation measures. FAO Eco (2009) 30.4, 31, 31.4 FAO Eco (2011) 41.4	**CoA 2.4.1 score**			4	
	Final mark 2.4.1 (CoE+CoA)			**7**	
2.4.2 Food web The role of the stock under consideration in the food web shall be considered, and if it is a key prey species in the ecosystem, management objectives and measures shall be in place to avoid severe adverse impacts on dependent preys and	**CoE 2.4.2 evaluation**	See Annex for graphs detailing ecosystem modelling results. medium to low overall impact of the species in the food web			
	CoE 2.4.2 score			4	
	CoA level 2.4.2 evaluation	n/a			
	CoA 2.4.2 score				

predators. FAO Eco (2009) 31.2	**Final mark 2.4.2** **(CoE+CoA)**			**8**	

ARFM marking grid_Socio-economics					
	Evaluation level	**Level of compliance**			
		Low confidence rating	**Medium Confidence Rating**	**Medium/High Confidence Rating**	**High Confidence Rating**
Supporting article 3.1	**Economic, social, and cultural value of resources shall be assessed by the appropriate fisheries management organization in order to assist decision making on their use and the fishing activities should be managed in coherence with the objectives of achieving economic, social and employment benefits.** FAO CCRF (1995) 10.2.2 Art. 2, point 1 of the EU Common Fishery Policy Basic Regulation – Reg. (EU) No 1380/2013				

3.1.1 Economic conditions The economic conditions under which fishing industries operate shall contribute to a fair standard of living for those who depend on fishing activities. Fisheries under assessment shall promote sustained and sustainable economic growth, full and productive employment. Art. 2, point 5 f) of the EU Common Fishery Policy Basic Regulation – Reg. (EU) No 1380/2013	**CoE 3.1.1 evaluation**	STECF Annual Economic Report (AER) shows employment and personnel costs have increased over time (2008-2017) and are above average for DTS fleet segment, 18-24m segment is in balance and increasing profitability but smaller (12-18) and larger (24-40) are not sufficiently profitable. GVA/FTE is just above the national average. DCF derived data gives med/high confidence level.			
	CoE 3.1.1 score			7	
	CoA level 3.1.1 evaluation	Not scored at CoA level – no fisher specific data or measures			
	CoA 3.1.1 score				
	Final mark 3.1.1 (CoE+CoA)			**7**	
Supporting article 3.2	**Excess fishing capacity shall be avoided and exploitation of the stocks shall remain economically viable.** Art. 22 of the EU Common Fishery Policy Basic Regulation – Reg. (EU) No 1380/2013				

3.2.1 Fishing capacity Based on the data available and the most recent assessments and advice from relevant scientific bodies on stock status and their exploitation rates, estimates indicators to judge about fleet overcapacity.	**CoE 3.2.1 evaluation**	DTS **Out of balance** as SHI indicates high dependency on overfished stocks. 30 days temporal closure in the fishing zones C and D and part of the fishing zone E. The effect of catch/effort management was a 7% reduction in the number of fishing days in 2019 in the DTS fleet compared to 2018. As a result, in 2019 total catch of demersal species in the bottom trawl net was reduced by 2% compared to 2018, and by 9% compared to 2015. DCF derived data gives med/high confidence level.			
	CoE 3.2.1 score			6	
	CoA level 3.2.1 evaluation				
	CoA 3.2.1 score				
	Final mark 3.2.1 (CoE+CoA)			**6**	
Supporting article 3.3.	**The fishery activity shall work in full compliance with international laws on labor, human rights and safety.**				

3.3.1 Human rights and safety on board International norm shall clearly be followed in fishing fleet under assessment, such as fisheries should not participate in slavery or other human rights abuses and shall promote decent work for all.	**CoE 3.3.1 evaluation**	Croatia has ratified ILO fundamental conventions on workers rights, but not yet C.188 Work in Fishing.			
	CoE 3.3.1 score			4	
	CoA level 3.3.1 evaluation	Vessel operators in the fishery undertake employment consistent with national requirements. Croatia's EU structural funding programmes in fisheries (EMFF) has sought to improve safety and work conditions onboard vessels.			
	CoA 3.3.1 score			4	
	Final mark 3.3.1 (CoE+CoA)			**8**	

Annex 2: Ecosystem & food web assessment method & results

Detailed explanation on methodology, application and results for the assessment of ecosystem and food web aspects into the ARFM

1. The approach

The assessment of ecosystem and food web aspects into the ARFM were considered by adopting a quantitative approach based on ecosystem modelling. To this purpose, a complex ecosystem model describing the renewable resources from plankton to top predators in the Adriatic Sea (GSA17-18) was adapted to include also the disaggregated description of species/gears under assessment. The model represent the marine ecosystem with 75 functional groups, including plankton and non-living organic groups (detrital pools) integrating the best information available from stock assessment, trawl surveys, literature and experimental data (example of data input: Celic et al., 2017). All the fisheries in the area are described at a great level of detail through 34 fleets representing combination of vessel size, main gear used and country using data from all official sources (STECF, DCF, GFCM data, FishstatJ and other) integrated with estimates of discards.

The ecosystem model developed with the software Ecopath with Ecosim (version 6.6.5; www.ecopath.org; Christensen and Walters, 2004) is using primary production changes (from Copernicus; Di Biagio et al., 2019) and effort dynamics (from combination of information from DCF, VMS analysis and Fleet register) as main forcings, and it is calibrated over data from 2004 to 2018 using trawl survey and stock assessment data. This model represents the state of the art of the ecosystem description calibrated for the whole GSA17 and 18 including data for Croatia, Italy, Slovenia, Albania, Montenegro and Bosnia and Hercegovina. It is worth noting that the model results in terms of trophic level was confronted with the results from isotopes measures for *Solea solea*, highlighting good degree of agreement between model and data and representing an additional indication of the accurate description of the ecosystem that the model represents.

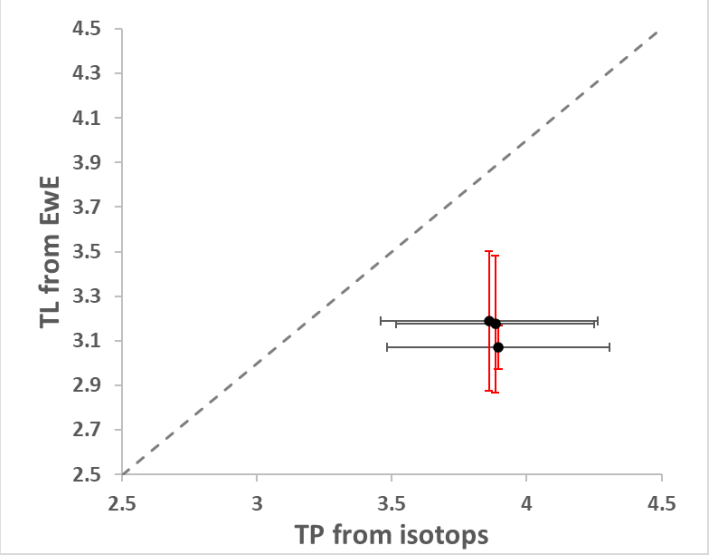

Figure 1. Comparison between trophic position (TP) estimated from isotope data and trophic level (TL) estimated from the food web model of the GSA 17-18 for the three age classes of *Solea solea* (age0+; age 1; age 2+). The model and the data showed differences inherent in the methods but allows corroboration of modelling application. The model outputs are, therefore, the best estimates

of biomass, flows of matter in the ecosystem (including catches) dynamically changing over time. These flows were used as a basis to carry on an input-output analysis that represent a sort of sensitivity (Libralato et al., 2006) of each node of the ecosystem model (species or fleet) to the changes on each other node (species or fleet). The input-output analysis generates for each year a matrix of effect of each node of the food web on any other node (species or fleet): the mean values of this trophic impacts (positive or negative) are resulting from propagation of direct (e.g., predation mortality, fishing mortality) and indirect (e.g., trophic cascading impacts; indirect fishing impacts) mediated by the food web (see Agnetta et al., 2019).

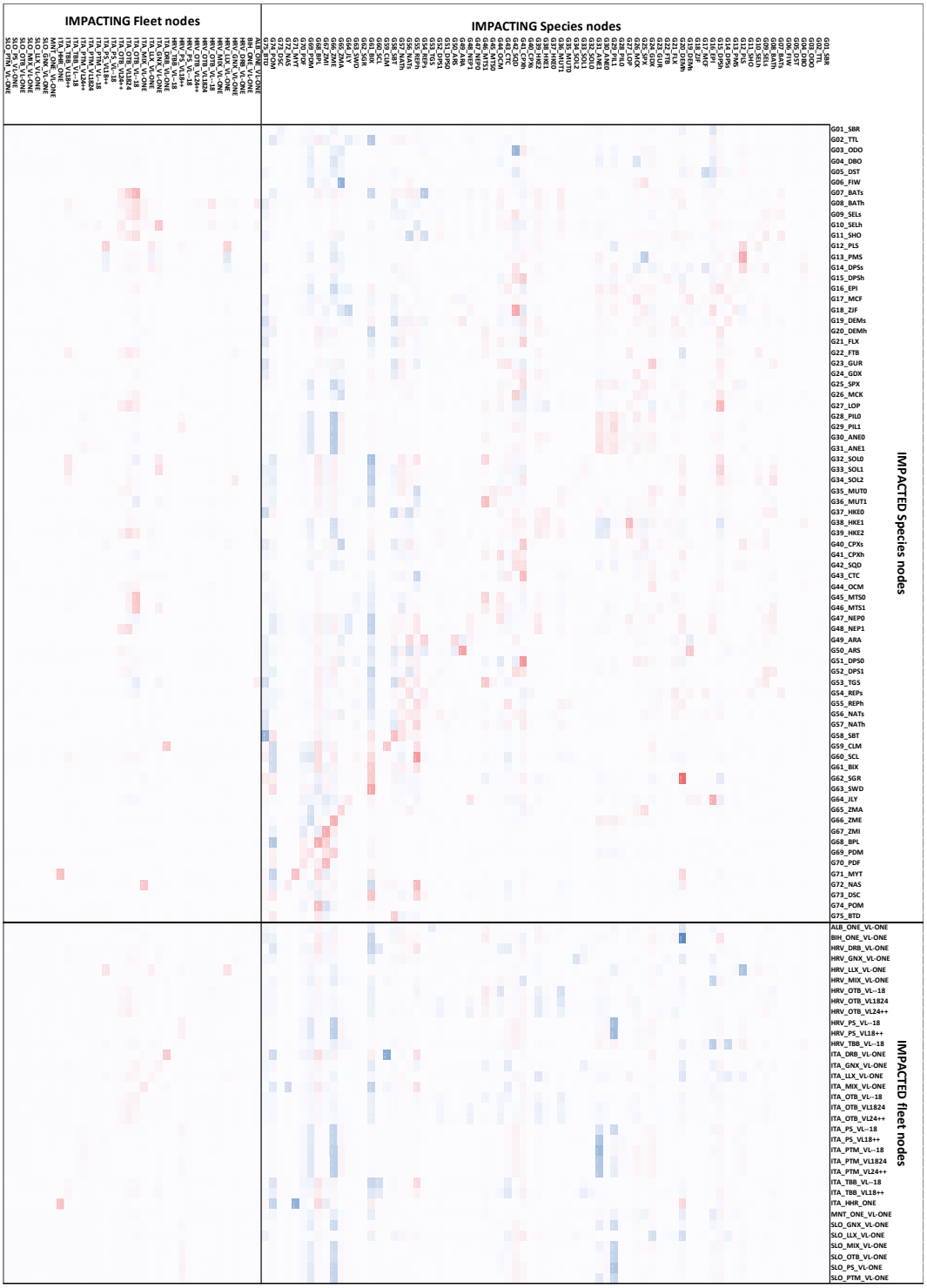

Figure 2. Extended mixed trophic impact matrix including functional living and non living nodes and fleets of the food web ecosystem model for the Adriatic Sea (GSA17 and 18). Blue positive impacts, red negative impacts.

2. Estimating ecosystem impacts of fisheries and food wed role

Ecosystem (adverse) impacts of a fisheries (2.4.1). The sum of all negative impacts produced by a fleet (***total ecosystem impact by fleet***) on the living nodes of the food web (i.e., excluding impacts on detrital forms) is considered ***the overall negative impact of the fleet on the ecosystem***. The calculation of this value for each fleet allows ranking all the fleets in the model and to identify the relative position of the ones under assessment in relation to the whole exploitations undergoing in the ecosystem. Notably positive effects (e.g., because of reduction of competitions) are not considered, remarkably the ecosystem impacts calculated in this way are resulting from a combination of magnitude of the flows of matter (i.e., catches) and importance of impacts. The ranking order of the total impacts of fisheries are used as an objective way to score the fleets' impact (article 2.4.1).

Food web role of a target species (2.4.2). The mixed trophic impact elements can also be useful to determine the role of a species in the ecosystem. Basically species with high impacts (positive or negative) on the food web are considered key elements: small changes of their biomass will have large effects on the ecosystem (Libralato et al., 2006). The sum of positive and negative impacts produced by a species node on all other living nodes of the food web (using absolute values to avoid eliciting negative and positive effects) is considered a measure of the ***overall impact of a species in the food web*** and can be used to define the central role of it in the food web. The raking of species overall impacts allows for a quantitative and objective scoring of the species role and thus on the criticality of its exploitation. Given that nodes were also defined to describe target species under assessment it is possible to use the indicator for scoring the article 2.4.2.

3. Application for pre-assessment of relevant fisheries in Croatia

3.1 Ecosystem (adverse) impacts of fisheries (article 2.4.1)

Purse Seine for anchovy & sardine

The Croatian purse seine for small pelagic fish (HRV_PS) has a total negative impact on the ecosystem equal to -0.28 (2.49% of total negative impact of all fisheries) ranking 13th in terms of contribution to the fishery impacts in the Adriatic Sea (Figure 1.2.1., 1.2.2). Thus, although the catches of this fishery are remarkable, it could be classified as **low-mid impacting fishing fleets** compared to other Adriatic fleets, possibly because of the low discard rate. The fleet has minimal impact on the anchovy but contributes with the main negative impact (59.91 % of the total) on the pilchard (G29_PIL1) (Figure 1.2.1., 1.2.2).

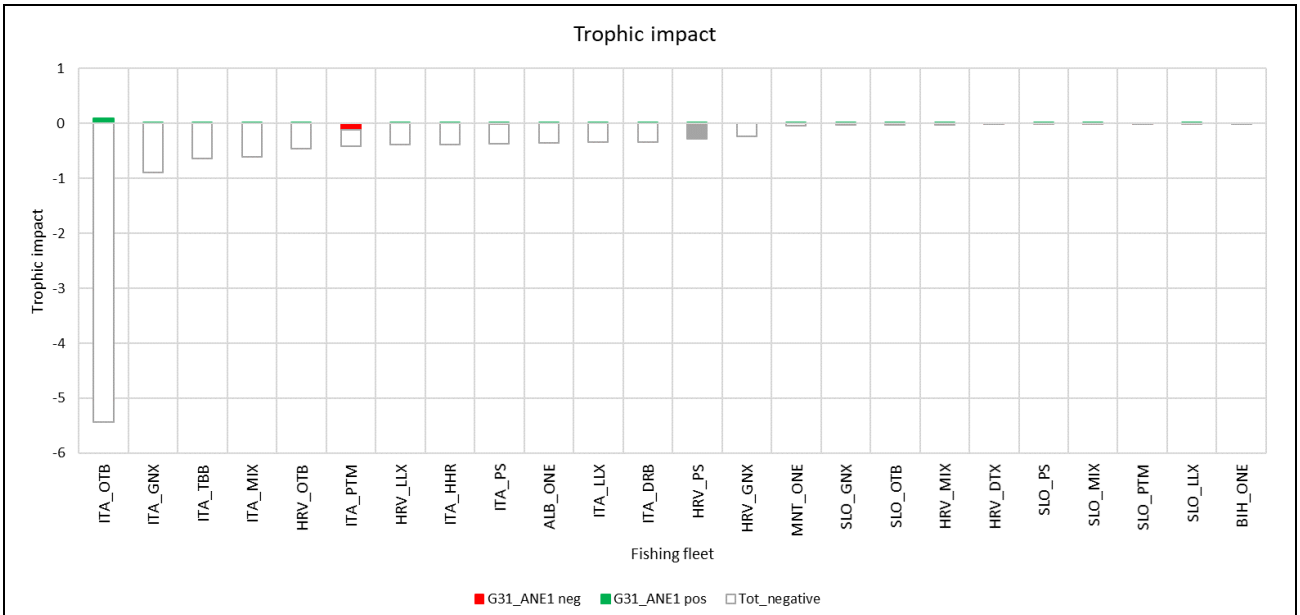

Figure 1.2.1: Total ecosystem impact by fleet in the Adriatic highlighting the contribution Croatian Purse seine (HRV_PS; highlighted in grey). Negative and positive Impacts on the target species anchovy (G32_ANE1) are highlighted in red and green, respectively, for all fleets.

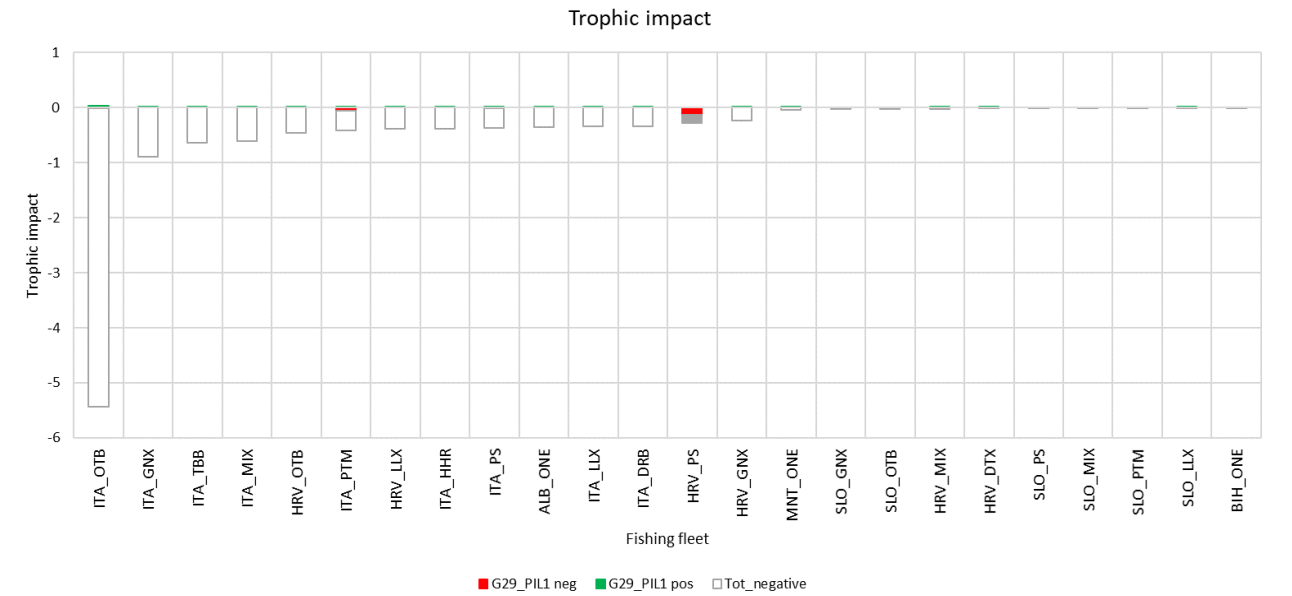

Figure 1.2.2.: Total ecosystem impact by fleet in the Adriatic highlighting the contribution Croatian Purse seine (HRV_PS; highlighted in grey). Negative and positive Impacts on the target species sardine (G29_PIL1) are highlighted in red and green, respectively, for all fleets.

Given the above the following scores were considered:

Purse Seine for anchovy and sardine, 2.4.1 Ecosystem impacts

Score CoE: 4 **[low** overall negative impact of the fleet on the ecosystem**]**

Score CoA: 3 **[medium-high** impact of the fleet on the target species**]**

Trammel net for common sole

The Croatian trammel net for common sole (HRV_GNX) has a total negative impact on the ecosystem equal to -0.24 (2.15% of total negative impact of all fisheries), ranking 14th in terms of contribution to total fleets impacts in the Adriatic Sea (Figure 1.2.3). The catches of this fishery are lower than the similar Italian fishery (ITA_GNX) and their diversity of caught species results in the observed negative impacts. The fleet has secondary contribution (14.5 %) to the fleets negative impacts on the common sole (G34_SOL2; Figure 1.2.3.). Overall it could be also classified as **low impacting fishing fleet.**

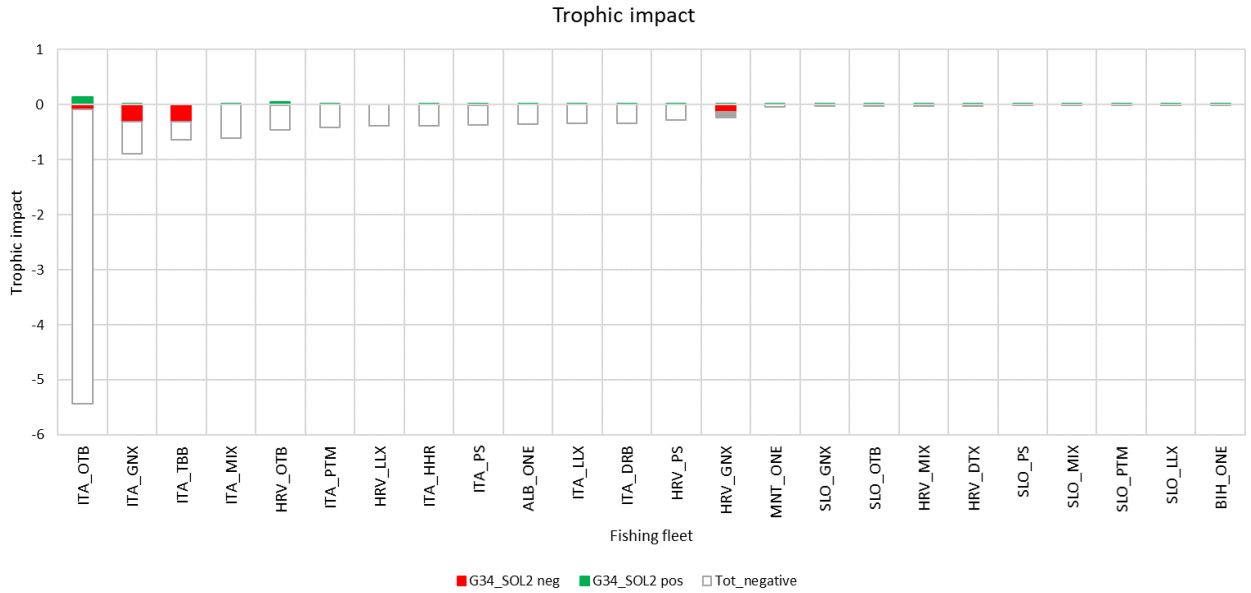

Figure 1.2.3.: Total ecosystem impact by fleet in the Adriatic highlighting the contribution Croatian trammel net (HRV_GNX, highlighted in grey). Negative and positive Impacts on the sole (G34_SOL2) are highlighted in red and green, respectively, for all fleets.

Given the above the following scores were considered:

Trammel net for common sole, 2.4.1 Ecosystem impacts

Score CoE: 4 [low overall negative impact of the fleet on the ecosystem**]**

Score CoA: 4 [low impact of the fleet to the target species**]**

Rampon for queen scallop

The Croatian rampon for scallop (HRV_DTX) has a total negative impact on the ecosystem equal to -0.01 (0.10% of total negative impact of all fisheries), ranking 19th in terms of contribution to the fishery impacts in the Adriatic Sea (Figure 1.2.4). Although caution should be carried towards this fishing gear, due to its high discards and the impact on the bottom epifauna, improvements in the techniques during the project support this low impact score. The fleet has a minimal contribution to the total negative impact of fleets (1.90 %) on the queen scallop (G60_SCL) (Figure 1.2.4.). The nature of this fishery, localized catches of a specific resource, could allow to classify it as **very low impacting fishing fleet**. The uncertainty due to quantification of discards support a low CoA value and might require management measures as a precautionary approach.

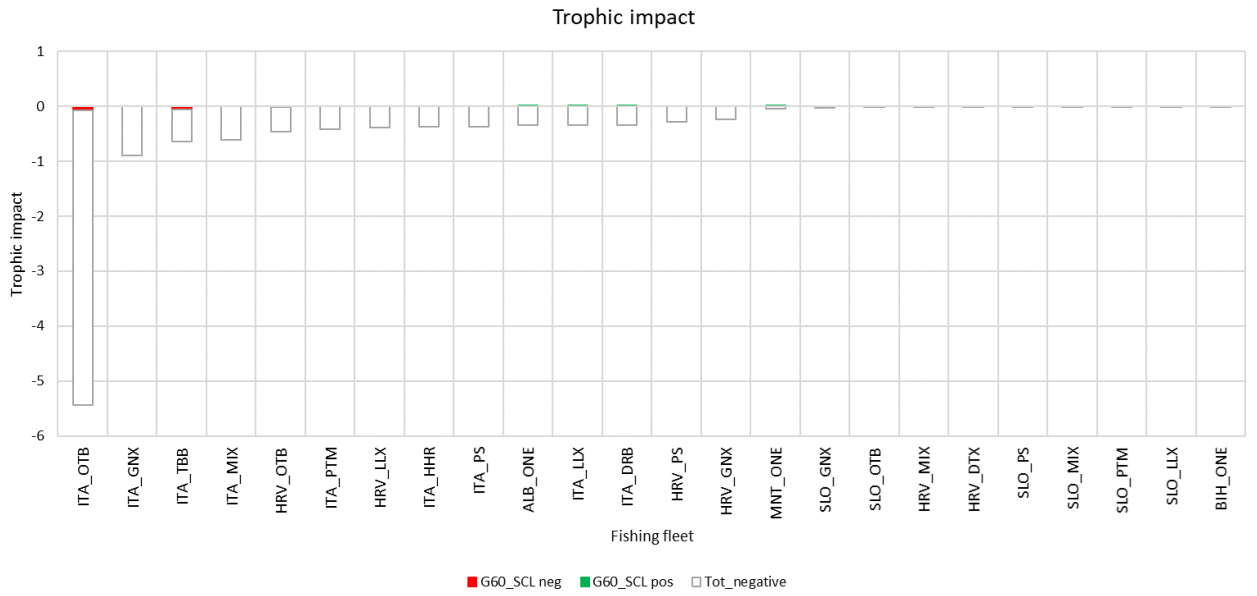

Figure 1.2.4: Total ecosystem impact by fleet in the Adriatic highlighting the contribution Croatian rampon (HRV_DTX, highlighted in grey). Negative and positive Impacts on the queen scallop (G60_SCL) are highlighted in red and green, respectively, for all fleets.

Given the above the following scores were considered:

Rampon for queen scallop, 2.4.1 Ecosystem impacts

Score CoE: 5 [very low overall negative impact of the fleet on the ecosystem**]**

Score CoA: 3 [low impact of the fleet to the target species, but precautionary value due to poorly quantified discards**]**

Bottom trawl for deep-water rose-shrimp

The Croatian bottom trawl for deep-water rose-shrimp (HRV_OTB) has a total negative impact on the ecosystem equal to -0.45 (4.06% of total negative impact of all fisheries), ranking 5th in terms of contribution to the fishery impacts in the Adriatic Sea, Figure 1.2.5). The impact of this fishery is mainly due to its diversified catches (several trophic groups) and discrete discards, thus resulting in **medium-high** impacting fleet. The fleet has a minimal impact (3.16 %) on the total impacts of fleets on the deep-water rose-shrimp (G52_DPS1; Figure 1.2.5.).

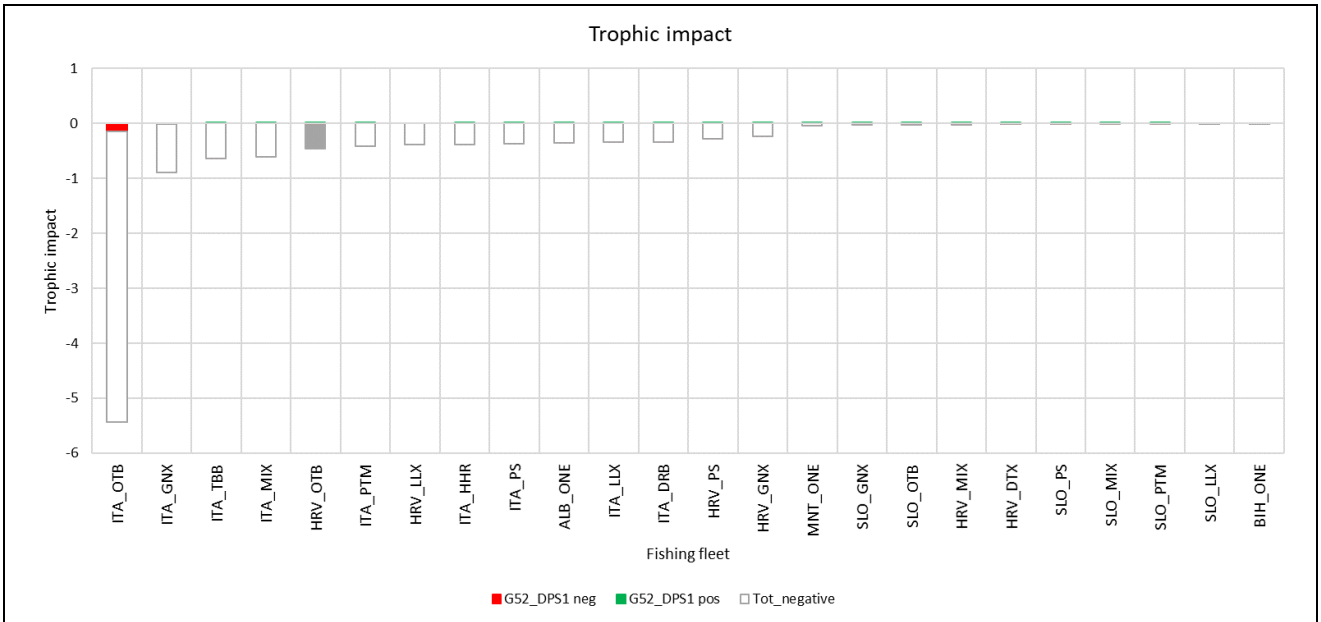

Figure 1.2.5.: Total ecosystem impact by fleet in the Adriatic highlighting the contribution Croatian trawl (HRV_OTB, highlighted in grey). Negative and positive Impacts on the deep-water rose-shrimp (G52_DPS) are highlighted in red and green, respectively, for all fleets.

Given the above the following scores were considered:

Bottom trawl for deep-water rose-shrimp, 2.4.1 Ecosystem impacts

Score CoE: 3 **[medium-high** overall negative impact of the fleet on the ecosystem**]**

Score CoA: 4 **[low** impact of the fleet to the target species**]**

3.2 Food web role of the target species (article 2.4.2)

Purse Seine for anchovy & sardine

The anchovy (G31_ANE1) is ranked at the 9th place of the impacting species in the Adriatic Sea (overall impact = 3.68; 3.29 % of all impacts), and it is responsible for 3.40 % of negative and 3.14 % of positive impacts (Figure 1.2.6.). The effect it has on itself is mainly negative (23.33 % of its negative impact): intraspecific trophic competition within common ranges. **It is a species of high role in the ecosystem.** The pilchard (G29_PIL1) is ranked at the 18th place of the impacting species in the Adriatic Sea (overall impact = 2.51; 2.24 % of all impacts), and it is responsible for 2.62 % of negative and 1.74 % of positive impacts (Figure 1.2.7.). Intraspecific trophic competition within common ranges (25.97 % of its negative impact). **These species have key role in the ecosystem.**

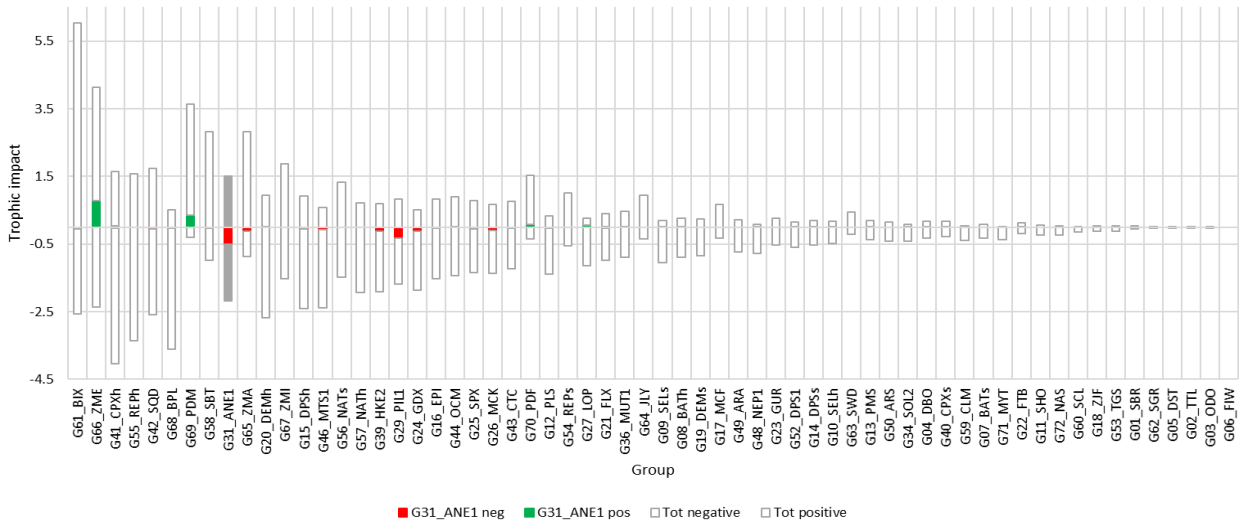

Figure 1.2.6.: Representation of trophic impact of trophic groups on the ecosystem. Trophic groups' total negative and positive impacts (white bars) are represented and the ratio of impact they have on the target specie (negative in red, positive in green). The assessed trophic group is highlighted in grey.

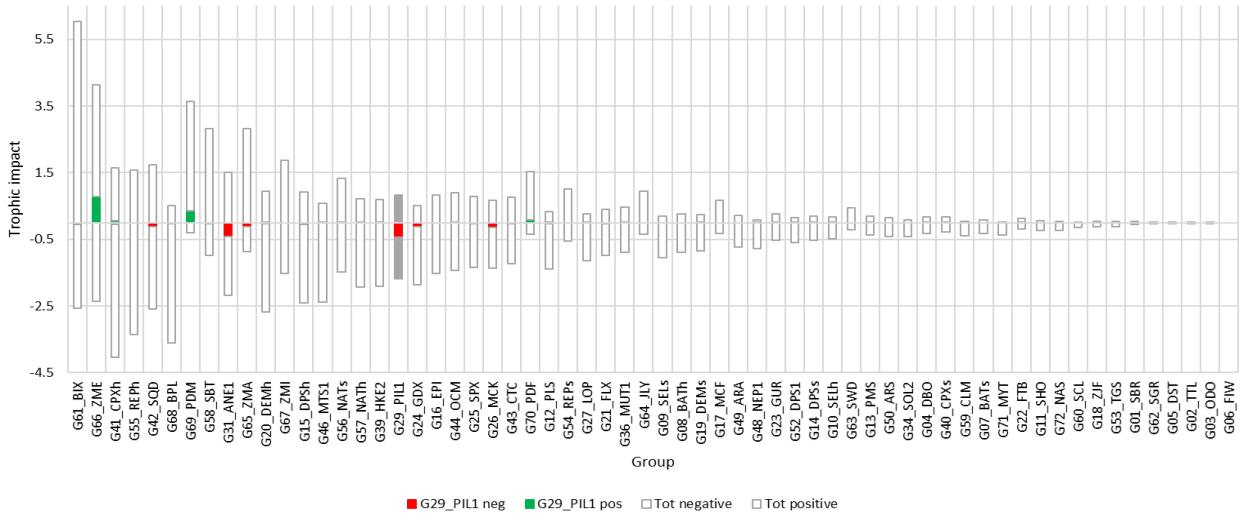

Figure 1.2.7.: Representation of trophic impact of trophic groups on the ecosystem. Trophic groups' total negative and positive impacts (white bars) are represented and the ratio of impact they have on the target specie (negative in red, positive in green). The assessed trophic group is highlighted in grey.

Given the above the following scores were considered:

Purse Seine for anchovy & sardine, 2.4.2 Food web role:

Score CoE: 3 [medium-high overall impact of the species in the food web**]**

Trammel net for common sole

The common sole (G34_SOL2) is ranked at the 45th place of the impacting species in the Adriatic Sea (overall impact = 0.51; 0.46 % of all impacts), and it is responsible for 0.65 % of negative and 0.19 % of positive impacts (Figure 1.2.8.). Common ranges for intraspecific competititon (39.04 % of its negative impact). **The species has low overall impact on the food web.**

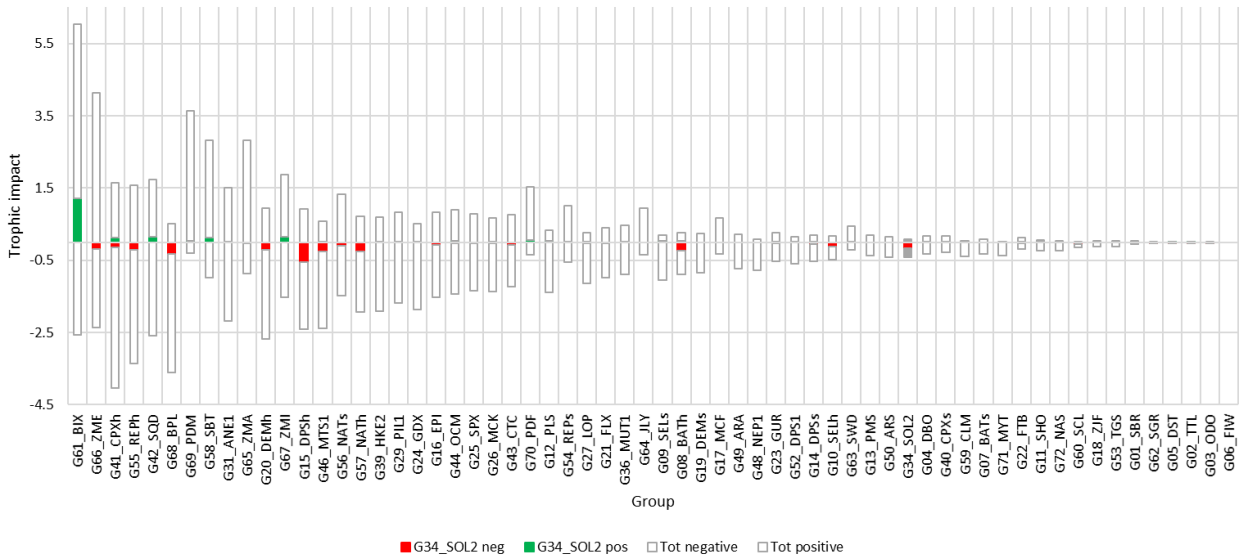

Figure 1.2.8.: Representation of trophic impact of trophic groups on the ecosystem. Trophic groups' total negative and positive impacts (white bars) are represented and the ratio of impact they have on the target specie (negative in red, positive in green). The assessed trophic group is highlighted in grey.

Given the above the following scores were considered:

Trammel net for common sole, 2.4.2 Food web role:

Score CoE: 5 [low overall impact of the species in the food web**]**

Rampon for queen scallop

The queen scallop (G60_SCL) is ranked at the 54th place of the least impacting species in the Adriatic Sea (overall impact = 0.15; 0.14 % of all impacts), and it is responsible for 0.22 % of negative and 0.03 % of positive impacts (Figure 1.2.9.). The specie has low intraspecific trophic competition (10.08 % of its negative impact). **The species has low overall impact on the food web.**

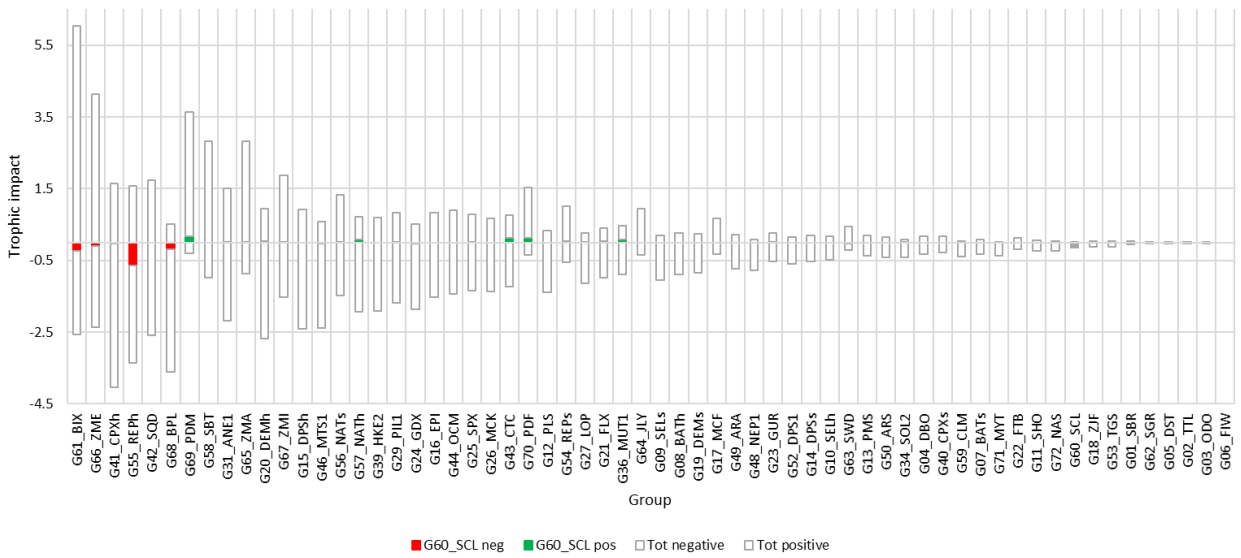

Figure 1.2.9.: Representation of trophic impact of trophic groups on the ecosystem. Trophic groups' total negative and positive impacts (white bars) are represented and the ratio of impact they have on the target specie (negative in red, positive in green). The assessed trophic group is highlighted in grey.

Given the above the following scores were considered:

Rampon for queen scallop, 2.4.2 Food web role:

Score CoE: 5 [low overall impact of the species in the food web**]**

Bottom trawl for deep-water rose-shrimp

The deep-water rose-shrimp (G52_DPS1) is ranked at the 39th place of the least impacting species in the Adriatic Sea (overall impact = 0.74; 0.67 % of all impacts), and it is responsible for 0.92 % of negative and 0.33 % of positive impacts (Figure 1.2.10.). It has a minimal intraspecific competition (8.93 % of its negative impact). **The species has medium to low overall impact on the food web.**

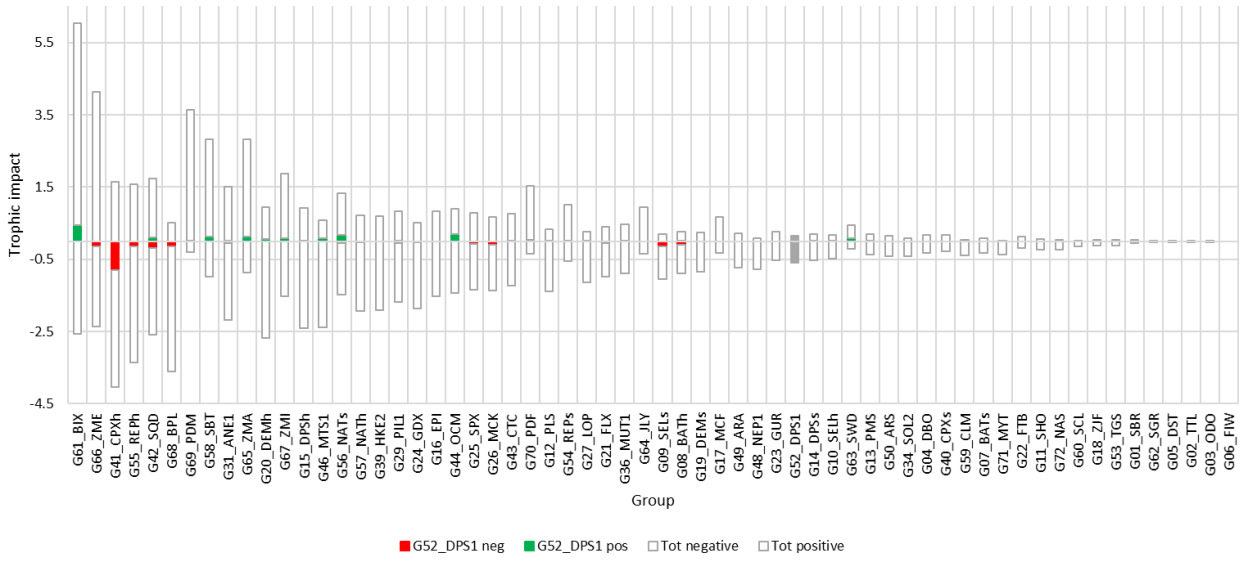

Figure 1.2.10.: Representation of trophic impact of trophic groups on the ecosystem. Trophic groups' total negative and positive impacts (white bars) are represented and the ratio of impact they have on the target specie (negative in red, positive in green). The assessed trophic group is highlighted in grey.

Given the above the following scores were considered:

Bottom trawl for deep-water rose-shrimp., 2.4.2 Food web role:

Score CoE: 4 [medium to low overall impact of the species in the food web**]**

4 Synthesis of scores applied

	2.4.1 Ecosystem impacts Score CoE	2.4.1 Ecosystem impacts Score CoA	2.4.2 Food web role Score CoE
Relevant fisheries in CROATIA			
Purse Seine for anchovy and sardine	**4** **low** overall negative impact of the fleet on the ecosystem	**3** **medium-high** impact of the fleet of the target species	**3** **medium-high** overall impact of the species in the food web
Trammel net for common sole	**4** **low** overall negative impact of the fleet on the ecosystem	**4** **low** impact of the fleet to the target species	**5** **low** overall impact of the species in the food web
Rampon for queen scallop	**5** **very low** overall negative impact of the fleet on the ecosystem	**3** **low** impact of the fleet to the target species, but precautionary value due to poorly quantified discards	**5** **low** overall impact of the species in the food web
Bottom trawl for deep-water rose-shrimp	**3** **medium-high** overall negative impact of the fleet on the ecosystem **low-medium** overall negative impact of the fleet on the ecosystem	**4** **low** impact of the fleet to the target species **medium-high** impact of the fleet to the target species	**4** **medium to low** overall impact of the species in the food web **very low** overall impact of the species in the food web

5 References

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