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DEVELOPMENT OF THE MARINE PROTECTED AREA NETWORK IN THE ARGENTINE ISLANDS AREA (AKADEMIK VERNADSKY ANTARCTIC STATION, UKRAINE)

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Based on underwater observations the establishment of marine protected areas in the Stella Creek and Skua Creek straits were proposed. Selection of areas was carried out in accordance with the protocol NAGISA and acoustic bottom survey of the Argentine Islands water area. Descriptions of the marine protected areas were developed and their categories according to IUCN methodology were defined. Compliance indices calculated according to the IUCN methodology assign the Stella Creek and the Skua Creek MPAs to the IUCN protected categories Ia and III, respectively. 3D models of the marine protected areas were designed.
Key words: Stella Creek, Skua Creek, biodiversity, underwater landscape, IUCN

Розвиток мережі морських охоронюваних районів в акваторії Аргентинських островів (Антарктична станція Академік Вернадський, Україна).
А.Ю. Утєвський, М.Ю. Колесникова, Д.В. Шмирьов, О.І. Сінна.
Реферат. За результатами підводних спостережень відповідно до протоколу NAGISA та акустичних досліджень дна в акваторії Аргентинських островів запропоновано утворення морських охоронюваних районів у протоках Stella Creek та Skua Creek. Розраховані за методикою IUCN індекси відповідності для МОР свідчать, що протоки Stella Creek та Skua Creek слід віднести до природоохоронних категорій Ia та III відповідно. Розроблено описи морських охоронюваних районів. Розроблено 3D моделі морських охоронюваних районів.

Развитие сети морских охраняемих районов в акватории Аргентинских островов (Антарктическая станция Академик Вернадський, Украина).
А.Ю. Утевский, М.Ю. Колесникова, Д.В. Шмырёв, Е.И. Сенная.
Реферат. На основании подводных наблюдений в соответствии с протоколом NAGISA и акустических исследований дна в акватории Аргентинских островов предложено создание морских охраняемых районов в проливах Stella Creek и Skua Creek. По результатам расчетов, по методологии IUCN, МОР Stella Creek и Skua Creek отнесены к природоохранным категориям Ia и III соответственно. Разработаны описания морских охраняемых районов. Разработаны 3D модели морских охраняемых районов.

Introduction

Previous CAMLR documents [1, 2] dealt with marine biodiversity surveys that are aimed at creating and developing the Marine Protected Area (MPA) network in the region of the Akademik Vernadsky Antarctic Station. In order to study the structure and biodiversity of benthic communities in the area of the Argentine Islands, the underwater research has been conducted. Recently over 140 SCUBA-dives have been done. These studies have led to the proposal for establishing two marine protected areas in the Stella Creek and Skua Creek. In 2014 twenty

research SCUBA-dives have been carried to survey the two already proposed MPAs (Fig. 1). (Fig. 1–11 see the color paste 5.) An acoustic survey in Stella Creek and Skua Creek for a 3D underwater landscape modeling of the MPAs was carried out for the first time.

Methods

More than 100 research SCUBA-dives to depths till 60 meters (2003-2004), and more than 40 research SCUBA-dives to depth till 50 meters (2011-2012) were done. We proposed to create two marine protected areas in the Argentine Islands water area. During the summer season of the 19th Ukrainian Antarctic Expedition in 2014, twenty research SCUBA-dives were done to survey two already proposed MPAs. Research dives were done to estimate species diversity, qualitative and quantitative composition of benthic communities and biomasses of certain species, to sample specimens of phyto- and zoobenthos and to take pictures and videos. The surveys were conducted in concordance with the NaGISA protocol (Natural Geography in Shore Areas) [3, 4, 5].

In 2014 traditional methods of studying benthic communities (SCUBA diving and underwater imaging) were supplemented with an acoustic survey using a Chartplotter LOWRANCE HDS7® (Echosounder+GPS). Acoustic data in the formats *sl2*, *usr* and *gpx* were treated by the software packages DrDepth® and Sonar Viewer and further converted into ArcGIS®. Detailed images of the seafloor and its 3D simulation were done for geographical sites that were previously determined as MPAs.

For a further development of Marine Protected Area Network it is necessary to establish a category in accordance with the IUCN procedure for each area. IUCN categorizes protected areas into seven types based on management objectives [6]:

Ia - Strict nature reserve; managed primarily for a scientific research or environmental monitoring;

Ib - Wilderness area; protected and managed to preserve its unmodified condition;

II - National park; protected and managed to preserve its natural condition;

III - Natural monument; protected and managed to preserve its natural or cultural features;

IV - Habitat/species management area; managed primarily, including (if necessary) through active intervention, to ensure the maintenance of habitats or to meet the requirements of specific species.

V- Protected Landscape/seascape; managed to safeguard the integrity of the traditional interactions between people and nature.

VI - Managed resource protected area; managed to ensure long-term protection and maintenance of biological diversity with a sustainable flow of natural products and services to meet community needs.

Compliance of a MPA is checked according to the procedure «A tool to help selecting the appropriate IUCN categories and governance types for protected area», which involves testing for compliance with the use of a special test table and index matching [7].

Results

Our proposal of establishing the Marine Protected Area Network was based on an idea that individual MPAs should be assigned to different IUCN categories. The Stella Creek MPA was previously classified as IUCN Ia (Strict nature reserve, managed primarily for a scientific research or environmental monitoring). The Skua Creek MPA was classified as IUCN III (Natural monument protected and managed to preserve its natural or cultural features) [8, 9].

For calculation of compliance indices (Table 1), four status priorities of objectives [7] were considered:

Primary objective, it is consistent with this category or management form – “1”;

Secondary objective, it is allowable in this category or management form – “2”;

Table 1

Testing MPA Stella Creek and Skua Creek for compliance to IUCN categories

Key issues	Questions	IUCN Categories						
		Ia	Ib	II	III	IV	V	VI
1. Natural-ness	Entire area in a more-or-less natural state	1	1	1	1/+	2	-	3
	Most of the area in a more-or-less natural state	2/+	-	1	1	2	3	1
	Less than 50% of the area in a more-or-less natural state	3	3	2	2	2	2	-
	Entire area resulting from a people-nature interaction over time	3	3	2	2	2	1	3
	Area requiring management to maintain biodiversity	-	-	2	2	1	2	2
2. Scale	Site large enough to conserve an ecosystem	**1**/+	1	1	2	2	2	2
	Site not large enough to conserve an ecosystem	2	2	-	2	2	2	2
	Site designated to conserve a specific feature	2	2	2	**1**/+	2	2	2
3. Connec-ted-ness	PA connected with other PAs or similar habitats	**2**/+	2	1	**2**/+	2	2	2
	PA unconnected with other PAs or similar habitats	2	2	3	2	2	2	2
4. Biodiver-sity	Many species requiring natural conditions	1	1	1	**2**/+	2	-	2
	Most species able to live in human-modified areas	**2**/+	2	2	2	3	3	2
	Key species need active management intervention (e.g., fire, grazing) to survive	-	-	2	2	1	2	2
	Some wild species routinely used in an extractive manner	-	-	3	2	2	1	1
5. Regene-ration	Ecosystem capable of regeneration	2	2	2	**2**/+	1	1	1
	Ecosystem difficult to regenerate to original quality	**1**/+	1	1	2	2	3	2
6. Environ-mental services	Area providing environmental services (water, soil…)	**2**/+	2	2	2	2	2	2
	Area not providing environmental services	2	2	2	**2**/+	2	2	2
7. Social values (li-velihoods, economic etc)	Area providing few socio-economic values	**1**/+	1	1	2	2	3	3
	Area providing non-extractive socio-economic values (e.g. tourism)	2	2	1	**1**/+	2	2	2
	Area providing extractive renewable resources	-	2	3	2	2	1	1
	Area providing extractive mineral resources	-	-	3	3	3	2	2
8. Traditio-nal occupancy	Area comprising traditional settlement/migration routes	**3**/+	3	3	3	2	1	1
	Area empty of traditional settlements/migration routes	1	1	1	**2**/+	2	2	2
9. User needs and wants	Users wish to practice resource extraction	3	3	2	2	2	1	1
	There are no users wishing to extract resources	**1**/+	1	2	**2**/+	2	3	-
10. Tourism	Many tourists are expected to use the site	-	-	1	2	2	1	2
	Few if any tourists are expected to use the site	**1**/+	1	2	**2**/+	2	2	2
11. Sacred and cultural values	Area with sacred or culturally valuable sites that are not regularly visited	1	1	2	2	2	2	2
	Area with sacred or culturally valuable sites that are regularly visited	3	3	2	1	2	2	2
	Areas without sacred or culturally valuable sites	**2**/+		2	**2**/+	2	2	2

Key issues	Questions	IUCN Categories						
		Ia	Ib	II	III	IV	V	VI
12. People-nature interaction	Historically present	**3**/+	3	2	1	2	1	2
	Historically absent	1	1	1	**2**/+	2	3	3
	Mostly negative with respect to desired biodiversity	1	1	1	1	2	-	3
	Mixed results with respect to desired biodiversity							
	Mostly positive with respect to desired biodiversity	2	2	2	2	2	2	2
	Very positive results with respect to desired biodiversity	3	3	3	3	1	1	1
Compliance indices		14<**21**<27			19<**21**<27			

Potentially applicable objective, it partly corresponds to this category or management form – "3"

Not applicable, it is not consistent with this category or management form – "-".

Stella Creek. The appropriate compliance index for category Ia is in the range of 14-27. The compliance index for category Ia is 21. This MPA can be assigned to this category (Table 1).

Skua Creek. The appropriate compliance index for category III is in the range of 19-27. The compliance index for category III is 21. This MPA can be assigned to the above category (Table 1).

Descriptions, management plans, core and buffer zones of the MPAs were developed based on previous standards [7, 8, 9].

Description of the Stella Creek MPA

Location and access. The Stella Creek MPA has been selected in the water area of the Argentine Islands (West Antarctica) and it is under protection of the Ukrainian Antarctic Akademik Vernadsky Station (Fig. 2). The navigation period lasts from November till March. All the rest of the time the access to the area is available for the staff of the Academik Vernadsky Station.

Physical features. The MPA surrounds the southern coast of the cape of Marina Point. The MPA includes two ranges. The first range is Marina Point (MP). The range is based on three transects (MP-1 - S65°14'43.9" W64°15'29.6"; MP-2 - S65°14'43.7" W64°15'28.8"; MP-3 - S65°14'44.4" W64°15'30.3") that extend from the littoral zone to the depth of 14.5 m.

The second range is Stella Creek (SC). The range is based on two transects (SC-1 - S65° 14'46.5" W64°15'27.3"; SC-2 - S65°14'46.72" W64°15'26.11") that extend from the littoral zone to the depth of 15 m.

The geological landscape in these locations does not contribute to the permanent and complete circulation of water mass. A depression of the sea-bed in front of the cape of Marina Point is separated by Galindez I., Indicator I., Channel Rock and submarine ridges that form a basin with depths up to 15 m. Another depression of the sea-bed is separated from the strait of Stella Creek by Galindez I., Indicator I. and Thumb Rock that form a shallow channel with depths up to 10 m. In the middle of Stella Creek, a steep descent of the sea-bed is formed by vertical walls that extend to depths up to 26 m towards Winter I. Thus, there are two separated zones in Stella Creek: a shallow one with depths up to 10 m and a deep one with depths up to 29 m. A trace of the acoustic survey is presented in Fig. 3. 3D models of the underwater landscape are presented in Fig. 4, 5.

Biological features. The Shallow Zone is the core of the MPA. It is a transformed ecosystem and it has been changed due to the prolonged use by the Akademik Vernadsky Station. The Deep Zone is a buffer area; it is not transformed and has maintained natural landscapes and benthic

Table 2

Features of the Stella Creek MPA (core area) biodiversity

Index	Biotopes													
	MP-1-5	MP-1-10	MP-1-15	MP-2-5	MP-2-10	MP-2-15	MP-3-5	MP-3-10	MP-3-15	SC-1- 5	SC-1-10	SC-1-15	SC-2-5	SC-2-10
Number of species	3	9	11	6	6	7	5	5	7	9	9	6	14	5
Total biomass for samples, gr	14,8	593	178,3	42,3	50,8	45,2	187,1	15,3	44,5	116,2	68,5	47,8	811,6	216,9
Average biomass for samples, gr	4,93	65,89	16,21	7,01	8,47	6,46	37,42	3,06	6,36	12,91	7,61	7,97	57,97	43,38
Shannon Index	0,336	0,317	0,667	0,545	0,439	0,622	0,24	0,36	0,628	0,691	0,619	0,462	0,708	0,539
Number of species for transects	15			11			11			12			16	
Total biomass for transects	786,1			138,3			246,9			232,5			1028,5	
Average biomass for transects	52,41			12,57			22,45			19,38			64,28	
Total Shannon Index	0,603			0,642			0,548			0,876			0,836	

communities of Antarctica. Features of the Stella Creek MPA biodiversity are shown in Table 2. Typical biotopes are presented in Fig. 6.

Description of the MPA Skua Creek

Location and access. The Skua Creek MPA has been selected in the water area of the Argentine Islands (West Antarctica) and it is under protection of the Ukrainian Antarctic Akademik Vernadsky Station (Fig. 7). The navigation period lasts from November till March. All the rest of the time the access to the area is not available due to complications by the ice circulation.

Physical features. The MPA is situated in the area separated by the Argentine Islands. The MPA occupies a part of Skua Creek between Winter I. and Skua I. The depth reaches 30 m at the deepest point. The uderwater rock fragment Key Stone (about 6 meters in length, 3 m in width and 3 meters in height) is located at a depth of 30 meters in the widest part of Skua Creek (S65°14'58.3" W64°10'00.3"). A characteristic feature of the object is vertical sides and the completely flat upper surface. The object in no way associated with the coastline of Winter I. and Skua I. that form the strait of Skua Creek. It appears that the object was "brought" by a glacier or an iceberg into the strait.

The geological landscape in these locations contributes to the permanent circulation of water mass. The water mass gets into the strait from the deep Penola Strait though the shallow strait Cornice Channel (depth is about 1.5 m) due to regular tides and the oceanic swell. In winter when the strait is entirely covered by ice the water circulation becomes complicated. A trace of the acoustic survey is presented in Fig. 8. 3D models of the underwater landscape are presented in Fig. 9, 10.

Biological features. The core of the MPA is Key Stone. The unique position and structure of the Key Stone and the hydrological regime of the strait promote to a constant flow of nutrients. These factors led to the formation of a unique age composition and biodiversity of filter feeders that cover the area with a dense layer. The age of some species (sponges) can reach 5-10 thousand years. In the shallow part of the strait (depth up to 5 m), which is bordered by Cornice Channel, we found high primary productivity of red algae – up to 6 kg/m^2. This primary biomass is actively digested by the gastropod *Nacella concina*. We did not use classic methods of registration of biomass and productivity of biotope with the removal of specimens because of the uniqueness of the object. Typical assemblages are presented in Fig. 11.

Conclusion

In order to achieve effective selection of MPAs in the water area of the Argentine Islands, five transects with 14 observation stations were planted. This was a criterion for the allocation of the Stella Creek MPA. Recovering the unique underwater object Key Stone was a criterion for the allocation of the Skua Creek MPA. Compliance indices allow assigning the Stella Creek and the Skua Creek MPAs to the IUCN categories Ia and III, respectively.

The ground to select certain aquatic components from the composition of marine protection areas should be information on their biodiversity. The biota is a fine identifier of dynamic changes of environmental conditions (temperature and chemical composition of the water, depth, illuminance conditions etc.) and historical factors. The zoning of areas of biodiversity protection should be based on three-dimensional models in connection with the water surface and the bottom contour. The MPA composition should be examined in a three-dimensional space where various components with special living conditions could be selected [10]:

- on the water surface (water surface biota),
- at various depths (water biota),
- with attaching to the bottom substrate (near-bottom biota),
- within bottom sediments (bottom biota),
- within ice masses (ice biota).

These studies should be carried out using scientific diving, underwater imaging, deep water television, acoustic survey and other method of a physical survey [11] with Geographic information system.

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