

Croatian artisanal fisheries and the state of it's littoral resources on the threshold of entering the EU: effectiveness of conventional management and perspectives for the future

Sanja MATIĆ-SKOKO*, Nika STAGLIČIĆ, Miro KRALJEVIĆ, Armin PALLAORO, Pero TUTMAN, Branko DRAGIČEVIĆ, Robert GRGIČEVIĆ and Jakov DULČIĆ

Institute of Oceanography and Fisheries, P.O.Box 500, 21000 Split, Croatia

***Corresponding author: sanja@izor.hr**

Artisanal fisheries in Croatia and throughout the Mediterranean coastal region have a long tradition. In recent times the booming growth of human populations along Mediterranean coasts has led to harvesting of its marine resources in almost insupportable quantities, thus placing the research of this topic in a complex context. At the same time, fisheries management throughout the Mediterranean region has remained conventional in its nature, implying that it is almost only based on gear specific management provisions. The current Croatian legislative framework and legislative changes of artisanal fisheries regulation in the last 15 years, as well as how these changes have impacted on the state of coastal fish resources, particularly target species condition, are discussed. The conclusion is that if we want to improve further the state of the resources a more comprehensive set of management measures incorporating closed areas and a new approach actively involving fishers in the management process should be adopted. Finally, guidelines for future management in terms of the monitoring and data collection framework (DCF) proposed by the EU are demonstrated.

Key words: Artisanal fisheries, management, Adriatic Sea, Croatia

INTRODUCTION

The Adriatic Sea, as part of the Mediterranean Sea, shares with that region all common characteristics in terms of geographical features, available marine resources, their type and intensity of exploitation. Moreover, those fisheries functioned in very specific socio-economical and historical contexts. All Mediterranean coastal areas have a high diversity of littoral benthic communities at a very small spatial scale which implies high biodiversity and trophic complexity (STAGLIČIĆ *et al.*, 2011, under review). Since ancient times fishing has played a role in shaping the Mediterranean food webs,

becoming more and more crucial in recent times (FARRUGIO *et al.*, 1993; SALA, 2004; GUIDETTI *et al.*, 2010) as the booming growth of human populations along Mediterranean coasts necessitates ever larger harvests of marine resources (GOŇI *et al.*, 2000; JUANES, 2001). The very characteristics of such fishery, i.e. numerous fleets using diverse fishing gears, multi species catches and extremely heterogeneous landing sites and marketing, place scientific research in a particularly complex context (FARRUGIO *et al.*, 1993). In that manner Croatian artisanal fishery is without exception a typical Mediterranean example. Thus, it has to be emphasized that in spite of artisanal fisheries importance and the extent

of impacts it has on littoral ecosystems, it has been poorly investigated to date (LLEONART & MAYNOU, 2003; BATTAGLIA *et al.*, 2010).

Recently, scientists and fishery managers involved in this subject have started to pay more attention to better understand the fishing activities and the stocks targeted, to improve their management and to save the cultural heritage of fishing traditions. However, the Mediterranean basin is a semi-enclosed sea and, to a large extent, its resources complete their life cycle within it. Therefore, only an integrated and global approach can answer the needs of an appropriate fishery resources management strategy in this region. In order to plan and improve management measures, an important objective becomes the gaining of a detailed knowledge of all Mediterranean coastal fishing activities, at large spatial and temporal scales (BATTAGLIA *et al.*, 2010).

Fisheries management throughout the Mediterranean region is conventional in nature (MATIĆ-SKOKO *et al.*, 2011a), meaning that it is almost only based on gear specific management provisions (PAPACONSTANTINO & FARRUGIO, 2000; LLEONART & MAYNOU, 2003). In recent years, seasonal closing of fishing grounds or proclamation of marine protected areas are increasingly advocated as a management tool for restoring littoral fish resources and ensuring the sustainability of their exploitation (FRANCOUR *et al.*, 2001, ROBERTS *et al.*, 2005). A large number of studies have focused on evaluating their effectiveness, while the effects of conventional forms of management, although they are still most frequently proposed and implemented, have been investigated only in studies reported by MATIĆ-SKOKO *et al.*, 2011a and STAGLIČIĆ *et al.*, 2011 (under review) for the eastern Adriatic Sea, while in other Mediterranean regions remain poorly investigated (McCLANAHAN *et al.*, 1997; PAPACONSTANTINO & FARRUGIO, 2000).

Since monitoring of the status and changes of coastal ichthyic-communities and artisanal fisheries management effects is a complex issue, the scope of the Institute of Oceanography and Fisheries' work, through our Laboratory of Ichthyology and Coastal Fisheries, encompasses as many different aspects as possible to get an

accurate insight from systematic research of fish biology, coastal fish community composition, biological characteristics and distribution of species, population dynamics and stock assessment of characteristic, commercially important coastal fish species, qualitative and quantitative catch structure, demographic structure of the most important stocks, exploitation level, by-catch composition, evaluation of selectivity properties and destructiveness of fishing gears, estimating potential impact of global climate change on fish biodiversity and other living resources in the Adriatic Sea, collection of new ichthyologic data and finally, as a result of all the aforementioned activities, preparing recommendations for conservation, sustainable use and management of Croatian coastal living resources. Those activities are supported through various projects, mostly financed by the Ministry of Science, Education and Sports and the Ministry of Agriculture, Fisheries and Rural Development. Thus, an extensive monitoring program of coastal fisheries was conducted in 2008 and 2009 (DULČIĆ *et al.*, 2009, DULČIĆ *et al.*, 2010) although, due to financial reasons, their continuation is in doubt. It is important to point out that exploration of coastal ichthyic-communities in the eastern Adriatic Sea goes as far back as the last 65 years. Data were collected through direct sampling using IOR's RV "Bios" (now "Bios II") or the speed boat "Navicula" or through analysis of commercial catches in collaboration with numerous fishermen. Sampling locations of analyzed experimental and commercial catches representatively cover all of the eastern Adriatic coastal waters.

This review study represents the first integrated approach in the eastern Adriatic to investigate the state and perspective of our artisanal fisheries. All specific characteristics of used gears and their limitations prescribed by the legislative framework are listed and discussed. Results of a monitoring program, over almost two decades, of littoral fish resources (MATIĆ-SKOKO *et al.*, 2011a; STAGLIČIĆ *et al.*, 2011, under review) are discussed in terms of littoral communities' state and future management actions. Different alternatives are proposed to modify the

strategies of management and research in order to achieve a sustainable exploitation of these resources. Finally, guidelines for future management in terms of the monitoring and data collection framework (DCF) proposed by the EU are demonstrated. In short, we are providing a comprehensive review of our current work regarding eastern Adriatic artisanal fisheries issues.

REVIEW AND DISCUSSION

Legislative framework and production levels

The baseline regulation governing fisheries issues in Croatia is the Sea Fisheries Act (NARODNE NOVINE, 2010a). Together with its subordinate acts (NARODNE NOVINE, 2010b, 2010c, 2010d) it regulates: spatial and temporal fishing restrictions; minimal landing size of commercial fish species and construction properties of fishing gear and application of fishing techniques. Four types of fisheries are defined by Croatia's Sea Fisheries Act: commercial, subsistence, recreational and sport fishing. Commercial fishing is a profit-making activity, while fish and other marine organisms caught in the course of subsistence, recreational or sport fishing are not to be placed on the market and are intended solely for fishers' and their families' own consumption. Allowance of use of limited type and quantity of nets primarily differentiates subsistence fishing practices from recreational and sport fishing which are trap and line fishing oriented. Additionally, the new Sea Fisheries Act (NARODNE NOVINE, 2010a) further distinguishes fishing for scientific purposes and tourism. In Croatia, subsistence fishing is still considered 'a socio-cultural activity' for most of the island and shoreline inhabitants. Issuing of new licenses stopped in 2008 and official statistics of the Fisheries Directorate (FD) for the period 2009-2010 counted around 4,000 vessels (number of vessels approximately corresponds to number of licenses) in the professional fishery sector, of which 3,360 vessels are under 12 m indicating their artisanal character, and 12,000 vessels registered under the subsistence category.

The Croatian Fisheries Act includes a large number of legal management issues applied

worldwide. Following its provisions, catch and trade of juvenile fish and other marine organisms, and catch of fish and other marine organisms during the closed fishing season and their trade when fresh, have been banned. For rational management and protection of commercially important fish species the following are defined: minimal landing size, closed seasons, closed zones and areas, temporal fishing limitations in different areas and zones, allowable catch quantity per single license, total number of licenses that may be issued in a single fishing zone and area, construction and technical features, method of operation and purpose of individual fishing gear type and fishing equipment and special habitats of fish and other marine organisms where fishing has been forbidden. The Sea Fisheries Act provides for a mandatory monitoring program of the state of economically important fish and other marine organisms' populations as well as the monitoring of the quality of marine areas where rearing activities are conducted. Furthermore, by sub-regulations a number of important issues are regulated. For example, no new licenses are to be issued for fishing Norway lobster with traps, bottom trawls in the internal waters, dredges for *Pecten jacobaeus*, trammel nets, tuna seines and floating long-lines. Also, construction and technical characteristics, operation methods and purpose of fishing gears are defined by sub-regulations. As protection measures, closed areas and closed seasons are determined. Control of age-length at recruitment is carried out by regulating the mesh and hooks sizes, and with a declaration of the minimum size of commercially important species below which they must not be caught, collected or traded (NARODNE NOVINE, 2008)

Marine fisheries landing in the eastern Adriatic ranged from 24,000-54,000 tones in the period 1983-1993 according to the national Croatian statistics (DULČIĆ *et al.*, 2007). Recently, JARDAS & PALLAORO (1997) reported that the Adriatic artisanal fisheries yield more than pelagic and trawl fisheries (total landing about 30,000 t). However, official statistics of the Fisheries Directorate (FD) for the period 2008-2010 shows that the annual landing is stable at

about 50,000 t of which 90% are landings of small pelagic while artisanal landings contribute only 1%. This contribution is certainly underestimated since the majority of artisanal landings go unreported.

Present state of Croatian artisanal fisheries, used gears and fishing effort

The rich fishing tradition of the eastern Adriatic artisanal fishery is fully reflected in this typical Mediterranean multi-species and multi-gear fisheries sector employing more than 50 different types of fishing gear to catch about 150 different species of commercial interest (CETINIĆ *et al.*, 2002). Both commercial fishers, excluding larger-scale commercial fleets such as trawlers or purse seiners, and subsistence fishers are regarded as artisanal in the Croatian eastern Adriatic Sea based on their use of traditional, relatively small size fishing gear and operating with relatively small fishing vessels not far from the shore. The key distinguishing features between commercial and subsistence artisanal fishers are the purpose of their activity, type and quantity of fishing gear allowed and daily catch limits. In the last 10 years the type and quantity of fishing gear with which commercial and subsistence artisanal fishing could be undertaken have been the subject of fisheries management changes (STAGLIČIĆ *et al.*, 2011, under review). Although legislative changes in the fishery sector are numerous, they are usually more “cosmetic” in nature.

Artisanal fisheries are carried out within a distance of one nautical mile from the mainland and islands coasts, in shallow waters at depths of no more than approximately 80 m, representing a little more than 3% of the total surface area of the Adriatic (CETINIĆ *et al.*, 1999a). The majority of commercially significant fish and invertebrate species live within this small area of the Adriatic Sea. Diversely constructed types of bottom otter trawls, dredges for shell fishing, purse seines, beach seines, gill nets, trammel nets, combined trammel-gillnets, pots, long-lines, hooks and lines, filter nets, surrounding nets, lift nets, falling gear, entangling nets, barrier gear, harvesting

machines, grappling and wounding and fishing using ropes (tramata fishing) are used in this zone (CETINIĆ *et al.*, 1999b).

One layer gillnets and three layer trammel nets are probably the most commonly used fishing gear along the coastal eastern Adriatic. Regional differences, conditioned by the distribution of target species, exist in the frequency of their use. While on the west coast of the Istra peninsula (northern Adriatic) trammel nets of smaller height called “listarice”, with *Solea vulgaris* as main target, are the main trammel nets used in winter, in the middle and south Adriatic trammel nets called “poponice” are prevalent (closed season 01.06-31.08). In the area of the outer middle Adriatic islands from Dugi otok to Lastovo fishers also commonly use gillnets named “psare” with 70 mm mesh size targeting mainly *Scorpaena scrofa* and *Palinurus elephas* at greater depths (> 60 m). Trammel nets have traditionally been the favoured fishing gear of Croatia’s artisanal fishermen as they regard it as the most efficient one providing them with catches as rich as possible (MOROVIĆ, 1970; JARDAS, 1979). On the other hand, numerous studies, besides confirming their great ability to catch, have pointed out the low selectiveness resulting from their specific construction and operation properties (JARDAS *et al.*, 1998 and references therein). Although artisanal fisheries are generally perceived as highly efficient, low impact fisheries that generate few discards (STOBART *et al.*, 2009 and references therein), these fisheries affect numerous species due to continuous substantial fishermen practice, despite having preferred target species. Illustrative of the aforementioned, trammel nets are often target specific, but an important part of the catch consists of multi-species by-catch (STERGIOU *et al.*, 2006). Due to the fairly large number of species that may be caught they are also often used for research purposes and to study coastal communities (STAGLIČIĆ *et al.*, 2011, under review). Legislative changes to Croatian artisanal fishing regulations have mostly been aimed at trammel nets and encompass the increase in minimum inner layer mesh size of trammel net from 28 to 40 mm in 1999 and excluding the trammel net from sub-

sistence artisanal fishing in 2002. Additionally, in 2002 for artisanal subsistence fishing, legal provisions proclaimed a daily catch limit of 5 kg and reduced the allowed quantity of most types of gillnets, orienting it thus much more to trap and line fishing (MATIĆ-SKOKO *et al.*, 2011a).

„Strašin“ and „kogol“ are two types of small coastal bottom trawl which are used during the night primarily for picarel fishing although other coastal bottom species can be caught with them. Both gears can be used only on boats with an engine power of 18.5 KW (25 HP) in the period from 1 October to 30 April. They are used from 5 to 20 m depth. The bar of mesh in the cod end must not be less than 12 mm. „Tartana“ is a small coastal otter trawl which can be used on boats with an engine power of 18.5 KW (25 HP). It is designed primarily for picarel fishing from 20 to 50 m depth during the period from 1 November to 1 March, exclusively during the night. With „tartana“ fishing otter boards are used. The bar of mesh must not be less than 12 mm. The coastal beach seine („migavica“) is designed primarily for day time picarel fishing. It is used from 1 October to 30 April. Fishing with coastal beach seine is carried out on bottoms at up to 30 m depth. However, besides picarel, migavica catches almost 70 different fish species. Other species are mostly represented by bogue, fish of the genus *Diplodus*, saddled seabream and common Pandora, and they constitute about 27% of the catch (DULČIĆ *et al.*, 2009). The problem with migavica is that it catches a relatively high percentage (around 35%) of immature specimens, especially of the Sparidae family. One of the possible solutions on how to increase the percentage catch of picarel and lower the proportion of other non-intended species could be to determine exact locations particularly suitable for using this fishing gear or, in other words, for catching picarel. Another possibility is to shorten the time period when this gear is allowed to operate. In the near future, additional effort through pilot studies has to be invested and directed toward finding appropriate fishing grounds not hosting *Posidonia oceanica* meadows as is suggested by EU directives. This net is pulled from the shore or from a boat

towards the shore. The bar of mesh in the cod end of coastal beach seine must not be less than 12 mm. „Tramata“ fishing is, undoubtedly, the most efficient method for seabream (Sparidae) harvesting, primarily saddled sea bream *Oblada melanura* and salema *Sarpa salpa*. It is based on the use of ropes, gillnets and beach seines. Ropes are used for enclosing a large sea area, herding fish by vibrations produced by pulling of ropes close to the coast; fish are then harvested by gillnets or beach seines. Depending on the enclosed area, length of the enclosing rope and “decorations” on the rope, fishing gear used and the fishery tradition of the area, distinction has been made between “ludar”, “zagonica” and “fružata”. This kind of fishing is only carried out in coastal areas of up to 50 m depth and only during the summer period. Decades ago, this method of fishing had provoked controversy and antagonism, and it was often forbidden or very restricted. By the findings of DULČIĆ *et al.* (2009, 2010) fružata is a highly selective fishing technique, catching almost only adult specimens and primarily of the Sparidae family. If used properly it should not have negative impact on the biology and ecology of exploited species. However, this fishing gear tends to be misused – operated outside the time or spatial limitations, using it with help of SCUBA divers, or using nets with undersized mesh size.

Regarding the fishing effort in Croatian artisanal fisheries it is probably very high, as in southern Italian coastal areas (COLLOCA *et al.*, 2004), yet has remained steady throughout the last twenty years. The number of vessels more or less remained the same in that period and has consistently been composed of multipurpose vessels smaller than 10 m. The only positive trend was in early 1990's during the war period when socio-economic reasons led to a high number of people engaging in fishing (STAGLIČIĆ *et al.*, 2011, under review). After 1995 a more restrictive fishing regime forbid the issuing of new licenses and from there on the number stagnated (JARDAS, 1999). In principle, reliable data on the type, dimension and quantity of fishing gear are needed for the accurate assessment of fishing effort in artisanal fisheries worldwide as well as

in Mediterranean and Adriatic Seas. Even when they exist, they are unsystematically monitored and recorded, making them practically unusable for any serious analysis (STAGLIČIĆ *et al.*, 2011, under review and papers therein). Fishing effort is complex to measure, especially given the diversity of gears and vessel types characterizing artisanal fisheries, so management assessment has been based mainly on the number of boats and/or number of fishers thus limiting the evaluation of the actual fishing pressure on the resources (SALAS *et al.*, 2007). Moreover, the reliability of catch statistics is also questionable since it's based on fishermens' logbooks and has never been validated by a systematic observer programme or sampling at landing (FARRUGIO *et al.*, 1993). In Croatia, artisanal fisheries catches are merely presumed for statistical purposes and thus may be considered as underestimated. In the current political and socio-economic environment, it is very difficult to reduce fishing effort by decreasing the number of fishing licenses because of the unpopularity of such measures. Therefore, it is essential to apply other forms of fishing regulations.

Present state of Croatian costal resources

In order to apply better and more successful measures for fishery resources protection, constant monitoring and assessment of the impact of fishing gear on coastal fish and other marine organisms' communities has to be performed, especially for fishing gear that is classified as harmful owing to its construction-technical characteristics. A common situation in the whole Mediterranean is that not only are long-terms studies and monitoring programmes lacking but also no accurate assessment of fishing effort or catch statistics can be found (STAGLIČIĆ *et al.*, 2011, under review). In particular, long term time series data are needed in order to estimate the real status of exploited resources and their evolution over time, yet even for fish those are rarely available (BATTAGLIA *et al.*, 2010). Data have mostly been obtained from scientific research projects which are typically short in duration, ≤ 3 years (LLEONART & MAYNOU,

2003). Fortunately, owing to our long term data sets of experimental trammel net catches we are in a position to analyze and determine the state of littoral fish communities along the eastern Adriatic coast.

Firstly, we analyzed the effectiveness of conventional management in the Mediterranean type artisanal fisheries (MATIĆ-SKOKO *et al.*, 2011a) at small spatial scale, in a pilot region around Vis Island. The primary goal was to investigate whether a more restrictive fishing regime, as mentioned earlier, that has progressively been put in place during the study period has been accompanied by the expected positive changes of littoral fish resources' abundance, biomass and structure. As a result, significant increases over time were observed in most of the community indices analyzed as well as a directional change in the abundance and biomass catch composition of littoral fish resources. Positive responses were, however, primarily related to a recovery of *Mullus surmuletus* stock. Taking into account minimal landing size of this species (11 cm; although it has to be mentioned that this size is given for both Mullidae species inhabiting the Adriatic – *M. surmuletus* and *M. barbatus*, and it is not biologically justified for *M. surmuletus*), no undersized specimens were present in the overall catch. Even when "poponica" destructiveness is assessed, considering a biologically justified size at first sexual maturity (18 cm), the catches contained a rather low, satisfying 1.2% of immature specimens. On the other hand, results indicate a rather alarming status of the *Scorpaena scrofa* populations. It can be seen that the overall catch is dominated by undersized specimens (62.5%). The situation is even more troublesome if biologically justified size at first sexual maturity is applied (TL 30 cm) since the proportion of immature specimens is in that case as high as 90% (MATIĆ-SKOKO *et al.*, 2009; MATIĆ-SKOKO *et al.*, 2011b). In terms of the aforementioned, UIBLEIN (2007) gives an opinion that Mullidae could be considered as an indicator species owing to their fast and strong response to human-induced factors such as fisheries and habitat modifications. Assessing the destructiveness of 'poponica' nets for spiny

lobster populations by taking into account the minimal landing size of this species (24 cm), there are 34.6% of undersized specimens in the overall catch. The results also indicate that the spiny lobster hunting season partially coincides with the beginning of their reproductive period. Specifically, about 10-15 of the last days of the hunting season are characterized by catches dominated by females carrying external eggs and an increased number of undersized specimens (MATIĆ-SKOKO *et al.*, 2009). Therefore, these results indicate that temporal restrictions should be rearranged.

Subsequently, we wanted to investigate if such a restoration of littoral fish assemblages can be seen on a wider spatial scale. STAGLIČIĆ *et al.* (2011, under review) reported in summary that littoral fish assemblages along the eastern Adriatic coast are characterized by continuous change throughout the last 16 years as patently evidenced through trends in abundance, biomass, diversity and structure which all indicate that fish assemblages are going through a restoration process. A common pattern among time trajectories of studied areas implies that the factor affecting the littoral fish assemblages is not localized but regional in nature. Since positive effects are seen at multiple levels and are so consistent and widespread we suggest that the most plausible causative factor is stricter fisheries management, the implementation of which coincided with the study period.

It is obvious that legislative changes have the potential to shift artisanal fishery towards sustainability as has already been shown in an off-shore Adriatic region (MATIĆ-SKOKO *et al.*, 2011a) and along the eastern Adriatic coast (STAGLIČIĆ *et al.*, 2011, under review). Their effectiveness was observed through positive changes of littoral fish resources' abundance, biomass and structure as well as through community indices and catch structure. An agreement between the studies is the recovery of the specific indicator species, *Mullus surmuletus* after 2002 when the trammel nets were excluded from subsistence artisanal fishing.

Due to the fact that longer time series (> 10 years) are difficult to maintain and keep

funded (LLEONART & MAYNOU, 2003; ROCHET & TRENKEL, 2003) and that available time series of landing data or official statistics of commercial catches are often very far from reflecting the reality since underestimation of total catch due to misreporting and/or not quantifying discards are widespread (FARRUGIO *et al.*, 1993; PAPA-CONSTANTINOU & FARRUGIO, 2000; LLEONART & MAYNOU, 2003) and are also not representative of the whole community as they are dominated by commercial species, compared with scientific surveys (ROCHET & TRENKEL, 2003 and references therein). We are now investigating the sensitivity to short term changes of some species like *M. surmuletus* or *Scorpaena porcus* which would than possibly nominate them as effective ecological indicators of changes in coastal communities. Namely, most existing community indicators are only sensitive to long term changes or to the effects of developing fisheries (ROCHET & TRENKEL, 2003 and references therein) while the effects of fishing and management actions are still assessed over very short time scales.

Socio-economic point and fishers' perceptions

Studies of eastern Adriatic artisanal fisheries have to date taken into consideration only the biological aspect. Socio-economic issues of artisanal fisheries are almost completely unknown. Interviews and questionnaires were conducted in the Vis area with the aim of getting relevant information on fishers' perceptions (MATIĆ-SKOKO *et al.*, 2011a). Fishing intensity is highest in the warm period (April-October) owing to suitable weather conditions. Previously, FORCADA *et al.* (2010) stated that artisanal fishing effort strongly depends on proximity to home harbor and habitat heterogeneity. Fishers rotate fishing gears throughout the year not only in accordance with legislative regulations, but also to optimize yields, based on their knowledge of the behavior and catchability of target species. Fishing respondents varied widely in age and fishing experience, but on average they were around 40 years old with 19 years of being professionally

engaged in artisanal fishing. Only 11 % were younger than 30 years indicating little interest in entering the fishing profession among the younger generation. A search for more profitable employment opportunities in urban surroundings is perceived as the main reason for the lack of interest by all the respondents.-

Regarding the trends in total catches fishermen reported not perceiving any changes, except for the fishermen with more than 15 years of professional engagement in fishing who experienced a substantial decline in trammel net catches. Nevertheless, the economic viability of their fisheries did not wane since the drop in the overall fish catches was compensated by catching on average larger sized, commercially more valuable specimens and by the continuous increase of fish prices in general. All the respondents felt that artisanal fishing, as it is currently prescribed, is to a large extent compatible with the sustainability of littoral fish resources. However, as major threat they perceived is the widespread misuse of fishing regulations by subsistence artisanal fishermen.

From the aforementioned, it seems that a different approach to management is needed, and also from a social perspective. Obviously, current fisheries management provokes resentment between commercial and subsistence artisanal fishers (MATIĆ-SKOKO *et al.*, 2011a). Limited institutional capability to effectively conduct surveillance and monitoring of fishing activities is exploited by subsistence fishers who don't comply with regulations mainly regarding restrictions on quantities of allowed fishing gear, thus also leading to violation of the daily catch limit of 5 kg. On the other hand, commercial artisanal fishers, with what and how they're allowed to fish, are in no need of violating the regulations. They argue that the catches of subsistence fishers, who greatly outnumber them, are in no way negligible and are often sold in unofficial markets, hindering sales by commercial fishers. Future management approaches aiming to alleviate the existing conflicts should increase the involvement of fishers in the management process (SALAS *et al.*, 2007).

Fishers' perceptions on trends in littoral resources are not entirely in line with what has

been observed by assessments of long-term experimental fishing (MATIĆ-SKOKO *et al.*, 2011a). Recent improvements went unnoticed by fishers since they are to a large extent involving only *M. surmuletus* – a species which, due to management changes of gear specific regulations, has been rarely present in their catches for the last 15 years. BATTAGLIA *et al.*, (2010) suggested that in a situation where there is a lack of long-term data sets, fishers' statements are often the only source of information on the status and historical changes of exploited resources. However, fishers' perception can be different from the real state due to different valorization of catches. Moreover, management changes of what fishers' are allowed to fish with inevitably influence their perception of trends in the catches (MATIĆ-SKOKO *et al.*, 2011a). Also fishers may in general be more sensitive to decreases rather than increases and are more likely to be more pessimistic than formal fisheries resource assessments. These findings suggest that consistent, standardized fisheries data collection is likely the better approach for documenting the trends of exploited resources. The importance of interviewing should in no way be discounted, as the information provided through this approach yields an important overview of the fisheries and provides an opportunity to build relationships with local fishers (LUNN & DEARDEN, 2006). Additionally, ROCHET *et al.*, 2008, point out that on shorter time-scales, not encompassing management changes, fishers' perceptions can be accurate and do have the potential to act as early warning signals.

Croatian artisanal fisheries on the threshold of entering the EU

Obligations regarding future management in terms of the monitoring and data collection framework (EU Data Collection Regulations (DCR), EC no. 199/2008) proposed by the EU is one of the tasks that we will have to carry out in the near future, yet at the same time it is necessary not to give up on current investigations and scientific approaches to artisanal fisheries issues. The guidelines for the data collection framework are defined by the EU Scientific, Technical and

Economical Committee for Fisheries (STCF) and they are directed toward the submission of National Data Collection Programme proposals and annual reports. The main steps in that process is to determine métiers and to establish our sampling scheme in all fisheries sectors. As was previously mentioned, the main characteristic of artisanal fisheries is heterogeneity, and which greatly complicates its management (TZANTOS *et al.*, 2005). Efficient sampling of this complex and poorly known sector is undoubtedly difficult (TZANTOS *et al.*, 2006) and thus even a definition of métiers is not an easy task. Each métier is a group of fishing operations defined by the combination of fishing gear, target species, area and season. A métier-based approach is likely to be useful for the design of stratified sampling surveys for the small-scale fisheries but will also be helpful for understanding the spatio-temporal patterns of fishing effort allocation (TZANTOS *et al.*, 2006). The historical original data series we previously reported and discussed will not be comparable with the new monitoring approach and thus we will probably continue with our research monitoring programme depending on funds that are available to us in the future. Based on realized fishing effort (days), total catch (kg) and value (kn), 5 groups of métiers were determined for Croatian artisanal fisheries: gillnets (GNS); trammel nets (GTS), pots (FPO), beach seines (SB_SV) and longlines (LLS). Sampling strategy (on board or/and at the landing place), sampling programme and expected number of sampling trips for each of the métiers are suggested. Pilot studies will be provided for all métiers to confirm the selected sampling strategy and sampling intensity. Also métiers related variables and stock related variables are defined according to DCR. Based on total landing, priority species for which we have an obligation for collecting stock related variables (age, length, weight, sex) were defined. Only flatfish *Solea vulgaris*, with a realized total catch of over 300 tonnes in 2009, meets the conditions of being a G1 species (those managed on the international level) for Croatian artisanal fisheries while others species are classified under G2 (main by-catch species) or G3 (other by-catch species) group. Sampling protocols and methodology

have to ensure data quality. It has to be emphasized that the DCF (Data Collection Framework) has minimal demands needed for the ecology-based approach as advocated by STCF. Also, Council Regulation (CE) 1967/2006 proposes allowed types of fishing gears together with their technical specifications and has a huge impact on both artisanal and open sea fisheries in all EU member states. Exceptions for some countries, e.g. for traditional fishing gear like beach seines “migavica” in Croatia, are possible, but should be within consistent local or national „Management Plans“ that are to be previously approved in Brussels. Moreover, it must be stated that an important matter is enforcement of the rules and recently new important EU rules have been put in place.

CONCLUSIONS AND PERSPECTIVES

Legislative changes have the potential to shift artisanal fishery towards sustainability, as has already been shown in an offshore Adriatic region (MATIĆ-SKOKO *et al.*, 2011a). Thus, conventional management can have positive effects although changes in provisions and regulations have to be accompanied with monitoring and studies that will give answers about the direction and extent of the effectiveness of such changes. Also, it has to be accompanied by a greater institutional capability to effectively conduct surveillance and monitoring of fishing activities of both professional and subsistence fishermen.

Unfortunately, the biological aspect, particularly knowledge of spawning properties and larvae dispersion and retention of most economically valuable or ecologically interesting fish species in the Adriatic and Mediterranean Sea, is still insufficient. This is particularly true for those fish undertaking more extensive spawning migrations to deeper open sea waters. We believe that future studies should be carried out in the southern Adriatic Pit, leading to support of the hypothesis of this area being a spawning place for numerous meso- and bathypelagic and bathybenthic Adriatic fish, but also for a number of coastal fish that undertake open sea spawning migration to complete the life cycle. Knowl-

edge about fish spawning places, nurseries and mechanisms of retention and dispersion of their larvae are exceedingly important to override some of the largest gaps related to recruitment and processes affecting survival of the early life stages. All of this is necessary for better species conservation and stock assessment.

In principle, reliable data on the type, dimension and quantity of fishing gear are needed for an accurate assessment of fishing effort in artisanal fisheries worldwide as well as in the Mediterranean and Adriatic Seas. Even when such data exist, they are not systematically monitored and gathered, thus making them practically unusable for any serious analysis (FARRUGIO *et al.*, 1993). It is now an appropriate time to become more meticulous in official data gathering and statistics. The large heterogeneity of artisanal activities implies differences in duration of fishing trips, in time and places of landings (a multitude of ports and shelters) and different destinations of products (retail, wholesale markets, fishmonger's shops and restaurants), representing additional difficulties in collecting information. In future, we have to attempt to find a way on how to determine specific landing places for artisanal fisheries.

Actively involving fishermen can not only bring otherwise unavailable traditional and local knowledge to the decision making process, but it also gives legitimacy to rules governing the fisheries in question and is more likely to result in management strategies that are respected and complied with willingly (DIMECH *et al.*, 2009). Combining conservation and social considerations should become essential in guiding future legislative decisions related to artisanal fisheries (GÓMEZ *et al.*, 2006). Better knowledge of recent changes in littoral fish communities, accompanied with better flow of communication and a sense of trust between scientists, fishermen and fisheries managers should significantly facilitate the desired outcome for the fisheries – i.e. fisheries managed in a sustainable way.

Therefore, the solution, at least in the short term, would be a sort of “data-less” management approach, building on available data, and to a large extent relying on the knowledge held

by local fishermen (JOHANNES, 1998). SILVANO & VALBO-JØRGENSEN (2008) have demonstrated that the value and usefulness of fisher's knowledge is especially high for complex fisheries where species diversity is high, and funds for carrying out biological research are very limited. Initiatives on the involvement of fishers in management process are advocated more and more. However, it is not clear how precisely this involvement should be realized. Several studies have shown that fishers' participation in management processes can contribute to the conservation of small-scale fisheries through their valuable knowledge on the biology of fish and fisheries as well as social and human capital (e.g. networking and collective action) that is critical for effective management (COSTELLO *et al.*, 2009 and references therein). In addition, to be useful for management purposes fishermen's knowledge should be properly recorded, analyzed and interpreted as suggested by SILVANO & VALBO-JØRGENSEN (2008). Such an approach could be an effective solution for managing Mediterranean type artisanal fisheries. In any case, it is an appropriate time for such management to become more adaptive, practical and objective oriented if we are to maintain and/or restore littoral marine resources.

Worldwide experience has shown that introducing MPAs (Marine Protected Areas) into fisheries management has numerous benefits: protection and preservation of ecosystem structure, function and integrity, habitat and biodiversity protection (prevent loss of species, restore population size and age structure, restore community composition and protect population genetic structures from fisheries selection), protection of ecological processes (maintain abundance of keystone species, prevent cascading ecosystem effects, maintain the trophic structure and ensure ecosystem resilience), but also improvement of fisheries through increased abundance of otherwise overfished stocks, increased spawning potential and spillover of juveniles and adults and, finally, enhancement and diversification of economic opportunities. In addition to permanently closing an area to fishing, currently we are testing whether a dynamic, rotational MPA

management can confer the aforementioned benefits in the specific context of Adriatic artisanal fisheries.

In the end, as a step in Croatia's accession to the EU, we are obliged to accept the monitoring and data collection framework (EU Data Collection Regulations, EC no. 199/2008 and related legislation) as proposed by the EU. However, according to our current scientific research and promising results related to this theme, it is necessary not to give up on current investigations and scientific approaches to artisanal fisheries issues. Moreover, since the DCF has minimal demands needed for an ecology based approach, detailed investigations can aid progress in this complex fisheries segment.

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Hrvatski priobalni ribolov i stanje njegovih litoralnih resursa na pragu ulaska u EU: učinkovitost konvencionalnog gospodarenja i buduća perspektiva

Sanja MATIĆ-SKOKO*, Nika STAGLIČIĆ, Miro KRALJEVIĆ, Armin PALLAORO, Pero TUTMAN, Branko DRAGIČEVIĆ, Robert GRGIČEVIĆ i Jakov DULČIĆ

Institut za oceanografiju i ribarstvo, P.O.Box 500, 21000 Split, Hrvatska

Kontakt adresa, e-mail: sanja@izor.hr

SAŽETAK

Priobalni ribolov u Hrvatskoj i cijelom priobalnom dijelu Sredozemlja ima dugu tradiciju. Zadnjih godina, ubrzani rast ljudske populacije uzduž obale Sredozemlja dovelo je iskorištavanje morskih resursa do gotovo iscrpljujućih količina što istraživanja ove problematike postavlja u složeni kontekst. Istovremeno, gospodarenje ribarstvom u Sredozemlju ostalo je konvencionalno u svojoj naravi što znači da je gotovo potpuno temeljeno na propisivanju specifičnih karakteristika ribolovnih alata. U radu se iznosi i raspravlja o trenutnom okviru hrvatskog zakonodavstva i zakonskim promjenama u reguliranju priobalnog ribolova u zadnjih 15 godina, te kako su te promjene utjecale na stanje priobalnih ribljih resursa, posebice na stanje ciljanih vrsta. Zaključak je da ako želimo poboljšati stanje resursa, moramo uvesti cijeli niz jasnih gospodarskih mjera koje će uključivati zone zabranjenog ribolova, ali i novi pristup koji će aktivno uključivati ribare u procese gospodarenja. Na kraju, biti će iznesene osnovne smjernice budućeg gospodarenja u smislu praćenja i prikupljanja podataka kako to predlaže i traži EU za sve zemlje članice.

Ključne riječi: priobalni ribolov, gospodarenje, Jadransko more, Hrvatska