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Title	Improving fishery law enforcement in marine protected areas.
Author(s)	Long, Ronán; Monteiro, Sara; Vázquez, Xavier
Publication Date	2010-02
Publication Information	Monteiro, Sara, Vázquez, Xavier, & Long, Ronán. (2010). Improving fishery law enforcement in marine protected areas. <i>Aegean Review of the Law of the Sea and Maritime Law</i> , 1(1), 95-109. doi: 10.1007/s12180-009-0002-6
Publisher	Springer
Link to publisher's version	<a href="http://dx.doi.org/10.1007/s12180-009-0002-6">http://dx.doi.org/10.1007/s12180-009-0002-6</a>
Item record	<a href="http://hdl.handle.net/10379/1790">http://hdl.handle.net/10379/1790</a>

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## Improving fishery law enforcement in marine protected areas

### Verbessern der Fischereien Strafverfolgung in geschützte Meeresflächen

### Améliorer la police des pêches dans des aires marines protégées

Sara Monteiro · Xavier Vázquez · Ronán Long

Published online: 14 August 2009

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**Abstract** There are several international and European legal instruments which provide a legal basis for the establishments of marine protected areas (MPAs) for the purpose of improving fishery management in the marine environment. Nevertheless, the effectiveness of MPAs remains open to debate and considerable attention is now focussed at international and European levels on how to improve the enforcement of regulations in MPAs. In this context, there is little doubt but that monitoring, control and surveillance (MCS) are indispensable tools for improving law enforcement and compliance in such areas. Indeed, recent experience in the European Union suggests that the effectiveness of MCS ought to be a primary consideration when designated areas to be protected in the marine environment. Accordingly, the aim of this article is to focus on some of the difficulties that must be overcome in order to improve the effectiveness of MCS in MPAs. Particular emphasis is placed on the problems that stem from the absence of common definitions regarding the characteristics of the area to be protected, the absence of harmonisation of MCS in such areas, as well as the problems that stem from practical considerations such as the size, shape and location of MPAs. The article also reviews basic fishery enforcement measures which can improve the

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The views in this article are personal and do not necessarily reflect those of the European institutions.

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effectiveness of MPAs including: hydrofencing, special fishing permits, one gear rule, as well as specific monitoring systems and security enforcement zones. Although the total harmonisation of regulatory measures is desirable from a law enforcement perspective, the article nonetheless concludes that it is also possible to have specific MCS solutions tailored to meet the characteristics of the area that needs to be protected.

**Keywords** Fishery management · Monitoring control and surveillance · Offshore marine protected areas · Enforcement · Fishery law

**Zusammenfassung** Es bestehen mehrere internationale und europäische Instrumente, die eine gesetzliche Basis für die Einrichtung der geschützten Meeresflächen versorgen, zwecks Verbesserung des Fischereimanagement in der Marineumwelt. Dennoch ist die Wirksamkeit von geschützten Meeresflächen zu debattieren und somit wird der Verbesserung der Regelungen der geschützten Meeresflächen beträchtliche Aufmerksamkeit an internationalen und europäischen Höhen geschenkt. In diesem Kontext gibt es wenig Zweifel dass Kontrolle und Überwachung unerlässliche Werkzeuge für die wirksame Strafverfolgung und verbessernde Erfüllung der Regelungen. Neue Erfahrung in der Europäischen Union befürwortet, dass die Wirksamkeit von Kontrolle und Überwachung eine primäre Berücksichtigung sein sollte, wenn bestimmte Gebiete in der Marineumwelt geschützt werden sollen. Dementsprechend ist das Ziel von diesem Artikel, sich auf einige Schwierigkeiten zu konzentrieren, die überwunden werden müssen, um die Wirksamkeit von Kontrolle und Überwachung in geschützten Meeresflächen zu verbessern. Besonderer Nachdruck ist auf die Probleme eingestellt, die von der Abwesenheit gemeinsamer Definitionen betreffend der Kennzeichen vom dem Gebiet, geschützt zu werden, stammen, weiterhin die Abwesenheit der Harmonisierung von Kontrolle und Überwachung in solchen Gebieten, sowie die Probleme, die von praktischen Berücksichtigungen wie zum Beispiel die Größe, Form und Lage von geschützten Meeresflächen stammen. Der Artikel überprüft auch grundlegende Fischereien Durchsetzungsmaßnahmen, die die Wirksamkeit von geschützten Meeresflächen verbessern können, unter anderem: “hydrofencing”, besondere Fischerei Genehmigungen, die nur ein Fanggerät Regelung, sowie spezifische Überwachungssysteme und Sicherheitsdurchsetzungszonen. Obwohl die gesamte Harmonisierung gesetzlicher Maßnahme wünschenswert von Strafverfolgungsperspektive ist, beendet der Artikel nichtsdestoweniger, dass es auch möglich ist, spezifische Lösungen für geschützte Meeresflächen zu haben, die darauf abgestimmt sind, die Kennzeichen vom Gebiet zu beachten, das geschützt werden muss.

**Résumé** Différents instruments juridiques internationaux et européens fournissent une base légale pour l'établissement des aires marines protégées (AMP) visant à améliorer la gestion des pêches dans l'environnement marin. Néanmoins, la discussion sur l'efficacité des AMP reste ouverte et la façon d'améliorer l'application des réglementations dans les AMP fait l'objet aujourd'hui d'une attention particulière au niveau international et européen. Dans ce contexte, il ne fait aucun doute

que le suivi, le contrôle et la surveillance (SCS) sont les outils indispensables pour améliorer la mise en œuvre et le respect des réglementations dans ces zones. En effet, une expérience récente de l'Union européenne montre que l'efficacité du SCS doit être prioritairement prise en considération lors de la création des aires marines protégées. En conséquence, cet article se concentre sur certaines difficultés qui doivent être surmontées afin d'améliorer l'efficacité du SCS dans les AMP. L'accent est mis en particulier sur les problèmes issus de l'absence de définitions communes des caractéristiques de l'aire à protéger, de l'absence d'harmonisation du SCS dans de telles zones, ainsi que sur les problèmes issus de considérations pratiques telles que la taille, la forme et la localisation des AMP. L'article passe en revue également les mesures basiques d'application des réglementations des pêches qui peuvent améliorer l'efficacité des AMP et notamment : l'hydrofencing, les permis de pêche spéciaux, la règle de l'engin unique de pêche, ainsi que les systèmes de surveillance spécifiques et les zones de mise en œuvre de sécurité. Même si du point de vue de la mise en œuvre de la réglementation, une harmonisation complète des mesures d'encadrement serait la meilleure solution, l'article conclut néanmoins qu'il est également possible de mettre en place des solutions spécifiques de SCS créées pour répondre aux caractéristiques de la zone à protéger.

**Mots clés** gestion des pêches · suivi, contrôle et surveillance · Aires marines protégées au large

## 1 Introduction

Many international and European legal instruments call for the establishment of marine protected areas (MPAs) both within and beyond national jurisdiction as a means to improve fishery management and to protect and preserve marine biological diversity (Tanaka 2008). In parallel with this development there is increasing concern at coastal State level about the effectiveness of MPAs in achieving their objectives. In this context, there appears to be some consensus among the marine law enforcement specialists that the efficacy of MPAs is very much dependent upon the system of monitoring, control and surveillance (MCS) that is implemented for such areas. Indeed, fishery law enforcement is at the heart of the common fisheries policy (Long and Curran 2000). Accordingly, this article aims to identify the difficulties that must be overcome in order to improve the effectiveness of MCS in MPAs. The discussion commences with a brief review of some of the legal instruments which provide a legal basis for the establishment of MPAs in international and European law. This is followed by a brief analysis of some of the problems that stem from, *inter alia*: the absence of common definitions in these instruments regarding the subject matter and characteristics of the area to be protected; the absence of harmonisation of MCS in such areas; as well as the enforcement difficulties that arise from practical considerations such as the size, shape and location of MPAs. The article also reviews a number of fishery enforcement measures which the authors believe can improve the effectiveness of MPAs including: hydrofencing, special fishing permits, one gear rule, as well as the

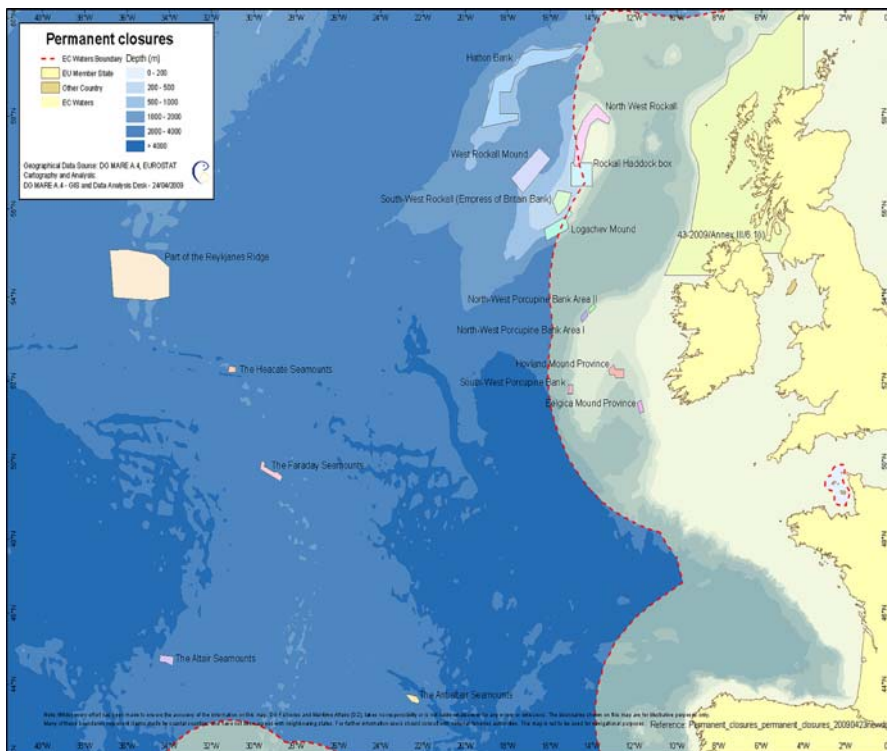
establishment of specific monitoring systems and security enforcement zones. Although the total harmonisation of regulatory measures is desirable from a law enforcement perspective, the article nonetheless concludes that it is also possible to have specific MCS solutions tailored to meet the characteristics of the area that needs to be protected. At the outset, it should also be noted that the discussion is focused on the concept of MPAs in general and for that reason does not distinguish between protected areas within and beyond nation jurisdiction. The latter present a different range of practical and legal problems.

### 1.1 Legal basis for MPAs in international and European law

There are several international and European legal instruments which provide a legal basis for the establishments of MPAs. As a start point it may be recalled that Article 194(5) of the 1982 United Nations Convention on the Law of the Sea calls upon States acting jointly or individually to take measures which include those necessary to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life. Although the Convention does not make reference to the term MPA *per se*, Article 211(6) provides for the coastal States to take preventive measures in “clearly defined area (or special area)” of their exclusive economic zones (EEZs) to combat vessel source pollution. Similarly Article 234 of the Convention provides a legal basis for the adoption of measures concerning vessel source pollution in iced covered areas of their EEZs. These measures and the considerable progress that has been made under MARPOL 73/78 and under the IMO Guidelines for the Identification of Particularly Sensitive Sea Areas fall outside the scope of this paper which is focused on the establishment of MPAs for the protection and preservation of biodiversity, as well as for fishery management purposes as a mitigation tool against the effects of fishing activities on the marine ecosystem. The requirement to establish MPAs for the latter purposes received considerable impetus from the Johannesburg Plan of Implementation which expressly calls upon States to establish a representative network of MPAs and time/area closures for the protection of nursery grounds consistent with international law and based on scientific information by 2012. This requirement is also reflected in many United Nations General Assembly Resolutions which have consistently called upon States since 2002 to use diverse approaches and tools for conserving and managing vulnerable marine ecosystems including the establishment of representative networks of MPAs by 2012. (Resolution 57/141, paras. 51 and 53; 59/240, para. 54; 59/24, para. 72; 60/30, para. 74; and 61/222, para. 97.)

There is considerable evidence supporting the contention that the legal basis for the establishment of MPAs pre-dates both the 1982 UNCLOS and the Johannesburg Plan of Implementation. Indeed several regional instruments including the 1976 Protocol to the Barcelona Convention provided for the adoption of spatial management measures in the 1970s. Since then, several initiatives have been taken in other ocean regions. One significant example is the Convention for the Protection of the Natural Resources and Environment of the South Pacific Region (Noumea Convention) which provides for the establishment of specially protected areas in sea areas under the sovereignty and jurisdiction of State parties. In the North Atlantic,

Bottom trawling and fishing with static gear is prohibited in the Hecate and Faraday seamounts, a section of the Reykjanes Ridge, the Altair seamounts and the Antialtair seamounts (see Fig. 1). Similarly, the Northwest Atlantic Fisheries Organization (NAFO) has prohibited bottom trawling on seamounts in the Northwest Atlantic and has asked the NAFO Scientific Council to assess the distribution of cold water corals in the NAFO Convention Area with a view to their future protection. In 2006, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) used MPAs agreed to “freeze the footprint”



**Fig. 1** Permanent fishery closures in the Northeast Atlantic under EC fishery law

of bottom trawling in the CCAMLR Maritime Area. The same year, the South East Atlantic Fisheries Organization (SEAFO) prohibited fishing activities in ten marine areas with prominent seamounts and to protect these habitats.

## 2 What constitutes an MPA?

Despite the considerable progress towards the achievement of the establishment of representative networks of MPAs by 2012 in line with the objectives of the world Summit on Sustainable Development there is considerable uncertainty in the specialist literature as to what constitutes an MPA. This uncertainty is also reflected in many international legal instruments mentioned above and in the working documents of several multilateral organisations that are concerned with the protection and preservation of the marine environment. Thus, for example, the World Conservation Union (IUCN 2004a) defines a protected area as an “area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means”. This organisation also defines an MPA as “any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment” (IUCN (b) 2004). One particular feature of this definition is that it only applies to coastal MPAs and this must be contrasted with the much broader perspective taken by the Convention on Biological Diversity (CBD 2007) which refers to “Marine and Coastal Protected Area” as “any defined area within its overlaying waters and associated flora, fauna and historical and cultural features, which has been reserved by legislation or other effective means, including custom, with the effect that its marine and/or coastal biodiversity enjoys a higher level of protection than its surroundings”. In recent years, much attention has been focused on the establishment of “High Seas Marine Protected Areas” which in words of IUCN/WCPA/WWF (2003) “represent an opportunity for the global community to cooperate to provide a higher level of protection than prevailing levels, a structure for coordinated decision-making amongst a range of stakeholders (i.e. governments, international and regional organizations, fishing, shipping, marine conservation, etc.) and a basis for integrated and ecosystem-based oceans management.” Although the need for ecosystem-based management is also evident in EU law, considerable effort has been made in secondary legal instruments to keep the definition of MPAs relatively simple and free from doubt. A good example is Council Regulation (EC) No1967/2006 which defines a “Fishing Protected Area”, as a “sea area in which all or certain fishing activities are temporarily or permanently banned or restricted in order to improve the exploitation and conservation of living aquatic resources or the protection of marine ecosystems”. Similarly, the authors of this article prefer a relatively uncluttered approach as is evident in the definition advocated by Scovazzi (2003) who suggests that a MPA can be broadly defined as an “area of marine waters which is granted a special

protection regime because of its significance for a number of reasons (ecological, biological, scientific, historical, educational, recreational, etc.).”

## 2.1 Some general comments on MCS in MPAs

From the discussion in the specialist literature there are a number of general comments that may be made regarding MCS which need to be taken into consideration in the design of MPAs. Firstly, there are two principal types of MPA which are focused on different objectives. Namely, areas aimed at the protection of a marine habitat(s) for the purpose of protecting biodiversity which need to be differentiated from areas used for fisheries management purposes such as the protection of juveniles, the protection of seasonal aggregations of spawning adults, or to limit the use of certain types of gear or to reduce the take of bycatch. Essentially, these two types of MPAs are not mutually exclusive in so far as it is possible to have an MPA aimed at the protection of biodiversity such as deep-water corals which also entails fishery management measures.

Secondly, if MPAs are not well designed the effectiveness of enforcement measures will be seriously undermined. In extreme cases, MPAs can become paper parks instead of protected areas. Importantly, location and size are two characteristics that can affect the success of a MPA (Jameson et al. 2002; Licuanan et al. 2006).

Thirdly, there is increased awareness at an international level of the importance of MCS have in the management of MPAs. This requirement was identified in a WWF High Seas Marine Protected Areas Workshop<sup>1</sup> which took place in Malaga in 2003. Similarly, compliance and enforcement in the MPA planning stage was considered by WPCA/IUCN (2007), as being one of the key elements needed to ensure that a representative network of MPAs achieves its goals.

Fourthly, experience in the European Union suggests that MCS is easier to achieve where the MPA coincides with an area that is closed to fishing area. In such situations the distance from land can make it more difficult and expensive to efficiently monitor the area and to take enforcement action when this is required. At a practical level, there are other benefits through the use of closures or to prohibiting fishing activity in a particular area. Principally, because they are easier to understand than an access system based on technical measures or quota restrictions. Therefore the chances of achieving higher levels of compliance are correspondently higher (Herrera 2007).

Fifthly, the size, shape and geographic position of an MPA can be related to its goals. According to Brown and Wooninck (2007) the area needed for an offshore MPA to be feasible biologically is much bigger than in coastal MPAs. This is due to the fact that macro fauna densities in offshore ecosystems tend to be much lower than in coastal ecosystems. The authors also consider that offshore networks of MPAs should contain fewer isolated areas and should be made-up of larger areas. Significantly, Stefansson and Rosenberg (2006) have noted a correlation between

<sup>1</sup> Organised by IUCN, the World Conservation Unit; WPCA, the World Commission on Protected Areas and WWF International, World Wide Fund for Nature.

compliance and area size. More specifically, they note that the chances of over-fishing by end users is greater in smaller isolated MPAs than in larger contiguous MPAs. As will be seen below, experience in the European Union suggests that it is equally desirable to have larger bigger areas as opposed to small protected areas in the coastal zone. Inappropriate size and location can also have negative effects on the conservation goals if fishing effort is redirected towards MPAs (Grafton et al. 2007).

Sixthly, evidence derived from social science studies should always be considered during the process of designing an MPA. In this context, it is important to recall that it is well known that one of the issues in resource allocation is reconciling conflicting interests between the different entities interested in conservation and exploitation (Sumaila et al. 2000). For these reasons it is very important to strike a balance when designing MPAs between the socio-economic needs and the ecological conservation needs. In particular, it is important to involve stakeholders in the decision-making process as regards future management measures. Stakeholder's participation will assist in creating respect for the impositions of the conservation obligations of the MPA. According to the United Nations Environment Programme (UNEP 2006), full stakeholder' participation enhances transparency whilst contributing to credible and accepted rules that identify and assign the corresponding responsibilities appropriately. Experience in the NAFO fisheries since the early 1980s suggests that fisheries observers appointed to monitor compliance with fishery management regime are also a useful conduit of information between the industry and regulators regarding the need for legislation as well as the level of environmental awareness. Experience also suggests that there are improved chances of compliance when the need for regulations are fully comprehended by the industry (Monteiro 2006).

## 2.2 Some law enforcement considerations in designing MPAs

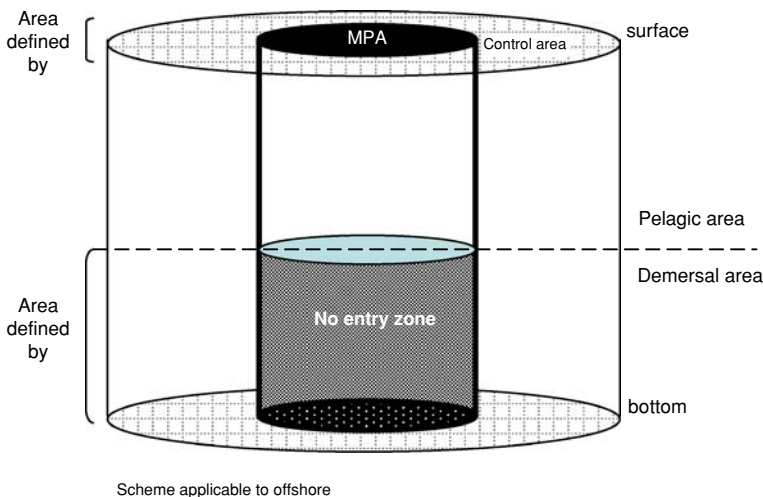
In designing an MPA several issues regarding MCS need to be taken into consideration. There is little doubt that where MCS is of paramount importance then the easiest way is to classify the marine reserve as a "no-entry" or "no-take" area. In effect this means that no exploitation of any resources is allowed. However, at a practical level, it is seldom possible to implement a "no-take" area if fishing activity or other offshore extraction activities are well established in the area to be protected. When designing a new MPA consideration ought to be given on how commercial fishing vessels may be used in enhancing MCS. In cases where a total closure is not feasible, there may be scope for partial closures. This often arises where the objective is to protect some feature on the seabed such as hydrothermal vent or cold water seep. Protection of the seabed can be achieved without total closure, thus allowing exploitation of the water column for fisheries (or other) purposes. The area to protect can be restricted by use of different fishing management measures including "hydrofencing" special fishing permits, dissemination of vessel activity data, one gear rule,. In light if their importance it is now proposed to say a little more about each of these concepts.

### 2.2.1 Hydrofencing

Many lawyers, scientists and fishery managers will be unfamiliar with the concept of hydrofencing which has its origin in the information technology term “geofence”. The latter can be described as a virtual boundary to delineate a restricted area on a computerised Geographical Information System (GIS). Unlike a physical fence, a geofence is not a physical barrier in so far as it is a virtual boundary on a GIS which triggers an alarm when a vessel enters a particular area. Similarly, hydrofencing entails the delineation of a three-dimensional boundary on a marine GIS with a view to allowing limited resource exploitation activities in the area that is being protected. In other words, the area is not classified as a no-take area but as an area where certain activities are permitted under the regulatory framework. For example, some MPAs are aimed at the protection of the seabed benthic layer and will thus not require the prohibition of all types of fishing in the area that is protected. In such instances, hydrofencing facilitates the adoption of a range of management measures including: gear restrictions, licences/special fishing permits and restricted access rights. This may entail a total prohibition on demersal fisheries in a particular MPA with a less restrictive regulatory regime for pelagic fisheries in the same area. An example of a hydrofence is illustrated in Fig. 2 below.

### 2.2.2 Special fishing permits

Clearly in the case of a no-take MPA it is important that the area is geographically well defined and all stakeholders are fully aware of its boundaries. Moreover, fishing licenses for adjacent areas or nearby protected areas should include extensive information on the no-take areas including the specific regulatory prohibitions that apply in the area. In addition, vessels which are authorised to fish in such areas ought to be obliged to carry a special fishing permit. Under Council



**Fig. 2** Hydrofenced MPA

Regulation (EC) No1627/94 such a permit is defined as “a prior fishing authorization issued to a Community fishing vessel to supplement its fishing license, thereby enabling it to carry out fishing activities during a specified period, in a given area, for a given fishery”. The special fishing permit ought to define the coordinates and possible spatial divisions of the MPA, as well as the permitted fishing gears, authorised time of year for resource exploitation, as well as any other obligations and conditions applicable to license holders. Moreover, since the navigation speed of fishing vessels is often an indicator of the activity and this may be monitored using a satellite based vessel monitoring system (VMS). In such instances, it may be desirable to prescribe a minimum speed allowed for vessels to transit a protected area. In this context it is important to recall that the majority of fishing vessels deploy their gear at speeds of at least four knots. Taking this into account it would seem prudent that the minimum speed to transit a protected area should be set at six knots. Any restrictions such as this should also be clearly set down in the special fishing permit. Linking the vessel’s historical record on compliance with the entitlement to a special fishing permit would be one obvious way to ensure that compliant vessels are only ever allowed in an MPA. This would also introduce a positive incentive for vessels to comply with fisheries regulations over and above the more conservative sanction backed approach to fishery management.

### *2.2.3 Access to information on fishing activity*

At a practical level, all offshore MPAs are “out of sight” in so far as it is not possible to physically see or monitor the levels of activity in such areas. In light of the fact that these areas are established to protect biodiversity in the interest of the common good, there appears to be a cogent case supporting free access by the public to information on MCS measures. This approach would be fully consistent with the 1998 Aarhus Convention which is implemented in EC law by Council Directive 2005/370 which guarantees the public free access to information on the environment. Indeed, under the Directive any member of the public or legal person may apply for access to information held by public authorities or by any person performing public administrative functions. In this context, it should also be recalled that transparency is enhanced when actions, decisions and decision-making process are open to scrutiny by its members, stakeholders, civil society and outside institutions (UNEP 2006). Accordingly, information on the distribution of licenses, fishing permits, vessel identification, characteristics of vessel, specification of gear used and species targeted ought to be made public. Where relevant, information regarding infringement procedures and sanctions should also be in the public domain unless declared confidential by law.

### *2.2.4 One gear rule*

The implementation of a no-take MPA will often entail setting gear restrictions and prohibitions. In some instances, this will entail a total prohibition on all pelagic and demersal gears as well as the imposition of speed restrictions on vessels transiting

no-take areas. However, some MPAs may allow for restrictions on fishing activity and in such cases there may be scope for the adoption of a “one gear” rule. This would limit the gear carried by a particular vessel to one of the following: pelagic longliner, pelagic trawl, pole and rod fishing, or purse seine. A list of the forbidden fishing techniques applicable to the MPA would also have to be adopted including: bottom longlining, bottom trawling, beam trawling, shellfish dredging, as well as any other fishing techniques which has an adverse impact on the benthic micro fauna or bottom dwelling organisms. All permitted and forbidden gears would have to be clearly described in the fishing permit. The marking and register of fishing gear should also be made compulsory by the national fishery administrative authority with a view to reducing the impact of lost gear on the marine environment.

#### *2.2.5 Vessel monitoring systems*

The monitoring of fishing vessel activity is a key component to the successful implementation of fishery management measures in MPAs. Activity in offshore MPAs can be monitored in situ through the use of aircraft and patrol vessels. In recent years due to the high costs of patrolling at sea and air surveillance there is greater emphasis on the use of satellite based VMS. This system has been implemented in Europe since the mid-1990s and usually entails the placing of a transponder onboard the fishing vessel and the transmission of information regarding the location and activities of the vessel to fisheries monitoring centres in the Member States. At the time of writing, all fishing vessels registered in the Member States with an overall length of more than 15 m are required to have VMS. More recently considerable progress has been made in the development of vessel detecting system (VDS) which are capable of identifying vessels that do not have a requirement to have VMS or who are engaged in fishing activity without a functioning VMS device. Apart from obtaining information from the VMS regarding the location, course and speed of the fishing vessel other new technologies are now available which electronic net monitoring devices which establish the distance between the net and seabed at all times. This device was successfully implemented in the New Zealand Benthic Protection Areas in 2007 (New Zealand Government 2007).

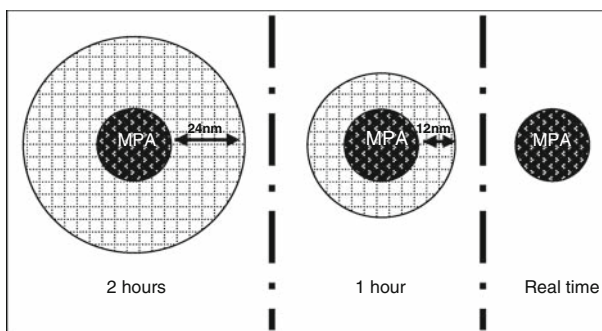
#### *2.2.6 MPA buffer zones*

MPA buffer zones have been defined as “the area surrounding a conservation unit, where human activities are subject to specific norms and restrictions, with the intent of minimizing negative impacts on the unit” (EJD 2007). A similar definition is provided by UNESCO which states that buffer zones are “the marine transition area that enables the people in the community to undertake fishing activities” (UNESCO 2007). From the MCS perspective, buffer zones operate as a transition area between the protected area and the wider marine environment. In many automated systems when a vessel enters a buffer zone this will entail transmission of an alarm signal to the authorities in the national fisheries monitoring centre who are responsible for law enforcement at sea. This in turn facilitates monitoring access to the MPA before

an unauthorised vessel enters the area or an illegal activity takes place. The size and design of the buffer zone will have a major bearing on the success of MCS in the MPA. For fisheries enforcement purposes, the activities in the area may be divided into two general categories; vessels engaged in fishing activity and vessels exercising their freedom of navigation rights. As mentioned previously, the average speed for a fishing vessel engaged in a fishing activity is approximately two to four knots and the average speed for vessels on passage is in the order of 10–12 knots. Therefore, the protected area should have a “safety” entry/exit surrounding zone that would allow authorities to react to suspected cases of illegal activities.

From a law enforcement perspective, two parameters should be taken into consideration when designing a buffer zone. These are: the average steaming speed of a fishing vessel; and the frequency of transmission of position coordinates by satellite or other means. Experience in the EU suggests that these parameters are 12 knots and 2 h, respectively. Accordingly when a vessel navigates through a 24 nautical miles area as shown in Fig. 3, a vessel travelling at 12 knots will emit at least one VMS signal, while a fishing vessel engaged in fishing activities at four knots would emit three VMS signals. This allows sufficient time for the authorities to intervene if it is suspected that the vessel is engaged in illegal activities in the protected zone. An increase in signal frequency of VMS data may facilitate the creation of a smaller buffer zone. However, it should also be taken into consideration that the minimum and maximum working speed of a fishing vessel can vary between 3 and 15 knots depending on the types of fishing gear deployed. The different speeds for the different types of fishing vessels are shown in Table 1. An average speed of two to four knots suggests that the much higher speeds of mobile gears such as vessels deploying purse seines are an exception when compared with the average working speeds of vessels deploying static and towed gears. This factor needs to be taken into consideration when designing and implementing a MCS scheme for an MPA.

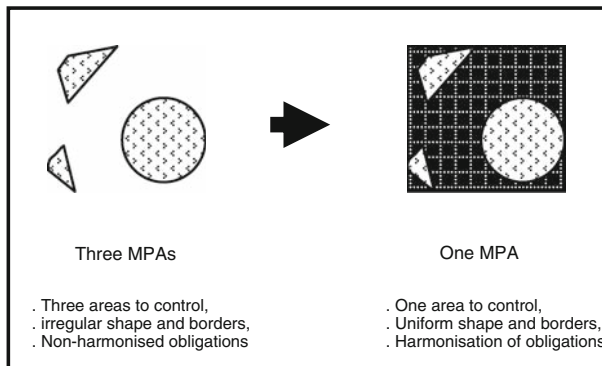
The size of the buffer zone is relevant where there are two or more areas to be protected. As can be seen from Fig. 4 it may be possible to have one large MPA instead of several smaller ones by embedding all the protected areas within one buffer zone. This has clear advantages from a law enforcement perspective in so far



**Fig. 3** MPA buffer zones

**Table 1** Fishing boats average working speeds

GEAR	SET (average speed, knots)	HAUL (average speed, knots)
Towed	4–7	3–4
Static	3–5	<2 or adrift
Mobile	10–15	Adrift

**Fig. 4** Example of offshore MPAs

as it eliminates “gaps” in the overall protected area and creates a more uniform shape which may be easier to patrol at sea and to map on a GIS for VMS purposes.

### 2.2.7 Fisheries observers

One of the best ways to improve MCS is to ensure that fishing vessels working in a protected area have an independent and duly authorised observer onboard as this will ensure good data collection as well as improved compliance with fisheries regulation in the area. Apart from their normal tasks such as data collection on catches, fisheries observers working in protected areas should also have responsibility for improving environmental awareness on board the vessel and for monitoring and reporting on the impacts of fishing activity on the wider marine ecosystem.

## 3 Conclusions

There are several international and European legal instruments which provide a legal basis for the establishments of MPAs for the purpose of improving fishery management in the marine environment. Nevertheless, the effectiveness of MPAs remains open to debate and considerable attention is now focussed at international and European levels on how to improve law enforcement in MPAs. In this context,

there is little doubt but that MCS are indispensable tools for the successful management of such areas. Indeed, recent experience in the European Union suggests that the effectiveness of MCS ought to be a primary consideration when designing and designating MPAs.

The regulatory framework applicable to MPA should be relatively simple and considerable emphasis needs to be placed on improving compliance with specific conservation and management objectives. In this context, the size of the area protected is an important consideration when designating a new offshore MPA. As a general rule, the larger the area the easier it will be to have a specific MCS regime. Clear delineation of the maritime boundaries between protected areas and non protected areas is a prerequisite for effective law enforcement. Experience in the EU suggests that monitoring vessel movement on an entry/exit basis in the area through VMS or other systems may not be sufficient to prevent illegal activities. Accordingly, additional measures may be required to improve enforcement and compliance. These may include the establishment of a system of hydrofencing which divides the water column on a vertical basis thus making it possible to authorise certain types of fisheries in a protected area. Special fishing permits may also be used to administer fishing activity in protected areas and the creation of buffer zones together with the use of vessel detecting technologies will facilitate law enforcement in and around protected areas. At present VMS rules in European waters require the transmission of position reports every 2 h. If the frequency of VMS data was increased to real time transmission together with the implementation of an alarm system, then the size of the buffer zone could be decreased significantly. Finally, it ought to be noted that access to environmental information is a key aspect of EC environmental law and this increases the importance of timely dissemination of fisheries enforcement and compliance information to the general public. Accordingly, there ought to be greater public debate about the need for integrating MCS considerations into the design of MPAs for fishery enforcement and biodiversity protection purposes.

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