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Underwater towed video: a useful tool to rapidly assess elasmobranch populations in large marine protected areas

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Abstract Elasmobranch stock assessment studies are usually made through fisheries surveys data. However, in large marine protected areas (MPAs) the use of destructive techniques must be dismissed in order to avoid population impacts. In 2005, while conducting a marine habitat survey in two marine Special Areas of Conservation (Sebadales de Playa de Inglés and Franja Marina de Mogán) in south Gran Canary Island (Canary Islands, Spain) with underwater towed video (UTV) and underwater visual census (UVC) transects, we recognized the opportunity rose to assess elasmobranch populations through UTV. Number of observed species and specimens, overall field work effort and total surveyed area were determined and compared between methods. Mean observations per day per unit of time (MOPUT) and mean observations per day per unit of surveyed area (MOPUA) were also compared through Mann–Whitney rank sum statistical test (α=0.05). Data analysis demonstrated that UTV is a very useful tool to rapidly assess elasmobranch populations in large MPAs in good visibility underwater environments. It can assess larger areas than UVC with the same effort (statistically significant difference found for the MOPUT; p=<0.001), leading to more observed species (5 *vs* 2) and specimens (46 *vs* 3) per day of work, with no loss in resolution power (MOPUA values were not significantly different between UTV and UVC; p=0.104).

Keywords Elasmobranch · Abundance estimation · Underwater video · Monitoring methods

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Introduction

Although many sharks and rays have been of lower economic value in Canary Islands fisheries (Rico et al. 1999), the economic impact of mortality in mixed-species fisheries and bycatch may be similar to more productive species (Musick 1999). In addition to the obvious concern over possible extinction of some species, a further problem can be the negative effects that strong declines in apex predators can have on ecosystems (Stevens et al. 2000; Schindler et al. 2002). Therefore, management must be implemented at the inception of fisheries (Musick and Bonfil 2005). However, due to the low biological productivity and, for many species, their high catch susceptibility, most elasmobranch species require management action long before sufficient data are available to undertake a stock assessment (Musick and Bonfil 2005). As a result, rapid assessment techniques have to be implemented to evaluate a possible threat from the effects of fishing (Walker 2007).

Traditionally, the elasmobranch stock assessment data have been derived from catch and effort statistics provided by logbooks and observer programs in commercial fisheries (Botsford et al. 1997). The use of this sort of information brings with it a number of problems that bias abundance estimates (Russell and Vail 1988). Furthermore, it provides no information on distribution and abundance in marine protected areas (MPAs) where fishing is prohibited or highly restricted (Lynch 2006). For these special cases, non-destructive monitoring methods have long been suggested to assess fish abundance over space and time (Davies 2001; Fraschetti et al. 2005).

In 2005, while performing a marine habitat characterization with underwater towed video (UTV) and underwater visual fish census (UVC) in two marine SACs (Special Areas of Conservation by the European Council Habitats Directive), in the southern coast of Gran Canaria Island (Canary Islands, Spain), we realized the opportunity to assess elasmobranch populations through the UTV still images. Here we compare data obtained by both methods in order to recognize the potential and problems of using UTV to rapidly assess elasmobranch species abundance in large MPAs.

Methods

The actual study was carried out in *Sebadales de Playa de Ingles* (2,452 ha) and *Franja Marina de Mogán* (29,852 ha) (European Council 1992) (Fig. 1), two south exposed marine SACs mainly composed by underwater sandbanks slightly covered by sea water all the time, and by a narrow along-shore rocky reef. All habitats (sandy bottoms, sandy bottoms with seagrasses, sandy bottoms with rocky boulders, hard rocky bottoms and artificial reefs) were investigated by means of UTV and UVC, two non-destructive methodologies, in order to record all sighted elasmobranch species and specimens. Both methodologies were used along 10 field work days, during daylight hours, at the same range of depths (5 m to 22 m), habitat types, sea state and daytime (daylight hours from 10 AM to 5 PM).

UTV method

Underwater towed digital video transects (camera MARI SCOPE™ M4C), with a distance of 500 m between them, were made perpendicular to the coast line (*e.g.* Bekkby et al. 2002; Franklin et al. 2003). At a constant boat speed of 2 knots, the camera was maintained at approximately 2 m above the seafloor. The video signals obtained by an umbilical cable were georeferenced and digitally recorded on an on-board laptop PC connected to a GPS. Subsequently, the digital videos and the GPS track files were analyzed to record georeferred elasmobranch species occurrence, within 2 m of either side of the transects, as well as transect length and time period of surveillance.

UVC method

Four replicated 25 m long transects were made at randomly chosen sampling locations whilst exploring the different habitats of the south of Gran Canary Island. Elasmobranch species abundance were recorded on waterproof paper by a SCUBA diver within 2 m of either side of the transects, according to standard procedures (Brock 1982; Lincoln-Smith 1989; Kingsford and Battershill 1998). Assessed transect area and time period of surveillance, per transect, were also recorded.

Personnel team

The survey team comprised the same three people for both methods. For the UTV, the team was composed by one helmsman, one technician to deploy the video and one technician to aid with navigation, take field notes, control the video recorder and assist with deployment and retrieval of the umbilical and camera. For the UVC, the team was composed by one helmsman and two trained SCUBA divers.

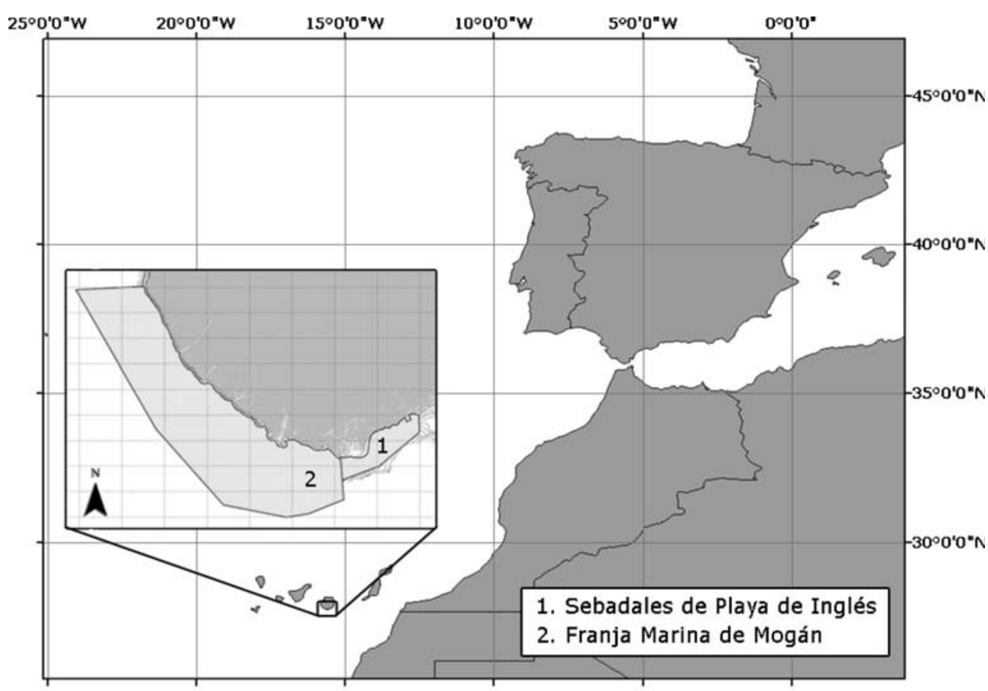

Fig. 1 Marine SACs (*1*) *Sebadales de Playa de Ingles* (2,425 ha) and (*2*) *Franja Marina de Mogán* (29,852 ha) in Gran Canary, Canary Islands (Spain)

Methods comparison

Number of observed species, number of observed specimens, overall time period of surveillance effort (hour) and total surveyed area (hectare) were determined and compared between methods.

To make a typical "captures per unit of effort" comparison, mean observations per day per unit of time (MOPUT) and mean observations per day per unit of surveyed area (MOPUA) were also compared between the two methods; captures were the specimens observations, while the used effort measures were time and area for MOPUT and MOPUA, respectively; groups of data from UVC and UTV tested through Mann–Whitney rank sum statistical test (α=0.05). To make reasonable comparisons, specimens observation results were standardize in terms of unit of time and unit of area.

Results

Underwater towed video

During the 10 field work days, 78 UTV transects were made in the two marine SACs, within a total surveillance area of 121,968 ha in 26h40m of overall video recording. Forty six observations of five different elasmobranch species were made (31 *Dasyatis pastinaca*, 3 *Dasyatis centroura*, 2 *Gymnura altavela*, 9 *Myliobatis aquila* and 1 *Mustelus sp.*). For this method, the MOPUT was of 1.654±0.279 observations/h and the MOPUA was of 2.836±0.711 observations/ha (Fig. 2).

Underwater visual census

During the field work days, 124 UVC transects were made within a total surveillance area of 0.310 ha in 14h48m of UVC counts. Three observations of two different elasmobranch species were made (2 *Dasyatis pastinaca* and 1 *Squatina squatina*). For this method, the MOPUT was of 0.205±0.109 observations/h and the MOPUA was of 2.292±1.180 observations/ha (Fig. 2).

Methods comparison

For the same field work days, number of observed species (5 *vs* 2), observed specimens (46 *vs* 3), overall time period of surveillance effort (26h40m vs 14h48m) and total surveyed area (121.968 ha *vs* 0.310 ha) were higher when using UTV. Statistically significant difference between groups (UTV and UVC) was found for the MOPUT (Mann–Whitney test, U=10, p=<0.001). On the other hand, the MOPUA compared values between groups did not reveal any statistically significant difference (p=0.104).

Discussion

The ability of a monitoring programme to meet its aims successfully hinges on the selection of an appropriate method (Davies 2001). Traditionally, the non-destructive most used methods to assess patterns of distribution and abundance of elasmobranches in MPAs are UVC by SCUBA divers (*e.g.* Castro and Rosa 2005), baited remote underwater video stations (e.g. Willis and Babcock 2000), telemetry (*e.g.* Nelson 1990) and physical external and internal tags (Rounsefell and Everhart 1953, Jackobsson 1970; McFarlane et al. 1990). The objective of this study was to evaluate the potentialities of UTV (non-destructive method), to rapidly assess elasmobranch populations in large MPAs, by means of comparison with UVC data. Much of the previous work using underwater video cameras has been designed to provide a means of visually enumerating fish in habitats or depths not accessible to divers (*e.g.* Ellis and DeMartini 1995, Priede and Merrett 1996, Gledhill et al. 1996). However, in our study, to

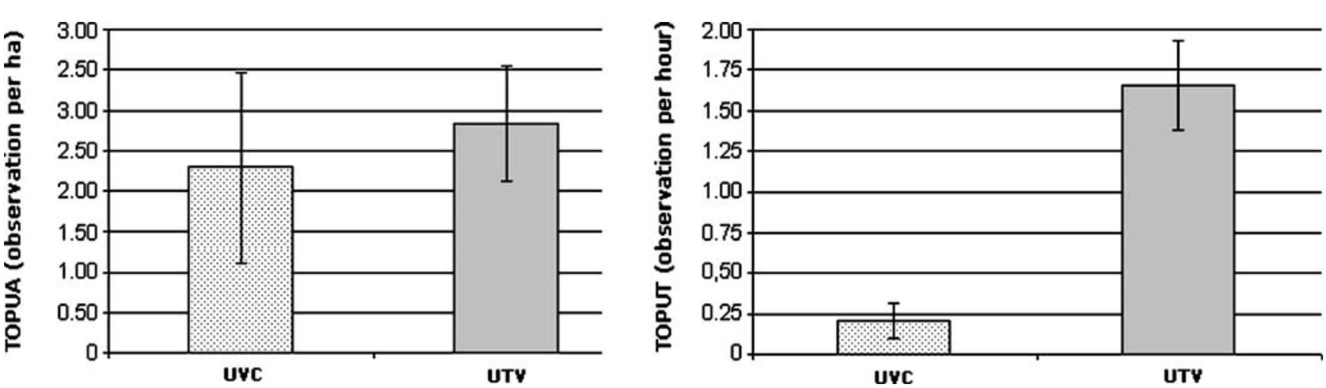

Fig. 2 Mean observations per day per unit of area (MOPUA, hectare) and mean observations per day per unit of time (MOPUT, hour). Data obtained by means of underwater visual census (*UVC*) and underwater towed video (*UTV*). *Bars* represent data standard error

validate the rapid assessment attribute of the applied methods, our approach was to survey the same locations and depths, during the same field work days.

Data analysis revealed that for our study both UTV and UVC methods are inappropriate to assess pelagic elasmobranch species—only demersal specimens were observed. With the same field work days, a higher number of species and specimens were recorded with UTV and, with this method, the field work effort was better invested to generally assess elasmobranch populations (MOPUT significantly higher for UTV), *i.e.* more observations could be made with the same amount of days. Additionally, both methods revealed no differences in terms of resolution power (between methods, MOPUA with no statistically difference), gathering comparable amount of data per unit of surveyed area. The difference found between methods in terms of MOPUT is explained by the disparity of surveyed area with the same effort (UTV gathered data from 393.440 times larger area than UVC). In addition, the UTV recorded time was almost two times greater than the UVC depth time, making it, one more time, a more effective method in terms of effort per field work day. This difference is because the operations with the UTV are not limited by the bottom time like UVC is (*e.g.* Davies 2001). Like in other cases, in our study, in order to follow the scuba diving safety protocols, the team was only able to dive twice in a field work day.

In terms of the assessed species composition, important differences were found. *D. pastinaca*, a common stingray in Canary Islands sandbanks (Brito et al. 2002), was the only species sighted with both methods. The UTV was able to detect a range of species that UVC could not (*Dasyatis centroura*, *Gymnura altavela*, *Myliobatis aquila* and *Mustelus sp.*). This is due to the ability of the UTV to sample bigger areas faster than UVC, leading to more richness and abundance estimates. Yet, the field work days were the same and there was no loss in resolution power, a goal when a rapid assess of demersal elasmobranch populations is the fieldwork objective. Not only may the difference in area surveyed be responsible for the found difference, but also the presence of the UVC SCUBA diver could be affecting fish behaviour (Chapman et al. 1974; Chapman and Atkinson 1986; Costello 1992), limiting the real value of presence/absence of this species (*e.g.* Kulbicki 1998). Moreover, contrary to UTV, the UVC method was able to assess specimens of *S. squatina*, a demersal species that can camouflage in sandy bottoms (Compagno 1984). This kind of behaviour could be preventing observations by the digital camera. Along a transect, a trained diver can count species that are camouflaged (Arigoni et al. 2002) with much more accuracy than a video camera. UTV data analysis of demersal species with camouflage abilities should then be treated with some reservation and low abundance assumptions should not be made. Another potential failure of the UTV that can induce bias to the results has to do with the sea conditions. Sometimes, during field work, the boat movement was translated to the towed camera umbilical, making it difficult to maintain the altitude above the bottom, essential to do accurate individual counts, species identification and area estimations. Despite our very good experience with the UTV, we found that this method, in rough sea conditions, could have different results.

Conclusions

Since the late 1990s digital still cameras have been in use for underwater marine science applications such as sea floor mapping from a towed body (Edwards et al. 2003) and are being applied to more demanding measurement tasks due to the high resolution of the images (Abdo et al. 2006). The obtained results suggest that the use of UTV to rapidly assess demersal elasmobranch populations in large MPAs is preferable to UVC. UTV brought significantly better results per number of field work days. However, like all sampling methods, it has limitations, especially related to rough weather conditions and species with camouflage abilities like *Squatina squatina*. Furthermore, while the UTV method described permit elasmobranch abundance assumptions to be made, by using the same video counts data, considerable extra information may be gained from another analysis point of view: data can also be used to estimate the area, variety and number of the different biotopes or biotope complexes (*e.g.* Connor et al. 1997) that a certain elasmobranch species is occupying in a monitoring campaign.

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