MSC Pre-assessment and FIP Scoping Study for the Croatian sardine purse seine fishery

On behalf of WWF Adria

Prepared by ME Certification Ltd

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1 Summary

This is the final pre-assessment and scoping report for the Croatia purse seine (srdelara) fishery for sardine with comments from WWF incorporated. The conclusions of the pre-assessment are as summarised below:

- Principle 1: It is noted that sardine in this ecosystem is probably a 'key low trophic level' (key LTL) species; these additional requirements therefore need to be applied. The pre-assessment predicts an overall fail for Principle 1. The stock assessment (although uncertain) considers that the stock is overexploited. A draft Multi-Annual Plan (MAP) is under discussion; meanwhile, a management plan (Croatian, GFCM) is in place but it is not clear whether it can rebuild the stock. More importantly, it is not clear what it should rebuild the stock to, since the Croatian management plan, GFCM, STECF and the draft MAP are not based on the same management objectives or areas. There are also problems with the data input into the stock assessment; notably the acoustic survey and historical data. It is predicted that this would result in scores <60 (fail) for PIs 1.1.2 and 1.2.1 and scores 60-80 (conditions) for PIs 1.1.1, 1.2.2, 1.2.3 and 1.2.4.
- Principle 2: The pre-assessment predicts an overall pass with conditions for Principle 2, unless catches of non-target species (mackerels and others) are more significant than thought. Anchovy is the only main primary species; it has the same issues as sardine, i.e. unclear objectives and likely over-exploitation, leading to predicted conditions for PIs 2.1.1 and 2.1.2. It is likely that there are no main secondary species, but there is a possibility that the catch (landings plus discards) of mackerel and horse mackerel may be sufficient that they are considered main; if so, conditions are predicted on 2.2.2; improved data on discards is required in any case. Likewise, interactions with ETP species are unlikely, but a lack of direct data suggests possible conditions on 2.3.2 and 2.3.3. Conditions are also predicted on 2.5.1 and 2.5.2 relating to the key LTL status of sardine (considered under Principle 1).
- Principle 3: The pre-assessment predicts an overall pass with conditions for Principle 3. Conditions are possible relating to the international management framework on 3.1.2 (consultation; GFCM and the MAP) and 3.2.1 (fishery-specific objectives; unclear as noted under Principle 1).

The scoping sets out a general list of issues for the FIP to deal with, as follows:

1. Ecosystem targets (1.1.2, 1.2.1, 2.5.1, 2.5.2): Evaluate suitable ecosystem-based target levels for the sardine and anchovy stocks based on MSC requirements for key LTL species.
2. Agreed management targets (1.1.2, 1.2.1, 3.2.1): Support the fishery in defining a clear management target for the sardine and anchovy stock, which can be estimated robustly and which is consistent with MSC requirements as evaluated above.
3. Rebuilding plan (1.1.1, 1.1.2, 1.2.1, 1.2.2): Support the fishery in evaluating the extent to which different management actions (existing or proposed) would rebuild the stock to agreed targets; incorporate this analysis into the draft MAP.

4. Improved acoustic survey (1.2.3, 1.2.4): Support the fishery in improving the coordination, operation and analysis of the acoustic survey such that it can play a more significant role in the stock assessment process.
5. Assessment of historical data (1.2.3, 1.2.4): If it has not already been done, evaluate historical data as to the levels of confidence and sensitivity; consider which historical datasets are suitable to use for stock assessment purposes.
6. Information/management for discards and ETP species (2.2.2, 2.3.2, 2.3.3): Collect and analyse data on discards of non-target species and interactions with ETP species. Evaluate if any additional management measures are required, including measures to reduce unwanted catch, and if so put them in place either within Omega 3 or via the Ministry for the Croatian fishery more widely.

2 Introduction, Objectives and Methodology

This report is the second draft pre-assessment and scoping report for the Croatian sardine purse-seine fishery Fisheries Improvement Plan (FIP), which is a collaboration between WWF Adria, the Ministry of Agriculture (Directorate of Fisheries) and the fisheries cooperative Omega 3. The objectives of the report are i) to evaluate the status of the fishery relative to the MSC Standard for sustainable fisheries, and ii) to propose in outline how the fishery could best move forward towards achieving certification under the MSC standard.

The report is divided into three sections: Part 1 provides some summary background information on the fishery, Part 2 provides the pre-assessment and Part 3 provides the scoping (outline approach to the FIP). For the purposes of discussion, Part 3 also provides a draft summary work plan, but it is expected that this will be extensively revised as the FIP scoping proceeds.

This report is based on information and documents collected at a site visit to Zadar and Omega 3 in June 2017. Some of the information used in the pre-assessment (e.g. the analysis of 'key low trophic species' status) has been taken from a previous pre-assessment for this fishery by MEC (April, 2015) which was never published; MEC would like to acknowledge the input of Dr. Pierre Fréon (independent consultant) to these elements. In general, however, changes to the fishery mean that the pre-assessment presented here is substantially revised from the previous version.

The process of FIP preparation is expected to continue as follows: This report has been reviewed by WWF Adria and Omega 3. A revised version will be presented to a workshop in October or November 2017. The outcome of this workshop will form the basis of the FIP work plan which will be used to guide implementation of the FIP.

3 Part 1 – Background

3.1 History

This fishery has a long history, with historical evidence of fishing with lights for sardine and anchovy several centuries ago, using wood fires and gill nets (according to Split Ethnography Museum). Croatians have been at the forefront of the development of purse-seine technology and over the years have introduced the technique around the world.

3.2 Geographic location of the fishery

The purse seine ('srdelara') fishery for sardine and anchovy takes place throughout Croatia's ZERP[1], which is situated in GFCM area GSA17 – the northern Adriatic (see Figure 1). For sardine, there is considered to be a single stock in the Adriatic; i.e. GSA17 and GSA18, meaning that the stock is shared between Croatia, Italy, Slovenia, Montenegro and Albania, although Croatia and Italy take by far the majority of the catch. The distribution of sardine catch within Croatia's zone is shown in Figure 2.

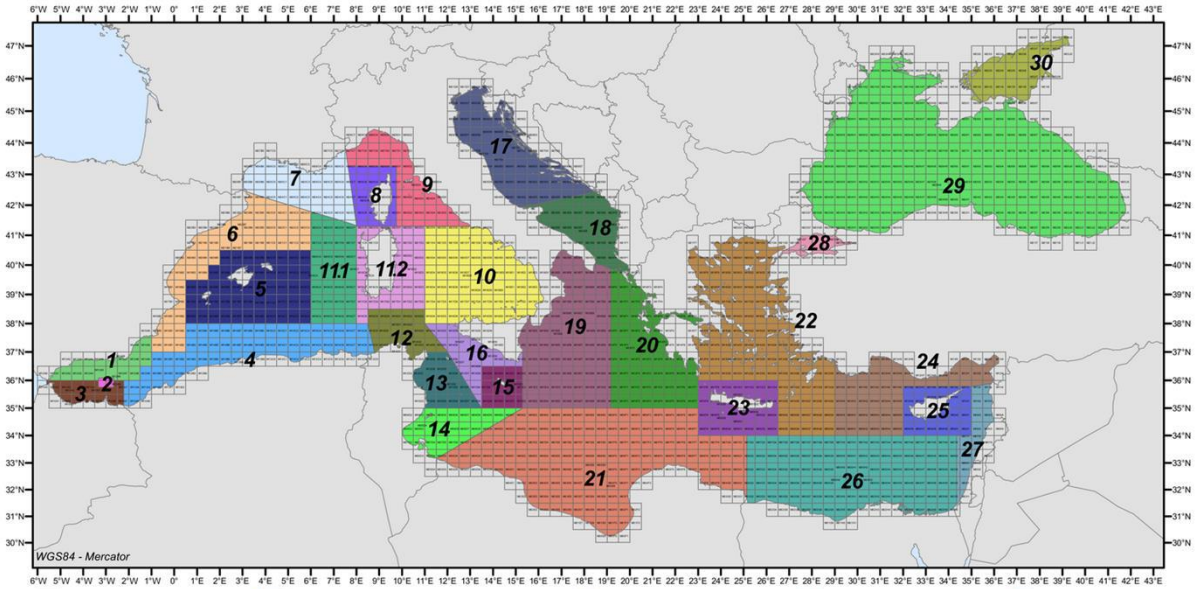

Figure 1. Map of GSA statistical areas in the Mediterranean used for stock assessment and management purposes; from http://www.fao.org/gfcm/background/area-of-application/statistical-grid/en/.

[1] Ecological and Fisheries Protection Zone; there are no EEZs in the Mediterranean

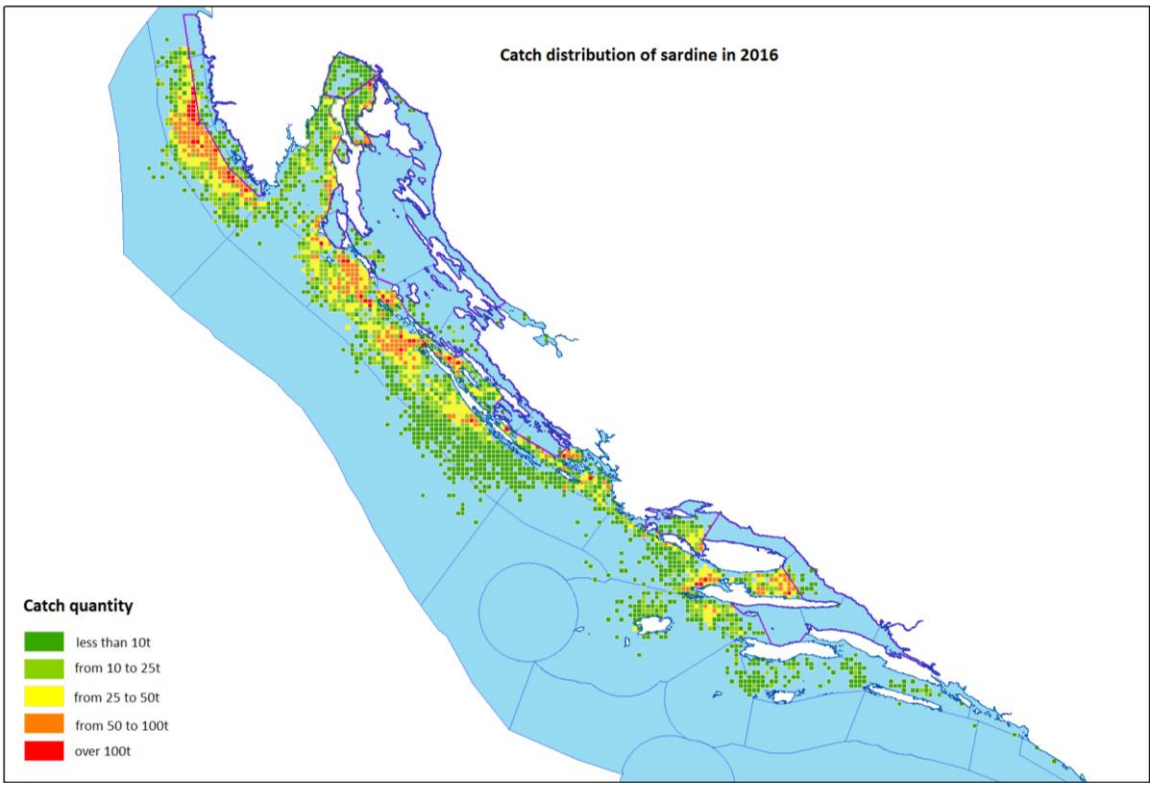

Figure 2. Distribution of catch of sardine in the Croatian fishery in 2016; dark green: <10t per vessel per night; light green: 10-25t; yellow: 25-50t; orange: 50-100t; red: >100t; the area outlined in blue shows the area closed to purse seine vessels for at least 6 months per year (map provided by the Directorate of Fisheries).

3.3 Fishing fleet

Overall, there are ~400 vessels targeting this sardine stock. Croatia has the biggest fleet, which is limited via a system of authorisations to 249 vessels (77 145 kW; 18 538 GT); in 2015, 202 of these vessels were active. A new authorisation process is starting in October 2017, so the number of authorised vessels will decrease. The entire Croatian fleet uses purse seine, while the Italian fleet, which makes up most of the remaining vessels, is a mixture of pelagic trawlers (the majority) and seiners. Slovenia has a small number of purse seiners, Montenegro only has small coastal fishing vessels, while the situation in Albania is unclear, although their fishery is not thought to be significant.

The Croatian vessels are mainly ~20-25m long; the largest in the fleet is 39m and some vessels are smaller with a few less than 12m.

3.4 Gear

The seine used in this fishery is 5-800m long x 120-200m deep, depending on the size of vessel. Mesh size is generally 16mm. The fishery has a derogation to some of the requirements of the Mediterranean Regulation (EU Regulation 1967/2006) regarding net drop (depth), on the basis of an assessment that habitat impacts are unlikely.

3.5 Operations

The vessels leave port in the afternoon (2-3pm winter, 4-5pm summer; depending on distance to the fishing grounds). They search for fish schools using sonar and a vertical sounder. When a suitable school cluster has been located, the vessel is anchored and the fish are aggregated around the vessel using powerful lights (up to 16 kW). At around dawn, less powerful lights are deployed on to a small skiff and the vessel progressively switches off its lights. Then the skiff deploys the seine around the school. The vessel returns to port once the fish has been brought on board – i.e. one trip is generally made up of one haul only. From time to time, the vessel may haul before dawn to allow time to get back to landing site in time for a sale, or, exceptionally, vessels may make two hauls in a night.

Although the fishery operates year-round (except for the closed season; see below), the main season for sardines is winter (October-February). In summer the fishery takes mainly anchovy, while the fishery in spring is mixed between the two species. It is important to note, however, that the fishery is always mixed; season differences relate to the relative proportions of the two species in the catch.

3.6 Management

Fisheries management in Croatia is the responsibility of the Ministry of Agriculture; specifically the Directorate of Fisheries, and is also subject to the requirements of the EU Common Fisheries Policy (CFP) and the Mediterranean Regulation (1967/2006). The landing obligation is implemented via Commission Delegated Regulation 1392/2014 (discard plan for small pelagics in the Mediterranean). The Mediterranean Regulation sets technical requirements for the gear (for some of which a derogation is in place for this fishery), and also requires that the fishery have a management plan, which has been prepared and approved by the Croatian government as required. The Croatian management plan is based on the requirements set out by the Mediterranean Regulation, and follows the principles set out by the General Fisheries Commission for the Mediterranean (GFCM, 2013 and subsequent measures). The European Commission has recently prepared a draft multi-annual plan (MAP) for this fishery, which is currently under discussion within and between the relevant Member States (European Commission, 2017; discussed further below).

The main organisation providing scientific input to fisheries management in Croatia is the Institute of Fisheries and Oceanography in Split. The Regional Fisheries Management Organisation (RFMO) for shared fisheries in the Mediterranean is the General Fisheries Commission for the Mediterranean (GFCM), which operates under the auspices of FAO – experts from the Institute of Fisheries and Oceanography participate in the working groups and Scientific Advisory Committee of GFCM. In addition, because this fishery is shared between three EU member states (Croatia, Italy and Slovenia), scientific advice is also provided by STEFC to the EU on the fishery (STECF, 2016a). Some of the advice provided by GFCM and STECF is at present conflicting – this is discussed in the pre-assessment below.

Under the Croatian management plan[2], the fishery is managed via control of effort rather than by TACs and quotas. The fleet size is limited via a system of permits and authorisations, and there is also a closed season (December/January – duration variable) and extensive closed areas which aim not only to limit effort but also to move the catch towards larger fish. The system of data collection and monitoring is extensive and exceeds EU requirements; e.g. all 'srdelara' vessels must have an electronic logbook and VMS, regardless of size. Full details are given below.

It is worth noting that this fishery is rare in suffering from possibly too much management rather than too little. There are two stock assessments using two sets of reference points to provide two sets of scientific advice (GFCM and STECF); there are also three management plans (GFCM and Croatian in implementation and the EU MAP under discussion). This is considered below.

3.7 Omega 3

Omega 3 is a cooperative which involves 30 purse seine vessels in total (15 sell exclusively to Omega 3; 15 partially). These vessels take 20-22% of the total Croatian catch. The key strategy of the cooperative is to focus on quality and size, in order to sell product to higher-value markets. The cooperative has a small staff and is managed by its members (fishing vessel owners and skippers) who meet regularly to review activities and take decisions. Omega 3 own a processing plant close to Zadar, and collect fish from landing sites around Croatia using trucks.

Omega 3 has supported its members in producing higher-quality landings by introducing better handling (e.g. sorting when frozen instead of on board, large containers instead of fish boxes on some vessels, a high standard of facilities at the plant). They also promote the fishing strategy of targeting larger fish rather than overall volume of catch, although they note that fish size varies by season so this is not achievable to the same extent year-round. Omega 3 has also targeted MSC certification as another opportunity for adding value to their product.

[2] The English version of the Croatian management plan used for this pre-assessment dates from 2014; the plan has been updated since then to take account of some comments provided by the Commission as well as further 'emergency measures' from GFCM. The latter are taken into account below, the former are reportedly not very significant.

4 Part 2 – MSC Pre-assessment

The pre-assessment, presented in Part 2 of this report, follows the most recent MSC pre-assessment template (version 2.0).

4.1 Aim, scope and constraints of the pre-assessment

The aim of the pre-assessment, as noted above, is to provide the basis for a FIP. The scope of the pre-assessment covers the entire Croatian sardine purse-seine fishery, even though the FIP includes a subset (the cooperative Omega 3); this is noted where relevant. No particular constraints were noted; all the information requested was provided in a timely and efficient manner.

4.2 Unit of Assessment

The Unit of Assessment for the FIP is proposed to be the following:

Species	Sardine (*Sardina pilchardus*)
Geographical Area	Croatia EEZ
Catch Method	Purse seine (srdelara)
Management Authority	Croatia Ministry of Agriculture, Directorate of Fisheries; also subject to EU Common Fisheries Policy
Fishers	All srdelara fishers have been included in the pre-assessment; however the FIP involves only the cooperative Omega 3.

4.3 Catch and TAC

Croatian sardine landings from 2000 are shown in Figure 3. The total catch from the stock in 2015 was 87,029 t, according to STECF (2016a; note this includes GSA 17 and 18). The Croatian catch was 50,108 t (Ministry figures), making up ~60% of the total catch. The stock is not managed via a TAC.

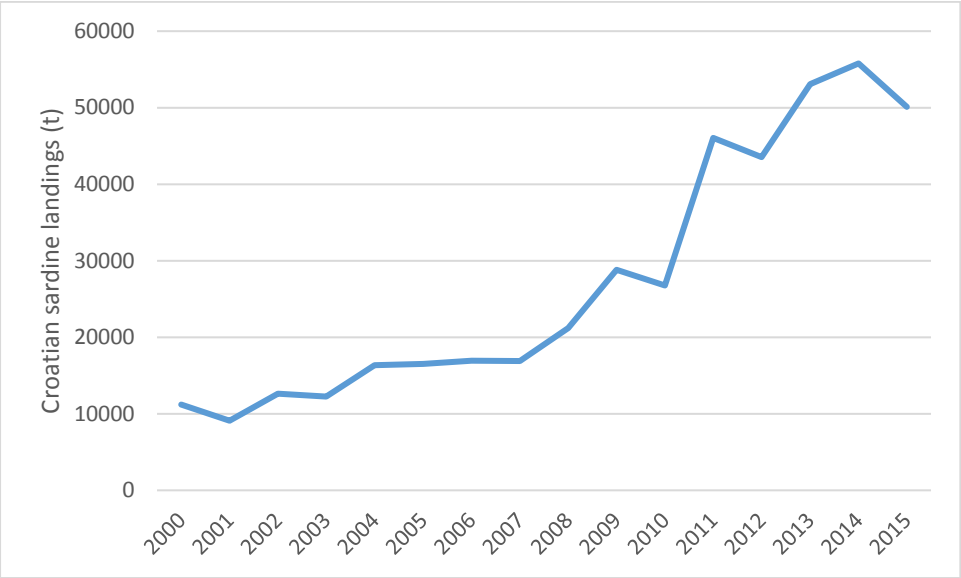

Figure 3. Croatian sardine landings, 2000-2015 (tonnes); data provided by the Ministry of Agriculture.

4.4 Principle 1 – sardine stock status and management

4.4.1 Stock identity

Sardine has in the past been assessed in GSA17 independent of GSA18, mainly because of a lack of data in GSA18 East. However, the areas are now merged in stock assessments by both GFCM and STECF, because genetically and ecologically there is no evidence for any stock boundary (see review in STECF, 2016a), and because there is a significant Italian fleet which is registered in GSA18 but fishes mainly in GSA17 – i.e. the datasets are overlapping between the two areas.

4.4.2 Key LTL status

For Principle 1, MSC has tougher requirements where a target species is considered to be a 'key low trophic species' (key LTL). What this means is that the species is considered to play an important role as a prey species in the ecosystem. MSC consider that under these circumstances, the management of the stock has to take into explicit consideration the requirements of the wider ecosystem as well as just the requirements relating to maintaining good stock status. In practice, what this means is that there are alternative, stricter requirements in the scoring guideposts for the stock status PI 1.1.1 (defined in PI1.1.1A; described below). It is therefore important to define as far as possible at this stage whether an MSC assessment team is likely to determine that these stocks are key LTL species in this ecosystem or not.

MSC define a list of species which may be considered to be key LTL by default, if further requirements are met (see Box SA1 of MSC Fishery Certification Requirements and Guidance v.2.0). This list includes sardines. For the additional requirements, two out of the following three criteria must be met (paragraph SA2.2.9):

- Significant predator-dependency on these species;
- A high proportion of the energy moving from lower to higher trophic levels (prey to predators) passes through these stocks;
- The ecosystem is 'wasp-waisted' (few other species at this trophic level).

An analysis of the available data suggests that there is evidence in favour of all these possibilities for sardine in this ecosystem:

- Based on the connectance of the species to other organisms within the ecosystem, sardine is considered a 'key' species the Proportional Connectance (PC) and SURF indices[3] (Pláganyi and Essington, 2014).
- The proportion of energy that gets channelled through sardines is high, as reflected in the value of the consumer biomass ratio (the biomass of the species in question relative to the biomass of consumers). This is estimated at ~11% (Coll et al., 2009; Barausse et al., 2009); MSC define possible key LTL species as >5%.
- The ecosystem may be 'wasp-waisted' according to Coll et al. (2007) and Barausse et al. (2009).

On this basis, it is likely that sardine would be considered a key LTL species by an MSC assessment – this has a considerable effect on the scoring for Principle 1, as detailed below.

4.4.3 Reference points

GFCM benchmarked their stock assessment in 2015. At the benchmarking it was agreed that reference points would be set as in Table 1. In other words, they propose that the fishery should be managed to achieve F=0.72 (the estimate of F_{MSY}), while maintaining the (spawner) biomass at or above ~250,000 t, which should ensure a low risk of biomass falling below ~125,000 t.

Table 1. GFCM agreed reference points for sardine in GSA17 and 18 (GFCM, 2015). Note that although they use 'B' (Blim and Bpa), they are referring to spawner biomass (biomass of fish age 1 and up, in this case).

Type of reference point	Limit	Trigger	Target
Reference point	B_{lim}	B_{pa}	F_{MSY}
Value	125 318 t	250 636 t	0.72

The biomass reference points are relatively straightforward in terms of their definition. B_{lim} is defined as the lowest value in the time series (B_{loss}); this is standard methodology and normally considered precautionary unless it is also the current value of biomass, since it is known that the stock can increase from this level. B_{pa} is set at 2 x B_{lim}, because this is considered to be a level above which the probability of the stock falling below B_{lim} is ~~5%,

[3] Briefly, these are ways of measuring the extent to which species are connected to other species in the ecosystem – i.e. the extent to which the biomass of a given species controls the biomass of other species in the system, either because they are prey or because they are predators (or because of indirect connections).

taking into account the level of variability of stock biomass (GFCM, 2016a). It is important to note, however, that a minor difference in the stock assessment assumptions between GFCM and STECF (explained further below) mean that spawner biomass estimates between the two assessments are not comparable – the above biomass reference points, therefore, can be used only in conjunction with the GFCM stock assessment.

The use of F_{MSY} as a management target is, however, more problematic. STECF notes '*considerable difficulty in providing robust estimates of F_{MSY} for these stocks*'. Attempts to estimate F_{MSY} for this stock over recent years have resulted in a range of estimates from 0.08-0.72 – almost an order of magnitude. Attempts by the STECF expert working group to estimate F_{MSY} have resulted in values of 0.23 (2014; STECF, 2014) and 0.08 (2015; STECF, 2015), while in 2016 they were not able to estimate it at all because estimates of F were very uncertain (STECF, 2016b). The problem seems to be with estimating the underlying stock-recruit function: some datasets suggest that recruitment is highly correlated with spawner biomass (which would give a high value of B_{MSY} relative to B_0 and a corresponding low, conservative value of F_{MSY}), but it seems more likely in fact that if there is a causal link, it goes in the opposite direction (i.e. spawner biomass changes in response to recruitment rather than vice versa), with recruitment driven by some external (environmental) factor, which is common for this type of species. No-one knows for sure, however.

STECF takes the view, therefore, that using F_{MSY} as a target is not an appropriate means to manage the stock. They recommend instead a precautionary approach based on the empirical analysis of Patterson (1992), which suggests that for small pelagics, a suitable target F should be set based on estimated levels of natural mortality (natural mortality M plus fishing mortality F give total mortality Z). Specifically, Patterson suggests a reference point of E=0.4, where E=F/Z; i.e. (if you work it out), F=0.67M; in other words, target F should be set at two-thirds of the estimated natural mortality. E=0.4 is (or has been) used for a range of small pelagic stocks in the Mediterranean, and was used by GFCM before they moved on to trying to estimate F_{MSY}.

GFCM WGSASP, however, defend their MSY approach, noting that they are constrained to follow the framework set out by the GFCM Scientific Advisory Committee to provide consistent advice across stocks (GFCM, 2016a). The Croatian scientists met at the site visit, however, (who participate in both GFCM and STECF working groups) expressed their concerns about the robustness of parameter estimates (such as F_{MSY}) because of concerns about the quality of historical data.

It is worth noting that the EU CFP specifically requires that management of the stock move towards an MSY approach – i.e. (implicitly) that MSY rather than precautionary/empirical reference points should be used where possible. The MSC standard also requires stocks be managed such that they are maintained around 'a level consistent with B_{MSY}'; setting target F at F_{MSY} would achieve that. However, the intent in both these cases is to ensure that the stocks are maintained at a productive level rather than management just working to avoid collapse; this can also be achieved by empirical reference points, so the STECF approach is not necessarily inconsistent with either the CFP or MSC.

4.4.4 Stock status

GFCM WGSASP carried out an update assessment in 2016 based on the benchmarking in 2015 (GFCM, 2016a). It appears that spawner biomass, recruitment and fishing mortality are all increasing. They estimate the current spawner biomass at 183, 873 t; i.e. above B_{lim} but below B_{pa} ($B_{current}$ = 1.47B_{lim} = 0.73B_{pa}). They estimate current fishing mortality at 1.49 which is above their estimate of F_{MSY} ($F_{current}$ = 2.1F_{MSY}). The estimated trends in spawner biomass, fishing mortality and recruitment from 1975-2015 are shown in Figure 4. On this basis, GFCM recommends that F should be reduced in line with estimates of F_{MSY} and so that the stock can recover towards B_{pa} at a faster rate.

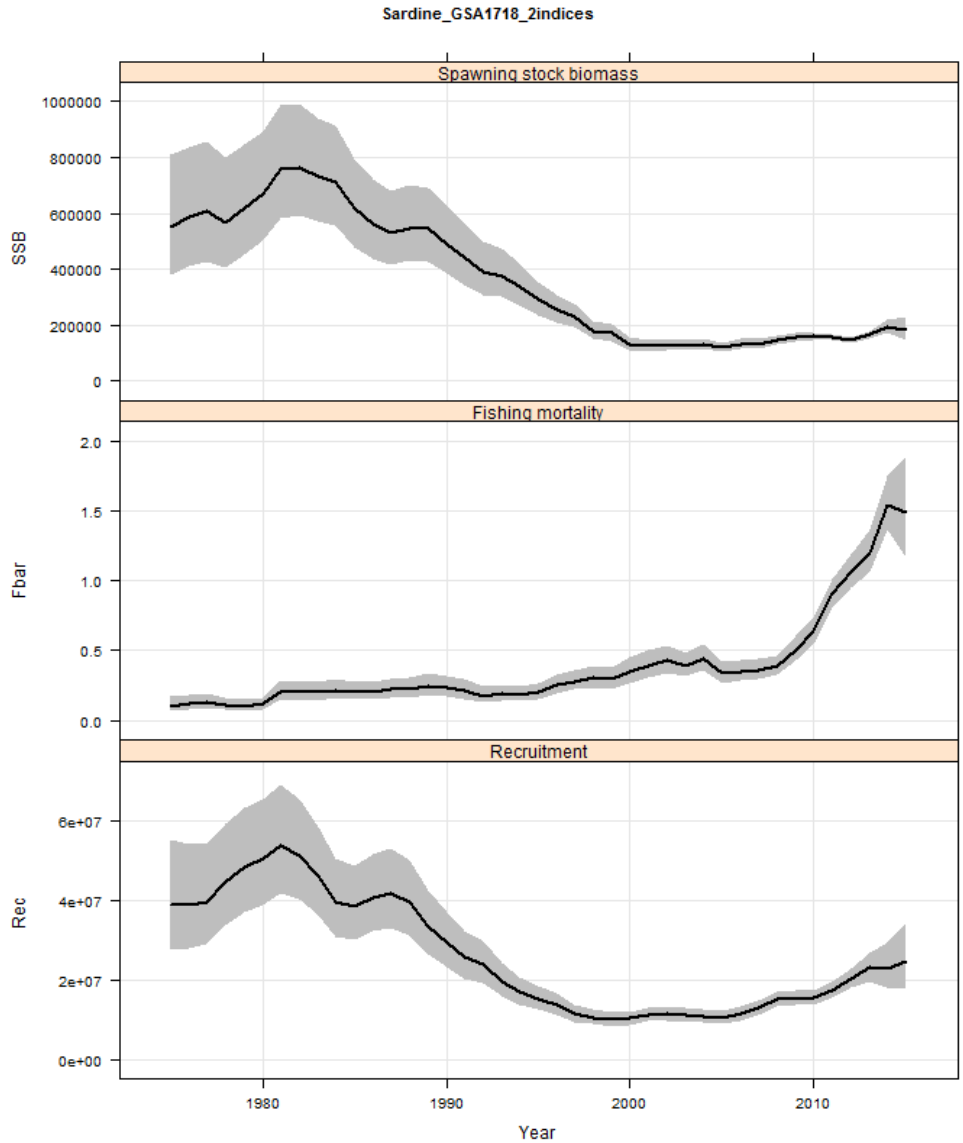

Figure 4. Trends in spawner biomass (top), fishing mortality (middle) and recruitment (bottom) as estimated by GFCM WGSASP (GFCM, 2016) based on a SAM model (described further below).

STECF (STECF, 2016a) uses the same model as GFCM but slightly different data because unlike GFCM they get no input from Albania and Montenegro (instead it assumes that they

take a small constant percentage of the Croatian catch). The trends in their stock assessment output look more or less identical to Figure 4, but the values are different: they estimate spawner biomass in 2015 at 383,080 t – more than double the GFCM estimate. The reason for this is that while GFCM assumes a 'knife-edge maturity ogive' (in English, this means that they assume that all fish reach maturity instantaneously when they turn one year old), STECF assumes that fish mature throughout their first year with an overall average of 50% of fish mature during their first year, compared to 0% for GFCM. This means that GFCM estimates of spawner biomass include all fish from age 1 onwards, while STECF estimates of spawner biomass include half the biomass of age 0 fish, and since there is a decreasing biomass in each age class (because of high rates of mortality), this makes a big different to absolute estimates of spawner biomass, although no difference to trends[4].

STECF estimates current F at 1.95 (higher than GFCM). They consider $F_{current}$ to be 'well above' the likely range of F_{MSY} and they also recommend reducing fishing mortality.

STECF also estimate that the harvest rate (catch as a proportion of total biomass) corresponding to E=0.4 is 8.6% (i.e. the fishery should remove not more than 8.6% of the spawner biomass each year). Based on the estimate of total biomass, which unlike spawner biomass should be more or less the same between the two assessments, they suggest that this would correspond to a catch of ~49 500 t, as compared to the current level of ~87 000 t; i.e. a reduction from the 2015 level of 43%. The catch level of 2015 results in E=~0.75, i.e. fishing mortality is estimated to be ~3x higher than natural mortality.

Overall, therefore, both GFCM and STECF agree that the stock is depleted and being overfished; there seems to be wide acceptance that this is the case (e.g. see summary in accompanying document with EU MAP proposal; European Commission, 2017). However, it is worth noting that the stock assessment is driven significantly by the apparent high biomass in the 1970s and 1980s (see Figure 4). The Croatian scientists met during the site visit expressed some concerns about the historical data used for the stock assessment, considered further below. If this biomass peak is an artefact of poor fishery-dependent data, then the conclusions about stock status could be completely wrong. There is also the possibility (indeed, likelihood) of significant fluctuations in stock productivity. If, for example, the recent period has been one of high productivity (as suggested by the fact that the stock biomass can continue to grow even at high levels of fishing mortality; Figure 4), applying the current observed stock dynamics to past periods of lower productivity will give a misleading picture. That's not to say that everything is fine, but it is important to bear in mind that the conclusions presented above must be regarded as quite uncertain.

In relation to default reference points for key LTL species, MSC defines them in relation to B_0 (the biomass in the absence of fishing): 20%B_0 for the limit reference point and in the range of 40-75%B_0 for the target. The problem with this is that B_0 is a problematic concept for these kinds of stocks, because biomass is naturally variable, even in the absence of fishing; B_0 is therefore hardly ever estimated in sardine stock assessments. One option would be to take the highest observed biomass in the time series and assume that this provides a

[4] In the scheme of things this is not very important, unless anyone tries to apply reference points from one assessment to the results of the other assessment because they are absolutely not comparable. The situation is, however, sufficiently confusing that it would be hard to blame someone for making that mistake, hence why it is explained here in otherwise unnecessary detail.

minimum estimate of B_0; on this basis, current biomass would be ~25% of this level (see Figure 4). As noted above, however, estimates of stock biomass from this period (the early 1980s) cannot be considered reliable, and productivity regimes may also have changed since then.

4.4.5 Harvest strategy and control rules

As already noted, there are several management plans associated with this fishery. Currently, the fishery is managed via a Croatian management plan which is based on the Mediterranean Regulation provisions but in terms of content follows the same lines as GFCM (2013) and subsequent annual 'emergency measures' (e.g. GFCM, 2016b). The EU, meanwhile, has proposed a MAP. For the purposes of planning the FIP, we evaluate all the various harvest strategies here.

GFCM plan and emergency measures

The GFCM management plan (GFCM, 2013) sets biomass precautionary and limit reference points and a target exploitation rate (E) as described above, for both sardine and anchovy. The harvest control rule based on these reference points that applies to GSA17 is as follows:

1. For $B>B_{pa}$ and exploitation rate <E, fishing capacity and activity should be maintained at the 2011 level;
2. For $B>B_{pa}$ but exploitation rate >E for both species, GFCM has scope for deciding if and how fishing capacity or activity should be adjusted in order to reduce exploitation rate;
3. For $B<B_{pa}$ but $B>B_{lim}$ for both species, fishing activity and/or capacity should be adjusted according to the ratios of B relative to B_{pa} and B_{lim}, i.e. $(B_{pa} – B_{current}) / (B_{current} – B_{lim})$; the ratio should be applied from the species with the lowest biomass relative to B_{pa};
4. If 1 or 2 is true for one stock and 3 for the other, GFCM has scope for deciding the best course of action (between 1. and 2.), as long as the biomass of the depleted stock is closer to B_{pa} than B_{lim};
5. If one of the stocks is below B_{lim}, GFCM should decide appropriate measures, including the closure of the fishery, but taking socio-economic as well as biological consequences into account.

It also sets a minimum size (11cm for sardine) and requires members to protect aggregations of age 0 fish using time/area closures, as well as requiring members to record and track fishing capacity and effort over time.

The main 'emergency measures' for 2017-18 (GFCM, 2016b; Appendix 7) are as follows:

- Small pelagic catches not to exceed 2014 level;
- Maximum of 144 fishing days per vessel targeting sardine (as well as 144 days for anchovy), maximum 180 days targeting small pelagics in general, maximum 20 days per month at sea;

- Closed period of 15-30 days in the period October-March for sardines;
- Closed areas for vessels >12m covering >30% of area considered a nursery area, for a minimum of 6 months.

Croatian management plan

The Croatian management plan, based on the GFCM plan, has been applied since 2015 and is updated to include each year's emergency measures. As a biological objective, it uses E as applied to GSA17 only (as in GFCM (2013); it is also the target still recommended by STECF, although they apply it to both areas). The plan refers in general terms to maintaining current trends in biomass and recruitment (i.e. continued improvement) but does not set any other specific reference values; however, since the implicit objective of the plan is to reduce fishing capacity and effort, it is consistent with the GFCM requirements. The plan only applies in Croatian waters out to 12 miles, but since the majority of Croatian sardine fishing takes place in this zone (see the pale blue area in Figure 2 above), in practice it applies to the entire Croatian fishery.

The objectives of the Croatian management plan are addressed via various measures aimed at reducing effort, as follows:

- Licencing and authorisation: Vessels must have a licence which specifies gears and fishing zones; new gears and zones cannot be added to existing licences. In addition, vessels must have a srdelara authorisation, which lasts for the period of the management plan (i.e. 2014-17, 2018-~2022). An authorisation can be obtained based on recent track record, i.e. it eliminates inactive or semi-active licences from the fishery.
- Decommissioning: With some support from EMFF, Croatia has put in place a scrappage scheme for fishing vessels, targeted at fisheries (including this one) where capacity is perceived to be out-of-balance with the resource (Directorate of Fisheries, 2015).
- Closed season: There is a closed season for srdelara in the winter (the main sardine season), of varying duration; in 2016-17 it lasted from 15 December-20 January (a little longer than required by GFCM). There is also a closure in May (15-20 days according to the season).
- Effort limits: There are limits on fishing days per month (20) and per year (180) (figures for the 2016/17 season).
- Catch limits: Monthly catch limits of 75t per vessel (July-Dec. 2017); these are subject to periodic revision depending on evaluations of stock status.

As well as these measures to reduce effort, there are extensive inshore areas closed for at least 6 months per year (decided on a season-by-season basis); also more extensive than required by GFCM. Essentially, more or less the entire inshore area between the islands and the shore is closed to purse seine vessels >12m (small vessels are exempt because they are not capable of working further offshore and take only a small proportion of the catch). The closures for 2016 are shown in Figure 5; those for 2017 are similar except with some areas closed all year round to vessels >12m. The purpose of these closures, as well to

reduce effort, is to target it in areas where there are larger sardines, rather than close to shore where they tend to be smaller. This can be seen in Figure 6, which shows mean size of sardines in the catch; it is apparent that they get larger offshore. As well as providing for more efficient exploitation of the stock (higher MSY) it also gives more value per unit weight of catch. The plan also incorporates the minimum size from GFCM (2013).

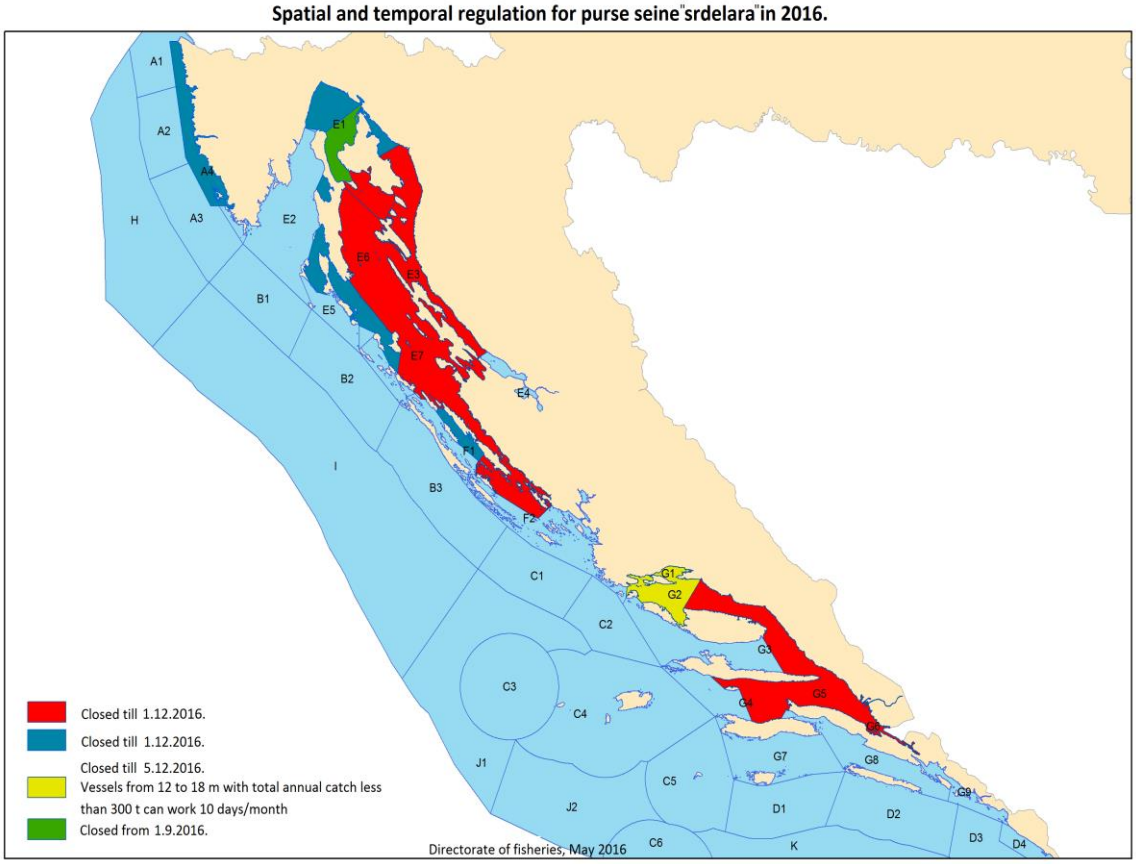

Figure 5. Closed areas for the srdelara fishery (2016), for vessels >12m; red and blue: closed until 1 Dec. 2016; yellow: closed until 5 Dec. 2016 except for vessels with total annual catch <300t who can fish 10 days/month in this area; green: closed from 1 Sept. 2016 (Directorate of Fisheries, 2017)

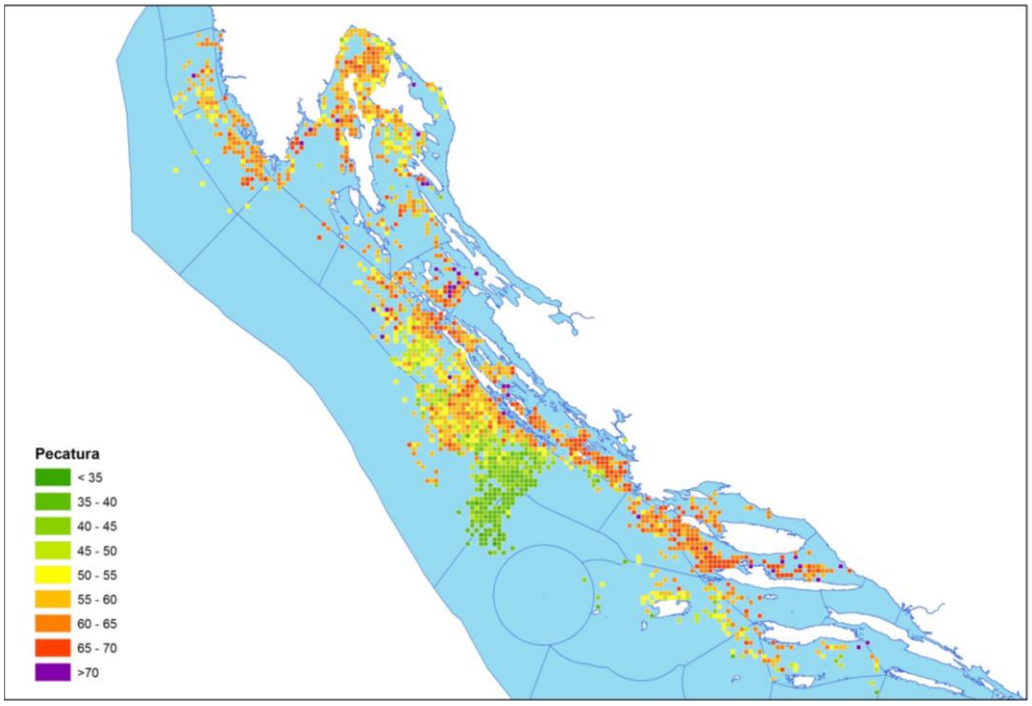

Figure 6. Sardine catch by area by fish size: green = large fish (<35/kg) → purple = small fish (>70/kg) prior to the area closures (Directorate of Fisheries, 2017).

The Ministry notes that the management plan has only been in implementation since 2014, so it is not yet really possible to evaluate whether it is working. Catch of sardine in 2015 (the most recent year for which public data are available) was lower than that of 2014, as required by GFCM (2016b), and the Ministry considers that they are 'on course' to meet capacity reduction targets of 20% by the end of 2017 (Directorate of Fisheries, pers. comm.), although these data are not yet available (fleet report for 2016 currently under review by STECF).

EU multi-annual plan

The development of multi-annual management plans (MAPs) are a key element of the reformed CFP, and a MAP is considered by the European Commission to be particularly important for this stock because of the pessimistic analyses of STECF and GFCM as to the status of the stock. The Commission has concluded that the current management framework for Adriatic sardine does not comply with the objectives and requirements of the CFP. A proposal for a MAP (European Commission, 2017[5]) has therefore been put forward with the objective of rebuilding the stock to B_{MSY} by 2020. The draft MAP proposes to define 'fishing opportunities' (i.e. a TAC) based on reference points derived from STECF, with F_{MSY} set as a range from 0.065-0.08 (the upper bound being the lowest STECF estimate of F_{MSY} – see above), although the plan does allow for it to be set higher (up to 0.11). It also defines a 'minimum spawning stock biomass reference point' (also called $MSYB_{trigger}$ – this is the value that should trigger management action), as well as a B_{lim}. If biomass is estimated to be below $MSYB_{trigger}$, the draft MAP requires that the TAC be set to correspond to a fishing

[5] See https://ec.europa.eu/fisheries/commission-proposes-multi-annual-plan-small-pelagic-stocks-adriatic_en

mortality lower than 0.065, while if it is below B_{lim}, further remedial measures are required, which could be put in place via a delegated act. These remedial measures(?)are not specified directly, although the Commission gives a list (technical measures, time/area closures, closure of targeted fishing and various other options).

This plan is for the moment just a proposal, and cannot progress without approval by the EU Council and Parliament. There has been a consultation process[6] and although there was reportedly wide agreement on the need for a MAP, many of the comments expressed reservations about the details of the current draft MAP; in particular the principle of management via TACs, as well as the scientific basis for evaluating stock status.

4.4.6 Information and stock assessment

There are two key datasets used in the stock assessment; i) fisheries-dependent data (catch, effort and associated biological data such as catch-at-size and catch-at-age) and ii) an acoustic survey conducted by the Croatians and the Italians. There are considerable problems with both sets of data.

Although catch and effort data from Croatia are now robust and accurate, Croatian scientists expressed strong concerns about historical data. The quality of Italian catch and effort data (including historical data) is not known. Data from Montenegro and particularly Albania are very uncertain, but these catches are not thought to be significant. As noted above, if historical fisheries data or assumptions about historical stock dynamics are significantly inaccurate, it puts the conclusions of the stock assessment in some doubt. STECF (2016a) also expresses some other concerns about historical fisheries data; they note that prior to 2005, biological data such as length-frequency in the catch is only available from Italy; this means that in order to disaggregate the catch data from the eastern side of the Adriatic by age they have to assume that the Croatian fishery took the same size distribution of fish as the Italians, whereas in practice the fisheries are significantly different in terms of gear and targeting.

In relation to the acoustic survey, there are problems of consistency between the Italian and Croatian surveys; the Italian survey is conducted in June, and the Croatian survey in September. The fish move around in the Adriatic; they also grow, so it is not clear to what extent they are comparable. It is also reported that they use different methods to estimate biomass (Advisory Service, pers. comm.), and there have reportedly also been changes over time within each survey time series. WGSASP suggests that more work is required on inter-calibration of these two datasets, as well as an analysis of the impact of changes in methodology and/or timing within each survey. Another problem is that the survey timing (in both cases) is not well adapted to GFCM's annual timetable; survey output in Year 0 is not available in time to support the stock assessment in Year 1, meaning that survey data are already two years old by the time it can be used in the stock assessment. For short-lived species such as sardine, this is a big time gap.

[6] Summary of main comments received is available here: https://ec.europa.eu/info/sites/info/files/consultation-multiannual-plan-northern-adriatic-sea-summary_en_0.pdf

Reportedly, Croatia and Italy are now working together to harmonise the timing and methodology of the two surveys (Directorate of Fisheries, pers. comm.), and GFCM (2016b) requires that timing is such that data are available by the end of January of the following year, which should hopefully reduce the period between data collection and use from two years to one. Meanwhile, however, the stock assessment is forced to rely mainly on fisheries data, although it uses the acoustic survey for tuning (estimating parameter values to give the best fit of the model to the data).

In the past, concerns have been expressed about aging, and particularly about consistency in reading otoliths between the different countries; however, the scientists have done considerable work to address this question as part of the AdriaMED project. This is important because an age curve is required for the stock assessment, as well as to estimate natural mortality (M – a key element of estimating the reference point E).

The stock assessment uses a state-space assessment model (known as SAM), which is a computationally-intensive age-structured model widely used for fisheries stock assessments. As noted above, the model used by GFCM and STECF is the same, although some of the data inputs and assumptions are a little different between the two groups. STECF (2016a) notes that the model results are consistent with previous assessments by both STECF (in 2014 and 2015) and GFCM (in 2015), except for difficulties in estimating fishing mortality over the last two years. The latest iteration of the model estimates fishing mortality to be very high (~1); a level that STECF apparently does not find plausible. They speculate that this may be due either to a change in how the acoustic survey data are treated (combining all surveys into one dataset instead of using each survey separately), or a consequence of applying a new aging procedure which estimates fewer fish in the older age classes (interpreted by the model as an increase in fishing mortality) – or both.

4.5 Principle 2 – bycatch and ecosystem impacts

4.5.1 Defining bycatch species as primary vs. secondary and main vs. non-main

MSC puts bycatch species into two categories for the purposes of evaluation under Principle 2: 'primary' and 'secondary', and evaluates each category under a different set of PIs. CR v2.0 defines 'primary' bycatch species in this context as those: *where management tools and measures are in place that aim to regulate fishing in relation to some biologically based limit and/or target reference levels*; secondary species are all the others.

MSC also makes a distinction between 'main' bycatch species and others. Main bycatch species are defined as those which exceed 5% of the total catch (including discards), or 2% if the species is considered to be vulnerable to fishing pressure (e.g. if the stock is known to be depleted or if the life history makes it vulnerable); assessment teams can also use their discretion to designate species as main if they feel it is necessary.

4.5.2 Bycatch species

The fishery is a mixed fishery targeting sardine and anchovy, with other species of small pelagics sometimes taken as bycatch (mackerel and horse mackerel). In recent years (since 2011), sardine has represented ~75% of the Croatian catch of small pelagics, while anchovy landings have fluctuated in the range of 12-22% of the total. Small pelagic landings of other species reached ~10% of the total in 2014, but in 2015 were only 4%. It is not clear, however, that the entire bycatch was taken by the purse seine fishery; the Ministry gives a figure of 3% total bycatch (i.e. catch other than sardine and anchovy) for the purse seine fishery for 2015 (Directorate of Fisheries, 2017). STECF (2016a) note that discarding in this fishery is 'considered negligible'. The Landing Obligation is now in force for this fishery, so in principle there should be no discarding. The electronic logbooks on purse seine vessels have recently (2015) been improved to allow for better recording of catch other than sardine and anchovy (Advisory Service, pers. comm.).

A dataset provided for the purpose of the previous pre-assessment gives a list of bycatch species as follows: horse mackerel (*Trachurus mediterraneus*, *T. trachurus*), mackerel (*Scomber japonicus*, *S. scombrus*), sardinella (*Sardinella aurita*), moon jelly (*Aurita aurita*), sprat (*Sprattus sprattus*), bogue (*Boops boops*), squid (*Loligo vulgaris*, *Illex coindettii*) and garfish (*Belone belone*); ~75% of the total being made up of *T. mediterraneus* and mackerels. The two horse mackerel species are difficult to distinguish and are not separated in logbook or landings declarations.

In MSC terms, anchovy would be considered a main bycatch species for this fishery. The management framework for anchovy is very similar to that of sardine, so on that basis, it would be a primary species. It is not completely clear which of the other bycatch species might be included; depending on recent data at the time of a full assessment, horse mackerel and mackerel might be included as main species, but probably not. Nevertheless, they are considered here on a precautionary basis. Since there is no direct management via reference points, they would be considered secondary species.

It is also reported that there may be some catch of swordfish and bluefin tuna associated with this fishery (D. Kanski, WWF Adria, pers. comm.); reportedly this is minor and they are considered primary species but not main.

4.5.3 Evaluation of bycatch species

STECF (2016a) considers that anchovy is over-exploited, with F estimated to be above all possible estimates of F_{MSY}. To obtain E=0.4, STECF estimates that catch in GSA17 and 18 would have to be reduced from ~30,000 t to ~10,000 t. GFCM also estimates that $F>F_{MSY}$, and estimates biomass at below B_{pa} but above B_{lim} (GFCM, 2016a). Anchovy are managed under the GFCM/Croatian management plan, with the same provisions as for sardine (days-at-sea limits, capacity reduction, closed periods and areas, minimum size), and are also included in the EU's proposed MAP.

STECF reviews stock status for *T. trachurus* (but not *T. mediterraneus*) and both species of mackerel, but is not able to assess stock status due to lack of data; since there is not a targeted fishery. GFCM WGSASP does not consider any of these stocks.

4.5.4 ETP species

Neither Ministry staff nor scientists nor Omega 3 staff reported any interactions between the purse seine fishery and any ETP species. It is reported that cetaceans (bottlenose dolphin), turtles (loggerhead) and birds (various) are present in the area, but do not interact particularly with the fishery or the fishing vessels. No seals are present in the area.

There are a variety of projects for monitoring populations of these species in the Northern Adriatic – e.g. NetCet[7], the Cetacean Alliance[8] and perhaps others. It is reported that the Croatian populations of bottlenose dolphins are among the best-studied in the Mediterranean (see Cetacean Alliance information). In relation to bottlenose dolphins, there are concerns over the status of some populations according to the Cetacean Alliance, but this fishery is not mentioned as an issue; in fact, they note a diet switch towards small pelagics as sardine biomass has increased. Increased pleasure boating and development is the main concern.

The main interaction of the fishery with species other than small pelagics is with bluefin tuna, which was formerly depleted but is now present in the area in increasing numbers. Bluefin tuna is fished under quota, managed by ICCAT, and is not on this basis an ETP species. Bluefin ranches provide a market for some of the catch of the fishery, but this would also not be considered under an MSC assessment, except in relation to traceability if relevant.

4.5.5 Habitats

The Mediterranean Regulation specifies rules for the depth of purse seine nets: they should be no more than 120m deep (measured when stretched and wet) and not deployed in water shallower than 70% of the total stretched-mesh depth of the net. The nets should also not be deployed within 300m of the shore or in depths of less than 50m. This fishery has, however,

[7] See http://www.netcet.eu/
[8] See http://www.cetaceanalliance.org/cetaceans/Tt_croatia.htm

received a derogation from these requirements, on the basis of studies which show that under normal conditions of deployment, impacts on benthic habitats from the srdelara nets are minimal (e.g. see Anon, 2009). There is habitat mapping and monitoring in Croatia; see for example RAC/SPA-UNEP/MAP, 2014.

4.5.6 Ecosystem

As noted above, sardine and anchovy are likely to be considered key low trophic level (LTL) species according to the MSC definition – i.e. there is a strong possibility that they play an important role in the ecosystem as forage fish for higher trophic levels, including fish and other predators.

A modelling study of the Adriatic ecosystem (Coll et al., 2009) identifies anchovy as key prey species, and sardines as key intermediate-level predators. It broadly identifies two different trends over time (1975-2002): a decline of commercially-important species, including anchovy, as a result of heavy fishing pressure (although it identifies trawling as the main culprit) and a pattern of increase followed by decrease of species in intermediate trophic positions (such as sardines), or species which are not targeted by fisheries. The authors postulate that this second pattern could arise from the removal of top predators from the system by fishing, with a subsequent decline a result of '*progressive impoverishment of the ecosystem*' as a result of overfishing, although warming and eutrophication are also possible causes. Overall, Coll et al. note '*a low probability that the ecosystem was being sustainably fished during the study period*'. There is no particular evidence that the situation has improved since then: sardine biomass has been more or less stable while anchovy has continued to decline; in relation to top predators, bluefin tuna biomass has increased substantially but hake and swordfish remain depleted (STECF, 2016a, ICCAT, 2014). Hake biomass may be declining as a consequence of climate change; however, the species has seen a huge expansion in the northern-most part of its range (Lav Bavčević, pers. comm.). In general, it is hard to rule out climate change rather than (or as well as) fishing as a possible driver of some of the patterns observed or postulated above.

4.6 Principle 3 – the management system

4.6.1 Area of operation and jurisdictions

The fishery operates in the northern and central Adriatic Sea; area GSA17 in the GFCM area classification (see Figure 1). Although no EEZs are declared in the Mediterranean, the area of the fishery outside Croatian territorial waters in GSA17 remains EU waters (shared between Croatia, Italy and Slovenia), with a cooperative management system under the EU framework (CFP, Mediterranean Regulation, STECF) and GFCM, so there are no particular jurisdictional problems. (Croatia has declared a 'ZERP' – ecological and fisheries protection zone, along the same lines as an EEZ.)

4.6.2 Organisations, roles and responsibilities

The organisations involved in the management of the fishery, and their roles and responsibilities, are set out in Table 2.

Table 2. Organisations involved in the management of the fishery, and their roles and responsibilities

Organisation	Role, responsibility
International	
EU Commission	Make proposal for management of the fishery to the Fisheries Council and the Parliament, based on scientific advice from GFCM and/or STECF (e.g. MAP)
European Fisheries Control Agency	Overarching agency for fisheries control in the EU – provide framework for cooperation between Croatia, Italy and Slovenia for monitoring and surveillance of this fishery
STECF	Scientific, Technical and Economic Committee for Fisheries – an advisory committee to the European Commission. Reviews stock assessments, reference points and management annually.
GFCM	General Fisheries Commission for the Mediterranean – the RFMO for the Mediterranean, operating under the auspices of FAO.
GFCM Scientific Advisory Committee (SAC)	Scientists from the member countries of the GFCM: run stock assessments and provide scientific advice to the GFCM
GFCM WGSASP	Working Group for Stock Assessment of Small Pelagics; conducts stock assessments for small pelagics in the Mediterranean for GFCM.
WWF	International NGO working on fisheries policy at the European and GFCM level
AdriaMed	An FAO project in which scientists from the Adriatic countries collaborate on fisheries biology and science – provides input information to the SAC

Organisation	Role, responsibility
Mediterranean Advisory Council (MedAC)	The EU stakeholder advisory council for the Mediterranean
National	
Ministry of Agriculture	Ministry of which the Directorate of Fisheries is a part. Responsible for putting EU Regulations and Directives into Croatian law via Ordinances.
Directorate of Fisheries	Responsible for management of fisheries in Croatia, including monitoring and enforcement, licensing, data gathering and implementation of fisheries ordinances. Run the GISR fisheries information system (see details below).
Institute of Oceanography and Fisheries	Carry out fisheries research, analyse data and provide scientific advice to the Directorate of Fisheries. Participate in AdriaMed and the GFCM SAC.
Chamber of Economy, Fishery Association	All larger businesses must be members, including fishing companies. Fishery Association groups together Chamber of Economy members with an interest in fishing.
Chamber of Crafts	All small/artisanal businesses must be members, including small-scale / artisanal fishermen.
Purse seine working group	Stakeholder group representing all interests in the purse seine fishery, including both Chamber of Economy and Chamber of Crafts. Consulted by government on management issues.
Omega 3	Purse seine fishing cooperative which owns processing plant for sardine and anchovy; members account for ~25% of Croatian sardine fishery.
WWF Adria	NGO; working with Omega 3 and the Ministry to support improved management of the fishery.

Roles and responsibilities are generally well defined. One issue is the overlap in the roles played by the GFCM Scientific Advisory Committee and STECF, which overlap and to some extent conflict, although many of the same individuals are involved in both. It is clear that this is a question of concern to scientific stakeholders in the fishery, not least in relation to demands on their limited time. Nevertheless, it is not fundamentally a bad thing to have different scientific perspectives brought to bear on a fishery, particularly where the situation is somewhat difficult as it is here.

4.6.3 Objectives

In terms of the broader management framework, this fishery, being an EU fishery shared between several Member States, falls inside the framework of the revised CFP. Therefore, at least implicitly, incorporates the broad objectives of the new CFP and the wider EU framework for marine conservation, including management to MSY, good ecological status for marine habitats etc. GFCM also has an overarching objective: to *promote the development, conservation, rational management and best utilization of living marine resources*[9].

As noted above, the fishery currently has two extant management plans: the national management plan and a GFCM management plan, as well as a third management plan recently presented as a proposal by the European Commission. The GFCM management plan has fishery-specific objectives set out in the form of reference points, as described in detail above. The Croatian management plan has two stated objectives:

- The socio-economic goal is to maximize the revenue from fishing, as well as to provide sufficient employment for participants fishing with this type of gear.
- The biological goal is to keep fishing at or above the level necessary to maintain productivity and recovery of exploited stocks. [NB: the intent is presumably to keep fishing at or *below* the level necessary, such that the stocks are at or *above* the sustainable level – this is most likely a problem with translation.]

More specifically, in biological terms, the specific goal of the plan is '*directing the activities of the fleet towards the achievement of safe biological limits of sardine and anchovy stocks, measured in relation to Patterson's exploitation level and trend of recruitment in whole GSA 17*'. [Patterson's exploitation level corresponds to the reference point E=0.4 – see above.]

4.6.4 Consultation

At Croatian national level, consultation processes in the fishery are reportedly well-developed. The purse-seine working group is a stakeholder body formally constituted to provide advice to the Directorate of Fisheries. However, it is reported by fishing company representatives that consultation goes more widely than this. Before any change in management or when introducing new management measures, the Ministry organises ad hoc meetings, and invites all purse seine licence holders for consultation; such meetings take place 5-6 time per year.

At international level, however, there was some concern about the operation of GFCM and the EU, and their interaction. The issue of conflicting reference points and multiple stock assessments by GFCM and STECF has already been considered above. Furthermore, although the preamble to the EU MAP makes much of the consultation process, there are indications the EU has not chosen to incorporate many of comments received from critical stakeholders (e.g. the national authorities concerned[10]).

[9] See http://www.gfcm.org/gfcm/about/en
[10] See https://ec.europa.eu/info/sites/info/files/consultation-multiannual-plan-northern-adriatic-sea-summary_en_0.pdf

4.6.5 Decision-making processes

In relation to decisions taken at EU level, the process is clear if sometimes a bit complex: the European Commission takes account of the regulations set by GFCM and the scientific advice from STECF as applicable, makes a proposal to the Fisheries Council and if required the Parliament. These decisions are then incorporated into Croatian law via ordinances, and via the management plan. For decisions at Croatian level (e.g. in relation to how to implement measures such as time/area closures required by international management decisions) the decision is made by the Ministry of Agriculture, following the consultation processes set out above.

4.6.6 Compliance and enforcement

Enforcement is one of the roles of the Directorate of Fisheries, including enforcement at sea, at landing sites and in relation to administrative requirements and chain of custody. The enforcement division operates under an annual enforcement plan, developed on the basis of a risk-assessment. This fishery is treated as high priority because of the international element – it is covered by a joint programme with the other EU countries concerned (Italy, Slovenia), which includes exchanges of inspectors, harmonised procedures etc.

In relation to enforcement at sea, the Directorate has six fisheries patrol vessels, and vessels from the police, Coast Guard and customs may also participate in fisheries enforcement at sea.

In relation to enforcement at landing sites, effort can be spread thinly because of the long coastline and high number of landing sites. Inspectors visit landing sites according to their importance, covering documentation and logbooks, landings declarations, traceability and gear inspections. Markets are also inspected for fish size and traceability.

Electronic systems: Where the Croatian fisheries management system is particularly strong is in the impressive electronic information system in place for tracking vessels, landings and buyers and sellers (GISR), which also operates for the purposes of enforcement. All vessels in the srdelara fishery must have electronic logbooks and VMS, regardless of size. The output of e-logbooks enters directly into the GISR system, as do landings declarations, and they are automatically cross-checked by the system, with mismatches appearing in red. VMS data likewise feed into the system, allowing cross-checking of landings with trip details. It also allows real-time tracking of the number of days targeting sardines vs. anchovy (defined as days when more than 50% of the catch was one vs. the other) in order to enforce the days-at-sea limits discussed above. All buyers must also be registered, so that quantities can be tracked down the supply chain. Again, mismatches are flagged up automatically, although the system is flexible enough to allow small differences in quantities, which might arise from direct sale by small-scale fishermen or from inaccuracies in the estimated quantities in logbooks (a common problem in fisheries data). New developments are i) that catch is reported in e-logbooks by number as well as by size, provided real-time data on catch-at-size (see Figure 6); and ii) an electronic transport document, which enables fisheries inspectors, veterinary and sanitary inspectors and customs to check refrigerated trucks during transport, through the electronic system.

4.6.7 Monitoring and management performance evaluation

Croatia's systems for fisheries management were extensively scrutinised by the EU Commission (along with everything else) as a pre-requisite for entry into the European Union. Croatia has worked hard to meet the EU requirements in relation to fisheries management, including preparation of the national management plan, and passing of a variety of ordinances to comply with the Mediterranean Regulation and others. On this basis, it can be argued that the national Croatian system has been subject to an extensive and relatively recent review. The work of GFCM in relation to this fishery is at least partially reviewed by STECF on a regular basis[11] (STECF, 2016a).

4.7 Traceability

Omega 3 has a system for product traceability based on lot numbers which stay with the product throughout processing to point of sale. The lot number identifies product to a specific date of landing and vessel, as well as by species and size grade. An example was given of a lot number: 13061703SD41; which can be interpreted as follows: 130617=date of landing; 03=vessel number (list of Omega 3 member vessels); SD=species sardine (alternatively AN); 41=41-45 pieces per kg (size grade). It is not foreseen that Omega 3 will have any trouble receiving MSC chain of custody certification for their plan, if desired.

4.8 Evaluation procedure

4.8.1 Assessment methodologies used

The pre-assessment was conducted in accordance with the MSC Fisheries Standard v2.0 and the pre-assessment reporting template version 2.0.

4.8.2 Summary of site visits and meetings held during the pre-assessment

The site visit was conducted from 13-15 June 2017 by Dr Jo Gascoigne. A summary of the meetings and discussions is provided in Table 3.

Table 3. Meetings held during and after the site visit

Individual	Organisation
Danijel Kanski	WWF Adria
Filip Bukša	WWF Adria
Ines Jablan	Omega 3
Šime Kosor	Omega 3
Simone Katharina Niedermüller	WWF Austria / Switzerland
Barbara Zorica	Institute of Oceanography and Fisheries

[11] See https://stecf.jrc.ec.europa.eu/reports/review-advice

Vanja Čikeš Keč	Institute of Oceanography and Fisheries
Marin Mihanović	Ministry of Agriculture
Lav Bavčević	Advisory Service

4.9 Preliminary evaluation of the fishery

4.9.1 Risk-based framework (RBF)

The only possible requirement for using the RBF would be if some species other than anchovy were considered to be 'main' bycatch species (see Section 4.5.2). This is probably not likely but is included here to be precautionary.

4.9.2 Evaluation of the fishery

Principle 1

Evaluating the stock status in relation to MSC's requirements for 'key low trophic level' species is problematic, because MSC defines them in terms which are not estimated by the stock assessment (and not easy to estimate). There is a consensus between GFCM and STECF that the stock is depleted in relation to MSY reference points and overfished, although these conclusions must be regarded as highly uncertain given the problems with the data and with the F_{MSY} reference point. There is, however, no evidence that recruitment is impaired (see Figure 4, bottom panel) and there is also no evidence of 'serious ecosystem impacts' (e.g. bluefin tuna, a key predator, has been increasing rapidly in abundance).

If the score for stock status is <80, MSC require a rebuilding strategy with a specified timeframe which needs to be a maximum 5 years (the latter in the case of sardine). This does not have to be a formal 'rebuilding plan' – it can be integrated into the general harvest strategy, which at present is the GFCM / Croatian strategy. There are, however, considerable problems with the harvest strategy at present:

1. The objective of the harvest strategy is not clear. The Croatian management plan uses E as the target, but since E would only apply to the entire stock, it (reasonably) makes no attempt to evaluate how it might apply to the Croatian fishery. Meanwhile, GFCM, whose annual 'emergency measures' have to be integrated into Croatian management, have switched from using E to using F_{MSY} as an objective. STECF and even GFCM participant scientists, however, are extremely sceptical about the estimates of F_{MSY}; STECF recommends a move back to using E. Despite STECF's concerns, however, GFCM appears to be sticking with F_{MSY}, and the European Commission (who are supposed to be advised by STECF) have also used F_{MSY} (albeit expressed as a range) as the target for their draft MAP. STECF is correct, however, that the estimates of F_{MSY} are not at all credible. A further complication is that for MSC certification, the fishery would need to show that stock objectives are consistent with ecosystem requirements, since sardine are a key LTL species.

2. The measures (harvest control rules and tools) set out in the current (GFCM/Croatia) harvest strategy are mainly indirect controls on exploitation rate (e.g. capacity reduction, days-at-sea limits, closed periods and areas etc.) and it is not easy to quantify the overall likely impact in terms of proportional reduction in effort or catch, and even more difficult to link that back to the recovery of the stock to a given target level (possibly because the target itself is not very clear and keeps changing). This means that it is not possible to evaluate whether the harvest strategy will recover the stock and if so over what timeframe, and how successful it is likely to be over the long-term at maintaining the stock at target levels.

There are also significant problems with the data input into the stock assessment process in two key areas: historical data and the acoustic survey. The stock assessment output is driven to quite a large extent by the very big peak in biomass in the early 1980s, but if this is an artefact of incorrect fisheries data (e.g. if catches were over-estimated during this period) then the conclusions as to recent stock status might be inaccurate. The lack of coordination between the Croatian survey, the Italian survey and GFCM mean that the (costly) acoustic survey is not being used to its full potential. This means that there seems to be a slightly strange situation whereby scientists who are key participants in both stock assessment processes have little confidence in the outcome of either.

Overall, and unsurprisingly, the fishery does not score at all well in relation to Principle 1 for the moment. A key problem is the scientific framework (data, stock assessment, scientific recommendations, objectives) which is slow, uncertain and based on questionable data. Without clear scientific input on the status of the stock and suitable objectives, management strategies are inevitably built on weak foundations.

Principle 2

The only main primary bycatch species is anchovy. Anchovy is estimated by GFCM and STECF to be over-exploited. Although recruitment is currently estimated to be low, there is no particular evidence that recruitment is impaired by the fishery; STECF note that recruitment has been at this low level in the past under low levels of fishing mortality, according to the assessment. Productivity of anchovy and sardine in the Adriatic may be negatively correlated to some extent (Lav Bavčević, pers. comm.). The management of anchovy has the same issues as for sardine; i.e. the scientific basis for management is unclear with the stock assessment based on uncertain data and conflicting views from GFCM and STECF on suitable objectives (F_{MSY} vs. E).

Horse mackerel and mackerel are possible main secondary species, but better data on bycatch may well rule them out based on proportion of total catch (if <5%) and/or on discard survival (if mainly slipped). If they are considered main secondary species, and if there is unwanted catch, the fishery will need to show that they periodically review options for reducing this.

Stakeholders are confident that the fishery does not interact negatively with any ETP species, but quantitative information (e.g. from observers or self-reporting) seem to be lacking. There is likewise no evidence of any negative impacts on habitats. (The provisions of the Mediterranean Regulation have shown not to provide habitat protection; see Anon, 2009. This issue is therefore considered as a regulatory issue under Principle 3 below.)

In relation to the role of the fishery in the ecosystem, the same issue arises as for Principle 1, i.e. that fisheries management objectives need to be clearly-defined and consistent with MSC requirements for key LTL species, such that the stocks (sardine and anchovy) can play their role in the ecosystem.

Principle 3

No major problems are identified with Principle 3. The main issues which might lead to a condition are i) the fishery-specific stock management objectives which, as already noted numerous times, are unclear; and ii) effective consultation process at GFCM and EU level.

Summary

A summary evaluation of the fishery against each of the MSC PIs is given in Table 4.

Table 4. Summary of likely scoring categories for each performance indicator. The key to the likely scoring levels is given below:

Information suggests fishery is not likely to reach SG60 and therefore would fail on this PI	**<60**
Information suggests fishery will reach SG60 but may need a condition for this PI	**60-79**
Information suggests fishery is likely to exceed SG80 resulting in an unconditional pass for this PI	**≥80**

Prin-ciple	Compo-nent	PI	Performance Indicator	Likely scoring level	Key issues to be addressed / other notes
1	Outcome	1.1.1	Stock status	?	No evidence of 'serious ecosystem impacts' although difficult to estimate biomass in relation to B_0 (as MSC require) but according to current assessments, the stock is below a level consistent with MSY and a level 'consistent with ecosystem needs' according to MSC's definition.
		1.1.2	Stock rebuilding		There is no evidence (such as projections) that the current management can rebuild the stock to a level consistent with MSY within five years. Furthermore, the definition of 'a level consistent with MSY' is highly uncertain at present.
	Manage-ment	1.2.1	Harvest Strategy		It is not clear if the harvest strategy is 'expected to work'; some stakeholders believe that it will (GFCM, Ministry) whereas others do not (the Commission). Because the strategy is based on indirect measures to reduce fishing mortality, it is difficult to evaluate quantitatively what the impact is on stock status. The objective of the harvest strategy is not clearly defined.
		1.2.2	Harvest control rules and tools (HCR)		While the HCR does not have a clearly-defined objective and is not clearly linked to stock status, progressive additional measures have been put in place and there can be some expectation that this will start to have an impact on stock status.
		1.2.3	Information and monitoring		Data are collected and stock status monitoring takes place but the uncertainty in the data and stock assessment is such that the objectives of the harvest strategy cannot be clearly defined.
		1.2.4	Assessment of stock status		The assessments estimate stock status in relation to reference points, but not sufficiently well to be useful for the harvest strategy.

	Combined score for Principle 1				**Not likely to pass; the scientific basis for management is weak and objectives poorly defined.**
2	Primary species	2.1.1	Outcome		Anchovy is the only main primary species (swordfish and bluefin tuna may be minor primary species). No evidence that recruitment is impaired but likely that this fishery is impairing recovery to MSY or similar level.
		2.1.2	Management		Similar measures in place as for sardine; some probability that they will be reducing the exploitation rate but as for sardine the objectives are not clear (F_{MSY} vs. E) and there is no quantitative link between the measures and the amount of reduction needed.
		2.1.3	Information		Information has the same issues as for sardine (1.2.3) but requirements for P2 species are lower.
	Second-ary species	2.2.1	Outcome	RBF	Horse mackerel and mackerel possible main secondary species; using RBF the risk from this fishery to these stocks is low (Annex).
		2.2.2	Management		Left: No evidence that a management strategy is required; but Right: If there is unwanted catch of these species and if they are 'main', a regular review is required of possible measures to reduce it.
		2.2.3	Information		Enough information to evaluate the risk as low (see 2.2.1) but need better information to better define main secondary species
	ETP species	2.3.1	Outcome		No evidence of any impacts on ETP species, and no real basis for such impacts
		2.3.2	Management		Measures in place (the type of fishing) but it does not qualify as a 'strategy' given lack of direct evidence
		2.3.3	Information		Monitoring of populations but a bit lacking in terms of fishery interactions. Probably sufficient for 'qualitative information' but nothing quantitative could be found at the time of this pre-assessment.
	Habitats	2.4.1	Outcome		Highly unlikely to cause harm; some indirect evidence (e.g. Greek study in similar

					fishery/environment)
		2.4.2	Management		Impacts not likely
		2.4.3	Information		Habitat mapping / monitoring appears to be in place
	Eco-system	2.5.1	Outcome		There is no particular evidence of ecosystem harm from the fishery, but harvest strategy objectives need to be consistent with an evaluation of ecosystem requirements (key LTL species)
		2.5.2	Management		There are measures in place which should restrain ecosystem impacts (biomass is estimated to be increasing) but it is not clear that ecosystem requirements are being met or will be met under the harvest strategy
		2.5.3	Information		The biology of the main species in the ecosystem is well understood and ecosystem dynamics have been modelled. The role of climate change (now and in future) is unclear but this ecosystem is hardly unique in that regard
	Combined score for Principle 2				**Only one possible pre-condition (red scores) identified and this is unlikely (precautionary scoring). Conditions mainly around harvest strategy (same as for P1) – either in relation to anchovy or in relation to the ecosystem impacts; also limited direct data on ETP species interactions.**
3	Govern-ance and Policy	3.1.1	Legal and customary framework		There is a clear and effective national and international framework. Although the role of scientists has been somewhat contradictory, this is not a problem with the framework itself so much as issues specific to this fishery/stock.
		3.1.2	Consultation, roles and responsibilities	?	There seems to be good structures and processes for consultation within Croatia but there might be some concerns in relation to i) the extent to which GFCM consults on its measures which are quite specific and binding; and ii) the extent to which the EU MAP reflects the views of keys stakeholders.
		3.1.3	Long-term objectives		There are a series of general long-term objectives provided by the CFP, the GFCM, the Croatian management plan, other EU legislation (Marine Strategy Framework Directive)

					etc.
	Fishery specific manage-ment system	3.2.1	Fishery-specific objectives	?	This is a difficult one to score: SG60 requires 'implicit' objectives 'broadly consistent' with MSC requirements, while SG80 requires 'explicit' and 'consistent' objectives. This fishery has various explicit objectives, all of which could be at least broadly consistent with MSC requirements, but they are neither clearly defined nor consistent with each other, nor is it clear how they are used in management.
		3.2.2	Decision-making processes		Clear, established decision-making process at both national and international level, which respond to issues such as stock status, albeit lacking clear scientific guidance about how
		3.2.3	Compliance and enforcement		Monitoring, control and surveillance system seems to be excellent.
		3.2.5	Management performance evaluation		Various structures for review of key areas of management, e.g. STECF reviewing stock assessment and objectives, the European Commission has reviewed Croatia's management plan; stakeholders are reviewing the EU MAP proposal etc.
	Combined score for Principle 3				**Not many issues; the management framework is solid. The main issue is the same one as raised above, i.e. conflicting objectives lacking sound scientific basis.**

5 Part 3 – Scoping

5.1 FIP scoping and preparation

The above pre-assessment provides the gap analysis for the fishery in relation to the MSC standard. This scoping section outlines in broad terms the areas that the FIP will need to address to improve the fishery to the point where MSC certification is achievable.

The scoping provides the basis for discussion in the FIP workshop, which is due to take place later in 2017. In order to facilitate discussion, a draft outline workplan has been provided below – it is foreseen that this will change significantly as a result of the workshop but provides a starting point.

5.2 Scoping: Issues for the FIP to deal with

1. *Ecosystem objectives (1.1.1A, 2.5.1, 2.5.2)*

Since sardine is likely to be identified as a key low trophic level (key LTL) species, MSC defines the targets for stock status in terms of ecosystem-level targets (1.1.1A) rather than stock-level targets (1.1.1). They provide some default levels for these ecosystem objectives: in terms of biomass the default target is 75%B_0, while in terms of fishing mortality, the default is 0.5F_{MSY} or 0.5M. The relevant requirements are given in the Text Box below.

These default MSC targets are very conservative which would be problematic for the fishery (for most fisheries) for two reasons: i) to maintain B or F targets at this level would require a very large (and most likely unnecessary) reduction in catches; and ii) as we already know, neither B_0 or F_{MSY} can be estimated for this fishery with any confidence, so these default targets can also not be estimated. MSC, however, provide for different targets to be set which are more appropriate for the stock and fishery, as long as it can be demonstrated that maintaining the fishery at that level does not have major impacts on other components of the ecosystem (defined in SA2.2.13/b/i and ii – see Box). In order to evaluate this, a quantitative ecosystem model is required. As noted above (Sections 4.4.2 and 4.5.6) some work on ecosystem modelling has already been done, but probably not enough to deal with these questions specifically. This is certainly scientific work that the FIP could support and promote, and as well as contributing to determining stock objectives and developing the MAP, would be helpful in other areas (e.g. it could be used to evaluate the limits of recovery of bluefin tuna biomass or to evaluate reasons for the decline of some populations such as dolphins and hake, for example).

Box: MSC requirements for defining target levels for stock biomass for key LTL species

SA2.2.13. When scoring PI 1.1.1A scoring issue (b), the expectations for key LTL species shall be as given below:

a) The default biomass target level consistent with ecosystem needs shall be 75% of the spawning stock level that would be expected in the absence of fishing.
b) A higher or lower target level, down to a minimum allowed 40% of the spawning stock level that would be expected in the absence of fishing, may still achieve an 80 level score if it can be demonstrated, through the use of credible ecosystem models or robust empirical data for the UoA/ecosystem being assessed, that the level adopted:
  i. Does not impact the abundance levels of more than 15% of the other species and trophic groups by more than 40% (compared to their state in the absence of fishing on the target LTL species); and
  ii. Does not reduce the abundance level of any other species or trophic group by more than 70%.

…

SA2.2.15. Where proxy indicators and reference points are used to score key LTL species at PI 1.1.1A, the team shall justify their use as reasonable proxies of stock biomass for the points where serious ecosystem impacts could occur and the level consistent with ecosystem needs.

a) Where fishing mortality rate is used to score stock status, the default fishing mortality required to maintain a stock fluctuating around the level consistent with ecosystem needs shall take the value of 0.5M or 0.5 FMSY, where FMSY has been determined in a single species context.
b) Proxy fishing mortalities required to maintain the stock above the point where serious ecosystem impacts could occur shall be lower than assumed to be able to keep the population above the point where recruitment would be impaired.

Departures from these default levels may be justified if it can be demonstrated that SA2.2.13.b is met.

2. Stock objectives (1.1.2, 1.2.1, 1.2.2, 2.1.2, 3.2.1)

It is difficult to put in place a management or rebuilding plan or harvest strategy which meets the requirements of MSC, because there is not a clear, agreed objective or target for the stock; it is not possible to evaluate how much rebuilding is required, because it is not clear what the stock should be rebuilding to.

On the one hand, the 'gold standard' is MSY-based reference points such as F_{MSY}, which GFCM and the CFP both require. On the other hand, it seems impossible with existing data and models to estimate F_{MSY} for this stock in any credible way, hence STECF suggest reverting to using E, an empirical (but precautionary) approach. Other approaches are also possible; e.g. a strategy based on evaluation of a series of standardised indicators without

trying to apply a population model at all. From MSC's perspective, the approach (MSY vs. empirical) is not important, as long as the target is consistent with MSC's requirements, i.e. set at a level which maintains stock productivity and ecosystem requirements. (Ecosystem issues are considered further below.)

The crucial initial requirement is that there is some scientific consensus around a stock objective that is robust and measureable. Since there are already a good many expert scientists and scientific bodies involved in the management of this fishery (you could even say too many), it does not seem helpful for the FIP to attempt another independent scientific analysis. Rather, the FIP needs to work with the existing scientific team (members of GFCM WGSASP and STECF for Mediterranean assessment; bearing in mind that they have overlapping membership) to facilitate a discussion leading to a consensus around a single agreed approach which can form a credible basis for a revised MAP. This could perhaps be tackled initially by bringing together Croatian and Italian scientists, since they represent the main fisheries and are holders of the key datasets.

Although the focus of the FIP is the sardine fishery, it probably makes sense to include anchovy in this process as well, since exactly the same issues apply, and anchovy is a main bycatch species for the FIP (as well as an important species for the fishery).

3. *Stock rebuilding plan / MAP (1.1.1A, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 3.1.2)*

Once there is an agreed approach to setting objectives and an agreed dataset for stock assessment making the best use of all the data, it should become easier to evaluate how much rebuilding the stock requires and to what extent different management actions for different fisheries can support rebuilding (by reducing the exploitation rate) – for anchovy as well as sardine, assuming that anchovy is included above. In other words, it should be possible to construct a rebuilding / management plan which can connect the stock objective, the rebuilding timeframe and the harvest control rules and tools together in a quantitative way – capacity reduction of X% plus spatial closures of Y% should result in Z% probability of stock rebuilding within five years (for example). When this is possible, there is a robust framework for a MAP which stakeholders are more likely to support (because they have a basis for believing that it will be helpful). A key role of the FIP will be support this process.

4. *Stock assessment data (1.2.3, 1.2.4)*

Scientists met at the site visit highlighted two key concerns with the data used for stock assessment; i) problems with the acoustic survey and ii) credibility of historical data.

In relation to the acoustic survey, this is not currently being used to its full potential; many similar fisheries, for example, (such as in the Bay of Biscay) depend for their management almost entirely on the results of an annual acoustic survey. It appears that work is already underway to coordinate the acoustic survey better between Croatia and Italy and with the GFCM stock assessment timetable – the FIP can support this.

In relation to historical data it might be worthwhile to propose a process of in-depth evaluation of scientific confidence in all the datasets, as well as evaluating the impact that they have on stock assessment conclusions (sensitivity); i.e. datasets with low confidence and high sensitivity should be considered for removal from the stock assessment. Some of this may also have been done already.

It is most likely useful for the wider fishery to include anchovy in this process, although it is not a direct requirement for the FIP in terms of likely MSC scoring (because P2 requirements are more lenient than P1 requirements); however it is necessary if anchovy is to be incorporated into the revised MAP (which presumably it needs to be).

5. *Discard and ETP species data (2.2.2, 2.2.3, 2.3.2, 2.3.3)*

Although it is not likely that this fishery has significant discards or significant interactions with ETP species, the lack of direct data (ideally from observers or cameras, or otherwise from self-reporting) prevents a score of 80 or above. If there is found to be unwanted catch of non-target species (horse mackerel, mackerel and others), including discards, the fishery needs to introduce a regular review of options to reduce it. The FIP could address this with all or some of the Omega 3 vessels.

5.3 FIP objectives and activities

It is proposed that the FIP be based around the list of objectives and activities below. In relation to how the FIP can tackle these various issues, this is what the workshop will hopefully be able to decide, but a suggested approach is given under 'How?'.

1. <u>Ecosystem targets</u>: Evaluate suitable ecosystem-based target levels for the sardine and anchovy stocks based on MSC requirements for key LTL species.

How? In order to address this question, we need a quantitative ecosystem model for the northern Adriatic. The scientists met during the site visit did not think that such a thing exists at present, although some work has clearly been done (see references in the text above). It may be that scientists in Italy will have more information. Ideally the model will be joint work by Croatian and Italian scientists since these models are quite demanding in terms of data. The FIP could best facilitate this work initially most likely by developing funding applications with scientists (applications supported by industry are much more likely to be successful than applications by scientists alone). It will also be important that the FIP is clear about the outputs we need from the modelling exercise – e.g. by developing a clear set of terms of reference or list of questions.

2. Agreed management targets: Support the fishery in defining a clear management target for the sardine and anchovy stock, which can be estimated robustly and which is consistent with MSC requirements as evaluated above.

How? A possible approach would be to invite independent scientists to review the stock assessments and reference points; however, this is the role the STECF is already playing, and it seems overall that additional scientific input might only lead to more confusion. The ideal would be if the group of scientists involved in GFCM and STECF could get together and agree an appropriate approach, from the scientific point of view, which they could then jointly suggest to managers as a basis for the next iteration of the MAP. The FIP could, for example, work with other stakeholders to organise and facilitate a workshop to address this question, perhaps along with the issues around data (below). Alternatively it might be addressed via some of the regional fora e.g. MedAC, AdriaMED, a GFCM intersessional meeting, STECF; if these could bring the relevant scientists together.

3. Stock rebuilding plan / MAP: Support the fishery in evaluating the extent to which different management actions (existing or proposed) would rebuild the stock to agreed targets; incorporate this analysis into the draft MAP.

How? This would be quite a technical analysis which needs to be carried out by GFCM or STECF (or both). It could form part of the next GFCM benchmarking, or a request via the EU to STECF; the FIP could ask the Ministry to request this.

In addition to this technical analysis, the FIP can support stock rebuilding by working to improve size and quality of sardines landed. These improvements allow fishers to earn the same amount of money from a smaller level of landings, and hence allow reductions to unsustainable levels of catch while mitigating the socio-economic impacts of regulatory reductions to catch and/or effort.

4. Improved data for stock assessment: Support the fishery in improving the coordination, operation and analysis of the acoustic survey such that it can play a more significant role in the stock assessment process. In addition, if it has not already been done, evaluate historical data as to the levels of confidence and sensitivity; consider which historical datasets are suitable to use for stock assessment purposes

How? Apparently work to improve the acoustic survey is ongoing; if so, the FIP can keep in contact with the relevant people on each side to provide encouragement. If not, it could be addressed at the proposed workshop (as above). An analysis of historical data may also have already been done at some point in the past, since it is a standard element of the stock assessment process; although the scientists met at the site visit expressed scepticism in the quality of the historical data being used in the stock assessment, at least from Croatia. It is probably best addressed by GFCM WGSASP; the FIP could encourage a detailed data review to form part of the next stock assessment benchmarking.

5. Information/management for discards and ETP species: Collect and analyse data on discards of non-target species and interactions with ETP species. Evaluate if any additional management measures are required and if so put them in place either within Omega 3 or for the Croatian fishery more widely.

How? This could be done by collecting data directly from cooperating Omega 3 fishing boats. The ideal would be independent observations such as from observers or on-board cameras, but another option is to ask skippers or crew members to record all discards and ETP species interactions; perhaps supported by a smaller number of independent observations; essentially, whatever Omega 3 consider is practicable.

5.4 Draft Work Plan for discussion by stakeholders

The work plan below has been sketched from the above objectives, and is provided as a summary basis for discussion at the FIP workshop. None of it is sacred; all of it can be changed.

Table 5. Preliminary outline work plan for Croatia sardine fishery

Objective		Activity	Indicative Timeframe	Lead Organisation
1	Ecosystem targets for sardine and anchovy	Draft clear list of questions / terms of reference for ecosystem modelling work	Year 1	FIP / WWF
		Evaluate existing work and available data for ecosystem model	Year 1	Scientists
		Develop joint funding proposal (FIP, Croatian and Italian scientists) for ecosystem modelling	Year 1	FIP / scientists
		Develop and test model	Year 1-2	Scientists
		Use model to answer questions about suitable stock targets for ecosystem requirements for sardine and anchovy	Year 2	Scientists
		Apply this information as an input to the development of management objectives and MAP, below	Year 2	Scientists, Ministry
2	Agreed management targets for sardine and anchovy	Work with Croatian and Italian scientists to find a suitable forum or structure for discussion of reference points (e.g. independent workshop, via GFCM, MedAC etc.)	Year 1	FIP
		Raise the issue in relevant regional fora such as MedAC and others	Year 1	FIP, Ministry
		Organise or support the organisation of a workshop to agree on a robust approach to developing management targets; e.g. support funding applications, provide independent facilitator or expert participants or reviewers if necessary	Year 1-2	FIP, Ministry

		Put forward the conclusions of the workshop to GFCM, STECF, the Commission and national authorities as a suitable basis for moving forward with management	Year 1-2	All
3A	Stock rebuilding plan	Work with the Ministry to request an evaluation of management options in relation to stock rebuilding and timetable	Year 1	FIP, Ministry
		Evaluation of probability and timing of stock rebuilding to agreed targets by GFCM, STECF or other	Year 2 or according to GFCM benchmark timetable	Scientists
		Put forward conclusions of analysis as a basis for a MAP		FIP, Ministry
3B	Improve quality to mitigate impacts of stock rebuilding	Provide training / education on selection and onboard handling for high quality product	Year 1	Omega 3
		Evaluate equipment on board and potential improvements; support fishers to source funds for improvement if necessary	Year 1	Omega 3, WWF
4A	Improved acoustic survey	Raise the issue with Ministry and scientists; keep informed of progress	Year 1 and ongoing as necessary	FIP
4B	Assessment of historical data	Work with Croatian scientists to identify main problem areas with historical data	Year 1	FIP, Inst. Oceanography and Fisheries
		Put forward joint proposal to WGSASP for review of sensitivity of stock assessment to data of concern	Year 1	FIP, IFO, GFCM
		Incorporate this analysis into next stock benchmark	Depends on benchmark timetable	GFCM WGSASP
5	Discards and	Discuss with Omega 3 skippers how best to collect data; develop data	Year 1	Omega 3, IFO

	ETP species	collection plan, data sheets etc.		
		Collect data according to plan	Year 2-3	Omega 3, IFO
		Analyse data; evaluate proportion of catch (including discards) which is made up of other species; evaluate interactions with ETP species and their output	Year 2-3	Omega 3, IFO
		If the data identify any species other than sardine and anchovy making up >5% of the catch, evaluate according to MSC standard, put measures in place if necessary	Year 3	Omega 3, Ministry
		If the data identify any negative interactions with ETP species, put measures in place to avoid if necessary	Year 3	Omega 3, Ministry

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Annex

PSA outcome for mackerel and horse mackerel (see PI 2.2.1). References taken from FishBase and from GFCM, 2016a.

Scientific name	Common name	Average age at maturity	Average max age	Fecundity	Average max size	Average size at Maturity	Reproductive strategy	Trophic level	Density Dependence	Total Productivity (average)	Availability	Encounterability	Selectivity	Post-capture mortality	Total (multiplicative)	PSA Score	**MSC PSA-derived score**	Risk Category Name	MSC scoring guidepost
Trachurus spp.	horse mackerel	1	2	1	1	1	1	3		1.43	2	3	3	3	2.33	2.73	81	Low	≥80
Scomber spp.	mackerel	1	2	1	1	1	1	3		1.43	2	3	3	3	2.33	2.73	81	Low	≥80