Environmental Statement

Appendix F

Intertidal Survey Report

F

Report on the Rocky Intertidal Coastline of the East side of Gibraltar together with a specific investigation into the presence of *Patella ferruginea* Gmelin, 1791, a protected species in danger of extinction

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Purpose of the Survey

To describe and establish a general characterization of the rocky intertidal along the east coast of Gibraltar from the northern end of Eastern Beach to the Ammunition Jetty south of the Admiralty Oil Tanks, together with a specific investigation into the presence of *Patella ferruginea* Gmelin, 1791, a protected species in danger of extinction.

To better describe the area the relevant stretch of rocky intertidal was divided into 3 sectors, which are described below:

Sectors for Rocky Intertidal Survey

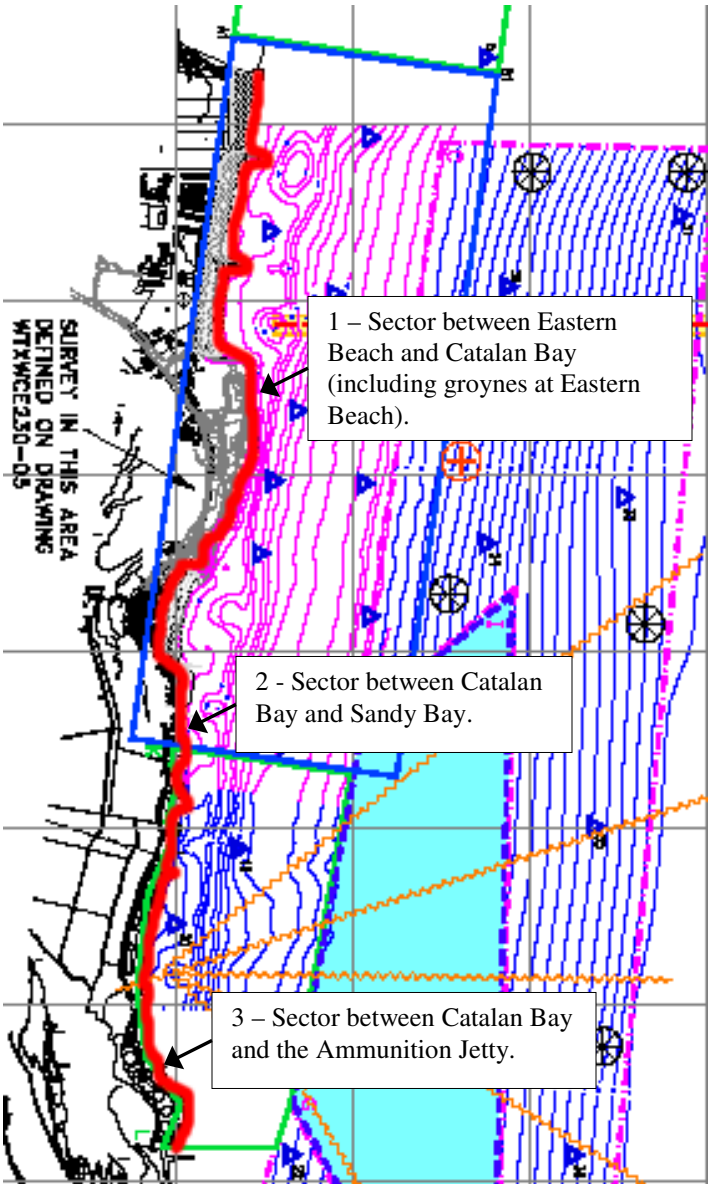


Fig. 1. A red line indicates the extent of the survey area, a distance of approximately 3 km of coastline. The numbers refer to sectors of rocky coastline that are described separately in the text.

Sector 1:
This includes the rocky coastline between the northern end of Eastern Beach and the northern end Catalan Bay. Two main types of rocky coastline, both of which are artificial, predominate:

1. Well constructed groynes and rock armoury (Eastern Beach, north end of Catalan Bay);
2. Loose rubble reclamation (most of the rocky coastline in this sector).

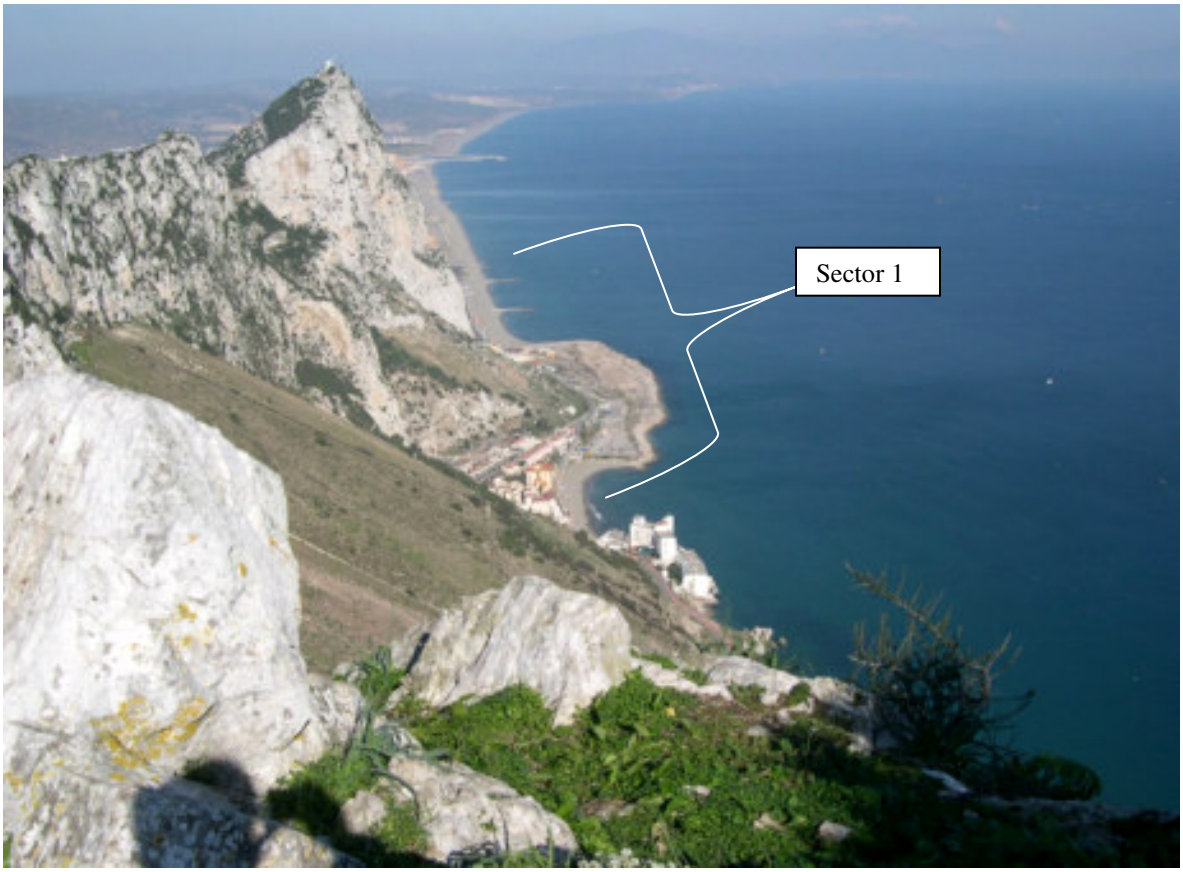
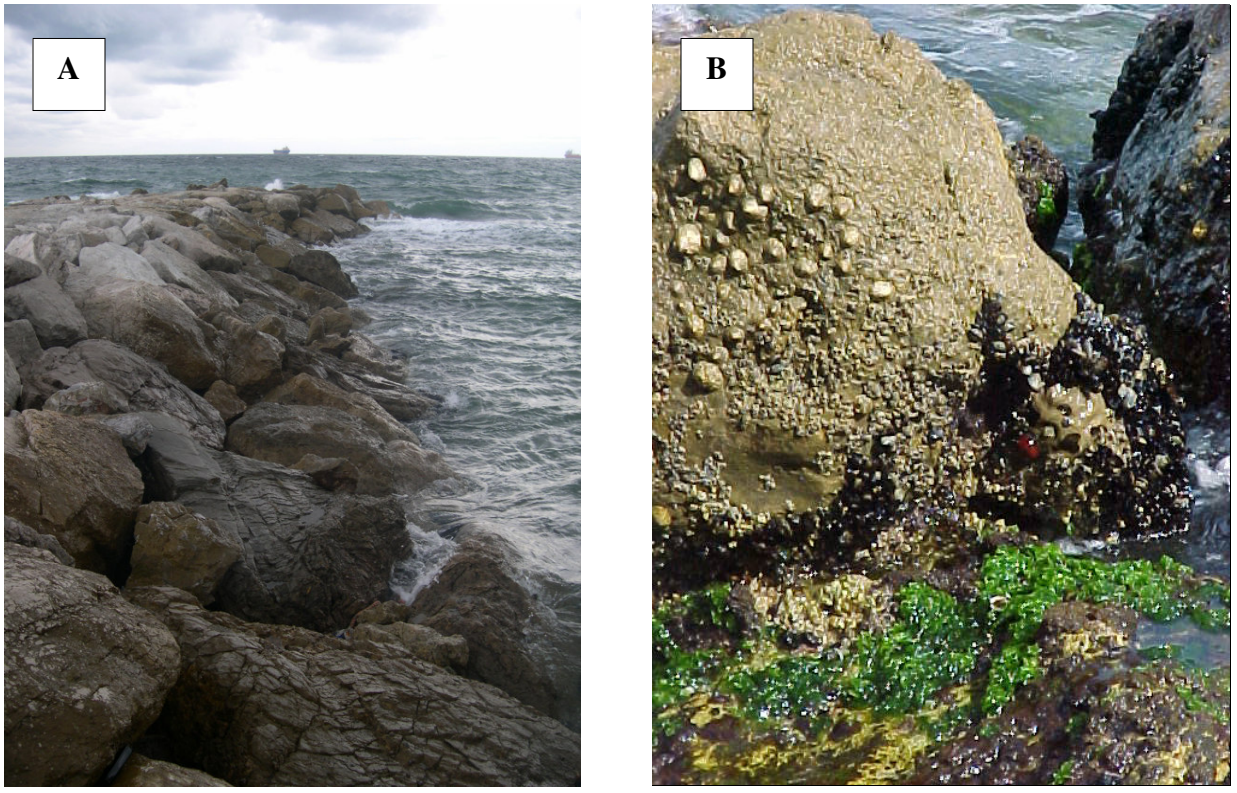


Fig. 2. Photograph showing the extent of Sector 1.

Despite being built relatively recently, the Eastern Beach groynes and Catalan Bay northern rock armoury in particular (due to earlier construction) appear to be colonizing well and already show a good degree of space structuration and increasing diversity.

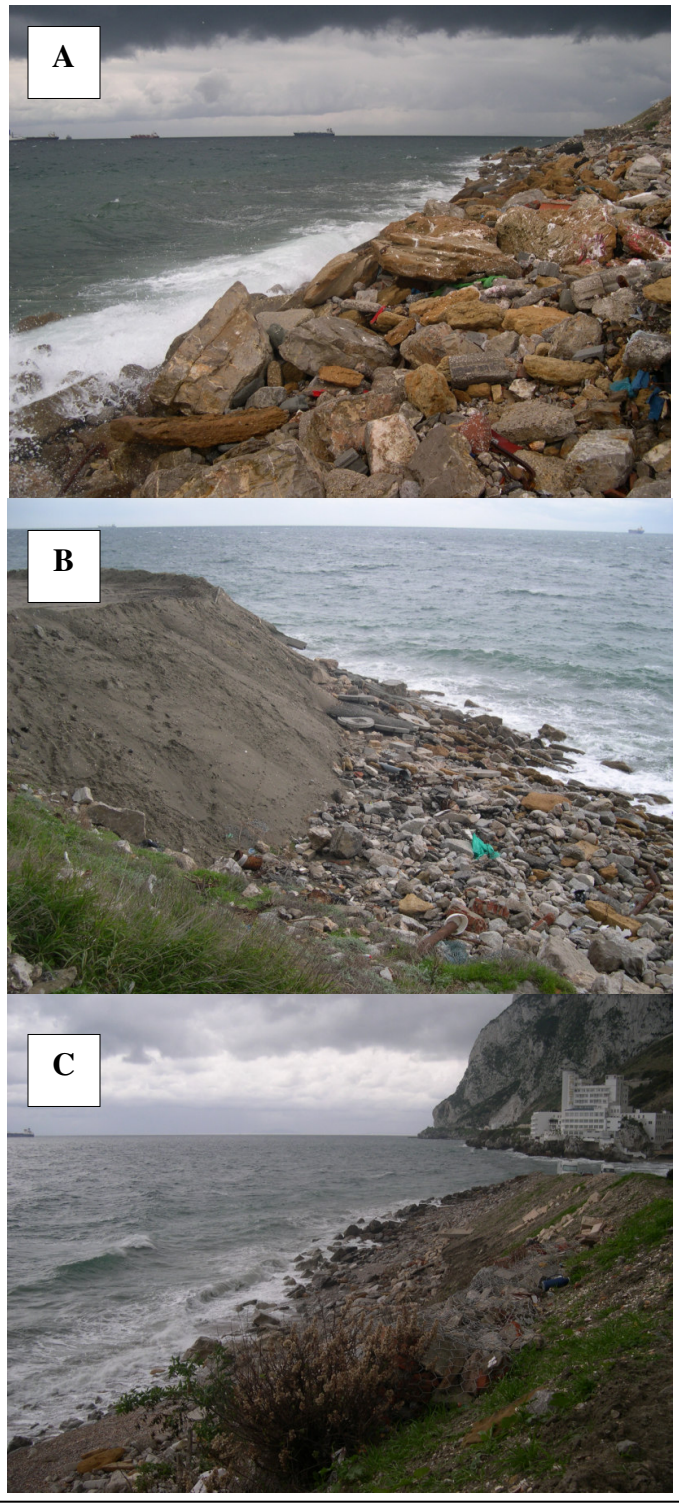
There exists a wide variety of intertidal flora and fauna, including algae (*Ralfsia* spp., *Corallina elongata, Ulva lactuca*), periwinkles (*Litorina neritoides, Littorina punctata),* topshells *(Mondonta turbinata, Gibbula* spp.*),* mussels (mainly *Mytlus galloprovincialis,* but *M. edulis* may also be present, given the proximity to the Atlantic), beadlet and

snakelocks anemones *(Actinia equina, Anemonia sulcata,* respectively), as well as a variety of other barnacles *(Chthamalus stellatus, C. depressum, Balanus perforatus)* and limpet and limpet-like species (*Cymbula safiana [=Patella nigra], Patella caerulea, P. rustica, P. uissiponensis* and *Siphonaria pectinata* -the latter is not actually a true limpet, being a pulmonate gastropod of the order basomatophora, but it adopts a limpet habit in terms of life history, habitat and morphology).



Figs.3 A&B. Sector 1 groynes and rock armoury show evidence of being colonized (A-Eastern Beach, B-Catalan Bay).

However, the main bulk of this reclamation shows evidence of instability and rock movement. It also suffers from undercutting due to wave action which causes periodic collapses of loose sand material accumulated at the ridge of the reclamation.



Figs 4 A-C. This entire section of sector 1 presents a highly unstable environment which is not conducive to the settlement of rocky intertidal organisms. The proposed reclamation and construction may actually be an environmental enhancement with regard to the rocky littoral in this area.

Sector 2:
This sector presents a mixed coastline composed of a small section of rock armoury and limestone cliffs under the Caleta Hotel to the north, then loose rubble and rubbish resulting from using this area as a dumping site a number of years ago (see Fig. 6), and a final stretch of limestone/sandstone natural coastline southwards to Sandy Bay.

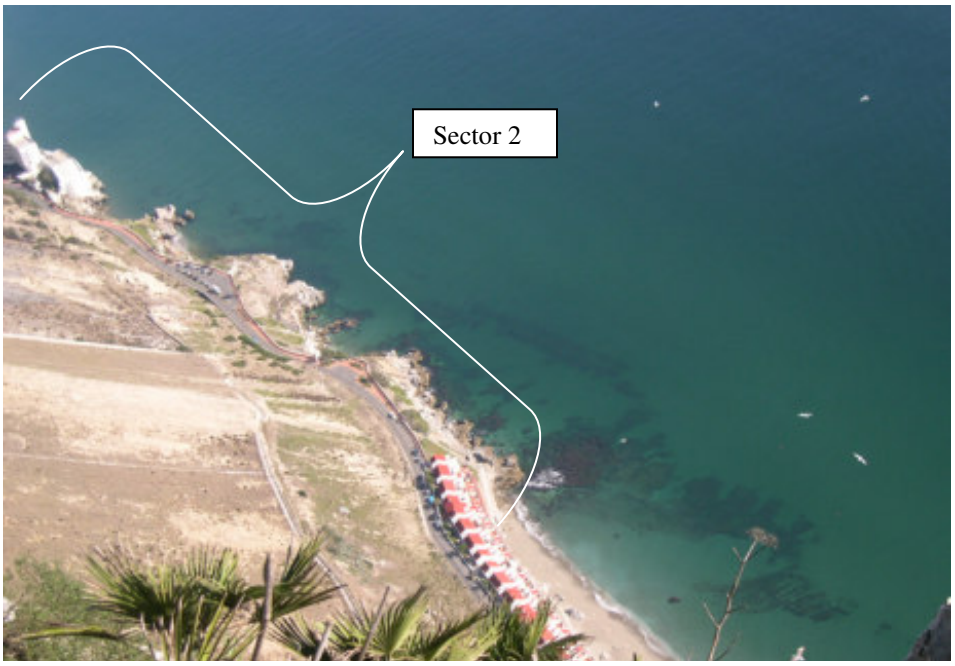


Fig. 5. Photograph showing the extent of sector 2.

Fig. 6. This area of sector 2 was unfortunately used as a dumping ground and the unstable and contaminated nature of the substrate has negatively affected the intertidal diversity in this part of the sector.

Fig. 7. The southern end of sector 2. A fossilized seashore underlies the limestone in this sector and consequently the intertidal is mainly composed of a hard sandstone. Two *P. ferruginea* individuals were found along this stretch of coastline. Although there is evidence that it does not favour sandstone, it appears that in this case conditions are suitable.

Fig. 8. The shoreline in this section is very diverse with a rich algal assemblage (mainly composed of *Corallina elongata* and *Ralfsia* spp.*)* and dense mussel beds *(Mytilus galloprovincialis/edulis).* Apart from the aforementioned species, these assemblages create a high degree of habitat heterogeneity and microclimates, affording shelter to a wide range of organisms.

Sector 3:
This sector comprises a stretch of natural rock scree breccia coastline from the south end of Sandy Bay up to the Ammunition Jetty.

Apart from a small section of shingle beach, the entire sector is composed of sizeable boulders and rock promontories containing very diverse intertidal communities.

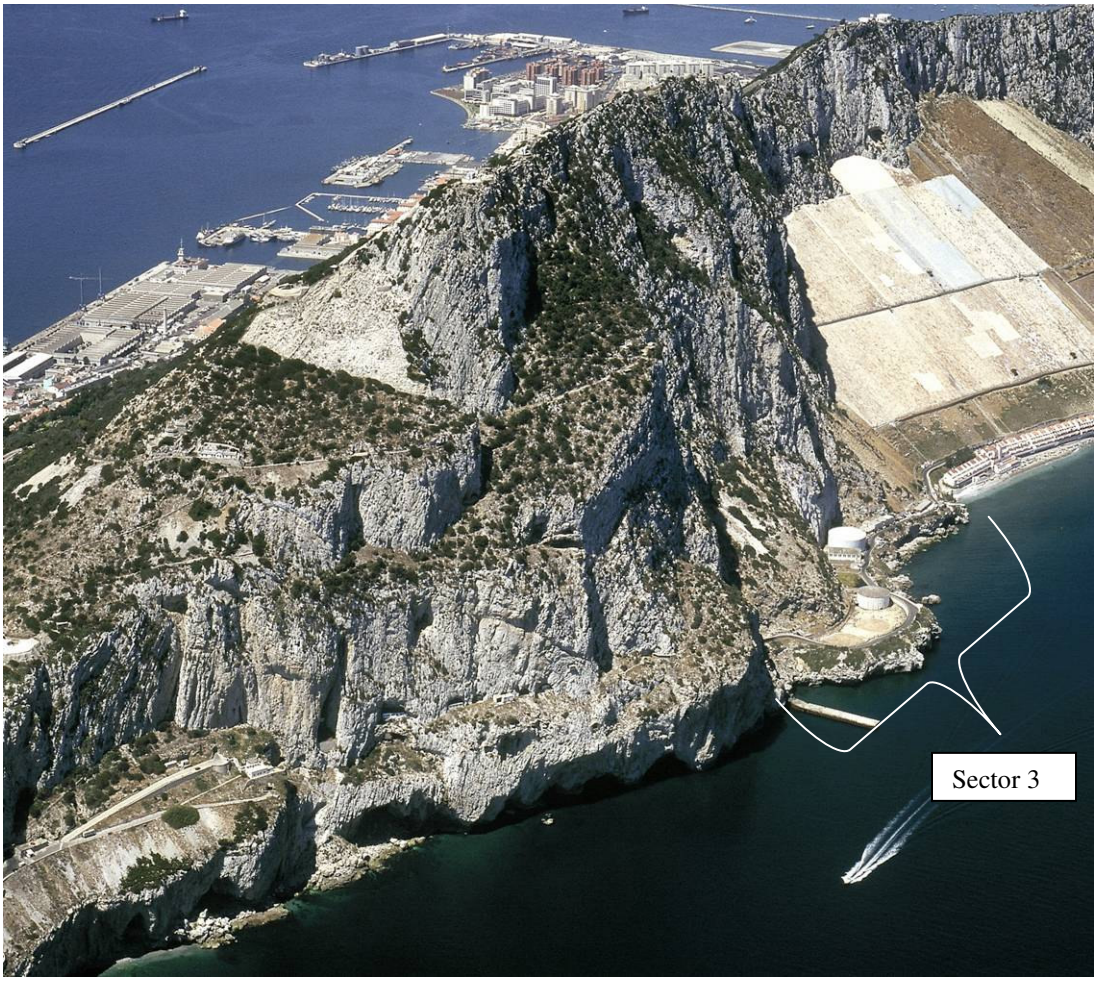


Fig. 9. Photograph showing the extent of sector 3.

Existing communities are varied and well-structured in terms of both algal and faunal components. A total of 22 *P. ferruginea* individuals were found along this sector, as well as a variety of other limpets *(Patella rustica, P. caerula, P. uissiponensis, Cymbula safiana)*, false limpets *(Siphonaria pectinata)* and keyhole limpets *(Diadora apertura).*

Algal species present include *Asparagopsis armata, Corallina elongata* and *Ralfsia* spp.

Fig. 10. The shoreline along sector 3 tends to be very diverse both in terms of fauna and flora, with a well-defined zonation. The main algal species encountered were *Asparagopsis armata, Corallina elongata, Lithophyllum tortuosum, L. lithothamnion* and *Ralfsia* spp. Tightly packed mussel beds *(Mytilus galloprovincialis/edulis)* also create microhabitats and help to raise biodiversity.

Fig. 11. Large-scale discontinuities in the physical shoreline further increase the diversity by creating macroenvironmental variations in shade, exposure, etc.

A sampling of the intertidal fauna was carried out in this sector to establish a quantitative baseline of the rocky-shore community. The results of this are presented below:

Results obtained from a transect sampling of an intertidal zonation in Sector 3

Based on the information presented above, it is evident that the intertidal in Sector 1 was for the most part, in an early successional phase. Sector 3 was located for the sampling because it was mainly limestone and hence the data obtained would be more readily extrapolated to other limestone-based coastal sites, than was the case for Sector 2. It was also the more diverse of the localities sampled, possibly because it was further removed from a variety of anthropogenic impacts that affect the coastline, such as those stemming from proximity to bathing areas or recent dumping/reclamation activities. It was therefore the closest to what could be considered a baseline for the eastern side rocky intertidal.

A continuous belt transect from the water's edge to the upper shore was selected as the method to sample the intertidal zonation and macrofaunal assemblages. A rectangular fixed-area $0.25m^2$ (1m x 0.25m) quadrat, placed vertically against the substrate and parallel to the air-water interface, was used to sample the faunal communities. This shape of quadrat was used as it helped to maintain the area being sampled as environmentally homogeneous as possible. The quadrat was made of PVC strips which made it both lightweight and flexible; this latter property allowed it to conform to any irregularities in shore topography, lessening the risk of counting individuals which lay outside the quadrat area. These strips were held together by plastic nuts and bolts which also helped the quadrat to "grip" the substrate. The quadrat was further subdivided into one hundred $25cm^2$ squares with thick fishing line, strengthened at their junctions by cyano-acrylate based adhesive. These helped in the estimation of numbers for superabundant species.

Fig. 12. Photograph of the shoreline sampled, located at N $36^0$07.645 W $005^0$20.429.

The shoreline was thus divided into a series of sequential 1 x 0.25 m samples, from Mean Low Water to a vertical height of 3m (a total of 12 samples). At each of these sampling stations a census of the species richness *(S)* and the number of individuals *(I)* within the quadrat was taken. These were assessed visually on site, with the more 'difficult' species being removed for later identification. Unfortunately, a few of the smaller and more motile species proved difficult to capture and consequently only a rapid visual identification was possible, allowing identification only down to genera.

The results for the exercise are shown below:

Table 1: Taxonomy of the species found

Kingdom: Animalia

Note: Sponges were not considered in this study due to the difficulties involved in resolving number of individuals

Phyla:	Number of Species:
Mollusca	12
Arthropoda	7
Cnidaria	2
Vertebrata	1

Phylum:	**Class:**	**Order:**	**Family:**	**Genus:**	**Species:**	**Author:**	**Synonyms:**	**Common Name:**
Cnidaria								
	Anthozoa							
		Actinaria						
			Actiniidae					
				Actinia	*equina*	(Linnaeus, 1767)		Beadlet Anenome
				Bunodactis	*verrucosa*	(Pennant, 1777)	*(=Bunodes gemmacea, Cribina v.)*	Gem Anemone
Mollusca								
	Polyplacophora							
		Chitonida						
			Chitonidae					
				Chiton	*cf. olivaceus*	Spengler, 1797		Chiton
			Acanthochitonida					
				Acanthochitona	*fascicularis*	(Linnaeus, 1767)	*(=A. communis)*	

Gastropoda							
	Archaeogastropoda						
		Patellidae					
			Patella	*ulyssiponensis*	Roding, 1798	*(=P. aspera, P. athletica, P. tarentina)*	China Limpet
			Patella	*caerulea*	Linnaeus, 1758	*(=P. coerulea, P. scutellaris, P. subplana)*	Mediterranean Limpet
			Patella	*ferruginea*	Gmelin, 1791	*(=P. lamarcki, P. barbara)*	
			Patella	*rustica*	Linnaeus, 1758	*(=P. lusitanica)*	
			Cymbula	*safiana*	(Da Costa, 1771)	*(=P. safiana, P. nigra)*	
		Fissurellidae					
			Diodora	*apertura*	(Montagu, 1803)	*(=D. graeca, D. reticulata, Fissurella mamillata)*	Keyhole Limpet
		Trochidae					
			Monodonta	*turbinata*	(Von Born, 1778)	*(=M. fragaroides, Trochus tesselatus, T. olivieri))*	Turban Shell Toothed Winkle
	Mesogastropoda						
		Littorinidae					
			Littorina	*neritoides*	(Linnaeus, 1758)	*(=Melaraphe n.)*	Little or Small Periwinkle
			Littorina	*punctata*	(Gmelin, 1791)	*(=L. syrica, Melaraphe p.)*	
	Neogastropoda						
		Muricidae					
			Stramonita	*haemastoma*	(Linnaeus, 1767)	*(=Thais h., Purpura h.)*	Rock Shell
	Basommatophora						
		Siphonariidae					
			Siphonaria	*pectinata*	(Linnaeus, 1758)	*(=S. algesirae, S. grisea, Liriola p., Patellopsis p.)*	
Bivalvia							
	Mytiloida						
		Mytilidae					
			Mytilus	*edulis*	Linnaeus, 1758		
			Mytilus	*galloprovincialis*	Lamarck, 1819		

Arthropoda								
	Crustacea							
		Thoracica						
			Chthamalidae					
				Chthalamus	*stellatus*	(Poli, 1791)		Star Barnacle
				Chthalamus	*depressum*	(Poli)	*(=Euraphia depressa)*	
			Balanidae					
				Balanus	*perforatus*	Bruguiere, 1789		
		Decapoda						
			Grapsidae					
				Pachygrapsus	*marmoratus*	(Fabricius, 1787)		Marbled or Runner Crab
		Isopoda						
			Protoniscina					
				Ligia	*italica*	Fabricius		Sea Slater
				Ligia	*oceanica*	(Linnaeus)		
			Gammaridae					
				-Id. to species not possible				
	Insecta							
		Polyphaga						
			Staphilinidae					
				-Id. to species not possible				
Vertebrata								
	Osteichthyes							
		Perciformes						
			Blenniidae					
				Blennius	*Canevae*	Vincinguerra		Yellow-Cheeked Blenny

Table 2: Results for the transect sampling

Species:	***Station 1***	***Station 2***	***Station 3***	***Station 4***	***Station 5***	***Station 6***	***Station 7***	***Station 8***	***Station 9***	***Station 10***	***Station 11***	***Station 12***		***I (species)***
Chthamalus depressum					35	32	97	113	15	20	12	3		**327**
Littorina neritoides			193	95	46	171	323	216	147	172	23	50		**1436**
Littorina punctata				10	29	36	57	3	3					**138**
Chthamalus stellatus	722	1526	680	193	172	52	111	58	6					**3520**
Staphilinidae				1				1						**2**
Patella rustica			19	108	17									**144**
Ligia italica/oceanica			1	1	2									**4**
Mytilus galloprovincialis/edulis	392	793	427	17	4									**1633**
Monodonta turbinata			2											**2**
Actinia equina			2											**2**
Siphonaria pectinata		6	12											**18**
Patella caerulea	17	52	68											**137**
Gammaridae	8	46	15											**69**
Balanus perforatus	85	655	11											**751**
Patella ulissiponensis	23	24	25											**44**
Pachygrapsus marmoratus	2	6	2											**10**
Stramonita haemastoma		2												**2**
Bunodactis verrucosa		2												**2**
Blennius canevae		1												**1**
Chiton cf. olivaceus		1												**1**
Acanthochitona fascicularis	9	4												**13**
Diodora apertura	5													**5**
I (Per Station)	**1263**	**3118**	**1457**	**425**	**305**	**291**	**588**	**391**	**171**	**192**	**35**	**53**		**8289**
S (Species Richness)	**9**	**13**	**13**	**7**	**7**	**4**	**4**	**5**	**4**	**2**	**2**	**2**		**22**
D (Simpson's Index)	**2.337**	**2.868**	**3.090**	**3.112**	**2.746**	**2.484**	**2.681**	**2.443**	**1.339**	**1.231**	**1.865**	**1.122**		**3.848**
H' (Shannon-Wiener Index)	**1.049**	**1.220**	**1.408**	**1.287**	**1.331**	**1.121**	**1.167**	**1.022**	**0.532**	**0.334**	**0.643**	**0.218**		**1.654**

Overall, a relatively high number of species was found (22). Values for both Simpson's and Shannon-Weiner diversity indices were not as high as expected due to the fact that the high number of *Mytilus* and *Chthamalus stellatus* specimens affected the equitability of the sample and biased the index to give a lower reading of diversity, especially in the more species-rich lower shore.

It must be remembered that this is a sample meant to allow a quantitative assessment of diversity and species richness. It is not an exhaustive species listing, and there are many other species in the area which were not sampled because they fell outside the sampling area (*P. ferruginea* being one of them).

Notwithstanding, there are a number of species in the sample that are in the Gibraltar Government's Nature Protection Ordinance No. 2,608, dated 9th May 1991 and which should be taken into consideration. These are:

Blennius canevae (all *Blennius* spp. are protected)
Monodonta turbinata (all *Monodonta* spp. are protected)
Stramonita haemastoma (under synonym *Thais haemastoma*)

It would be expected that this number would rise if a more exhaustive survey were carried out.

The following section of the report focuses specifically on the status of *Patella ferruginea* along the surveyed coastline.

Purpose of the *Patella ferruginea* survey

To establish the presence and distribution (or not) of the marine intertidal limpet *Patella ferruginea* Gmelin, 1791 (Gastropoda, Patellidae), a species requiring strict protection under Annexe IV of the EU Directive 92/43/CEE, dated 21st May 1992, and the Gibraltar Government's Nature Protection Ordinance No. 2,608, dated 9th May 1991, along the eastern shoreline of Gibraltar.

Introduction

The limpet *Patella ferruginea* Gmelin, 1791, is endemic to the Mediterranean and is the most endangered marine invertebrate along the Western Mediterranean rocky shoreline (Laborel-Deguen & Laborel, 1991a; Ramos, 1998). Although its relative abundance in Palaeolithic and Neolithic deposits indicates an extensive former distribution in the Western Mediterranean Basin (East coast of Italy, Mediterranean France, Iberian Peninsula, Morocco, Tunisia and the Western Mediterranean islands), today its Mediterranean range has progressively contracted to restricted areas (Cretella *et al.,* 1994; Templado, 1996) probably due to anthropogenic pressure (Aversano, 1986) and, presently, the species is threatened with extinction (García-Gómez *et al.,* 2000).

Fig.13. *Patella ferruginea* Gmelin, 1791. Note the distinctly ribbed shell of the species.

In spite of this, *P. ferruginea* has been scarcely studied and data of its biology and habitat references are lacking in the literature. The species has a very low growing and reproductive rate, reaching sexual maturation at 2-3 years. It is a proterandric species,

being initially male (from around 25 mm length) and latterly female (from around 60 mm length – Espinosa, 2005) with the relatively large sizes of the ovocites suggesting a short planktonic phase (Frenkiel, 1975; Templado, 1996). *P. ferruginea* is considered a *k*-strategist (Laborel-Deguen & Laborel, 1991b), that is, its life history is based on being a specialist with low growth rates and reproductive outputs. Individuals may have a lifespan of over 30 years (Espinosa, 2005). The adults usually live in the midlittoral zone (Pérès and Picard, 1964) but they can also be found in the suppralittoral zone (Biagi & Poli, 1986). They feed mainly on cyanobacteria and the algae *Ralfsia* spp. and *Rissoella* spp.

A recent study (Espinosa *et al.,* 2005) found that the area of the Bay of Gibraltar houses the largest known population of this species in the entire Iberian Peninsula, and very probably in the entirety of continental Europe. The highest densities of this species were encountered along a relatively short stretch of coastline along the east side of Gibraltar immediately south of Sandy Bay through to the area occupied by the Admiralty Oil Tanks (Fig.14). As part of the environmental impact assessment for a proposed marina and other construction works along the east side of the Rock, a survey on the presence of *P. ferruginea* was conducted.

Fig. 14. The small stretch of rocky coastline where *P. ferruginea* was reported by Espinosa *et al.,* (2005).

Methods

Given that the species occupies a rocky intertidal habitat, a visual survey of the rocky shoreline along the survey area was elected as the method for censusing any *P. ferruginea* individuals. Fig. 1 shows the extent of the survey area.

The entire shoreline was carefully searched for any *P. ferruginea* individual. Sampling was carried out by foot or swimming, where required. The area under the Admiralty Oil Tanks was surveyed from a rigid inflatable boat. Where any specimen was found, its size was recorded to the nearest cm (Fig. 15) and its position recorded using a *Garmin GPS 76* (Fig. 16).

Fig.15. Measuring a *P. ferruginea* individual.

Given that *P. ferruginea* can be quickly covered by the rising tide and moreover sampling becomes difficult and indeed, dangerous, during periods of strong wave action (Fa, 1998; Fa *et al.,* 2000), the area under study needed to be sampled at or as near to low water as possible during calm water episodes, i.e. for the area in question, during westerlies. A 'window' of two hours on either side of low water was established as the best time to carry out the surveys.

Fig.16. Using a *Garmin GPS 76* to locate a *P. ferruginea* individual.

Results

A total of 24 *P. ferruginea* individuals were found along the coastline under study, all in the southern end of the sampled area. Only two individuals were found outside the area reported by Espinosa *et al.,* (2005). Photographs of all the individuals found can be found in appendix 1. Fig. 17 below shows the approximate locations of all individuals.

Fig. 17. Approximate locations of the 24 *P. ferruginea* individuals encountered during the survey. It will be noted that all the limpets found were concentrated towards the southern end of the survey area (sectors 2 & 3).

Table 3: GPS positions and sizes of the individuals found.

Limpets close to each other (<50cm) share the same GPS coordinate.

Limpet Number	GPS Latitude	GPS Longitude	Length (cm)
1	N 36^0 08.022	W 005^0 20.436	6
2	N 36^0 08.004	W 005^0 20.429	4
3	N 36^0 07.685	W 005^0 20.480	4
4	N 36^0 07.680	W 005^0 20.476	6
5	N 36^0 07.671	W 005^0 20.475	4
6	N 36^0 07.663	W 005^0 20.470	4
7	N 36^0 07.662	W 005^0 20.470	6
8	N 36^0 07.653	W 005^0 20.460	6
9	N 36^0 07.653	W 005^0 20.460	5
10	N 36^0 07.652	W 005^0 20.462	5
11	N 36^0 07.651	W 005^0 20.458	8
12	N 36^0 07.650	W 005^0 20.461	6
13	N 36^0 07.644	W 005^0 20.448	8
14	N 36^0 07.642	W 005^0 20.445	3
15	N 36^0 07.642	W 005^0 20.445	8
16	N 36^0 07.642	W 005^0 20.450	8
17	N 36^0 07.641	W 005^0 20.451	5
18	N 36^0 07.639	W 005^0 20.443	3
19	N 36^0 07.638	W 005^0 20.446	2
20	N 36^0 07.631	W 005^0 20.451	4
21	N 36^0 07.633	W 005^0 20.446	6
22	N 36^0 07.635	W 005^0 20.444	3
23	N 36^0 07.629	W 005^0 20.440	5
24	N 36^0 07.630	W 005^0 20.439	5

The size distribution of the sample follows a normally-distributed range of sizes and is indicative of a reproducing population containing both males and females (Fig. 18).

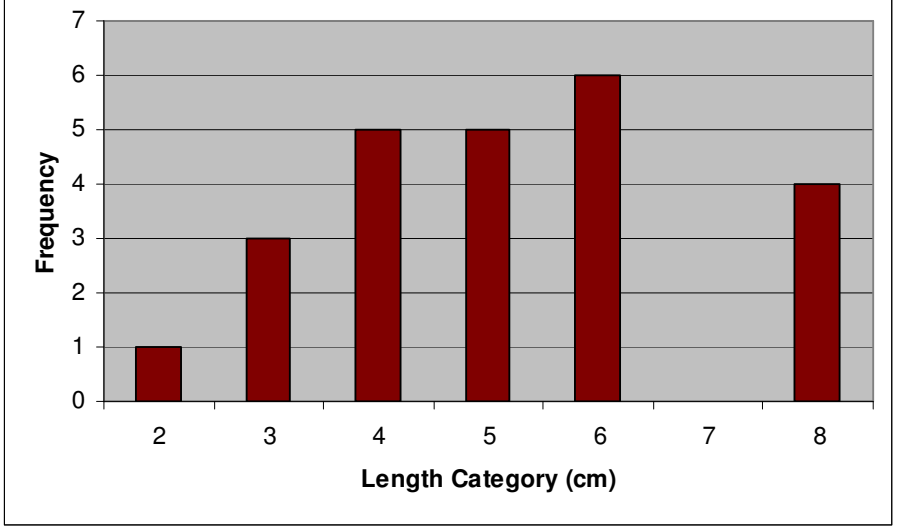


Fig. 18. Size-Frequency distribution of the 24 *P. ferruginea* individuals encountered during the survey.

Discussion, conclusions and recommendations

Various authors have put forward various reasons for the regression of *P. ferruginea,* all of which cite anthropogenic factors as a major contributor. Its relative ease of collection by people for possible consumption, use as bait, or decoration (due to its large size and attractive shell) has been proposed as a major cause for its decline (Laborel-Deguen & Laborel, 1991a,b; Templado, 2001; Paracuellos *et al.,* 2003). Other contributing factors include the progressive habitat deterioration due to human proximity, low individual fecundity and poor dispersal ability.

This survey has identified a total of 24 individuals of *P. ferruginea* inhabiting the southern end of the survey area. The limpet density along Sector 2 is approximately 0.004 individuals m^{-1}, and for Sector 3, approximately 0.08 individuals m^{-1}. Given that a total of 140 individuals were censused over approximately 20km of coastline along the Bay of Gibraltar and that these 140 limpets at the time of writing represented the largest known population of the species in Iberia (Espinosa *et al.,* 2005), the results of this survey represent a significant contribution to the known species pool.

Collection by people is a possible reason for *P. ferruginea*'s absence along the Eastern Beach and Catalan Bay groynes, despite these being colonised by other limpet species, such as *P. rustica, P. caerulea, P ulissiponiensis* and *Cymbula safiana (= P. nigra).*

The majority rocky shorelines within sector 1 (except the more stable and well-constructed Eastern Beach and Catalan Bay groynes) showed very low diversity overall, due to it being composed of loose boulders with large areas subjected to sand inundation and periodic dumping from works carried out immediately above the shoreline and also coastal erosion bringing down loose material due to undercutting (see Figs. 4 A-C).

The results obtained for an independent quantitative survey in sector 3 (Table 2) show a well-structured and highly diverse intertidal community, indicative of little perturbation and low levels of environmental stress.

Recent studies (Espinosa, 2005) also suggest that the species dislikes areas that are too exposed to wave action, and also tends to avoid vertical surfaces. This has been borne out in this survey, where no individuals were found along the vertical cliffs beneath the Caleta Hotel or the Admiralty Oil tanks. The latter in particular is surprising given its proximity to the majority of individuals found. Most of the specimens were located along gently sloping surfaces and rarely faced directly out to sea.

This species has a particularly low tolerance of areas of reduced water movement where oxygen levels drop and pollutants and other negative factors can reach significant levels (Guerra-García *et al.,* 2004). The sensitivity of the species to alterations in the environment is such that it has recently been proposed as a bioindicator, that is, a species whose presence can be used as an indicator of environmental quality (Espinosa *et al., in press a*).

The presence of the species along Sectors 2 and 3 may be due to the relative inaccessibility of the site, (especially Sector 3, where access is via dangerous steps and ladders – see Fig. 19 - and moreover is in an area of restricted access due to danger of rock falls), thereby reducing collecting pressure by humans. Its absence further north could be due to a combination of anthropogenic collection pressure and instability of the substrate.

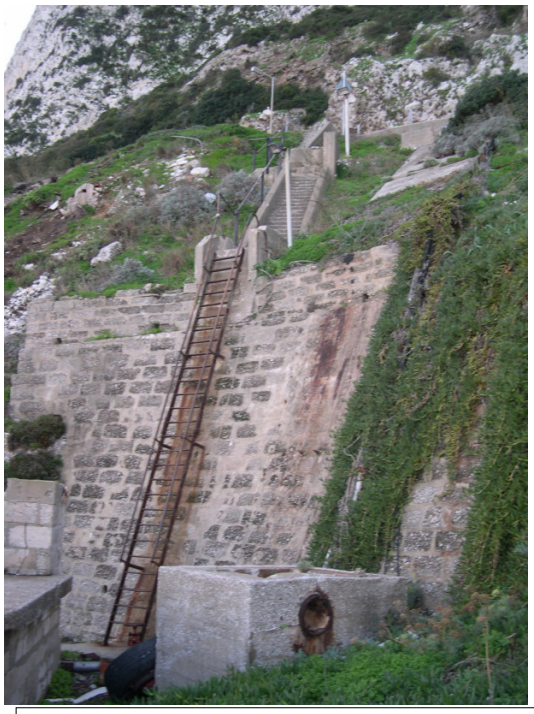


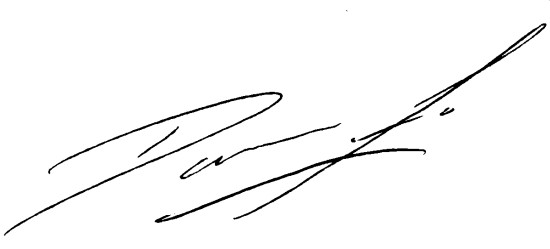
Fig. 19 Access ladder to Sector 3.

The species therefore restricted to areas which satisfy its very specific habitat requirements of clean, well-oxygenated and mixed water, and a heterogenous and stable rock substrate which allows some protection from direct wave impact. A recent study (Espinosa *et al., in press b*) has highlighted the use of enclosures to improve survival rates of transplanted individuals. It may therefore be possible to transplant some of the individuals closest to the reclamation away from the site to an alternative location, but this should be considered a last resort.

Silting of the surrounding waters will probably cause the greatest initial risk posed by the proposed reclamation and construction project. The main direction of longshore drift along the east side is from north to south, and thus any silt in the water column would be carried towards the area inhabited by the species. Fine suspended sediments will remain for a long time in the water column and twice daily tides would 'paint' the intertidal zone with these particles, which not only smother algae which the organisms graze on, but also clog up their gills. However, this effect may be ameliorated in part given the relatively high degree of hydrodynamism along this coast due mainly to frequent easterlies (Estacio *et al.,* 1997).

There may also be a higher possibility of pollutant spills such as oil from machinery. Following reclamation, increased risks would include possible further deterioration in water quality caused by changes in the water movement regime in the area, together with the possibility of augmented access to the shoreline, and the introduction of new pollution sources stemming from the new marina development (such as tributyltins from antifouling paints from visiting ships). All these in combination would amplify the risk of potential impacts, either directly on the organisms or indirectly by affecting the ecosystem of which they form a part (Fa *et al.,* 2002). It would therefore be necessary to pay close attention to the proposed methods for reclamation and construction so as to minimize as far as possible the suspension of fine particulates in the water column (and also ensure other working practices are modified so as to minimize physical, pollution and other risks), and it would also be necessary to incorporate some form of long-term monitoring of this assemblage into the scheme so as to establish whether any remedial actions that may be taken prove effective in protecting the *P. ferruginea* individuals present.

Signed, on the 28th November 2005



Dr. Darren Fa

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Appendix 1: Photographs of the 24 *P. ferruginea* individuals found in the survey

Appendix 2 (contd.):