PA/02175/18

PROPOSAL TO CONSOLIDATE TEMPORARY TUNA FARMING AREA AT A PARCEL OF SEA APPROXIMATELY 5 KILOMETERS FROM THE SHORE (IN GENERAL AREA APPROVED FOR PA/03072/17 AND PA/05858/17) FOR A TOTAL BIOMASS OF 3,300 TONNES OF FISH

APPROPRIATE ASSESSMENT

Version 1: July 2018

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Proposal to consolidate temporary tuna farming area at a parcel of sea approximately 5 kilometers from the shore (in general area approved for PA/03072/17 and PA/05858/17) for a total biomass of 3,300 tonnes of fish
Appropriate Assessment
July 2018

Report for: **AJD Tuna Ltd**

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00	July 2018	Submission to Client	**Krista Farrugia** Senior Environmental Consultant	**Rachel Xuereb** Director	**Adrian Mallia** Managing Director

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Kappara Business Centre
113 Triq Birkirkara
San Gwann SGN 4197
MALTA

Tel. / Fax: 21378172 - 77

Email: info@adi-associates.com
Web: www.adi-associates.com

ASSOCIATES

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1. INTRODUCTION

1.1. This Appropriate Assessment (AA) has been prepared following a request by the Environment & Resources Authority (ERA) in connection with development permit application PA/02175/18 for a proposal to consolidate a temporary tuna farming area at a parcel of sea approximately 5 kilometers from the shore (in general area approved for PA/03072/17 and PA/05858/17) for a total biomass of 3,300 tonnes of fish. This development is hereinafter referred to as the 'Scheme'.

1.2. In addition to an Appropriate Assessment, ERA also requested an Environmental Impact Assessment (EIA) Report. This document makes reference to the EIA Report as appropriate.

1.3. This Appropriate Assessment is based on Terms of Reference (ToR) prepared by the ERA.

TERMS OF REFERENCE

1.4. The ToR required that the Appropriate Assessment should address the following:

The Appropriate Assessment report should follow the following format:

1. Executive Non-Technical Summary

A description of the salient points of the AA study including surveys, impacts and their significance, proposed mitigation measures, and any residual impacts.

2. Project Description

A description of the proposed project, with particular emphasis on those elements that are likely to give rise to potentially significant effects on the integrity of the protected site, or on its habitats, species and ecosystems. The description shall also address any foreseeable consequential requirements or implications of the proposal (e.g. need for new or altered access or infrastructure).

3. Site Description

A general description of the site environment within the area of influence, with particular emphasis on the salient features of the site and its species, habitats and ecosystems. Any other aspects of the physical environment and its processes that may in any way interact with the development or its impacts shall also be described.

The description shall also address any other constraints relevant to the site, including statutory legal protection, any relevant management plan framework.

4. Impact Assessment vis-a-vis the integrity of the site and its species, habitats and ecosystems

An evaluation of the way in which the integrity of the site and its species, habitats and ecosystems are likely to be affected by the project.

Impact assessment should clearly indicate all foreseeable direct and indirect impacts, and their expected timeframes (short/long-term, etc). Any impact interactions (e.g. accumulation, synergy, interaction with natural forces) shall also be identified and assessed. The significance of all AA-relevant impacts must also be discussed.

Impact assessment shall also take into account practical implications (e.g. conflicts with site protection or management plan implementation, any foreseeable constraints on future management plan formulation, etc).

5. Mitigation Measures

Where possible, measures should be identified to eliminate and/or mitigate adverse effects on the integrity of the site as well as on the relevant habitats and species.

In this regard, the AA should include:

- *A reasonably detailed identification of the measures to be introduced for all relevant phases of the project;*
- *An explanation of how the measures will eliminate and/or mitigate adverse effects;*
- *Evidence of how the mitigation measures will be tangibly implemented and by whom;*
- *Evidence of the degree of confidence in their likely success;*
- *A timescale, relative to the project, when they will be implemented;*
- *An explanation of any proposed monitoring scheme and how any mitigation failure will be addressed; and*
- *Proposals for decommissioning as may be appropriate.*

6. Residual Impacts

The report should include a prediction of residual impacts and implications of the proposal on the site and its species habitats and *ecosystems, following the implementation of the mitigation measures. The report shall also evaluate the significance of such residual impacts and implications.*

7. Alternative solutions

A list of alternatives to the proposal is to be submitted. Examples of alternatives may include, but not necessarily limited to, alternative technologies, alternative layouts, and relocation or downsizing of the project. The zero-option (do-nothing scenario) should also be considered. Each alternative is to be thoroughly assessed by comparing it with the original proposal and clearly indicating the relative effects on the site's listed habitats and species.

BACKGROUND TO THE SCHEME

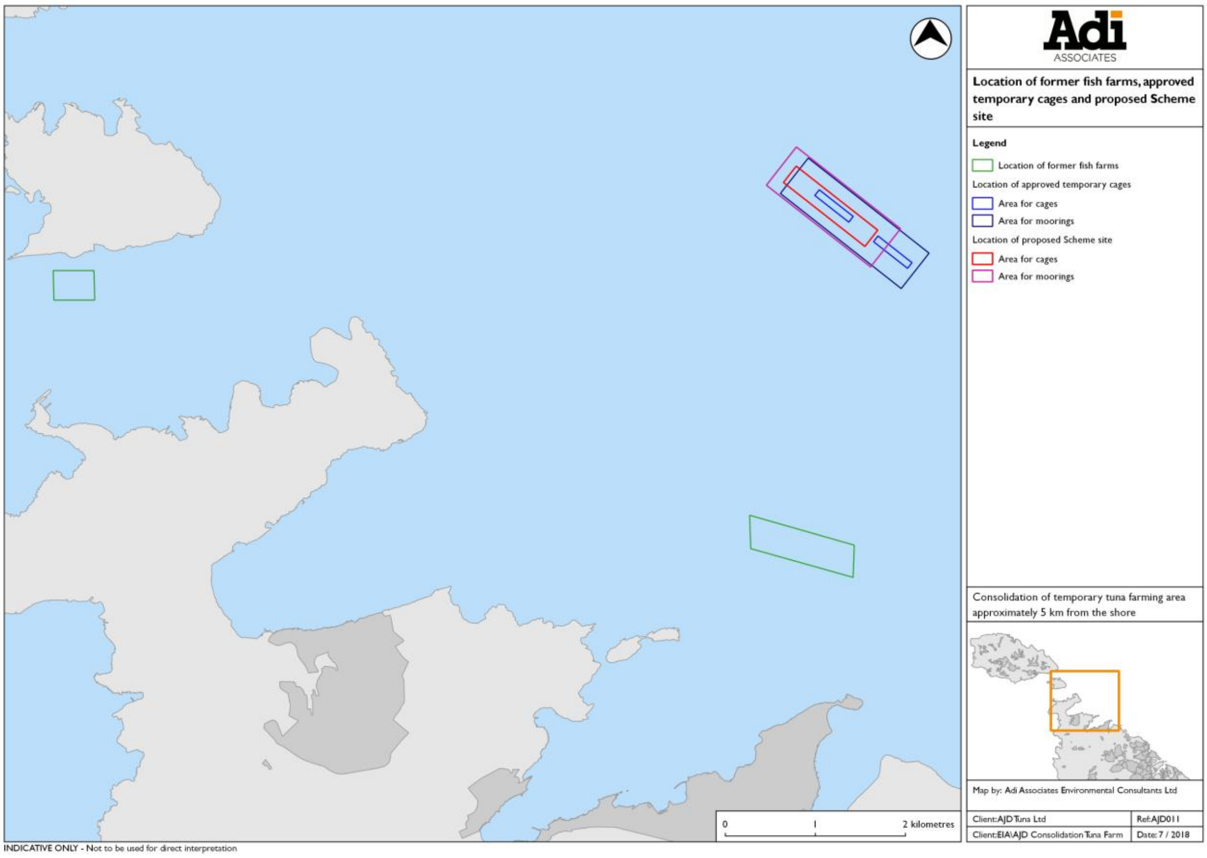
1.5. In 2017, AJD Tuna Ltd submitted a proposal to relocate its existing tuna penning farm from its former location approximately 1.5 km off Qawra Point, St Paul's Bay to a site further offshore. This was in response to a decision of the Planning Authority (PA) that all fish farms must relocate further offshore by May 2017 in order to mitigate the impacts that had been reported over the previous years, and in particular in summer 2016, on the marine environment, including social impacts related to amenity and nuisance from odour and water quality at affected areas of the coast. Previously, the farm had been operating since 1999 under permit PA 07377/98; however, in September 2016 the PA revoked this permit.

1.6. Furthermore, permit PA 01741/01, to substitute part of the breeding of sea bream with tuna in cages located in the South Comino channel was also revoked. Although a permit was in hand, the cages at this site only ever harboured tuna twice. This is because the site experienced strong currents and was not appropriate for tuna farming. The application to relocate farming operations further offshore incorporated the capacity of tuna permitted at this second farm as well.

1.7. The current set up, of 12 cages has only been in operation for one season (2017) after the Applicant was awarded two planning permits that allowed the deployment of two six-cage installations at the current location (one for each of two companies – AJD Tuna Ltd and Malta Mariculture Limited).

1.8. Following the completion of the baseline studies undertaken for the EIA and stakeholder consultation, the latest proposal aims to shift the farm location slightly to the northwest to avoid other uses in the area and important seabed habitats. **Figure 1.1** shows the location of the original farms, the site of the 2017 relocation and the original extension proposal, and the latest proposed Scheme site.

Figure 1.1: Farm locations



1.9. In 2017, the farm stocked approximately 2,220 tonnes of biomass, which over 12 cages meant a stocking density of approximately 225 tonnes at input, approximately double the optimal stocking density based on the ICCAT recommendation (refer also to **Chapter 2**). With the current permitted setup, the following summarises the experiences from the 2017 season:

- In view of existing contracts with fishermen that the farm operator was obliged to honour, the same amount of tuna as in previous years had to be purchased such that the stocking density in the permitted cages was double that of previous years. As a result, the tuna did not grow to full size due to excessive competition in a relatively small area;

- In addition, the delays in the permitting process meant that a substantial part of the purchased tuna had to be retained on tow for a considerable period of time before they could be caged[1]. During this period the tuna are not fed and hence rather than fattening they ended up losing weight; and

- It was necessary to cull earlier in the season[2] than would normally be carried out

[1] First caging took place in the first week of August 2017 (instead of mid-June).
[2] The first harvesting took place in the third week of September.

as a result of sub-optimal conditions within the cages (limited space and increased competition for food). This, together with the late caging, resulted in lower weight gain in the tuna in general.

1.10. Based on the above the Applicant is applying to double the number of cages to support the biomass that it is permitted to rear. In line with ICCAT concessions, this is a maximum of 3,300 tonnes of biomass in total.

APPROPRIATE ASSESSMENT OBJECTIVES

1.11. The aim of the Appropriate Assessment is to determine whether the Scheme will have an impact on the Specially Protected Area (SPA) Il-Baħar ta' Madwar Għawdex as well as on the Northeast of Malta marine Special Area of Conservation (SAC); and whether any potential impacts identified will be significant.

1.12. The ecology of breeding seabirds includes a reliance on the sea cliffs and therefore when considering potential impacts on avifauna, the context of the terrestrial SPAs upon which the breeding seabirds are also dependant will be considered insofar as it is within the scope of this impact assessment. Of note in the context of the Scheme and the marine conservation area within which it is located, is the SPA Ramla tat-Torri / Rdum tal-Madonna, located along the north east coast of Malta, on the L-Aħrax tal-Mellieha promontory, Kemmuna, Kemmunett, il- Ħaġriet ta' bejn il-Kmiemen u l-Iskoll ta' Taħt il-Mazz, and Selmunett.

AREA & SCOPE OF STUDY

Avifauna

1.13. The Area of Influence (A of I) of relevance in terms of avifauna is illustrated in **Figure 1.2.** The A of I lies within two marine Natura 2000 areas as identified above and therefore both these marine Natura 2000 sites fall within the scope of the assessment. In the case of the avifauna assessment, certain coastal SPAs will also be considered insofar as they support breeding seabird colonies. This is because any impacts identified on the marine SPAs with regard to seabirds could impact the conservation status of the breeding colonies for which these terrestrial sites have been designated. The terrestrial sites of particular importance and located in the A of I include Kemmuna, Kemmunett, il- Ħaġriet ta' bejn il-Kmiemen u l-Iskoll ta' Taħt il-Mazz, Ramla tat-Torri / Rdum tal-Madonna, Selmunett, L-Inħawi tal-Imġiebah tal-Miġnuna, and L-Inħawi tal-Għadira.

Marine Ecology

1.14. The Area of Study (AOS) for marine ecology is shown in **Figure 1.3**. The survey was conducted in two stages: an initial survey of the marine benthic habitats present in the northeastern part and covering the cage area was carried out by Ecoserv Ltd in May 2017 (Borg & Evans, 2017)[3] (Area 2 in **Figure 1.3**), and a second survey

3

undertaken by Seastar Surveys Ltd of the UK in May 2018 (Area 1 in **Figure 1.3**) as part of the EIA for the Scheme (see also **Technical Appendix 2B: *Remote Sensing Survey Report 2018*** and **Technical Appendix 4: *Marine Ecology Baseline Report*** in the EIA Report). As shown in **Figure 1.3**, most of the area currently occupied by AJD Tuna Ltd's 12 tuna cages, and where a further 12 cages are planned to be deployed, falls within the area surveyed in May 2017.

1.15. In the latest study marine benthic study for the EIA, in addition to consolidating the benthic assemblages map, data on the physico-chemical attributes of the water column and of the soft sediment seabed in the vicinity of area ABCD were collected. The soft sediment habitat in the vicinity of the area ABCD was also sampled to establish the associated species of flora and fauna.

METHODOLOGY

Baseline studies

1.16. A number of baseline studies on the marine environment were carried out as part of the EIA for the Scheme. The data from these are relevant to this Appropriate Assessment. These studies included: (i) sediment and water quality sampling and analysis, (ii) marine ecology surveys (including benthic diversity and benthic habitats mapping), and (iii) avifauna studies.

Sediment and water quality

1.17. Fieldwork in relation to the water quality survey was undertaken on 4th April 2018; this date was randomly chosen requiring, however, good sea conditions to ensure successful undertaking of fieldwork and data collection. Fieldwork was carried out using a 12 m vessel equipped with hoisting jib and winch. The locations of the six sampling stations, A – D and R1 and R2, are shown in **Figure 1.4**, and their geographical coordinates and water depth are given in **Table 1.1**.

Table 1.1: Sampling locations

Station	Latitude / Longitude	Depth (m)
A	36° 00.584' / 14° 25.780'	50 m
B	36° 00.131' / 14° 26.127'	48 m
C	36° 00.163' / 14° 25.508'	45 m
D	36° 00.567' / 14° 25.367'	48 m
R1	36° 00.848 / 14 24.474'	46 m
R2	35° 59.597 / 14 26.815'	48 m

18. The list of physico-chemical parameters that were included in the water quality survey are given in **Table 1.2,** see **Appendix 1** for methods of analysis. Measurements of temperature, salinity, turbidity and dissolved oxygen in water were made *in-situ* at each of the six stations using a YSI 650 MDS meter connected to a 6920 V2 multi-parameter probe. The meter was calibrated according to the manufacturer's instructions immediately before use. Measurements using the *in-situ*

meter were made at the surface (0.5 m below the surface). Two replicate measurements were taken at each of the six stations A – D, and R1 and R2. Two replicate samples of seawater were then collected from each of the same six stations; samples were collected at a depth of 0.5 m, from each of the six stations using a standard Van Dorn water sampler of 3 L volume. All water samples were transported in a cooler box and maintained at a temperature of 4°C.

19. Estimates of current velocity and direction at the two reference stations (R1 and R2; see **Figure 1.4**) were made using drogues according to the La Grange method. The drogues employed for this purpose had four rectangular perspex vanes, each of which has a surface area of 0.2 m^2. The drogues were suspended from an inflatable surface float by means of a length of twine which was 1 m long. The position of the release point (determined using the GPS) and time of the release were recorded. After allowing the drogues to float for a given period of time, the position of the collection point and the time of collection were recorded.

20. For sediment granulometric and chemical studies, samples were collected using a 0.1m^2 Van Veen grab that was deployed from a 12 m vessel equipped with hoisting jib and winch. Two replicate grab samples were collected from each of the six stations A – D, and R1 and R2.

Table 1.2: List of physico-chemical attributes which were considered in the water quality studies.

Parameter	Units
Temperature	°C
Salinity	psu
Dissolved Oxygen	%, mg/l
Turbidity	NTU
Turbidity (Secchi Depth)	m
pH	pH units
Chlorophyll a	µg/l
Total Nitrogen	µg/l
Total Phosphorus	µg/l
Total Carbon	µg/l
Total suspended matter	mg/l

Marine ecological surveying

Benthic diversity

1.21. To collect data for benthic diversity studies, a grab sample was taken from each of the four stations A – D using a 0.1 m^2 Van Veen grab that was deployed from a 12 m vessel equipped with hoisting jib and winch. After the grab was brought on board, surplus seawater was drained from the sample by placing it on a 1 mm-mesh sieve; the retained sediment and biota were temporarily preserved in 10% formaldehyde in seawater. In the laboratory, each sample was first washed to remove the fine sediment (<0.5 mm fraction) and the preservative, and it was then sorted to separate out all macrofauna (animals larger than 0.5 mm). The motile macrofauna was then identified as far as possible. Where identification to species level was not possible, the different species present were labelled using an alphabetical code (e.g. Mysidacea sp. A, etc).

Benthic habitats map

22. As explained, fieldwork in relation to the videographic survey to map the distribution of benthic habitats was undertaken in two stages: an initial survey using ROV undertaken by Ecoserv in May 2017 (Borg & Evans, 2017), and a second survey undertaken by Seastar Survey Ltd (UK) using a towed underwater camera system in May 2018, which survey focused on the area just south and west of the farm. The latter survey was based on the field data from the side scan sonar survey undertaken previously, which guided the video survey (see **Appendix 1** for details).

1.23. The positions of the video transects for the two surveys are shown in **Figure 1.5**. 22 transects were filmed in the May 2017 survey, whereas an additional ten transects were taken in the May 2018 survey.

1.24. Video footage and photographs of the benthic assemblages and species encountered along the transects were recorded on a PC hard drive and later analysed in the laboratory. Photographs taken during the survey were used to illustrate the present report.

1.25. Characterisation of the benthic assemblages was made using the scheme of Borg *et al.* (2013)[4], which is based on the EUNIS typology that has been adapted for local use.

Avifauna

1.26. The findings for the avifauna study are based on accumulated data obtained from long-term observations on the breeding biology and ecology of Malta's breeding seabirds (1982-2018) as well as published and unpublished reports from three EU LIFE funded projects:

- EU LIFE+ Progett Garnija (2006-2010);
- EU LIFE+ Malta Seabird Project (2012-2016); and
- EU LIFE funded Arcipelagu Garnija (2016-2020).

1.27. The technical report is reproduced in **Appendix 2**.

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[4] Borg J.A., Knittweis L. & Schembri P.J. (2013) *Compilation of an interpretation manual for marine habitats within the 25 NM Fisheries Management Zone around the Republic of Malta.* [MEPA tender reference: T2/2013]. MEPA, Malta.

Impact Assessment Criteria

1.28. The Terms of Reference for the AA require '*An evaluation of the way in which the integrity of the site and their species, habitats and ecosystems are likely to be affected by the project...'*. There is also a requirement to discuss the significance of relevant impacts.

1.29. In assessing the significance of the potential negative impacts arising from the Scheme on the marine habitats and species of conservation interest in the area, the following criteria have been used:

- **Not significant -** no material change in site integrity[5] and / or conservation status[6] of habitats and species of conservation interest; in particular Annex I habitats and Annex II species as listed in the Habitats Directive and species listed under the Birds Directive. No material change expected to other species of ecological value and conservation interest including those listed in the Red Data Book for the Maltese Islands in terms of range, population and habitat important for the ecology of the species;

- **Minor significance -** small-scale loss / disturbance including to species populations / extent of habitat that is unlikely to affect the integrity of the overall site/habitat and species populations of conservation interest; and

- **Major significance -** large-scale loss / disturbance / change in habitat that is likely to affect the ecological integrity and/or species populations' viability whereby the conservation status of the habitat and/or species is likely to be compromised within the Natura 2000 area of interest.

1.30. The concept of "material change" needs to be viewed in the context of the Scheme. For a change to be material, it must affect the long-term interactions of the species present at the site more than they would be affected by impacts from natural processes or by the continuation of the uses already extant in the area and to which the ecology may be accommodated.

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[5] Integrity is not defined in the Habitats Directive, although it is introduced under Article 6. Official guidance on nature conservation in the UK provides a definition in relation to European sites that can be applied more generally: *'The integrity of a site is the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and / or the levels of populations of the species for which it was classified.'* (Box, J. 2006. A guide to Ecological Impact Assessment. Town and Country Planning).

[6] Conservation status for a natural habitat is defined under Article 1 (e) as follows: '*...the sum of the influences acting on a natural habitat and its typical species that may affect its long-term natural distribution, structures and functions as well as the long-term survival of its typical species within the territory...'* Conservation of a species means: '*...the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations within the territory...'*.

Figure 1.2: Avifauna Area of Influence

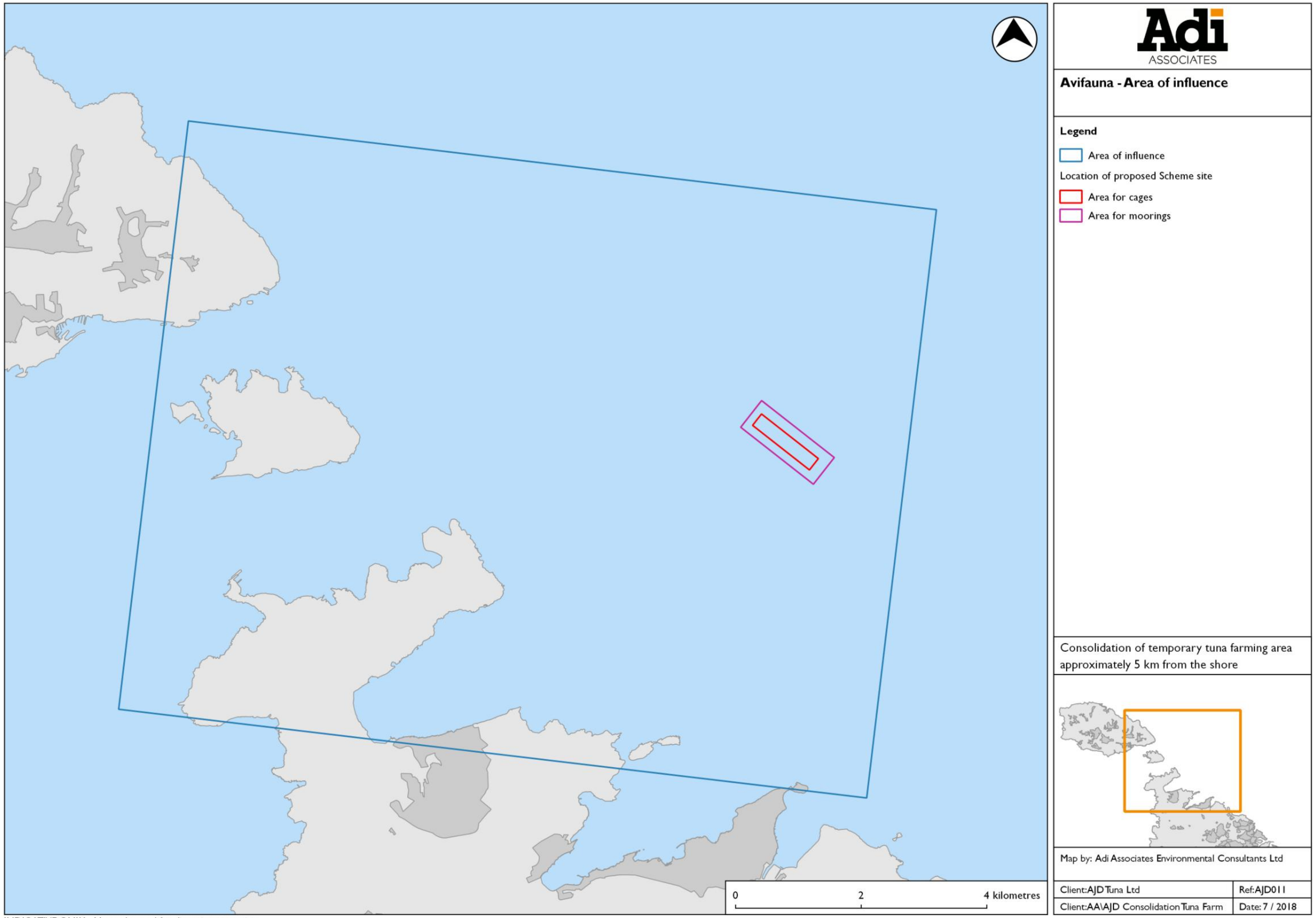

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Figure 1.3: Marine Ecology Area of Study

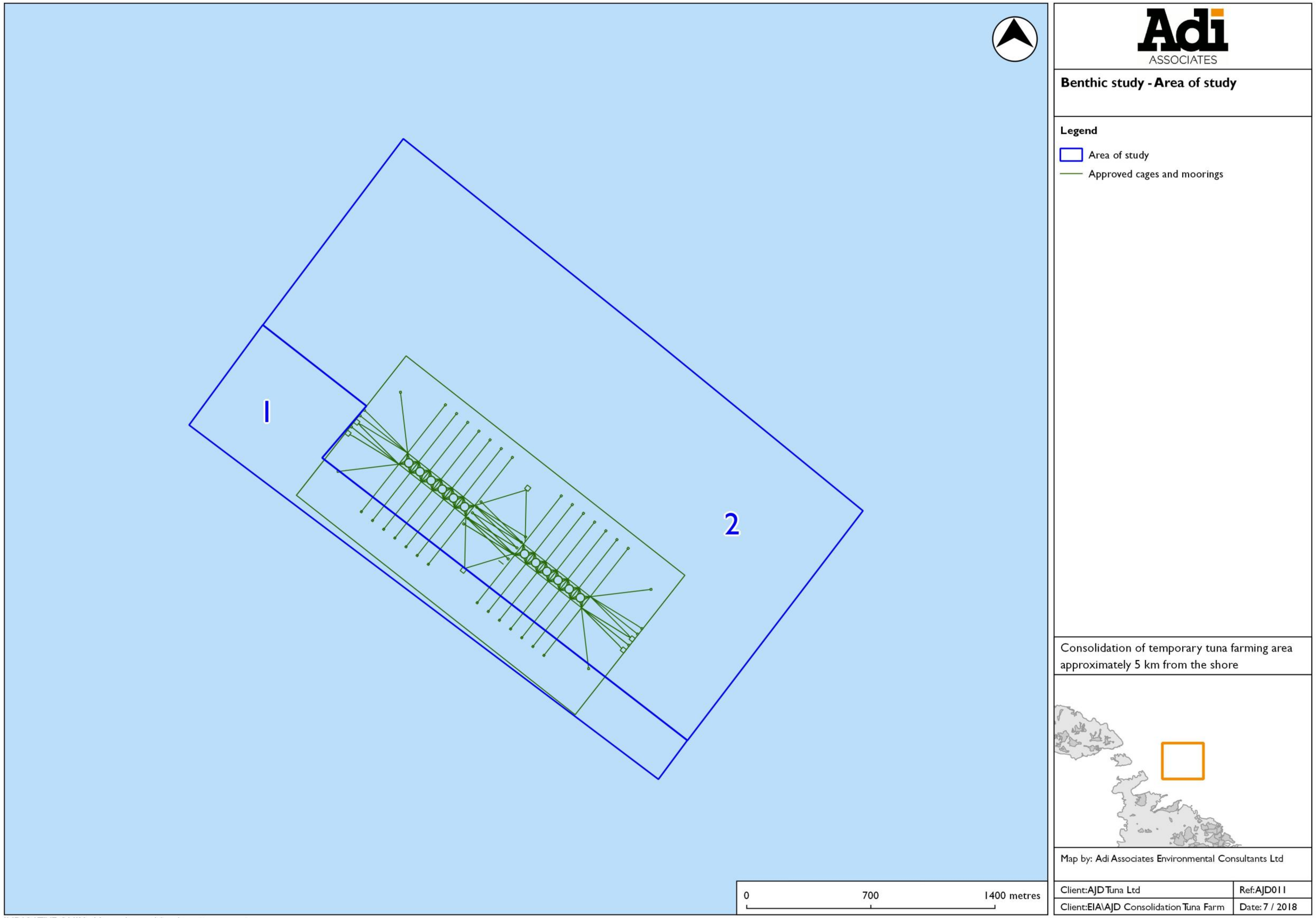

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Figure 1.4: Sampling stations for sediment and water quality analysis

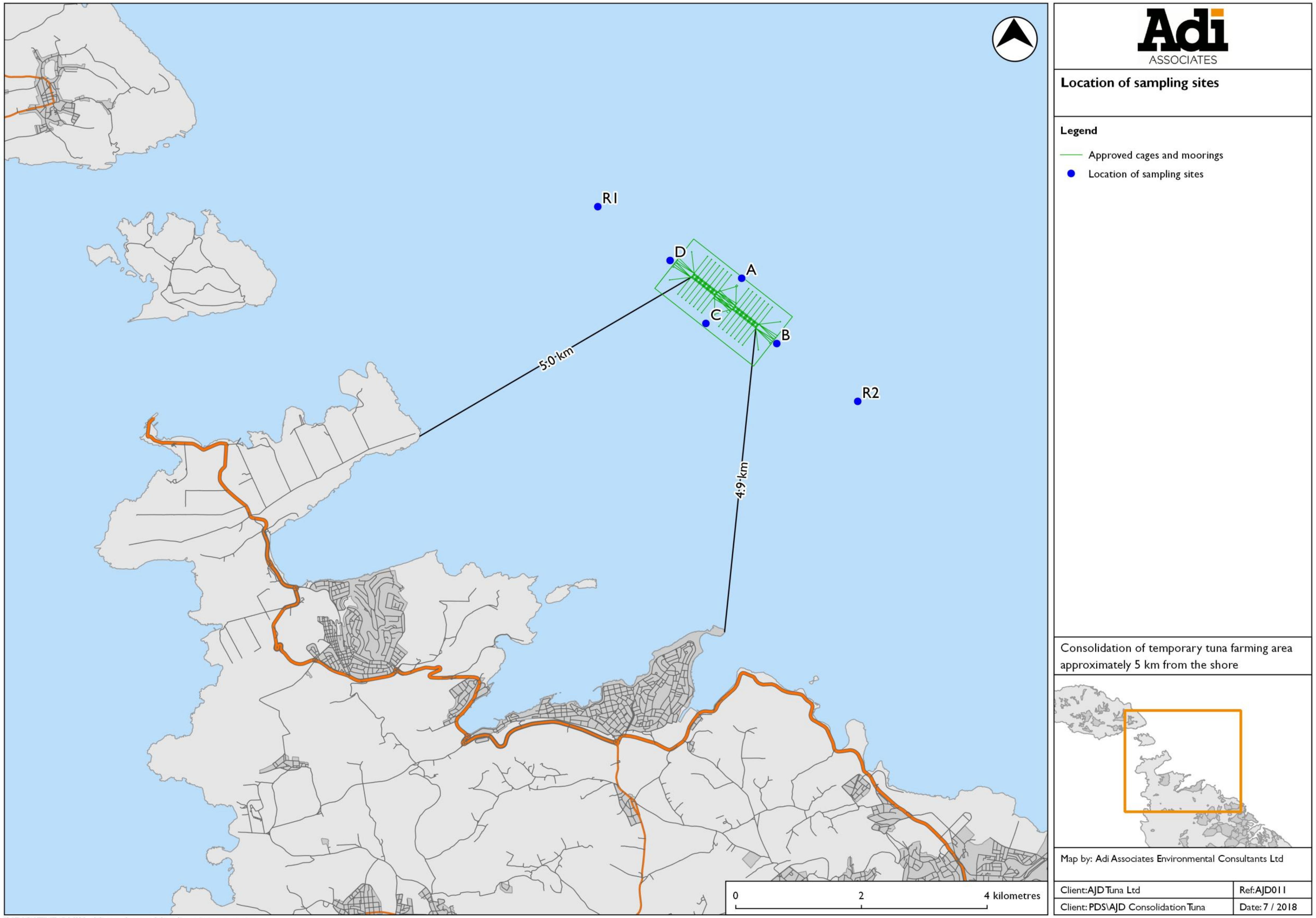

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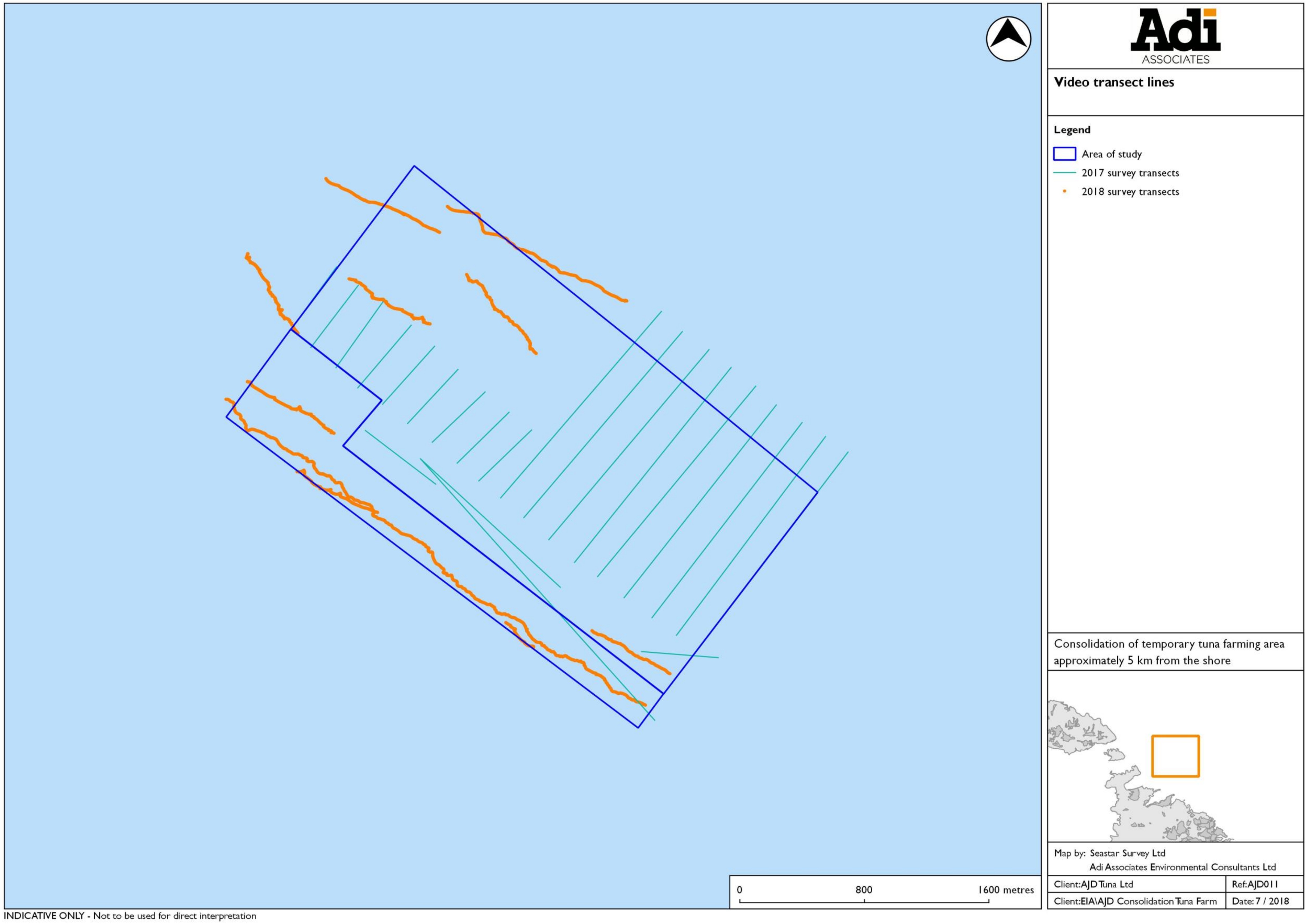
Figure 1.5: Location of video transects surveyed (May 2017 & May 2018)



2. SCHEME DESCRIPTION

PURPOSE OF THE SCHEME

2.1. The purpose of the Scheme is to improve the existing fish farm operation in an attempt to address some of the challenges that were encountered during the 2017 season (refer to **Chapter 1**) that were largely as a result of not having sufficient cage space to optimally support the Applicant's tuna quota.

BACKGROUND TO THE SCHEME

Operations – the Tuna Penning Process

Tuna capture and transfer to farm

2.2. Tuna are caught by purse seining on the high seas. This activity is allowed under ICCAT[7] rules for a restricted time during the year as the fish are migrating through the Mediterranean Sea. There are no Maltese purse seiners and therefore the fish are caught by foreign vessels from whom the Applicant purchases stock.

2.3. The tuna caught in the purse seines normally range in size from 50 to 300 kgs, with the vast majority of the fish being between 100 and 200 kgs.

2.4. Once the tuna are caught in the purse seines and the required amounts are purchased, they are led through openings in the purse seine into the farm's fattening cages. Once the cages are filled with the required stock, they are slowly towed to the on-growing site[8] where they are anchored in position to the mooring system that would have already been deployed.

2.5. The entire operation is overseen by ICCAT international observers.

Penning

2.6. Once on the farm, the tuna are fed and fattened, largely a process of conditioning, through which the fat-to-protein ratio is adjusted through a high fat diet. The fish are kept in the pens for between 3 and 7 months, after which they are harvested and sold to the Japanese market.

2.7. The transhipment of tuna to fattening pens is considered to be a landing operation and the catches involved must comply with regulations in force[9] as well as ICCAT requirements.

[7] ICCAT is the International Convention for the Conservation of Atlantic Tunas.
[8] Towing speeds rarely exceed 1 knot, with the transfer taking a number of weeks (depending on the distance between the catch area and the farm).
[9] Council Regulation (EU) 2016/72 of 22 January 2016 fixing for 2016 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters, and amending Regulation (EU) 2015/104

Feeding and feed management techniques

2.8. The tuna are fed small pelagic fish, usually, herring, mackerel, anchovy, sardines, etc. It is estimated that it takes 10-25 kgs of baitfish to produce 1 kg of tuna (EC, 2004)[10].

2.9. The feed is ordered from a number of suppliers and five reefer containers with feed arrive on a daily basis in Malta. These are stored at the Freeport. Every day a number of containers (usually between 1 and 4, depending on the stock) are transferred to the Kordin land base facility operated by AJD Tuna Ltd (**Figure 2.1**). The fish are transferred from their transportation packing and placed in apposite jumbo bags (**Figure 2.2**). The bags are then placed in crates and stored on flat bed trailers, where they are allowed to partially thaw overnight (**Figure 2.3**). Following discussions with ERA, as part of the environment permit application for the farm, the jumbo bags used for the transportation of the baitfish were changed to impermeable ones so that the thaw water, which includes fish oils, water, and mucus, is contained and not lost into the environment.

2.10. Early next day (around 4:00 am), the fish are transferred to the Grand Harbour where they are loaded onto feeder vessels (**Figure 2.4**). Once loaded, the vessel sets sail towards the farm.

2.11. The tuna are fed once a day, at dawn. Semi-frozen baitfish are normally placed in small feeding cages floated at the centre of the pen (**Figure 2.5**), and once they have been thawed enough, the central cage is opened by divers and the fish dispensed into the pen. The divers monitor the tuna and control the amount of feed released into the pen to minimise wastage. Once the tuna are satiated, the diver stops feeding. The process may be repeated two hours later; however, if the tuna are satiated, any remaining fish can be lifted from the pen and transferred to other cages.

2.12. In order to optimise efficiency it is necessary to ensure that when fed to the tuna the baitfish are not completely defrosted so that the high calorific oils are ingested too and not lost from the feed. Nonetheless, the process does involve the development of an oily slick originating from the semi-frozen feed. In order to address this issue, a number of measures have been taken throughout the past season. These include:

- The baitfish is retained in the impermeable jumbo bags while transported from the land base in Kordin to the farm to contain the thaw water;
- An oil boom is permanently deployed inside each cage to contain any fish oils that may be released for the feed;
- When the baitfish are transferred to the fattening cages, they are transferred inside the impermeable jumbo bags referred to above and their contents emptied inside the cage. This would release both the fish and the thaw water inside the

[10] European Communities, 2004. Tuna: a global fishing activity. Fishing in Europe No. 23. Directorate-General for Fisheries, European Commission, September 2004;

cages; however, the presence of the oil boom along the entire internal diameter of the cage contains all such surface materials within the cage; and

- The oily slick so released and contained in the cages is then collected from the surface of the sea inside the cages by means of a skimmer (see **Figure 2.6**) operated by divers inside the cages. The oil so collected is stored in IBCs and transferred to land for onward transmission to a waste oil recycling company.

Harvesting and processing

2.13. Harvesting of fresh tuna is largely on demand, although the vast proportion of the tuna is today being harvested for the frozen fish market.

2.14. When harvesting occurs, the bottom of the net is raised to a degree, forcing the fish closer to the surface. Slaughtering is particularly delicate since the amount of stress the fish are subjected to must be kept low because if the fish are stressed their body temperature rises sharply, which would compromise the quality of the meat[11]. Slaughtering is carried out by divers who enter the cage and harvest the tuna one by one by shooting them in the head.

2.15. The tuna are transferred to a service vessel by crane (**Figure 2.7**) from where they are then quickly transported by service boats (**Figure 2.8**) to a waiting processing vessel anchored further out at sea (**Figure 2.9**). Onboard the ship, the tuna are weighed, heads and tails are cut off and the guts removed. Currently, the head, tails and guts are a waste by-product and they are currently being disposed of at sea beyond the 12 nautical mile limit as directed by the Veterinary and Phytosanitary Regulation Department.. The option of incinerating the material was discounted as the abattoir incinerator is too small to handle the volume of waste generated by the tuna farms. The operation typically generates approximately 8-10 tonnes of offal per day during the peak fattening period. The Applicant is pursuing the possibility of selling the by-product to foreign companies for the generation of fish meal to be used for feeding pets, however, to date, this has encountered difficulties in relation to maritime and EU legislation. Further discussions on this matter will be pursued with the relevant authorities in an attempt to identify an alternative option to offshore dumping. This is also a requirement of the environment permit issued by ERA for the current tuna penning operations.

2.16. If the harvested fish are to be sold to the fresh fish market, they are normally processed onboard the service boats (not the freezer ships) and at the land base facility in Marfa (**Figure 2.10**). In this case, processing has to take place in a short time interval in order to minimise the length of time that the fish remain at ambient

[11] Tuna maintain body temperatures between 15 and 20 degrees centigrade above surrounding water. However stress will lead to an alarm reaction and secretion of hormones in preparation for emergency action. As part of the process, the body temperature can rise up to 40 degrees centigrade above the surrounding water, compromising the redness of the flesh once the fish has been slaughtered (See http://www.niri.co.jp/agroup/maguro3.pdf).

temperatures. The fish are processed in the same manner as described above, except that rather than blast frozen, the fish are cooled in an ice and salt mixture to the desired temperature and packed in purposely designed carton boxes for export.

2.17. The fresh fish produce is air freighted to its final destination, whereas the fish intended for the frozen fish market are transferred to a reefer vessel or exported on the same factory vessel on which they were processed.

Post-harvest

2.18. Following harvesting, between November and May, the Applicant is allowed to keep up to 15% of the stock in the cages for research purposes[12]. The fish so retained are fed between two and three times a week during this period.

Stocking Density

2.19. The stocking density of the fish in the cages is a crucial factor in aquaculture that has an important bearing on mortality and the quality of the fish produced. The current maximum stocking density recommended for a 50 m diameter cage is 200 tonnes of biomass at harvest. At input, therefore, the maximum stocking density should be 110 tonnes since the tuna experience a 40-45% growth rate during the fattening season (as explained by the Applicant). However, ICCAT requires that Bluefin Tuna are partitioned in cages on the basis of Joint Fishing Operation (JFO) in line with Para. 5 of ICCAT Rec. 11-20. JFO is a group of vessels of the same or of a different flag that share quota and fishing effort. JFO groups are duly authorised by ICCAT. The Department of Fisheries and Aquaculture follows ICCAT's recommendation such that mixing of fish in the same cage that originate from separate JFOs is not authorised[13]. This often affects the stocking density of a single cage as well as the number of cages deployed on a farm[14].

Antifouling and net cleaning

2.20. No anti-fouling or other chemicals are used on tuna nets, since unlike the nets of traditional finfish aquaculture units, which remain in the water for an extended time period, the tuna nets are removed at the end of the season for drying.

Feed supplements, chemicals and antibiotics

2.21. As explained earlier tuna are only fed baitfish. No feed supplements or other chemicals or vitamins are used to date. Equally, since the tuna are effectively wild and

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[12] Research in tuna spawning and farming of fry has been undertaken by the Applicant over the past years in conjunction with the Department of Fisheries and Aquaculture, MCAST and the University of Malta (Azzopardi, C., pers. comm., Oct 2016).

[13] Gatt Mark, Department of Fisheries and Aquaculture, personal communication; 28 October 2016.

[14] Note that the approach taken by the former MEPA in the development permit for the setting up of the South-East Aquaculture Zone was to approve a maximum tonnage of production but not to specify the number of cages that could be deployed in order to allow for such flexibility. Single operations at the Aquaculture Zone are then regulated through an aquaculture permit issued by the Department of Fisheries and Aquaculture. This is the approach being proposed for the Scheme.

only kept on site for fattening, i.e. they are not actually farmed[15], no chemicals or antibiotics are used[16]. Mortalities are more effectively controlled by lowering stocking densities and monitoring the fish for any signs of stress.

Storage of feed and packing materials

2.22. The Applicant operates two land bases (see **Figure 2.11**). One land base is situated in Marfa and is used for packing and processing of fresh fish for export by air freight. The second land base is located at the Kordin industrial estate and is used to receive and prepare the bait fish as well as for the washing and storage of crates. A third site in Magħtab is used to store cage materials and nets and ancillary materials.

[15] The process is more appropriately called tuna ranching than tuna farming.

[16] Had these to be used, they would be similar to those already in use in the other finfish aquaculture operations.

Figure 2.1: Kordin land-based facility

Figure 2.2: Frozen feed transferred to jumbo bags

Figure 2.3: Flat-bed trailer with feed in jumbo bags left to partially defrost

Figure 2.4: Feed being loaded on to feeder vessel

Figure 2.5: Loading of semi-frozen baitfish into feeding cage

Figure 2.6: Skimmer

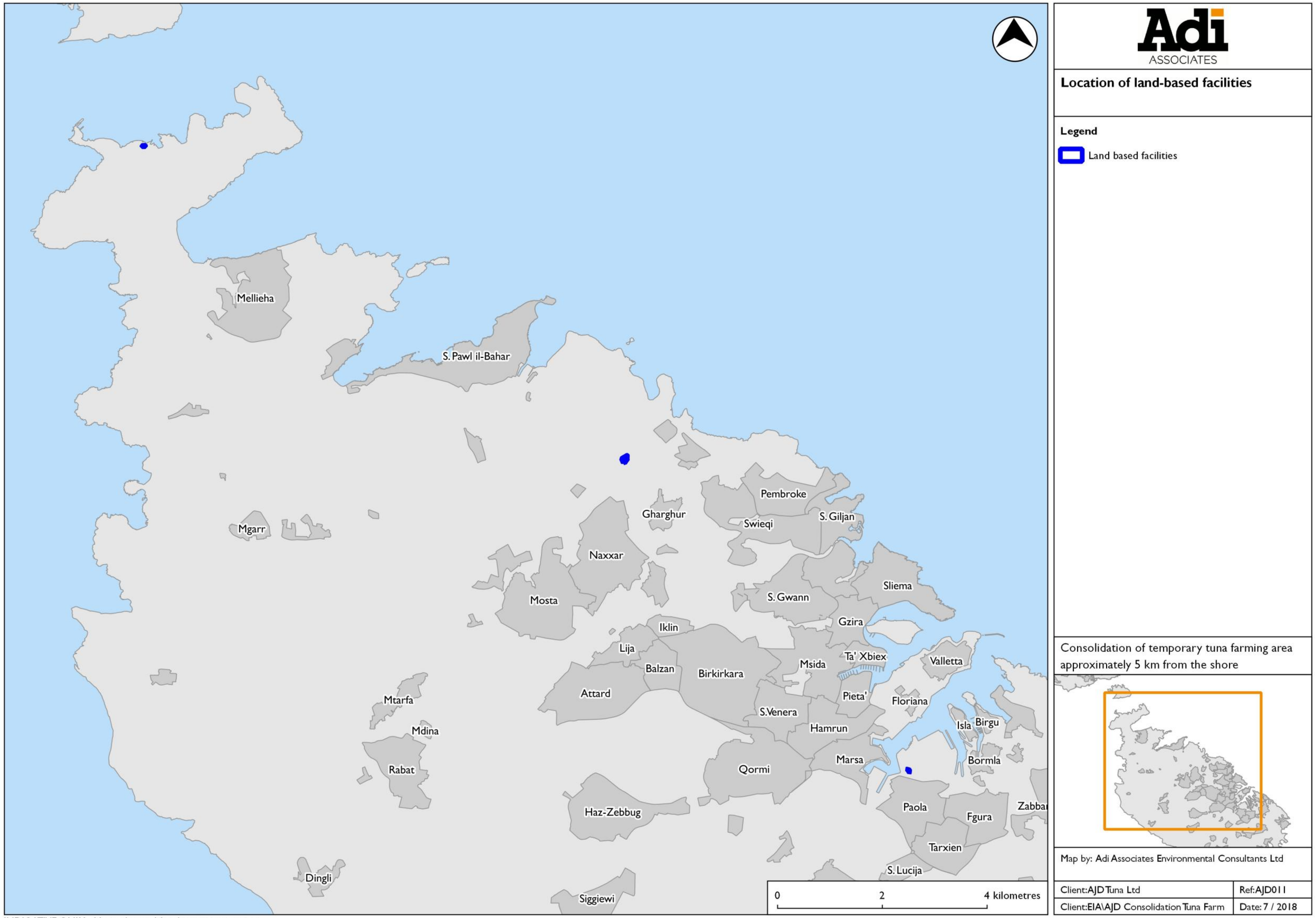
Figure 2.7: Tuna harvesting

Figure 2.8: Service boat transferring tuna to processing vessel

Figure 2.9: Processing ship

Figure 2.10: Marfa land-based facility

Figure 2.11: Map indicating location of land-based facilities in Marfa, Magħtab, and Kordin



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THE SCHEME

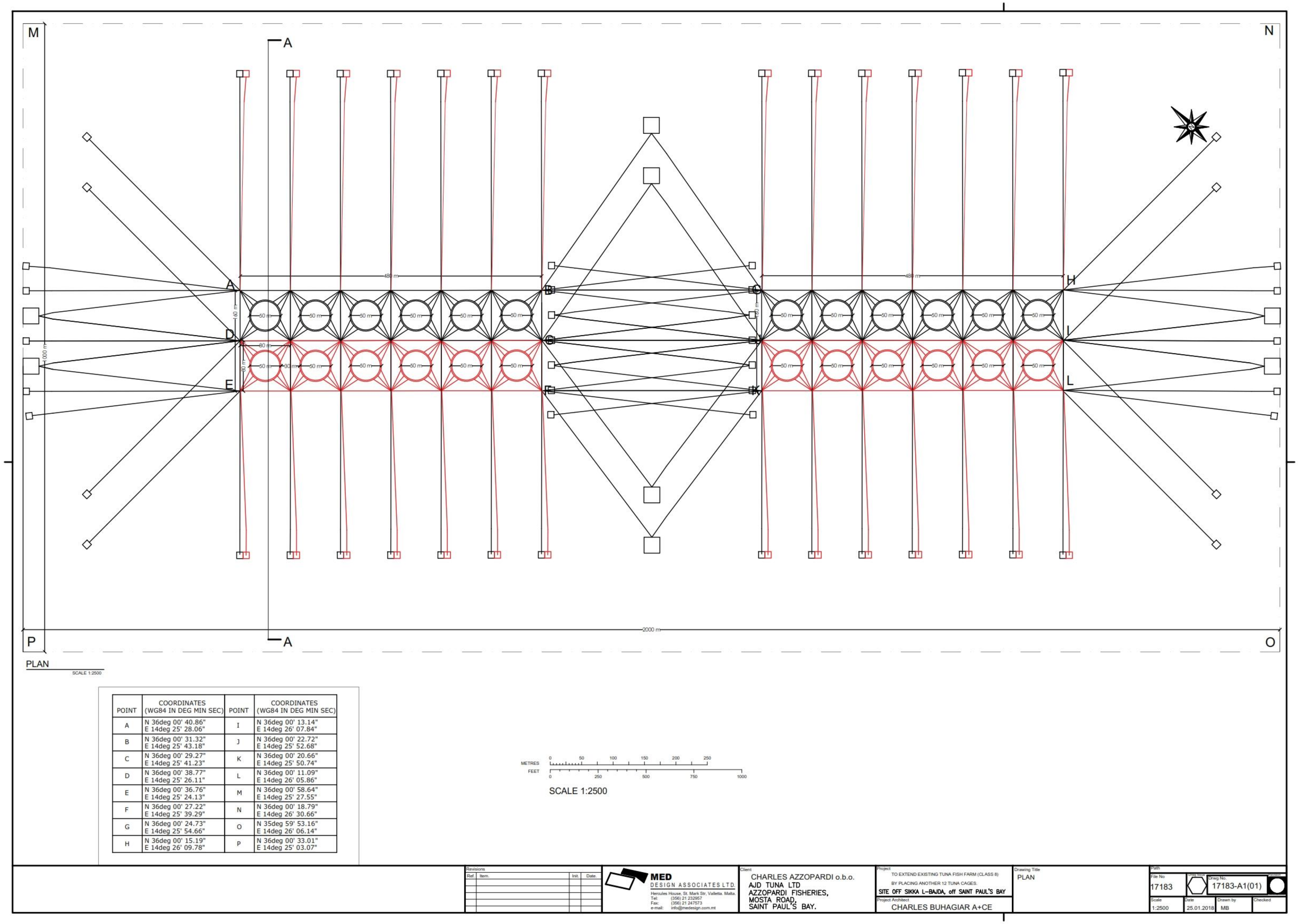
2.23. **Figure 2.12** illustrates the proposed cage layout.

2.24. The Scheme will essentially operate in the same way as it currently does. The following lists the types of vessels used in operations, all of which are registered with ICCAT, as per requirements:

- One feeding vessel used to transport the feed to the cages;
- One service boat;
- Two other feeding vessels are leased as required; and
- Vessel for transportation of offal waste offshore (see below).

2.25. The Applicant's main client sends over the processing ship where the fish are transferred and processed following harvesting.

Figure 2.12: Proposed cage layout



POINT	COORDINATES (WG84 IN DEG MIN SEC)	POINT	COORDINATES (WG84 IN DEG MIN SEC)
A	N 36deg 00' 40.86" E 14deg 25' 28.06"	I	N 36deg 00' 13.14" E 14deg 26' 07.84"
B	N 36deg 00' 31.32" E 14deg 25' 43.18"	J	N 36deg 00' 22.72" E 14deg 25' 52.68"
C	N 36deg 00' 29.27" E 14deg 25' 41.23"	K	N 36deg 00' 20.66" E 14deg 25' 50.74"
D	N 36deg 00' 38.77" E 14deg 25' 26.11"	L	N 36deg 00' 11.09" E 14deg 26' 05.86"
E	N 36deg 00' 36.76" E 14deg 25' 24.13"	M	N 36deg 00' 58.64" E 14deg 25' 27.55"
F	N 36deg 00' 27.22" E 14deg 25' 39.29"	N	N 36deg 00' 18.79" E 14deg 26' 30.66"
G	N 36deg 00' 24.73" E 14deg 25' 54.66"	O	N 35deg 59' 53.16" E 14deg 26' 06.14"
H	N 36deg 00' 15.19" E 14deg 26' 09.78"	P	N 36deg 00' 33.01" E 14deg 25' 03.07"

Waste management

2.26. Wastes generated by the Scheme are likely to include:

- Packaging waste from importation of baitfish;
- Thaw water from baitfish preparation;
- Oily slick (from baitfish);
- Uneaten feed;
- Fish excreta;
- Dead tuna;
- Blood (during slaughtering);
- Wastewater from onboard processing of fish (mixture of blood, water, and offal);
- Offal (gutted heads, tails, and internal organs);
- Algal and other net fouling marine growth; and
- Marine litter.

Packaging waste and thaw water

2.27. This waste stream is generated as a result of the importation of baitfish. The Applicant has a contract with a third party who takes the packaging waste away for reuse. Thaw water is collected in culverts at the land base (**Figure 2.1**) and directed to the sewer (the need for a sewer discharge permit is being explored by the Applicant). In addition, once on the flat bed trailer, the thaw water is collected in a specially installed container retrofitted on the flat bed trailer (see **Figure 2.3**). The use of impermeable jumbo bags for the transportation of the baitfish from the landbase to the farm ensures that this oily material is not lost to the environment until the baitfish is placed inside the cages, from where it is collected – see below.

Oily slick

2.28. The oily slick generated at the fish farm is essentially a combination of fish oils, melting ice, body fluids, and fish mucus released from the baitfish as it thaws in the feeding cage. Although this oily slick can extend over a considerable area as it is carried on the surface of the water by surface currents, it is restricted to the immediate surface of the sea and does not dissolve into the rest of the water column, until it is dispersed or evaporates. In summer 2016, there were numerous complaints from other marine users (especially bathers, divers and boaters) who made specific reference to the amount and consistency of the oily slick. According to the Applicant, the main reason for this was the purchase of baitfish from a different supplier (in Morocco), which turned out to be of inferior quality. The baitfish supplier has since been changed and the fish are being imported from the Netherlands.

2.29. In addition, the Applicant has also undertaken the measures described earlier to contain and collect as much of this oily material as possible. As explained, the measures taken include the transportation of the baitfish in impermeable jumbo bags, the permanent deployment of an oil boom inside each cage, and the collection of the oily slick by means of oil skimmers. The skimmer is operated by a diver who collects the floating oil, which is then transferred to an IBC on board the vessel. Once full the IBC is transferred to land where the collected materials are allowed to separate and the water phase decanted. The oily phase is collected by a licensed waste oil recycling company.

Uneaten feed

2.30. In addition to adding to the costs of the fish farming operation, uneaten feed (especially the baitfish used in tuna penning operations) passes through the net and settles on the seabed, which, depending on the amounts lost in unit time, can result in overloading of the scavenging community and an accumulation of organic carbon and nitrogen in the sediment beneath the cages or in the direction of the prevailing currents.

2.31. Uneaten baitfish that deposits on the bottom of the sea will start to decompose, releasing gases such as hydrogen sulphide[17] and ammonia. These gases are insoluble in seawater and therefore rise through the water column until they reach the surface where they produce unpleasant odours, which, depending on the prevailing wind currents at the time, could be blown towards the coast.

2.32. The capacity of the environment to assimilate the pollutants settling on the seabed depends largely on the amount of settlement of material and the capability of seabed bacteria and scavengers to utilise this material.

2.33. Over the past few years the Applicant has carried out monitoring of the seabed, sediment and water quality as per permit conditions. In the early years of farm operation (between 2001 and 2004) towards the end of each penning season, significant amounts of dead fish were recorded littering the seabed in the area lying directly below the pens. As summarised by Borg (2014)[18], this resulted in changes to the physical and biological characteristics of the seabed. By the end of the penning season little of the uneaten dead fish remained although thick layers of fish bones and decomposing organic material were recorded by Borg (2014). Borg (2014) observed that once the source

[17] Hydrogen sulphide is also very poisonous to farmed fish.

[18] Borg, J.A. 2014. Azzopardi Fisheries Tuna Penning Project: Report on a video survey of the seabed in the vicinity of the tuna-pens made in April-July 2014. Ecoserv.

of the impact was removed, i.e. following harvesting, the benthic environment eventually largely returned to its original state, as attested to by the shift in species that dominate the benthic environment, i.e. during feeding the area is dominated by scavenger and detritus feeders, once the uneaten fish is gone, the site returns to its previous ecology and species typical of a bare sand habitat are again noted.

2.34. In 2005, the monitoring surveys recorded a significantly lower amount of uneaten fish under the cages indicating an improvement in feed management. This trend continued up to 2007 although the benthic ecology was noted to have altered and species typical of bare habitat were absent from the area.

2.35. In 2008, large amounts of uneaten feed were again noted and high populations of detritus feeders and scavengers were recorded. Borg (2014) emphasised that when the amount of uneaten feed overwhelms the scavenger feeders, the feed decomposes slowly resulting in a significant adverse effect on the benthic habitat. Eventually, anoxic conditions persist such that the environment is no longer favourable for scavengers. This means that it is left to the physical environment, waves and currents, to disperse the decomposing material.

2.36. The situation with feed management improved again in 2009 although the changes to the seabed ecology remained.

2.37. The previous improved situation with feed management appeared to have reversed again in 2010. The surveyors noted significant differences between the amounts of uneaten feed beneath different cages. Similar observations were recorded in 2012. AJD Tuna Ltd assigns specific divers to specific cages and therefore they can pinpoint who may need additional training with regards to feeding management.

2.38. Also in the 2012 survey large whole dead tunas and decomposing parts were recorded on the seabed. The Applicant explained that the source of this tuna was not the tuna farm. Amateur fishermen that angle around or in the vicinity of the fish farms often capture then release (accidentally or deliberately) tuna that may be attracted to the area. Though largely anecdotal, some evidence of this exists in whole tuna carcasses washed ashore that had fishing hooks embedded in their mouths. Such activities are also reported in Arechavala-Lopez *et al.*, 2015[19].

2.39. In 2014, uneaten fish was only recorded underneath one of the nine pens. The reason for this was attributed to the fact that the survey was carried out during the fallow period. Dead specimens of other organisms such as sea

[19] Arechavala-Lopez P., Borg J. A., Sĕgvić-Bubić T., Paolo Tomassetti P., Özgül A.. & Sanchez-Jerez P., 2015. Aggregations of wild Atlantic Bluefin Tuna (Thunnus thynnus L.) at Mediterranean offshore fish farm sites: Environmental and management considerations. Fisheries Research 164: 178-1

urchins and bivalves, that form part of the fouling community on the nets, were also recorded in places under the cages. During the survey, the scientific divers removed the first few centimetres of the surface sediment, which uncovered black anoxic layers. Particulate organic matter was released from the sediment into the water column when the sediment was disturbed.

2.40. The 2014 survey also recorded the alien alga *Caulerpa cylindracea* in places under most of the cages. A pink filamentous alga, possibly *Lophocladia* sp. was also present. Both species were located in patches of coarse sediment. The survey again confirmed the alteration of the benthic ecology in the area.

2.41. With respect to sediment analysis, except for the initial year, the results indicate that the parameters tested for, i.e. sediment grain size, organic carbon content, organic nitrogen content and recently organic phosphorus content, as well as heavy metals and organic compounds were not altered as a result of the tuna penning activities (Borg *et al*, 2013)[20].

2.42. With regards to water quality, Borg & Evans (2016)[21] concluded that overall, the Applicant's penning activities did not appear to have affected the water quality in the vicinity of the farms in terms of the parameters tested for; however, a fishy odour was recorded and a film of fish oil and residues at the water surface were recorded at two of the five monitoring stations.

Fish excreta

2.43. Like uneaten feed, fish excreta contain or release ammonia, nitrates, and phosphate in soluble form. These nutrients can enhance the growth of marine plants and algae (including phytoplankton). Some of these nutrients are taken up by algae and net-fouling assemblages and also by benthic dwellers and scavengers. Faeces are nitrogen depleted and phosphorus enriched compared with feed (Fernandes *et al*., 2007)[22]. Fernandes *et al* (2007) studying dissolved nutrient release from solid wastes of southern bluefin tuna (*Thunnus maccoyii*) identified that the phosphorus available for leaching from baitfish and faeces of baitfish-fed tuna was around 17-21% whereas the proportion of soluble nitrogen was 35-43%. They concluded that more than 90% of nitrogen loads and approximately 50% of phosphorus are likely to be released into seawater before solid wastes reach the seafloor.

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[20] Borg, J.A., Debono, S., Evans, J. 2013. Azzopardi Fisheries Tuna Penning Project: Environmental Monitoring Programme (Sediments) – Report on analyses of sediment samples collected in October 2012 from Azzopardi Fisheries' tuna penning site and control sites, off the St Paul's Bay/Qawra coast. Ecoserv.

[21] Borg, J.A., Evans, J. 2016. Azzopardi Fisheries Ltd Tuna Penning Activities: Report of a water quality survey at Azzopardi Fisheries Ltd's tuna penning site off the St. Paul's Bay/Qawra area, made in July 2016. Ecoserv.

[22] Fernandes, M., Angove, M., Sedawie, T., Cheshire, A. 2007. Dissolved nutrient release from solid wastes of southern bluefin tuna (*Thunnus maccoyii*, Castelnau) aquaculture. Vol 36 (4). Aquaculture Research.

Dead tuna

2.44. Tuna deaths are mainly a result of stress or panic, especially when the nets billow under strong currents. The number of deaths is limited as far as possible by closely monitoring the tuna and culling any fish that shows signs of stress or are moribund.

Blood

2.45. As explained, the tuna have to be killed in a very short time interval so as to avoid a sudden increase in body temperature that would negatively affect the quality of the meat. Blood is released into the sea when the fish are killed and handled prior to being transported to the processing vessel.

Wastewater from onboard processing of fish (tuna)

2.46. The further processing of the tuna onboard the service vessels invariably results in the generation of wastewaters mixed with blood and possibly some offal. The vessels have holding tanks where wastewater is collected (Azzopardi, C., pers. comm.; Nov 2016).

Offal

2.47. Tuna processing creates a substantial amount of offal, which is composed of the internal organs, the tails, and the heads of the tuna. As identified earlier, during harvesting, the farm generates between 8 and 10 tonnes of offal per day. Despite an initial policy and regulatory direction to transport this waste back to land for incineration, the incinerator at the abattoir in Marsa does not have the capacity to process the amount of waste generated during this period and thus no longer accepts this waste. In view of this, the accepted practice has returned to offshore offal disposal. A VMS-equipped vessel[23] takes the waste from the processing vessel and transports it further offshore to a dumping site as agreed with the Competent Authorities. The vessels are monitored by the Fisheries Department to ensure that the offal is dumped at the designated sites. The possibility of identifying alternative options for the disposal of the offal is a condition of ERA's environment permit and will be discussed in detailed with the relevant authorities as part of that process.

[23] VMS (Vessel Monitoring System) is a satellite surveillance system primarily used to monitor the location and movement of commercial fishing vessels and other craft. The system uses satellite-based communications from on-board transceiver units, which certain vessels are required to carry. The transceiver units send position reports that include vessel identification, time, date, and location, and are mapped and displayed on the end user's computer screen. Each vessel typically sends position reports once an hour, but these can be increased when the vessel is approaching an environmentally sensitive area. Alerts can be sent to the VMS technicians and other personnel when a particular vessel location might require additional inquiry or contact with the vessel operator. VMS allows enforcement to use advanced technologies to monitor compliance, track violators, and provide substantial evidence for prosecution. (see www.nmfs.noaaa.gov).

Net fouling marine growth

2.48. Marine growth on tuna nets is removed through air drying on the collars and later by scraping on land. The growth that is removed on land is disposed of as organic waste (see earlier).

Marine litter

2.49. Other wastes generated by the farms could include anthropogenic material such as rope, boxes, and municipal-type wastes from the service vessels that may occasionally find their way overboard. Monitoring reports for tuna farms in Maltese waters have repeatedly made reference to the presence of anthropogenic waste associated with the fish farm operations on the sea bed. Any such material will need to be collected and disposed onshore. In addition, the environment permit issued by ERA for the current operation also includes an obligation for the operator to collect any floating anthropogenic materials in the farm area, whether they originate from the operations or form outside.

Environmental Management System

2.50. In order to fulfil environmental permit conditions, the Applicant will be setting up and Environmental Management System (EMS) that will be integrated with the current operational system. The EMS will include:

- An assessment of how the Applicant's activities, processes, services might affect the environment including (i) the evaluation of significant environmental aspects; (ii) development of a register of environmental aspects; and (iii) development of a register of legislation;
- The development of an environmental policy;
- Developing objectives and targets and setting up an Environmental Management Programme (EMP) to achieve them;
- Defined roles and responsibilities for all employees;
- A training and awareness programme;
- Procedures to control activities with a significant environmental impact (also in relation to the EMP);
- A controlled system of records;
- Periodic auditing to ensure effective operation; and
- A formal review by senior management.

2.51. An EMS is currently under preparation as part of the environmental permit application.

Employment

2.52. The Applicant currently employs 40-45 full-timers and 40 part-timers. Employees include divers, boatmen, handymen, and drivers. The number of full-time employees is expected to increase to 55 whereas the part-timers will remain 40 once the additional cages are deployed.

ALTERNATIVE SITES

2.53. The current operational site at sea was identified following a selection exercise as described hereunder. To begin with, the site previously identified for the north aquaculture zone (for which planning approval had not been concluded) was reviewed. This site was, however, no longer considered to be suitable for consideration as a search area for the fish farm. This was mainly due to the fact that the proposed site also lies relatively close to the coast thereby potentially not fulfilling the spirit of the permit revocation and the PA conditions. Discussions with ERA and the Department of Fisheries and Aquaculture indicated that a minimum distance of 4.5 – 5 km from the shore was expected for all relocated farms[24].

2.54. To this end, it was considered that an appropriate approach would be to identify a suitable search area within which to study parameters in order to identify a final relocation site for the cages. **Figure 2.13** identifies the search area that was studied. This is located north of Qawra Point, St Paul's Bay. This search area was chosen based on (i) technical requirements for operation, e.g. the cages should not be deployed in water that is significantly deeper than 50 m and not deeper than 100 m because it will be difficult for divers to work under such conditions; (ii) a desk-top analysis using GIS overlays to identify the various marine uses off the north and east coast of the islands; and (iii) any constraints associated with the relocation as specifically directed by relevant Authorities or entities. Notably, with respect to the latter, Transport Malta's Harbour Master directed that the search area should be located no closer than 300 m from the bunkering zone. **Figure 2.14** identifies the various other uses and constraints around the search area.

2.55. Following identification of the search area, the following studies were carried out under licence from the Continental Shelf Department of the Ministry for Transport and Infrastructure:

- Multibeam echo sounder and back scatter survey within the search area; and
- Initial video surveys of the benthic environment to identify benthic habitats in the area.

[24] Meeting Adi Associates, ERA and Department of Fisheries and Aquaculture; October 2016

2.56. The benthic habitat survey revealed that the search area included maerl and rhodolith beds. The proposed site was then located as far as possible over the sandy bottom area as shown in **Figure 2.15**.

Figure 2.13: Search area for relocation

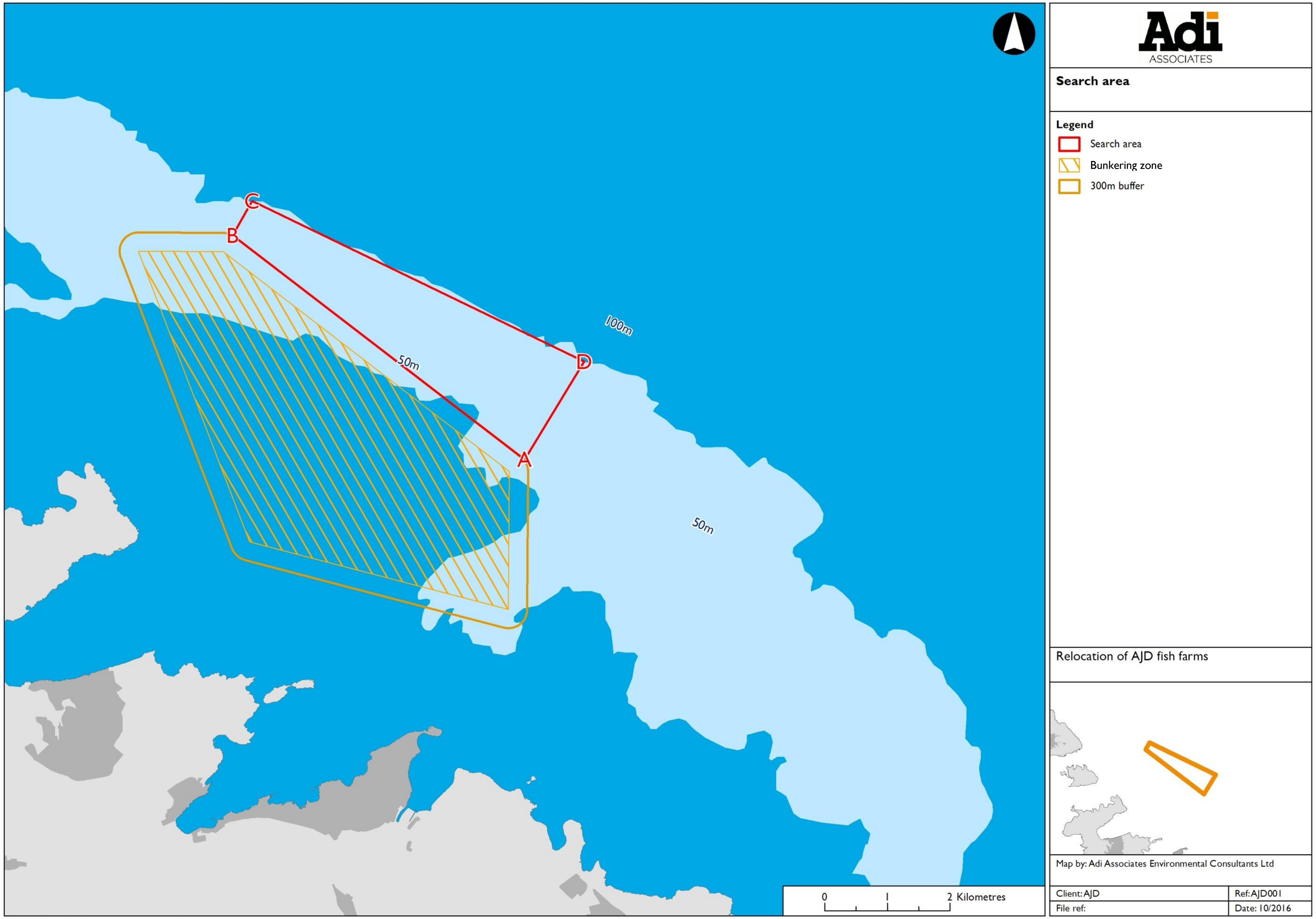

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Figure 2.14: Search area and other marine uses in the vicinity

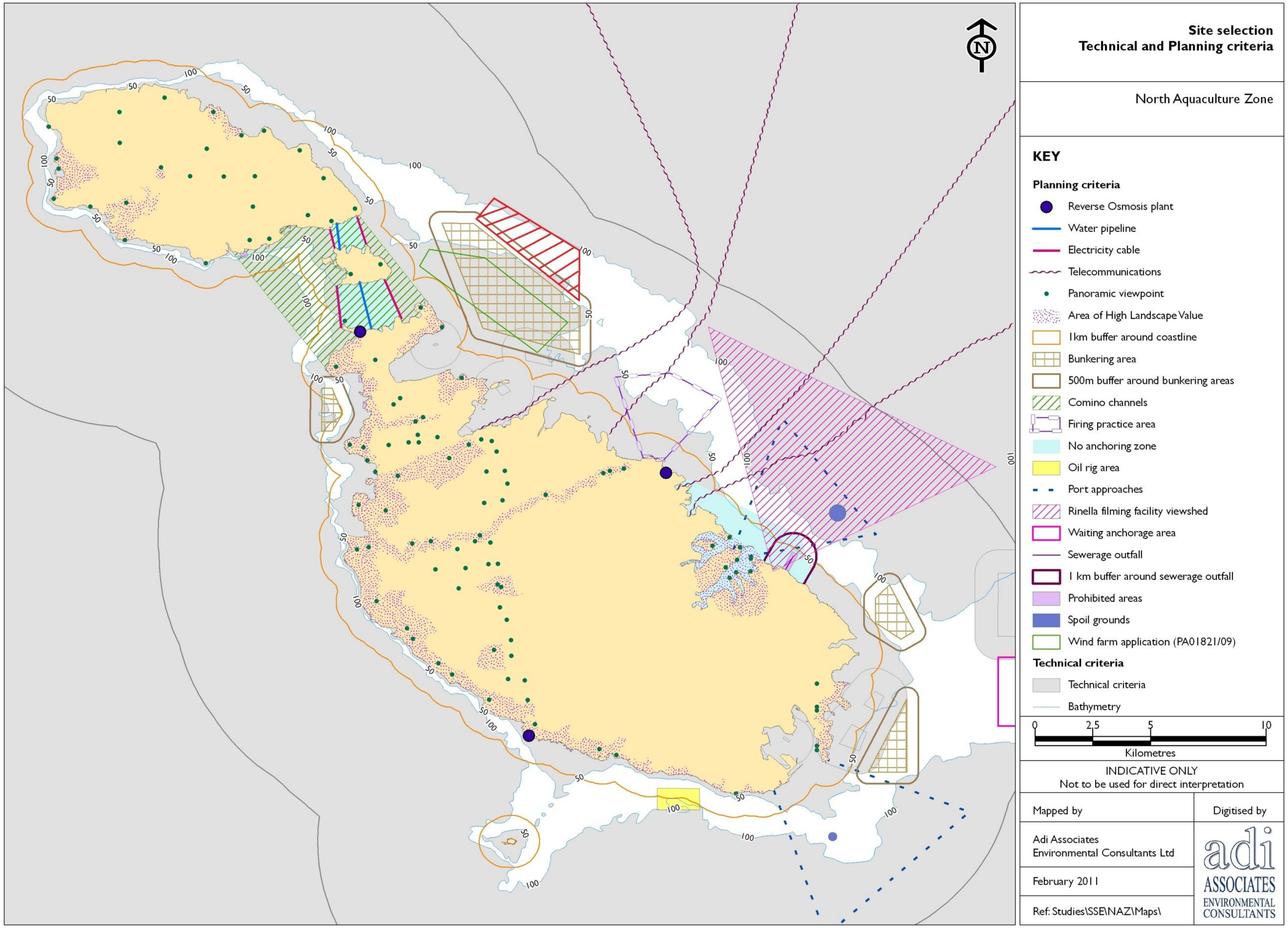
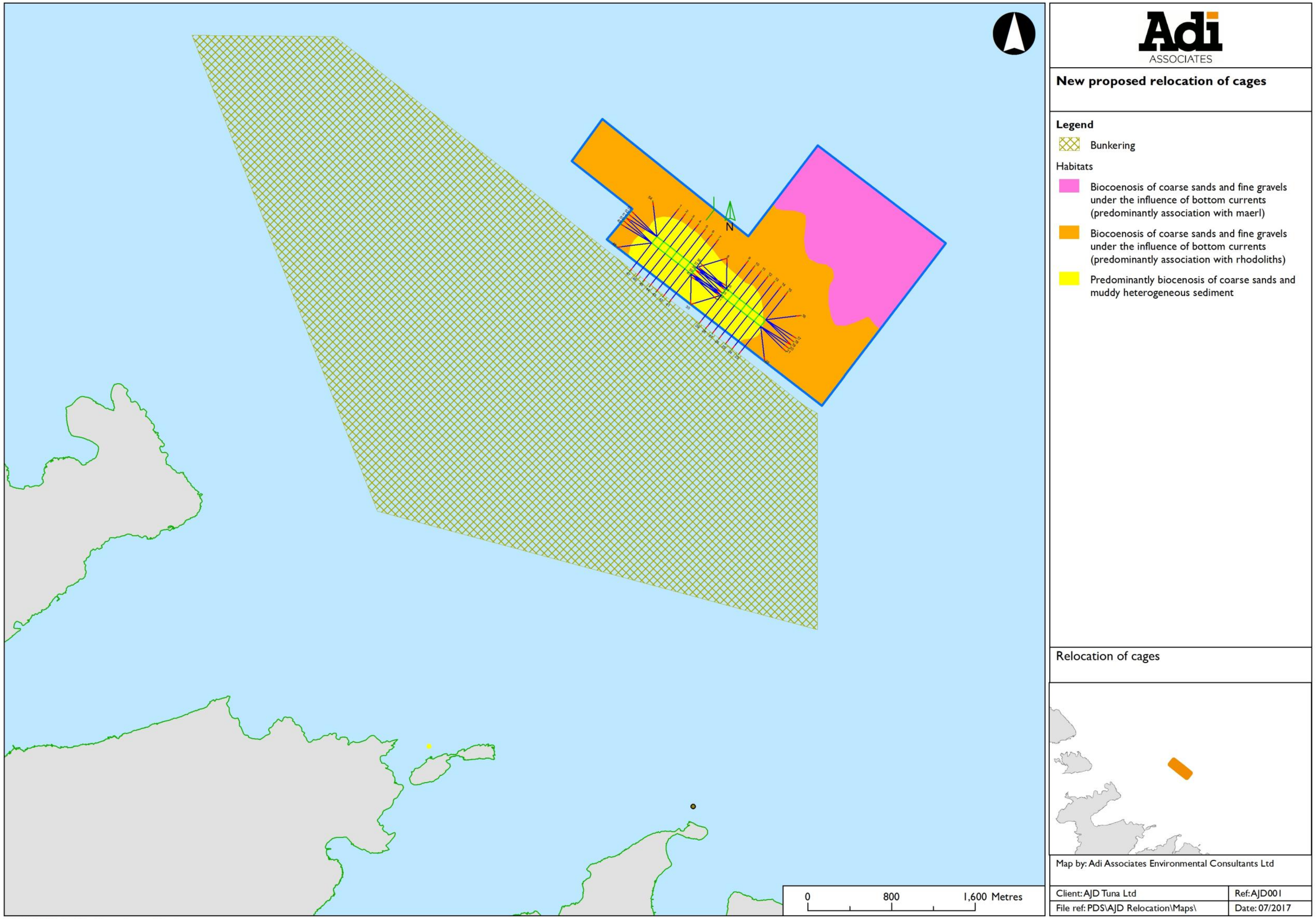


Figure 2.15: Site identified for relocation in the context of the identified benthic habitats



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3. DESCRIPTION OF THE SAC/SPA

MARINE

Northeast of Malta Marine SAC

3.1. The site falls within SAC MT0000105 *Zona fil-Baħar fil-Grigal ta' Malta* (Marine Area in the Northeast of Malta). The extent of this marine Natura 2000 site is illustrated in **Figure 3.1**. Given the relatively large size of this SAC, the seabed geomorphology within this site is particularly heterogeneous giving rise to a number of varied seascapes, bottom types, and a number of different habitat types.

Quality and importance of the SAC

3.2. Three Annex I habitats have been described within this SAC:

- ***Sandbanks which are slightly covered by sea water all the time*** (Habitat 1110) – There is little data available regarding this habitat type in the Maltese Islands and the Standard Data Form (SDF) specifies that the extent of this habitat type is not known. However, sandbanks with associations of *Cymodocea nodosa* have been recorded and the following subtypes occur:
    - Sandbanks with associations of *Cymodocea nodosa* on well-sorted fine sands;
    - Sandbanks with associations of *Cymodocea nodosa* on superficially muddy sands in sheltered waters; and
    - Facies with *Cymodocea nodosa* occurring within coarse sands and gravels with more or less mud.
- ***Posidonia beds*** (Habitat 1120) – This SAC hosts a large variety of Posidonia sub-types and the SDF considers that the representativity of each is relatively superior. Subtypes noted to be present as reported in the SDF include:
    - *Posidonia* settled on matte, whose meadows are normally continuous and having a high density;
    - *Posidonia* settled on rock, showing a reticulate distribution of dense strands;
    - *Posidonia* settled on sand, with continuous beds generally showing low densities and variable percentage cover;
    - Mosaic morphology, intermixed between *Posidonia oceanica*, *Cymodocea nodosa* and coarse sand, showing a reticulate structure; and

- Ecomorphosis of 'barrier reef' *Posidonia* meadows.

The *Posidonia* within this SAC is described as having a high connectivity and percentage coverage. MEPA's *Posidonia* Baseline Survey carried out in 2002 revealed that *Posidonia* in various parts of this SAC are healthy and abundant. The meadows are dense and show a high degree of shoot density, particularly in White Tower Bay, which, as reported in the SDF, seemingly hosts perhaps the highest shoot density in the Mediterranean. Records for the deepest areas where *Posidonia* has been recorded are held within this SAC, specifically off the south coast of Comino. Signs of regression of the meadows have, however, been reported at, for example, Mistra Bay and Mellieha Bay as a result of anthropogenic activities. *Gibbula nivosa*, considered as the only endemic marine mollusc of the Maltese Islands is associated with this SAC and has been found on *Posidonia* leaves as well as under stones.

- ***Reefs*** (Habitat 1170) – During the 2002 survey, reefs of the following subtypes were identified within this SAC:
    - Reefs with associations of *Dictyopteris polypodioides*;
    - Reefs with associations of *Halopteris scoparia* and *Padina pavonica*;
    - Reefs with associations of *Flabellia petiolata* and *Peyssonnellia squamaria*; and
    - Reefs with associations of *Cystoseira* spp.
- ***Partially submerged caves*** (Habitat 8330) – These are mostly located along the coast of Comino. Species of conservation interest associated with this habitat type include *Lithothamnion minervae*.

Pressures on and vulnerability of the SAC habitats

3.3. Threats, pressures and activities that result in impacts on the site as listed in the SDF include:

- Water pollution / pollution from run-off as a result of fertilisation, use of biocides, hormones and chemicals, household waste / recreational facility waste / discharges;
- Leisure and recreation facilities / recreational activities / nautical sports;
- Noise pollution;
- Collapse of terrain;
- Hunting / fishing / collecting activities;
- Professional fishing;

- Acid rain;
- Ports;
- Invasive, non-native species; and
- Shipping lanes.

Il-Baħar Ta' Madwar Għawdex SPA

3.4. I-Baħar ta' Madwar Għawdex surrounds Gozo and Comino and the northern tip of Malta as shown in **Figure 3.2**. The SPA covers an area of approximately 556.7 km^2.

3.5. This SPA was included in the Maltese marine Important Bird Area (IBA) inventory as a result of the EU LIFE+ Malta Seabird Project (LIFE10NAT/MT/090) due to its importance for *Calonectris diomedea*, and *Puffinus yelkouan* during the breeding season.

3.6. The Standard Data Form reports a population of 7,300 for *Calonectris diomedea* and a population ranging from 3,270 to 4,650 birds for *Puffinus yelkouan*.

TERRESTRIAL

3.7. **Figure 3.3** shows the terrestrial sites located on the eastern coast of the islands. Those being considered within the scope of this AA in view of the populations of breeding seabirds within each, are discussed in more detail below.

L-Inħawi tar-Ramla tat-Torri u tal-Irdum tal-Madonna SPA

3.8. As reported in the Management Plan (2015), this site supports between 366 and 544 breeding pairs of *Puffinus yelkouan,* an Annex I species (Birds Directive). L-Irdum tal-Madonna supports the largest colony of breeding Yelkouan Shearwaters in the Maltese Islands. This species belongs to the family Procellariidae, whose characteristic feature is a pair of tube-like nostrils on the end of their beak to filter out salt. *P. yelkouan* feeds mainly on small fish, crustaceans and cephalopods. The birds start to arrive at the colony to breed in October, flying in at night. Eggs are laid at the end of February-beginning March. The egg is laid on bare ground in a burrow or crevice. Nesting sites are located from 2-120 m above sea level, although some nests are closer to the top of the cliffs. Incubation is carried out for about 50-52 days, and both partners participate. Chicks hatch in the third week of April. The birds leave the colony at the end of July. Birds reach breeding maturity in their third or fourth year, although some juveniles may return to the colony in the meantime. This species breeds alongside *Calonectris diomedea* at this site although only 8-10 breeding pairs of *C. diomedea* make use of this site. Direct competition is avoided because breeding seasons do not overlap exactly. *P. yelkouan* begin breeding earlier than *C. diomedea*. Each species is then undertaking different aspects of this phase and in this way competition for food is minimised, e.g. when *P. yelkouan* are feeding the young, *C. diomedea* are incubating. However, cases of nest eviction of *P. yelkouan* by *C. diomedea* have been recorded (Sultana *et al*, 2011). Fishermen have been known to take these birds at sea to use as bait. Between 2000 and 2006 the main cause of Yelkouan mortality was rat predation. Other causes included predation by domestic ferrets *Mustela putorius furo* and/or possibly wild weasels. Increased human disturbance results in reduced numbers returning to the breeding colony in following years. Another threat to this species is light sources on the mainland. Attracted by the light fledglings have been recovered inland where they were found to be disoriented (Sultana *et al*, 2011). In 2008, IUCN and Birdlife International revised this species' status from Secure to Near Threatened. The Management Plan assigns a conservation status of A (favourable) for *P. yelkouan* at this site.

3.9. *C. diomedea* is also an Annex I seabird of the family Procellariidae. This species makes its first landfall just prior to breeding in late February. By the second week of March, many of the birds have reached the colony, paired up, set up nest and mating begins. A single egg is then usually laid at the end of May. The egg is laid on bare ground, although this is often surrounded by material such as dry twigs, feathers, and pebbles. All females lay their eggs within a few days of each other. Both parents incubate the eggs, with the male taking the first incubation sitting, which on average lasts 4.5 days (Sultana *et al*, 2011). Incubation lasts up to 52 days. The main fledging period is the first half of October, and the colony is generally deserted by the end of October. Males start to breed aged 4-6, whilst females reach maturity in their 5th or 6th year. This species exhibits strong site tenacity, with pairs using the same nests year after year. Lifespan can exceed 25 years. *C. diomedea* prefers nesting sites with extensive vegetation cover (Sultana *et al*, 2011). Breeding success in the Maltese Islands is deemed to be relatively low and is attributed to direct human persecution and predation by rats, cats, and dogs. This species has been provisionally rated as Vulnerable by Birdlife International. The Management Plan assigns a conservation status of B (inadequate) to *C. diomedea* at this site.

3.10. Metzger *et al* (2015) also reported the presence of a small breeding colony of the Storm Petrel (*Hydrobates pelagicus melitensis*[25]) at Rdum tal-Madonna of about 1-10 breeding pairs. As reported by Sultana & Borg (2011)[26], the Mediterranean Storm Petrel is asynchronous in its breeding behaviour whereby the egg-laying period spans four months (April to July) and courtship

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[25] This is a Mediterranean subspecies of the European Storm Petrel (*Hydrobates pelagicus*).

[26] Sultana, J. Borg, J.J. 2011. The Mediterranean Storm-petrel *Hydrobates pelagicus melitensis* in Malta. Part 2: Ecology and Conservation of Mediterranean Storm-petrel and Mediterranean Shag. Proceedings of the 13th Medmaravis Pan.Mediterranean Symposium

is still at its peak in mid-May. The latest birds leave by October.

3.11. As noted in the Management Plan as well as **Appendix 2** to this report, the marine environment in front of the colonies used for rafting is also an important consideration in the ecology of these seabirds and their breeding success.

Kemmuna u l-Gzejjer tal-Madwarha SPA

3.12. Kemmuna u l-Gżejjer ta' Madwarha is a Special Protection Area because of the important breeding *P. yelkouan* and *Calonectris diomedea* seabird populations located along the cliffs as well as other breeding species such as the Short-toed Lark which are ground nesting birds.

3.13. 50-60 breeding pairs of *P. yelkouan* have been recorded from this site as noted in the Management Plan. Colonies are found on Cominotto, north of Comino and west of Comino. Comino is an Important Bird Area of global importance based on this population. *P. yelkouan* colonies have a wider distribution than *C. diomedea* within this SPA. The Management Plan reports the conservation status of *P. yelkouan* as 'A' within this SPA.

3.14. 40-60 breeding pairs of *C. diomedea* occur in the northwest of Comino and its conservation status in this SPA is considered to be favourable.

Selmunett SAC

3.15. Selmunett is not an SPA, however, as noted in **Appendix 2,** in the last decade, a small colony of Yelkouan Shearwaters has been re-discovered breeding on the island.

Others

3.16. Whilst the Għadira and L-Inħawi tal-Imġiebah Natura 2000 sites lie within the A of I, they do not support breeding populations of the Annex I seabirds and therefore they do not fall within the scope of this AA.

Figure 3.1: Northeast of Malta Marine Special Area of Conservation

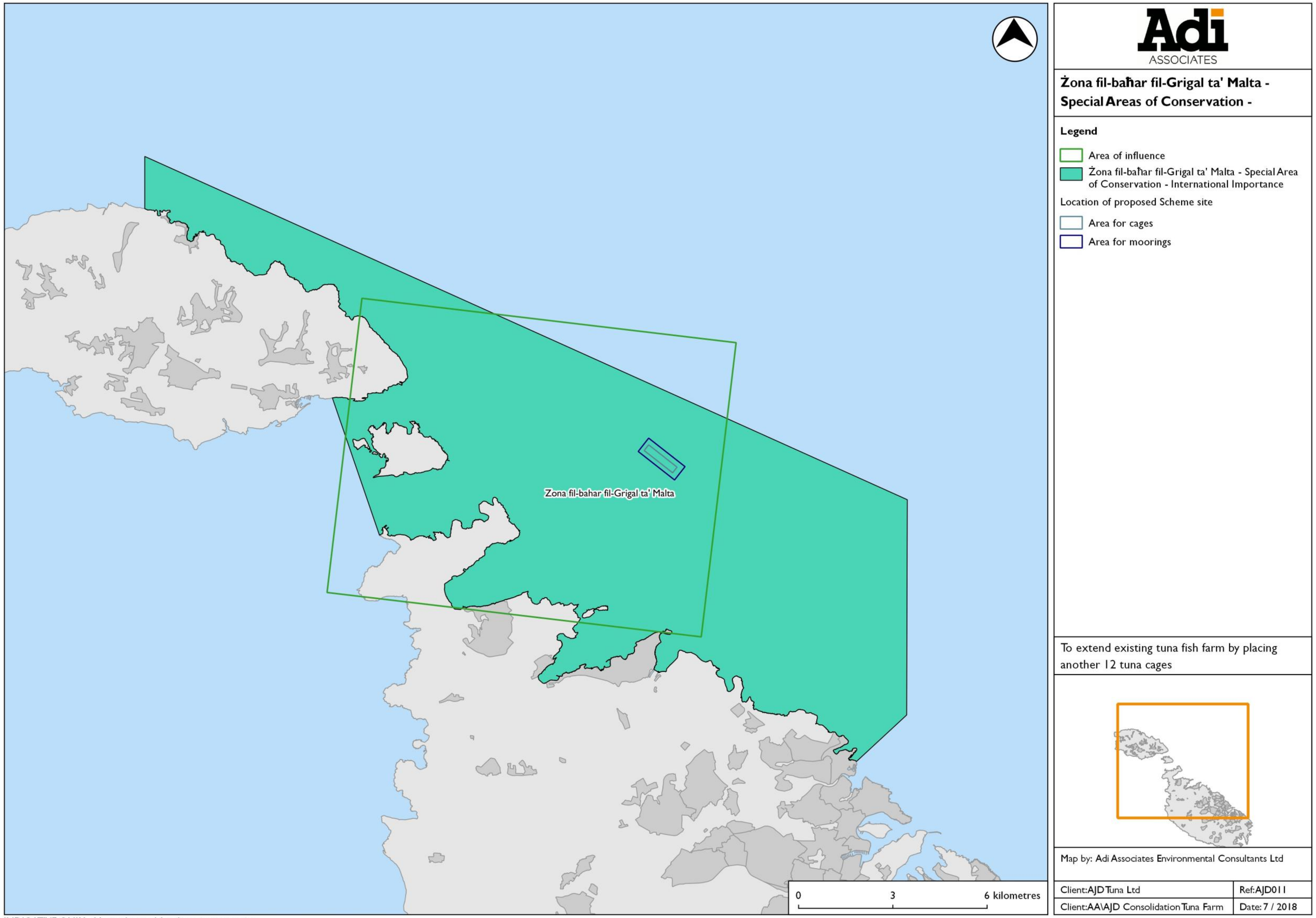

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Figure 3.2: Il-Baħar ta' Madwar Għawdex Special Protection Area

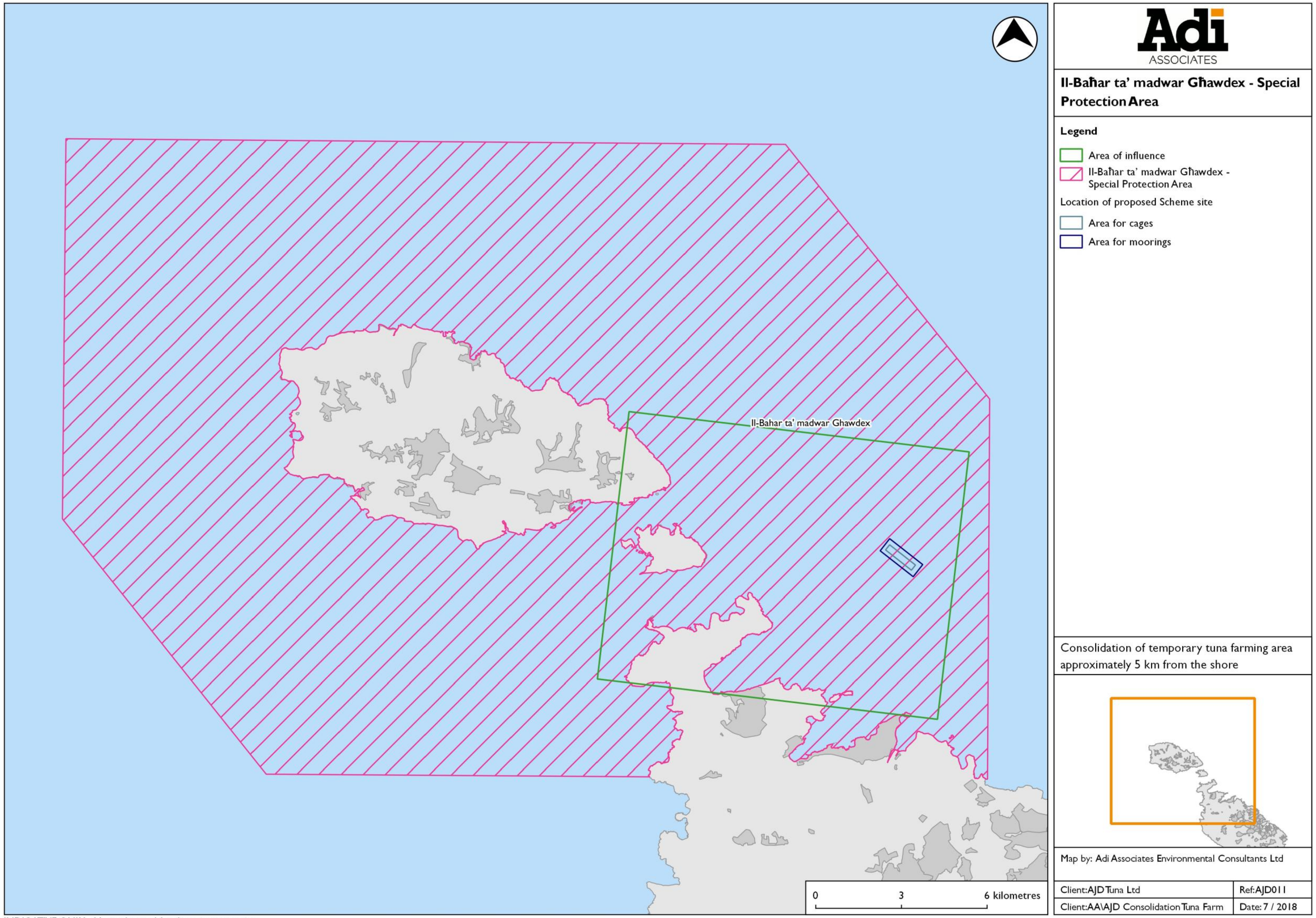

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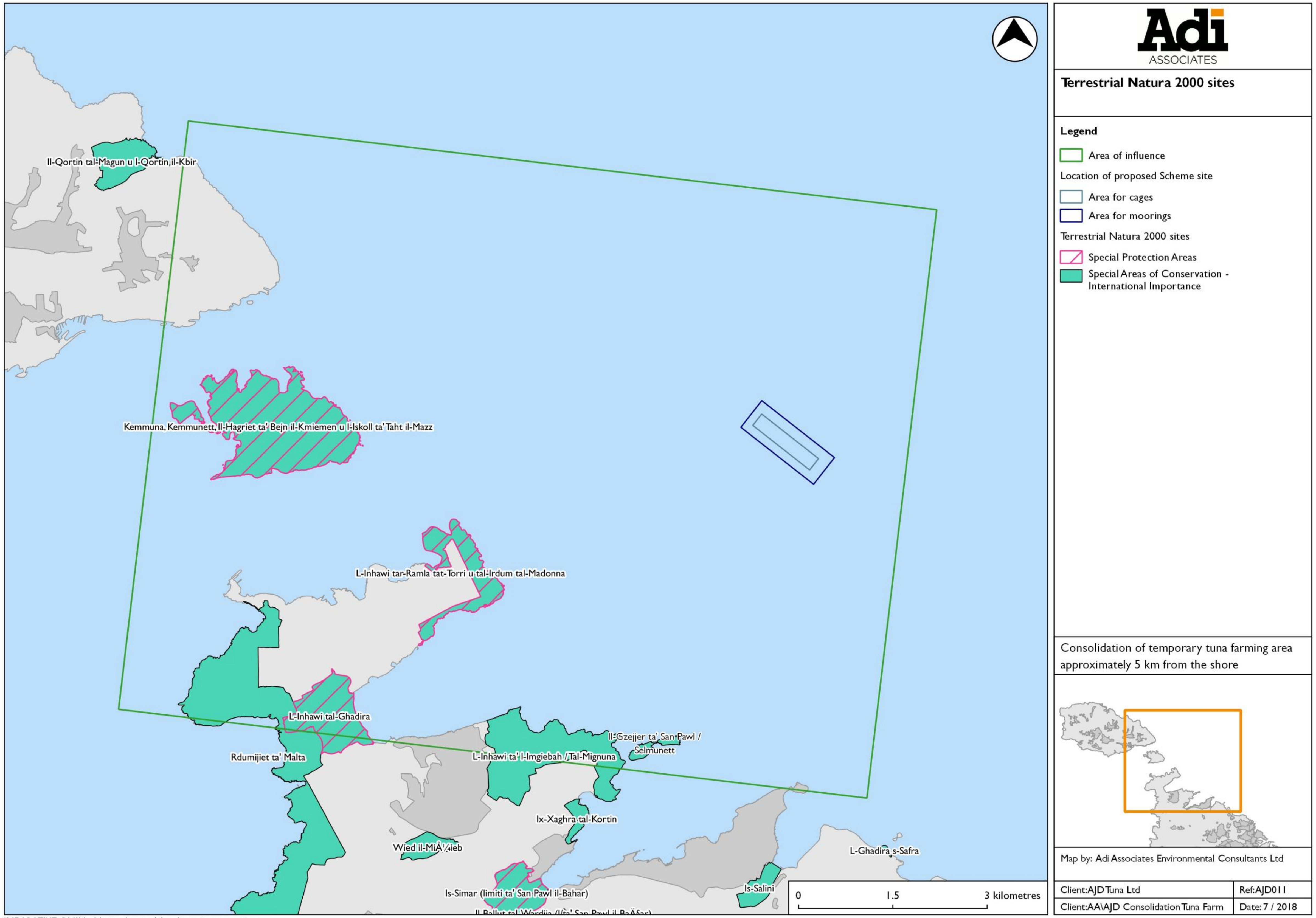
Figure 3.3: Terrestrial Natura 2000 sites



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4. BASELINE STUDIES

INTRODUCTION

4.1. This Chapter describes the ecological communities within the Area of Study considered for the marine ecology study and evaluates the significance of the site in terms of ecological dynamics, conservation status, and applicable policies. The evaluations for the marine environment are based on field studies and literature reviews whilst the evaluation of avifauna is based largely on existing data gathered over a period of time.

FINDINGS

Northeast of Malta marine SAC

4.2. The findings from the surveys carried out are presented in detail in **Appendix 1** and **2**.

Sediment and water quality

4.3. The results of the water quality survey and granulometric analysis are given in tables in **Appendix 1**.

4.4. The results of *in situ* measurement of physico-chemical parameters of the water column indicate temperature values and levels of salinity, water transparency and dissolved oxygen that are expected of local pristine offshore coastal waters during spring. The Secchi Disc measurements indicated a high water transparency of between 24 m and 29 m.

4.5. Low, though detectable, levels of total organic carbon (TOC), total suspended solids (TSS), total nitrogen, and total phosphorous were recorded from the sampling stations, while levels of Chlorophyll *a* were below the limit of detection, thereby indicating a low phytoplankton abundance.

4.6. A weak southeasterly surface sea current having a speed of between 0.11 m/s and 0.13 m/s was recorded at the two reference stations R1 and R2.

4.7. The results of chemical analysis of sediments from the sampling stations indicated detectable though low levels of total organic carbon (TOC), total nitrogen, and total phosphorous, while levels of sulphide were below the limit of detection. Values of pH and redox potential were of an order that is expected of background levels for local offshore sediments.

4.8. The results of granulometric analysis indicate that the sediments characterising the six sampling stations comprise poorly sorted coarse sand having a mean grain size of between 0.55 mm and 0.95 mm.

Physical characteristics of the seabed

4.9. The bottom within the area surveyed consisted predominantly of coarse mobile sediments. A drop-off (some 10 m – 25 m high) that is characterised by rock exposed to sedimentation is present at the northwestern part of the study area.

4.10. What are often referred to as 'maerl[27] beds', however, more correctly termed 'rhodolith beds', occupy a large part of the study area, which were more dense and continuous in the northeastern (and deeper) half of the survey area. In many places, the rhodolith beds were interspersed with a bare sand bottom that supported sparse rhodoliths[28]. In the southwestern half of the survey area, the rhodolith density varied such that they are less dense in the shallower part (45 m – 50 m) of the survey area, where large expanses of bare sand that supported little or no rhodoliths were present. Overall, the seabed had physical features that corresponded with the bathymetry: coarse sand with sparse accumulations of rhodoliths (0 % - 20 % rhodolith cover) was present at a water depth of between 43 m and 50 m; between a water depth of 50 m and 55 m, the seabed comprised coarse sediment having denser rhodolith accumulations (20 % - 50 % rhodolith cover); and in waters deeper than 55 m, the seabed mainly consisted of dense rhodolith beds (50 % - 100 % rhodolith cover). Beyond the rocky drop-off, at water depths exceeding 100 m, the seabed mainly consisted of bare muddy sand.

4.11. Depth varied between around 43 m and just over 100 m. The underwater visibility was good (25 – 30 m) throughout the study area; however, flocculate material was noted in the water column along some of the transects.

4.12. A current was present in places close to the seabed, as evidenced by debris and other material originating from benthic vegetation that were seen being moved on the bottom.

4.13. Some anthropogenic items were observed during the survey. These included glass and plastic beverage bottles, abandoned fish traps and fishing lines, and other unidentified items. However, no remains of tuna, feed fish used in tuna farming, or any other item that may have originated from tuna farming activities, was recorded on the seabed during the survey.

Benthic diversity

4.14. A classified list of species, and their abundance, recorded from the four grab

[27] 'Maerl' is a term used to describe calcareous sediments dominated by coralline algae. Maerl as used here describes sedimentary habitats in which living or dead unattached calcareous rhodophytes are a dominant component. These algae may take the form of nodules (rhodoliths) or fragmented thalli. However, according to Basso *et al*. (2016), 'rhodolith beds' should be identified and delimited as those areas of the sea floor with >10% cover of live rhodoliths over a minimum surface of 500 m^2, while the term "maerl" refers to a specific type of rhodolith bed that is composed of non-nucleated, unattached growths of branching, twig-like coralline algae. 'Maerl' as used here conforms to the definition of Basso et al. (2016).

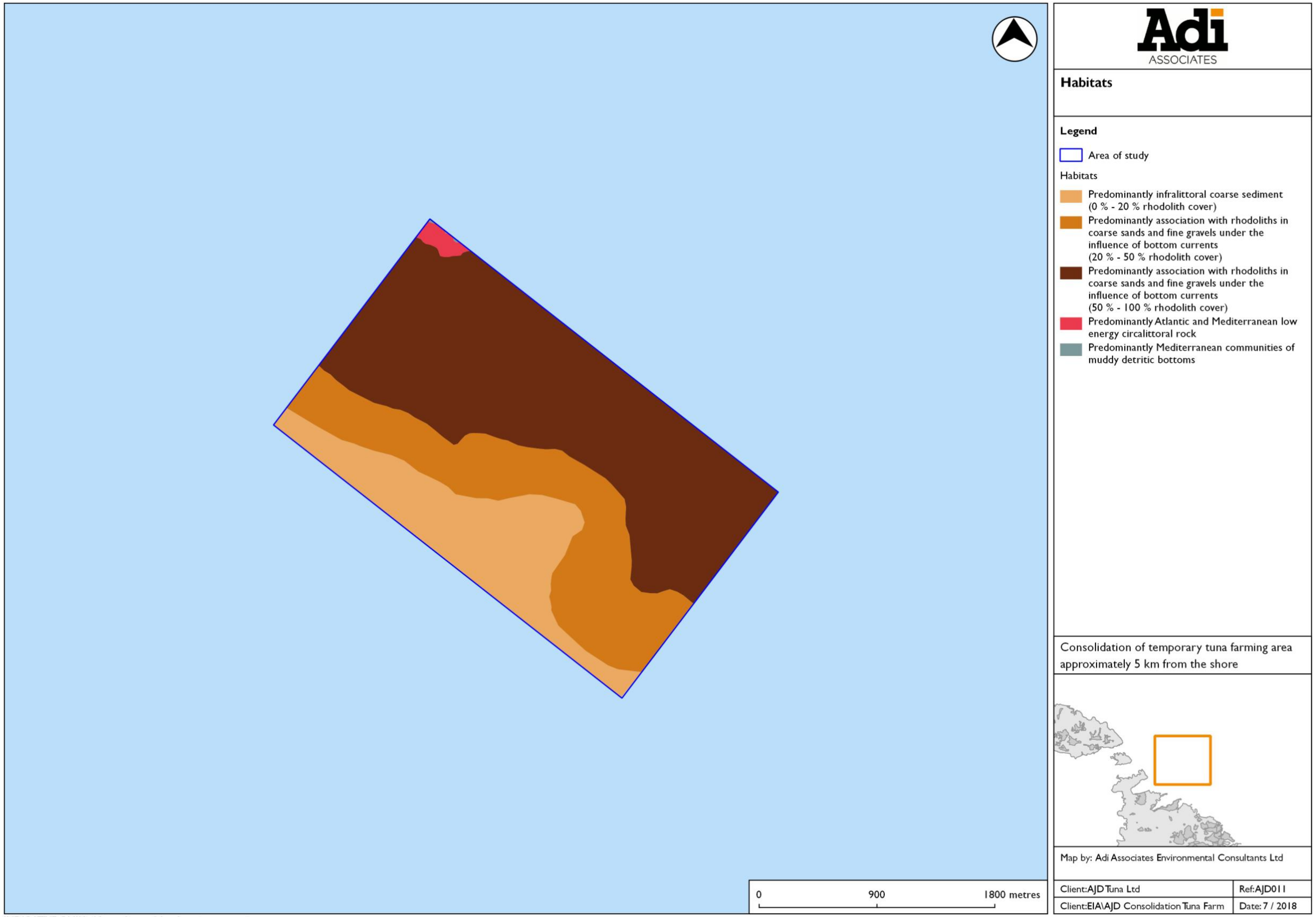
[28] Rhodoliths consist either of free-living calcareous rhodophytes (red algae), or else of an inner nucleus, such as stone or shell, encrusted by calcareous rhodophytes.

samples collected from Stations A – D is given in **Appendix I**. A total of 1,763 individuals comprising 79 macrofaunal species were recorded. A high diversity of macrobenthic fauna was recorded from the grab samples; the two most represented taxonomic groups, in terms of species richness and abundance, were the polychaetes and the crustaceans. No protected species were recorded from any of the grab samples

Benthic assemblages

4.15. The findings from the survey made in May 2017 that was undertaken using a remotely operated vehicle (ROV) and which entailed collection of underwater footage of the seabed along transects within the survey area were combined with the data obtained in the May 2018 survey in order to generate a habitats map (**Figure 4.1**).

Figure 4.1: Habitats map



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4.16. The main biotic assemblage types recorded from the study area were:

- Association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents (EUNIS code A5.515)[29];
- Infralittoral coarse sediment (EUNIS code A5.13)[30];
- Mediterranean communities of muddy detritic bottoms (EUNIS code A5.38); and
- Atlantic and Mediterranean low energy circalittoral rock (EUNIS code A4.3).

Association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents

4.17. This association was present as two subtypes: one which was predominantly characterised by a rhodolith-rich bottom in which the proportion of rhodoliths covering the bottom was dense (50% - 100% cover, see **Figure 4.2a**) and constituted a well developed rhodolith bed, as described by Basso *et al*. (2016)[31]. This association subtype was mostly present in the deeper, northeastern half of the survey area within the 55 m – 80 m water depth range. The other subtype mainly consisted of a rhodolith bed in which the density of rhodoliths was sparser and predominantly formed accumulations such that the overall rhodolith cover was around 20 % - 50% (see **Figure 4.2b**); this association subtype was mainly present as a band in the central parts of the survey area within the 50 – 55 m water depth range.

4.18. Preliminary examination of rhodoliths that were retrieved from sediments collected by grab from Stations A, B and D indicated that the algal species that contribute to the rhodoliths include species from the following genera: *Lithophyllum, Lithothamnion*, *Mesophyllum* and *Sporolithon* (see Lanfranco *et al*., 1999; Borg and Schembri 2002; Sciberras *et al*., 2009).

4.19. Where present, the dense rhodolith beds appeared to comprise a pseudo-hard substratum that supported macroalgae; the predominant alga being *Flabellia petiolata* (see **Figure 4.2a**) and *Zonaria tournefortii*. Other algae including *Halimeda tuna*, *Peyssonnelia squamaria*, *Dictyota* sp. and unidentified filamentous forms, were also recorded in places.

20. The most abundant megafaunal species that were recorded from this association are the cidariid sea urchin *Stylocidaris affinis* and the Purple Heart

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29 Equivalent to RAC/SPA 'Association with Rhodoliths'; code III.3.2.2.

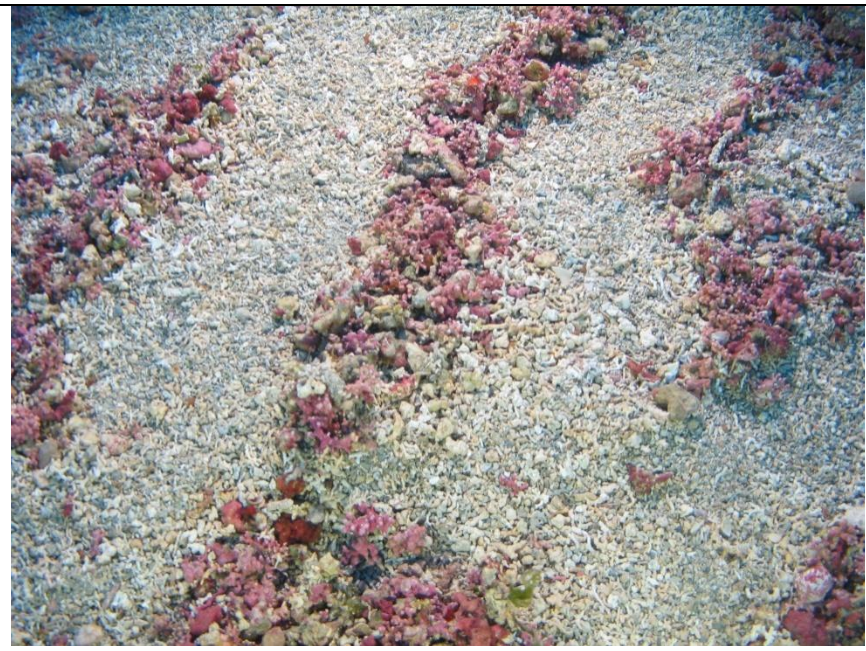
30 Equivalent to RAC/SPA 'Biocoenosis of coarse sands and fine gravels under the influence of bottom currents; code III.3.2.

31 Basso D., Babbini L., Kaleb S., Bracchi V.A., Falace A. (2016). *Monitoring deep Mediterranean rhodolith beds*. 26(3). Aquatic Conservation: Marine and Freshwater Ecosystems.

Urchin *Spatangus purpureus* (see **Figure 4.2c**); other megafaunal species that were recorded during the survey included several species of sponges and bryozoans (including *Sertella* sp.), the Long-spined Urchin *Centrostephanus longispinus* (see **Figure 4.2d**), the Red Seastar *Echinaster sepositus* (see **Figure 4.2e**), the crinoid *Antedon mediterranea*, the crab *Inachus* sp., and the seastar *Luidia ciliaris*. Furthermore, the presence of openings to numerous burrows in places indicated an associated rich infauna.

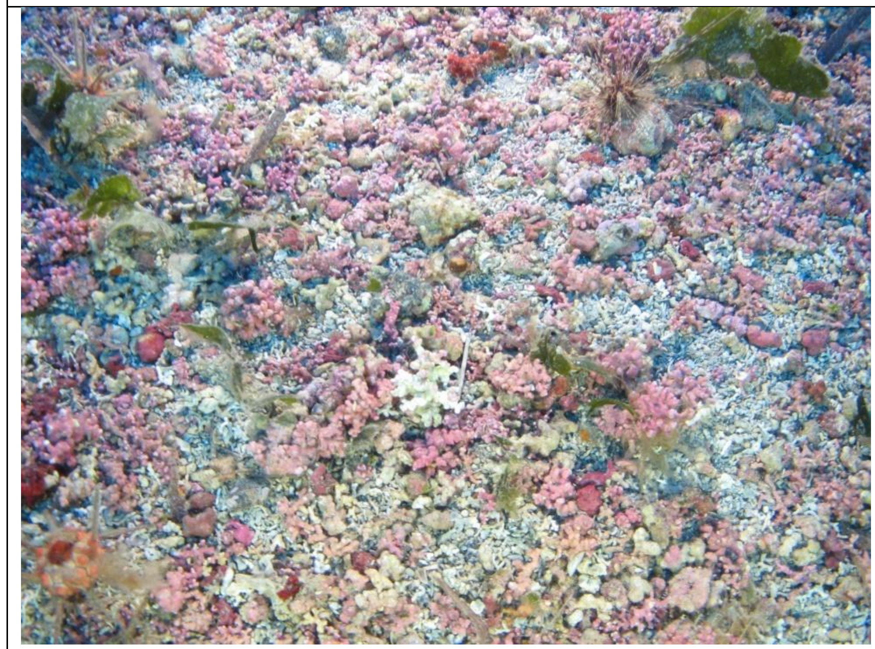
Figure 4.2: Association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents *(Source: Borg, 2018)* [32]

a. Photograph of the seabed taken at a point along Transect 5, showing a close-up of a dense rhodolith bed. The green alga visible in the photo is *Flabellia petiolata*.

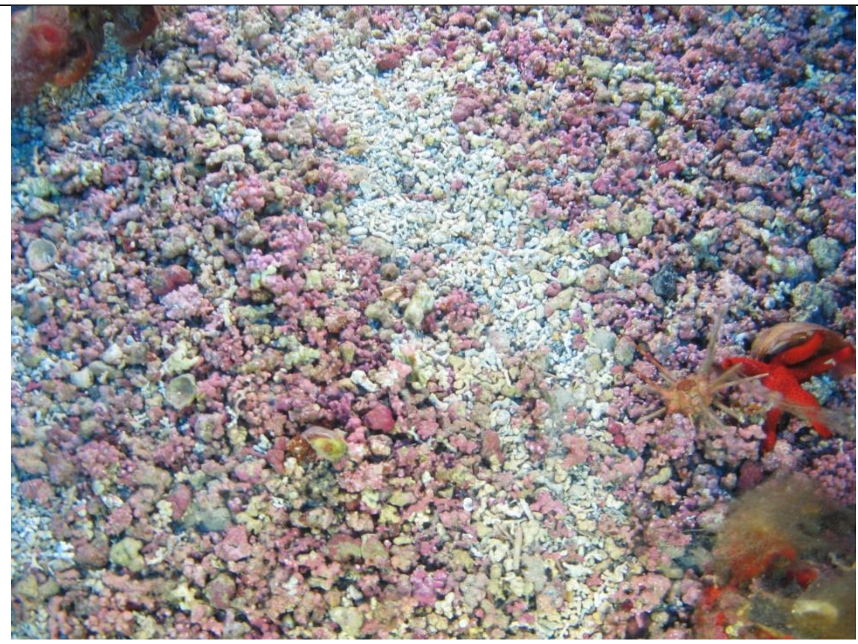


b. Photograph of the seabed taken at a point along Transect 12, showing a close-up of a sparse rhodolith bed.

c. Photograph of the seabed taken at a point along Transect 5, showing a close-up of a rhodolith bed intermixed with bare sediment. The five orange coloured long-spined urchins are individuals of *Stylocidaris affinis*. The large purple coloured urchin is a the Purple Heart Urchin *Spatangus purpureus*



d. Photograph of the seabed at a point along Transect 3, showing a close-up of a rhodolith bed. A Long-spined Urchin *Censtrostephanus longispinus* is visible adjacent the alga *Flabellia petiolata* (green).



e. Photograph of the seabed taken at a point along Transect 5, showing a close-up of a rhodolith bed. An individual of the urchin *Stylocidaris affinis* and another of the Red Seastar *Echinaster sepositus* are visible on the right side of the photo.

[32] Borg, J.A. 2018. *Report on an ecological assessment of an area off the northeastern coast of Malta, proposed for designation as an offshore tuna penning site, undertaken as part of the Environment Impact Assessment in connection with PA 02175/18: Extension to an existing tuna farm operation off the North East coast of Malta*. Ecoserv Ltd.

Infralittoral coarse sediment

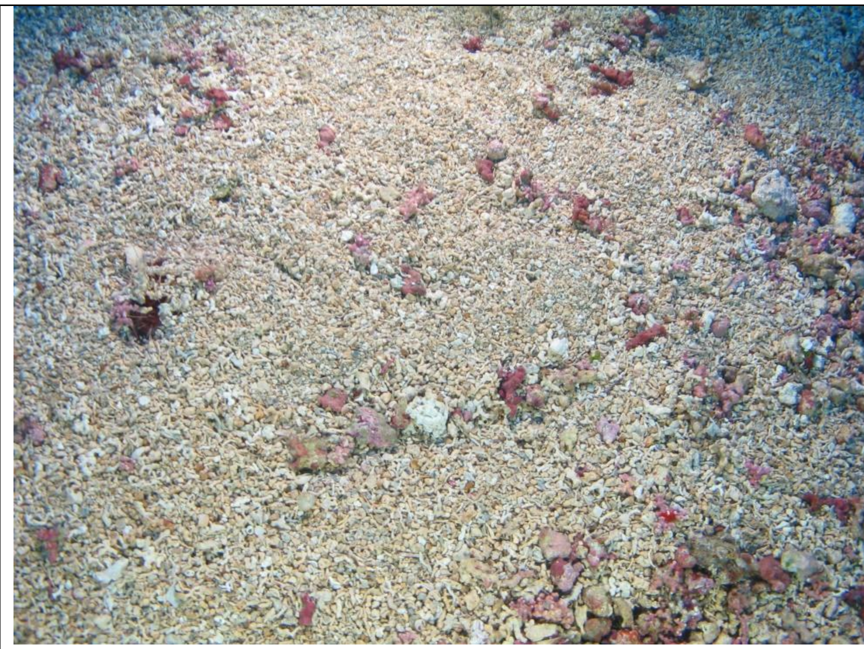
21. This assemblage type occurred as a band at the southwestern part of the Area of Study, where the water depth was some 43 m – 50 m. In places, the sediment bottom supporting this assemblage type had small accumulations of rhodoliths or sparse rhodoliths, such that where these were present their cover was some 1 – 20% (see **Figure 4.3a** to **Figure 4.3d**). Detached algal and plant (seagrass) material was present in places on the seabed where this assemblage occurred; however, no attached fleshy algae or seagrasses were present. The epifauna associated with this assemblage was impoverished; the most abundant macrofaunal species was the Purple Heart Urchin *Spatangus purpureus* (see **Figure 4.3e**) and groups of the Purple Urchin *Sphaerechinus granularis*. However, the presence of openings to burrows present in many places indicated the presence of a rich infauna.

4.22. In general the area surveyed mainly supported the assemblage types and subtypes as described above and as shown in **Figure 4.1**. However, certain parts supported patches with a different assemblage type with varying density of rhodolith beds.

Figure 4.3: Infralittoral coarse sediment *(Source: Borg, 2018)*

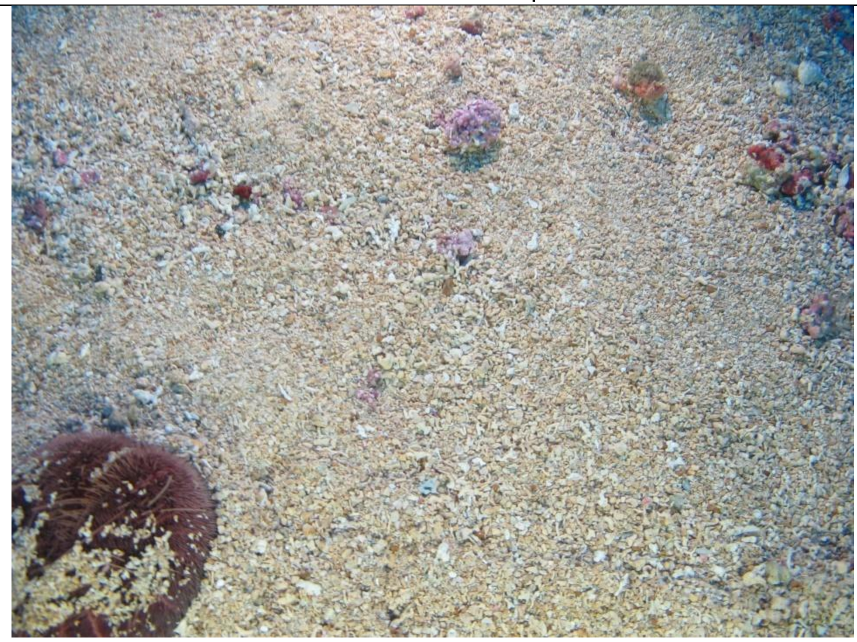
a. Photograph of the seabed taken at a point along Transect 2, showing a close-up of an assemblage of infralittoral coarse sediment.

b. Photograph of the seabed taken at a point along Transect 2, showing a close-up of an assemblage of infralittoral coarse sediment. An individual rhodolith is visible at the centre of the photo.



c. Photograph of the seabed taken at a point along Transect 11, showing a close-up of an assemblage of infralittoral coarse sediment. Individual rhodoliths are visible in places in the photo.

d. Photograph of the seabed taken at a point along Transect 11, showing a close-up of an assemblage of infralittoral coarse sediment. Three narrow strips with rhodoliths are visible in the photo.



e. Photograph of the seabed along Transect 11, showing a close-up of an assemblage of infralittoral coarse sediment. A few individual rhodoliths (Purple colour) – most of them having a very small size (few mm) – and an individual of the Purple Heart Urchin *Spatangus purpureus*, are visible in the photo..

Mediterranean communities of muddy detritic bottoms

4.23. This assemblage type was recorded from the extreme northwestern corner of the Area of Study at a water depth exceeding 100 m and occurred at the base of the 10 m – 25 m high drop-off from where it extended further into deeper waters (**Figure 4.4**). No macroflora was recorded from this assemblage type, although detached macroalgae (mainly *Zonaria tournefortii*) were present on the sediment surface in various places. No macrofauna was recorded from this assemblage type but the presence of openings to burrows indicated an associated rich infauna.

Figure 4.4: Muddy detritic bottoms *(Source: Borg, 2018)*

Atlantic and Mediterranean low energy circalittoral rock

24. This assemblage type was recorded from the extreme northwestern corner of the Area of Study and formed part of the drop-off some 10 m to 25 m high that separated the assemblage of coarse sands and fine gravels under the influence of bottom currents and the assemblage of infralittoral coarse sediments (see **Figure 4.5**). The associated macroalgae mainly comprised *Zonaria tournefortii* and unidentified coralline algae (**Figure 4.5**). The associated macrofauna mainly comprised sponges, bryozoans, and other sessile macrobenthic species. Individuals of the echiuran worm *Bonellia viridis* were recorded in places from this assemblage type.

Figure 4.5: Atlantic and Mediterranean low energy circalittoral rock

Demersal and pelagic fauna

25. The demersal fish fauna recorded during the survey mainly comprised large shoals of Picarel *Spicara* sp. and individuals of the Comber *Serranus cabrilla*. Several individuals of the Mauve Stinger *Pelagia noctiluca* were recorded in the water column during the survey.

Ecological appraisal

4.26. In Maltese waters, the main rhodolith-forming algae in rhodolith/maerl beds are *Lithothamnion corallioides* and *Phymatolithon calcareum/Lithothamnion minervae*[33] with *Peysonnelia rosa-marina*, *Mesophyllum* sp., and *Neogoniolithon brassica-florida* constituting a minor component (Lanfranco *et al*., 1999)[34]. Associations with rhodoliths are a habitat type that qualifies sites for inclusion in national inventories of natural sites of conservation interest as required by the Protocol for Specially Protected Areas and Biodiversity in the Mediterranean (SPA/BD) of the Barcelona Convention[35]. Furthermore, the

[33] It is not possible to distinguish between *Phymatolithon calcareum* and *Lithothamnion minervae* using gross morphology alone.

[34] Lanfranco, E.; Rizzo, M.; Hall-Spencer, J.; Borg, J.A. & Schembri, P.J. 1999. *Maerl-forming coralline algae and associated phytobenthos from the Maltese Islands*. 3(1). The Central Mediterranean Naturalist.

[35] The *Convention for the Protection of the Mediterranean Sea against Pollution* (the Barcelona Convention) was adopted on 16th February 1976. A number of protocols were adopted under this convention, amongst which is the *Protocol concerning Mediterranean Specially Protected Areas* done at Geneva on 3 April 1982. The parties later amended this protocol and its name changed to *Protocol for Specially Protected Areas and Biodiversity in the Mediterranean* (SPA/BD). Malta ratified this new Protocol on 28th October 1999. A draft reference list of habitat types for the selection of sites to be included in

coralline algae *Lithothamnion corallioides* and *Phymatolithon calcareum* are listed in Annex V (Animal and plant species of Community interest whose taking in the wild and exploitation may be subject to management measures) of the European Union's 'Habitats Directive' as amended[36]. Both species probably occur in the rhodolith beds in the present study area; however, only microscopic examination of samples of rhodoliths collected from the area will confirm this.

27. *Lithothamnion corallioides*, *Phymatolithon calcareum*, together with *Lithothamnion minervae* are listed in Schedule III (Animal and plant species of national interest whose conservation requires the designation of Special Areas of Conservation), and the first two named also in Schedule VII (Animal and plant species of Community interest whose taking in the wild and exploitation may be subject to management measures) of the *Flora, Fauna and Natural Habitats Protection Regulations, 2006* as amended[37], which transpose the requirements of the EU's Habitats Directive to local legislation.

32. Rhodolith and maerl beds are included in the UNEP/MAP/RAC-SPA "Reference list of marine habitat types for the selection of sites to be included in the national inventories of natural sites of conservation interest" (UNEP/MAP/RAC-SPA, 2006) while an action plan for their conservation has been formulated (UNEP/MAP/RAC-SPA, 2008), both within the ambit of the Barcelona Convention. Within European legislation, Council Regulation (EC) 1967/2006, concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea, bans the use of specific fishing

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the National Inventories of Natural Sites of Conservation Interest was drawn up at the Fourth Meeting of National Focal Points for Specially Protected Areas (Tunis, 12-14 April 1999) [see UNEP(OCA)/MED WG.154/7]. The most recent '*Classification of benthic habitat types of the Mediterranean*' dated 2006 is available from the UNEP RAC/SPA at http://rac-spa.org/sites/default/files/doc_fsd/lrhm_en.pdf

[36] The European Union's *Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora* is known as the 'Habitats Directive'. Annexes I and II of this Directive have been amended by Council Directive 97/62/EC of 27 October 1997. Annex I of the Habitats Directive lists natural habitats whose conservation requires the designation of Special Areas of Conservation. Annex II lists species of plants and animals whose habitats must be protected for their survival. Annex III lists criteria for selecting sites eligible for consideration as "Sites of Community Importance" and designation as Special Areas of Conservation, while Annex IV lists species of Union interest in need of strict protection. Annex V lists species of plants and animals of Union interest whose taking from the wild and exploitation is subject to management, and Annex VI lists prohibited methods and means of capture and killing of mammals and fish, and prohibited modes of transport. In anticipation of the 2004 enlargement of the EU, the Annexes of the Habitats Directive were modified by the Act of Accession signed in Athens on 16th April 2003, to take into account the expanded geographical area of the EU15+10. The annexes were further amended by Council Directive 2006/105/EC of 20 November 2006 in anticipation of Bulgaria and Romania joining the European Union in 2007 and then again by Council Directive 2013/17/EU of 13 May 2013 due to the accession of the Republic of Croatia.

[37] These regulations were last amended by the Flora, Fauna and Natural Habitats (Amendment) Regulations, 2013 (Legal Notice 322 of 2013).

gear (trawl nets, dredges, shore seines or similar nets) on coralligenous or maerl beds[38]. In order to conform to the requirements of EC 1967/2006, the local 'Implementation and Enforcement of Certain Fisheries Management Plans Order' (Legal Notice 354 of 2013) amends Zones C and G referred to in Annex V of EC 1967/2006 that originally overlapped with rhodolith beds as well as closed to trawling all areas where conclusive evidence exists for the presence of such beds (see Figure 44 in LN 354/2013).

32. The Needle-spined sea-urchin, *Centrostephanus longispinus* is listed in the Habitats Directive under Annex IV (Animal and plant species of Community interest in need of strict protection), in Appendix II of the Bern Convention[39], and in Annex II of the SPA/BD Protocol)[40]. This species is also protected locally under the *Flora, Fauna and Natural Habitats Protection Regulations, 2006* as amended, where it is listed in Schedule V (Animal and Plant Species of Community Interest in need of Strict Protection).

Marine and terrestrial Special Protection Areas

Breeding seabirds in the Maltese Islands

4.28. The Maltese coastal cliffs support four breeding seabird species, namely Scopoli's Shearwater (*Calonectris diomedea*), Yelkouan Shearwater (*Puffinus yelkouan*), Mediterranean Storm-petrel (*Hydrobates pelagicus melitensis*), and the Yellow-legged Gull (*Larus michahellis)*.

4.29. Shearwaters are members of the Order Procellariformes which includes also the albatrosses and petrels. They are pelagic species with the characteristic tube-noses on the base of the upper mandible. They visit land during the breeding season and do so under cover of darkness. A single egg is laid in a deep crevice or burrow or under loose boulders and vegetation. Sometimes, rabbit burrows are also used as breeding sites.

4.30. **Table 4.1** illustrates the breeding cycle of the three pelagic breeding seabird species and **Table 4.2** indicates their presence at the colonies throughout the

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[38] According to this Regulation,"Mäerl is a collective term for a biogenic structure due to several species of coralline red algae (Corallinaceae), which have hard calcium skeletons and grow as unattached free living branched, twig-like or nodule corallines algae on the seabed, forming accumulations within the ripples of mudflats or sandflats seabed. Maerl beds are usually composed of one or a variable combination of red algae, in particular, *Lithothamnion coralloides* and *Phymatolithon calcareum*". In this definition, 'maerl' is used in the wider sense to refer to 'rhodolith beds' as defined by Basso *et al.* (2016); true maerl is a particular type of rhodolith bed.

[39] The Bern Convention is the *Convention on the Conservation of European Wildlife and Natural Habitats*. Malta acceded to this Convention on the 26th November 1993. Appendix II of the Bern Convention lists strictly protected species of fauna and the Convention prohibits the deliberate capture, the destruction of breeding or resting sites, the deliberate destruction, and the deliberate killing of, and trade in, these species.

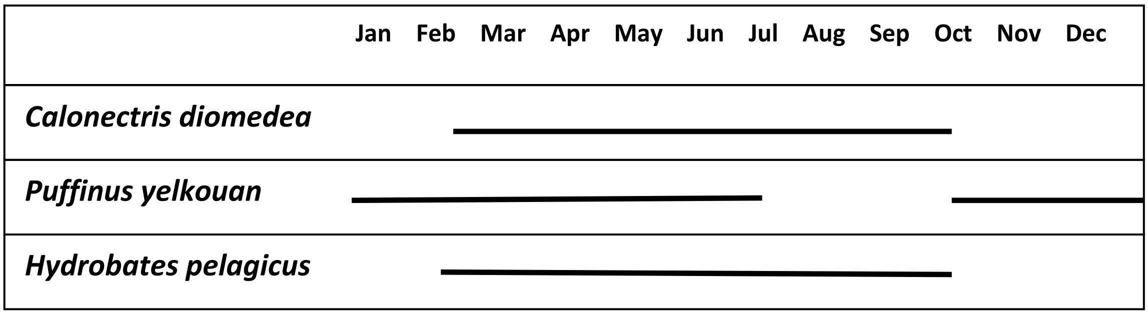
[40] A number of species are listed in annexes to the SPA/BD Protocol: Annex II lists endangered or threatened species and Annex III lists species whose exploitation is regulated.

year.

Table 4.1: Breeding biology and ecology of *P. yelkouan, C. diomedea*, and *H. pelagicus*

Arrival at colonies		Egg laying	Hatching	Fledging
Puffinus yelkouan	mid October	early February	early May	mid June/early July
Calonectris diomedea	end February	end May	mid July	mid October
Hydrobates pelagicus	end February	April-June	May-August	August to October

Table 4.2: Presence in colonies of the three pelagic breeding seabird species



Daily movements by Procellariiformes

4.31. Shearwaters travel vast distances to and from their breeding colonies in search of food. During the breeding season of *C. diomedea*, large numbers can be seen flying offshore in an east to west direction. Distance from land is conditioned by wind direction and strength. During strong North-westerly winds the shearwaters can be seen flying at a distance of less than 50 metres from the coast.

4.32. The same area is also used by Yelkouan Shearwaters, especially birds originating from the Rdum tal-Madonna colony (Borg *et al,* 2002[41], Borg *et al,* 2010[42], Raine *et al,* 2010[43], 2011[44] and 2012[45]) and more recently from the St

[41] Borg. J.J. & J. Sultana. 2002. Status and Distribution of the Breeding Procellariiformes in Malta. (30) Il-Merill.

[42] Borg, J.J., H., Raine, A.F. Raine, & N. Barbara, 2010. Protecting Malta's wind chaser: The EU LIFE Yelkouan Shearwater Project Report. Malta: EU LIFE Yelkouan Shearwater Project.

[43] Raine, A., H. Raine, A. Meirinho & **J.J. Borg**. 2010. Rafting behaviour of Yelkouan Shearwater *Puffinus yelkouan* breeding at Rdum tal-Madonna, Malta. (32) **Il-Merill**.

[44] Raine, A., H. Raine, **J.J. Borg** & A. Merinho. 2011. Post-fledging dispersal of Maltese Yelkouan Shearwaters *Puffinus yelkouan*. Vol.26 (2) **Ringing & Migration.**

[45] Raine, A., **J.J. Borg**, H. Raine & R.A. Philips. 2012. Migration Strategies of the Yelkouan Shearwater *Puffinus yelkouan* (154) **Journal of Ornithology**.

Paul's islands (see **Appendix 2**).

Other bird species

4.33. Another regular visitor to the study area and immediate whereabouts is the Yellow-legged Gull (*Larus michahellis*). This resident breeding bird is present almost all year round.

Rafting

4.34. Rafting is the convergence of birds on water, normally in the vicinity of their breeding colonies. During calm afternoons these congregations of birds can reach impressive numbers with several hundreds of birds waiting for darkness. Birds start assembling about two to three hours before sunset and then start to dissipate around dusk when the whole congregation is within a few hundred metres from the cliffs. The main reason for birds rafting is to rest, and it is safest to do this in large numbers when many birds are looking out for danger. For example, both the Scopoli's and Yelkouan Shearwaters raft offshore in the evenings, waiting to return to their breeding colonies under the safety of darkness. Rafting is a time to socialise, and is an important aspect of a seabird's life. As noted in **Appendix 2**, it has also been hypothesised, that seabirds use these congregations to assess the health of their population, although this is now highly disputed considering the fact that individual birds from other colonies in other countries form part of these rafts.

Fish pens: supplementary food source for seabirds

4.35. Borg (2012) presented some preliminary results from studies into tuna farms acting as a supplementary food source for storm petrels. It was noted that the use of raw, unwashed fish food is fundamental in attracting storm petrels closer to these tuna pens. The same food supply attracts a constant presence of small fish around the pens which in turn attract gulls and terns, especially the Black Tern (*Chlidonias niger*).

4.36. Observations have shown that the majority of storm petrels frequenting the IBA are adult birds undergoing primary wing moult, suggesting breeders, probably not venturing far away from the colonies during the chick rearing period. A smaller number of birds seen during the site visits were juvenile birds covered in a fresh coat of dark plumage. These young birds are present from the latter part of August to early September. Tuna penning is locally carried out during the summer and autumn months (mid-July to November / December).

4.37. It was recommended that further investigations should focus to identify if this reliable food source has any effect on the breeding success and fledglings survival in storm petrels. While adult storm petrels regularly fall prey to yellow-legged gulls on Filfla (Borg *et al*., 1992-94, Sultana *et al,* 2011) no interactions between gulls and storm petrels were ever noted near the tuna pens. Further research is required to determine the extent of dependency by storm petrels on this food source.

Threats

Light pollution

4.38. The use of light sources from land and at sea is of particular concern for seabirds. It is known that light interferes with the behaviour of birds and other animal groups, including bats. In those areas where electricity has been installed especially close to seabird colonies, birds have completely deserted the site. Birds and other animals found close to light sources are known to behave in an abnormal way; several species of birds remain active during night time. Light also disrupts the normal cycle of other vertebrates as well as numerous species of invertebrates making them susceptible to predation.

4.39. In some cases, seabird breeding colonies have been abandoned when electricity was introduced in the area, places like Xlendi Bay, Ħal-Far, Għar Lapsi and Wied iż- Żurrieq, where colonies of both Scopoli's and Yelkouan Shearwaters have been negatively affected.

Noise

4.40. Noise has a negative effect on the normal patterns of incoming shearwaters during night time. Birds tend to fly away from any sound source as was observed on numerous occasions. When a boat passes close to a breeding colony, all activity stops until the boat (noise source) is no longer audible.

Importance of areas of ornithological conservation interest in the A of I

4.41. The following summarises the importance of the areas of conservation importance within the A of I:

- **Ramla tat-Torri/Rdum tal-Madonna area MT0000009**: This area holds the most important Yelkouan Shearwater (*Puffinus yelkouan*) colony in the Maltese Islands as well as a small colony of Scopoli`s Shearwater (*Calonectris diomedea*). **Figure 4.6** shows the cliff area occupied by the seabird colonies. In 2016 the Mediterranean Storm-petrel (*Hydrobates pelagicus melitensis*) was found breeding inside one of the numerous caves in the area. Other breeding bird species in this SPA are the Blue Rock Thrush (*Monticola solitaries*), Short-toed Lark (*Calandrella brachydactyla*), Sardinian Warbler (*Sylvia melanocephala*) and Spectacled Warbler (*Sylvia conspicillata*).

- **Kemmuna, Kemmunett, il- Ħa ġriet ta' Bejn il-Kmiemen u l-Iskoll ta' Taħt il-Mazz MT0000017**: The eastern coast is of particular interest for this study as it supports breeding colonies of Yelkouan and Scopoli`s Shearwaters, see **Figure 4.7**.

- **Il-Gżejjer ta' San Pawl (Selmunett) MT0000022**: In the last decade, a small colony of Yelkouan Shearwaters has been re-discovered breeding on the island.

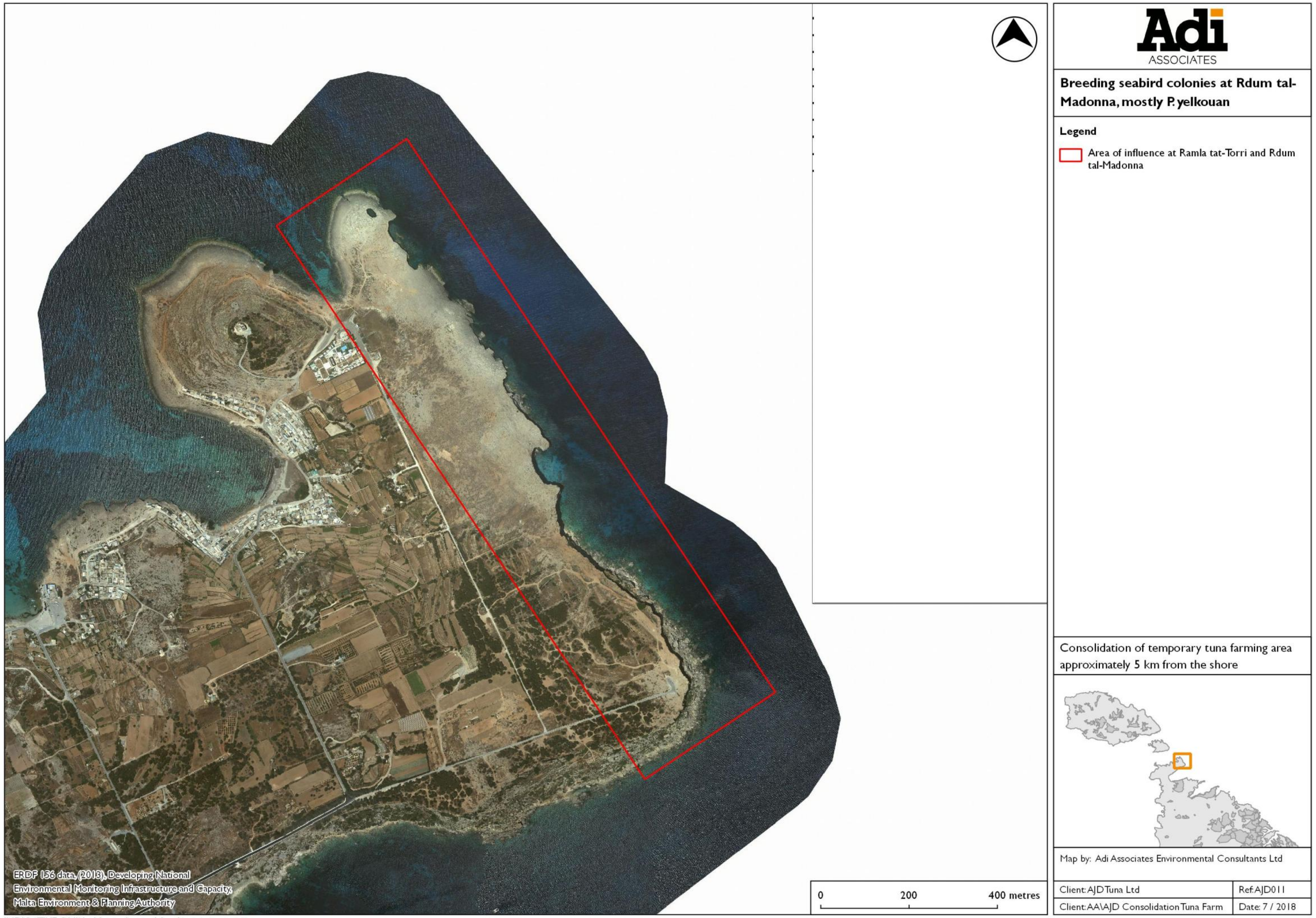
- **Il-Baħar madwar Għawdex MT0000112 and il-Baħar tal-Grigal MT0000107**: Two marine conservation areas identified during the EU Life funded project Malta Seabird Project (2012-2016) for their importance as feeding grounds for the three pelagic species, namely *Calonectris diomedea, Puffinus yelkouan* and *Hydrobates pelagicus*.

Priority areas in the marine environment for the three Procellariiformes

4.42. **Appendix 2** makes reference to the IBA Inventory, 2015 (Metzger *et al*., 2015) which provides additional detail about how each breeding seabird species uses the marine environment. This report helped to provide the basis for the designation of marine SPAs.

4.43. For the Maltese breeding population of *P. yelkouan*, three main hotspot areas were identified, one around Gozo, including the Gozo-Comino Channel and along the west- and southwest coast of Malta, a second one offshore in the northeast of Malta and a third one offshore in the southwest of Malta (see **Appendix 2**). For the Maltese breeding population of *C. diomedea*, five priority areas were identified in the Maltese Exclusive Fishing Zone (EFZ), the first one around and north of Gozo and a second one along the west and southwest coast of Malta. In addition, three offshore areas were identified east, southeast, and south of Malta (see **Appendix 2**). For *H. pelagicus melitensis* breeding in the Maltese Islands the core area covers a coastal zone around Malta and a larger area of sea east of the island. Additionally, a small area is found in the Pantelleria channel northwest of Gozo as well as an area southwest of Malta (see **Figure 4.8** and **Appendix 2**).

Figure 4.6: Area of importance for seabird colonies at Rdum tal-Madonna

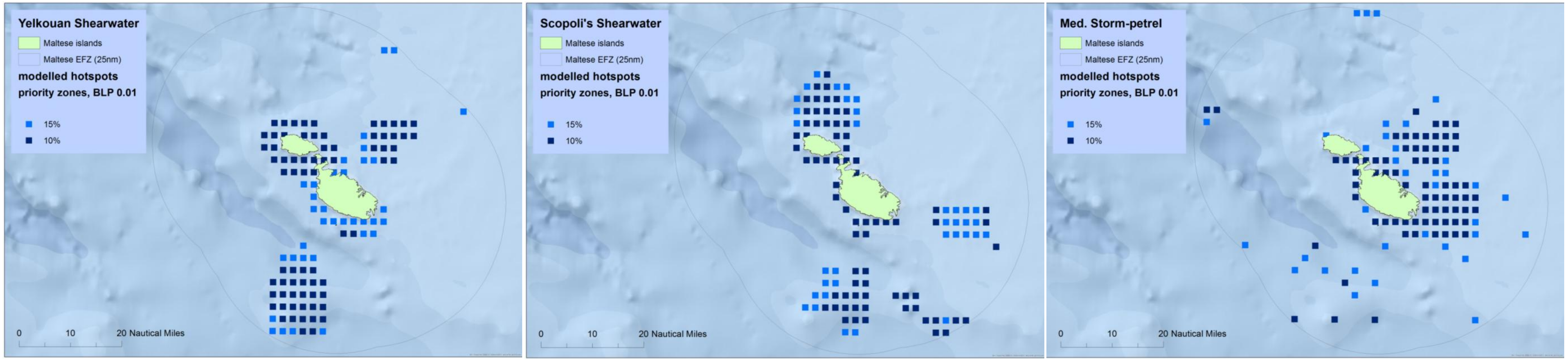


INDICATIVE ONLY - Not to be used for direct interpretation

Figure 4.7: Seabird colonies on Comino

INDICATIVE ONLY - Not to be used for direct interpretation

Figure 4.8: Maps showing priority areas for breeding Procellariiformes



Priority areas for *P. yelkouan* within the Maltese EFZ, dark blue squares: 10%, light plus dark blue squares: 15%

Priority areas for *C. diomedea* within the Maltese EFZ, dark blue squares: 10%, light plus dark blue squares: 15%

Priority areas for *H. pelagicus melitensis* within the Maltese EFZ, dark blue squares: 10%, light plus dark blue squares: 15%

Source: Metzger *et al.*, 2015

5. ASSESSMENT

APPROPRIATE ASSESSMENT, CONSERVATION OBJECTIVES AND SIGNIFICANCE

5.1. As described above, an Appropriate Assessment was requested to determine whether the effects of the Scheme are likely to result in potentially significant impacts. In determining impacts on SACs and SPAs, an Appropriate Assessment is restricted to the effects of the plan or project on the conservation objectives of the specific SAC or SPA. However, specific conservation objectives for the marine SACs / SPAs have not yet been determined. ERA is currently working on management plans for the marine sites, during which process conservation objectives are likely to be developed. In the meantime, in the absence of specific objectives, therefore, the overall conservation objective is to ensure the long-term conservation of the habitat and species of conservation interest with a view to improving their conservation status or maintaining a favourable status as relevant.

Impact assessment

Determining impact significance

5.2. In assessing the significance of the potential negative impacts arising from the Scheme on the vegetation communities and species of conservation interest in the area, the following criteria have been used:

- **Not significant** (e.g. no material change in extent of species populations and/or habitats of conservation interest);
- **Minor significance** (e.g. small-scale or temporary disturbance that is unlikely to affect the viability of the species populations and/or integrity/conservation status of the habitat types of conservation interest); and
- **Major significance** (e.g. large-scale or long-term disturbance that is likely to affect the viability of the species populations and/or the integrity/conservation status of habitats of conservation interest).

5.3. The concept of "material change" needs to be viewed in the context of the Scheme. For a change to be material, it must affect the long-term interactions of the species present at the site more than they would be affected by impacts from natural processes or by the continuation of the uses already extant in the area and to which the ecology may be accommodated.

Potential impacts - prediction and significance

Direct loss of benthic habitat

5.4. Deployment of the cage mooring is expected to impact the benthic habitat when the concrete block is deployed on the seabed. All benthic flora and fauna, the latter mostly comprising sessile and slow moving invertebrates, that will end up underneath the mooring block will be decimated. The more motile fauna, such as fast moving invertebrates and fishes are expected to move away rapidly from a mooring block that is being deployed.

5.5. On deployment, the moorings hitting the seabed will lead to suspension of sediment in the water column. Settling of the suspended sediment on the bottom will lead to smothering of flora and sessile fauna, resulting in potential adverse effects on such organisms, although the concerned species are usually adapted to disturbance from suspended sediment and will recover quickly, while the high energy environment of the area will help rapid removal of any sediment particles that may have been deposited on the biota.

5.6. Good practice and measures to reduce the adverse impact of deployment of the mooring on the seabed, for example, by avoiding dragging the mooring block on the seabed during deployment, are the only mitigation measures to reduce potential adverse impacts.

5.7. **Figure 5.1** illustrates the proposed cage and mooring locations in relation to the habitats as mapped during the baseline study. The moorings will largely be located in the coarse sediment area but also through the habitats with varying percentages of rhodoliths ranging from 0 to 50%, and a small part on the northwestern area of the Scheme, also in the area with 50 - 100% live rhodolith cover. The number of moorings along these habitat types is considered to result in cumulative effects within these biocoenoses.

5.8. As described in **Chapter 4**, maerl and rhodolith associations are important from a conservation point of view. Taking the above into consideration, the overall level of impact on the seabed is predicted to be of minor to major significance depending on the amount of rhodoliths affected[46].

5.9. The impact on the flora and fauna that will end up beneath the mooring block will be permanent, while impacts on the flora and sessile fauna present in the immediate vicinity of the block will be temporary and of short duration (few days).

Disturbance to marine fauna resulting from increased vessel activity

5.10. An increase in vessel activity is envisaged in the vicinity of the tuna penning site to enable deployment of the cage moorings, mooring ropes and tuna pens and then during operation. This is expected to result in disturbance to pelagic fauna present in the general area where the new tuna pens will be deployed. Although detailed data on the pelagic fauna that occur within the Area of Study are lacking, it is expected that several species of pelagic fish, turtles and

[46] Impacts on the habitats containing 0-20% or 20-50% of live rhodolith cover are deemed to be minor; Impacts on habitats containing 50 -100% live rhodolith cover are deemed to be major.

cetaceans migrate in its vicinity. Such fauna will be exposed to disturbance from the increased vessel activity and from deployment of the cage moorings, ropes and tuna pens. However, the fauna that are expected to be affected are mobile and will swim away from the affected area such that there could be a small deviation of the migratory route whereby significant adverse effects to the animals would not be expected.

5.11. Good practice and measures to reduce disturbance to a minimum are the only mitigation measures to reduce potential adverse impacts.

5.12. The overall level of impact is predicted to be not significant to minor. The impacts will be temporary and effective during deployment of the cage moorings, ropes and tuna pens.

Contaminants from vessels used in connection with the tuna penning operations reaching the marine environment

13. A number of vessels are expected to operate in the vicinity of the tuna penning site in connection with the farming acvitiy. These include work boats that will be used to transport the feed fish and to feed the caged tuna, boats used for general maintenance of the tuna pens, and vessels used during the period when the tuna are harvested. The latter vessels will be the largest of the ones used in connection with the tuna farming activity but will only be present during the 2 – 3 month period during which harvesting of the tuna will be carried out. Because of the regular presence of such vessels in the vicinity of the tuna penning site, there is a potential for accidental or deliberate introduction of contaminants such as fuel or lubricants to reach, the marine environment. However, excepting an accident, whether such introduction of hazardous substances and chemicals into the marine environment will actually occur will largely depend on good management and work practices, and effectiveness of environmental protection measures.

14. Contaminants may have toxic effects on the marine flora and fauna, which could include reduction in reproductive potential and capacity, fertilisation success, development and physiological function. However, the site concerned is located in deep offshore waters that are characterised by a high hydrodynamic regime; hence, any small spillage of hazardous substances and chemicals will be rapidly dispersed. The impact is likely to be not significant to minor, and would only be minor to major in case of a larger spill.

15. Any introduction of toxic substances and contaminants will depend heavily on application of precautionary measures, and on the toxicity and levels of substances and contaminants potentially introduced to the marine environment. Therefore, good practice and measures to reduce spillage into the marine environment, hence ones that prevent the introduction of toxic substances and contaminants to the marine enviroment, will be important to mitigate potential adverse impacts.

16. In summary, therefore the overall level of impact is predicted to be not

significant to minor, which could increase to minor to major significance in the case of large scale spillage.

Decreased light reaching the seabed as a result of shading by the tuna cages

5.17. Tuna cages typically have a diameter of around 50 m and support a cage net that is approximately 35 m high. The cage net and the tuna they hold are expected to produce a shading effect and reduce the amount of light reaching the seabed. The reduced light availability will have an adverse effect on any rhodoliths present on the seabed, even if these are present in small accumulations or are sparsely distributed on the bottom, given that the photosynthetic capacity of the algae making up the rhodoliths will be decreased such that they will stop growing or die. With regard to any associated megafauna and macrofauna, the sparse rhodolith accumulations recorded from the Scheme site are not known to support a high diversity of associated fauna, at least compared to dense rhodolith beds, while the fauna that occurs in association with such habitat is more typical of lower infralittoral and upper circalittoral coarse sediments. Therefore, the main adverse impact is expected to be mostly on the rhodoliths.

5.18. The shading effect cannot be mitigated unless the cages are removed and is a consequence of the presence of a floating structure – the tuna pen - which cannot be modified or replaced by another structure that does not cause shading.

5.19. **Figure 5.1** illustrates that half of the cages will be located over the association with 20-50% rhodolith cover and the other half will be located over the association with 0-20% rhodolith cover. The impact on the rhodoliths is considered to be of major significance, whereas it is not significant in the case of the other habitats.

5.20. The impact will be present throughout the period when the tuna pens are in place; however, if these are removed (e.g. to relocate to the North Aquaculture Zone once this is established and assuming this is located in a different site), recovery is expected since coralline algae will recolonise any rhodoliths whose algal component would have demised, a process that would be expected to take at least a few months.

Increased nutrient input, originating from the farmed tuna's waste and feed fish, to the water column

5.21. The tuna farming operations are expected to result in some nutrient and organic loading of the water column. The nutrients and organic matter will mainly originate from faecal matter excreted by the farmed tuna and from decomposition of any uneaten feed fish that will end up on the seabed. Water quality surveys have been carried out at local tuna penning sites since the early 2000s. During these surveys, standard water quality attributes, namely dissolved oxygen, temperature, salinity, turbidity, nitrates, phosphates, chlorophyll *a*, ammonia, and counts of intestinal bacteria, as well as sea currents, were measured at a number of sampling stations located in the immediate vicinity of the tuna farms and at up-current and down-current reference stations. The results of such surveys indicate that, very rarely, lowered levels of oxygen, reduced water transparency and elevated nutrient (nitrates and/or phosphates and/or ammonia) levels were recorded from the tuna penning sites during the farming season (July – December). However, the observed changes in the monitored attributes were often sporadic and not statistically significant, and have not resulted in appreciable alteration of water quality. Elevated counts of intestinal bacteria have also been occasionally recorded, these originate from sewage, not tuna farming, therefore their presence was not attributed to the tuna penning activities directly, although there is the possibility that large ships (e.g. the processing ships present during harvesting of the tuna) may be the source of such contamination through discharge of sewage from their holding tanks. Such favourable results with respect to water quality are attributed to the high energy environment, particularly strong sea currents present, that characterise the offshore area where the proposed tuna penning site is located, and which lead to rapid and effective dispersal of nutrients that may originate from the tuna farming activity.

5.22. Nevertheless, good practice and measures to reduce loading of the water column with nutrients and organic matter are recommended; in particular excessive loading by organic matter can be reduced by ensuring that overfeeding is avoided, such that the amount of uneaten feed fish that are introduced to the marine environment will be minimal.

5.23. Thus, the overall level of impact of nutrient and organic matter loading of the water column on water quality and associated biota (e.g. plankton) is predicted to be minor to not significant.

5.24. With respect to the duration of impact and residual effects; the impact will be effective throughout the period when tuna farming is carried out (4 - 6 months), with progressively reduced effects as the tuna is harvested and the reared biomass reduced.

Deposition of organic matter, originating from the farmed tuna's waste and feed fish, on the seabed

5.25. The tuna farming operations are expected to result in organic loading of the seabed. The organic matter will mainly originate from decomposition of uneaten feed fish that may end up on the seabed. Such organic loading is expected to have a large impact on benthic habitat, which would result in changes to sediment quality and to the species composition of biotic assemblages associated with lower infralittoral/upper circalittoral coarse sediment habitat. In cases where the impact is large and adverse, loss of habitat and biodiversity may occur.

26. Video surveys of the seabed underneath tuna cages have been undertaken

regularly at local tuna farms since the early 2000s. The main aim of such surveys was to gather qualitative and semi-quantitative data, using direct observation, on the physical and biological characteristics of the seabed underneath the tuna pens. The results of these surveys have indicated that towards the end of each penning season (in autumn) considerable amounts of uneaten feed fish littered the seabed in the area lying directly below the tuna pens, although not in areas beyond the perimeter of the tuna pens. This resulted in alterations in the physical and biological characteristics of the seabed under the pens, namely (i) changes in biological characteristics, which typically consist of high population densities of detritus-feeding and scavenging benthic (i.e. associated with seabed) fauna, and whose occurrence is unusual considering the benthic habitat type present at the tuna penning sites surveyed; (ii) alterations in physical characteristics, which typically consist of the presence of large quantities of fish bones and baitfish that are gradually consumed by scavengers or eventually decompose. The results of the video surveys also indicated that the amount of uneaten feed fish present varied considerably between the different pens, and between different farms, with some only having small amounts of feed-fish beneath them and others having multiple layers of decomposing feed-fish. Once the tuna farming season is over (late winter), a negligible amount of uneaten feed-fish remain on the seabed below the pens. However, thick layers of fish bones and of decomposing organic material persisted under some of the pens. These observations indicate a consistent pattern, with the volume of uneaten feed-fish on the seabed decreasing only when the tuna have been harvested (and therefore there is no further addition of feed-fish). Any uneaten fish remaining on the seabed at this time will continue to decompose slowly and, if present in large numbers, form a continuous layer of decomposing organic material. Sometimes, following storms and possibly due to strong bottom currents, this layer is admixed with the underlying mobile sediment. In places where the decomposition process is complete, the only remains are fish bones that eventually disperse in the sediment leaving little or no trace of the original uneaten fish on the surface. Once the source of the impact (periodic addition of new uneaten food) is removed, slow recovery to the original state is characterised by the re-appearance of certain megafaunal species (e.g. the irregular sea urchin *Spatangus purpureus* and the crinoid *Antedon mediterranea*) that form part of the original fauna that characterise the bare muddy sand bottom of the areas where the tuna farms are located.

27. Monitoring of sediment quality at local tuna penning sites has also been carried out regularly since the early 2000s. The main aim of such monitoring is to assess the levels of organic carbon content and organic nitrogen content of the sediments, as well as sediment granulometric characteristics. Moreover, at least one survey involving assessment of levels of pollutants, including heavy metals and organic pollutants, was carried out at some of the

extant tuna penning sites. The monitoring design of the surveys to assess organic carbon content and organic nitrogen content of the sediments, and sediment granulometric characteristics, was based on a Beyond BACI[47] layout, in which the results of quantitative analyses of sediment samples collected from the tuna farming site and from a number of control sites before the start of the farming operations are compared with those obtained after a farming season using advanced statistical analyses. Overall, the findings from surveys that were aimed at assessing organic carbon content and organic nitrogen content of the sediments, and sediment granulometric characteristics, indicated 'pulse' (i.e. short duration) changes in the physico-chemical properties of the sediment following some of the tuna penning seasons. When these changes were recorded they were restricted to the seabed area located in the immediate vicinity of the tuna pens and/or in the general area occupied by the pens; however, no significant permanent alterations of the sediment characteristics at the operational sites have been recorded to date. Where significant changes were detected, these appeared to have resulted from accumulation of large amounts of uneaten feed-fish in the vicinity of the tuna pens, which decompose slowly causing alterations in the physico-chemical properties of the sediments. The results of the surveys aimed at assessing levels of heavy metals and pollutant organics indicated that no elevated levels were present in the sediments in the vicinity of the tuna farms.

28. Monitoring of benthic diversity at local tuna penning sites has also been carried out regularly since the early 2000s. The main aim of such monitoring is to assess for potential changes in benthic species populations and habitat that may result from the tuna penning activities. The monitoring design was based on assessing total species richness and total abundance of selected benthic faunal species, as these are deemed good indicators of the overall state of species and habitats associated with the seabed. As in the case of the physico-chemical attributes monitoring component, the design for monitoring of benthic diversity was based on a Beyond BACI layout, in which the results of quantitative analyses of samples collected from the tuna farming site and from a number of control sites before the start of the farming operations are compared with those obtained after a farming season using advanced statistical analyses. Overall, the findings from monitoring of benthic diversity indicate a significant, long-lasting adverse impact (manifested as a significant decrease in total macroinvertebrate species richness and/or decrease in the abundance of one or more of the indicator species) following some of the tuna penning seasons; when these changes were recorded they were restricted to the seabed area located in the immediate vicinity of the tuna

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[47] Before After Control Impacted; see Underwood (1992): Underwood, A. J. (1992) *Beyond BACI: the detection of environmental impacts on populations in the real, but variable, world*. 161. Journal of Experimental Marine Biology and Ecology

pens and/or in the general area occupied by the pens. Furthermore, enhanced productivity in the general area of the tuna farms and beyond, as a result of the tuna-penning activities, was evident from significant increases in the abundance of some of the indicator species recorded in some of the monitoring sessions. These observations are a strong indication that, where present, adverse impacts on the benthic macroinvertebrate assemblages and habitat at the tuna penning sites have resulted from processes that are mainly attributed to accumulation of large amounts of uneaten feed-fish and slow decomposition of same, in the vicinity of the tuna pens. The uneaten feed-fish attract scavengers and other opportunistic fauna that cause changes to the original species composition of the benthic assemblages, while slow decomposition of the accumulated material causes alterations in the physico-chemical properties of the sediments, and presumably of the sediment-water interface, leading to adverse conditions for the biota originally present. Mangion *et al* (2014; 2017; 2018)[48] similarly describe the influence of local tuna penning activities on marine benthic habitat.

5.29. Good practice and measures to reduce excessive loading of the seabed by organic matter are the main mitigation measures that can be adopted to avoid or at least reduce adverse impacts on the benthic biota and habitat present in the vicinity of the tuna penning site. Essentially, good feed management procedures will be very important to mitigate adverse impacts resulting from organic loading of the seabed.

5.30. Taking the above into consideration, the overall level of impact of organic matter loading of the seabed, and hence on benthic biota and habitats present at the tuna penning site, is predicted to be minor to major within the seabed area directly underneath the cages (depending on the feed management practices); and minor to not significant in the seabed area beyond.

5.31. The impact may persist even after the cages are removed until all introduced organic matter has decomposed, been scavenged.

Generation of a surface slick comprising fish oils released from the feed fish

5.32. The tuna farming activity is expected to generate oils and fats that are released from the thawing feed-fish when these are fed to the tuna. Release of such substances occurs when the semi-frozen feed fish are introduced in

[48] Mangion M., Borg J. A., Thompson R. & Schembri P. J., 2014. *Influence of tuna penning activities on soft bottom macrobenthic assemblages*. 79. Marine Pollution Bulletin 79.

Mangion M., Borg J. A., Sanchez Jerez P & Schembri P. J., 2017. *Assessment of benthic biological indicators for evaluating the environmental impact of tuna farming*. 48. Aquaculture Research.

Mangion M., Borg J. A., Sanchez-Jerez P., 2018. Differences in magnitude and spatial extent of impact of tuna farming on benthic macroinvertebrate assemblages. 18. Regional Studies in Marine Science.

the tuna pens, and when uneaten feed-fish end up outside the fish cages. The resulting floating slick of fatty substances that accumulate on the surface may be transported offshore or inshore, depending on sea current strength and direction. Such substances, commonly known as 'fish farm slime', have caused much public concern and outcry. Although they are not deemed to have any toxic effects on pelagic marine species and habitats, they are aesthetically unpleasing and a nuisance to bathers, divers and coastal recreational activities. A modelling exercise was carried out as part of the Environmental Impact Assessment that is concurrently being prepared for this development permit application whereby it was determined that, in effect, such oily slicks can in fact have a wide trajectory around the Maltese Islands, even crossing between the Malta – Gozo channel to the west coast. The deposition of such substances on the shore is not envisaged to have any large adverse effects on marine species and habitats also because they will rapidly biodegrade. However, it should be noted nonetheless this has not yet been thoroughly assessed given the lack of studies that deal specifically with this aspect.

5.33. Good practice and measures to reduce the release of oils and fats from the feed fish, restrict their presence to the immediate vicinity of the tuna farm (e.g. by using booms), and carrying out immediate collection of the substances (e.g. using skimmers) when appreciable amounts of them are released to the marine environment, are the main mitigation measures that can be adopted to avoid or at least reduce their presence on the surface in coastal areas close to the fish farms and inshore.

5.34. The overall level of impact when floating oily and fatty substances originating from the feed fish end up on the surface in offshore waters and are potentially transported inshore, is predicted to be minor to not significant with respect to adverse impacts on marine ecology, including shore habitat where they may be deposited.

Littering of the seabed underneath the tuna cages and in their vicinity

5.35. The results of video surveys made below tuna cages at local tuna penning sites have indicated that, in places, a considerable amount of anthropogenic items are found below the pens that appear to originate from farm operations. These include concrete weights with ropes attached, sheets and sacks of fabric and other material, car tyres, lengths of rope and other unidentified items. While plastic items are known to be hazardous to marine life, items deposited on the seabed lead to physical alteration of the bottom leading to potential changes to the benthic habitat present in the vicinity of the fish farm. Items such as ropes also provide a risk of entanglement to marine life.

5.36. Good practice and measures to reduce littering of the seabed by anthropogenic items originating from the tuna penning activities are the main mitigation measures that can be adopted to avoid littering of the seabed. Should any items originating from the fish farm accidentally end up in the sea, whether floating or deposited on the seabed, these should be recovered immediately.

5.37. The overall level of impact when anthropogenic items originating from the fish farm end up in the sea, whether floating or deposited on the seabed, is predicted to be minor to major depending on the type of items and whether they can be transported away from the site if not removed imminently.

Attraction of wild fauna to the tuna farm

5.38. Fish farms, including tuna ranches, are known to attract a variety of wild marine pelagic fauna. These include shoals of small pelagic fish (such as Clupeid species) which eat the fragments of feed fish that are released in the water, and the biota growing on the tuna pen nets; medium-sized predators such as *Coryphaena hippuris* and *Seriola dumerilii* which feed on the small pelagic fish that aggregate in the vicinity of the tuna cages; large pelagic predators including cetaceans (namely dolphins), which feed on the medium-sized predators and uneaten feed fish present outside the tuna pens; and wild tunas that are attracted to the caged tuna and also feed on uneaten feed fish that end up outside the tuna pens. The site therefore acts as a fish aggregating device and can change the composition of the ecology within the area. This can have an impact on throughout the food chain; refer also to impact assessment on avifauna below.

5.39. The attraction of fish to the Scheme site also attracts fishermen who carry out fishing activities in the vicinity of the tuna farms, targeting the wild fish present there; indeed because of such 'facilitated' harvesting of wild fish, fish farms have been described by marine ecologists as serving as 'ecological traps'. Prohibition/strict control of fishing activities in the vicinity of the tuna farms is the main mitigation measure that can be adopted to avoid detrimental (and sometimes) illegal harvesting of wild fish, including tunas) in the vicinity of the fish farms.

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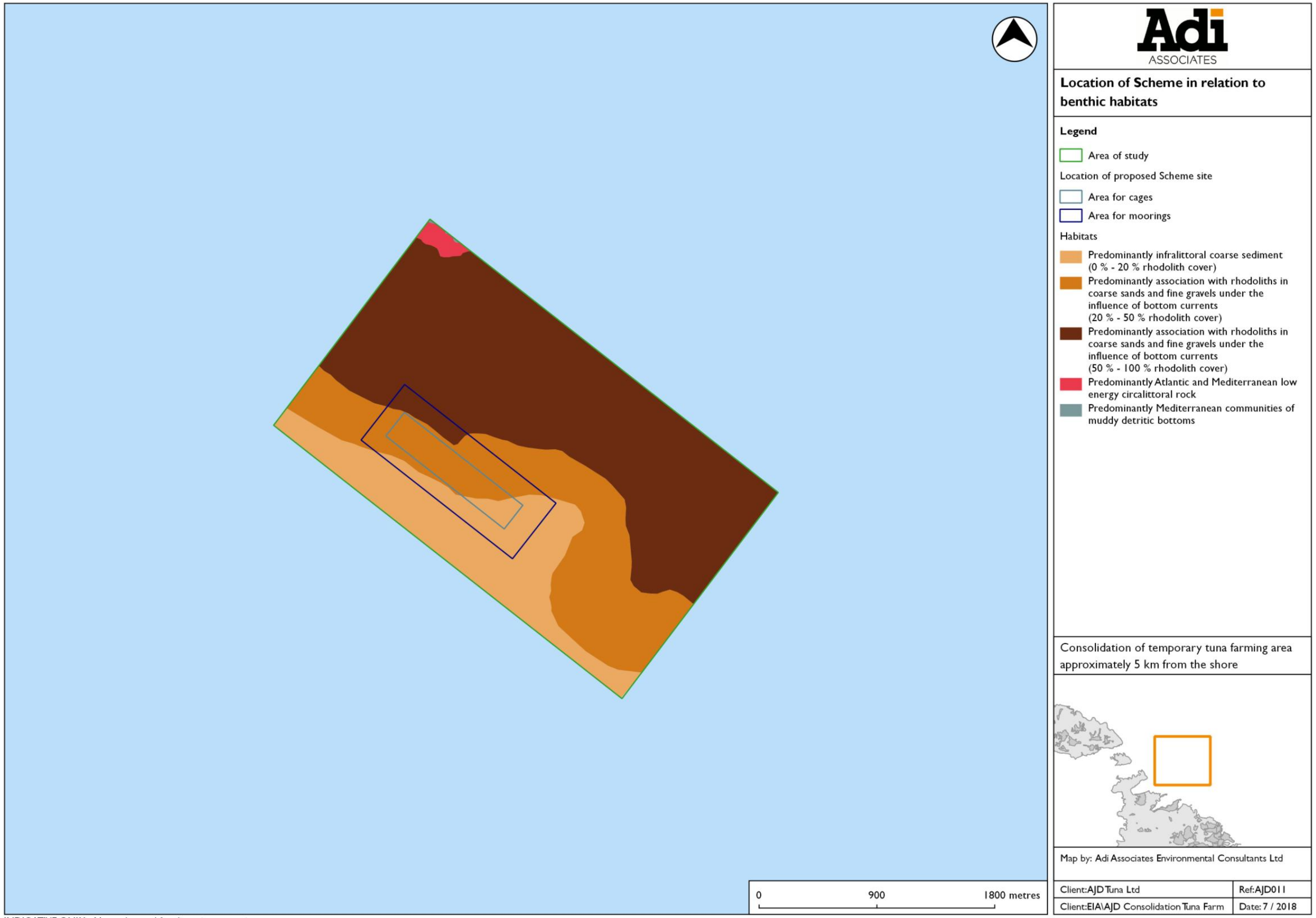
Figure 5.1: Location of Scheme in relation to benthic habitats



INDICATIVE ONLY - Not to be used for direct interpretation

Impacts on seabirds

5.40. The Scheme could result in a number of impacts on seabirds, including:

- Impinging on sea area that is used by the seabirds for activity including rafting, social interaction, potentially feeding, etc;
- Disturbance due to light pollution;
- Disturbance due to noise pollution;
- Change in prey abundance;
- Increasing population of Yellow-Legged Gull (predator);
- Entanglement; and
- Ingestion of marine debris.

Competition for sea space

5.41. As described in **Chapter 3**, importantly, the Scheme falls within the SPA Il-Baħar ta' Madwar Għawdex which was designated on account of its importance for the ecology of *C. diomedea* and *P. yelkouan* breeding populations. **Appendix 2** reports on the priority marine areas identified that are used by the three species of Procellariiformes and upon which the eventual designation of the marine SPAs was based (refer also to Malta's IBA Inventory Report, 2015). These first maps show too that the sea space in this area is also used by *H. pelagicus melitensis*. As described in Malta's IBA Inventory Report, 2015, each species has been recorded spending time in the marine environment close to their colonies before entering the colonies. They use these areas for gathering, rafting, social interaction, and possibly also sometimes foraging. These areas are therefore considered to be seaward extensions to the terrestrial breeding colonies. The extent of these areas used is species-specific and considered by Metzger *et al* (2015) to be as follows:

- *Puffinus yelkouan* up to 7 km;
- *Calonectris diomedea* up to 4 km; and
- *Hydrobates pelagicus* up to 1 km.

5.42. It is also noted that these areas are used by prospective individuals that may not yet have bred as well as other non-breeding species.

5.43. Additionally, these three breeding seabird species carry out pelagic foraging in areas further offshore. Such areas were also identified as part of the 2015 IBA Inventory.

5.44. Thus, analysing the importance of Il-Baħar ta' Madwar Għawdex SPA for each of the species and how they use this area, allows for a better understanding of the potential impact on each species.

5.45. The Scheme is located approximately 4.8 km from the Rdum tal-Madonna seabird colonies and 6.6 km from the eastern Comino colonies. Thus, the Scheme is located in an area that lies within the seaward boundary of the *P. yelkouan* breeding colony. According to the maps as reproduced in **Appendix 2,** the Scheme site is also part of the priority area for *H. pelagicus*, and could be important for foraging for this species. From the findings of the desk study, the Scheme site does not lie within a priority area for *C. diomedea*.

5.46. Although the Scheme lies within an area of importance, in particular for *P. yelkouan*, the Scheme takes up an area of approximately 0.26 km^2. Considering that this species has a relatively extensive seaward colony extension and considering also that *P. yelkouan* prefers to raft in relatively small groups[49], the presence of the Scheme is not expected to disrupt the behaviour of *P. yelkouan* to such an extent that could affect the breeding success of the identified colonies on the coast. Similarly with regards to foraging within this area, Forrest *et al*. (2007)[50] noted that if any adverse effects of habitat exclusion occurred, then their significance will depend on the spatial scale of the aquaculture facility in relation to the distribution and abundance of prey species. The impact is therefore considered to be of minor significance.

<u>Impacts on seabirds from light pollution</u>

5.47. As noted in **Appendix 2**, light poses a threat to birds, affecting their behaviour, sometimes to such an extent that can affect breeding colonies and therefore, possibly also breeding success. Lights can cause disorientation, collision, and death of seabirds transiting through the site at night due to inappropriate navigation or vessel level lighting.

5.48. The addition of the Scheme will include lights as a safety precaution to alert mariners to the presence of the cages at night time. A total of six solar-powered navigational lights will be installed at the periphery of the aquaculture area, as instructed by Transport Malta. In addition, one solar marine light (see **Appendix 3** for specifications) will be fixed to each cage for safety reasons, providing approximately 24 additional lights. During consultation, Transport Malta, stated that the six navigational lights must always be switched on whereas the additional cage lights are not required in terms of navigational safety. The Scheme is located adjacent to a bunkering

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[49] Raine, A., Raine, H., Merinho, A., Borg. J.J. 2010. *Rafting behaviour of Yelkouan Shearwater,* Puffinus yelkouan *breeding at Rdum tal-Madonna, Malta*. 32. Il-Merill.

[50] Forrest, B.M, Keeley, N., Gillespie, P., Hopkins, G., Knight, B., Govier, D. (2007). *Review of the ecological effects of marine finfish aquaculture: Final report*. Prepared for Ministry of Fisheries. Cawthron Report 1285. Cawthron Institute, Nelson, New Zealand.

area, another artificial light source. It is considered that the Scheme will potentially contribute cumulatively to the existing light pollution seaward of the breeding sites. It is difficult to assess the extent of this impact in the absence of data related to how the existing situation affects seabirds and to what extent. It is also noted that the lights are not downward facing, which could otherwise help mitigate the extent of impact. In light of this the impact is judged to be of minor to major significance reflecting the uncertainty on the impact to the breeding seabird populations. If only navigational lights (six lights) remain on during the breeding season, the impact may be more likely to be minor. Monitoring would be required in order to provide a more robust understanding of the extent of the impact on each of the species' breeding populations.

Impacts on seabirds from noise pollution

5.49. The Scheme will be a source of noise generally as a result of the movement of the boats which will intensify during fattening and harvesting operations. Thus, the increase in noise will mostly be during the day time when the seabirds are away from their colonies. Moreover, *Puffinus yelkouan* would have already left the colonies by the time harvesting operations start (refer to **Table 4.1** and **Table 4.2**). The impact of noise as a result of Scheme operations on the breeding seabirds is thus considered to be not significant to minor.

Change in the abundance of prey

5.50. Aquaculture facilities can act as artificial reefs and increases in abundance and diversity of small fish species looking for shelter and foraging on falling food pieces is well documented (e.g. Forrest, 2007)[51]. All of the breeding seabirds include fish as part of their diet. Consequently, the birds may be attracted to the area occupied by the Scheme and benefit from an increased abundance of prey as well as a reduction in the energy spent in order to obtain the prey. It is considered, however, that further studies are required in this regard because it is not certain to what degree this is exploited by the seabirds in the area and the *P. yelkouan* breeding population is particularly large so it is unlikely that the population as a whole is sustained by the presence of the fish farm. Moreover, it is also noted that *P. yelkouan* leaves the colony by the beginning of the fattening season. The impact is considered to be minor to not significant in the absence of any further data. *H. pelagicus melitensis* may also be attracted, the smaller population and the presence of the species during fattening time could result in at least a minor and potentially a major impact if all birds in the colony frequent the site regularly, noting, however, that these birds are not exclusively piscivorous.

[51] Ibid.

Increasing population of increaser species – Yellow-Legged Gull

5.51. During stakeholder consultation, BirdLife Malta raised the concern of the potential increased vulnerability of, in particular, storm petrels to seagulls that may also be attracted to the farm and are known to predate on the much smaller storm petrels. However, evidence of predation has been recorded locally largely on nesting petrels. It is not clear at this stage whether gulls would actively hunt storm petrels aggregating in a similar area. Monitoring is required and therefore the impact is considered to be uncertain.

5.52. The presence of the farms may provide particular opportunity for the increaser species[52], Yellow-legged Gull. The farms use semi-defrosted bait fish to feed the tuna. This provides an additional food source for foraging seabirds. Gulls are particularly likely to take advantage of this food source. This, together with the additional prey available as a result of the farm acting as an FAD (fish aggregating device), may serve to increase the success of this species resulting in an increase in its population. Moreover, gull species are also known to feed around lights, further enhancing the benefits that this species may obtain from the presence of the Scheme (Surman & Dunlop, 2015)[53]. If these introduced opportunities result in an increase in the gull population, this could directly and indirectly impact upon the breeding population of the other breeding seabirds through increased predation and competition for nesting sites. Such a scenario could ultimately result in a major significant negative effect if the breeding success of the colonies of the Annex I seabirds is reduced as a result. However, although the Scheme application occurs at a new site, the proposed degree of operation is not new and therefore, the Scheme does not introduce additional capacity for subsidising the diet of gulls and subsequently increasing their breeding / population success. The conservation status assessment of the breeding colonies along the east coast of the north of Malta and Comino, as described in the respective Management Plans, does not indicate an increase in Gull populations that could be threatening the other seabird populations. Therefore, with the data currently available, the actual impact is considered to be uncertain.

Entanglement

5.53. Shearwaters and the storm petrel are all diving birds and therefore risk entanglement in the fish farm nets, resulting in drowning. Entanglement from any lost ropes or netting as well as other marine debris from operations is

[52] Increaser species are more generalist in their requirements. Some may also benefit from modification of habitat and increase in abundance. Decreaser species, on the other hand, are more sensitive to changes.

[53] Surnam, C., Dunlop, J.N. 2015. Impact Assessment of aquaculture on seabird communities of the Abrolhos Islands, to support the Mid West Aquaculture Development Zone proposal. Halfmoon Biosciences for Government of Western Australia, Department of Fisheries.

also a risk. Further data is required locally to provide a better understanding of the extent of this problem for the populations of breeding seabirds in the Maltese Islands. Consultant John J. Borg has noted that no such incidences have yet been reported (personal communication). Impact is considered to be not significant to minor with the limited data available.

Ingestion of marine debris

5.54. Ingestion of marine litter, particularly plastics, is common among seabirds and can cause death by dehydration, blockage of the digestive tract, or toxins released in the intestines (Sagar, 2013)[54]. Ingestion of plastics by adults may also be passed on to chicks when being fed through regurgitation. Fish farms could be a source of such marine debris. If unmanaged, this impact could range from minor to major depending on the number of birds affected.

MITIGATION

5.55. The way the fish farm is managed will have an important influence on the significance of any residual impacts. The following lists mitigation measures that should be put in place to ensure that as far as possible there are few or no significant residual impacts:

- Dragging the mooring block on the seabed during deployment should be avoided;
- Feeding should be carefully monitored and stopped as soon as (or just before) the fish are satiated. Regular checks of the seabed below the tuna pens should be carried out by an independent environmental monitor;
- Oil booms should be in place throughout the season to contain any fish feed oils which should then be immediately collected using skimmers and transported to land for recycling or disposal;
- Marine litter should be avoided, and any materials that fall overboard should be collected immediately and on a daily basis (whether floating or settling on the seabed;
- Development of a monitoring programme to re-evaluate impacts during operation;
- If feasible, consider relocation of the Scheme outside of the priority areas for breeding Procellariiformes species;

[54] Sagar P. 2013. *Literature Review of Ecological Effects of Aquaculture: Chapter 6 Seabird Interactions*. Cawthorn Institute & NIWA Taihoro Nukurangi for Ministry of Principal Industries, Mahatu Ahu Matua.

- Minimise use of lights to the minimum required for navigational safety purposes and on vessels use only downward-facing shaded light sources;
- Adopt seasonal lighting plan, with all internal cage lights (i.e. not the external navigational lights) to be switched off after the harvesting period when the nets are empty or only cage collars are present on site;
- Minimise requirements to operate at night;
- Remove the need for vessels to be in the area at night;
- Digital camera monitoring to monitor which bird species are visiting the cages and their behaviour at the farm;
- Use visual bird deterrents;
- Control feed rate to reduce feed waste;
- Remove dead fish from cages;
- Prepare and implement waste management plan – all wastes, including food scraps should be disposed of on-shore;
- Monitoring of gull colonies annually if observed feeding at the farm;
- To reduce risk of entanglement, nets should be kept taut, mesh size should be within the 6-7 cm range and nets should be well-maintained (any holes should be repaired);
- Reduce lines and riggings on vessels;
- Train staff in appropriate bird handling and reporting; and
- Ensure regular maintenance of farm infrastructure;
- Screen vessel scuppers to prevent loss of material overboard.

APPENDIX 1: MARINE ECOLOGY BASELINE REPORT

Report on an ecological assessment of an area off the northeastern coast of Malta, proposed for designation as an offshore tuna penning site, undertaken as part of the Environment Impact Assessment in connection with PA 02175/18: Extension to an existing tuna farm operation off the North East coast of Malta

Prepared by

Joseph A. Borg
BSc MSc PhD (Plymouth) CBiol MIBiol MMBA FIBMS

Logistic & Technical Support:

12, Sir Arthur Borton Street
Mosta, MST1881
MALTA

Telephone: (+356) 2143 1900
Fax: (+356) 21424 137

www.ecoserv.com.mt

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1. INTRODUCTION

1. Adi Associates Environmental Consultants Ltd (hereafter 'ADI'), acting on behalf of their client AJD Tuna Ltd, have commissioned Ecoserv Ltd to undertake an ecological assessment of an area located off Mellieha Bay (northeastern coast of Malta); see Figure 1, which has been identified for potential designation as a tuna penning site. The main aims of the assessment are to collect and analyse data on general physico-chemical attributes of the sediments and water column, and on the ecological characteristics of the site, and to provide ADI with the findings and assist the consultants with predicted potential impacts of the proposed activity on the ecology of the site. Ultimately, the present document will feed into the Environment Impact Assessment for the concerned project; i.e. PA 02175/18: Extension to an existing tuna farm operation off the North East coast of Malta by placing another 12 tuna cages without any increase in the tonnage of tuna fish caged.

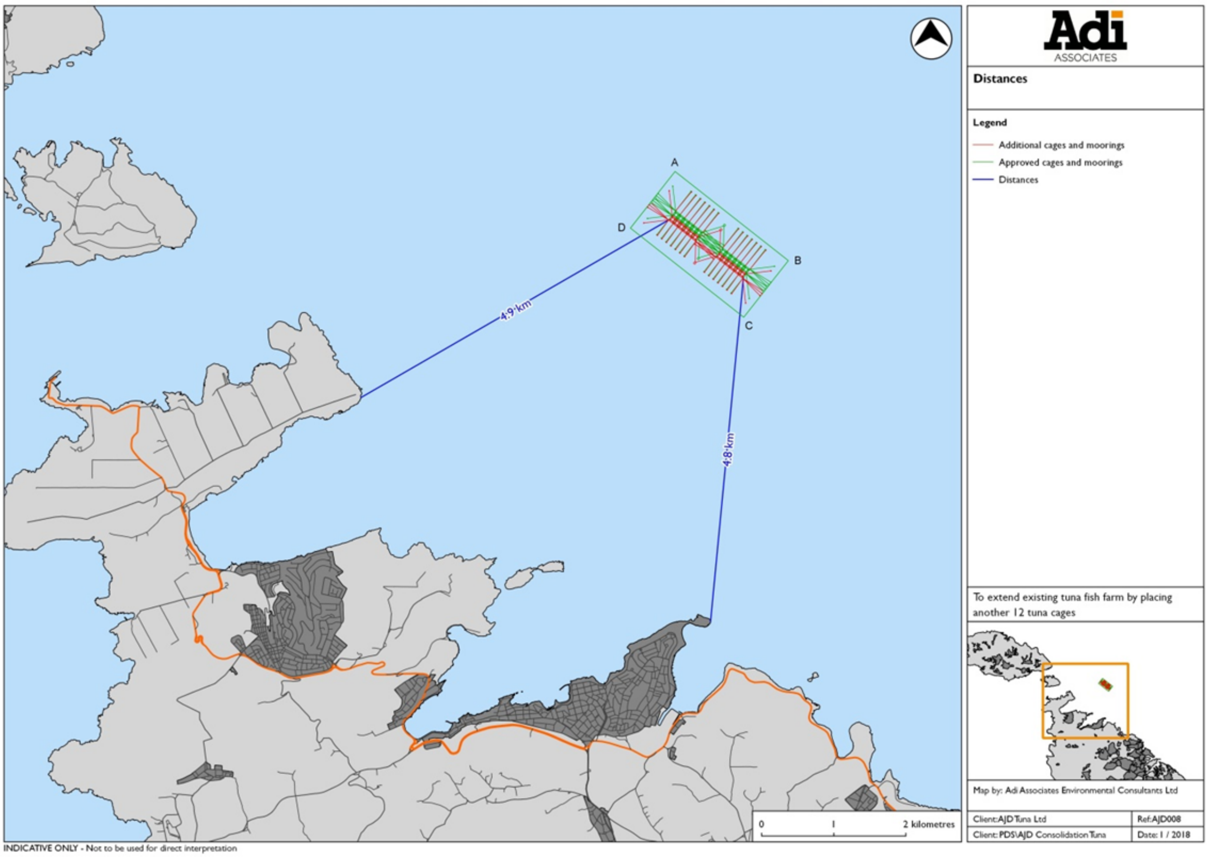


Figure 1. Map showing the site (area marked by points ABCD) off Mellieha Bay, which has been identified for potential designation as a tuna penning site. Cages indicated in green have already been deployed on site, while cages indicated in red are planned to be deployed on issue of the necessary permit. Map source: Adi Associates Environmental Consultants Ltd.

2. A survey of the marine benthic habitats present within an area that overlaps with the one that is the subject of the survey carried out in May 2018 for the present assessment was made in May 2017 (Borg & Evans, 2017); see the area enclosed by the blue boundary in Figure 2. Part of the area currently occupied by AJD Tuna Ltd's 12 tuna cages, and where a further 12 cages are planned to be deployed, falls within the area surveyed by Borg & Evans

in May 2017, however, the area bounded by the green line had not yet been surveyed (see Figure 2). A main aim of the present study was to map the marine benthic assemblages present within the area enclosed by the green boundary and adjacent areas using data from a survey by Seastar Survey Ltd undertaken in May 2018, and from Borg & Evans' survey made in May 2017. Furthermore, the present document also reports on data of physico-chemical attributes of the water column, and of the soft sediment seabed in the vicinity of area ABCD (Figure 1). A further aim was to sample the soft sediment habitat in the vicinity of the area ABCD (Figure 1) to establish the species of benthic flora and fauna present.

3. The findings from the survey made in May 2017 that was undertaken using a remotely operated vehicle (ROV) and which entailed collection of underwater footage of the seabed along transects within the survey area indicated the following (see Borg & Evans, 2017):

- In terms of physical characteristics, the bottom within the area surveyed consisted predominantly of coarse mobile sediments. A drop-off (some 10 m – 25 m high) is present just outside the study area on its northeastern side. What are usually referred to as 'maerl[1] beds' but which are more properly termed 'rhodolith beds' occupied a large part of the study area, which were more dense and continuous in the northeastern (and deeper) (outer) half of the survey area; in many places, the rhodolith beds were interspersed with a bare sand bottom that supported sparse rhodoliths[2]. "Rhodolith beds were densest in the central parts of the study area but the rhodolith density varied, such that they were less dense in the southwestern (shallower) parts of the survey area. A large stretch of predominantly bare sand was present in the southwesterly extreme part of the study area. Depth varied between 46 m and 72 m. The underwater visibility was good (25 – 30 m) throughout the study area, and an appreciable current was noted close to the seabed along some of the transects; as evidenced by debris and other material originating from benthic vegetation that were seen being moved rapidly on the bottom. Some anthropogenic items were observed during the survey; these included glass and plastic beverage bottles, fish traps and other unidentified items.
- In terms of biological characteristics, the following two main biotic assemblage types were recorded from the study area (see Figure 2):

  (i) Association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents (EUNIS code A5.515)[3]

  (ii) Infralittoral coarse sediment (EUNIS code A5.13)[4]

  The association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents was present as two subtypes: one which was characterised by a rhodolith-rich bottom in which the proportion of rhodoliths covering the bottom was dense, constituting a well developed rhodolith bed, *sensu* Basso *et al*. (2016). This association subtype was present in the deeper parts (> 60 m) of the survey area (Figure 2). The other subtype consisted of a rhodolith bed in which the density of rhodoliths was

[1] 'Maerl' is a term used to describe calcareous sediments dominated by coralline algae. Maerl as used here describes sedimentary habitats in which living or dead unattached calcareous rhodophytes are a dominant component. These algae may take the form of nodules (rhodoliths) or fragmented thalli. However, according to Basso *et al*. (2016), 'rhodolith beds' should be identified and delimited as those areas of the sea floor with >10% cover of live rhodoliths over a minimum surface of 500 m^2, while the term "maerl" refers to a specific type of rhodolith bed that is composed of non-nucleated, unattached growths of branching, twig-like coralline algae. 'Maerl' as used here conforms to the definition of Basso *et al*. (2016).

[2] Rhodoliths consist either of free-living calcareous rhodophytes (red algae), or else of an inner nucleus, such as stone or shell, encrusted by calcareous rhodophytes.

[3] Equivalent to RAC/SPA 'Association with Rhodoliths'; code III.3.2.2.

[4] Equivalent to RAC/SPA 'Biocoenosis of coarse sands and fine gravels under the influence of bottom currents; code III.3.2.

sparser and in which the rhodoliths formed accumulations or were dispersed as single rhodoliths amongst other sediment components; this association subtype was present in areas having an intermediate water depth (50 m – 60 m); see Figure 2. Although no samples of rhodoliths were collected from the survey area, it is well established that a variety of coralline algal species that completely coat coarse sediment granules to form 'cored rhodoliths', contribute to local rhodolith beds; these include *Lithophyllum incrustans*, *Lithothamnion valens*, *Mesophyllum alternans* and *Sporolithon ptychoides*. Where present in the survey area, the rhodolith-rich bottom appeared to comprise a pseudo-hard substratum that supported macroalgae; the predominant alga being *Flabellia petiolata*. The main megafaunal species that was recorded from this association is the cidariid sea urchin *Stylocidaris affinis*. The rhodolith beds occupied the greater part of the area surveyed but the density of the rhodoliths varied greatly, with the general tendency being for the beds to be less dense with a decrease in water depth and on moving from the northeastern parts of the study area to the southwestern parts. Where dense, the rhodolith beds supported the alga *Flabellia petiolata* and, in places, an unidentified filamentous alga. The most abundant megafaunal species recorded from this association were the cidariid sea urchin *Stylocidaris affinis*, the Heart Urchin *Spatangus purpureus*, and the Long-Spined Urchin *Centrostephanus longispinus*. Individuals of the crinoid *Antedon mediterranea*, and single individuals of the seastar *Luidia ciliaris* and of the seaslug *Pleurobranchia meckeli* were also recorded from this assemblage. Burrows of the Common Octopus *Octopus vulgaris* were recorded in some places.

The infralittoral coarse sediment assemblage occurred at the southwestern part of the area surveyed, where the water depth was some 46 m – 50 m. In places, the sediment bottom supporting this assemblage type had current ripples; in places the trough of such ripples had small accumulations of rhodoliths or sparse rhodoliths. Detached algal and plant (seagrass) material was present in places on the seabed where this assemblage occurred but no attached fleshy algae or seagrasses were present. The epifauna associated with this assemblage was impoverished; the only recorded macrofauna comprised the Heart Urchin *Spatangus purpureus* and groups of the Purple Urchin *Sphaerechinus granularis*.

4. The present submission comprises a report of a survey of the main marine benthic habitats, benthic diversity and water quality, undertaken within the concerned study area. Video footage collected during the underwater videographic component of the present survey is appended to the present document and is titled '*Video transects of the seabed in an area off Mellieha Bay proposed for designation as an offshore tuna penning site, made in May 2018*.

2. METHODOLOGY

SEDIMENT AND WATER QUALITY

5. Fieldwork in relation to the water quality survey was undertaken on 4th April 2018. The day during which fieldwork was made was chosen at random but subject to good sea conditions to ensure successful undertaking of fieldwork and data collection. Fieldwork was carried out using a 12 m vessel equipped with hoisting jib and winch. The locations of the six sampling stations, A – D and R1 and R2, and shown in Figure 3, and their geographical coordinates and water depth are given in Table 1.

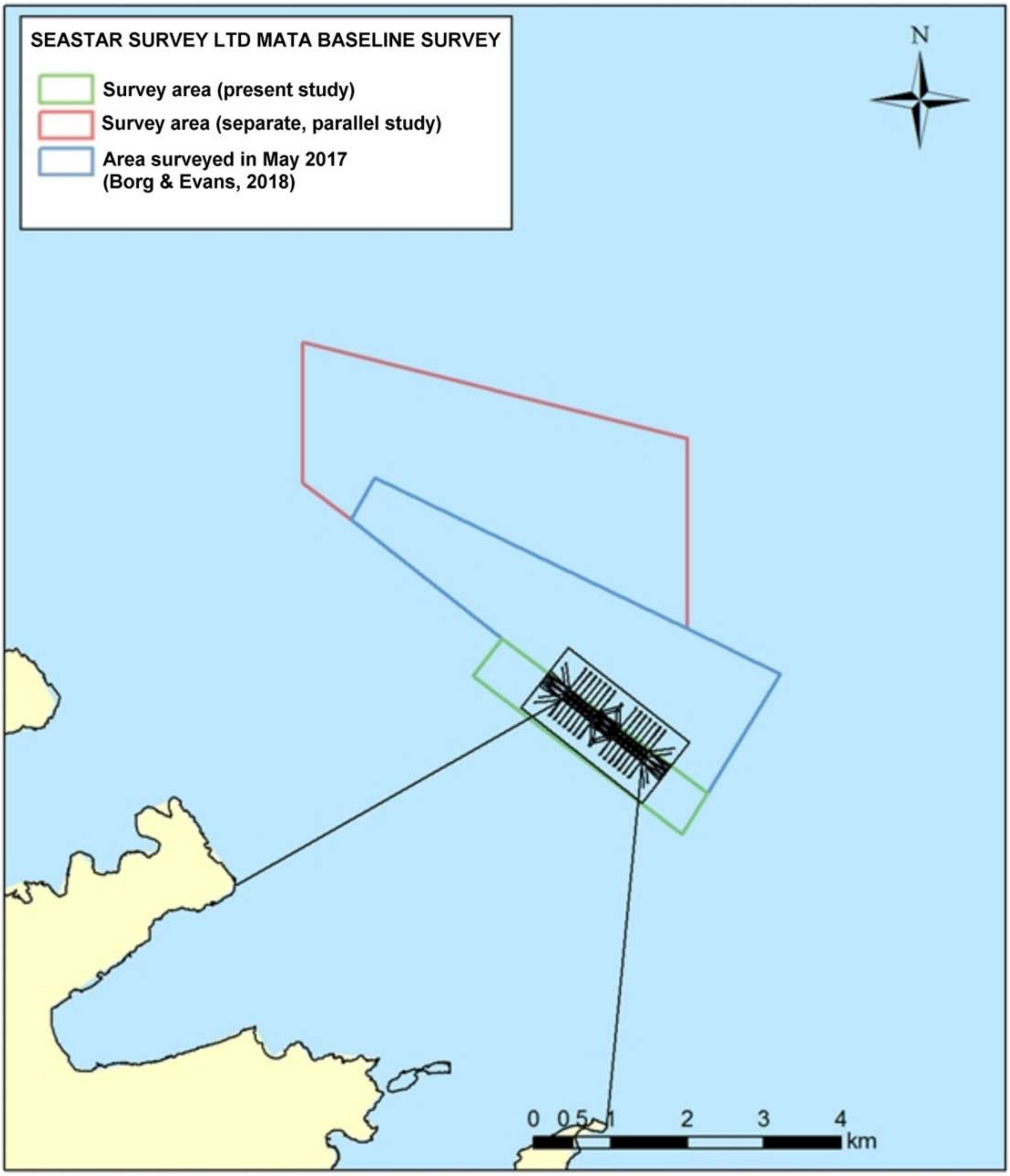


Figure 2. Map showing: the tuna farm site off Mellieha Bay that is currently used temporarily by AJD Tuna Ltd, and which has been identified for potential designation as a tuna penning site; the area used in the May 2017 benthic habitats survey (blue boundary); the area used in the present benthic habitats survey (green boundary); and the area used in a separate survey undertaken in parallel with the present study. Map source: Seastar Survey Ltd, UK.

6. The list of physico-chemical attributes that were included in the water quality survey are given in Table 2. Measurements of temperature, salinity, turbidity and dissolved oxygen in water were made *in-situ* at each of the ten stations using a YSI 650 MDS meter connected to a 6920 V2 multi-parameter probe. The meter was calibrated according to the manufacturer's

instructions immediately before use. Measurements using the *in-situ* meter were made at the surface (0.5 m below the surface). Two replicate measurements were taken at each of the six stations A – D, and R1 and R2. Two replicate samples of seawater were then collected from each of the same six stations; samples were collected at a depth of 0.5 m, from each of the six stations using a standard Van Dorn water sampler of 3 L volume. All water samples were transported in a cooler box and maintained at a temperature of 4^{o}C.

7. Estimates of current velocity and direction at the two reference stations (R1 and R2; see Figure 3) were made using drogues according to the La Grange method. The drogues employed for this purpose had four rectangular perspex vanes, each of which has a surface area of 0.2 m^2. The drogues were suspended from an inflatable surface float by means of a length of twine which was 1 m long. The position of the release point (determined using the GPS) and time of the release were recorded. After allowing the drogues to float for a given period of time, the position of the collection point and the time of collection were recorded.

8. For sediment granulometric and chemical studies, samples were collected using a 0.1 m^2 van Veen grab that was deployed from a 12 m vessel equipped with hoisting jib and winch. Two replicate grab samples were collected from each of six stations A – D, and R1 and R2; see Figure 3 and the corresponding geographical coordinates given in Table 1. The list of physico-chemical attributes that were included in the water quality survey are given in Table 3.

BENTHIC DIVERSITY

9. To collect data for benthic diversity studies, a grab sample was taken from each of the four stations A – D using a 0.1 m^2 Van Veen grab that was deployed from a 12 m vessel equipped with hoisting jib and winch. After the grab was brought on board, surplus seawater was drained from the sample by placing it on a 1mm-mesh sieve; the retained sediment and biota were temporarily preserved in 10% formaldehyde in seawater. In the laboratory, each sample was first washed to remove the fine sediment (<0.5 mm fraction) and the preservative, and it was then sorted to separate out all macrofauna (animals larger than 0.5 mm). The motile macrofauna was then identified as far as possible. Where identification to species level was not possible, the different species present were labelled using an alphabetical code (e.g. Mysidacea sp. A, etc.).

BENTHIC HABITATS MAP

10. Fieldwork in relation to the videographic survey to map the distribution of benthic habitats in those parts of the study area which had not been mapped by Borg & Evans (2017) was undertaken by personnel from Seastar Survey Ltd (UK) using the Maltese registered vessel MV Awrata, a 14 m steel workboat owned and operated by Azzopardi Fisheries. During the survey, a towed underwater camera system was used, which had the following specifications:
- Kongsberg 14-208 camera and flash
- Four video LED lights
- Seastar Survey camera frame
- EdgeDVR Digital video recorder with overlay
- 300 m umbilical

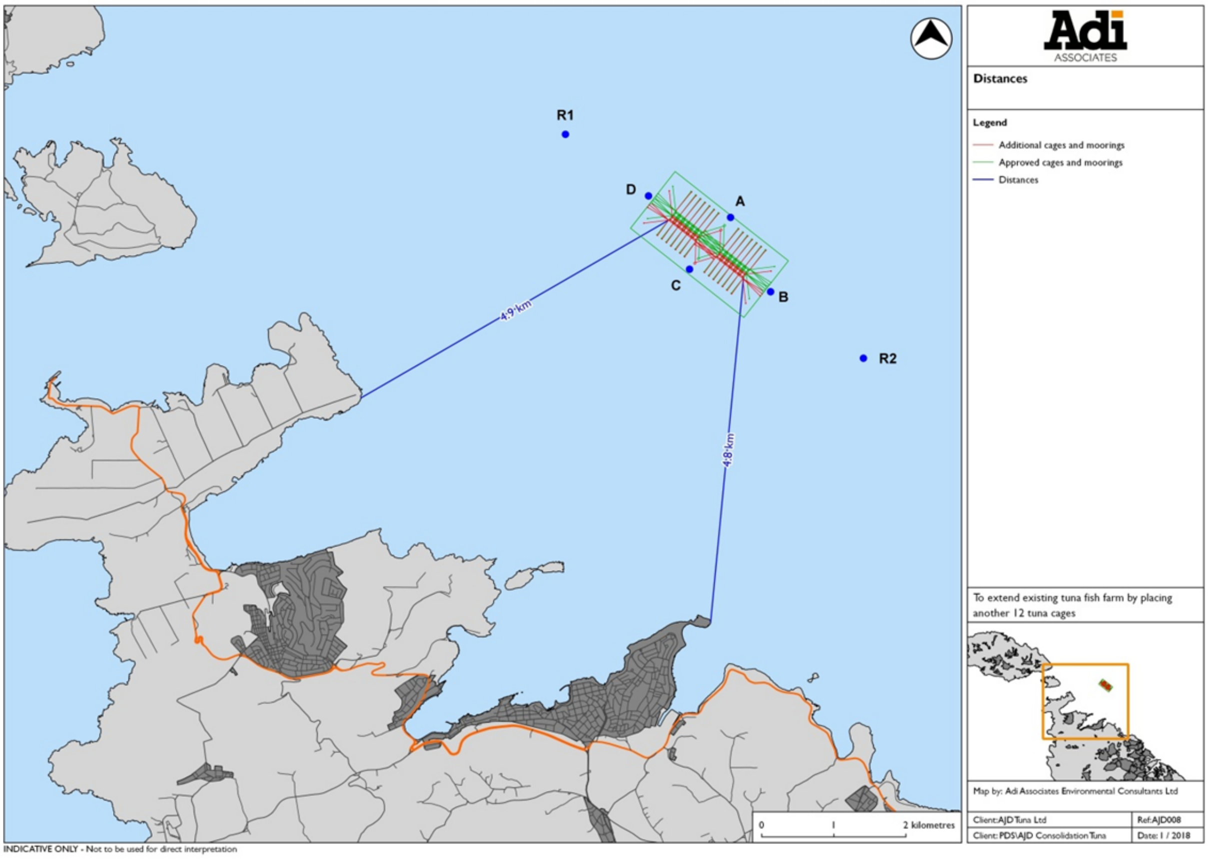


Figure 3. **Map showing the study site off Mellieha Bay, and the six stations used for collecting samples for sediment and water quality, and benthic diversity. Stations A – D are located in the vicinity of the farm cages, while Stations R1 and R2 are reference sites. Map source: Adi Associates Environmental Consultants Ltd.**

Table 1

Latitude/longitude coordinates and depth of the six sampling stations shown in Figure 3. In the field, readings were taken using the boat's Global Positioning System (GPS)[5] set.

Station	Latitude / Longitude	Depth (m)
A	36° 00.584' / 14° 25.780'	50 m
B	36° 00.131' / 14° 26.127'	48 m
C	36° 00.163' / 14° 25.508'	45 m
D	36° 00.567' / 14° 25.367'	48 m
R1	36° 00.848 / 14 24.474'	46 m
R2	35° 59.597 / 14 26.815'	48 m

5 Chart datum set to European 1950; accuracy degeneration = *ca* 15m.

11. The camera and lights were set up on the camera frame so as to optimise field of view and video lighting. At each site, the vessel was manoeuvred to the transect position and first taken out of gear so as to determine the direction and speed of drift. Once the drift direction was determined, the vessel was manoeuvred to a distance of around 300 m from the transect position in the direction of drift, and then turned so that the camera transect was driven into the current. The positions of the video transects are shown in Figure 4; a total of ten transects were used in the survey. No transects were made within the area occupied by AJD Tuna Ltd’s cages since the cages and mooring lines prevented deployment of the video camera along transects, but in any case most of the area had already been surveyed in 2017 (Borg & Evans, 2017). At the start of a transect, the vessel slowed to between 0.5 and 1.0 knot. The camera frame was deployed using the DT winch, wire tow-line and the vessel’s crane, and the camera umbilical was bulldog taped to the winch wire at regular intervals to prevent it streaming out in the water column. During deployment, a layback position was calculated and recorded in Hypack, and an output of layback position and GPS time (GMT) was sent to the video overlay and recorded along with the video using EdgeDVR software. At regular intervals (approximately every minute), the camera frame was landed on the seabed and a high resolution still image was taken of the seabed. The still images were saved on the camera and downloaded at the end of each survey day. The position of the still images was recorded by noting the time of the photograph with the layback position from the navigation log for the same time.

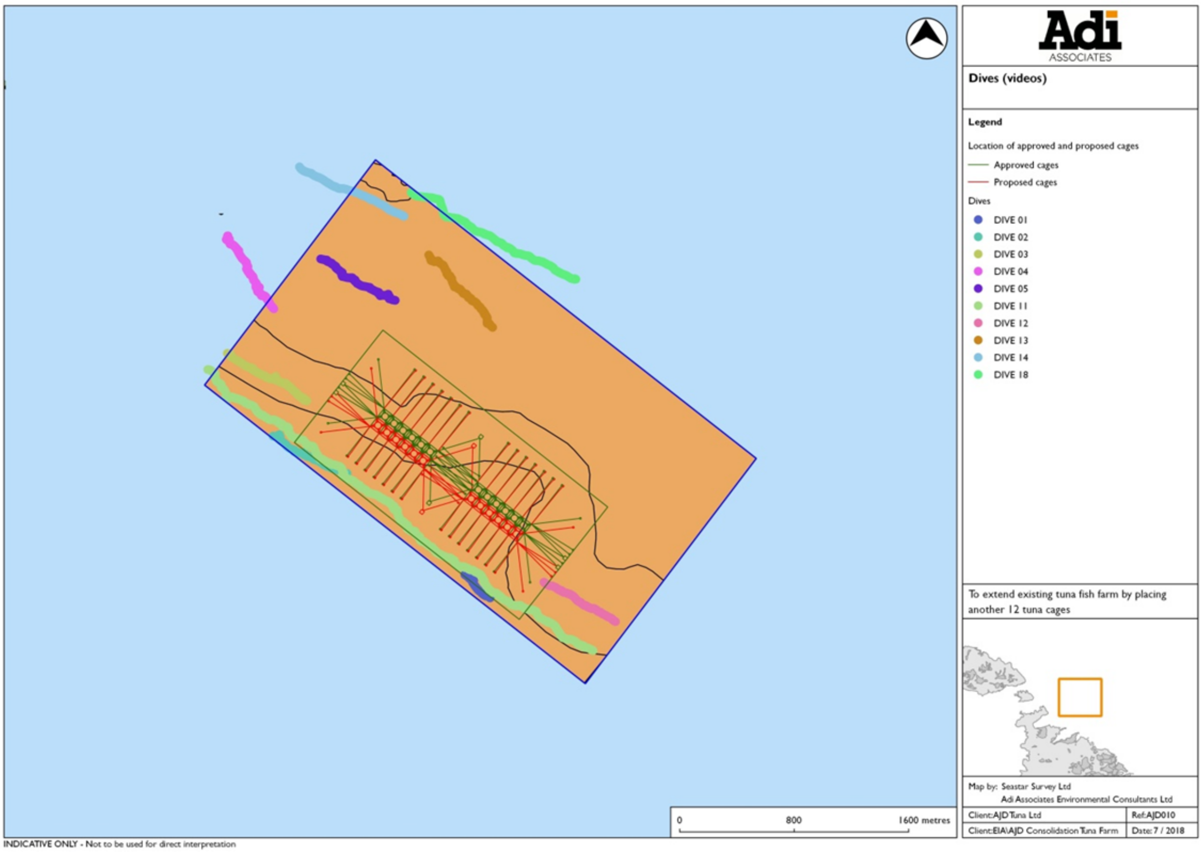


Figure 4. **Map showing the survey area (blue boundary) and locations of the ten video transects (referred to as ‘Dives’ in the figure key) that were used to survey the marine benthic habitats present in the area of interest. Map source: Seastar Survey Ltd (UK) and Adi Associates Environmental Consultants Ltd.**

12. Video footage and photographs of the benthic assemblages and species encountered along the transects were recorded on a PC hard drive and later analysed in the laboratory. Photographs taken during the survey were used to illustrate the present report.

13. Characterisation of the benthic assemblages was made using the scheme of Borg *et al*. (2013), which is based on the EUNIS typology that has been adapted for local use.

Table 2. List of physico-chemical attributes, together with the corresponding method of analysis, which were considered in the water quality studies.

Parameter	Method	Units
Temperature	In-situ / Portable Meter	°C
Salinity	In-situ / Portable Meter	psu
Dissolved Oxygen	In-situ / Portable Meter	%, mg/l
Turbidity	In-situ / Portable Meter	NTU
Turbidity (Secchi Depth)	Secchi Disk	m
pH	pH meter	pH units
Chlorophyll a	APAT CNR IRSA 9020 Man 29 2003	µg/l
Total Nitrogen	APAT CNR IRSA 5030 Man 29 2003 + APAT CNR IRSA 4040 A1 Man 29 2003 + APAT CNR IRSA 4050 Man 29 2003	µg/l
Total Phosphorus	APAT CNR IRSA 4110 Man 29 2003	µg/l
Total Carbon	UNI EN 1484:1999	µg/l
Total suspended matter	APAT CNR IRSA 2090 B Man 29 2003	mg/l

Table 3. List of physico-chemical attributes, together with the corresponding method of analysis, which were considered in the sediment quality studies.

Parameter	Method	Units (on D.M.)
Granulometry	Buchanan 1984	g
Total Organic Carbon (TOC)	UNI EN 13137:2002	%
Redox Potential	CNR IRSA 2 Q 64 Vol 3 1985	mV
Sulphide	CNR IRSA 12 Q 64 Vol 3 1986	µg
pH	CNR IRSA 1 Q 64 Vol 3 1985	pH units
Total Nitrogen	CNR IRSA 6 Q 64 Vol 3 1985	mg/g
Total Phosphorus	DM 13/09/1999 SO n°185 GU n°248 21/10/1999 Met XV.I	mg/g

3. RESULTS

14. Ecoserv's laboratory report reference for the present document is **068-18**.

15. The sample reference codes for the water quality and sediment surveys are as follows:
    - Water in-situ parameters: W-158-18
    - Secchi depth readings: W-159-18
    - Water chemical parameters: W-160-18 to W-171-18
    - Sediment chemical parameters: S-063-18 to S-074-18
    - Sediment granulometry: S-051-18 to S-062-18
    - Benthic diversity: S-075-18, S-077-18, S-079-18 and S-081-18
    - Video footage: D-025-18 to D-031-18

SEDIMENT AND WATER QUALITY

16. The results of the water quality survey are given in Tables 4 to 6, while those for the sediment quality survey are given in Table 7. The results of granulometric analysis are given in Table 8.

17. The results of *in situ* measurement of physico-chemical parameters of the water column indicate temperature values and levels of salinity, water transparency and dissolved oxygen that are expected of local pristine offshore coastal waters during spring. The Secchi Disc measurements indicated a high water transparency of between 24 m and 29 m.

18. Detectable but low levels of total organic carbon (TOC), total suspended solids (TSS), total nitrogen, and total phosphorous were recorded from the sampling stations, while levels of Chlorophyll *a* were below the limit of detection, thereby indicating a low phytoplankton abundance.

19. A weak southeasterly surface sea current having a speed of between 0.11 m/s and 0.13 m/s was recorded at the two reference stations R1 and R2.

20. The results of chemical analysis of sediments from the sampling stations indicated detectable but low levels of total organic carbon (TOC), total nitrogen, and total phosphorous, while levels of sulphide were below the limit of detection. Values of pH and redox potential were of an order that is expected of background levels for local offshore sediments.

21. The results of granulometric analysis indicate that the sediments characterising the six sampling stations comprise poorly sorted coarse sand having a mean grain size of between 0.55 mm and 0.95 mm.

Table 4. Mean values (± standard deviation) of physico-chemical attributes recorded from the water column at the six sampling stations.

Parameter	Temperature (°C)		Salinity (ppt)		Turbidity (NTU)		Dissolved Oxygen (%)	
Station	**Mean**	**± SD**	**Mean**	**± SD**	**Mean**	**± SD**	**Mean**	**± SD**
SA1	15.82	0.02	37.80	0.28	0.28	0.00	99.94	0.09
SA2	15.79	0.00	37.81	0.00	0.28	0.00	99.80	0.07
SB1	15.89	0.03	37.95	0.01	0.36	0.04	100.32	0.08
SB2	15.86	0.02	37.95	0.01	0.36	0.04	100.30	0.10
SC1	15.91	0.01	37.96	0.00	0.32	0.09	100.38	0.08
SC2	16.05	0.11	37.97	0.02	0.28	0.00	100.60	0.23
SD1	15.96	0.03	37.96	0.01	0.18	0.07	100.40	0.10
SD2	15.92	0.01	37.95	0.00	0.26	0.04	100.30	0.00
R1a	15.83	0.00	37.94	0.00	0.28	0.00	100.16	0.05
R1b	15.83	0.00	37.94	0.00	0.28	0.00	100.10	0.00
R2a	15.86	0.00	37.95	0.02	0.00	0.63	100.06	0.05
R2b	15.85	0.00	37.88	0.01	0.26	0.04	100.00	0.07

Table 5. Mean values (± standard deviation) in metres for water transparency recorded from the six sampling stations using the Secchi Disc method.

Station A		Station B		Station C		Station D		Station R1		Station R2	
Mean	**± SD**	**Mean**	**± SD**	**Mean**	**± SD**	**Mean**	**± SD**	**Mean**	**± SD**	**Mean**	**± SD**
24.00	0.00	29.25	0.35	25.00	0.00	26.00	0.00	26.00	0.00	26.25	0.35

Table 6. Mean values (± standard deviation) of chemical parameters recorded from water samples collected from the six sampling stations.

Parameter	Units	Station A		Station B		Station C		Station D		Station R1		Station R2	
		Mean	± SD	Mean	± SD	Mean	± SD	Mean	± SD	Mean	± SD	Mean	± SD
TOC	mg/L	0.75	0.35	0.50	0.00	0.55	0.35	0.60	0.14	0.90	0.14	0.60	0.14
TSS	mg/L	0.20	0.00	0.20	0.00	0.20	0.00	0.20	0.00	0.20	0.00	0.20	0.00
pH		8.50	0.00	8.50	0.00	8.55	0.07	8.55	0.07	8.55	0.07	8.45	0.07
Chlorophyll a	µg/L	< 0.01	0.00	< 0.01	0.00	< 0.01	0.00	< 0.01	0.00	< 0.01	0.00	< 0.01	0.00
Total Nitrogen	mg/L	3.94	0.43	4.30	0.58	4.03	0.71	3.50	0.10	3.51	0.07	3.96	0.15
Total Phosphorus	µg/L	6.90	0.85	10.10	0.42	10.85	0.35	12.95	2.05	8.25	0.07	7.00	0.42

Table 7. Mean values (± standard deviation) of chemical parameters recorded from sediment samples collected from the six sampling stations.

Parameter	Units	Station A		Station B		Station C		Station D		Station R1		Station R2	
		Mean	± SD	Mean	± SD	Mean	± SD	Mean	± SD	Mean	± SD	Mean	± SD
pH	unit	8.75	0.07	8.75	0.35	9.30	0.00	9.00	0.14	8.90	0.14	8.85	0.21
TOC	%	0.45	0.00	1.90	0.99	0.80	0.71	0.36	0.04	0.58	0.47	0.63	0.40
Sulphide	mg/kg	< 2	0.00	< 2	0.00	< 2	0.00	< 2	0.00	< 2	0.00	< 2	0.00
Total nitrogen	% S.S.	0.04	0.00	0.04	0.00	0.04	0.00	0.04	0.00	0.05	0.00	0.06	0.00
Total Phosphorous	% S.S.	0.02	0.00	0.02	0.01	0.02	0.00	0.02	0.00	0.03	0.00	0.03	0.00
Redox Potential	mV	266.05	6.58	245.65	3.04	233.15	4.60	227.50	3.54	202.30	22.34	167.15	4.03

Table 8. Mean values (± standard deviation) of grain size and sorting, together with classification of sorting and sediment classification for sediment samples collected from the six sampling stations.

Station	Ecoserv sample ref.	Mean sediment grain size (mm)	Wentworth grade classification	Mean Sorting (Ø)	Degree of sorting
A	**S-051-18 / S-052-18**	0.716 ± 0.042	Coarse Sand	2.11 ± 0.09	Very Poorly Sorted
B	**S-053-18 / S-054-18**	0.550 ± 0.055	Coarse Sand	2.29 ± 0.04	Very Poorly Sorted
C	**S-055-18 / S-056-18**	0.751 ± 0.082	Coarse Sand	1.95 ± 0.10	Poorly Sorted
D	**S-057-18 / S-058-18**	0.693 ± 0.072	Coarse Sand	2.14 ± 0.05	Very Poorly Sorted
R1	**S-059-18 / S-060-18**	0.763 ± 0.023	Coarse Sand	1.74 ± 0.10	Poorly Sorted
R2	**S-061-18 / S-062-18**	0.937 ± 0.222	Coarse Sand	2.14 ± 0.33	Very Poorly Sorted

BENTHIC DIVERSITY

22. A classified list of species, and respective abundance, recorded from the four grab samples collected from Stations A – D (Figure 3) is given in Table 9. A total of 1,897 individuals comprising 111 macrofaunal species were recorded. The Polychaeta and Crustacea were the most common taxonomic groups, both in terms of total number of species and in abundance of individuals.

Table 2

Classified list of species recorded from the respective stations, and respective abundance (number of individuals per 0.1 m^2 grab sample).

Classified Species List	**Station**			
	A	**B**	**C**	**D**
Ecoserv Sample no.	**S-075-18**	**S-077-18**	**S-079-18**	**S-081-18**
SIPUNCULIDA				
Aspidosiphon muelleri		2		1
MOLLUSCA				
Gastropoda				
Ascobulla fragilis		1		
Caecum armorium		1		
Caecum auriculatum				2
Cerithidium submamillatum	1	1		
Euspira nitida	1			
Haminoea hydatis	3			
Opistobranchia sp.	3			
Parthenina interstincta	1	1		
Parvioris ibizenca	1			
Sticteulima jeffreysiana	2		2	
Vitreolina sp.		1		
Volvarina mitrella		2		
Polyplacophora				
Acanthochitana fascicularis	7		1	
Callochiton calcatus	32			
Chiton corallinus	1			
Ischnochiton rissoi	1			
Leptochiton cancellatus	5	6		
Parachiton africanus	4			5
Bivalvia				
Astarte fusca	2		2	4
Coripia corbis		2	3	6

Table 2. Continued…

Classified Species List	Station			
	A	B	C	D
Ecoserv Sample no.	**S-075-18**	**S-077-18**	**S-079-18**	**S-081-18**
Digitaria digitaria	4			
Diplodonta trigona	1			
Gari costulata		1		
Glans trapezia	1			
Gonilia calliglypta		2	2	2
Hiatella arctica		2		
Loripes orbiculatus				1
Modilula phaseolina	2	1		
Musculus costulatus	2			
Papillicardium papillosum		1		
Thracia phaseolina				1
Timoclea ovata	1	1	1	1
NEMERTEA				
Nemertea sp.	1		3	5
POLYCHAETA				
Ampharetidae sp.				1
Aphroditidae sp.			1	
Lepidonotus	2	5		
Capitellidae sp.	30	23	41	14
Cirratulidae sp.	5	3	6	
Dorviliidae sp.	11	21	7	8
Eunice sp.		5	5	4
Marphysa sp.	4			
Glycera sp.	1	5	1	5
Glyceridae sp.	1	2		
Lacydoniidae sp.	13	52	35	9
Lumbrineridae sp. A	2	1		
Lumbrineridae sp. B		1		1
Lumbrineridae sp. C		1		
Maldanidae sp. A				1
Maldanidae sp. B		1		
Nematonereis unicornis	5	4	3	
Nephtydae sp. A	38	38	29	15
Nephtydae sp. B		3	7	10
Nephtydae sp. C				1
Nereidae sp.			1	
Nereis rava	7	1		1
Notomastus sp.	11	9	3	2
Opheliidae sp.	1			16

Table 2. Continued…

Classified Species List	Station			
	A	B	C	D
Ecoserv Sample no.	**S-075-18**	**S-077-18**	**S-079-18**	**S-081-18**
Orbiniidae sp.		3		
Paraonidae sp.	33	26	65	41
Pectinaridae sp.	1	1		
Phyllodocidae	10	5	4	5
Polychaeta sp.	6	9	17	26
Polynoinae sp.			1	
Sabellidae	20	16	3	9
Scalibregmidae sp.	1	3	1	1
Sthenlais sp.				2
Syllidae	56	38	28	68
Terebellidae sp.	2	14		2
CRUSTACEA				
Leptostraca				
Nebalia bipes			1	
Decapoda				
Achaeus sp.		1		
Alpheus dentipes	1			
Anapagurus sp.		1	3	
Cestopagurus timidus	3	3	2	2
Galathea intermedia	2	2	1	
Ilia nucleus	1			
Liocarcinus sp.	1			
Parthenope sp.	5		1	
Processa sp.		1		
Mysidacea				
Mysidacea sp. B	1	1		1
Tanaidacea				
Apseudes sp.	9	1		
Leptochelia savignyi	28	47	20	18
Isopoda				
Anthuridae sp.	4	1	1	6
Cymodoce sp.	39	1	2	2
Eurydice sp.	3	1		
Gnathia sp.		2		1
Janiridae sp.	13	10	10	3
Synisoma sp.	1	2		
Amphipoda				
Amphilochus sp.	4	1	4	2
Aoridae sp.		2	6	4
Apherusa bispinosa		1		1
Caprellidae sp.		17	7	11

Table 2. Continued…

Classified Species List	Station			
	A	B	C	D
Ecoserv Sample no.	**S-075-18**	**S-077-18**	**S-079-18**	**S-081-18**
Cheirocratus sundevallii	4	1	1	
Elasmopus sp.	39	24	33	18
Harpinia sp.	1		1	
Hippomedon oculatus	18	9	8	3
Leptocherius sp.	15	2	8	10
Leucothoe spinicarpa	7	6	7	1
Lysianassa sp.	13	3	3	1
Maera sp.	8	2	9	3
Melita sp.	1	2	5	2
Monoculodes sp. F			1	
Pereionotus testudo	6	3	1	2
Phoxocephalidae sp.	5	10	13	11
Socarnes filicornis	10	1	7	
Stenothoe sp.	1			
Urothoe sp.		1		
Cumacea				
Cumacea sp.	1	2	2	1
ECHINODERMATA				
Echinoidea				
Genocidaris maculata	5	6	1	14
Spatangus purpureus			1	
Stylocidaris affinis	1	1		
CEPHALOCORDATA				
Branchiostoma sp.		3	2	2

VIDEO SURVEY

Physical characteristics of the seabed

23. The bottom within the area surveyed consisted predominantly of coarse mobile sediments. A drop-off (some 10 m – 25 m high) that is characterised by rock exposed to sedimentation is present at the northwestern part of the study area.

24. What are usually referred to as 'maerl[6] beds' but which are more properly termed 'rhodolith beds' occupy a large part of the study area, which were more dense and continuous in the northeastern (and deeper) half of the survey area. In many places, the rhodolith beds were interspersed with a bare sand bottom that supported sparse rhodoliths[7]. In the southwestern half of the survey area, the rhodolith density varied such that they are less dense in the shallower part (45 m – 50 m) of the survey area, where large expanses of bare sand that supported little or no rhodoliths were present. Overall, the seabed had physical features that corresponded with the bathymetry: coarse sand with sparse accumulations of rhodoliths (0 % - 20 % rhodolith cover) was present at a water depth of between 43 m and 50 m; between a water depth of 50 m and 55 m, the seabed comprised coarse sediment having denser rhodolith accumulations (20 % - 50 % rhodolith cover); and in waters deeper than 55 m, the seabed mainly consisted of dense rhodolith beds (50 % - 100 % rhodolith cover). Beyond the rocky drop-off, at water depths exceeding 100 m, the seabed mainly consisted of bare muddy sand.

25. Depth varied between around 43 m and just over 100 m. The underwater visibility was good (25 – 30 m) throughout the study area but flocculate material was noted in the water column along some of the transects.

26. A current was present in places close to the seabed, as evidenced by debris and other material originating from benthic vegetation that were seen being moved on the bottom.

27. Some anthropogenic items were observed during the survey. These included glass and plastic beverage bottles, abandoned fish traps and fishing lines, and other unidentified items. However, no remains of tuna, feed fish used in tuna farming or any other item that may have originated from tuna farming activities, was recorded on the seabed during the survey.

BENTHIC ASSEMBLAGES

28. The main outcome of the benthic survey carried out in May 2018, in combination with data from the survey carried out by Ecoserv in May 2017 (Borg & Evans, 2017) is a map showing the distribution of the main benthic habitats and assemblages (Figures 4 and 5) present in the area surveyed.

[6] 'Maerl' is a term used to describe calcareous sediments dominated by coralline algae. Maerl as used here describes sedimentary habitats in which living or dead unattached calcareous rhodophytes are a dominant component. These algae may take the form of nodules (rhodoliths) or fragmented thalli. However, according to Basso *et al*. (2016), 'rhodolith beds' should be identified and delimited as those areas of the sea floor with >10% cover of live rhodoliths over a minimum surface of 500 m^2, while the term "maerl" refers to a specific type of rhodolith bed that is composed of non-nucleated, unattached growths of branching, twig-like coralline algae. 'Maerl' as used here conforms to the definition of Basso et al. (2016).

[7] Rhodoliths consist either of free-living calcareous rhodophytes (red algae), or else of an inner nucleus, such as stone or shell, encrusted by calcareous rhodophytes.

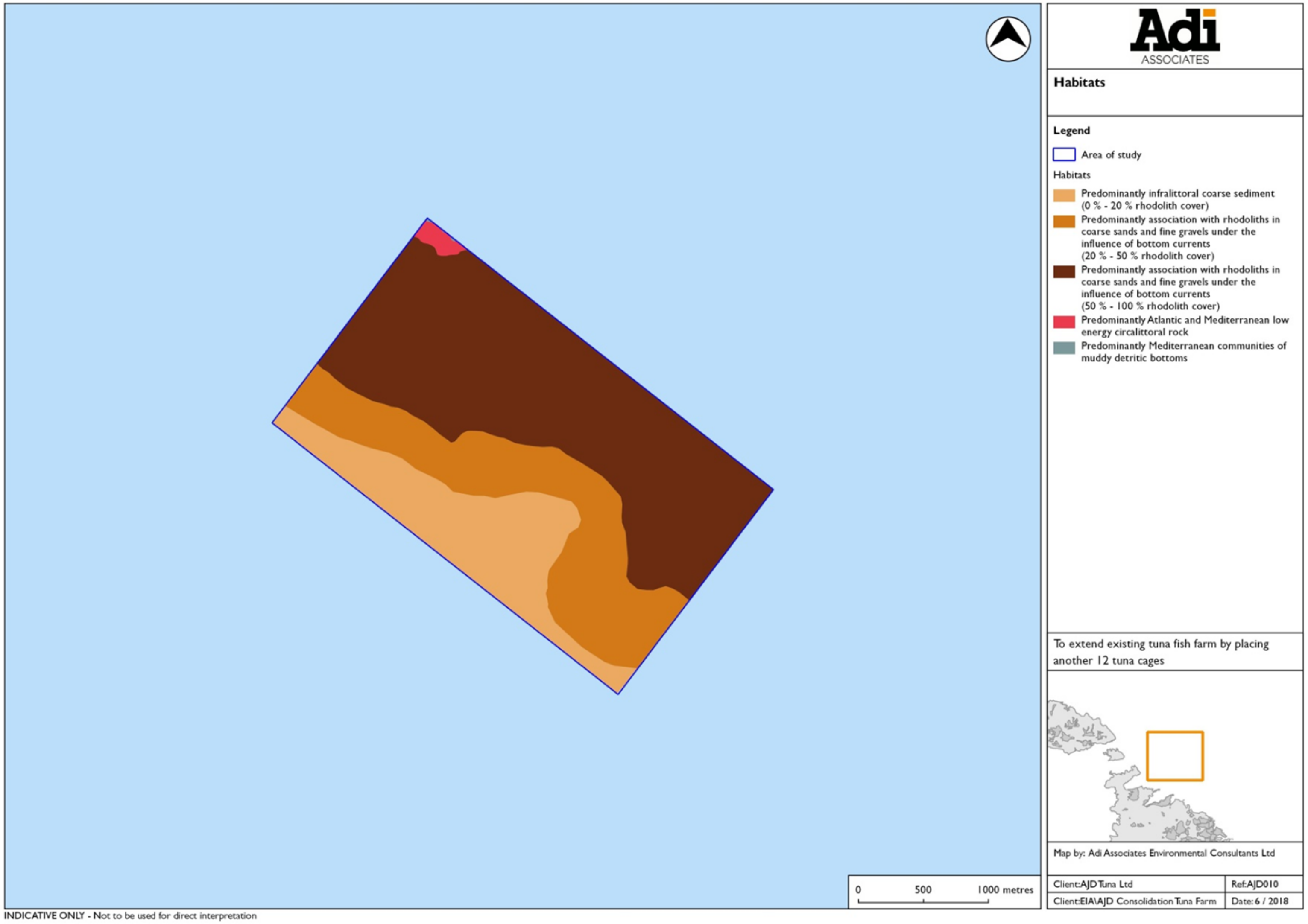
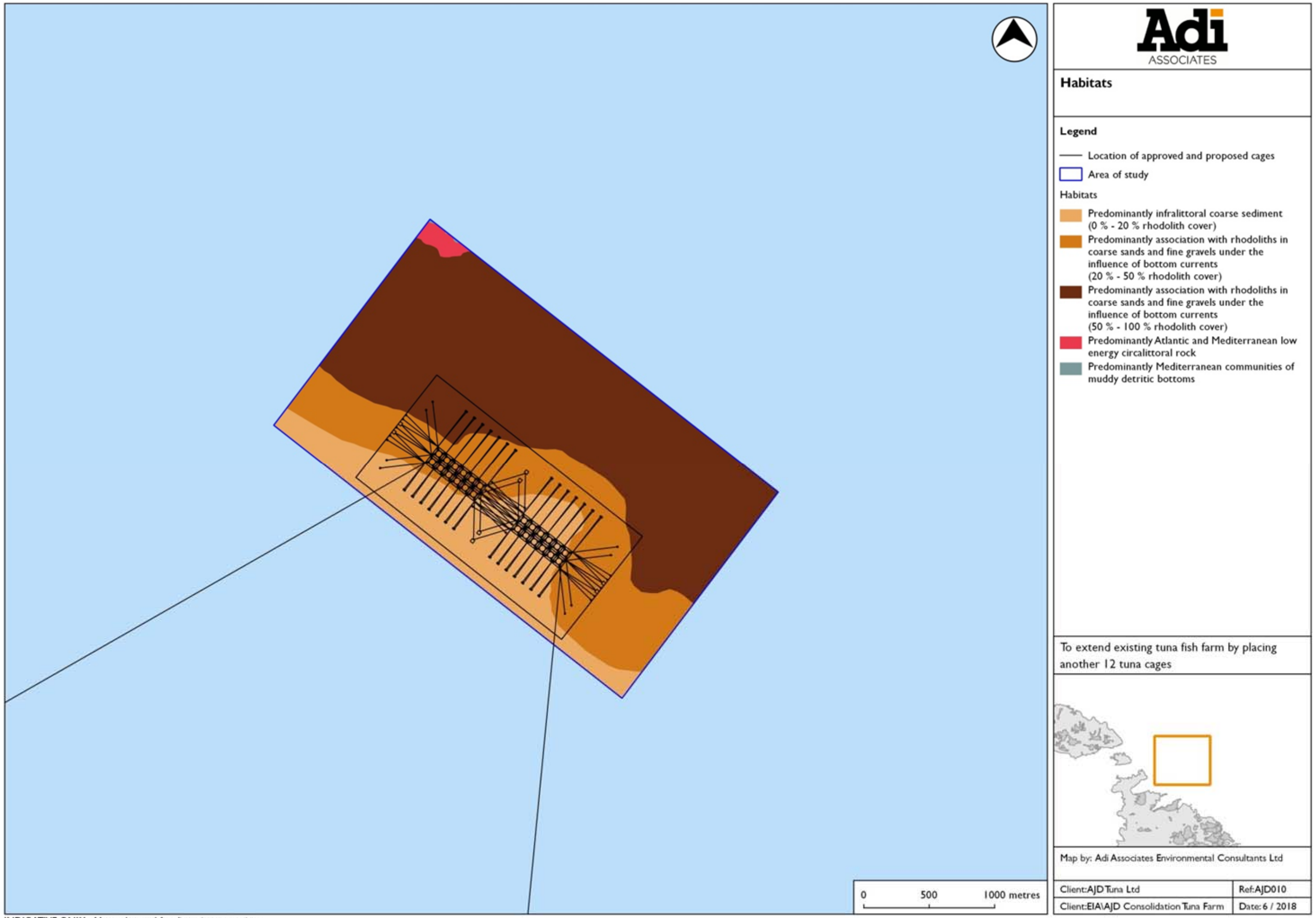


Figure 4. Map showing the main benthic habitats present in the survey area.



INDICATIVE ONLY - Not to be used for direct interpretation

Figure 5. Map showing the main benthic habitats present in the survey area. The area currently occupied by AJD Ltd's 12 Tuna Cages and which has been identified for deployment of 12 additional pens is also shown. Map: Adi Associates Environmental Consultants Ltd.

29. The following two main biotic assemblage types were recorded from the study area:
    (i) Association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents (EUNIS code A5.515)
    (ii) Infralittoral coarse sediment (EUNIS code A5.13)
    (iii) Mediterranean communities of muddy detritic bottoms (EUNIS code A5.38)
    (iv) Atlantic and Mediterranean low energy circalittoral rock (EUNIS code A4.3)

    A description of each of the above four assemblage types follows.

Association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents

30. This association was present as two subtypes: one which was predominantly characterised by a rhodolith-rich bottom in which the proportion of rhodoliths covering the bottom was dense (50 % - 100 % cover; see Figure 6) and constituted a well developed rhodolith bed, *sensu* Basso *et al*. (2016). This association subtype was mostly present in the deeper, northeastern half of the survey area (see the brown shaded area in Figures 4 and 5) within the 55 m – 80 m water depth range. The other subtype mainly consisted of a rhodolith bed in which the density of rhodoliths was sparser and predominantly formed accumulations such that the overall rhodolith cover was around 20 % - 50% (see Figure 7); this association subtype was mainly present as a band in the central parts of the survey area (see the orange shaded area in Figures 4 and 5) within the 50 – 55 m water depth range.

31. Preliminary examination of rhodoliths that were retrieved from sediments collected by grab from Stations A, B and D (see Figure 3) indicated that the algal species that contribute to the rhodoliths include species from the following genera: *Lithophyllum, Lithothamnion*, *Mesophyllum* and *Sporolithon* (see Lanfranco *et al*., 1999; Borg and Schembri 2002; Sciberras *et al*., 2009).

32. Where present, the dense rhodolith beds appeared to comprise a pseudo-hard substratum that supported macroalgae; the predominant alga being *Flabellia petiolata* (Figure 6) and *Zonaria tournefortii* but other algae including *Halimeda tuna*, *Peyssonnelia squamaria*, *Dictyota* sp. and unidentified filamentous forms, were also recorded in places.

33. The most abundant megafaunal species that were recorded from this association are the cidariid sea urchin *Stylocidaris affinis* and the Purple Heart Urchin *Spatangus purpureus* (Figure 8); other megafaunal species that were recorded during the survey included several species of sponges and bryozoans (including *Sertella* sp.), the Long-spined Urchin *Centrostephanus longispinus* (Figure 9), the Red Seastar *Echinaster sepositus* (Figure 10), the crinoid *Antedon mediterranea*, the crab *Inachus* sp., and the seastar *Luidia ciliaris*. Furthermore, the presence of openings to numerous burrows in places indicated an associated rich infauna.

Infralittoral coarse sediment

34. This assemblage type occurred as a band at the southwestern part of the study area (see the yellow-brown shaded area in Figures 4 and 5), where the water depth was some 43 m – 50 m. In places, the sediment bottom supporting this assemblage type had small accumulations of rhodoliths or sparse rhodoliths, such that where these were present their cover was some 1 –

20% (see Figures 11 - 14). Detached algal and plant (seagrass) material was present in places on the seabed where this assemblage occurred but no attached fleshy algae or seagrasses were present. The epifauna associated with this assemblage was impoverished; the most abundant macrofaunal species was the Purple Heart Urchin *Spatangus purpureus* (Figure 15) and groups of the Purple Urchin *Sphaerechinus granularis*. However, the presence of openings to burrows present in many places indicated the presence of a rich infauna.

Figure 6. Photograph of the seabed taken at a point along Transect 5, showing a close-up of a dense rhodolith bed. The green alga visible in the photo is *Flabellia petiolata*.

Figure 7. Photograph of the seabed taken at a point along Transect 12, showing a close-up of a sparse rhodolith bed.

Figure 8. Photograph of the seabed taken at a point along Transect 5, showing a close-up of a rhodolith bed intermixed with bare sediment. The five orange coloured long-spined urchins visible in the photo are individuals of *Stylocidaris affinis*. The large purple coloured urchin on the right hand side of the photo is an individual of the Purple Heart Urchin *Spatangus purpureus*.

Figure 9. Photograph of the seabed taken at a point along Transect 3, showing a close-up of a rhodolith bed. An individual of the Long-spined Urchin *Censtrostephanus longispinus* is visible at the top right hand corner of the photo adjacent the alga *Flabellia petiolata* (green).

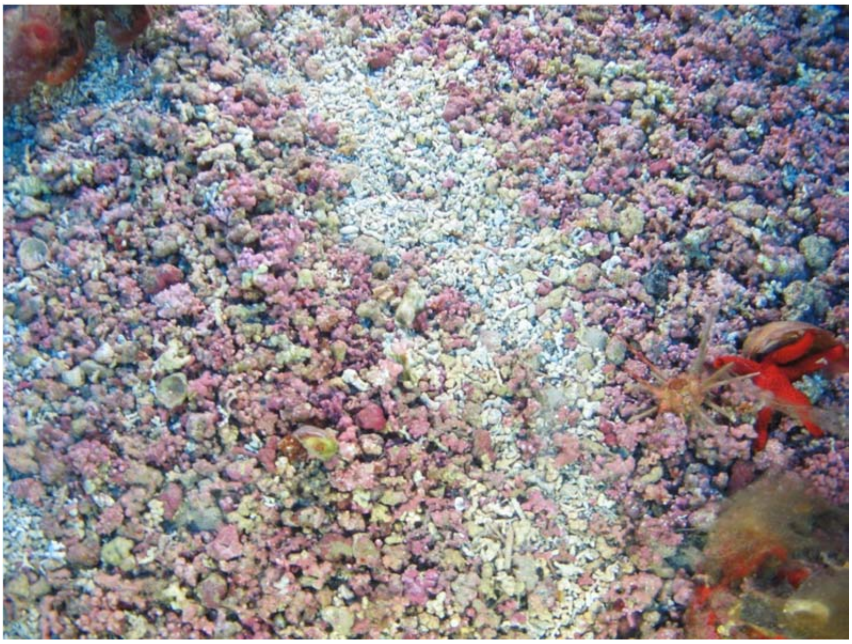


Figure 10. Photograph of the seabed taken at a point along Transect 5, showing a close-up of a rhodolith bed. An individual of the urchin *Stylocidaris affinis* and another of the Red Seastar *Echinaster sepositus* are visible on the right side of the photo.

Figure 11. Photograph of the seabed taken at a point along Transect 2, showing a close-up of an assemblage of infralittoral coarse sediment.

Figure 12. Photograph of the seabed taken at a point along Transect 2, showing a close-up of an assemblage of infralittoral coarse sediment. An individual rhodolith is visible at the centre of the photo.

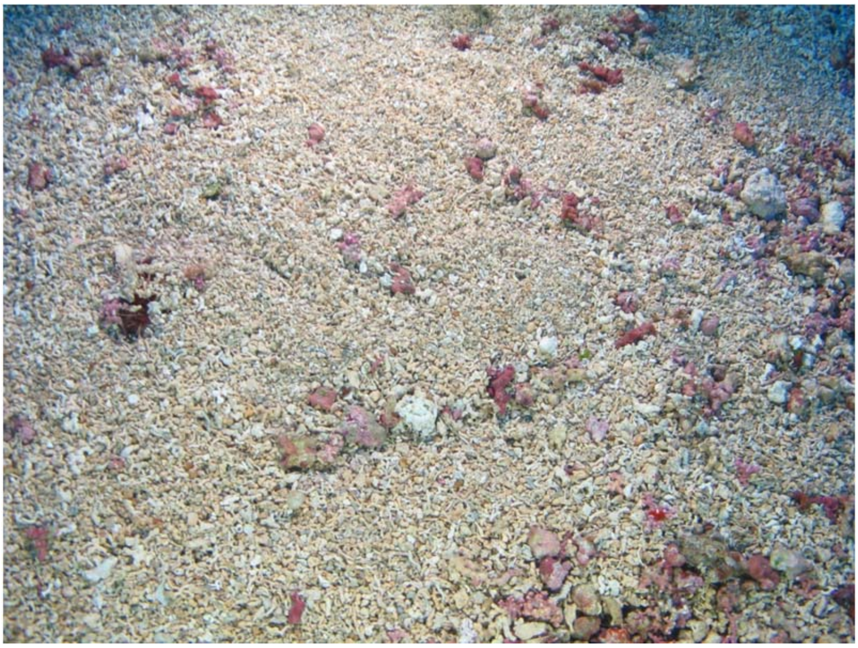


Figure 13. Photograph of the seabed taken at a point along Transect 11, showing a close-up of an assemblage of infralittoral coarse sediment. Individual rhodoliths are visible in places in the photo.

Figure 14. Photograph of the seabed taken at a point along Transect 11, showing a close-up of an assemblage of infralittoral coarse sediment. Three narrow strips with rhodoliths are visible in the photo.

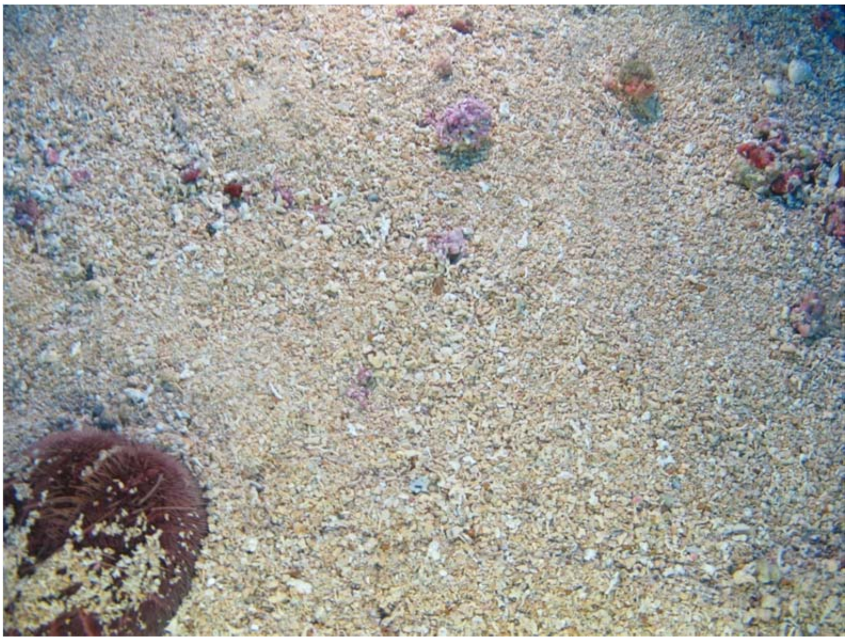


Figure 15. Photograph of the seabed taken at a point along Transect 11, showing a close-up of an assemblage of infralittoral coarse sediment. A few individual rhodoliths (Purple colour) – most of them having a very small size (few mm) – and an individual of the Purple Heart Urchin *Spatangus purpureus*, are visible in the photo.

35. Although in general the area surveyed mainly supported the assemblage types and subtypes as described above and as depicted in Figures 4 and 5, parts within the shaded areas shown in the habitat map (Figures 4 and 5) supported patches with a different assemblage type, such that:

- The area which supported the association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents (dense rhodolith bed) had, in places, patches with the association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents (sparse rhodolith bed) ;
- The area which supported the association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents (sparse rhodolith bed) had, in places, patches with the association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents (dense rhodolith bed) or patches with the assemblage of coarse infralittoral sediment;
- The area which supported the assemblage of coarse infralittoral sediment had, in places, the association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents (sparse rhodolith bed).

Furthermore, comparison between data from video transects made during Borg & Evans' 2017 survey and data from the survey made by Seastar Survey Ltd in May 2018 indicate some differences in the spatial distribution of the assemblage of coarse infralittoral sediment and the association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents (sparse rhodolith bed); these differences are discussed in the discussion section below.

Mediterranean communities of muddy detritic bottoms

36. This assemblage type was recorded from the extreme northwestern corner of the study area (Figures 4 and 5) at a water depth exceeding 100 m and occurred at the base of the 10 m – 25 m high drop-off from where it extended further into deeper waters (Figure 16). No macroflora was recorded from this assemblage type, although detached macroalgae (mainly *Zonaria tournefortii*) were present on the sediment surface in various places. No macrofauna was recorded from this assemblage type but the presence of openings to burrows indicated an associated rich infauna.

Atlantic and Mediterranean low energy circalittoral rock

37. This assemblage type was recorded from the extreme northwestern corner of the study area (Figures 4 and 5) and formed part of the drop-off some 10 m – 25 m high that separated the assemblage of coarse sands and fine gravels under the influence of bottom currents and the assemblage of infralittoral coarse sediments (Figure 17). The associated macroalgae mainly comprised *Zonaria tournefortii* and unidentified coralline algae (Figure 17). The associated macrofauna mainly comprised sponges, bryozoans, and other sessile macrobenthic species. Individuals of the echiuran worm *Bonellia viridis* were recorded in places from this assemblage type.

Figure 16. Photograph of the seabed taken at a point along Transect 21, showing a close-up of a Mediterranean community of muddy detritic bottoms.

Figure 17. Photograph of the seabed taken at a point along Transect 21, showing a close-up of a Mediterranean community of muddy detritic bottoms.

Demersal and pelagic fauna

38. The demersal fish fauna recorded during the survey mainly comprised large shoals of Picarel *Spicara* sp. and individuals of the Comber *Serranus cabrilla*. Several individuals of the Mauve Stinger *Pelagia noctiluca* were recorded in the water column during the survey.

4. APPRAISAL

SEDIMENT AND WATER QUALITY

39. The results of the sediment and water quality surveys indicate physico-chemical characteristics that are typical of marine waters and the seabed off the northeastern coast of Malta. Water depth varies between around 43 m and just over 100 m. The underwater visibility was good (25 – 30 m) throughout the study area but flocculate material (of unknown origin) was present in the water column along some of the transects. A weak southeasterly surface sea current having a speed of between 0.11 m/s and 0.13 m/s was present in the study area.

40. The bottom within the area surveyed consists predominantly of coarse mobile sediments; in the vicinity of the site currently used by AJD Tuna Ltd, the seabed comprises poorly sorted coarse sand having a mean grain size of between 0.55 mm and 0.95 mm. A drop-off, some 10 m – 25 m high, and characterised by rock exposed to sedimentation is present in the northwestern part of the study area. The base of this drop-off is characterised by a bare muddy sand bottom. A large part of the seabed in the study area comprises rhodolith beds, which are more dense and continuous in the northeastern (and deeper) half of the survey area. In many places, the rhodolith beds are interspersed with a bare sand bottom that supports sparse rhodoliths, while in the southwestern half of the survey area, the rhodolith density varies such that they are less dense in the shallower part (45 m – 50 m) of the survey area, where large expanses of bare sand that supported little or no rhodoliths are present. Overall, the seabed has physical features that correspond with the bathymetry: coarse sand with sparse accumulations of rhodoliths (0 % - 20 % rhodolith cover) is present at a water depth of between 43 m and 50 m; between a water depth of 50 m and 55 m, the seabed comprises coarse sediment having denser rhodolith accumulations (20 % - 50 % rhodolith cover); and in waters deeper than 55 m, the seabed mainly consists of dense rhodolith beds (50 % - 100 % rhodolith cover). A current was present in places close to the seabed, as evidenced by debris and other material originating from benthic vegetation that were seen being moved on the bottom.

41. Some anthropogenic items were observed during the survey. These included glass and plastic beverage bottles, abandoned fish traps and fishing lines, and other unidentified items. However, no remains of tuna, feed fish used in tuna farming, or any other item that may have originated from tuna farming activities, was recorded on the seabed during the survey.

BENTHIC DIVERSITY

42. Analysis of the grab samples showed the presence of macrofauna that is typical of the benthic biotic assemblages that characterisize the lower infralittoral to circalittoral transition zone and the upper circalittoral zone that occurs off the northeastern coast of the Maltese islands. (cf. Borg *et al.*, 1998; Schembri 1998; Sciberras *et al.*, 2009). A high diversity of macrobenthic fauna was recorded from the grab samples; the two most represented taxonomic groups, in terms of species richness and abundance, were the polychaetes and the crustaceans. No protected species were recorded from any of the grab samples.

BENTHIC ASSEMBLAGES

43. Overall, the benthic biotic assemblages in the study area are characteristic of ones present in the infralittoral and circalittoral zones off the northeastern coast of the Maltese Islands (e.g. Borg *et al*., 1998; Schembri 1998; Sciberras *et al.,* 2009; Schembri, 2011).

44. Four main biotic assemblage types were recorded from the study area: (i) Association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents (EUNIS code A5.515); (ii) Infralittoral coarse sediment (EUNIS code A5.13); Mediterranean community of muddy detritic bottoms (EUNIS code A5.38); and Atlantic and Mediterranean low energy circalittoral rock (EUNIS code A4.3). The former association was present as two assemblage subtypes: (i) dense rhodolith beds (having a rhodolith cover of between 50 % and 100 %), some of which may possibly be classified as maerl (sensu Basso *et al*., 2016), which occupy a large part of the northeastern half of the study area; and (ii) sparser rhodolith beds (having a rhodolith cover of between 20 % and 50 %), which occupy the central parts of the area surveyed. The assemblage of infralittoral sediment was present in the shallower, southwestern parts of the study area and in places supported sparse rhodolith accumulations (having a rhodolith cover of between 1 % and 20 %). The Mediterranean community of muddy detritic bottoms and the assemblage of Atlantic and Mediterranean low energy circalittoral rock were present in the northwestern corner of the study area.

45. It is emphasised that although the area surveyed mainly supported the assemblage types and subtypes described above, parts within the different areas that represent different habitats (Figures 4 and 5) support patches with a different assemblage type, such that:

- The area which supported the association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents (dense rhodolith bed) had, in places, patches with the association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents (sparse rhodolith bed) ;
- The area which supported the association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents (sparse rhodolith bed) had, in places, patches with the association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents (dense rhodolith bed) or patches with the assemblage of coarse infralittoral sediment;
- The area which supported the assemblage of coarse infralittoral sediment had, in places, the association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents (sparse rhodolith bed).

Furthermore, differences in the spatial distribution of the assemblage of coarse infralittoral sediment and of the association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents (sparse rhodolith bed) were evident when comparing data from video transects made during Borg & Evans' 2017 survey with data from the survey made by Seastar Survey Ltd in May 2018. These differences, which are mostly applicable to the shallower (43 m – 55 m) parts of the study area indicate that the soft sediment seabed there is dynamic and undergoes changes that involve shifting of accumulations of rhodoliths from one place to another, possibly even over large distances of several hundred metres. Such changes would happen during very strong wave action, typically during strong northeasterly winds, such as ones that characterised autumn 2017 and winter 2018. As a result, the spatial distribution of the aforementioned two habitat types changes.

46. Although video footage collected from the present survey enabled recording of several macroalgal species, including *Flabellia petiolata* and Zonaria tournefortii which appeared to be the most abundant, several other algal species are known to be associated with the association with rhodoliths in coarse sands and fine gravels under the influence of bottom currents (see Borg *et al*., 1998; Borg & Schembri, 2008; Schembri, 2011). Likewise, apart from the megafauna, including the urchin *Stylocidaris affinis,* the Heart Urchin *Spatangus purpureus,* the crinoid *Antedon mediterranea* and the Needle-Spined urchin *Centrostephanus longispinus*, and other species recorded from the present survey, numerous other mega- and macrofaunal species occur in association with the rhodolith habitats (see Borg *et al*., 1998; Borg & Schembri, 2008; Schembri, 2011). Apart from these mega- and large macrofaunal species, rhodolith beds support numerous small macrofaunal species including polychaete, mollusc, crustacean, and echinoderm taxa (e.g. Schembri, 2011).

47. No fleshy algae were recorded from the assemblage of infralittoral sediment but very sparse accumulations of rhodoliths or single rhodoliths were present in places, especially in the troughs formed by the current ripples. The megafauna recorded from this assemblage type comprised the Heart Urchin *Spatangus purpureus* and the Purple Urchin *Sphaerechinus granularis.* However, this assemblage undoubtedly supports a rich infauna as evidenced by the macrofaunal species (Table 9) recorded from the grab samples collected from Stations A – D (Figure 3). The recorded species are typical of the assemblage of infralittoral to circalittoral coarse sediment assemblages present of the northeastern coast of Malta within the 45 m to 80 m depth range.

48. The study area is located within the boundaries of the '*MT0000105 Marine Area in the Northeast of Malta*' Special Area of Conservation of International Importance declared by Government Notice 851 of 2010[8] under the provisions of the *Flora, Fauna and Natural Habitats Protection Regulations, 2006*. This area forms part of the European Union's NATURA 2000 network.

49. In Maltese waters, the main rhodolith-forming algae in rhodolith/maerl beds are *Lithothamnion corallioides* and *Phymatolithon calcareum/Lithothamnion minervae*[9] with *Peysonnelia rosa-marina*, *Mesophyllum* sp., and *Neogoniolithon brassica-florida* constituting a minor component (Lanfranco *et al*., 1999). Associations with rhodoliths are a habitat type that qualifies sites for inclusion in national inventories of natural sites of conservation interest as required by the Protocol for Specially Protected Areas and Biodiversity in the Mediterranean (SPA/BD) of the Barcelona Convention[10]. Furthermore, the coralline algae *Lithothamnion corallioides* and *Phymatolithon calcareum* are listed in Annex V (Animal and plant species of Community interest whose taking in the wild and exploitation may be subject

[8] *Malta Government Gazette* No.18,633, 17 August 2010.

[9] It is not possible to distinguish between *Phymatolithon calcareum* and *Lithothamnion minervae* using gross morphology alone.

[10] The *Convention for the Protection of the Mediterranean Sea against Pollution* (the Barcelona Convention) was adopted on 16th February 1976. A number of protocols were adopted under this convention, amongst which is the *Protocol concerning Mediterranean Specially Protected Areas* done at Geneva on 3 April 1982. The parties later amended this protocol and its name changed to *Protocol for Specially Protected Areas and Biodiversity in the Mediterranean* (SPA/BD). Malta ratified this new Protocol on 28th October 1999. A draft reference list of habitat types for the selection of sites to be included in the National Inventories of Natural Sites of Conservation Interest was drawn up at the Fourth Meeting of National Focal Points for Specially Protected Areas (Tunis, 12-14 April 1999) [see UNEP(OCA)/MED WG.154/7]. The most recent '*Classification of benthic habitat types of the Mediterranean*' dated 2006 is available from the UNEP RAC/SPA at http://rac-spa.org/sites/default/files/doc_fsd/lrhm_en.pdf

to management measures) of the European Union's 'Habitats Directive' as amended[11]. Both species probably occur in the rhodolith beds in the present study area; however, only microscopic examination of samples of rhodoliths collected from the area will confirm this.

50. *Lithothamnion corallioides*, *Phymatolithon calcareum*, together with *Lithothamnion minervae* are listed in Schedule III (Animal and plant species of national interest whose conservation requires the designation of Special Areas of Conservation), and the first two named also in Schedule VII (Animal and plant species of Community interest whose taking in the wild and exploitation may be subject to management measures) of the *Flora, Fauna and Natural Habitats Protection Regulations, 2006* as amended[12], which transpose the requirements of the EU's Habitats Directive to local legislation.

32. Rhodolith and maerl beds are included in the UNEP/MAP/RAC-SPA "Reference list of marine habitat types for the selection of sites to be included in the national inventories of natural sites of conservation interest" (UNEP/MAP/RAC-SPA, 2006) while an action plan for their conservation has been formulated (UNEP/MAP/RAC-SPA, 2008), both within the ambit of the Barcelona Convention. Within European legislation, Council Regulation (EC) 1967/2006, concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea, bans the use of specific fishing gear (trawl nets, dredges, shore seines or similar nets) on coralligenous or maerl beds[13]. In order to conform to the requirements of EC 1967/2006, the local 'Implementation and Enforcement of Certain Fisheries Management Plans Order' (Legal Notice 354 of 2013) amends Zones C and G referred to in Annex V of EC 1967/2006 that originally overlapped with rhodolith beds as well as closed to trawling all areas where conclusive evidence exists for the presence of such beds (see Figure 44 in LN 354/2013).

32. The Needle-spined sea-urchin, *Centrostephanus longispinus* is listed in the Habitats Directive under Annex IV (Animal and plant species of Community interest in need of strict protection), in Appendix II of the Bern Convention[14], and in Annex II of the SPA/BD Protocol)[15]. This

[11] The European Union's *Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora* is known as the 'Habitats Directive'. Annexes I and II of this Directive have been amended by Council Directive 97/62/EC of 27 October 1997. Annex I of the Habitats Directive lists natural habitats whose conservation requires the designation of Special Areas of Conservation. Annex II lists species of plants and animals whose habitats must be protected for their survival. Annex III lists criteria for selecting sites eligible for consideration as "Sites of Community Importance" and designation as Special Areas of Conservation, while Annex IV lists species of Union interest in need of strict protection. Annex V lists species of plants and animals of Union interest whose taking from the wild and exploitation is subject to management, and Annex VI lists prohibited methods and means of capture and killing of mammals and fish, and prohibited modes of transport. In anticipation of the 2004 enlargement of the EU, the Annexes of the Habitats Directive were modified by the Act of Accession signed in Athens on 16th April 2003, to take into account the expanded geographical area of the EU15+10. The annexes were further amended by Council Directive 2006/105/EC of 20 November 2006 in anticipation of Bulgaria and Romania joining the European Union in 2007 and then again by Council Directive 2013/17/EU of 13 May 2013 due to the accession of the Republic of Croatia.

[12] These regulations were last amended by the Flora, Fauna and Natural Habitats (Amendment) Regulations, 2013 (Legal Notice 322 of 2013).

[13] According to this Regulation, "Mäerl is a collective term for a biogenic structure due to several species of coralline red algae (Corallinaceae), which have hard calcium skeletons and grow as unattached free living branched, twig-like or nodule corallines algae on the seabed, forming accumulations within the ripples of mudflats or sandflats seabed. Maerl beds are usually composed of one or a variable combination of red algae, in particular, *Lithothamnion coralloides* and *Phymatolithon calcareum*". In this definition, 'maerl' is used in the wider sense to refer to 'rhodolith beds' as defined by Basso *et al.* (2016); true maerl is a particular type of rhodolith bed.

[14] The Bern Convention is the *Convention on the Conservation of European Wildlife and Natural Habitats*. Malta acceded to this Convention on the 26th November 1993. Appendix II of the Bern Convention lists strictly protected species of fauna

species is also protected locally under the *Flora, Fauna and Natural Habitats Protection Regulations, 2006* as amended, where it is listed in Schedule V (Animal and Plant Species of Community Interest in need of Strict Protection).

5. IMPACTS ON MARINE ECOLOGY

51. The present assessment of impacts will consider the following phases:
    (i) Cage deployment phase
    (ii) Operational (tuna farming) phase

    Where details on the proposed activity are not available or insufficiently detailed, hence resulting in a degree of uncertainty, the 'precautionary principle' is applied and the worse case scenario is considered. The present assessment of impacts considers the study area within which the ecological assessment described above was made.

52. In making the present assessment of impacts, the procedure will be as follows:
    - The main source of impact will be identified and described, and specifically established as adverse or beneficial.
    - The likely severity and extent, as well as the receptors and sensitivity of the latter will be described.
    - Any possible mitigation measures will be indicated.
    - The following criteria will be used to determine the level of overall impact:
        - **Insignificant**: no impact or change is predicted in space and time;
        - **Low**: low level of impact that is localised in space, i.e. within the area of interest (AoI), and occurring over a short time period of a few days to a few weeks, and which may be mitigated.
        - **Moderate:** moderate level of impact that may extend beyond the area of influence and occurring over a longer time period of several months, and which may not necessarily be mitigated.
        - **High**: high level of impact that may extend well beyond the area of influence, which will probably leave some permanent/residual effects, and which may not necessarily be mitigated.
    - The duration of the impact and residual effects will be considered.

    The above procedure will be adopted using knowledge of marine ecology of the study area as baseline.

and the Convention prohibits the deliberate capture, the destruction of breeding or resting sites, the deliberate destruction, and the deliberate killing of, and trade in, these species.

[15] A number of species are listed in annexes to the SPA/BD Protocol: Annex II lists endangered or threatened species and Annex III lists species whose exploitation is regulated.

POTENTIAL IMPACTS DURING THE CAGE DEPLOYMENT PHASE

Source of impact

- **Disturbance to marine fauna resulting from increased vessel activity during deployment of cage moorings, ropes and tuna pens**
- **Accidental and/or deliberate spillage of toxic substances and contaminants from vessels used to deploy cage moorings**
- **Deployment of cage moorings**

Disturbance to marine fauna resulting from increased vessel activity during deployment of cage moorings, ropes and tuna pens

53. An increase in vessel activity is envisaged in the vicinity of the tuna penning site to enable deployment of the cage moorings, mooring ropes and tuna pens. This is expected to result in disturbance to pelagic fauna present in the general area where the new tuna pens will be deployed. Although detailed data on the pelagic fauna that occur within the study area are lacking, it is expected that several species of pelagic fish, turtles and cetaceans migrate in its vicinity. Such fauna will be exposed to disturbance from the increased vessel activity and from deployment of the cage moorings, ropes and tuna pens. However, the fauna that are expected to be affected are mobile and will swim away from the affected area such that there will be a small deviation of the migratory route without significant adverse effects to the animals.

54. Good practice and measures to reduce disturbance to a minimum are the only mitigation measures to reduce potential adverse impacts.

55. Taking the above into consideration, the overall level of impact is predicted to be **insignificant to low**.

56. With respect to the duration of impact and residual effects; the impacts will be temporary and effective during deployment of the cage moorings, ropes and tuna pens.

Accidental and/or deliberate spillage of toxic substances and contaminants from vessels used to deploy cage moorings

57. Given that vessels, including ones used to deploy the cage moorings, ropes and tuna pens, will be used during installation of the pens, there is a potential for introduction of hazardous substances and chemicals, whether deliberate, accidental or indirect into the marine environment. However, excepting an accident, whether such introduction of hazardous substances and chemicals into the marine environment will actually occur will largely depend on good management and work practices, and effectiveness of environmental protection measures.

58. The introduction of hazardous substances and chemicals (for example, fuel and lubricants, amonsgt others) may have toxic effects on the marine flora and fauna, which could include reduction in reproductive potential and capacity, fertilisation success, development and physiological function. However, the site concerned is located in deep offshore waters that are characterised by a high hydrodynamic regime, hence any small spillage of hazardous

substances and chemicals will be rapidly dispersed and are not expected to have a significant impact on the marine biota present in the vicinity.

59. Any introduction of toxic substances and contaminants will depend heavily on application of precautionary measures, and on the toxicity and levels of substances and contaminants potentially introduced to the marine environment. Therefore, good practice and measures to reduce spillage into the marine environment, hence ones that prevent the introduction of toxic substances and contaminants to the marine enviroment will be important to mitigate potential adverse impacts.

60. Taking the above into consideration, the overall level of impact is predicted to be **insignificant** unless there is large accidental or deliberate spillage, in which case the level of impact is predicted to be **low to medium.**

61. With respect to the duration of impact and residual effects; the impact of potential introduction of toxic substances and contaminants will be temporary and of very short duration (few days), as long as there is no large accidental or deliberate spillage.

Deployment of cage moorings

62. Deployment of the cage mooring is expected to impact the benthic habitat when the concrete block ends up resting on the seabed as there will be direct physical contact with the latter, although the area of the seabed that will be significantly impacted is that which will be occupied by the mooring block. All benthic flora and fauna, the latter mostly comprising sessile and slow moving invertebrates, that will end up underneath the mooring block will be decimated. The more motile fauna, such as fast moving invertebrates and fishes are expected to move away rapidly from a mooring block that is being deployed and will not be affected adversely.

63. On making contact with the soft sediment seabed, disturbance of the latter will lead to suspension of sediment in the water column. Settling of the suspended sediment on the bottom will lead to smothering of flora and sessile fauna, resulting in potential adverse effects on such organisms, although the concerned species are usually adapted to disturbance from suspended sediment and will recover quickly, while the high energy environment of the area will help rapid removal of any sediment particles that may have been deposited on the biota.

64. Good practice and measures to reduce the adverse impact of deployment of the mooring on the seabed, for example, by avoiding dragging the mooring block on the seabed during deployment, are the only mitigation measures to reduce potential adverse impacts.

65. Taking the above into consideration, the overall level of impact is predicted to be **high** within the area that will be occupied by the mooring block, but **insignificant to low** on the sessile benthic species present in the vicinity (a few metres away) of the deployed mooring block.

66. With respect to the duration of impact and residual effects; the impact on the flora and fauna that will end up beneath the mooring clock will be permanent, while impacts on the flora and sessile fauna present in the immediate vicinity of the block will be temporary and of very short duration (few days).

POTENTIAL IMPACTS DURING THE OPERATIONAL (TUNA FARMING) PHASE

Source of impact

- **Disturbance to marine fauna resulting from increased vessel activity during tuna farming**
- **Accidental and/or deliberate spillage of toxic substances and contaminants from vessels used in connection with the tuna penning operations**
- **Decreased light reaching the seabed as a result of shading by the tuna cages**
- **Increased nutrient input, originating from the farmed tuna's waste and feed fish, to the water column**
- **Deposition of organic matter, originating from the farmed tuna's waste and feed fish, on the seabed**
- **Generation of a surface slick comprising fish oils released from the feed fish**
- **Littering of the seabed underneath the tuna cages and in their vicinity**
- **Attraction of wild fauna to the tuna farm**

Disturbance to marine fauna resulting from increased vessel activity during tuna farming

67. An increase in vessel activity is envisaged in the vicinity of the tuna penning site in connection with the tuna farming activity. A number of vessels are expected to operate in the vicinity of the tuna penning site in connection with the farming activity. These include work boats that will be used to transport the feed fish and to feed the caged tuna, boats used for general maintenance of the tuna pens, and vessels used during the period when the tuna are harvested. The latter vessels will be the largest ones used in connection with the tuna farming activity but will only be present during the 2 – 3 month period during which harvesting of the tuna will be carried out and normally anchor some distance offshore from the tuna farm. The presence of vessels is expected to result in disturbance, mainly through generation of underwater noise, to pelagic fauna present in the general area where the new tuna pens will be deployed. Although detailed data on the pelagic fauna that occur within the study area are lacking, it is expected that several species of pelagic fish, turtles and cetaceans migrate in its vicinity. Such fauna will be exposed to disturbance, mainly through generation of underwater noise, from the increased vessel activity in the vicinity of the tuna farm. However, the fauna that are expected to be affected are mobile and will swim away from the tuna penning site such that there will be a small deviation of the migratory route without significant adverse effects to the animals.

68. Good practice and measures to reduce disturbance to a minimum are the only mitigation measures to reduce potential adverse impacts.

69. Taking the above into consideration, the overall level of impact is predicted to be **insignificant to low**.

70. With respect to the duration of impact and residual effects; the impacts will be effective throughout the period when tuna farming is carried out.

Accidental and/or deliberate spillage of toxic substances and contaminants from vessels used in connection with the tuna penning operations

71. A number of vessels are expected to operate in the vicinity of the tuna penning site in connection with the farming acvitiy. These include work boats that will be used to transport the feed fish and to feed the caged tuna, boats used for general maintenance of the tuna pens, and vessels used during the period when the tuna are harvested. The latter vessels will be the largest of the ones used in connection with the tuna farming activity but will only be present during the 2 – 3 month period during which harvesting of the tuna will be carried out. Because of the regular presence of such vessels in the vicinity of the tuna penning site, there is a potential for accidental or deliberate introduction of hazardous substances and chemicals (for example, fuel and lubricants, amonsgt others), whether deliberate, accidental or indirect, into the marine environment. However, excepting an accident, whether such introduction of hazardous substances and chemicals into the marine environment will actually occur will largely depend on good management and work practices, and effectiveness of environmental protection measures.

72. The introduction of hazardous substances and chemicals may have toxic effects on the marine flora and fauna, which could include reduction in reproductive potential and capacity, fertilisation success, development and physiological function. However, the site concerned is located in deep offshore waters that are characterised by a high hydrodynamic regime; hence, any small spillage of hazardous substances and chemicals will be rapidly dispersed and are not expected to have a significant impact on the marine biota present in the vicinity.

73. Any introduction of toxic substances and contaminants will depend heavily on application of precautionary measures, and on the toxicity and levels of substances and contaminants potentially introduced to the marine environment. Therefore, good practice and measures to reduce spillage into the marine environment, hence ones that prevent the introduction of toxic substances and contaminants to the marine enviroment, will be important to mitigate potential adverse impacts.

74. Taking the above into consideration, the overall level of impact is predicted to be **insignificant** unless there is a large accidental or deliberate spillage, in which case the level of impact is predicted to be **low to medium.**

75. With respect to the duration of impact and residual effects; the impact of potential introduction of toxic substances and contaminants will be temporary and of very short duration (few days), as long as there is no large accidental or deliberate spillage.

Decreased light reaching the seabed as a result of shading by the tuna cages

76. Tuna cages typically have a diameter of around 50 m and support a cage net that is some 35 m high. The cage net and the tuna they hold are expected to produce a shading effect and reduce the amount of light reaching the seabed. The reduced light availability will have an adverse effect on any rhodoliths present on the seabed, even if these are present in small accumulations or are sparsely distributed on the bottom, given that the photosynthetic capacity of the algae making up the rhodoliths will be decreased such that they will stop growing or die. With regard to any associated megafauna and macrofauna; the sparse rhodolith accumulations recorded from the site identified for tuna penning are not known to support a high diversity of associated fauna, at least compared to dense rhodolith beds,

while the fauna that occurs in association with such habitat is more typical of lower infralittoral and upper circalittoral coarse sediments. Therefore, the main adverse impact is expected to be mostly on the rhodoliths.

77. The shading effect cannot be mitigated unless the cages are removed and is a consequence of the presence of a floating structure – the tuna pen - which cannot be modified or replaced by another structure that does not cause shading.

78. Taking the above into consideration, the overall level of impact is predicted to be **high** on any rhodoliths present within the area that will be occupied by a tuna cage, but **insignificant** in other areas at the tuna penning site.

79. With respect to the duration of impact and residual effects; the impact will be effective throughout the period when the tuna pens are in place (c. 6 months); however, once the latter are removed, recovery (which will require at least a few months) is expected since coralline algae will rapidly recolonise any rhodoliths whose algal component would have demised.

Increased nutrient input, originating from the farmed tuna's waste and feed fish, to the water column

80. The tuna farming operations are expected to result in some nutrient and organic loading of the water column; the nutrients and organic matter will mainly originate from faecal matter excreted by the farmed tuna and from decomposition of any uneaten feed fish that will end up on the seabed. Water quality surveys have been carried out at local tuna penning sites since the early 2000's. During these surveys, standard water quality attributes, namely dissolved oxygen, temperature, salinity, turbidity, nitrates, phosphates, Chlorophyll *a*, ammonia, and counts of intestinal bacteria, as well as sea currents, were measured at a number of sampling stations located in the immediate vicinity of the tuna farms and at up-current and down-current reference stations. The results of such surveys indicate that, very rarely, lowered levels of oxygen, reduced water transparency and elevated nutrient (nitrates and/or phosphates and/or ammonia) levels were recorded from the tuna penning sites during the farming season (July – December). However, the observed changes in the monitored attributes were often sporadic and not statistically significant, and have not resulted in appreciable alteration of water quality. Elevated counts of intestinal bacteria have also been occasionally recorded but since such organisms do not originate from the tuna but from sewage, their presence were not attributed to the tuna penning activities *per se*, although there is the possibility that large ships (e.g. the processing ships present during harvesting of the tuna) may be the source of such contamination through discharge of sewage from their holding tanks. Such favourable results with respect to water quality are attributed to the high energy environment, particularly strong sea currents present, that characterise the offshore area where the proposed tuna penning site is located, and which lead to rapid and effective dispersal of nutrients that may originate from the tuna farming activity.

81. Nevertheless, good practice and measures to reduce loading of the water column with nutrients and organic matter are recommended; in particular excessive loading by organic matter can be reduced by ensuring that overfeeding is avoided, such that the amount of uneaten feedfish that are introduced to the marine environment will be minimal.

82. Taking the above into consideration, the overall level of impact of nutrient and organic matter loading of the water column on water quality and associated biota (e.g. plankton) is predicted to be **insignificant to low**.

83. With respect to the duration of impact and residual effects; the impact will be effective throughout the period when tuna farming is carried out (4 - 6 months), with progressively reduced effects as the tuna is harvested and the reared biomass reduced.

Deposition of organic matter, originating from the farmed tuna's waste and feed fish, on the seabed

84. The tuna farming operations are expected to result in organic loading of the seabed; the organic matter will mainly originate from decomposition of uneaten feed fish that may end up on the seabed. Such organic loading is expected to have a large impact on benthic habitat, which would result in changes to sediment quality and to the species composition of biotic assemblages associated with lower infralittoral/upper circalittoral coarse sediment habitat. In cases where the impact is large and adverse, loss of habitat and biodiversity may occur.

85. Video surveys of the seabed underneath tuna cages have been undertaken regularly at local tuna since the early 2000's. The main aim of such surveys was to gather qualitative and semi-quantitative data, using direct observation, on the physical and biological characteristics of the seabed underneath the tuna pens. The results of these surveys have indicated that towards the end of each penning season (in autumn) considerable amounts of uneaten feed fish littered the seabed in the area lying directly below the tuna pens, but not in areas beyond the perimeter of the tuna pens. This resulted in alterations in the physical and biological characteristics of the seabed under the pens, namely: (i) changes in biological characteristics, which typically consist of high population densities of detritus-feeding and scavenging benthic (i.e. associated with seabed) fauna, and whose occurrence is unusual considering the benthic habitat type present at the tuna penning sites surveyed; (ii) alterations in physical characteristics, which typically consist of the presence of large quantities of fish bones and baitfish that are gradually consumed by scavengers or eventually decompose. The results of the video surveys also indicated that the amount of uneaten feed fish present varied considerably between the different pens, and between different farms, with some only having a few feed-fish beneath them and others having multiple layers of decomposing feed-fish. Once the tuna farming season is over (late winter), a negligible amount of uneaten feed-fish remain on the seabed below the pens. However, thick layers of fish bones and of decomposing organic material persist under some of the pens. These observations indicate a consistent pattern, with the volume of uneaten feed-fish on the seabed decreasing only when the tuna have been harvested (and therefore there is no further addition of feed-fish). Any uneaten fish remaining on the seabed at this time will continue to decompose slowly and, if present in large numbers, form a continuous layer of decomposing organic material. Sometimes, following storms and possibly due to strong bottom currents, this layer is admixed with the underlying mobile sediment. In places where the decomposition process is complete, the only remains are fish bones that eventually disperse in the sediment leaving little or no trace of the original uneaten fish on the surface. Once the source of the impact (periodic addition of new uneaten food) is removed, slow recovery to the original state is characterised by the re-appearance of certain megafaunal

species (e.g. the irregular sea urchin *Spatangus purpureus* and the crinoid *Antedon mediterranea*) that form part of the original fauna that characterise the bare muddy sand bottom of the areas where the tuna farms are located.

86. Monitoring of sediment quality at local tuna penning sites has also been carried out regularly since the early 2000's. The main aim of such monitoring is to assess the levels of organic carbon content and organic nitrogen content of the sediments, as well as sediment granulometric characteristics. Moreover, at least one survey involving assessment of levels of pollutants, including heavy metals and organic pollutants, was carried out at some of the extant tuna penning sites. The monitoring design of the surveys to assess organic carbon content and organic nitrogen content of the sediments, and sediment granulometric characteristics, was based on a Beyond **BACI**[16] layout, in which the results of quantitative analyses of sediment samples collected from the tuna farming site and from a number of control sites before the start of the farming operations are compared with those obtained after a farming season using advanced statistical analyses. Overall, the findings from surveys that were aimed at assessing organic carbon content and organic nitrogen content of the sediments, and sediment granulometric characteristics, indicated 'pulse' (i.e. short duration) changes in the physico-chemical properties of the sediment following some but not all of the tuna penning seasons; when these changes were recorded they were restricted to the seabed area located in the immediate vicinity of the tuna pens and/or in the general area occupied by the pens but no significant permanent alterations of the sediment characteristics at the operational sites have been recorded to date. Where significant changes were detected, these appeared to have resulted from accumulation of large amounts of uneaten feed-fish in the vicinity of the tuna pens, which decompose slowly causing alterations in the physico-chemical properties of the sediments. The results of the surveys aimed at assessing levels of heavy metals and pollutant organics indicated that no elevated levels were present in the sediments in the vicinity of the tuna farms.

87. Monitoring of benthic diversity at local tuna penning sites has also been carried out regularly since the early 2000's. The main aim of such monitoring is to assess for potential changes in benthic species populations and habitat that may result from the tuna penning activities. The monitoring design was based on assessing total species richness and total abundance of selected benthic faunal species, as these are deemed good indicators of the overall state of species and habitats associated with the seabed. As in the case of the physico-chemical attributes monitoring component, the design for monitoring of benthic diversity was based on a Beyond **BACI** layout, in which the results of quantitative analyses of samples collected from the tuna farming site and from a number of control sites **before** the start of the farming operations are compared with those obtained **after** a farming season using advanced statistical analyses. Overall, the findings from monitoring of benthic diversity indicate a significant 'press' (i.e. long-lasting) adverse impact (manifested as a significant decrease in total macroinvertebrate species richness and/or decrease in the abundance of one or more of the indicator species) following some but not all of the tuna penning seasons; when these changes were recorded they were restricted to the seabed area located in the immediate vicinity of the tuna pens and/or in the general area occupied by the pens. Furthermore, enhanced productivity in the general area of the tuna farms and beyond, as a result of the

[16] **B**efore **A**fter **C**ontrol **I**mpacted; see Underwood (1992): Underwood, A. J. (1992) Beyond BACI: the detection of environmental impacts on populations in the real, but variable, world. *Journal of Experimental Marine Biology and Ecology* 161: 145 –178.

tuna-penning activities, was evident from significant increases in the abundance of some of the indicator species recorded in some of the monitoring sessions. These observations are a strong indication that, where present, adverse impacts on the benthic macroinvertebrate assemblages and habitat at the tuna penning sites have resulted from processes that are mainly attributed to accumulation of large amounts of uneaten feed-fish and slow decomposition of same, in the vicinity of the tuna pens. The uneaten feed-fish attract scavengers and other opportunistic fauna that cause changes to the original species composition of the benthic assemblages, while slow decomposition of the accumulated material causes alterations in the physico-chemical properties of the sediments, and presumably of the sediment-water interface, leading to adverse conditions for the biota originally present. A number of scientific publications, which present detailed results – mainly as described above - of the influence of local tuna penning activities on marine benthic habitat, are available; see Manion *et al* (2014; 2017; 2018).

88. Good practice and measures to reduce excessive loading of the seabed by organic matter are the main mitigation measures that can be adopted to avoid or at least reduce adverse impacts on the benthic biota and habitat present in the vicinity of the tuna penning site. Essentially, good feed management procedures will be very important to mitigate adverse impacts resulting from organic loading of the seabed. The following measures are deemed particularly important: (i) Feeding of the tuna should be carefully monitored and stopped as soon as the fish are satiated, in order to avoid as much as possible uneaten feed ending up on the bottom. The tuna operators may want to implement a procedure to ensure proper feed management by having random checks of the seabed below the tuna pens made by an independent environmental monitor; (ii) In the case of accident, should an inordinate amount of dead uneaten feed-fish end up on the bottom, every attempt should be made to recover as much of the material as possible using techniques that do not have an adverse effect on the seabed habitat.

89. Taking the above into consideration, the overall level of impact of organic matter loading of the seabed, and hence on benthic biota and habitats present at the tuna penning site, is predicted to be **medium to high** within the seabed area directly underneath the cages; and **insignificant to low** in the seabed area beyond.

90. With respect to the duration of impact and residual effects; the impact will be effective throughout the period when tuna farming is carried out.

Generation of a surface slick comprising fish oils released from the feed fish

91. The tuna farming activity is expected to generate oils and fats that are released from the thawing feed-fish when these are fed to the tuna. Release of such substances occurs when the semi-frozen feed fish are introduced in the tuna pens, and when uneaten feed-fish end up outside the fish cages. The resulting floating slick of fatty substances that accumulate on the surface may be transported offshore or inshore, depending on sea current strength and direction. Such substances, commonly known as ‘fish farm slime’, have caused much public concern and outcry. Although they are not deemed to have any toxic effects on pelagic marine species and habitats, they are aesthetically unpleasing and a nuisance to bathers, divers and coastal recreational activities, because of their sheer presence in the water and since they deposit on the shore and on artificial surfaces (e.g. boat hulls etc.). The deposition of such substances on the shore is not envisaged to have any large adverse effects on marine

species and habitats, given that they will rapidly biodegrade; however, this has not yet been assessed given the complete lack of studies that deal specifically with this aspect.

92. Good practice and measures to reduce the release of oils and fats from the feed fish, restrict their presence to the immediate vicinity of the tuna farm (e.g. by using booms), and carrying out immediate collection of the substances (e.g. using skimmers) when appreciable amounts of them are released to the marine environment, are the main mitigation measures that can be adopted to avoid or at least reduce their presence on the surface in coastal areas close to the fish farms and inshore.

93. Taking the above into consideration, the overall level of impact when floating oily and fatty substances originating from the feed fish end up on the surface in offshore waters and are potentially transported inshore, is predicted to be **medium to high** from the aesthetics and water quality for recreational activities points of view, but **insignificant to low** with respect to adverse impacts on marine ecology, including shore habitat where they may be deposited.

Littering of the seabed underneath the tuna cages and in their vicinity

94. The results of video surveys made below tuna cages at local tuna penning sites have indicated that, in places, a considerable amount of anthropogenic items is present below the pens that appear to originate from the farm operations; these include concrete weights with ropes attached, sheets and sacks of fabric and other material, car tyres, lengths of rope and other unidentified items. While plastic items are known to be hazardous to marine life, items deposited on the seabed lead to physical alteration of the bottom leading to potential changes to the benthic habitat present in the vicinity of the fish farm.

95. Good practice and measures to reduce littering of the seabed by anthropogenic items originating from the tuna penning activities are the main mitigation measures that can be adopted to avoid littering of the seabed. Should any items originating from the fish farm accidentally end up in the sea, whether floating or deposited on the seabed, these should be recovered immediately.

96. Taking the above into consideration, the overall level of impact when anthropogenic items originating from the fish farm end up in the sea, whether floating or deposited on the seabed, is predicted to be **low** to **medium**.

Attraction of wild fauna to the tuna farm

97. Fish farms, including tuna ranches, are known to attract a variety of wild marine pelagic fauna. These include: shoals of small pelagic fish (such as Clupeid species) which eat the fragments of feed fish that are released in the water, and the biota growing on the tuna pen nets; medium-sized predators such as *Coryphaena hippuris* and *Seriola dumerilii* which feed on the small pelagic fish that aggregate in the vicinity of the tuna cages; large pelagic predators including cetaceans (namely dolphins), which feed on the medium-sized predators and uneaten feed fish present outside the tuna pens; and wild tunas that are attracted to the caged tuna and also feed on uneaten feed fish that end up outside the tuna pens. Such aggregations of wild pelagic fauna are not envisaged to be adversely affected by the tuna penning activities *per se*, since they will be acquiring food that will potentially lead to enhanced local production. However, the aggregations tend to attract fishermen who carry

out fishing activities in the vicinity of tuna farm such that they will harvest the wild fish present there; indeed because of such 'facilitated' harvesting of wild fish, fish farms have been described by marine ecologists as serving as 'ecological traps'. The problem at local tuna farms gets more complicated since fishermen who target the wild tunas and carry out their activities in the vicinity of the farms may actually be the cause of whole dead tunas ending up on the seabed in the vicinity of the tuna farms. This problem is highlighted in Arechavala-Lopez *et al*. (2015); fishermen deploy fishing lines in the vicinity of the tuna farms with an aim to catch wild tuna that aggregate there. Any tunas that are caught may: (i) either break free but will have the hook and a length of fishing line attached to their mouth, which may eventually become entangled against the cage mooring ropes, such that the fish will be restricted in its ability to swim or get exhausted trying to break free but in both cases will end up dying; or (ii) become entangled against the cage mooring ropes and, being unable to retrieve them, the fishermen[17] cut them free, however, the hook and length of fishing line attached to their mouth may, again, eventually become entangled against the cage mooring ropes, leading to (i) as stated previously. Fishermen have also been observed to clean tunas they would have caught and discard the head and offal overboard.

98. Prohibition/strict control of fishing activities in the vicinity of the tuna farms is the main mitigation measure that can be adopted to avoid detrimental (and sometimes) illegal harvesting of wild fish, including tunas) in the vicinity of the fish farms.

99. Taking the above into consideration, the overall level of impact of uncontrolled fishing activities that are aimed at harvesting pelagic wild fauna, including tunas, which aggregate in the vicinity of the tuna farms, leading to the adverse effects described in para 100 above, is predicted to be **low**.

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ASSOCIATES

APPENDIX 2: AVIFAUNA BASELINE REPORT

An Environmental Impact Statement (EIS) is to be prepared *for GF00250/07: Proposal for a new aquaculture zone in the North of Malta, Zone offshore Malta*

Baseline study on Avifauna

Prepared by

John J. Borg

Independent Consultant

Logistic Support:

12, Sir Arthur Borton Street
Mosta, MST14
Malta

Telephone: (+356) 2143 1900
Fax: (+356) 21424 137
e-mail: info@ecoserv.com.mt

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Ecoserv Report Reference: 046-18

CONTENTS

1.1 TERMS OF REFERENCE

An Environmental Impact Statement (EIS) is to be prepared *for GF00250/07: Proposal for a new aquaculture zone in the North of Malta, Zone offshore Malta* as required by Schedule IA Section 6.3.1.1 of the Environmental Impact Assessment Regulations, 2007 (S.L. 549.46). May 2017

3.3 to 3.7 Light, noise and vibration: with respect to possible impacts on avifauna

The impacts on avifauna including (but not restricted to) disturbance, noise, vibration, loss of habitat, shadow flicker and lighting, collision risks.

The impact of the fish pens as barriers/hazards to movement shall be assessed in terms of the seabird colonies and other marine avifauna. The impact on prey availability for breeding and "visiting" seabirds shall also be assessed.

The assessment shall analyze the disruption of ecological links between feeding, breeding and roosting areas. An assessment of collision risks for seabirds shall be taken into account.

The assessment shall also investigate the annual change in populations of birds if necessary through modeling and the decline in territory occupancy.

1.2 SCOPE OF THIS WORK

The scope of this work is to present an updated report on any possible direct and indirect interactions and impacts by the fish pens on the avifauna, particularly the breeding pelagic seabirds. If any such impacts are identified, the report will propose mitigation measures.

1.3 Area of influence

The North Aquaculture Zone will be located at a minimum distance of 4.5 km from the shore and the main scope of the zone would be for capture-based aquaculture. The area lies in a straight line of sight from two Natura 2000 shearwater colonies which are; Ramla tat-Torri/Rdum tal-Madonna area MT0000009, Kemmuna, Kemmunett, il-Ħaġriet ta' Bejn il-Kmiemen u l-Iskoll ta' Taħt il-Mazz MT0000017 and il-Gzejjer ta' San Pawl (Selmunett) MT0000022 as well as two Marine N2K sites; il-Bahar madwar Ghawdex MT0000112 and il-Bahar tal-Grigal MT0000107.

1.4 Competence of consultant

This report was prepared by John J. Borg:

- Senior Curator of the Natural History Unit (Heritage Malta);
- Member of the Royal Society of Biologists UK (2013 -)
- Licensed Bird Ringer BirdLife Malta (1981 -) ISPRA (Italian Ringing Scheme 2010 -)
- Researcher in the fields of Ornithology and animal ecology, author of over 100 scientific papers and books;
- Participated in numerous local and foreign E.I.A.s and technical reports related to Ornithology and other vertebrates; and
- Holds a number of posts in local and foreign scientific institutions.

2. Study Methodology

2.1 **Desk Study**:

This assessment is based on accumulated data obtained from long-term observations on the breeding biology and ecology of Malta's breeding seabirds (1982-2018).

Published and unpublished reports from three EU LIFE funded projects:

EU LIFE+ Progett Garnija (2006-2010)

EU LIFE+ **Malta Seabird Project** (201**2**-2016) and

EU LIFE funded **Arcipelagu Garnija** (2016-2020)

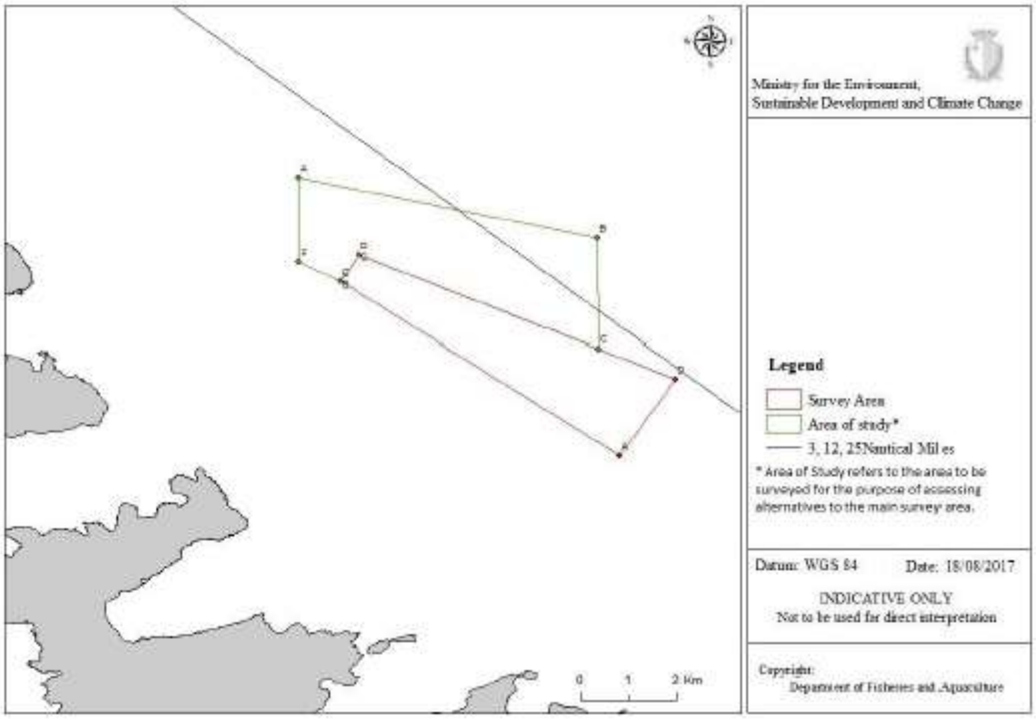

Fig. 1 Area of influence.

3 STUDY AREA

Ramla tat-Torri/Rdum tal-Madonna area MT0000009

Rdum tal-Madonna (35°59'28.76"N, 14°22'15.02"E) is located along the north-east coast of Malta, situated on the l-Ahrax tal-Mellieha promontory. The geological formations are composed entirely of Upper Coralline Limestone formations, with the result that the cliffs are honey-combed with caves, crevices and fissures as well as extensive rubble scree. There are stretches of karst garrigue and patches of woodland. One also finds remnants of sand-dune habitat at White-tower bay. The are holds the most important Yelkouan Shearwater *Puffinus yelkouan* colony in the Maltese Islands as well as a small colony of Scopoli`s Shearwater *Calonectris diomedea*. In 2016 the Mediterranean Storm-petrel *Hydrobates pelagicus melitensis* was found breeding inside one of the numerous caves in the area. Other breeding bird species are the Blue Rock Thrush *Monticola solitarius*, Short-toed Lark *Calandrella brachydactyla* Sardinian Warbler *Sylvia melanocephala* and Spectacled Warbler *Sylvia conspicillata*.

Fig 2. Area of influence at Ramla tat-Torri and Rdum tal-Madonna

Kemmuna, Kemmunett, il-Ħaġriet ta' Bejn il-Kmiemen u l-Iskoll ta' Taħt il-Mazz MT0000017

Kemmuna u l-Gzejjer ta' Madwarha (Comino and its islets) Kemmuna is a small island lying mid-way between Malta and Gozo surrounded by a number of small islets known as Kemmunett, Il-Hagriet ta' Bejn il-Kmiemen and l-Iskoll ta' Taht il-Mazz. The cliff sides in the southern area of Kemmuna are characterised by scarps and boulders. The cliffs, especially areas that are shady, support the Cliff Groundsel (Senecio leucanthemifolius - a very rare species having a restricted distribution in the Maltese Islands as well as the Mediterranean, protected under national legislation. Cliffs are colonised by typical rupestral vegetation. The coastline between the northern and western areas of Kemmuna is indented with coves and inlets. The eastern coast is of particular interest for this study as it supports breeding colonies of Yelkouan and Scopoli`s Shearwaters.

Fig.3 = *C.diomedea & P. yelkouan* = *P. yelkouan*

il-Gzejjer ta' San Pawl (Selmunett) MT0000022

Il-Gzejjer ta' San Pawl (Selmunett) (35°57'54.40"N; 14°24'06.35"E) lie about 85 metres off the coast of Malta. The "islands" are linked by a shallow and narrow isthmus whose depth varies according to the sea level. Geologically the island is made up of Upper Coralline Limestone. The vegetation consists of a mixture of maritime garigue dominated by Golden Samphire, Maltese fleabane and various other species. The eastern side is more exposed and has less vegetation than the main island. A population of the land snail *Trochoidea spratti* can be found on the islands. Wild rabbits used to live on the island but the population died off due to Myxomatosis and overhunting. The endemic population of the Maltese wall lizard *Podarcis filfolensis kieselbachi* has not been recorded since 2005. In the last decade, a small colony of Yelkouan Shearwaters has been re-discovered breeding on the island.

Fig 4. Il-Gzejjer ta` San Pawl / Selmunett

- il-Bahar madwar Ghawdex MT0000112
- il-Bahar tal-Grigal MT0000107.

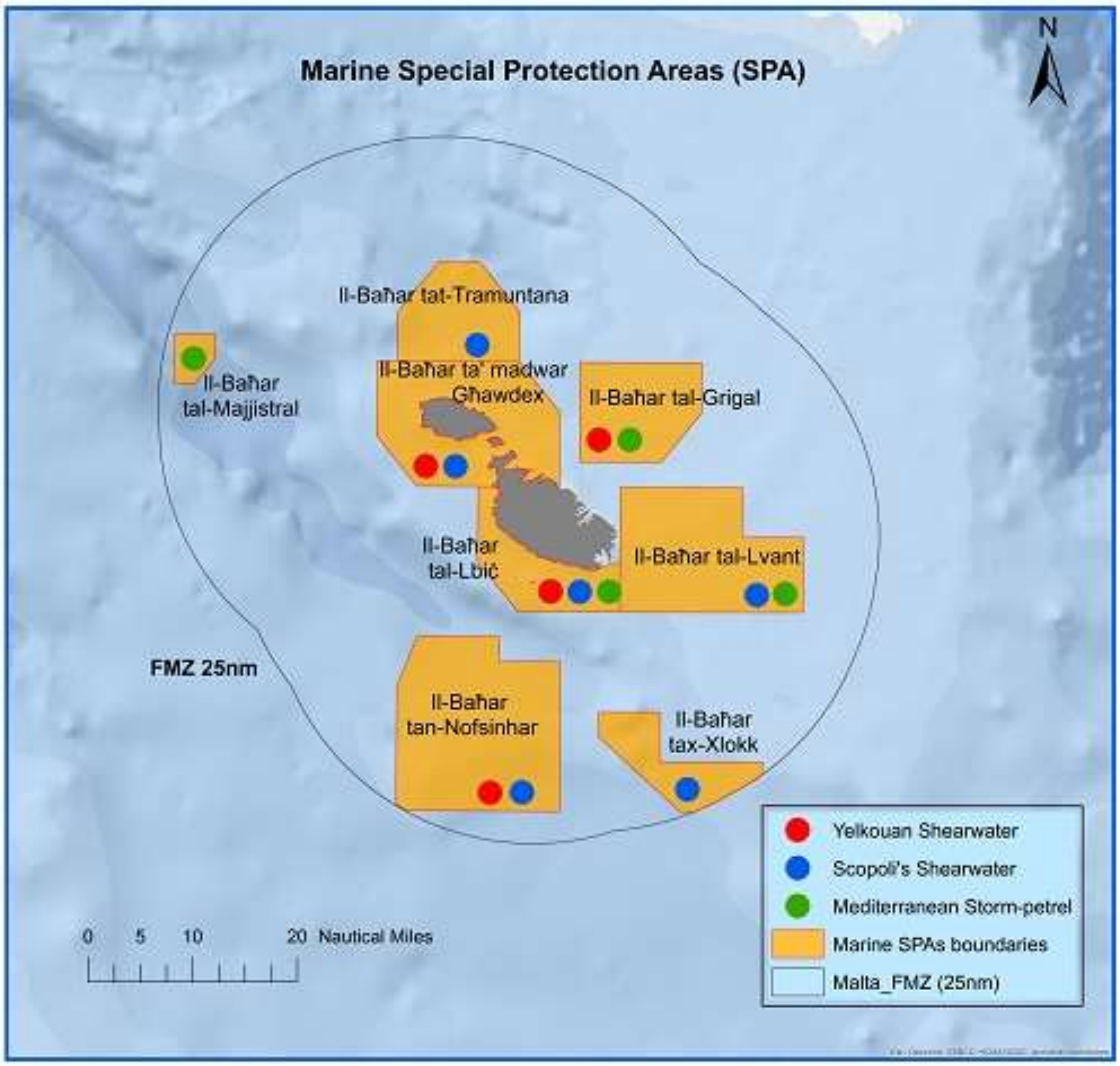

Fig 5. Marine Special Protection Area (SPA), designated under Govt. Notice 1311 of 2016.

4. Marine IBAs

Seabirds face a wide range of threats during their lifecycles and have undergone one of the most rapid declines of any bird group in the past 20 years (Lascelles 2007). This has been recognised by the European Union and consequently, all Member States have a duty to designate Marine Special Protection Areas (SPAs) under the Birds Directive by 2008 (European Commission 2004).

Malta is a particular hotspot for seabirds. The island of Filfla is home to the largest colony of breeding European Storm-petrels1 in the Mediterranean. The Maltese Islands also host approximately 10% of the world's population of breeding Yelkouan Shearwaters and approximately 5% of the Mediterranean population of Cory's Shearwaters. This gives Malta a high global responsibility for the conservation of seabirds. Furthermore, the Gozo Channel is very important for Ferruginous Ducks (*Aythya nyroca*), with over 1% of the global population passing through the channel annually, as well as a range of other species of conservation concern (Coleiro, unpublished data). *Aythya nyroca* is classified as globally Near Threatened by BirdLife International, the official authority on birds for the IUCN Red List.

In order to assist the Government in the task of identifying and designating Marine SPAs, one of the primary outputs of the EU LIFE Yelkouan Shearwater Project is to produce a report outlining the mechanisms being used to develop Marine SPA programmes across Europe. The report will also propose a roadmap for the designation of Marine SPA sites in the Maltese Islands, in order to protect these critically important seabird populations. The following document presents this research. The scope of the report includes Marine SPAs only and does not address Marine Special Areas of Conservation (SACs).

For both marine and terrestrial IBAs, the function of the Important Bird Areas (IBAs) programme of BirdLife International is '*to identify and protect a network of sites, at a biogeographic scale, critical for the long-term viability of naturally occurring bird populations, across the range of those bird species for which a sites-based approach is appropriate*'.

IBAs are chosen using quantitative, standardised, globally agreed criteria (in the case of Marine IBAs this is still in the process of being agreed – see Annex One for a full description of current criteria). The selection of IBAs has been a particularly effective way of identifying terrestrial conservation priorities across Europe. Marine IBAs are intended to extend this protection to the marine environment. Marine IBAs will do one (or more) of three things:

- Hold significant numbers of one or more globally threatened species
- Be one of a set of sites that together hold a suite of restricted-range species or biomerestricted species
- Have exceptionally large numbers of migratory or congregatory species (Lascelles & Fishpool 2007)

Malta already has 11 terrestrial IBAs of European importance (five of which are of international importance, namely Filfla, Ta'Cenc, Rdum tal-Madonna, Buskett and Comino), nine of which are identified for breeding seabirds. Marine IBAs are the next step and will provide protection for shearwaters, petrels and migratory seabirds in Maltese waters.

4.1. Marine SPAs

SPAs are areas of international importance for the conservation of wild birds, classified under the EU Directive on the Conservation of Wild Birds (the 'Birds Directive'). They are usually, but not always, based on IBAs. To date, only terrestrial SPAs have been designated in Malta. Marine SPAs will provide protection to marine birds in accordance with the provisions of the Birds Directive2 in the inshore and offshore marine environment.

Once a site is designated as an SPA the legal protective requirements defined in Article 6 (2) (3) and (4) of the Habitats Directive apply to it. Member States must send to the Commission all relevant information so that it may take appropriate initiatives to ensure that the SPA network forms a coherent whole

4.2 Types of Marine IBA / SPA

The classification for Marine SPAs by BirdLife International currently focuses on four types of Marine IBAs:

- Seaward extensions of breeding colonies
- Non-breeding coastal concentrations
- Migratory bottlenecks
- Areas for pelagic species

(BirdLife International 2007c)

<u>**Annex One presents a full description of the current proposed Marine IBA criteria.**</u>

4.3 Why Marine IBAs/SPAs?

Seabirds are under pressure worldwide from human activity and consequently many species are now threatened with extinction. They face a multitude of threats both at sea and during their land-based breeding period (BirdLife International 2007a). As a group, seabirds have deteriorated in IUCN Red List status faster than other group of bird species.

Until recently, seabird protection across Europe, as in Malta, has tended to focus principally on land-based threats such as habitat loss, introduced predators and disturbance, because these threats are easier to identify and address than issues in the wider marine environment.

However, while legal protection has been extended to some breeding seabird colonies on land through the terrestrial SPA network, birds using the marine environment have remained unprotected. Since most seabirds spend the vast majority of their time away from breeding sites at sea, and with pressures increasing in the marine environment, there is an urgent need to move towards protecting areas of importance for birds at sea (SPEA 2007, Lascelles 2007).

One of the primary threats at sea is by-catch by long-line fisheries. There is insufficient data on levels of seabird by catch in the Mediterranean, but preliminary results suggest that this could be a serious threat particularly for Scopoli`s Shearwaters (Dimech et al 2008, Cooper et al 2003). However, this can be addressed relatively easily using existing technology if the political will to do so exists (Ardron & Burfield 2006). Marine IBAs/SPAs can contribute to solving this problem through the requirement of appropriate fisheries management within SPA boundaries.

Seabirds utilising the marine environment adjacent to colonies face direct threats such as oil pollution and fishing gear entanglement. There are also indirect threats such as disturbance due to recreational activities (Harding & Riley 2000, Tasker & Leaper 1993, Borg & Cachia-Zammit 1998). In Malta in particular, hunting at sea is a serious threat (Sultana 1986, Armed Forces of Malta 2008). Unless action is taken to limit these threats, many seabird populations are likely to continue to seriously decline (Lascelles 2007). Again, Marine IBAs/SPAs will identify the key areas that require additional protection and will suggest which areas are inappropriate for heavy recreational use or offshore wind-farms for example.

The identification of Marine IBAs will make a vital contribution to global initiatives to gain greater protection and sustainable management of the oceans, including towards the designation of Marine Protected Areas (MPAs) of which Marine SPAs will form a large part. The intention is that Marine IBAs will be the precursors for Marine sites of the Natura 2000 network (Lascelles 2007).

There is a clear obligation that EU Member States classify appropriate SPAs in the marine environment (see sections 4 & 5). In Malta, the identification of Marine SPAs is of particularly pressing importance because the limited land resources and high population density of the Maltese Islands have made the coastal zone and adjacent contiguous marine area a focal point for resource use conflicts (MEPA 2005). To ensure that these conflicts are resolved in a sustainable way, Marine SPAs and SACs will be an invaluable tool.

Figure 6. Following years of field work and data compiling, BirdLife Malta in 2012 presented to BirdLife International a report in proposing the highlighted area for the Malta-Gozo Channel Marine Important Bird Area.

PRIORITISATION AND ZONATION MODELLING FOR THE THREE PROCELLARIIFORMES (From Metzger *et al* 2015)

Figure 6-8 present the results of the prioritisation modelling of core areas of seabird distribution inside the Maltese EFZ, including the zonation approach with a moderately low 0.01 border length penalty. Shown are the 10% and 15% core areas within the Maltese EFZ resembling the areas of highest importance for each of the three species.

For the Maltese breeding population of *P. yelkouan*, three main hotspot areas are identified, one around Gozo, including the Gozo Channel and along the west- and southwest coast of Malta, a second one offshore in the northeast of Malta and a third one offshore in the southwest of Malta (see Fig. 7). For the Maltese breeding population of *C. diomedea*, we identified five priority areas in the Maltese EFZ, the first one around and north of Gozo and a second one along the west and southwest coast of Malta. Additionally to that, three offshore areas are found east, southeast and south of Malta (see Fig. 8). For *H. pelagicus melitensis* breeding in the Maltese islands the core area is covering a coastal zone around Malta and a larger area of sea east of the island. Additionally, a small area is found in the Pantelleria channel northwest of Gozo and several fragmented squares are spread over an area southwest of Malta (see Fig. 9).

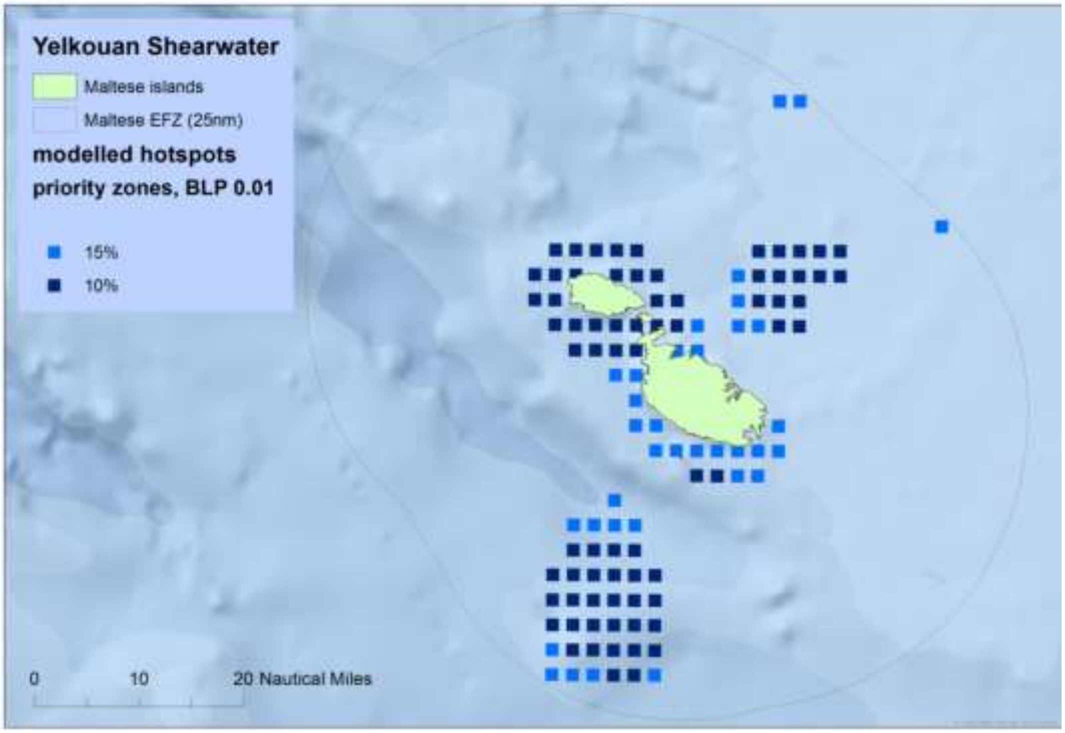

Fig 7. Priority areas for *P. yelkouan* within the Maltese EFZ, dark blue squares: 10%, light plus dark blue squares: 15%.

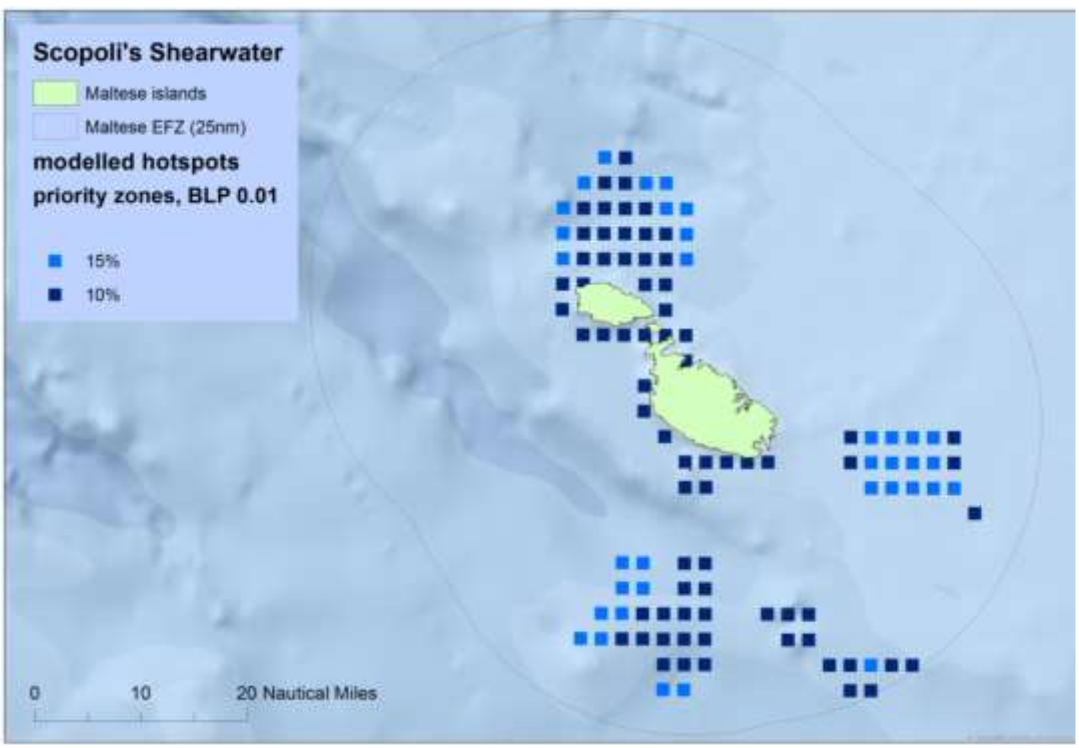

Fig 8. Priority areas for *C. diomedea* within the Maltese EFZ, dark blue squares: 10%, light plus dark blue squares: 15%.

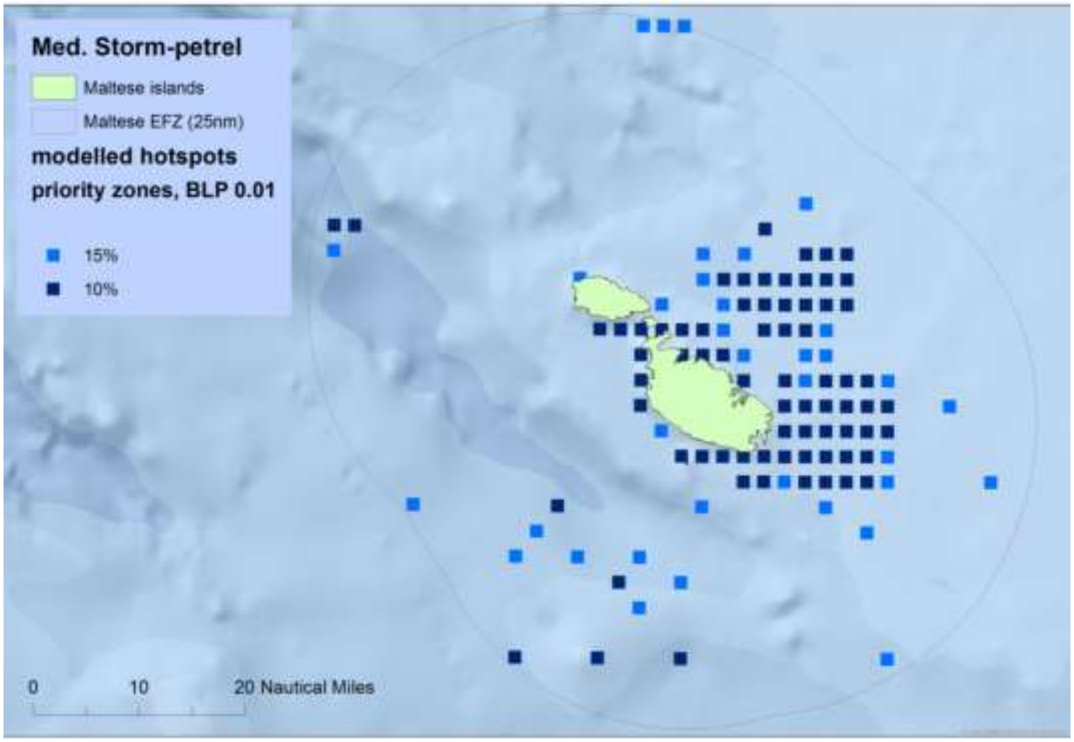

Fig 9. Priority areas for *H. pelagicus melitensis* within the Maltese EFZ, dark blue squares: 10%, light plus dark blue squares: 15%.

5.1 Breeding Species

The Maltese coastal cliffs support four seabird species, namely: Scopoli's Shearwater *Calonectris diomedea*, Yelkouan Shearwater *Puffinus yelkouan*, Mediterranean Storm-petrel *Hydrobates pelagicus melitensis*, and the Yellow-legged Gull *Larus michahellis*.

The Storm Petrel and the Yellow-legged Gull have not been recorded breeding in the Ghar Lapsi area in the last 50 years but both the Scopoli's and the Yelkouan shearwaters still breed in the area.

Shearwaters are members of the Order Procellariformes which includes also the albatrosses and petrels. They are pelagic species with the characteristic tube-noses on the base of the upper mandible. They visit land during the breeding season and do so under cover of darkness. A single egg is laid in a deep crevice or burrow or under loose boulders and vegetation. Sometimes, rabbit burrows are also used as breeding sites.

5.1 Scopoli's Shearwater *Calonectris diomedea*

Scopoli's Shearwater is a breeding visitor to the Maltese islands. The first birds make landfall in the last ten days of February. The single egg is laid in a crevice, fissure, or under boulders and vegetation in the latter half of May. Incubation lasts 52 day (Cachia-Zammit & Borg 1986) and the chicks hatch in mid-July. By the end of October all the colonies are deserted (Tab 1). The estimated breeding population of this bird in the Maltese Islands has been estimated at less than 5,000 pairs (Sultana *et al*. 2011) and the Ghar Lapsi cliffs and boulder scree hold about 51-100 breeding pairs (Borg & Sultana 2002, Raine et al 2009). Because of increasing human pressure (direct persecution, noise and lights pollution on the cliffs) these birds are being pushed down the more inaccessible cliff sites. In the last 10 years several "accessible" nest sites located on the top parts of the cliffs have been deserted.

Every evening from March to October, streams of flying birds, coming from their feeding grounds, pass within 1-4km offshore on their way to their breeding colonies. The distance from land is conditioned by climatic factors mainly the presence or absence of strong winds. At certain times of the year; especially during the incubation and the fledging period, the two species of shearwaters frequent specific areas for feeding and these areas lie primarily off the south-eastern coast of Malta at distances ranging from 12 to 500km away.

Fig 10 Scopoli`s Shearwater *Calonectris diomedea*

5.2 Yelkouan Shearwater *Puffinus yelkouan*

The Yelkouan Shearwater is endemic to the central and eastern Mediterranean. The world population is estimated at 13.000-33,000 breeding pairs with Malta holding an estimated population of 1,500 pairs that is 10% of the global population (Borg *et al* 2010). The population at Ghar Lapsi has been estimated at 10 to 50 pairs (Borg & Sultana 2004, Raine et al 2009).

The first birds start to visit the colonies in October and egg laying takes place from the last days of February through the first two weeks of March. Chicks hatch in mid-May and by the third week of June the chicks start to abandon the nesting sites. The colonies are deserted by mid-July (Tab.1). Ringing recoveries and satellite tracking of young birds, have shown that Maltese birds head towards the Aegean and Black Seas in the post breeding period while observations confirmed that an unknown number of adult birds remain around the Maltese Islands to moult their feathers (Borg *et al*. 2002).

Fig 11. Yelkouan Shearwater *Puffinus yelkouan*

5.3 European Storm-petrel *Hydrobates pelagicus melitensis*

Filfla island lies just 5km off the Ghar Lapsi shore and holds the largest known breeding population of this tiny seabird in the Mediterranean with an estimated breeding population of 5,000 to 8,000 pairs (Raine et al 2009, Sultana et al 2011).

Birds visit the colonies at night, from February to late October (Tab.1), and like its larger cousins, under the cover of darkness. On Filfla, egg laying is asynchronous which is quite unusual in the procellariiformes. On Filfla the Yellow-legged Gull is the main predator of Storm petrels while rats influence the breeding on the main islands (Sultana *et al*. 2011).

Fig 12. Mediterranean Storm-petrel *Hydrobates pelagicus melitensis*

Arrival at colonies		Egg laying	Hatching	Fledging
Puffinus yelkouan	mid October	early February	early May	mid June/early July
Calonectris diomedea	end February	end May	mid July	mid October
Hydrobates pelagicus	end February	April-June	May-August	August to October

Table 1: Synthesis of breeding biology and ecology of *P.yelkouan, C.diomedea & H.pelagicus*

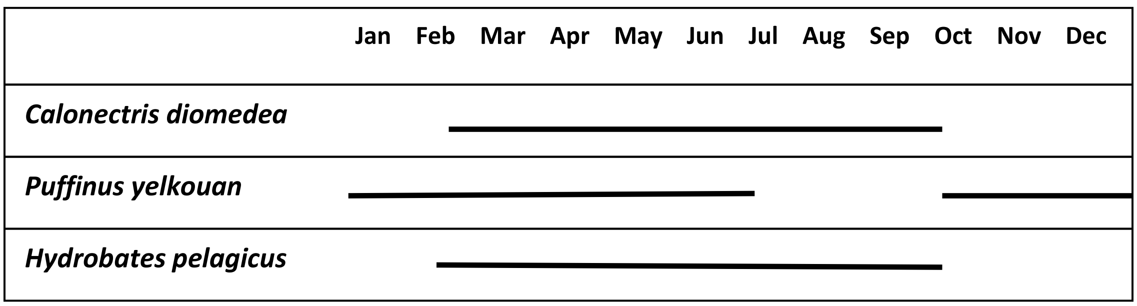

Table 2 Presence in Colonies by the three pelagic seabird species

5.2. Daily movements by Procellariiformes

Shearwaters travel vast distances to and from their breeding colonies in search of food. During the breeding season of *P. diomedea*, large numbers can be seen flying offshore in an east to west direction. Distance from land is conditioned by wind direction and strength. During strong North-westerly winds the shearwaters can be seen flying at a distance of less than 50 metres from the coast.

The same area is also used by Yelkouan Shearwaters, especially birds originating from the Rdum tal-Madonna colony (Borg *et al* 2002, Borg *et al* 2010, Raine *et al* 2010, 2011 and 2012).

Another regular visitor to the study area and immediate whereabouts is the Yellow-legged Gull *Larus michahellis*. This resident breeding is present almost all year round and double figures normally congregate in and around the fish farm off the South-west coast of Comino. The terminal area is frequented by birds coming from the breeding colonies at Filfla and Dingli Cliffs, heading towards the fish farm and *vice-versa*.

Fig 12. Daily evening movements by the two Procellariids from their feeding grounds to the breeding colonies.

5.3. Rafting

Rafting is the convergence of birds on water, normally in the vicinity of their breeding colonies. During calm afternoons these congregations of birds can reach impressive numbers with several hundreds of birds waiting for darkness. Birds start assembling about two to three hours before sunset and commence to dissipate around dusk when the whole congregation is within a few hundred metres from the cliffs.

Fig 13 Rafting *C. diomedea*

5.4 Fish Pens: Supplementary food source for seabirds

Borg (2012) presented some preliminary results on Tuna farms as a supplementary food source for Storm-Petrels. In July and August of 2006, very small numbers of storm-petrel were reported to the author, while an increase was noted in July 2007, but with fewer numbers in autumn. In the summer of 2008, again in the months of July and August, single birds where noted almost daily with up to 30 counted on several occasions. The use of raw, unwashed fish food is fundamental in attracting storm petrels closer to these tuna pens. The same food supply has attracted a constant presence of small fish around the pens which in-turn attract gulls and terns, especially the Black Tern *Chlidonias niger*.

Observations have shown that the majority of storm petrels frequenting the area are adult birds undergoing primary wing moult, suggesting breeders, probably not venturing far away from the colonies during the chick rearing period. The planned use of radio tags on storm petrels from the Filfla colony in summer of 2012 will provide more information on this aspect. A smaller number of birds seen during the site visits where juvenile birds covered in a fresh coat of dark plumage. These young birds are present from the latter part of August to early September. Tuna penning is locally carried out during the summer and autumn months (mid-July to December).

Further investigations will aim to identify if this reliable food source has any effect on the breeding success and fledglings survival in storm petrels. While adult storm petrels regularly fall prey to yellow-legged gulls on Filfla (Borg *et al*. 1992-94, Sultana *et al* 2011) no interactions between gulls and storm petrels were ever noted near the tuna pens. Further research is required to determine the extent of dependency by storm petrels on this food source, especially if feeding regulations are enforced and the baitfish is washed before fed to the tuna.

6. Threats

6.1 Light Pollution

The use of light sources from land and at sea is of particular concern. It is known that light interferes with the behaviour of birds and other animal groups, including bats. In those areas where electricity has been installed especially close to seabird colonies, birds have completely deserted the site. Birds and other animals found close to light sources are known to behave in an abnormal way; several species of birds remain active during night time. Light also disrupts the normal cycle of other vertebrates as well as numerous species of invertebrates making them susceptible to predation.

In some cases, seabird breeding colonies have been abandoned when electricity was introduced in the area, places like Xlendi Bay, Hal-Far, Ghar Lapsi and Wied iz-Zurrieq where colonies of both Scopol's and Yelkouan Shearwaters have been negatively effected

6.2 Sound pollution

Sound over water travels longer distances than on land; therefore, any noise generated during the operational phase needs to be minimised. Noise also affects the normal patterns of incoming shearwaters. When a boat passes close by to a breeding colony, all activity stops until the boat is out of "earshot".

6.3 Possible entanglement in pens

In some cases, as the larger members of the procellariiformes need a long "runway" for takeoff, sometimes they get entangled in the netting surrounding the fish pens, or in some cases, there is not enough space for take-off and so birds remain trapped inside the pens. This is most likely to occur during the fledging periods but in some cases can also affect adult birds as can be seen in Fig 14.

FIg 14. Streaked Shearwaters *Calonectris leucomelas* inside fish pens in the Sea of Japan.

6.4 Mitigation measures

Avoid the use of artificial lighting units whenever and wherever possible, in this particular case more so as the site is located in front of seabird colonies.

Avoid perimeter nets around the fish pens, thus reducing possible entanglement by the shearwaters.

7. SUMMARY OF IMPACTS

Impact type and Source		
Impact type	Light Pollution from land and sea Noise pollution from land and sea	
Specific intervention leading to impact	Un-shaded white shades spilling over and beyond the area of influence Maintain Low noise level	
Project phase	Construction/Installation works Yes	Operations Yes
Impact Receptor		
Receptor type		
Sensitivity and resilience toward impact	Installation works	Operations
	NA	Yes
Effect and Scale of Impact		
	Installation works	Operations
Direct/Indirect		Direct by disturbing the avifauna, especially the pelagic seabirds. Increase predation by Yellow-legged Gulls smaller avian species.
Cumulative		
Beneficial/Adverse		Adverse
Severity		High
Physical/geographic extent		
Short/Medium/Long Term		Long Term
Temporary/Permanent if temporary indicate duration		Permanent if not addressed
Reversible/Irreversible if reversible indicate ease of reversibility		Use of proper directional lamps and/or shading of lamps can significantly reduce impacts.

Probability – Significance – Mitigation – Residual Impacts – Other Requirements		
	Construction/Installation works	Operations
Probability of impact occurring Inevitable, likely, remote uncertain		Inevitable
Significance overall Impact		Medium to High

Proposed Mitigation Measures		Use of proper directional lamps and/or shading of lamps.
Significance Residual Impact		Abandonment of area by some species. Increase predation by Yellow-legged Gulls on Storm-petrels and other smaller avian species in the area
Monitoring		Monitoring program to be formulated, setup and implemented. Seasonal visits for all three seabird species
Authorizations	Development Permission under the Environment and Development Planning Act (Cap 504)	Development Permission under the Environment and Development Planning Act (Cap 504) (Operations Permit under the Industrial Emissions (Integrated Pollution and Control) Regulations (SL504.54; LN10/03) (Approval of major accident prevention policy document under the Control of Major Accident Hazard Regulations (SL424.19; LN37/03)

7.1 Criteria used to describe impacts

Beneficial/Adverse	
Level	**Criteria**
High	
Moderate	Disturbance marine avifauna during operational stages
Low	xxxxxxxxxxxxxx
Neutral	xxxxxxxxxxxxxx
Severity	
Level	**Criteria**
High	Light spill-off leading to disorientation by seabird fledglings
Moderate	xxxxxxxxxxxxxxx
Low	xxxxxxxxxxxxxxx
Neutral	xxxxxxxxxxxxxxx
Probability of impact occurring	
Level	**Criteria**
High	Unless mitigated both light and noise pollution will have a negative impact on the seabird colonies on both sides of the development.

Probability of impact occurring	
Level	Criteria
Moderate	Light and sound pollution as well as excessive noises over an extended period of time will have a negative effect on the avifauna present in the area and the immediate surroundings.
Low	xxxxxxxxxxxxxxx
Neutral	xxxxxxxxxxxxxxx

Significance: Overall Impact	
Level	Criteria
High	Light Pollution will affect the seabird colonies on the mainland as well as on St.Paul's Island and Comino. Including increased predation by Yellow-legged Gulls on Storm-petrels and other similar sized birds. Lighting also adds to the disorientation by fledging seabirds. Mitigation measures addressing this issue can reduce the overall impact on the seabirds.
Moderate	xxxxxxxxxxxxxxx
Low	xxxxxxxxxxxxxxx
Neutral	xxxxxxxxxxxxxxx

Significance: Residual	
Level	Criteria
High	Same as above. Shaded and directional lights should reduce the light pollution issue.
Moderate	

Impact type and source			Impact receptor		Effect and Scale							Probability of impact occurring	Overall impact significance	Proposed mitigation measures	Residual impact significance	Other requirements
6	Specific intervention leading to impact	Project phase	Receptor type	Sensitivity and resilience toward impact	Direct Indirect Cumulative	Beneficial Adverse	Severity	Physical geographic extent of impact	Short medium long term	Temporary Permanent	Reversible Irreversible					
		construction operation decommissioning								if temporary indicate duration	if reversible indicate ease of reversibility	Inevitable likely unlikely remote uncertain				Monitoring authorisations
Light spillage	Disruption of normal behaviour in avifauna Including predation by YLG on Storm-petrels and other small avian species.	Throughout all phases		High	Direct	Adverse	High	Immediate area as well as along the entire coastline	Long term	Permanent	Reversible if mitigation measures are taken and recommended lighting units are installed	inevitable	Moderate to high	Avoid light spillage		
Noise	Disruption of normal behaviour by seabirds.	Throughout all phases		Medium	Direct impacts on the local fauna	Adverse	Medium	Immediate area	Long term	Permanent	Reversible only if low noise generators are used.	inevitable	Moderate	Low noise generators		
Vibrations	Disruption of normal behaviour by seabirds.	Construction phase		High	Direct	Adverse	High	Immediate area	Medium term	Temporary but for some species it may be permanent		Inevitable	High	Operations are not prolonged over a long period of time		

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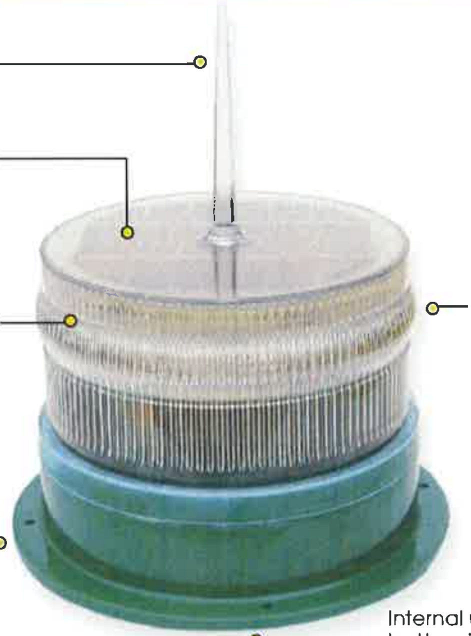
John J. Borg
Independent Consultant
18/04/2018

APPENDIX 3: LIGHTS SPECIFICATIONS

SL60
2nm Solar Marine Light

Sealite
www.sealite.com.au

This equipment complies with requirements of the U.S. Coast Guard in 33 CFR part 66



The Sealite Advantage

- Red, green, yellow, white or blue
- 256 IALA flash patterns, user-adjustable without the need for external devices
- User-replaceable battery in sealed battery compartment
- 4 user-adjustable intensity settings
- ON/OFF storage switch
- Bird deterrent spike
- IP68 waterproof

Shown with optional 200mm OD base pattern

The Sealite SL60 is the most popular and versatile 2nm solar marine light available. Made from tough, durable polycarbonate and using the latest high-intensity LED's, no expense has been spared in the design and development of this lantern.

The SL60 can be installed in minutes, and requires no operator intervention. The flash-characters are easily adjusted on-site by the user, and the lantern has a permanent ON/OFF switch for easy storage.

During daylight hours the solar module will charge the battery, and the lantern will automatically begin operation at dusk - once the ambient light threshold drops sufficiently.

The SL15, SL60 & SL70 lanterns are the only compact marine lanterns available with a sealed battery compartment, allowing the battery to be replaced after years of service - don't throw the light away at the end of the battery service life.

The unit is sealed using polycarbonate bonding compounds similar to those used by major automobile manufacturing companies.

The SL-CGC 60W, an enhanced version of the SL60, is United States Coast Guard approved for use on Class "C" structures.

SL60's marking gas transfer lines, Guajira Peninsula, Colombia

Head Office:
Sealite Pty Ltd
AUSTRALIA

Ph. +61 3 5977 6128
Fax. +61 3 5977 6124
Internet: www.sealite.com.au
Email: info@sealite.com.au

USA Customers:
Sealite USA
USA (Gilford, NH)

Ph. (603) 524-6066
Fax. (603) 524-8100
Internet: www.sealiteusa.com
Email: info@sealiteusa.com

SL60
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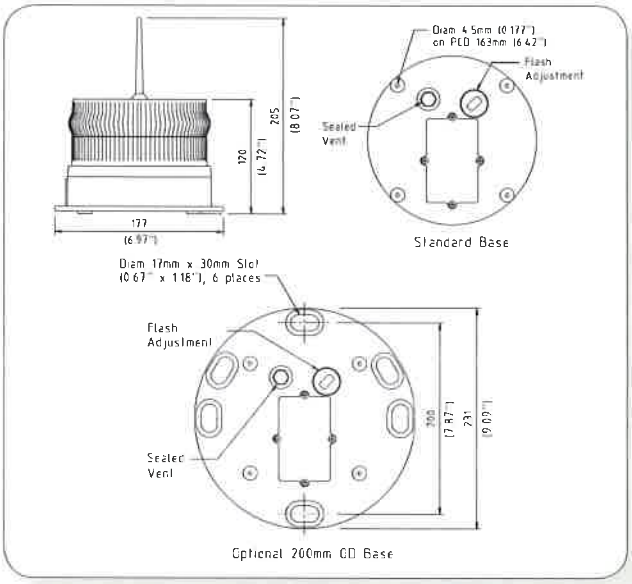
Battery access via sealed compartment



SPECIFICATIONS •

Light Characteristics	
Light Source	6 ultra-high intensity LEDs
Available Colours	Red, Green, White, Yellow, Blue
Peak Intensity (cd)	>8.3
Visible Range (nm)	>2
Horizontal Output (degrees)	360
Vertical Divergence (degrees)	9
Reflector Type	Omnidirectional 360° LED Reflector (US Pat. No. 6,667,582. AU Pat. No. 778,918)
Available Flash Characteristics	Up to 256 IALA recommended (user adjustable)
Intensity Adjustments	Adjustable in 25% increments
LED Life Expectancy (hours)	100,000
Electrical Characteristics	
Current Draw (mA)	Minimal
Circuit Protection	Integrated
Operating Voltage (V)	3.6
Autonomy (days)	>20 (14 hour darkness, 12.5% duty cycle)
Solar Characteristics	
Solar Module Type	Multicrystalline
Output (watts)	1.4
Solar Module Efficiency (%)	14
Charging Regulation	Microprocessor controlled
Power Supply	
Battery Type	High grade NiMH - Environment friendly
Battery Capacity (Ah)	4
Nominal Voltage (V)	3.6
Physical Characteristics	
Body Material	LEXAN ® Polycarbonate – UV stabilised
Lens Material	LEXAN ® Polycarbonate – UV stabilised
Lens Diameter (mm/Inches)	140 / 5½
Lens Design	External optics with Interior flute design
Mounting	4 x 4.5mm mounting holes
Height (mm/Inches)	205 / 8 1/8
Width (mm/Inches)	177 / 7
Mass (kg/lbs)	1.1 / 2 3/8
Product Life Expectancy	Up to 12 years
Certifications	
CE	EN61000-6-3:1997. EN61000-6-1:1997
Quality Assurance	ISO9001:2000
Waterproof	IP68
Intellectual Property	
Patents	US Pat. No. 6,667,582. AU Pat. No. 778,918
Trademarks	SEALITE® is a registered trademark of Sealite Pty Ltd
Warranty	3 years
Options Available	• 8Ah battery • 200mm OD base • Hard wire synchronisation • 50mm pole mount adaptor plate

CE

• Specifications subject to change or variation without notice

Head Office: Sealite Pty Ltd AUSTRALIA
Ph. +61 3 5977 6128
Fax. +61 3 5977 6124
Internet: www.sealite.com.au
Email: info@sealite.com.au

USA Customers; Sealite USA USA (Gilford, NH)
Ph. (603) 524-6066
Fax. (603) 524-8100
Internet: www.sealiteusa.com
Email: info@sealiteusa.com