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FAST, NOT FURIOUS - ADAPTATION OF THE SPECIES LIST AND FISH SIZE CLASSES FOR FISH ASSEMBLAGE SURVEY TECHNIQUE (FAST) FOR THE ADRIATIC SEA

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ABSTRACT

Marine Protected Areas and other managed marine sites are designated to improve the status of coastal fish assemblages and protect valuable habitats. The implementation of management practices relies on data collected through monitoring activities. The monitoring of fish assemblages using the standard non-destructive methods requires significant financial resources and time. A new approach to monitoring fish assemblages in the coastal waters was recently implemented in the Mediterranean – Fish Assemblage Survey Technique (FAST). It is based on Citizen Science where trained volunteer divers collect the data following a pre-established protocol. Considering the differences in species presence/absence and their sizes between the Mediterranean and the Adriatic Sea, a modification of the method was necessary. This study presents 23 main fish species and four '*joker*' species selected for the Croatian FAST list and their respective sizes that will be considered Large (>2/3 of the total size) for implementing the method in the Croatian part of the Adriatic Sea.

INTRODUCTION

Increasing anthropogenic pressures on the ocean make it crucial to determine the current state of the marine realm and implement monitoring procedures to successfully manage available resources. Existing Marine Protected Areas (MPAs) are of critical interest to researchers and stakeholders (fishers, tourists, divers), but it is even more important to define the areas as the potential MPAs which will be designated in the future, based on scientific evidence (Ferrier, 2002; Hiscock, 2020). To evaluate if there is a need for protection, the area assessment needs to be done. One of the most common ways of determining the area protection potential and importance is investigating fish abundance, biomass and biodiversity (Gaines et al. 2010.). Knowing that fish grow larger in a marine protected area (PISCO and UNS, 2016), large specimens could be an indicator of a healthy marine ecosystem.

Managing any MPA needs to be based on the most recent scientific knowledge and relevant information (Cvitanović et al., 2015). To assess the changes in the coastal fish communities and evaluate effectiveness of management practices in a (newly) designated area, appropriate methods and tools need to be used (FAO, 2016, Prato et al., 2017). It is often time-consuming and expensive to do excessive underwater research, so a cost-effective method regarding the time and money is needed. The new underwater visual census (UVC) method, called FAST (Fish Assemblage Survey Technique), developed by Seytre and Francour (2008, 2009), could be a faster, more efficient way to determine conservation status of an area.

FAST (Fish Assemblage Survey Technique)

While standard UVC methods provide detailed information about fish in an area, the FAST method for monitoring fish assemblages is based on a preselected fish species list divided into two size-dependent groups – Small to Medium (S-M) and Large (L); large specimens being considered longer than two-thirds of the maximum reported size for each species. Exhaustive information on fish fauna, such as biomass and the size of each fish in an area, is not included. The FAST method relies on predetermined values collected on a presence-absence basis (Seytre and Francour, 2009). The species used for the survey are those with a high trophic level (predators), species targeted by professional or recreational fishers (e.g. net fishing, spearfishing or angling), and species of some conservation or commercial value (indicators of the ecosystem stability and health, i.e. important prey species, endangered species, species indicative of a particular habitat) that are at the same time easy to recognize underwater. Additional 'joker' species can be selected and these are usually rare or extraordinary species that increase the conservation value of the area. The list of species differs according to the selected bio-geographic regions (Francour, 2017).

The FAST survey consists of six 15-min visual censuses covering all substrates (sand, seagrass and rock) between 0 and 20 m of depth, along a random pathway using scuba diving. The fish counts are pooled and averaged per site (Seytre and Francour, 2009). The census is performed on a presence-absence basis and a two-size-class category (S-M and L), making it a relevant, rapid assessment method. The main advantage of the method is that the results obtained by the scientifically trained volunteers (divers) are not significantly different from the scientific divers (Ben Lamine et al., 2018). Therefore, it can be used for routine monitoring of coastal areas within Citizen Science initiatives.

The details of the method are described in Seytre and Francour (2008, 2009). This paper aims to provide information relevant to the adaptation of the UVC-FAST method to monitor fish communities along the Croatian Adriatic coast. The species list needed to be modified, and the sizes of fish needed to be relevant to the Adriatic basin to successfully apply the proposed method in Croatian marine sites in the future.

MATERIALS AND METHODS

The first step in modifying the FAST method, which was developed for the north Mediterranean coast, was the species selection. Fish species that can be encountered between 0- and 20-meters depth, targeted by professional and recreational fishermen (spearfishing and angling), vulnerable, easy to identify in scuba diving, and species representative of the main coastal habitats were selected (Seytre and Francour, 2009). Other factors considered for the inclusion criteria for each fish species were: endemism, diet (omnivores or strict herbivores and carnivores), rarity, longevity, hermaphroditism, specificity toward habitat, whether or not it is a high trophic level predator (HTLP) and if it is a Lessepsian species (Ben Lamine, 2017).

Following the species selection, their maximum size and 2/3 of the full size were defined. The primary tool used was an online survey created for the non-scientific divers, sports fishers and recreational fishers to evaluate their perception of fish size in a given area (Croatian part of Adriatic Sea). The first part of the questionnaire included one question about the method used to observe or catch fish (observation only – SCUBA/freediving, spearfishing, angling), and one question about the location where their activities usually took place (Istra, Rijeka/Kvarner, North Dalmatia, Mid Dalmatia, South Dalmatia). In both cases, the participants were asked to tick all answers that apply. Additionally, the participants were asked to give their opinion on how precisely they can estimate the fish size (within 2, 5 or 10 cm), a multiple-choice question. The central part of the questionnaire consisted of 23 items in which the participants were asked to estimate, in centimeters, which minimum size (for each given species) they consider to be Large (large size being >2/3 of the maximum reported size).

Table 1. Fish species selected for the Croatian FAST list and the original French list (Francour, 2017). M - main list, J - *joker* list; A - all size classes receive weight 2, C - large size class receives weight 2 for conservation status, T - large size class receive weight 2 for trophic level

Species name	Common name (English; Croatian)	FAST Croatia	FAST France
Conger conger (T)	Conger eel; ugor	M	M
Dentex dentex (C, T)	Common dentex; zubatac	M	M
Dicentrarchus labrax (C, T)	European bass; brancin, lubin	M	M
Diplodus annularis	Annular seabream; špar	M	M
Diplodus cervinus	Zebra seabream; -	-	M
Diplodus puntazzo	Sharpsnout seabream; pic	M	M
Diplodus sargus	White seabream; šarag	M	M
Diplodus vulgaris	Common two-banded seabream; fratar	M	M
Epinephelus costae (A)	Goldblotch grouper; kirnja zlatica, galinjača	M	-
Epinephelus marginatus (A)	Dusky grouper; kirnja	M	M
Labrus mixtus	Cuckoo wrasse; smokva	M	-
Labrus merula	Brown wrasse; vrana	M	-
Labrus spp	-	-	M
Labrus viridis	Gren wrasse; drozd	M	-
Mugilidae	-	-	M
Mullus surmuletus	Surmullet; trlja kamenjarka	M	M
Muraena helena (T)	Mediterranean moray eel; murina	M	M
Sarpa salpa	Salema; salpa	M	M
Sciaena umbra (A)	Brown meagre; kavala	M	M
Scorpaena scrofa (T)	Red scorpionfish; škrpina	M	M
Seriola dumerili (T)	Greater amberjack; gof	M	M
Serranus cabrilla (T)	Comber; kanjac	M	M
Serranus scriba (T)	Painted comber; pirka	M	M
Sparus aurata (C)	Gilthead seabream; komarča, orada	M	M
Spondyliosoma cantharus	Black seabream; kantar	M	M
Symphodus tinca	East Atlantic peacock wrasse; lumbrak	M	M
Sphyraena sp.	Barracuda; barakuda	J	M
Hippocampus sp.	Seahorse; morski konjić	J	J
Lithognathus mormyrus	Sand Steenbras; ovčica	J	J
Phycis phycis	Forkbeard; tabinja	J	J

Participants were also asked to name species which are not listed, but they think should be (because of their value in spearfishing or angling), and also to name species that can be frequently observed in the last ten years but were not observed in the past; these were open-ended questions.

Seventy-one (N=71) anonymous participants completed the survey, giving their estimate of the Large fish size. The questionnaire was created and distributed using Google Forms, and the data collected were analyzed using Microsoft Excel, R (R Development Core Team, 2017) and RStudio 1.1.383. The final result from the questionnaire (large size for each species) was reported as the mean (± SD) value of all answers. Before the final calculation of the mean, the outliers (values greater than the upper boundary and lower than the lower boundary) were excluded from the analysis.

To validate the results obtained from the online questionnaire, which was the primary source of information, the data on the maximum reported size (in the Croatian part of Adriatic Sea, when available) were collected from Dulčić and Kovačić (2020), and the two-thirds of that value were calculated. The final size that would be considered Large, for each species, was defined as the mean value between the online questionnaire and the literature data. The number that the divers will use as a guide to set the limit between small/medium and large individuals in the FAST method, for each fish species, was rounded down to the nearest integer of 5.
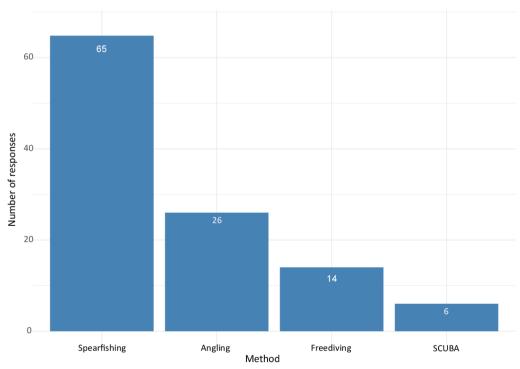
RESULTS

Species list

Twenty-three (N=23) fish species belonging to 10 fish families were selected for the FAST main list used in the Croatian part of the Adriatic Sea (Table 1). Additional four taxa were chosen for the *'joker'* list based on their unique characteristics (*Sphyraena* sp., *Hippocampus* sp., *Lithognathus* sp. and *Phycis phycis*).

Fish sizes considered to be Large

Seventy-one anonymous participants gave their best estimates of Large sizes for each of the fish species included in the main list. The species on the *'joker'* list were not sized as their value is considered equally important regardless of the size. Most of the participants (65 out of 71) observed fish while spearfishing (Fig. 1) and consider themselves to be able to estimate fish sizes within 5 cm (52.1 %) or even 2 cm (37%) (Fig. 2).

The final size (in cm) that can be considered Large, for each species, is presented in Table 2. The measures in Table 2 are the mean values between the size calculated for each species from the data acquired through the online questionnaire, and the two-thirds of the maximum total length size reported in Dulčić and Kovačić (2020).

Fig 1. Bar chart of the methods/activities used to observe/catch fish in the Adriatic Sea, Croatia, according to the online survey (it was possible to select more than one option)

Table 2. The size (in cm) for each fish species that can be considered Large (L), used for the FAST method in the Croatian part of the Adriatic Sea. TL – total length, SD – standard deviation

Species name	Dulčić & Kovačić 2020 [2/3 of TL](cm)	Questionnaire mean (cm)	Questionnaire SD (cm)	Literature and questionnaire mean (cm)	FINAL SIZE (cm)
Conger conger	200.00	131.77	23.03	165.89	165
Dentex dentex	66.67	59.23	16.37	62.95	60
Dicentrarchus labrax	68.67	54.63	14.92	61.65	60
Diplodus annularis	16.00	17.06	4.08	16.53	15
Diplodus puntazzo	31.33	29.90	5.98	30.62	30
Diplodus sargus	31.33	30.47	5,17	30.90	30
Diplodus vulgaris	30.00	24.37	5.20	27.19	25
Epinephelus costae	93.33	56.24	12.10	74.79	70
Epinephelus marginatus	100.00	72.13	18.49	86.07	85
Labrus merula	34.00	35.54	6.14	34.77	30
Labrus mixtus	29.33	31.62	5.88	30.48	30
Labrus viridis	40.00	35.30	6.39	37.65	35
Mullus surmuletus	33.33	25.88	5.67	29.61	25
Muraena helena	86.67	118.82	24.40	102.74	100
Sarpa salpa	34.00	32.55	4.94	33.28	30
Sciaena umbra	34.67	37.49	4.63	36.08	35
Scorpaena scrofa	38.67	36.35	5.99	37.51	35
Seriola dumerili	126.67	103.31	35.94	114.99	110
Serranus cabrilla	26.67	21.47	6.12	24.07	20
Serranus scriba	24.00	21.03	4.70	22.52	20
Sparus aurata	46.67	43.77	10.88	45.22	45
Spondyliosoma cantharus	33.33	32.48	4.35	32.91	30
Symphodus tinca	28.33	28.29	4.62	28.31	25

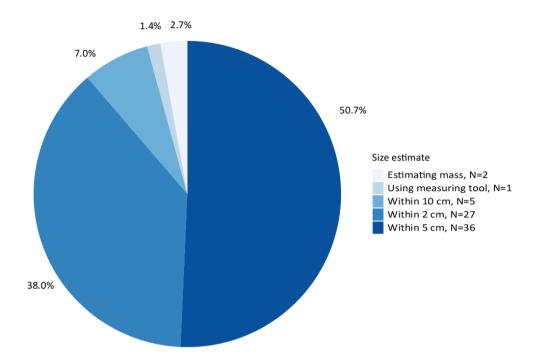**Fig 2.** Pie chart representing the opinion of online survey participants on how precisely they can estimate fish size underwater

DISCUSSION

Based on the study results, the Croatian list is similar to the French list (Seytre and Francour, 2008) and the Tunisian list (Ghanem and Ben Soussi, 2017; Ben Lamine et al., 2018) because the same criteria were used for the selection. Still, there are a couple of changes in comparison to the other Mediterranean versions of FAST. For example, *Diplodus cervinus* is not on the Croatian list, since it is not a species inhabiting the Adriatic Sea. The family Labridae species are listed individually on the Croatian list, mainly because *Labrus viridis* is protected under national law (OG 144/2013), while in Seytre and Francour's (2009) table, they are all included in the *Labrus* spp. group. The family Mugilidae was excluded from the list as they are relatively common in the Adriatic and indicate no exclusive habitat preference, and at the same time, it can be hard to identify individual species underwater due to unclear morphometric characteristics (Turan et al., 2011). Croatian *'joker'* list contains species of high conservation value (e.g. *Hippocampus* sp.), the high trophic level predators (*Sphyraena* sp.), as well as two species under high fishing pressure (*Lithognathus mormyrus* and *Phycis phycis*).

The FAST method can be used in all geographic areas and different habitats, but the list of target species and their respective sizes needs to be adapted for each country/region. While some authors decided to use the data on the fish sizes from the public databases (Fishbase.org) (Ben Lamine, 2017; Ghanem and Ben Soussi, 2017), we have chosen to validate literature data with the information acquired from the questionnaire. Questionnaires are a standard method used in ecology when information is required from a specific human target population, particularly for approaching public or stakeholder perceptions in ecological management (White et al., 2005). The online questionnaire used in this research was selected as the primary method for determining the Large (L) fish size category. It was essential to know how local stakeholders (mostly sport fishers) perceive the size of the fish and to acknowledge their experience gained through a significant amount of time spent underwater/fishing. Considering that more than 50% of the participants think that they can estimate the fish size within 5 centimeters (Figure 2), it was even more critical to acknowledge the perception of the fish sizes by the spearfishers. They initially estimate the fish size underwater, and later measure (or weight) their total length, allowing for a better calibration of their ability to estimate fish sizes. The values from the questionnaire are similar to the data from the literature source (Dulčić and Kovačić, 2020). However, in this study, the values of the final sizes are rounded down to the nearest integer of 5, as the main focus of the proposed method is to detect changes (an increase) in the fish sizes, which might occur due to the enforced protection/management of a specific marine area.

Two primary objectives of this paper have been achieved. One is selecting fish species for the future implementation of the FAST method in the Adriatic Sea, and the other is determining the Large category for each of the selected fish species.

The simplicity of FAST is making it a prospective method used in providing information about marine areas and monitoring the effectiveness of protection in the MPAs. It is also promoting Citizen Science initiatives, a relatively new way of acquiring data via trained volunteers. This paper presents the first step toward implementing the FAST method in the Croatian Adriatic Sea.

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SAŽETAK

PRILAGODBA POPISA VRSTA I VELIČINSKIH KATEGORIJA RIBA ZA POTREBE PRIMJENE FAST (FISH ASSEMBLAGE SURVEY TECHNIQUE) METODE U JADRANSKOM MORU

Morska zaštićena područja i druga morska područja kojima se upravlja koriste se za poboljšanje statusa priobalnih zajednica riba, kao i za zaštitu vrijednih staništa. Učinkovito upravljanje počiva na podacima prikupljenim kroz aktivnosti praćenja stanja (monitoringa). Monitoring riba standardnim nedestruktivnim metodama zahtijeva značajna financijska sredstva i vrijeme, stoga se nova, brža i jeftinija metoda praćenja zajednica riba u priobalnim područjima od nedavno primijenjuje u Sredozemnom moru. U metodi FAST (Fish Assemblage Survey Technique), obučeni ronioci volonteri prikupljaju podatke o opažanju ribljih vrsta prema unaprijed utvrđenom protokolu. S obzirom na razlike u prisutnosti/odsutnosti vrsta i u njihovim veličinama između Sredozemnog i Jadranskog mora, bilo je potrebno modificirati metodu. Ovdje predstavljamo 23 vrste riba na glavnom popisu i 4 *'joker'* vrste koje su odabrane za hrvatski popis FAST, zajedno s pripadajućim veličinama (cm) koje će se smatrati velikim za potrebe korištenja ove metode u hrvatskom dijelu Jadranskog mora.

Ključne riječi: Jadransko more, FAST, zajednice riba, monitoring, vizualni cenzus

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