A strategy for Scottish invertebrate conservation

Ensuring important habitats, sites and endangered species are conserved

PREPARED BY THE INITIATIVE FOR SCOTTISH INVERTEBRATES

ISI
Initiative for
Scottish Invertebrates

A strategy for Scottish invertebrate conservation

PREPARED BY THE INITIATIVE FOR SCOTTISH INVERTEBRATES

Edited by Craig Macadam and Graham Rotheray.
With assistance from Geoff Hancock, Iain MacGowan and Alastair Sommerville.

On 20th February 1991, the Edinburgh Entomological Club established the Initiative for Scottish Insects (ISI) to further knowledge and conservation of the Scottish insect fauna. The ISI has since expanded to include all invertebrates. Today, the ISI acts as a forum on Scottish invertebrates and, through the expertise available to the ISI, is an authoritative voice on their status and ecology.

This strategy to conserve Scottish invertebrates is the work of the ISI in consultation with relevant statutory bodies, non-governmental organisations (NGOs) and individual specialists. It represents the views of over 100 experts across a wide range of invertebrate groups and related interests. The work to produce this strategy was grant aided by Scottish Natural Heritage (SNH) and co-ordinated by Buglife – The Invertebrate Conservation Trust.

This document was published by Buglife – The Invertebrate Conservation Trust with financial assistance from Butterfly Conservation (Scotland), Bumblebee Conservation Trust, Forestry Commission Scotland, RSPB Scotland, Scottish Wildlife Trust, SEPA and The John Muir Trust.

Acknowledgements
Many people have been involved in the development of this strategy. The ISI would particularly like to thank the following for their help and support: Dave Goulson, Geoff Hancock, Paul Kirkland, Craig Macadam, Iain MacGowan, Margaret Palmer, Jamie Roberts, Graham Rotheray, Ro Scott, Matt Shardlow, Mark Shaw, Alastair Sommerville, Ian Strachan, Alan Stubbs, Chris Sydes, Athayde Tonhasca, Mark Young.

Citation: Macadam, C.R. and Rotheray, G.E. (eds.) 2009.
A strategy for Scottish invertebrate conservation.
Prepared by the Initiative for Scottish Invertebrates.
Published by Buglife – The Invertebrate Conservation Trust, Stirling.
ISBN: 978-1-904878-94-0 © January 2009

Design: Redpoll Design
♻ Printed on recycled paper

Contents

For more information contact:

Initiative for Scottish Invertebrates
c/o Buglife Scotland
Balallan House, 24 Allan Park
Stirling FK8 2QG.

Tel: 01786 446504

Email: craig.macadam@buglife.org.uk

Summary

1. In consultation with a wide range of organisations and individuals, this strategy to conserve Scottish invertebrates has been prepared by the Initiative for Scottish Invertebrates (ISI).

2. Scottish invertebrates, i.e. animals without backbones - from ants to worms, butterflies to whelks, centipedes to sea urchins - are vital to the environment and to the economy. Their roles in ecological services like pollination, waste disposal and recycling are irreplaceable. They are a source of direct and indirect food for a wide range of wildlife and also people.

3. Over 1,400 Scottish invertebrate species are significant to UK biodiversity because they are confined to Scotland. Many others have populations centred in Scotland. Scotland has the best representation of upland species in the UK and is a refuge for species becoming rare or extinct elsewhere in the UK and Europe.

4. Across Europe, including the UK, invertebrate biodiversity is declining and only a few species are being actively conserved. Expert opinion is that an increasing number of Scottish invertebrates are, or soon could be, critically endangered.

5. Major threats to Scottish invertebrates include habitat loss and fragmentation, climate change, development pressures, competition from non-native species and pollution. Lack of understanding is also an important issue.

6. This strategy will identify which are the most endangered species and which are the most important habitats and sites. Conservation action can, in many cases, manage these threats and reverse declines. Implementation of this strategy will deliver conservation plans for endangered species and management plans for important habitats and sites.

7. By bringing together statutory agencies, non-governmental organisations (NGOs), local communities and individuals across Scotland, this strategy will aim to build capacity and create an impetus for effective invertebrate conservation action. The end result will be that invertebrates are valued and conserved for their key roles and that a wide range of people and organisations will be working in partnership to better use, understand and appreciate the natural world.

8. Progress with the strategy will be reported annually by the means of a website which will also provide news on new projects and report results of key actions as they are progressed.

© Jon Mold

Our Vision

Our vision is for a Scotland in which invertebrates are valued and conserved for their key roles in a healthy environment and for their potential to bring people together to better use, understand and appreciate the natural world.

We will achieve this through:

- mobilising expertise and data to ensure important habitats, sites and endangered species are recognised and conserved;
- highlighting through publicity and education the importance of Scottish invertebrates and the conservation issues they face.

Scope

Invertebrates are extremely diverse and include creatures like sponges, worms, shellfish, slugs, snails, crabs, lobsters, millipedes, mites, spiders and insects. This conservation strategy covers these and other invertebrates living on the Scottish mainland and off-shore islands, including their freshwaters, and in the seas around Scottish coasts.

- This is only the beginning of the process of conserving Scottish invertebrates. This strategy will develop methods, build capacity, harness experience and create an impetus for effective conservation action for Scottish invertebrates.
- The strategy works within existing legislative frameworks and conservation initiatives; in particular, the EU Habitats Directive, the European Invertebrate Strategy, the UK Biodiversity Action Plan, the Scottish Biodiversity Strategy and the SNH Species Action Framework.
- The strategy complements and adds value to invertebrate conservation work undertaken by statutory bodies and NGOs.
- Key actions will be implemented through partnerships established between the ISI and statutory agencies, NGOs, landowners and managers, and interested specialists.

Why Scottish invertebrates need conservation

© Greg Hitchcock - www.grhphotography.co.uk

Biodiversity importance

At least 24,000 invertebrate species exist in Scotland. This is more than 12 times the number of all UK bird, mammal and vascular plant species put together. Five terrestrial invertebrate species and many more marine invertebrates are unique to Scotland in the entire world. More than 1,400 are special in being confined to Scotland in the UK. Many others have their UK populations centred in Scotland. More montane and boreal (north European) species exist in Scotland than elsewhere in the UK. Scotland is also the last stronghold for increasing numbers of invertebrate species that have become rare or extinct elsewhere[1,2]. Despite their significance, the conservation needs of most of these species are poorly understood.

Over and above these species, unique variants and local adaptations characterise many populations of Scottish invertebrates. They represent an important fund of biological diversity. This diversity arose in response to the particular conditions in Scotland and is hugely significant to UK and European biodiversity as a source of future adaptability[2].

Ecosystem services

Invertebrates are essential to the maintenance of healthy ecosystem functioning. They provide vital services including waste recycling and pollination, and form the basis of most food chains. They are the "oil in the ecological engine". Without invertebrates, vertebrate and plant life could not continue (Appendix 1).

Economic impact

Invertebrates underpin many important resources. Major parts of Scotland's rural and maritime economy depend directly or indirectly on invertebrates (Appendix 2).

Lack of action

Only a handful of invertebrate species are currently benefiting from active conservation management. Many habitats and sites in Scotland are protected as Sites of Special Scientific Interest or as Special Areas of Conservation however the invertebrate interest on these sites is often overlooked. Protection of individual species is possible through the legislation such as the Wildlife and Countryside Act 1981, however only 19 Scottish invertebrate species have such protection under European and UK law (Appendices 5 and 6). Legal protection is appropriate in some circumstances, however a far better solution for invertebrate conservation is the appropriate management of habitats and sites to benefit a wide range of invertebrates.

Increasing threats

In common with invertebrates across Europe, many Scottish species are declining. Major threats to Scottish invertebrates include habitat loss and fragmentation, climate change, development pressures, widespread use of agrichemicals in modern farming and competition from non-native species. Neglect and lack of understanding are also important issues (Appendix 3). Conservation action can, in many cases, manage these threats and reverse declines.

1 Rotheray, G.E. 1996. Why conserve Scottish insects? In Rotheray, G.E. and MacGowan, I. (Eds.) Conserving Scottish Insects, Edinburgh.
2 Young, M.R. and Rotheray, G.E. 1997. Insect Biodiversity in Scotland. In Fleming, L.V., Newton, A.C., Vickery, J.A. and Usher, M.B. (Eds.) Biodiversity in Scotland: Status, Trends and Initiatives. The Stationery Office, Edinburgh.

Strategic objectives for conserving Scottish invertebrates

The following strategic objectives are divided into three sections covering **habitats, species** and the **mobilisation of data and support**. Successful implementation of the strategy will require a partnership approach with the involvement of all stakeholders. An implementation plan will be developed, which will initially cover the period 2009 to 2013. This plan will list the actions and projects required to achieve the objectives and will ensure that progress is made on all objectives. It will be a dynamic web-based document and will be subject to regular review by the Initiative for Scottish Invertebrates and updated as key actions are progressed.

The mechanism for monitoring and review of the strategy is as follows:

a) **regular reports at Strategy Implementation Group meetings**

b) **reports collated into annual web report**

c) **annual reports collated into two-yearly review with recommendations.**

Habitats

Habitats such as woodland, scrubland, grassland, moorland, mountains, freshwater bodies, rivers, estuaries, tubeworm reefs, gaping file shell beds and less obvious wildlife habitats like agricultural set-aside, road verges, post-industrial land, parks and gardens are all important for Scottish invertebrates. To ensure that environmental and economic benefits due to invertebrates continue, beneficial management for invertebrates needs to be practised. At present few habitats are suitably managed. This is because invertebrates are either poorly appreciated or taken for granted. Alternatively landowners and managers may be willing to act, but lack the knowledge of what to do.

Furthermore, certain habitats and sites are more important than others for invertebrates. Some of these are boreal pine, birch, aspen and Atlantic oak woodlands, unimproved grassland, the extensive bog systems of the Caithness and Sutherland flows, many riverine habitats, coastal reefs, certain mountains like the Cairngorms Plateau, glens like Affric and Cannich and localities like Rannoch, the Solway coast and Strathspey. In the deep waters to the east of Mingulay in the Western Isles, there are cold water reefs with exceptionally rich associated marine invertebrate communities. Many more exist but are poorly recognised. This is because their invertebrates are neglected in assessments, accorded a low priority or they have not been adequately surveyed.

CASE STUDY

Habitat action

The Marsh fritillary butterfly (*Euphydryas aurinia*) is declining over most of Europe and is now extinct in the Netherlands and Belgium. The UK is one of the major European strongholds for the species, but even here its range has contracted by over 60%. Argyll now probably represents the most important area in the UK for this species.

Some sites in Scotland have been lost through agricultural intensification (e.g. drainage, heavy grazing) or afforestation, while others have suffered from under-grazing and even abandonment. The isolation of many of the remaining colonies is a long-term threat to their viability.

Beneficial habitat management, usually in the form of low-intensity cattle grazing, is in place in many areas, but this will depend in the long term on the economics and availability of agri-environment schemes. There are now five Special Areas of Conservation (SAC) which have the Marsh Fritillary as a qualifying feature. Work is continuing to develop and implement suitable management regimes for these sites.

Habitats and sites important for invertebrates need better definition and recognition. Their management plans need to incorporate requirements for key invertebrates; and those declining habitats should be identified and action taken to halt their loss. The following objectives are designed to address these issues.

OBJECTIVE 1

Produce and maintain a list of Scottish invertebrate habitats and sites.

Based on a collation and analysis of species records, Scottish habitats and sites will be assessed in terms of their importance for invertebrates. Significant invertebrate features will be highlighted and threats to these habitats listed. Indicator groups and species, and gaps in our knowledge, will be identified.

OBJECTIVE 2

Devise and carry out a programme of assessment of prioritised invertebrate habitats and sites.

To deal with gaps in knowledge, such as inadequate survey and poor recognition and definition of important invertebrate habitats and sites, a programme of targeted assessments will be undertaken to provide the missing data.

OBJECTIVE 3

Devise and implement plans to conserve and maintain habitats and sites for Scottish invertebrates.

Specific plans targeting the conservation of high priority habitats and sites and also particular features of importance will be prepared. In partnership with site owners and managers, these plans will be implemented and monitored. Habitat connectivity and the ability of invertebrates to move in response to changes in their environment will be key considerations.

OBJECTIVE 4

Prepare and disseminate general advice on managing habitats and sites for invertebrates.

Information about the management of invertebrate habitats will be collated. General advice on conserving invertebrates in Scottish habitats and sites will be prepared and disseminated. Demonstration sites will be established and workshops will be held to promote this advice.

Species

Habitat and site conservation is sometimes not enough. This is usually because some invertebrates have requirements that are so specific they need targeted action. In other cases species are so critically endangered that tailored actions are the only answer. Species protected by law also need individual conservation action and management. With the right measures many species can recover. Recent examples of recovery following protection and establishment of new breeding sites are the New Forest burnet moth (*Zygaena viciae argyllensis*) and the Aspen hoverfly (*Hammerschmidtia ferruginea*).

An important part of this strategy is recognising and actively conserving endangered Scottish invertebrates. To determine the conservation status of invertebrates data are needed on status, distribution and ecological requirements.

With thousands of species, difficult choices have to be made and the starting point for this strategy is:

1. **Species within existing initiatives - for example, the UK Biodiversity Action Plan, Scottish Biodiversity List and those protected by law - not yet under active management (Appendices 4-6).**
2. **Species known or strongly suspected to be endangered not covered under 1.**
3. **Species confined or mostly confined to Scotland.**
4. **Rare Scottish species i.e. species with a few populations or records in Scotland but more widespread elsewhere.**
5. **Reef building organisms and other keystone marine invertebrates.**

CASE STUDY

Science improving management

The Pine hoverfly (*Blera fallax*), is an endangered hoverfly and confined to just two localities in Inverness-shire. It breeds in holes and roots of live and dead pine containing wet, decaying wood. Probably as a result of the way pine woods have been managed in the past, natural breeding sites are now very rare. The Pine hoverfly was included in SNH's Species Action Framework and the Malloch Society is managing a project to implement conservation measures to protect, maintain and expand existing populations.

To overcome the lack of breeding sites, artificial ones have been created by cutting holes in pine stumps and by sinking plastic pots filled with pine wood chips and saw dust into the ground. These have been successful in attracting the Pine hoverfly to breed. Work is now underway to find out how to make the artificial breeding sites work in the best way. Data on water levels and microbe populations in the breeding sites are being studied to work out the conditions required for optimising breeding success. It is hoped that the outcome of this work, together with the management of pine woods in a fashion that is sensitive to the requirements of the Pine hoverfly, will ensure the survival of this original pioneer of the Scottish landscape.

© Bastiaan Wakkie

OBJECTIVE 5

Produce and maintain a list of important Scottish invertebrates.

Based on the categories above, data on Scottish invertebrate species will be collected, collated, and assessed in terms of status. Ecological requirements, threats and gaps in knowledge will be identified.

OBJECTIVE 6

Devise and carry out a programme of prioritised invertebrate species assessment.

An outline statement will be prepared for each invertebrate group, detailing the current state of knowledge and availability of data concerning species status and requirements. A programme of prioritised assessments will be developed to deal with gaps in knowledge, including data deficient species, and to address a lack of information on species status and requirements.

OBJECTIVE 7

Devise and implement plans to conserve and maintain important Scottish invertebrates.

Information about the requirements and needs of prioritised invertebrate species will be collated and made available to those who need it. In partnership with site owners and managers, targeted plans will be devised, implemented and monitored to conserve and maintain these invertebrate species.

OBJECTIVE 8

Promote the study and recording of poorly recorded invertebrate groups.

Poorly recorded groups of invertebrates will be identified. Champions for these groups will be sought and materials such as identification keys and advice will be prepared to aid their study.

CASE STUDY

Promoting poorly recorded groups

Riverflies, defined here as mayflies (Ephemeroptera), caddisflies (Trichoptera) and stoneflies (Plecoptera), include 278 species in the UK. Following widespread concern about a perceived decline in riverfly populations, and the lack of data on these groups, The Riverfly Partnership was established in 2004 to increase our knowledge of riverfly populations and to actively conserve their habitats. The Partnership brings together anglers, conservationists, entomologists, scientists, watercourse managers and relevant authorities from across the UK.

Despite the importance of riverflies for monitoring river water quality, there are few individuals studying these insects. Much of the previous research into the decline of riverfly populations was instigated by individuals and by voluntary bodies. One of the key aims of the Riverfly Partnership is to enable anglers to identify and record riverfly species.

© Stuart Crofts

To enable more people to study riverflies a series of easy to use, inexpensive identification guides for caddisflies, mayflies and stoneflies has been published by the Partnership in collaboration with the Field Studies Council.

Mobilising support for the Strategy

Existing data about Scottish invertebrates is scattered, of variable quality and needs to be collated and mobilised. Levels of awareness, participation and dissemination of knowledge are poor. Advice on maintaining habitats, sites and features important for invertebrates and conservation plans for threatened species need to be promoted to land owners and managers and potential funders for implementation.

The objectives detailed below will help to address these issues and push the management and conservation of invertebrates higher up the environmental agenda.

OBJECTIVE 9

Devise and implement Scottish invertebrate data management protocols.

Data management protocols and procedures will be agreed and implemented in liaison with other relevant organisations like the National Biodiversity Network (NBN), national recording schemes and societies, Local Record Centres, museums, statutory agencies and NGOs.

OBJECTIVE 10

Provide the training and promotion necessary to implement this strategy.

Training and promotion will be provided to meet the needs of implementing the strategy. Partnership agreements and regular communications will be established between the ISI and all concerned with implementing the strategy. The effectiveness of training, communication and publicity will be monitored.

OBJECTIVE 11

Ensure the strategy is fully implemented into biodiversity, environmental and land use plans at national, regional and local levels.

Invertebrate requirements and outputs from this strategy will be communicated to the appropriate bodies, organisations and individuals and incorporated as appropriate into future plans, schemes and legislation, such as agri-environment schemes and development plans.

© John McFarlane/BTCV

CASE STUDY

Building taxonomic capacity

The BTCV Natural Talent programme aims to train the next generation of naturalists through an innovative apprenticeship scheme. Supported by the Heritage Lottery Fund, Natural Talent offers paid apprenticeships in vital taxonomic and specialist conservation skills that are rapidly being lost from the environmental sector.

Working primarily with environmental organisations throughout Scotland and Northern Ireland, including the Hunterian Museum, Ulster Museums and World Museum Liverpool, apprentices gain "on the job" experience and develop skills needed to begin to specialise in their chosen field. BTCV Scotland is currently coordinating apprenticeships in Coleoptera and Hymenoptera, with apprentices in hoverflies and micro-moths planned in the future. As the experts of the future, Natural Talent apprentices will be involved in implementing this strategy at all levels -from policy to on the ground conservation and education.

Appendix 1

Why invertebrates are important for the environment

An important service provided by invertebrates is waste recycling - making minerals and organic material available again to plants and other animals. In the soil, earthworms and other invertebrates play crucial roles in the decomposition of organic matter. Their activities improve the drainage, aeration and composition of the soil, thus enabling plant growth. The decomposition of dead plants and animals including dung and fallen wood relies upon invertebrates.

Most marine habitats are dominated by invertebrates. In some cases, such as Flameshell (*Limaria hians*) reefs and Northern sea fan (*Swiftia pallida*) and sponge communities, the entire habitat is based on invertebrates. Birds and fish rely on these invertebrates for food, and the abundance and diversity of marine plankton is a useful indicator of healthy marine ecosystems.

Many plants rely on insects to pollinate their flowers and so complete their reproductive cycle. Well-known pollinators include bumblebees, honeybees, butterflies and hoverflies; less well-known ones include moths, thrips, beetles and solitary bees.

Invertebrates form the basis of numerous food chains. Many birds feed on invertebrates, whether as food for their chicks or as part of their adult diet. Migrant birds such as swallows, swifts and martins travel long distances to feed on insects in the British Isles. The chicks of Blue tits eat an estimated 35 billion caterpillars and other small invertebrates every year. A number of uplands birds, such as Golden plovers and Greenshanks, time their breeding to coincide with the emergence of craneflies, which form the majority of the diet of their chicks. Baleen whales such as the Minke whale and many seabirds feed extensively on Krill (*Euphausia superba*) and other marine crustaceans.

The diet of Puffins primarily consists of Sand eels, which in turn feed upon planktonic species of crustacean and other invertebrates. Mammals such as bats, badgers, voles and shrews also feed on invertebrates. It is estimated that a single Pipistrelle bat will consume over 3,000 small insects every night[3]. In freshwater ecosystems the diet of game fish such as the Atlantic salmon and Brown/Sea trout is comprised entirely of aquatic invertebrates. Birds such as the Dipper and Grey wagtail also depend upon aquatic invertebrates in our rivers and streams.

There is a long history of invertebrates being used as indicators of the health of our environment. In determining the quality of our rivers and lochs, the Scottish Environment Protection Agency routinely use assessments of the number and variety of aquatic invertebrates alongside chemical analyses. Invertebrates are also used to test the toxicity of chemicals such as pesticides.

Since 1979 the UK butterfly monitoring scheme has been recording trends in butterfly species. The information gathered plays an important role in assessing habitat diversity, habitat fragmentation and the impacts of climate and other environmental change. Through the Rothamsted light-trap network, which started in 1965, we know that about two-thirds of moth species are declining, and about 20% of all species are declining sharply.

The Scottish Agricutural Science Agency monitors aphid populations as part of the Rothamsted suction trap network which has been in operation since 1965. The information from this network is used to study the factors affecting the dynamics of aphid populations and to guide aphid control decisions.

In agricultural systems, simple measures such as conserving headlands and making 'beetle banks' encourage predatory invertebrates such as beetles and hoverflies, which not only help to control pests but also provide additional food for birds and mammals.

In addition, pests can be individually targeted with specific invertebrate enemies like native ladybirds and parasitoid wasps. Increasingly these are available commercially and they may offer an environmentally friendly alternative to chemical control.

[3] Anon. (2005). Pipistrelles. Species information leaflet. Bat Conservation Trust, London

Appendix 2

Why invertebrates are important for the economy

© David Pryce

The Scottish fishing industry relies on invertebrates like shrimps, prawns, crabs, lobsters and other shellfish such as mussels and oysters which make an important contribution to the economy of coastal communities. Catches of Langoustine (Norway Lobster or Scampi) contribute £89.3 million to the Scottish economy each year – more than the combined catches of Cod, Haddock and Monkfish[4]. In the pelagic fisheries our important stocks of cod, herring and haddock depend on invertebrates such as krill and copepods for their food.

Freshwater fisheries for game fish contribute over £112 million annually to the Scottish economy[5]. Aquatic invertebrates like stoneflies and mayflies are an essential source of food for such fish.

Invertebrates provide a number of important 'ecological services'. These services are often overlooked until they are damaged or lost. They are usually impossible to replace. One example is crop pollination. Insects are responsible for the pollination of a variety of crops in Scotland. The most significant is the soft fruit industry, with the raspberry crop in Scotland worth £52 million annually. The blackcurrant crop is valued at £8 million; however, the associated processing industry is worth an additional £200 million[6].

Invertebrates play an important role in sewage treatment. One of the simplest but most effective treatments for sewage involves passing the effluent over a bed of stones on which a biofilm of bacteria, fungi and algae grow and process the waste. The biofilm attracts, and is ingested by, invertebrates including non-biting midges, moth-flies and worms. Altogether these organisms turn the sewage into clean water and an organic sludge that can be used as fertiliser or fuel.

© Nigel Jones

Earthworms and other soil invertebrates like springtails benefit agriculture by maintaining and improving the structure and aeration of soil by their constant feeding and burrowing. They breakdown organic matter such as dead leaves and return essential minerals and organic matter to the soil so enabling renewed crop growth.

© Stewart Taylor

Tourism - especially 'eco-tourism' - constitutes an important and increasing element of economic activity in Scotland. Much of this is about history and landscape but it is also about wildlife. Indirectly, invertebrates are important in underpinning the survival of popular plants and animals such as Ospreys and Otters. But there is also an increasing interest in Scotland's special invertebrate fauna. Certain iconic species such as the Kentish glory moth (*Endromis versicolora*), Chequered skipper (*Carterocephalus palaemon*) and Mountain ringlet (*Erebia epiphron*) butterfly as well as the many striking dragonflies, beetles and flies of our boreal woodlands increasingly attract visitors not just from within Scotland but also from other parts of the UK and Europe.

Some invertebrates have a negative economic impact. For example certain aphids cause damage to crops, the Heather beetle (*Lochmaea suturalis*) can affect areas of moorland and the Pine looper moth (*Bupalus piniarius*) can have an impact on Scots pine forests. In general however these outbreaks are short lived and populations return to a normal level within a season or two. A more difficult issue is the biting midges (*Culicoides* species) which, at high densities, can contribute to the loss of work-days and potentially a loss of tourism revenue[7].

---

[4] Anon. (2007). Marine and Fisheries Business Plan 2007/08. Department of Environment, Food and Rural Affairs.

[5] Radford, A., G. Riddington, J. Anderson, H. Gibson (2004). The Economic Impact of Game and Coarse Angling in Scotland. Research report prepared for Scottish Executive Environment and Rural Affairs Department.

[6] SCRI's role in supporting the soft fruit industry. http://www.fruitgateway.co.uk/our_role.asp

[7] Blackwell, A., Ritchie, A., Hillman, J.R. and Fenton, B. (2002). Meanbh-chuileag – The Highland biting midge. Scottish Crop Research Institute.

Appendix 3

Current threats and risks to Scottish invertebrates

In Scotland, as well as in other parts of Europe, there is a general consensus that invertebrate abundance, both in terms of overall population levels and numbers of individual species, is declining. With large numbers of species and an almost negligible amount of systematic monitoring taking place it is difficult to be definitive even within a comparatively well recorded area such as the British Isles.

There is however information about some of the larger, more charismatic groups which can be used to indicate what may be happening to the fauna as a whole. Three of the 25 British species of bumblebees are now extinct in the British Isles[8], over 70% of butterfly species are in significant decline and 66% of riverflies (caddisflies, mayflies and stoneflies) have declined in recent years[9]. The abundance of zooplankton in the seas around the United Kingdom has declined by around 70% since 1960[10].

Loss and fragmentation of semi-natural habitats

The loss and fragmentation of semi-natural habitats is a major threat to invertebrate populations. This process has been taking place for many generations, but it is now taking a higher profile as development pressure increases and the effects of climatic change make the continuity of habitats to facilitate species movement a vital issue. This is evidenced by recent data from the UK Butterfly Monitoring Scheme. In Scotland, butterfly species that are largely restricted to blocks of semi-natural habitat ('specialists') are decreasing in abundance, whereas populations of those species that can live in a broader range of habitats ('generalists') are increasing[11].

Natural habitats are under threat from a wide range of activities. There is a need to take an overview of the remaining natural habitats, and by planning and proactive action ensure that habitat networks are maintained or created. The use of invertebrates to identify critical aspects such as patch size and dispersive corridors can be in the forefront of achieving greater connectivity within our natural habitats.

There is increasing pressure on habitats arising from the need for more housing, industrial and recreational

CASE STUDY

Habitat loss

The Mud snail (*Omphiscola glabra*) is typically found in soft, nutrient poor waters with few other aquatic animals or plants. These include freshwater marshes, small ditches, temporary pools or seepages that dry up or significantly diminish in summer. These water-bodies are challenging habitats, which in the past were regarded as inferior wildlife habitats and were typically converted into productive agricultural land or improved visually for landscape reasons. Historically, this species was widespread throughout acidic lowland areas of England, Wales and Scotland, as far north as Perth. A recent survey has shown that this species has been lost from 64% of historical sites in Scotland.

© Paul Baker

developments. In many cases the impact of these developments on invertebrate species and populations is unknown. Similarly, there is little information on whether the mitigation measures proposed for invertebrates in development plans actually work.

Overgrazing by Red deer and by sheep continues to be an issue, both in the way in which it curtails natural regeneration of woodland and scrub habitats but also in the way that it decreases the structure and botanical diversity of our upland areas. In lowland areas intensive farming coupled with increased house building and development pressure continues to be an issue and has led to a decrease in the availability of suitable habitat for invertebrates.

In the marine environment many fragile ecosystems such as Flameshell reefs and Northern sea fan and sponge communities are prone to disturbance. Trawling for langoustine and dredging for scallops can damage and even completely destroy these fragile communities and the invertebrates they contain.

Increased concentrations of nutrients in the environment can have an adverse effect on habitats and their associated invertebrates. Although diffuse pollution in the aquatic environment is now being tackled through the use of General Binding Rules for water managers, eutrophication continues to be a serious problem in terrestrial ecosystems. An increase in nutrients in the soil as a result of nitrogen deposition or excessive use of fertilisers leads to changes in the composition of the vegetation. Habitats such as bogs, forests and unimproved grassland, and the invertebrates they support, are all under threat from eutrophication.

Climatic change

Climate change is widely recognised as being one of the major long term threats to biodiversity. Most recent predictions are that Scotland will become warmer and wetter as a result of climate change and this will inevitably

[8] Benton, T. (2006). Bumblebees. New Naturalist No. 98.
[9] Hayes, P. (2004). National River Fly Survey: headline results from the 1950s to 2001. Salmon and Trout Association, London.
[10] Anon. (2008). Marine Programme Plan 2008/09. Department for Environment, Food and Rural Affairs, London. (http://www.defra.gov.uk/marine/pdf/mpp08-09.pdf)
[11] Anon. (2007). Scotland's Biodiversity Indicators: S8 Terrestrial Insect Abundance: Butterflies. The Scottish Government, Edinburgh.
[12] Marine Conservation Society. http://www.mcsuk.org/mcsaction/fisheries/scallops

CASE STUDY

Habitat protection

The Isle of Man fishery for Scallops began in 1937 with early catches consisting of large numbers of large old scallops. The fishery peaked in the mid 1980s with over 80 vessels landing over 2,000 tonnes of scallops. By the end of the 1980s the fishery had collapsed with catches at an all time low and the majority of scallops being below the legal catch size.

Areas of the seabed were closed to scallop dredging in 1989 and with protection the number of scallops steadily increased. There are now over 10 times as many scallops in the protected areas compared to the nearby fishing grounds and catch rates in the fishing grounds have increased by 100%. The marine communities in the protected areas have flourished with the re-appearance of marine invertebrates such as hydroids, sponges and fan-worms[12].

have an impact on invertebrate populations. Indeed with the majority of species having relatively short life cycles and good powers of mobility they are likely to be one of the first groups to show the impact of a changing climate. Cold-loving species will retreat northwards and uphill, while warm-loving species will increase their range and species normally found further south in the UK and even in Europe may become established in Scotland.

Temperature plays a vital role in the breeding success of cold-blooded organisms and therefore the population size and viability of many invertebrate species. It is probable that small changes in temperature will be enough to jeopardise the survival of some invertebrate populations. This effect will most likely be seen in cold-adapted montane species whose very survival may be at stake; however, it is also evident in other habitats. In the marine environment, the planktonic copepod *Calanus finmarchius* (a cooler water species) has undergone a decline in abundance while a warmer water species, *Calanus helgolandicus*, has increased in abundance. The change in the species composition of the marine plankton community is evidence of a biological response to climate change[13].

Wetter conditions and an increase in the frequency of summer floods are also likely to have a significant effect on invertebrate populations. Ground-dwelling invertebrates may be drowned or washed away, and for those that survive, the catastrophic loss of their food resource may prove fatal.

Pollution

Whether on land, at sea, or in freshwaters, pollution continues to be a serious problem for invertebrates, typically leading to a decrease in the diversity and abundance of invertebrate species. Freshwater invertebrates are affected by various forms of pollution. Organic pollution can arise from point sources such as sewage treatment works and discharges from industry or as diffuse pollution such as run-off from roads and buildings or fields. Acidification continues to be a problem in some areas of Scotland and various toxic chemicals can find their way into the aquatic environment.

The use of chemicals such as pesticides can have devastating effects on invertebrate populations. Sheep dip compounds based on the synthetic pyrethroid Cypermethrin pose a threat to both terrestrial and freshwater invertebrates. Even a small amount of this chemical dripping from a freshly dipped sheep can kill aquatic invertebrates for many kilometres downstream. Disposal of used sheep dip is typically by spraying it onto

CASE STUDY

Non-native species

The Australian barnacle (*Elminius modesta*) occurs naturally in Australasia. It was introduced from Australia or New Zealand either on the hull of a ship or as larvae in ballast water. It was first recorded in the British Isles in 1945 and has since spread around our coasts and was found as far north as Shetland in 1983. The Australian barnacle competes with native species such as the Acorn barnacle (*Semibalanus balanoides*). In addition, the Australian barnacle can also tolerate lower salinity habitats. The Bay barnacle (*Balanus improvisus*) which lives in saline lagoons and other habitats with variable salinity appears to be retreating where it is in competition with the Australian barnacle[15].

fields, potentially resulting in losses of invertebrates living on, or under, the ground. The sale of Cypermethrin as a sheep dip is currently banned, however its use is still allowed and it can still be purchased for many other uses including for the treatment of sea lice infestations in marine fish farms, protection of crops, and for the control of fleas and other invertebrates in the home. Avermectins, which are used against intestinal worms and mites in livestock, can have adverse effects on dung fauna and soil-dwelling invertebrates.

In the marine environment, the effects of pollution are less obvious, however they are still as damaging. Anti-fouling paints were developed in the 1960s to prevent the build up of barnacles and other organisms on the hulls of ships. Whilst these paints were designed to target particular species, they have since been found to cause sex-reversal in non-target molluscs, leading to near extinction of some species in some areas. The use of these paints will be completely phased out by the end of 2008, however their legacy will continue as the constituent chemicals persist in the sediment.

Non-native species

Many non-native species are now found in Scotland. An audit by Scottish Natural Heritage in 2001 found 988 non-native species of animal and plant occurring in Scotland[14]. These species have arrived through a variety of routes. Some have arrived accidentally, for example in ballast water from ships, or alongside imported products such as timber and fresh produce. Others have escaped from gardens or were introduced as a food source.

Most non-native species pose no risk to our native wildlife, and some are even beneficial; however, some species, if conditions are conducive, can become invasive. Predation, competition and the spread of disease from non-native species are all potentially very harmful to our native wildlife. The introduction of invasive non-native species to semi-natural habitats can transform these habitats and threaten the species that naturally live there.

Invasive non-native species can have serious negative impacts on native species by predation, competition and/or spread of disease. They transform habitats and can threaten whole ecosystems, causing serious problems to the environment and to the economy. In many cases this may be exacerbated by the effects of climate change.

© Dragisa Savic

Neglect and ignorance

Widespread views of invertebrates tend to emphasise their negative aspects reinforcing the notion that 'the only good invertebrate is a dead one' and that they do not matter. Except for certain shellfish and pests, their environmental and economic importance is little discussed or understood outside narrow, special interest groups.

This is most evident in the marine environment where invertebrates are often overlooked in favour of seabirds, fish and cetaceans, despite many of these more popular species depending upon invertebrates for their survival. On both land and sea, the idea that invertebrates need conservation as much as plants or vertebrates is not widely accepted. They are neglected in assessments and accorded a low priority amongst land owners, managers and decision makers.

The majority of Scotland's wildlife heritage comprises invertebrates and if the threats to biodiversity are to be properly addressed, then focussed attention on conserving invertebrates will be essential.

[13] Anon. (2007). Scotland's Biodiversity Indicators: S14 Marine Plankton. The Scottish Government, Edinburgh.
[14] Welch, D., Carss, D.N., Gornall, J., Manchester, S.J., Marquiss, M., Preston, C.D., Telfer, M.G., Arnold, H., and Holbrook, J. (2001). An audit of alien species in Scotland. SNH Review No. 139. Scottish Natural Heritage, Edinburgh.
[15] Eno, N.C., Clark, R.A and Sanderson, W.G. (eds.). (1997). Non-native marine species in British waters: a review and directory. Joint Nature Conservation Committee, Peterborough.

Appendix 4

Scottish Biodiversity List species and UKBAP Priority Species that occur in Scotland

Order	Common Name	UKBAP[16]	SBL[17]
Annelida	Worms, leeches, etc.	-	1
Araneae	Spiders	10	8
Bryozoan	Moss animals	-	13
Cnidaria	Sea anemones, Jellyfish, Sea pens, etc.	8	15
Coleoptera	Beetles	10	82
Crustacea	Crustaceans	5	2
Dermaptera	Earwigs	-	1
Diptera	True-flies	12	62
Echinodermata	Sea stars	-	1
Ephemeroptera	Mayflies	1	-
Hemiptera	True-bugs	-	4
Hymenoptera	Bees, wasps and ants	11	63
Lepidoptera	Butterflies and moths	95	35
Mollusca	Snails and slugs	10	39
Nemertinea	Ribbon worms	-	11
Neuroptera	Lacewings	1	2
Odonata	Dragonflies and damselflies	-	1
Orthoptera	Grasshoppers, crickets, etc.	-	2
Plecoptera	Stoneflies	1	1
Porifera	Sponges	-	8
Siphonaptera	Fleas	-	1
Trichoptera	Caddisflies	1	-
Tunicata	Sea squirts	1	-
Total		**166**	**350**

[16] Number of UKBAP Priority Species that occur in Scotland. A full list of UKBAP Priority Species can be found at www.ukbap.org.uk

[17] Scottish Biodiversity List species. A full list of Scottish Biodiversity List species can be found at www.biodiversityscotland.gov.uk

Appendix 5

Internationally protected species that occur in Scotland

Scientific name	Common name	EC Annex[18]	Bern Appendix[19]	CITES Appendix[20]
Lepidoptera (butterflies)				
Euphydryas aurinia	Marsh fritillary butterfly	IIa	II	-
Crustacea (crayfish and shrimps)				
Austropotamobius pallipes	White-clawed crayfish	IIa, Va	III	-
Mollusca (bivalves, snails and slugs)				
Margaritifera margaritifera	Pearl mussel	IIa, Va	III	-
Vertigo angustior	Narrow-mouthed whorl snail	IIa	-	-
Vertigo genesii	Round-mouthed whorl snail	IIa	-	-
Vertigo geyeri	Geyer's whorl snail	IIa	-	-
Annelida (segmented worms)				
Hirudo medicinalis	Medicinal leech	Va	III	II

[18] Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (Habitats Directive)
- Annex IIa - designation of protected areas for animal species listed
- Annex Va - exploitation of listed animal species to be subject to management if necessary

[19] Council of Europe Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention)
- Appendix II - special protection for listed animal species and their habitats
- Appendix III - exploitation of listed animal species to be subject to regulation

[20] Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
- Appendix I - trade only in exceptional circumstances for species listed
- Appendix II - trade in listed species subject to licensing
- Appendix III - trade in listed species subject to limited licensing

CITES regulations apply also to other non-native species not listed here.

Appendix 6

Species known from Scotland that are protected by the Wildlife and Countryside Act 1981

Scientific name	Common name	Sections of Act in force	Year scheduled
Lepidoptera (butterflies)			
Aricia artaxerxes	Northern brown argus	Sale only S. 9(5)	1989
Boloria euphrosyne	Pearl-bordered fritillary	Sale only S. 9(5)	1989
Carterocephalus palaemon	Chequered skipper	Sale only S. 9(5)	1989
Coenonympha tullia	Large heath	Sale only S. 9(5)	1989
Cupido minimus	Small blue	Sale only S. 9(5)	1989
Erebia epiphron	Mountain ringlet	Sale only S. 9(5)	1989
Euphydryas aurinia	Marsh fritillary	Full protection	1998
Lepidoptera (moths)			
Zygaena viciae	New Forest burnet	Full protection	1981
Crustacea (crayfish and shrimps)			
Austropotamobius pallipes	White-clawed crayfish	Taking S. 9(1) (part). Sale S. 9(5)	1988
Triops cancriformis	Tadpole shrimp	Full protection	1988
Mollusca (bivalves, snails and slugs)			
Atrina fragilis	Fan mussel	Killing, injuring & taking S. 9(1) Possession S. 9(2) Sale S 9(5)	1998
Margaritifera margaritifera	Freshwater pearl mussel	Full protection	1998
Paludinella littorina	Lagoon snail	Full protection	1992
Tenellia adspersa	Lagoon sea slug	Full protection	1992
Thyasira gouldi	Northern hatchet-shell	Full protection	1992
Annelida (segmented worms)			
Hirudo medicinalis	Medicinal leech	Full protection	1988

The development and publication of this strategy has been supported by the following organisations:

Buglife – The Invertebrate Conservation Trust is convinced that the implementation of this strategy will secure the future of Scotland's invertebrate fauna and the associated benefits. We are delighted that the strategy has such universal support and look forward to working in partnership to provide a bright future for bugs.

The Bumblebee Conservation Trust are delighted to support this new initiative that seeks to unite invertebrate conservation efforts in Scotland, and hope that it will succeed in raising the profile of this often-overlooked group of organisms that comprise the majority of species on Earth.

This strategy is endorsed and commended by Butterfly Conservation. It emphasises the essential role of invertebrates within Scotland's ecosystems, and the need for nature conservation to give due regard to the myriad species that live around us. As such, it is a valuable step on the long road to safeguarding all of our biodiversity for future generations to enjoy, utilise and of which to be proud.

Forestry Commission Scotland are pleased to support the publication of an invertebrate conservation strategy for Scotland and look forward to playing a part in implementing it in Scottish woodlands.

The Initiative for Scottish Invertebrates is grateful to all the organisations and individuals who have supported and helped in the development of this strategy. It represents a crucial milestone for Scottish invertebrates, however the amount of work before us is daunting and we need the continuing support and active participation of many individuals and organisations to achieve results. With the launch of the strategy we have before us an historic opportunity to show what can be done not only for Scotland and the rest of the UK, but for Europe and the rest of the world too.

The John Muir Trust strongly supports this strategy. We strive to deliver for biodiversity, including invertebrates, on wild land.

RSPB Scotland supports this strategy and has been pleased to contribute to its development. We hope it will complement both the partnership effort to advocate beneficial policies and practice across Scotland, and our direct management work for invertebrate species on RSPB nature reserves.

The Scottish Wildlife Trust is pleased to support the development and implementation of this strategy which is an important milestone in the conservation of invertebrates in Scotland.

SNH has supported the development of this strategy by the Initiative for Scottish Invertebrates because we recognise the crucial importance of voluntary enthusiasts to the conservation of this huge and difficult group of organisms. As the strategy emphasises, most animals in Scotland are invertebrates and they underpin the functioning of every element of our landscape, and the sea. The implementation of this strategy will be a long and difficult road for invertebrate supporters but one that should bring a great sense of achievement and SNH will work with you on every inch of the journey.

SEPA is pleased to support the development and implementation of this strategy. Beyond their biodiversity value, invertebrates are key indicators of environmental health and play an important role in environmental monitoring. Increasing knowledge of Scottish invertebrates will enable SEPA to carry out its regulatory activities in a manner that will minimise its impact on priority species.