



Background Document for Azorean limpet
Patella aspera



OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the “OSPAR Convention”) was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. It has been ratified by Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom and approved by the European Community and Spain.

Convention OSPAR

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998. La Convention a été ratifiée par l'Allemagne, la Belgique, le Danemark, la Finlande, la France, l'Irlande, l'Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d'Irlande du Nord, la Suède et la Suisse et approuvée par la Communauté européenne et l'Espagne.

Acknowledgement

This report has been prepared by Ricardo Serrão Santos, Rodrigo Delgado and Rogério Ferraz (Department of Oceanography and Fisheries of the University of the Azores) for Portugal as lead country.

Photo acknowledgement: *Patella aspera*© RFerraz/ImagDOP

Contents

Background Document for Azorean limpet <i>Patella aspera</i>	4
Executive Summary	4
Récapitulatif	4
1. Background information	5
Name of species	5
2. Original Evaluation against the Texel-Faial selection criteria	5
OSPAR Regions and Dinter biogeographic zones where the species occurs.....	5
OSPAR Regions where the species is under threat and/or decline.....	5
General	5
Original evaluation against the Texel-Faial criteria for which the species was included on the OSPAR List.....	6
Relevant additional considerations.....	7
3. Current status of the species (2008).....	8
Distribution in the OSPAR maritime area	8
Population (current/trends/future prospects)	8
Condition (current/trends/future prospects).....	8
Limitations in knowledge	8
4. Evaluation of threats and impacts.....	9
Threat and link to human activities.....	9
5. Existing Management Measures.....	9
6. Conclusion on overall status	10
7. Action to be taken by OSPAR.....	10
Action/measures that OSPAR could take, subject to OSPAR agreement.....	10
Brief summary of proposed monitoring system (see Annex 1)	11
Annex 1: Detailed description of the proposed monitoring and assessment strategy	12
Rationale	12
Use of existing monitoring programmes	12
Synergies with monitoring of other species or habitats	12
Assessment criteria.....	12
Techniques/approaches.....	12
Selection of monitoring locations	12
Timing and frequency of monitoring.....	12
Data collection and reporting	12
Quality assurance	12
Annex 2: References	13

Background Document for Azorean limpet *Patella aspera*

Executive Summary

This Background Document on the wild Azorean limpet – *Patella aspera* - has been developed by OSPAR following the inclusion of this species on the OSPAR List of threatened and/or declining species and habitats (OSPAR agreement 2008-6). The document provides a compilation of the reviews and assessments that have been prepared concerning this species since the agreement to include it in the OSPAR List in 2003. The original evaluation used to justify the inclusion of *Patella aspera* in the OSPAR List is followed by an assessment of the most recent information on its status (distribution, population, condition) and key threats prepared during 2008-2009. Chapter 7 provides proposals for the actions and measures that could be taken to improve the conservation status of the species. In agreeing to the publication of this document, Contracting Parties have indicated the need to further review these proposals. Publication of this background document does not, therefore, imply any formal endorsement of these proposals by the OSPAR Commission. On the basis of the further review of these proposals, OSPAR will continue its work to ensure the protection of *Patella aspera*, where necessary in cooperation with other competent organisations. This background document may be updated to reflect further developments or further information on the status of the species which becomes available.

Récapitulatif

Le présent document de fond sur la patelle des Azores a été élaboré par OSPAR à la suite de l'inclusion de cette espèce dans la liste OSPAR des espèces et habitats menacés et/ou en déclin (Accord OSPAR 2008-6). Ce document comporte une compilation des revues et des évaluations concernant cette espèce qui ont été préparées depuis qu'il a été convenu de l'inclure dans la Liste OSPAR en 2003. L'évaluation d'origine permettant de justifier l'inclusion de la Patelle des Azores dans la Liste OSPAR est suivie d'une évaluation des informations les plus récentes sur son statut (distribution, population, condition) et des menaces clés, préparée en 2008-2009. Le chapitre 7 fournit des propositions d'actions et de mesures qui pourraient être prises afin d'améliorer l'état de conservation de l'espèce. En se mettant d'accord sur la publication de ce document, les Parties contractantes ont indiqué la nécessité de réviser de nouveau ces propositions. La publication de ce document ne signifie pas, par conséquent que la Commission OSPAR entérine ces propositions de manière formelle. A partir de la nouvelle révision de ces propositions, OSPAR poursuivra ses travaux afin de s'assurer de la protection de la patelle des Azores, le cas échéant avec la coopération d'autres organisations compétentes. Ce document de fond pourra être actualisé pour tenir compte de nouvelles avancées ou de nouvelles informations qui deviendront disponibles sur l'état de l'espèce.

1. Background information

Name of species

Patella aspera (*Patella ulyssiponensis aspera*)

Azorean limpet

Patella ulyssiponensis aspera was nominated for the OSPAR list as a Macronesian subspecies of *P. ulyssiponensis*. There has been some uncertainty about the systematics of Azorean limpets and the most recent work suggests that there are two distinct species - *P.aspera* which is endemic to Macaronesia, and *P. ulyssiponensis* which occurs on continental Europe (e.g. Hawkins *et al.*, 2000). This background document therefore refers to *P. aspera*. The local name for this species is “*lapa brava*”.



2. Original Evaluation against the Texel-Faial selection criteria

OSPAR Regions and Dinter biogeographic zones where the species occurs

OSPAR Region: V

Biogeographic zone: Azores shelf biogeographic zone

OSPAR Regions where the species is under threat and/or decline

Region & Biogeographic zones specified for decline and/or threat: Macaronesian province,

General

Locally known as “*lapa brava*” *Patela aspera* is one of the two species of limpets collected for human consumption in the Azores. The taxonomical status has some uncertainty, but the most recent study (Hawkins *et al.* 2000) suggests that the Azorean species previously considered a subspecies, *P. ulyssiponensis aspera*, is in fact a valid and well differentiated endemic of the Macaronesia region. Its distribution in the OSPAR Maritime Area is limited to the islands of the Azores where it occurs on rocky substrates in the intertidal, and in the shallow sublittoral. (e.g. Christiaens, 1973; Titselaar,

1998). In the Azores this species is one, if not the most, important grazer in the superior subtidal, and is considered as keystone species on the rocky shore of the archipelago.

In 1984/1985 limpets represented 15% of the economic value of all seafood supplied through the Azorean fisheries auction. They reached 6th place in economic importance. At that time only a small proportion of the limpets went through the official market. An estimated 80% went directly from the harvester to the market. In subsequent years the drop of limpet populations was dramatic, from a maximum of 90 tons in 1985 to a minimum of 10 tons in 1988. This had an effect on the structure of sub-littoral communities and assemblages with no recovery as yet. In the early 1990's there were still places where Catch Per Unit Effort (CPUE) was around 12kg/half hour but this has fallen to 5g/half hour in recent years

Original evaluation against the Texel-Faial criteria for which the species was included on the OSPAR List

P.aspera was nominated for inclusion on the OSPAR list in 2001 with particular reference to its decline, keystone status and sensitivity with information also present on threat.

Decline: *P.aspera* is one of two species of limpet collected for human consumption in the Azores. Moderate harvests, mainly for self consumption, are believed to have taken place since the islands were colonised in the 15th century (Santos et al. 1995). A combination of easier access to sublittoral populations, improved refrigeration, increased commercial value and a hypothetical "limpet disease" led to a decline of stocks mainly in the Central group of islands (Faial, Pico, Terceira, São Jorge and Graciosa) in the mid to late 1980's and a collapse of the fishery by 1988 (e.g. Martins *et al.*, 1987; Santos *et al.* 1995; Ferraz *et al.*, 2001; Hawkins *et al.*, 2000) (see figure). Effects have also been observed in the size distribution with more large individuals in professionally harvested landings than in unexploited stocks (Martins *et al.*, 1987). Various fisheries management measures were introduced and since then populations appear to have recovered and were stable in the end of the 90's (Delgado et al. 2007) with regard to their biomass in the Central and Western Groups while those in the Eastern group of island (Santa. Maria and São Miguel) have not recovered from over-exploitation and seem to be dangerously low (Ferraz & Menezes, 1998 & 1999; Ferraz & Santos, 2000; Ferraz *et al.*, 2001).

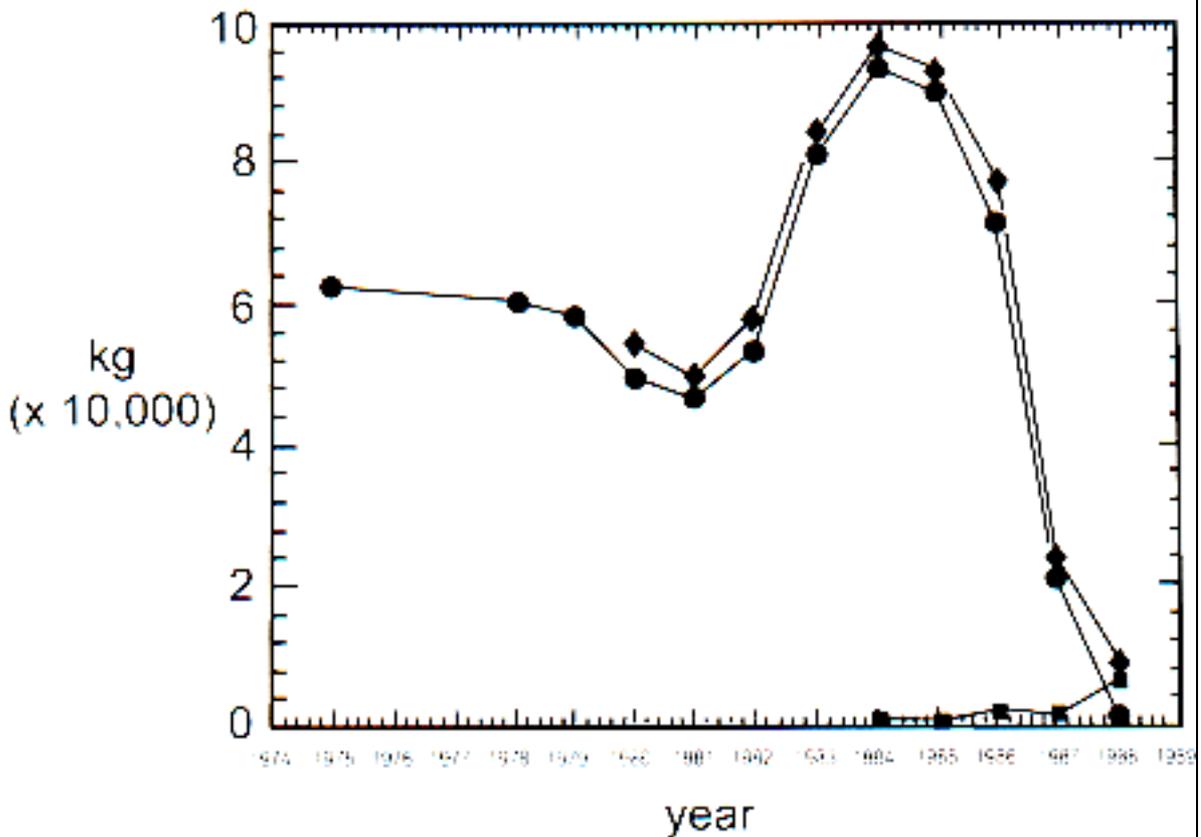
Keystone species: Limpets are known to have an important influence on the structure and function of rocky shore communities. They are dominant grazers that have a major influence on the community composition of rocky shores and can be considered keystone species (e.g. Raffaelli & Hawkins, 1996). Once removed, conditions may also change to a state that makes recolonisation less likely. In areas where uncontrolled human exploitation has taken place, for example, algal turfs tend to dominate the rock surfaces, which deprives the limpets of a lithothamnia covered nursery ground which can be easily grazed. There are only two species of patellid limpets found on the Azores therefore changes in the population status of *P.aspera* could have far reaching implications for rocky shore ecology of the islands.

Sensitivity: *P.aspera* is thought to be a protandrous hermaphrodite. In heavily exploited populations the average size decreases and therefore the number of the large sized females is affected. This may lead to increased likelihood of recruitment failure due to lowered reproductive output. Genetically, it would also reduce the effective populations size considerably (Santos *et al.* 1995; Hawkins *et al.*, 2000). *P.aspera* is susceptible to "recruitment overfishing" due to distortion of the sex ratios by removal of the larger females, and to heavy exploitation which disturbs the well-grazed lithothamnia dominated habitat needed for continual recruitment (Santos et al. 1990).

Threat : The main threat to *P.aspera* is overexploitation for the fishery. When harvesting was banned in the central group of islands in 1985 this increased exploitation in other islands, mainly in São Miguel and Santa Maria, and stocks in these islands have still to recover. The total ban on limpet collection in

1989 probably allowed the stocks to avoid catastrophic over-exploitation. Since then progressively tighter fisheries regulations have been introduced but limpet populations are still very much reduced in many of the islands (Hawkins *et al.*, 2000). Recent studies have shown that illegal harvesting in the Formigas islets, which had healthy stocks some years ago, has reduce the population to nearly zero (Cardigos *et al.* 2002; Delgado *et al.* 2007). It can be concluded that there has been and continues to be a threat to this species across most of its range within the OSPAR Area.

Collapse of the São Miguel limpet fishery (diamonds all islands; circles São Miguel, Squares other islands. Decline in landings (from Santos *et al.*, 1990)



Relevant additional considerations

Sufficiency of data: There are nearly 30 years of data on landings from limpet fisheries in the Azores but no records and statistical data prior to the 1980s. Since then, landings have been recorded from all the islands. The data show a substantial increase in landings in 1997 and 1998 which appears to be connected with the policy of the Regional Directorate of Fisheries to only issued licences to harvesters who declared catches in the previous year. Catch per unit effort data have been calculated using the information from individual "limpet capture diaries". Fisheries independent data on the status of the limpet population have also been collected (e.g. Martins *et al.*, 1987; Ferraz *et al.*, 1999; Santos & Santos 2005; Delgado *et al.* 2007) which enables a more direct assessment of the stock to be made. Taken together, there appears to be a sound information base on which to determine the status of *P.aspera* in the Azores.

Changes in relation to natural variability: Natural fluctuations occur in the limpet population. One of the causes is known to be prolonged storms and heavy seas that can lead to boulder damage on rocky shores.

During the severe decline of limpet populations in the early 1980's there was a suggestion that a "limpet disease" was partly responsible. The nature, extent and cause of this remains a mystery as it was virtually over before an investigation could be started although possible culprits include red tides or unusual warm temperature or disease (Martins *et al.*, 1987). However, it seemed to occur primarily on the southern coasts, which are the more populated areas, with calmer seas, and thus also more accessible for harvesters. The only clear facts are that there was a huge increase on limpet's landings at the fish auction posts between 1982 to 1986, followed by a dramatic decline. Fisheries independent data and data comparing the size structure of natural populations with catches by professional harvesters give an indication of "natural" changes in *P.aspera* but are only available for recent years.

Expert judgement: Local knowledge and unquantified observations pointed to a dramatic decline in the population of *P.aspera* on most of the islands of the Azores in the 1980s. This is supported by a good data set showing changes in the landings of *P.aspera* from 1978 and verified by surveys (e.g. on the southern coasts of Pico and São Jorge in 1983) which provided fisheries independent data. Consideration of the case on the basis of expert judgement was therefore unnecessary.

ICES evaluation: The ICES review of this nomination raised the question of whether the decline of the subspecies is rather local given that *P. ulyssiponensis* is abundant in the Cantabrian Sea (northern Spain). Recent research has however proposed that there are two distinct species (*P. aspera* an endemic species which occurs in Macaronesia and *P. ulyssiponensis*, which occurs on the continent of northern Europe) (Hawkins *et al.*, 2000). The status of the mainland population therefore becomes less relevant to the overall status of the species found in the Azores.

3. Current status of the species (2008)

Distribution in the OSPAR maritime area

Patella aspera is found in the shelves of all Azorean islands and islets. Beyond the OSPAR area it may be found in the Macaronesian archipelagos of Madeira and the Canaries (Weber & Hawkins 2005).

Population (current/trends/future prospects)

The analysis of commercial activity (Delgado *et al.* 2007) shows that the catches decreased abruptly from a high of 10 000 kg that was reached in 2001-2002 (following some successful recovery due to full closure of the fisheries) to a tenth of this value. The majority of the islands where in 2002 catches were at the level of 2000Kg (Faial, Pico and St. Jorge) suffered important decreases. In 2003 there were no reported commercial catches, and in Graciosa island, one of the most important contributors for commercial limpets, the catch decline to 50% of values of 2 years before (Delgado *et al.* 2007)

Condition (current/trends/future prospects)

Patella aspera is practically commercially extinct in the Azores. Due to the decline of Azorean stocks the market initiated the importation of limpets from other sources, including mainland Portugal, Madeira and North Africa. But no data is available.

Limitations in knowledge

The biology, ecology and fisheries are fairly known. The fact that importation is allowed without reporting of the introductions in the market is a major handicap and may contribute for the introduction of remaining local limpet in the market, even during the protection season.

4. Evaluation of threats and impacts

Threat and link to human activities

Cross-reference to checklist of human activities in OSPAR MPA Guidelines

Relevant human activity: Fishing, hunting, harvesting. *Category of effect of human activity:* Biological – removal of target species

The increase in landings, subsequent crash of the fishery, and recovery (in some areas) following temporary closure and licensing arrangements for the harvest of limpets, suggests that there is a strong link between the threat to *P.aspera* populations and the collection of limpets in the Azores. Records showing that the sex ratios of the population were seriously distorted after the dramatic decline in landings are another indication that over-exploitation was a major factor in their decline as females are the larger individuals and therefore more valuable to the harvesters (Martins *et al.*, 1987). Independent research to evaluate the effects of new regulations based on reserve areas versus fisheries areas, have shown that after the open season the mean individual size and the proportion of females is higher on the populations of the reserve areas in spite of poor enforcement of regulations.

Human activities representing threats to limpets in the Azores are still fishing and harvesting. Besides leading to over-exploitation in several islands with concomitant disturbance of coastal benthic facies (these change is already visible in São Miguel Island, the more exploited island during the 1980's), these activities have an impact on the pool of reproductive females in the population. The removal of target larger sizes, females, which are bigger in this protandrous species, has led to biased sex ratio.

5. Existing Management Measures

A number of management measures have been introduced for the limpet fishery since its dramatic collapse in the late 1980's. These comprise, closed seasons, closed areas (limpets MPA's), size limits, licensing of fishermen and endeavours to get better management information. This combination of measures is planned to continue for the foreseeable future although the details may change depending on the status of the population. Complete closure of the fishery has been instituted in the past, and remains an option if required to stabilise, aid recovery and/or prevent decline in the stocks.

There are currently 34 marine reserves designated strictly to enhance the conservation of the limpets in the archipelago (DRR-19/93/A) with 10-20% of the shore is closed to exploitation. Each island has at least three closed areas. Exploration of limpets is based on licences issued by the Fisheries Directorate of the Azores. In 2004, 70 permits were issued, which was a reduction of about 70% compared to the previous year.

Effectiveness of Management Measures: Existing management measures are not effective in protecting the limpet population and, consequently, the coastal habitats. One of the main problems is illegal exploitation, with limpets being caught all year round around the islands. Management is based on a closure period (from the beginning of October until the end of May) and a network of closed areas, but since there is poor enforcement these two measures are not as effective as they could be. Nevertheless, the annual reports, evaluating the declared landings and monitoring results show that up to 2000 the implemented management measures led to some improvement in the islands where the limpet harvesters were fulfilling the regulations. In 2001, the harvesters start to move between islands and there was an increase on exploitation and landings. Concomitantly a decrease of the populations was observed and the landings have since decreased. In 2003, total catches are identical to values recorded before. This decrease of captures seems to be related to a decrease of the populations, since the surveys have shown a significant reduction in all the islands sampled.

Enforcement of the law needs to be improved however this will not be sufficient on its own. . There is also a need for an education and information programme to be implemented and maintained for several years. The licence reduction of 70% for the 2004 exploitation season is not sufficient since the main problem affecting this resource is illegal catches.

6. Conclusion on overall status

Patella aspera is commercially extinct in the Azores. The extent of the coast of the islands and remoteness make the creation of sparse MPAs inefficient and highly difficult to control.

7. Action to be taken by OSPAR

Action/measures that OSPAR could take, subject to OSPAR agreement

As set out in Article 4 of Annex V of the Convention, OSPAR has agreed that no programme or measure concerning a question relating to the management of fisheries shall be adopted under this Annex. However where the Commission considers that action is desirable in relation to such a question, it shall draw that question to the attention of the authority or international body competent for that question. Where action within the competence of the Commission is desirable to complement or support action by those authorities or bodies, the Commission shall endeavour to cooperate with them.

Apart from maintaining the present management measures, which have been effective in the past, it is necessary to reduce the illegal activity. This is difficult to control, due to the lack of equipment and personnel so another approach may be to reduce the demand for limpets. For this to happen, a programme of environmental awareness should be developed and directed at the local population and tourists. It should include explaining what is happening with the stocks and the importance of protecting the limpets in the breeding period, as well as providing information to visitors about what they can and cannot eat in each season. Finally, it should be noted that some of the illegally exploited limpets are sent to the Azorean emigrants that live in the USA and Canada. Information is needed on the exported quantities which are currently grouped with other exported fishery products under the general category of "fish".

Competent authorities:

Authorities	Role
Azorean Fisheries Directorate	Licence issuing
Azorean Fisheries Inspection	Inspection of activity
Maritime Police	Inspection of activity
Economic Activities Inspection	Inspection of activity
Azorean Environmental Directorate	Environmental protection
University of the Azores	Scientific follow up

Role of OSPAR:

Management measures which should be implemented by OSPAR: The major problem affecting this resource is illegal harvesting. If the demand for limpets can be reduced it should be possible for the populations to recovery and to exploit them at sustainable levels. Alerting consumers (local

people, tourists and Azorean emigrants) through environmental awareness campaigns with the objective of promoting the consumption of limpets only during the open catch season, could help in the reduction of exploitation during the breeding season.

International pressure for the effective protection and enforcement of the marine reserves network could help the protection and recovery of this species as could greater awareness of the need to introduce special measures for the protection of this species given its inclusion on the OSPAR list.

Management matters which should be drawn to the attention of other relevant bodies: Local authorities should be encouraged to take action to protect the limpet population given that they are disappearing and that their protection is not only of economic importance, but also environmental importance Limpets are a keystone species on the rocky shores of the archipelago, with no other species fulfilling the same role.

Brief summary of proposed monitoring system (see Annex 1)

Since 1986 there have been a set of non regular evaluation actions. In 1998 a monitoring programme was set up but, due to the lack of resources, monitoring was only carried out around islands where the declared exploitation was more significant and where historically the limpets were more exploited (São Miguel and Santa Maria). Monitoring involves 1) declared catches at the Azorean fish auction (Lotaçor), which is regularly supplied to the Fisheries Directorate; 2) half hour independent dives in randomly pre-selected stations (catch per unit of effort); 3) depletion experiments in two selected stations in Faial to study resilience and rates of recovery.

The intention is to carry out twice yearly monitoring, before and after the open season but to date, this has only been possible around Faial and Pico. With these two well-established monitoring periods it will be possible improve knowledge of the biological parameters needed for a better fishery evaluation and application of fisheries models.

A significant gap is the lack of data on imported limpets, entering the Azores, from mainland and Madeira. Such information is crucial for adequate enforcement of the law at the level of restaurants and consumers.

Annex 1: Detailed description of the proposed monitoring and assessment strategy

Rationale

The main threat to this species is human exploration (“fishing”). Wild limpets have life-history traits that make them especially vulnerable, namely hermaphroditism and sex change. Recruitment is also a limiting factor. Being a grazer and “gardner species” recruitment may be also affected by lack of appropriate habitat due to over-occupation of rocky substract by algae turfs that gained completion due to the lack of grazers, namely the adult limpets.

Given its vulnerability and the threats facing this species, it is important to coordinate research activities in the all Macaronesia, despite part of it not been included in OSPAR.

Use of existing monitoring programmes

The existing monitoring programs proved good for the knowledge of the state of the stocks and independent evaluation is essential because the data on commercial catches is not reliable.

Synergies with monitoring of other species or habitats

Patella aspera should be a key species in the monitoring actions of the Azorean N2000 sites.

Assessment criteria

CPUE by independent divers measured as catches by unit of time and/or length of coast. Evaluation of recruitment and sex ratio.

Techniques/approaches

Artisanal diving to collect limpets using snorkelling and traditional gears.

Selection of monitoring locations

Faial/Pico – Flores – São Miguel and Santa Maria Islands

Timing and frequency of monitoring

Every six months.

Data collection and reporting

The University of the Azores at DOP keeps a 20 year old data base of independent surveys and 10 year old information of voluntary diary reports from the licensed fishermen.

Quality assurance

The independent surveys are fully controlled by scientists and are reliable. Information concerning commercial catches is not reliable.

Annex 2: References

- Cardigos, F. *et al.* (2002). Bancos 2002: Relatório de Missão de 2002 do Departamento de Oceanografia e Pescas da Universidade dos Açores aos Bancos D. João de Castro e Complexo Formigas/Dollabarat. Arquivos do DOP, série estudos, in press.
- Delgado, R., E. Isidro & R. S. Santos (2007). Evaluation of the actual situation of limpets populations in the Azores (in Portuguese). Final Report for ORPAM/InterReg. Departamento de Oceanografia e Pescas da Universidade dos Açores, Horta: 57pp.
- Ferraz, R.R. (1998). Avaliação do recurso de lapas – *Patella ulyssiponensis aspera* e *Patella candei candei* – no arquipélago dos Açores. Tese de Licenciatura e Biologia Marinha e Pescas. Universidade do Algarve. Faro. 66pp.
- Ferraz, R. R. & Menezes, G. (1998). Análise das capturas de Lapas nos Açores entre 1993 e 1997 e Parecer para a emissão de licenças para 1998. *Arquivos do DOP*, Série: Estudos n.º 2/98, 16 p.
- Ferraz, R. R. & Menezes, G. (1999). Análise das capturas de Lapas nos Açores em 1998 e Parecer para a emissão de licenças para 1999. *Arquivos do DOP*, Série: Estudos n.º 3/99, 19 p.
- Ferraz, R.R., Castro, T. & Menezes, G. (1999). Quantas lapas há no Faial e no Pico? Poster Científico apresentado na XVIII Semana das Pescas dos Açores, Horta, Açores, Portugal.
- Ferraz, R.R. & R.S. Santos (2000). Análise das capturas de lapas nos Açores em 1999 e parecer para a emissão de licenças para 2000. *Arquivos do DOP*, série estudos, 1/2000, 17p
- Ferraz, R.F., Menezes, G.M. & Santos, R.S. (2001). Limpet (*Patella* spp.) Mollusca: Gastropoda) exploitation in the Azores, during the period 1993-1998.
- Ferraz, R. R., R. S. Santos, J. Gonçalves, G. Menezes, H. R. Martins, M. R. Pinho & G. Carreira. 1999. Scientific Report on the Activities of Project RIVA – Support to the Management of Small Invertebrates of the Azores – Year 1998 (in Portuguese). *Arquivos do DOP*, Série: Relatórios Internos n.º 1/1999: 28 p.
- Ferraz, R. R., R. S. Santos, G. P. Carreira, J. M. Gonçalves, G. Menezes, H. R. Martins & M. R. Pinho. 2000. Scientific Report on the Activities of Project RIVA – Support to the Management of Small Invertebrates of the Azores – Year 1999 (in Portuguese). *Arquivos do DOP*, Série: Relatórios Internos n.º 2/2000, 31 p.
- Ferraz, R. R. & R. S. Santos (2000). Analysis of catches of limpets in the Azores between 2000 and 2003 and advice to licensing in 2004 (in Portuguese). *Arquivos do DOP*, Série: Estudos n.º 1/2000, 17 p.
- Ferraz, R. R., G. Menezes, J. Gonçalves & R. S. Santos (2004). Analysis of catches of limpets in the Azores between 2000 and 2003 and advice to licensing in 2004 (in Portuguese). *Arquivos Internos do DOP - Série Relatórios Internos nº2/2004*: 26pp.
- Hawkins, S.J., Corte-Real, H.B., Corte-Real, S.M., Pannacciulli, F.G., Weber, L.C. & Bishop, J.D.D. (2000). Thoughts on the ecology and evolution of the intertidal biota of the Azores and other Atlantic islands. *Hydrobiologia* 440: 3-17.
- Martins, H.R., Santos, R.S. & Hawkins, S.J. (1987). Exploitation of limpets (*Patella* spp). In the Azores with a preliminary analysis of the stocks. ICES. C.KM.1987/K:53.
- Raffaelli, D. & Hawkins, S.J. (1996). Intertidal Ecology. Kluwer Academic Publishers. Dordrecht, The Netherlands. 356pp.

Santos, V. & R. S. Santos (2004). Analysis of catches of limpets in the Azores in 2004 and advice to licensing in 2005 (in Portuguese). Arquivos Internos do DOP - Série Relatórios Internos nº2/2005: 25pp.

Santos, R. S., S. J. Hawkins, L. R. Monteiro, M. Alves & E. J. Isidro (1995). Marine research, resources and conservation in the Azores. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 5 (4): 311-354.

Santos, R.S., Martins, H.R. & Hawkins, S.J. (1990) Relatório de estudos sobre o estado das populações de lapas do Arquipélago dos Açores e da Ilha da Madeira. Relatório da X Semana das Pescas dos Açores. Universidade dos Açores, Horta, Açores. 137-161.

Titselaar, F.F.L.M. (1998). A revision of the recent European Patellidae (Mollusca: Gastropoda). Part I. The Patellidae of the Azores, Madeira, the Selvagens and the Canary Islands. *Vita Marina* 45 (3/4): 21-62.



New Court
48 Carey Street
London WC2A 2JQ
United Kingdom

t: +44 (0)20 7430 5200
f: +44 (0)20 7430 5225
e: secretariat@ospar.org
www.ospar.org

**OSPAR's vision is of a clean, healthy and biologically diverse
North-East Atlantic used sustainably**

ISBN 978-1-907390-29-6
Publication Number: 488/2010

© OSPAR Commission, 2010. Permission may be granted by the publishers for the report to be wholly or partly reproduced in publications provided that the source of the extract is clearly indicated.

© Commission OSPAR, 2010. La reproduction de tout ou partie de ce rapport dans une publication peut être autorisée par l'Editeur, sous réserve que l'origine de l'extrait soit clairement mentionnée.