Status Survey and Conservation Action Plan

Dragonflies

Compiled by Norman W. Moore

IUCN/SSC Odonata Specialist Group

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Cover photo: *Anax imperator,* widely distributed in Europe, Asia, Africa and Madagascar. The small tears in the wings in this mature male are signs of territorial fighting. (K. Dolbear)

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Contents

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The Odonata Specialist Group was created in 1980 through the initiative of the late Sir Peter Scott. It meets once every two years on the occasion of the International Symposia of Odonatology. In addition, the members keep in touch by correspondence and through a small journal *Reports of the Odonata Specialist Group, Species Survival Commission, International Union for Conservation of Nature and Natural Resources (IUCN)* - edited by the Chairman and published under the aegis of the journal *Odonatologica.*

This Action Plan has been discussed through correspondence with members and at the meetings of the Group. Other odonatologists who are not members of the Group, but who regularly attend its meetings, have also been most helpful. Thus this action plan owes much to numerous people, but I would particularly like to thank past and present members of the Odonata Specialist Group - S. Asahina, H. Bick, H.J. Dumont, S.W. Dunkle, J.I. dos R. Furtado, M. Hämäläinen, B.Kiauta, A.B.M. Machado, M.N. Parr, D.R. Paulson, R. Rowe, M.J. Samways, E.G. Schmidt, Z. Spuris, B.K. Tyagi, J. van Tol and the late J.A.L. Watson.

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The complexity of the problems which confront those who attempt to achieve practical conservation action on behalf of large, poorly known invertebrate groups is immense. I am aware that my aim to present a simple coherent strategy has resulted in my omitting mention of many valuable publications on dragonflies and their conservation, even when these have been most helpful in providing background information. For this I apologise. Needless to say that I am solely responsible for any errors which this document still contains.

Norman W. Moore
Chairman IUCN/SSC Odonata Specialist Group

Executive Summary

Before there were dinosaurs there were dragonflies (Odonata). Today their size and beauty make them especially valuable subjects for research on insect behaviour and ecology and for art. As their larvae are aquatic, dragonflies can be used in making rapid assessments of water quality. In addition, because they are predators they have considerable potential for the biological control of mosquitoes which transmit diseases to human beings.

Over 5,000 species of dragonfly have been described and many more await discovery or description. Most species live in the tropics, mainly in rainforest. Our knowledge of them is very patchy. Much is known about the relatively few species which inhabit the temperate regions, where most specialists in dragonflies (odonatologists) live; on the other hand very little is known about hundreds of species in the tropics where there are very few odonatologists. The rapid destruction of rainforest makes the conservation of dragonflies a very urgent matter. This Dragonfly Action Plan faces these problems and outlines the necessary solutions. The strategy for conserving dragonflies contains three basic elements:

1. Establish protected areas (National Parks, nature reserves etc.)
2. Conserve habitats outside protected areas by modifying agricultural, forestry and industrial procedures.
3. Carry out measures to support 1 and 2. The principal ones are:
   a) Research - notably taxonomy and studies of the distributions and biological requirements of species.
   b) Pollution Control
   c) Legislation - notably to provide protected areas, to control development and to control pollution
   d) Education and raising public awareness

Fortunately the action which would protect most dragonfly species does not require detailed information about species: there is good evidence to show that if viable examples of the main habitat types in each country are conserved, this measure would effectively conserve most dragonfly species. Therefore, by far the most important recommendation of this Action Plan is that Governments, statutory conservation bodies and non-governmental organisations which manage nature reserves should establish or complete networks of protected areas to cover all the main habitat types found in each country. This procedure is necessary to conserve all groups of invertebrate animals where, as with the dragonflies, there is not enough time or resources to study the distribution and habitat requirements of thousands of species. No country would consider undertaking the work for dragonflies alone, but when it is realised that it is an essential first step in maintaining the biodiversity of the world as a whole it becomes an entirely practical objective.

Apart from supporting this general measure, it is recommended that odonatologists make the maximal use of the facilities available to them to study particular 'centres of endemism' (areas containing large amounts of species which are unique to that area) and special species which are threatened. To assist them this Action Plan for Dragonflies provides guidance on which areas and which species should be given priority. By using The 1996 IUCN Red List of Threatened Animals as a starting point, the listing of dragonflies must be improved so that it can be used effectively as a guide to detailed conservation work. Proposed work on centres of endemism and species would involve the training of odonatologists where they are most needed. Finally, studies which contribute to the Odonata Conservation Database are proposed so that better use can be made of existing information in collections and publications. Individual entomologists and others have an important role in promoting this work, and industry in supporting it.

Chapter 1

Dragonflies

Dragonflies, including the smaller damselflies, belong to an order of insects, the Odonata, which is taxonomically isolated and very ancient. They possess anatomical features relating to feeding, flight and reproduction which are unique among insects. Today dragonflies are conspicuous inhabitants of many types of country: they are large, active predators which hunt by day. Many species, especially those with iridescent wings, are extremely beautiful, rivalling butterflies in their splendour.

The first insects which can be called dragonflies evolved in the Carboniferous period (300 million years ago). Huge fossil dragonflies with a wing span of 70cm have been found in France. These insects were over five times the size of the largest dragonflies living today. They were contemporaries with primitive amphibia and the first reptiles. The fossil record shows that by the Permian (250 million years ago) dragonflies had already evolved into many of the taxonomic families which exist on the earth today. They were contemporaries of ichthyosaurs (shark-like aquatic reptiles), plesiosaurs (large aquatic reptiles - up to 15m long) and the early mammal-like reptiles. It was not until the Cretaceous (100 million years ago), when dinosaurs still nourished, that dragonflies became the potential prey of birds. At this period dragonflies themselves could prey on the huge range of insects which evolved with the coming of flowering plants. Dragonflies evolved at a time enormously different from the present. Yet their structure and way of life have stood them in good stead ever since. What has been the secret of their success? Their biology and special features give some clues.

The dragonfly egg hatches to produce a pro-larva, which quickly discards its embryonic cuticle to produce a highly mobile little larva. This grows steadily, moulting several times in the course of its relatively long life in the water. Dragonfly larvae are adapted to living in many types of aquatic environments but they are all predators. They all catch their prey by stalking it until they are close enough to impale it by shooting out their fiercely armed labium (lower jaw). This is done by using hydrostatic pressure: the method is unique among insects. Dragonfly larvae feed on anything that moves - minute Crustacea, mosquito larvae and even small fish.

Damselfly larvae breathe by means of external gills, but the larvae of the larger, true dragonflies breathe by pumping water in and out of the rectum. This mechanism can also be used to jet propel the larva away from predators.

After a period ranging from 30 days to several years the larva prepares for its short adult life of a few days or weeks. It climbs up plants which grow in the water or close by and begins to breathe air. Shortly afterwards the adult body bursts through the discarded larval skin; the wings expand and harden, and then the insect flies away from water. Dragonflies disperse over wide areas at this stage. Immature dragonflies feed away from water for several days until they become sexually mature.

Adult dragonflies, like their larvae, are opportunistic predators, preying on whatever prey is available. They

Aeshna cyanea, an anisopteran dragonfly found in most European countries east to the Caucasus. It frequently breeds in small garden ponds. This larva has just caught its prey and has retracted its labium.

R. Thompson

Coenagrion mercuriale, a local Mediterranean damselfly confined to South West and Central Europe and North Africa. Its habitats are protected by special legislation of the European Union. Note the external gills at the end of the abdomen of the larva.

R. Thompson

mainly feed on flying insects, which they catch with their forwardly directed legs that form a basket-like trap. The wing musculature, which is unique among insects, together with the form of their wings enables them to manoeuvre with great skill - hovering, flying backwards and darting forwards. Their hunting skills are further enhanced by their exceptional powers of vision. Much of the dragonfly's head consists of its two great eyes. They can detect very small, distant movements and they also have colour vision.

At night adult dragonflies roost in vegetation away from water. In the morning when the weather is fine, males return to water: the males of most species set up territories there. Females only come to water to mate and lay their eggs.

The way dragonflies mate is unique among insects. Males transfer their sperm to secondary genitalia on the underside of the second and third segments of the abdomen. When a male has caught a female he holds her head or the front part of her thorax with the claspers at the end of his abdomen. She then bends her abdomen round so that her genital opening can receive the penis of the male. Mating dragonflies fly and perch in this "wheel" position. Males of many species of dragonfly have a complicated apparatus in their secondary genitalia whose function is to remove sperm from previous matings before depositing their own. After mating, the male often remains attached to the female while she lays eggs, or he hovers over her. These types of behaviour prevent other males from seizing her and fertilising her with their sperm. Most damselflies and some of the large Hawker dragonflies (Aeshnidae) insert cylindrical eggs into plants growing in or by the water. Other dragonflies disperse their rounded eggs on the water surface or on ground nearby.

R. Thompson

Brachytron pratense, a central European species found from Ireland to the Caspian Sea. A mating pair in the "wheel" position.

From what is known about the biology of dragonflies we can guess what has been the secret of their success: dragonflies combine catholicity in their larval and adult feeding habits with great manoeuvrability in flight and great visual acuity. Although their prey and predators have changed over the millions of years in which dragonflies have existed, their generalised feeding habits and flying skills have enabled them to survive successfully throughout the ages, wherever there is warmth and unpolluted water.

Chapter 2

The Number of Dragonfly Species and their Classification

By 1990 over 5,000 species of Odonata had been described (Tsuda 1991). Since that date more have been described, a number have been discovered but not yet described, and doubtless many remain to be discovered, especially in tropical South America and South East Asia. Thus there are more species of dragonflies than of mammals (over 4,000), perhaps about as many species as there are of birds (over 9,000).

All living dragonflies belong to three well-defined suborders: the Anisoptera or true dragonflies, the Zygoptera or damselflies and the Anisozygoptera, which has an intermediate position between the other suborders. Most Anisozygoptera are known only as fossils. In 1985 the Anisoptera included over 2,500 known species belonging to 7 families, the Zygoptera over 2,300 species belonging to 21 families and the Anisozygoptera 2 species

J. Silsby

Libellula pulchella, a widely distributed species in Canada and the USA. An example of the Anisoptera or true dragonflies.

R. Thompson

K. Inoue

LEFT *Platycnemis pennipes,* a species of streams and rivers and found in most European countries, Turkey and Siberia. An example of the Zygoptera or damselflies. It has courtship and threat displays.

RIGHT *Epiophlebia superstes,* one of the two surviving species of the Anisozygoptera. It breeds in mountain streams in Japan. It has a long developmental period. The larva squeaks when picked up. The photograph shows a recently emerged adult with the cast off larval skin (exuvia).

belonging to one family (Davis and Tobin 1984, 1985). The number of species in each family and the distribution of each family is given in Table 2.1. Dragonflies are essentially tropical animals, and most species occur in South America, South East Asia, tropical Africa and Australasia. The number of species in the cooler parts of the earth is relatively small, but the number of individual dragonflies of a temperate zone species can be very large. Thus dragonflies can be very abundant in any part of the world which they inhabit.

Table 2.1. The world distribution of dragonfly families

Suborders and Families	Abbreviation	Number of Species	Distribution					
			Europe[a]	Asia	Africa[b]	North America	South America[c]	Oceania[d]
Zygoptera								
Amphipterygidae	Amph	13		+	+		+	
Calopterygidae	Cal	152	+	+	+	+	+	+
Chlorocyphidae	Chl	129		+	+			+
Dicteriadidae	Dict	2					+	
Diphlebiidae[e]	Diph	5						+
Euphaeidae	Euph	57		+				
Polythoridae	Pol	53					+	
Rimanellidae[e]	Rim	1					+	
Synlestidae	Syn	31		+	+		+	+
Lestidae	Lest	150	+	+	+	+	+	+
Lestoideidae	Loid	2						+
Megapodagrionidae	Meg	229		+	+		+	+
Perilestidae	Per	21			+		+	
Pseudolestidae[e]	Psl	10		+				
Hemiphlebiidae	Hem	1						+
Coenagrionidae	Coen	1059	+	+	+	+	+	+
Isostictidae	Iso	38						+
Platycnemidae	Plcn	180	+	+	+			+
Platystictidae	Plst	146		+			+	+
Protoneuridae	Prot	239		+	+	+	+	+
Pseudostigmatidae	Pst	19					+	
Anisozygoptera								
Epiophlebiidae	Ep	2		+				
Anisoptera								
Aeshnidae	Ae	384	+	+	+	+	+	+
Gomphidae	Gom	868	+	+	+	+	+	+
Neopetaliidae	Neo	8					+	+
Petaluridae	Pet	10		+		+	+	+
Cordulegastridae	Clg	60	+	+		+		
Corduliidae	Cord	378	+	+	+	+	+	+
Libellulidae	Lib	946	+	+	+	+	+	+

Families and number of species as per Davies and Tobin 1984 and 1985, with some modifications
a. including North Africa
b. Sub-Saharan Africa including Madagascar
c. including Meso America
d. including Australia, Papua New Guinea and Pacific Islands
e. The validity of these families is disputed by some authors. See footnotes x, y and z of Table 6.1.

Chapter 3

Why Should Dragonflies be Conserved?

Measures should be taken to conserve dragonflies if they are valuable and are under threat. But are dragonflies valuable and are they threatened?

The value of all life on earth is now recognised. There is increasing concern that genetic information should not be squandered: species, the variations of species and ecosystems to which they belong should be conserved as far as practicable. In recent years attention has been focused on the variety of life and the need to conserve it by the use of the term "biodiversity". The Convention on Biological Diversity was signed at the Earth Summit at Rio de Janeiro in June 1992. Dragonflies are part of the world's biodiversity and therefore should be conserved.

There are also special, subsidiary reasons why dragonflies should be conserved. They are all connected with the fact that dragonflies are exceptionally large, day-flying insects. Their size has brought them to the attention of people throughout the world so that they have become part of the folklore of many countries, notably in China and Japan, where they are the subject of poetry and painting. Their size makes them especially suitable subjects for biological research, especially for studies on behaviour and ecology: individual dragonflies can be observed and counted in the field like birds. As dragonflies are so easily observed they have considerable potential as bio-indicators. Some species are characteristic of particular habitats and so can be used for rapid mapping of the habitats which they represent. Dragonflies vary in their sensitivity to different sorts of pollution. Although they are less sensitive than some other aquatic insects, their conspicuousness makes them valuable for quick assessment of water quality. The number of species present on a lake or river can be compared with that on an unpolluted example of the same type. A count of dragonflies would provide a quick, and therefore low-cost, indication of the health or sickness of the lake or river.

Ninety-five percent of all animal species and ninety-nine point nine percent of all individual animals are invertebrates. But since most invertebrates are small and inconspicuous their immense importance in nature is grossly underestimated. Therefore large conspicuous insects are of great importance in drawing attention to invertebrates and their conservation needs: what butterflies do as flagships for the terrestrial environment dragonflies can do for the aquatic environment.

Finally, dragonflies eat vast quantities of insects which are harmful to humans, and recent work in Asia shows that the larvae of a libellulid dragonfly can be used deliberately to control the insect vectors of dengue fever which breed in water containers (Sebastian *et al.* 1990). Dragonflies therefore have a potential health and economic value which is not yet fully exploited.

Chapter 4

Are Dragonflies Threatened?

Comparisons between past and present records show that dragonflies have disappeared from numerous waterbodies throughout the world. In countries where the dragonfly fauna has been well studied there is good evidence that several species have been exterminated locally or nationally. For example, three of the 42 species which originally bred in the British Isles have become extinct there since 1950. In the tropics many species are likely to be exterminated totally before they have been described.

The causes of exterminations and declines are generally obvious. By far the most important is the destruction or reduction of the habitat on which they depend. The most important cause of habitat loss is forest clearance, because it causes forest streams and pools to dry up or become clogged with silt. Forest clearance also removes the habitat in which adult insects shelter and catch their prey. Since most dragonfly species are dependent upon tropical rain forest **the clearance of tropical rain forest, for whatever purpose, imposes the greatest world-wide threat to dragonflies.**

The damming of rivers for hydro-electric schemes and water supplies has exterminated populations of species which depend on fast running streams in the USA and other countries (Bick 1983). In the lowlands drainage and pollution provide the main threats for dragonflies. Drainage and excessive water extraction totally destroy many freshwater habitats. Lowering the watertable can turn permanent waterbodies into temporary ones: as a result they cannot support dragonflies with a long developmental period. In other streams and ditches changes in the rate of flow can cause local loss of species.

Pollution from sewerage and industrial wastes, fertiliser run-off and pesticide drift have wiped out or greatly reduced dragonfly populations throughout the industrialised world. The faunas of large navigable rivers have been particularly prone to damage and loss. The wash of fast moving boats harms dragonflies directly by sweeping away emerging insects, and indirectly by making the water turbid and thus reducing the amount of submerged vegetation on which the larvae depend. This may become an important problem in areas such as the Okavango Swamp where there is an increase in tourism. Increased numbers of domestic animals on land bordering lakes and rivers and increased recreational pressures can both have damaging effects on the waterside vegetation which is essential for many dragonfly species. Pest control schemes which involve widespread spraying of waterbodies with insecticides have affected many dragonfly populations.

The effects of introducing alien species have been little studied, but there is good evidence to show that at least one of the endemic damselflies of Hawaii have been nearly exterminated by the introduction of the Mosquito Fish (*Gambusia*) in order to control mosquitoes in the Hawaiian lowlands (Gagne 1981).

We must conclude that dragonflies are valuable, and that they are threatened throughout the world through habitat loss and pollution. Therefore action to conserve dragonflies is urgent. A wide range of measures is required.

Chapter 5

A Strategy for Conserving Dragonflies

Any strategy for conserving dragonflies, or indeed any group of animals, must contain three basic elements:

1. Establishing Protected Areas (National Parks, nature reserves etc.) and ensuring that activities in existing protected areas are managed appropriately for dragonfly conservation.
2. Conserving habitats outside protected areas by modifying agricultural, forestry and industrial procedures.
3. Carrying out measures to support 1 and 2. The principal ones are:
   a) Research - notably taxonomy and studies of the distributions and biological requirements of species.
   b) Pollution Control
   c) Legislation - notably to provide protected areas, to control development and to control pollution.
   d) Education and raising public awareness

A strategy for conserving dragonflies based on these elements is outlined below under the three headings.

5.1 Protected areas

Protected areas are established to protect species or ecosystems from developments which would endanger them. They are places where conservation is the primary land-use, although in many tourism, research and even some forms of agriculture and forestry may be important secondary land-uses. Protected areas have been selected for a wide range of reasons, including the protection of outstandingly beautiful landscapes, big game, threatened habitats, and species.

Not surprisingly the conservation of dragonflies has rarely been the primary purpose of establishing protected areas. Japan, where dragonflies have a special cultural significance, provides a notable exception: no less than 24 protected areas have been established there primarily for dragonflies (Eda 1995). Particularly important are the Dragonfly Kingdom at Nakamura, established in 1987 to conserve an outstandingly rich assemblage of species, and the Conservation Area at Okegaya-numa

The dragonfly Kingdom at Nakamura, Shikoku, Japan. The first public nature reserve to be established specifically for dragonflies. It supports over 80 species of dragonflies.

N.W. Moore

Libellula angelina, a very rare Japanese dragonfly. The Conservation Area of Okegaya-numa has been established to protect one of its very few localities in Japan. The area supports many other dragonfly species as well.

K.Inoue

established to protect one of the very few populations of *Libellula angelina* as well as many other species. In Great Britain three or four reserves have been set up, notably the Ashton Water Dragonfly Sanctuary designed principally to promote interest in dragonflies (Corbet 1993).

Although few protected areas have been set up primarily for dragonflies, nearly all protected areas, apart from those in polar and desert regions, support dragonflies. Some, like the Wilson Promontory National Park in Australia, support a very important species - in this case the highly specialised but ancient *Hemiphlebia mirabilis* (Sant and New 1988). Others support outstanding assemblages of species, notably protected areas in tropical rainforests, for example the Tambopata - Candamo Reserved Zone in Peru in which over 150 species of dragonflies have been recorded (Paulson 1985, Butt 1995).

An increasing number of countries are attempting to establish networks of protected areas. The aim in each country is to cover the whole range of habitats which occur in it. For example, Great Britain has established c.300 National Nature Reserves to represent the main types of woodland, grassland, heathland and aquatic habitats which occur in it. The National Nature Reserves havebeen selected primarily on the basis of vegetational types, none has been selected specifically to conserve dragonflics. Nevertheless all but one or two species of the British dragonflies occur in one or more National Nature Reserves (Moore 1976, 1991a). Similarly the Royal Society for the Protection of Birds, the largest voluntary conservation body in the country, selects its reserves in order to conserve bird biodiversity. Their network of over 130 reserves also protects virtually all the British species of dragonfly (Pickess 1989). Thus, without any special studies of dragonfly distribution both the official conservation organisations and a non-governmental one have succeeded in providing a high level of protection for the British dragonfly fauna. There is no reason to suspect that the British experience would prove to be exceptional. Therefore it would appear that **any nation which protects significant examples of all its main habitat types will succeed in conserving most of its dragonfly species.**

After protected areas have been selected and established they have to be managed if those in charge are to succeed in conserving their flora and fauna. In each protected area selected as an example of a particular habitat type a balance has to be struck between the requirements of different taxa. These can conflict; for example, the cutting down of vegetation round a pond so that it can be used as a water-hole for large mammals may exterminate most of its dragonflies. If a protected area contains important populations of dragonflies efforts should be made to maintain the main dragonfly habitats within it, bearing in mind that dragonflies have numerous life strategies and thus varied requirements. The larvae of nearly all dragonflics are aquatic, but each species has its special requirements: some need mud, others silt or dead leaves to hide in, others require abundant submerged vegetation. Some species can only live in waterfalls or fast streams, others only in large rivers or ponds or lakes. A number of tropical species lay their eggs in tree holes or in the water-fillcd axils of epiphytic plants and their larvae develop in these tiny waterbodies high above the forest floor. Most adults require tall vegetation away from water in which to roost at night. In the day some fly in the shade, others seek little sunspots deep in the forest shade. For these reasons it is crucial to retain the natural heterogeneity of the forest

in all protected areas. The great range of microhabitats is easily destroyed by the illicit felling of trees - especially old ones with water-filled holes and epiphytes, by illicit grazing with domestic animals, and by pollution originating from areas outside the protected area. In other words, all work done to achieve the detailed integrity of the protected area is extremely important for dragonfly conservation.

Tourism not only allows many people to enjoy the flora and fauna of a National Park, but often provides the revenue necessary to manage it. Dragonflies are not directly disturbed by people but they can be seriously affected by pollution of breeding areas caused by thoughtless visitors. As noted above (p.6) fast moving boats used to convey tourists along rivers can cause serious problems.

5.2 Conserving habitats outside protected areas

Protected areas are vital for the conservation of dragonflies especially for rare, localised species which depend on primary forest. However, most individual dragonflies live outside them on land whose primary use is not conservation - in commercial forests, farms and grazing lands. Therefore it is very important to conserve dragonfly habitats on such land wherever this is possible. Fortunately quite small modifications of forestry and farming practices can make a great difference for dragonflies. Most of these modifications support rather than hinder productive forestry and farming practice. Some of the more useful ones are described below.

Where native forest trees are harvested or where plantations of exotic species are planted on the site of native forest, strips of the original vegetation adjoining streams and rivers should be left untouched. This helps maintain the larval habitats of dragonflies in the river and prevents excessive shading by planted conifers etc. It is important to prevent pollution of streams from sources both within and outside the forest area.

Similarly where forest has been cleared for agriculture, strips of native vegetation should be retained along the edges of streams and rivers. This will not only support dragonflies, fish and other forms of wildlife but will help to reduce the effects of soil erosion.

Drainage ditches, irrigation ponds and ponds constructed for watering cattle can provide valuable habitats for dragonflies so long as they are kept free from pollution. For agricultural reasons these habitats will need management using physical or chemical means to control excessive growth of water plants. If this is done so that part of the waterbody is left untreated at each treatment dragonflies will quickly recolonise the treated areas. This procedure benefits fish and other aquatic organisms as well as dragonflies. Special care should be taken to prevent sewage, slurry or other farm effluents and spray drift from getting into watercourses. If such care is taken it will reduce fish kills, and will often reduce the amount of weed control necessary in the watercourse where pollutants are causing excessive weed growth.

Urban and industrial areas can support a surprisingly large number of the commoner dragonfly species if rivers, ornamental lakes and ponds are kept free of pollution, and if water plants are allowed to develop on their margins. In Japan the Nagisa Sewage Treatment Plant in Hirakata City has even made a dragonfly reserve on ponds and streams filled by water emerging from its treatment works, thus drawing attention to the effectiveness of its treatment!

If carried out, the simple measures outlined above for forests, farms and urban areas will do much to conserve dragonfly populations throughout the world and will fulfil an important part of the strategy to conserve dragonflies. However, in the long term the conservation of dragonflies outside protected areas will largely depend on countries developing sustainable types of agriculture based on sound ecological principles. The extent to which all conservation measures are successful will depend on education and the provision of advice, both of which are dependent upon research. These topics are discussed below.

5.3 Supporting measures

5.3.1 Research

5.3.1.1 Taxonomy

All research on the biology of dragonflies may help towards their conservation but some types of research are essential. **Taxonomy is a discipline which is rarely given priority today, yet for conservation it is obviously essential.**

5.3.1.2 Mapping

Once species have been described we can discover where they occur. This is achieved by systematic mapping of their distributions.

Systematic mapping of dragonfly species in several countries has been achieved with varying degrees of accuracy for example in - Belgium and Luxembourg (Michiels *et al.* 1986), France (Dommanget 1994), Ireland (Merritt *et al.* 1996), Japan (Asahina 1994), Netherlands (Geijskes and van Tol 1983), New Zealand (Rowe 1987), Switzerland (Maibach and Meier 1987) and the United Kingdom (Merritt *et al.* 1996). In addition distribution maps have been made in parts of some countries, for example in Finland, Germany, Italy, Spain and the USA. Knowledge of the distribution of tropical species is largely confined to studies of small areas or is based on the data given in taxonomic papers.

5.3.1.3 Building a database

If survey data are to be used effectively they must be easily available and stored in a world conservation Odonata database. The check list of the world's Odonata (Davies and Tobin 1984, 1985) which provides some information about distribution has already been very valuable. Subsequently Dr Shigero Tsuda (1991) has drawn up a database which provides more information about distribution. This provides the basis for an initial global assessment of dragonfly distribution on a country basis. Both works have been most useful in writing this action plan. The principal requirement now is to relate the distribution of species to conservation requirements. To this end a world conservation odonata database is necessary.

5.3.1.4 Habitat requirements

Managers of protected areas often need to know the exact habitat requirements of rare species in their charge so that they can provide what is necessary. Hence studies of the habitat requirements of some individual species will be needed.

5.3.2 Pollution control

Pollution can be caused naturally as when an exceptionally high tide inundates coastal freshwater marshes with salt water; but usually pollution is caused by intentional or unintentional human activities. Water pollution can be direct, for example when a river is polluted by sewage or factory effluent, or indirect, for example by pesticide spray drift or acid rain. Some of the worst pollution effects are caused by agricultural, transport or industrial accidents. Rivers and streams, the habitats of most of the rarer dragonflies, are particularly vulnerable to pollution.

Increases in human populations, increased industrialisation and increased intensification of agriculture will augment pollution throughout the world unless vigorous local, national and international steps are taken to control it. The maintenance of clean water supplies for drinking provides a strong incentive to prevent pollution in at least some areas, which as a result may protect the dragonflies which inhabit them.

As noted above, dragonflies are useful as biological indicators when making quick assessments of water quality. Species vary in their tolerance to pollution, for example in Europe *Ischnura elegans* is much more tolerant to pollution than *Platycnemis pennipes.* No dragonfly can breed in badly polluted water.

Those concerned with the conservation of dragonflies and other freshwater organisms should always give special support to measures designed to prevent or reduce pollution and to the adoption of internationally agreed standards of water quality.

5.3.3 Legislation

Many countries have legislation designed to protect wildlife, either through the designation of protected areas to protect habitats or through legislation controlling the harvesting and collecting of species on endangered species lists. In addition, international trade in species of wild fauna and flora can be further regulated and monitored through the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The work of TRAFFIC supports CITES and helps to ensure that wildlife trade is at sustainable levels and in accordance with domestic and international laws and agreements. While legislation to control the harvesting of invertebrates such as some corals, molluscs and butterflies is necessary, it is not at present required for dragonflies as there is no significant trade in them. Blanket legislation which prohibits the collection of all species of dragonflies, whether they are endangered or not, is very questionable. In the first place, it is a waste of time, since the collecting of a few individual insects rarely affects their populations. Secondly, it hinders those who undertake the essential conservation task of studying dragonfly distribution. Thirdly, it prevents children from collecting dragonflies to observe them closely. This discourages children from becoming interested in dragonflies and thus concerned about their conservation. Finally, much harm is done if blanket legislation to prevent collecting of dragonflies is used - as it often appears to be - as a substitute for legislation to protect their habitats.

Legislation which empowers national and state governments and local authorities to conserve habitats is extremely important for the conservation of all wildlife including dragonflies. Such legislation includes laws providing for the establishment and management of protected areas, planning laws by which important habitats can be protected from unsuitable development and laws making Environmental Impact Assessments obligatory when major developments are proposed.

The increasing use of international law such as the Habitat Directive of the European Community to support the conservation of habitats is to be welcomed. In Great Britain, the Netherlands, Sweden etc. legislation has enabled the conservation authority to establish a series of protected areas of the main habitat types of the country concerned. The British planning system includes a consultative mechanism by which unsuitable development of designated "Sites of Special Scientific Interest" can be prevented. SSSI can be designated for being the habitat of rare dragonflies or of outstanding assemblages of dragonfly species (Nature Conservancy Council 1989). Similar

arrangements for protecting habitat types occur in Northern Ireland, Republic of Ireland, Germany, Netherlands, Sweden). Despite this legislation, experience shows that many SSSI, and even National Nature Reserves, continue to suffer some damage (Nature Conservancy Council 1990) but there is no doubt that planning legislation to conserve habitats is necessary. Individual landowners and enlightened land-owning companies can do much to protect wildlife habitats, but it would be naive to believe that alone they could ever acquire or control large enough areas to conserve the biodiversity of their countries. **Therefore legislation to conserve habitats is a necessary part of effective conservation action in all countries.**

5.3.4 Education and raising public awareness

Adequate site protection, based on sound legislation and planning and adequate pollution control, can only occur when enough people support the measures required. Therefore education concerning conservation is crucial in achieving conservation goals.

Education should teach children and adults alike to value wildlife. Dragonflies, thanks to their conspicuousness and beauty, provide great opportunities for interesting people about nature. This opportunity has been taken up with great success by Professor Angelo Machado, the Brazilian authority on Odonata. His book *O Menino e o Rio* (The Boy and the River) (Machado 1989), in which a dragonfly is the hero, has run to eight editions in Portuguese and has been translated into English. Television, aided by high speed photography, has already done much to popularise dragonflies. Yet people still need to be told that dragonflies sting neither horse nor human! Urban dwellers find it difficult to realise that species depend on their habitats for survival. This message needs to be emphasised continually as regards dragonflies as well as other wildlife. Ponds are increasingly used to introduce children to biological principles. The Tombo Kingdom at Nakamura in Japan has been particularly helpful in instilling an interest in dragonflies into young and old alike. Dragonflies and their larvae owing to their size and conspicuousness do indeed "stand in" for smaller and more obscure insects. Today's children will be tomorrow's farmers, business-people, officials, teachers and politicians. What they learn today will influence how they will react to the increasing environmental problems of the world of tomorrow.

Once education and awareness-raising has fostered an interest in wildlife and its conservation, a growing demand for advice develops. This can be provided by advisers from statutory conservation organisations, agricultural departments and voluntary conservation bodies. For example in the United Kingdom farmers and landowners together with the official and voluntary organisations concerned with farming, forestry and conservation jointly support an organisation called the Farming and Wildlife Advisory Group (FWAG). It employs over 70 biologists who give conservation advice (largely free) to farmers throughout the United Kingdom (Moore 1991a). It is estimated that several hundred ponds have been created or restored as a result of FWAG's work: dragonflies must have benefited considerably from this work. The British Dragonfly Society has produced leaflets on pond construction and the management of habitats for dragonflies which can be used by advisers and others who wish to have specific advice about the conservation of dragonflies (British Dragonfly Society 1990, 1993).

5.4 Interaction of the different elements of the conservation strategy

All three elements of the conservation strategy to conserve dragonflies should be pursued simultaneously. They reinforce each other. For example, protected areas provide bases from which newly improved habitats outside them can be colonised. Existing habitats outside protected areas provide corridors or stepping stones between populations in protected areas. The effectiveness of protected areas and conservation outside them, the effectiveness of legislation and of pollution control all depend upon public demand and hence upon education and raising awareness.

Chapter 6

Priorities

6.1 Background

Implementing the strategy outlined above in full would be a massive undertaking and could not be achieved in the short time available. Circumstances will dictate what in practice can be done: circumstances must be spelt out and their implications faced squarely, so that feasible recommendations for timely action can be made.

Conservation should be based on scientific knowledge, yet the information now available for most dragonfly species is very inadequate and would take centuries to acquire because there are so few specialists in dragonflies (odonatologists). This is because at present dragonflies have little direct economic importance and so studies on them are not subsidised by agriculture or industry. As a result few research workers study dragonflies and virtually none study them full time. Those that do work on dragonflies mostly live in the north temperate zones, where the dragonfly fauna is not very diverse and where much of it consists of widely distributed species. There is a great dearth of odonatologists in those areas which support most species, notably tropical South America and South East Asia. Whereas there are over 1400 members of the British Dragonfly Society in a country with only 38 species of dragonfly, only a handful of people work on dragonflies in Brazil whose fauna consists of hundreds of species, many of them undescribed. Countries such as Australia, India and South Africa are intermediate: some of their areas are well known and well documented, others much less so. Where there are most dragonfly species many still await discovery or description. The situation is vividly illustrated by Meso America. In 1982 Dr. Dennis Paulson listed 48 species of dragonflies discovered there but not described. Since then 57 species have been described from the same region but they include only 19 of the original list. There are many parts of the world where less is known about dragonflies than in Meso America (Paulson 1982 and personal communication).

In addition to the lack of taxonomic information very little is known about the distribution of many of the tropical species which have been described and even less about their habitat requirements.

Habitat destruction is proceeding at an unprecedented rate throughout the world. For the foreseeable future there is no way by which odonatologists can provide the necessary information to conserve most species on a species by species basis. **Therefore most species can only be conserved by adopting a broad brush approach, which must depend on what can be done on existing information. The risk of doing the wrong thing through lack of scientific knowledge is much less than the risk of delay** (Moore 1991b).

6.2 Immediate priority action

6.2.1 Protected area establishment to cover examples of main habitat types

As shown above (p.8) enough is known about the relationship of dragonflies to habitats to state categorically that if each and every nation conserved viable examples of the main habitat types found within its borders the vast majority of dragonfly species would be conserved. It would be unrealistic to suggest that a network of protected areas should be established for dragonflies alone, however such a network would also conserve most species of other animals and plants. Therefore it is a crucial mechanism for maintaining global biodiversity when so little is known about invertebrates and their requirements. Its implementation would go a long way in fulfilling the Rio declaration. Those concerned with the conservation of dragonflies should endorse what should be done for all taxa.

No country has yet achieved adequate protection of all its habitat types. In some the need to do so is not even appreciated. However, the range of protected habitats in some countries is already quite extensive and it could be extended further without too much difficulty. All countries, organisations and individuals should do all in their power to ensure that representative protected areas of viable size are established to cover their main habitat types, and that once established the protected areas should be adequately protected and managed. International conservation organisations should give their fullest support to these endeavours. **Completion of national networks of protected areas can be achieved without further research on dragonflies. It is the most effective way of conserving the largest number of dragonfly species. Top priority should be given to this work.**

In a few countries in Europe and North America and in Japan and New Zealand enough is already known about the distribution and broad habitat requirements of their dragonfly species to enable the conservation of all their dragonfly species to be based on existing scientific knowledge. In these countries gaps in the coverage provided by the network of protected areas can be identified and can be filled by creating new nature reserves or by making

special arrangements with the managers of the localities concerned.

6.3 Research priorities for dragonfly conservation

The small amount of scientific manpower available must be used in such a way as to give the greatest support possible to the broad brush approach of conserving representative habitats outlined above. This can best be done by making sharply focused studies on special areas and special species. The priorities in choosing these are discussed below.

6.3.1 Identification of priority areas for dragonflies

Some of the areas which are or should be protected as parts of national networks of representative habitats are much more important than others. This is because dragonflies are unevenly distributed: Antarctica and much of the Arctic support no dragonflies; there are relatively few species in most of the Holarctic region; great concentrations of species occur in South and Central America and in South East Asia. Odonatologists must explain why some areas are much more important for dragonflies than others and state which areas should receive priority for study and protection.

Dragonflies have evolved at different rates and at different times in different parts of the world. Geological events have caused the formation of geographical and ecological islands which have produced centres of endemism which are exceptionally rich in species, most of which have very limited ranges. Such areas are of particular interest for the study of evolution, and failure to protect them can result in the mass extinction of species. The main centres of endemism in dragonflies are known to include the following: the eastern slopes of the Andes in northern South America, Central America, Madagascar, the mountains of Central Africa, the mountains of Myanmar, Thailand, Cambodia, Laos and Vietnam, Indonesia, The Philippines, the Ryu-Kyu islands, New Guinea, New Caledonia, Australia, New Zealand and Hawaii. In many parts of most of these areas no studies have been made on dragonflies and in others the information is very scanty. **Most of the centres of endemism in dragonflies are under considerable threat of deforestation:** studies on their dragonflies both within and outside protected areas are urgently required. These studies will reveal localities where large assemblages of species occur together; such places are always of great interest and should be conserved as potential protected areas wherever they occur. In countries which contain centres of endemism their value is immense. In New Zealand, Hawaii and the Ryu-Kyu islands some have been identified already, elsewhere they must be sought while there is yet time.

6.3.2 Identification of priority species

Special species require special attention: in particular they need studies on their distribution and habitat requirements. Research resources are so small that only a small proportion of the world's dragonfly species can be studied in detail. Therefore odonatologists must first make judgements about which species are special, and secondly which of the special species are threatened. Clearly, threatened special species should be given top priority.

The following criteria for prioritising species are adopted. The first is taxonomic isolation: there is general agreement that any groups of animal species which have few or no living relations are of special interest because they often provide links with fossil forms or because they extend the characteristics of the groups to which they belong. Therefore threatened taxonomically isolated dragonfly species should be among those receiving priority. The more isolated a species is taxonomically the more likely it is to be interesting. As a result detailed priority is based on taxonomy: the higher the taxon with only a few species in it the more important it is to conserve its members. Clearly among dragonflies the two sole surviving members of the suborder Anisozygoptera (*Epiophlebia superstes* and *Epiophlebia laidlawi*) should receive first consideration. Practical considerations have to determine how far up the taxonomic tree special species should go. The list of 75 species proposed here (see Table 6.1) includes all species of suborders, superfamilies and families containing 15 or fewer species and all species of subfamilies containing five or fewer species. Where applicable, local species in monotypic genera of all families should be added to the list (see Table 6.2).

The other criterion for prioritising species is the possession of outstandingly unusual biological characteristics; for example, the few dragonfly species with terrestrial larvae or with an ability to breed in saline waters. Such species are shown in Table 6.3.

Many priority species inhabit protected areas or areas which should become protected areas when nations have set up their national networks. However a number of priority species will not be thus protected, because they occur either in very small remnants of habitat, or in degraded forest or farmland: in neither case are such places likely to be included in national networks of protected areas. These species need to be identified so that special measures can be taken to protect them.

The action proposals which follow are based on the priorities which have been outlined above. The proposals are mutually supportive.

Table 6.1. Priority species: taxonomically isolated species

Taxon	Species	Distribution	Notes Red List Category and criteria
Suborder			
Anisozygoptera	*Epiophlebialaidlawi*	India, Nepal	VU(B1,2c)
	E.superstes	Japan	N
Superfamily			
Hemiphlebioidea	*Hemiphlebiamirabilis*	Tasmania, Victoria (Australia)	VU(B1,2c)
Family			
Rimanellidae[x]	*Rimanellaarcana*	Venezuela, Surinam	
Lestoideidae	*Lestoideabarbarae*	Queensland (Australia)	N
	L. conjuncta	Queensland (Australia)	N
Dicteriadidae	*Dicteriasatrosanguinea*	Brazil	
	Heliocharisamazona	All countries in South America less Bolivia, Chile, Uruguay	N
Diphlebiidae[y]	*Diphlebiacoerulescens*	New South Wales, Queensland (Australia)	N
	D.euphaeoides	Queensland (Australia)	N
	D. hybridoides	Queensland (Australia)	N
	D. lestoides	New South Wales, Queensland, Victoria (Australia)	
	D.nymphoides	New South Wales, Queensland, Victoria (Australia)	
Neopetaliidae	*Archipetaliaauriculata*	Tasmania (Australia)	N
	Austmpetalia patricia	New South Wales, Victoria (Australia)	N
	Hypopetaliapestilens	Chile	N
	Neopetalia punctata	Chile	
	Phyllopetaliaapicalis	Chile	
	P. apollo	Chile, Peru?	
	P. pudu	Chile	
	P. stictica	Chile	
Petaluridae	*Petaluragigantea*	New South Wales, Queensland (Australia)	N
	P.hesperia	Western Australia (Australia)	
	P.ingentissima	Queensland (Australia)	N
	P.pulcherrima	Queensland (Australia)	EN(B1,2c)
	Phenesraptor	Chile	N
	Tachopteryxthoreyi	Canada, USA (East)	N
	Uropetalacarovei	New Zealand	N
	U. chiltoni	New Zealand	N
	Tanypteryxhageni	USA (West)	N
	T.pryeri	Japan	N
Pseudolestidae[z]	*Lestomimaflavostigma*	China	
	Pseudolestesmirabilis	Hainan (China)	
	Rhipidolestesaculeatus	Taiwan, Japan	
	R.apicatus	China	
	R.jucunda	China	
	R.malaisei	Burma	
	R.nectans	China	
	R.okinawanus	Okinawa (Japan)	EN(B1,2c)
	R.rubripes	China	
	R.truncatidens	China	

Table 6.1. continued

Taxon	Species	Distribution	Notes Red List Category and criteria
Amphipterygidae	*Amphipteryx agrioides*	Colombia, Honduras, Mexico	EN(A1c)
	Devadetta argioides	Indonesia, Myanmar, Singapore, Thailand	
	D. basilanensis	Philippines	
	D. ducatrix	Vietnam	
	D. filipina	Philippines	
	D. multinervosa	Laos	
	D, podolestoides	Borneo (Indonesia, Malaysia)	
	Pentaphlebia gamblesi	Nigeria	
	P. stahli	Cameroon	
	Philoganga loringae[y]	Burma, Thailand	
	P. montana[y]	Bangladesh, India, Malaysia, Nepal	
	P. robusta[y]	China	
	P. vesfusfa[y]	China, Hong Kong	
Subfamily			
Chlorismagrioninae[a]	*Chlorismagrion risi*	Queensland (Australia)	
Coryphagrioninae[b]	*Coryphagrion grandis*	Kenya, Mozambique, Tanzania, Uganda	N
Philosininae[b]	*Philosina buchi*	China	
Thaumatoneurinae[b]	*Thaumatoneura inopinata*	Panama, Costa Rica	
Neophyinae[c]	*Neophya rutherfordi*	Gabon, Ivory Coast, Nigeria, Sierra Leone, Democratic Republic of the Congo	
Hypolestinae[b]	*Hypolestes clara*	Dominican Republic, Haiti, Jamaica	EN(A1c)
	H. trinitatis	Cuba, Haiti	EN(A1c)
Idomacromiinae[c]	*Idomacromia lieftincki*	Gabon, Liberia, Sierra Leone	
	I. proavita	Cameroon, Gabon, Democratic Republic of the Congo	
Caliphaeinae[d]	*Caliphaea confusa*	Bhutan, China, India, Laos, Myanmar, Nepal	N
	C. thailandica	Thailand	
Noguchiphaea	*N. yoshikoae*	Thailand	
Cordulephyinae[c]	*Cordulephya bidens*	Queensland (Australia)	
	C. divergens	New South Wales(Australia)	
	C. montana	New South Wales (Australia)	
	C. pygmaea	New South Wales, Queensland, Victoria (Australia)	N
Onychothemistinae[e]	*Onychothemis abnormis*	Indonesia, Philippines	
	O. coccinea	Indonesia, Malaysia	
	O. culminicola	Indonesia, Malaysia, Myanmar, Thailand	N
	O. hova	Madagascar	
	O. testacea	India, Malaysia, Myanmar, Sri Lanka, Taiwan, Thailand, Vietnam	N

Families to which the subfamilies belong:
a Synlestidae
b Megapodagrionidae
c Corduliidae
d Calopterygidae
e Libellulidae

Disputed nomenclature
x Now usually placed in Amphipterygidae
y Now usually placed in Lestoideidae
z Some authors eg.Tsuda (1991) believe that these species belong to the Megapodagrionidae

Notes:
N Species not under threat in 1996

Red List categories:
EN Endangered
VU Vulnerable
For Criteria for selecting categories see IUCN 1994 and 1996

Where no Red List category nor N is shown in the final column this signifies that the species has not yet been evaluated. It is possible that most of these species will have to be put in the DD (Data Deficient) category until more work has been done on them (see section 7.3).

Table 6.2. Priority Species: Species of Monotypic Genera[1] confined to one country

Country	Species
Australia	*Chorismagrion risi* (Per)
	Hemiphlebia mirabilis (Hem) *
	Caliagrion billinghursti (Coen)
	Acanthaeschna victoria (Ae) *
	Antipodophlebia asthenes (Ae)
	Austrogynacanthaheterogena (Ae)
	Austrophlebia costalis (Ae)
	Dendroaeschnaconspersa (Ae)
	Armagomphus armiger (Gom)
	Austroepigomphus praeruptus (Gom)
	Archipetalia auriculata (Neo)
	Austropetalia patricia (Neo)
	Apocordulia macrops (Cord)
	Austrophya mystica (Cord)
	Hesperocordulia berthoudi (Cord)
	Pentathemismembranulata (Cord)
	Synthemiopsisgomphomacromioides (Cord)
	Austrothemis nigrescens (Lib)
	Notolibellula bicolor (Lib)
Brazil	*Dicteriasatrosanguinea* (Dict)
	Skiallagmabaueri (Coen)
	Idioneura ancilla (Prot)
	Roppaneura beckeri (Prot)
	Mitragomphus ganzanus (Gom)
	Nadiplax diversa (Lib)
	Ophippus garbei (Lib)
Cameroon	*Nubiolestes diotima* (Per)
Chile	*Hypopetalia pestilens* (Neo)
	Neopetalia punctata (Neo)
	Phenes raptor (Pet)
China	*Agriomorpha fusca* (Meg)
	Philosina buchi (Meg)
	Lestomima flavostigma (Psl)
	Pseudolestesmirabilis (Psl)
	Amphigomphus hansoni (Gom)
	Eogomphus neglectus (Gom)
	Gastrogomphus abdominalis (Gom)
	Labrogomphus torvus (Gom)
	Shaogomphus lieftincki (Gom)
Colombia	*Kalacoraaurea* (Pol)
	Mesagrion leucorrhinum (Meg)
	Archaeallagmaovigerum (Coen)
	Mesamphiagrion occultum (Coen)
Congo	*Anectothemis apicalis* (Lib)
Cuba	*Microneura caligata* (Prot)
Ecuador	*Agnophilogenia monotis* (Meg)
	Neuragrion mysticum (Meg)
Equatorial Guinea	*Cornigomphus guineensis* (Gom)
Ethiopia	*Thermagrionwebbianum* (Coen)
Fiji	*Hypothemis hageni* (Lib)
French Polynesia	*Aceratobasis cornicada* (Coen)
Guinea	*Sleuthemis diplacoides* (Lib)
Guyana	*Epipotoneuranehalennia* (Prot)
Haiti	*Phylolestes ethelae* (Syn) *
Hawaii	*Nesogonia blackburni* (Lib)
India	*Calocypha laidlawi* (Chl)
	Melanoneura bilineata (Prot)
	Phylloneurawestermanni (Prot)
	Davidioides martini (Gom)
	Dubitogomphus bidentatus (Gom)
	Epithemis mariae (Lib)
Indonesia	*Disparocyphabiedermanni* (Chl)
	Melanocyphasnellemanni (Chl)
	Pachycyphaaurea (Chl)
	Schlerocypha bisignata (Chl)
	Celebargiolestescinctus (Meg)
	Austroallagmasagittiferum (Coen)
	Celebophlebiadactylogastra (Lib)
	Celebothemis delecollei (Lib)
Ivory Coast	*Zygonichidium gracile* (Lib)
Japan	*Boninagrion ezoin* (Coen)
	Boninthemis insularis (Lib)
Madagascar	*Millotagrion inaequistigma* (Coen)
	Paracnemisalluaudi (Plcn)
	Isomma hieroglyphicum (Gom) *
	Malgassogomphus robinsoni (Gom)
	Libellulosoma minuta (Cord) *
	Archaeophlebia martini (Lib)
	Viridithemisviridula (Lib)
Malawi	*Oreocnemisphoenix* (Plcn)
Malaysia	*Bornargiolestes niger* (Meg)
	Linaeschnapolli (Ae)
Marquesas	*Bedfordia helecarpenteri* (Coen)
Mauritius	*Thalassothemismarchali* (Lib)
Micronesia	*Pacificothemis esakii* (Lib)
Myanmar	*Palaeothemistillyardi* (Lib)
New Zealand	*Antipodochlora braueri* (Cord)
Papua New Guinea	*Hylaeargiasimulatrix* (Coen)
	Papuargiastueberi (Coen)
	Plagulibasisciliata (Coen)
	Cyanocnemisaureofrons (Plcn)
	Lochmaeocnemismalacodora (Plcn)
	Thaumatagrionfunereum (Plcn)
	Torrenticnemisfilicornis (Plcn)
Philippines	*Cyrano unicolor* (Chl)
	Cyclophaeacyanifrons (Eu)
	Moroagrion danielli (Coen)
	Asthenocnemisstephanodera (Plcn)
	Heteronaiasheterodoxa (Cord)
Peru	*Proneuraprolongata* (Prot)
Seychelles	*Allolestes maclachlini* (Meg)
	Leptocnemis cyanops (Plcn)
Sierra Leone	*Argiagrion leoninum* (Coen) *
Solomon Islands	*Guadalcainsularis* (Cord)
	Tapeinothemisboharti (Lib)
Sri Lanka	*Synhalestesorientalis* (Lest)
Surinam	*Nothodiplax dendrophila* (Lib)
Tanzania	*Amanipodagrion gilliesi* (Meg) *
	Nepogomphoides strulmanni (Gom)
Thailand	*Noguchiphaeayoshikoae* (Cal)
USA	*Anomalura prognatha* (Coen)
	Zoniagrionexclamatione (Coen)
	Platycorduliaxanthosoma (Cord)
Venezuela	*Chalcothore montgomeryi* (Pol)
	Sciotropis cyclanthorum (Meg)
	Hylaeonymphamagoi (Coen)
	Leucobasiscandicans (Coen)
	Junix elumbis (Prot)
Vietnam	*Calilestespallidistigma* (Meg)

For family abbreviations see Table 2.1

1 Genera containing one species in each. * Red Data Book threatened species. See Table 7.1.

Table 6.3. Priority Species: species which are special because of their unusual biology

Species	Family	Distribution	Special Feature
Coenagrionhylas			
European population	Coen	Austria Germany	An unusually isolated population - 3,000km from its main one, with unusual habitat requirements and behaviour
*Mortonagrionhirosei**	Coen	Japan	Breeds in saline water
*Megalagrionoahuense**	Coen	Hawaii	Terrestrial larva living in leaf mould under ferns
Idomacromiaproavita	Cord	Cameroon Democratic Republic of the Congo Gabon Ivory Coast	Terrestrial larva in rain forest habitat
Pseudocorduliacircularis	Cord	Australia	Terrestrial larva in rain forest habitat
Pseudocorduliaelliptica	Cord	Australia	Terrestrial larva in rain forest habitat

* Red Data Book threatened species. See Table 7.1.

Chapter 7

Priority Action Recommendations

All the activities outlined in the strategy for conserving dragonflies (see Chapter 5) should be pursued as opportunities arise. Governmental and non-governmental organisations should establish more protected areas. Farmers, landowners and the managers of state and private forests should maintain dragonfly habitat on their land wherever possible. Governments should support taxonomical and ecological research, achieve higher standards of pollution control and enact legislation which protects habitats. Educationalists and the media should promote an interest in dragonflies and their conservation. These are all long term objectives that should all be pursued energetically. However, the various elements of the strategy vary in their urgency. The following recommendations outline what is most urgently required.

The first recommendation concerning protected areas, is fundamental and can only be implemented by governments and conservation organisations. The other recommendations can only be implemented by odonatologists and their helpers, with financial support from governments, non-governmental organisations or industry.

7.1 The completion of national networks of protected areas representing the principal habitat types of each nation

7.1.1 Objective

To conserve the largest number of dragonfly species as quickly as possible on the basis of immediately available information.

7.1.2 Background

As discussed above, one essential step that can be taken immediately, without need for further research, is the establishment of a sufficient number of protected areas to encompass the principal habitat types needed by dragonflies. This measure to conserve dragonflies would also make a significant contribution to conserving the vast majority of species of all invertebrate groups.

It is now generally accepted that the establishment of protected areas is crucial for conserving biodiversity. **It cannot be emphasised too strongly that the provision of a comprehensive global network of protected habitat types is the only immediate practical way of conserving invertebrate biodiversity and, since most animals are invertebrates, of implementing the Convention on Biological Diversity of the Rio de Janeiro conference.** Since only nations can establish protected areas it is essential that each nation establishes its own network of protected areas representing the habitat types found in it. The concept of national networks of protected areas to conserve biodiversity for the common good is now generally accepted. Conservation agencies in many nations are already making studies to identify the gaps in their coverage of habitats (eg. Canada, Uganda, USA). However in most countries the process of identifying the gaps and then establishing new protected areas to fill them is proceeding too slowly. The race against time is not being won. Nothing could give greater support for dragonfly conservation than to take measures to accelerate the completion of national networks of protected areas.

7.1.3 Actions proposed

A. Actions to be carried out by those responsible for Protected Area policy in each country (i.e. Governments, statutory conservation agencies and non-governmental organisations which own or manage protected areas).

1. Examine current list of protected areas in the country concerned.
2. Using existing information identify gaps in the national network of protected areas particularly those in forest and freshwater habitats. Note that birds, which have been relatively well studied, will often be valuable indicator organisms of these habitats (Bibby *et al.* 1992). Note also that organisations such as the World Conservation Monitoring Centre in Cambridge, UK may be able to help with enquiries.
3. Establish new protected areas as required. At the very least each country should establish a protected area for each "province" found within it (see Bailey 1989a and b).

B. Actions to be carried out by individual odonatologists, entomologists, and conservationists. If the direct approach outlined above requires initiation or support from individuals the following actions should be taken by them:

1. Examine list of protected areas in the country concerned.
2. Using existing information identify gaps in the forest and freshwater habitats in the national network of protected areas. Note as above that birds, which have been relatively well studied, will often be valuable

indicator organisms of these habitats (Bibby *et al.* 1992). Note also that organisations such as the World Conservation Monitoring Centre in Cambridge, UK, may be able to help with enquiries.

3. Contact other workers concerned with conservation in the country, especially those who are specialists on invertebrate groups.
4. Organise with them a joint approach to the national organisation(s) responsible for the national network of protected areas in the country and urge action to fill the gaps identified. Emphasise that completion of the national network of protected areas is essential for all groups of plants and animals, not only dragonflies, and that it is the principal means by which the Rio Convention on Biodiversity can be implemented.

7.1.4 Procedure and costing

Conservation is organised differently in different countries (WCMC 1992). Therefore no one particular approach by or to government or non-governmental organisations can be suggested.

The costs involved in establishing new protected areas will vary from place to place and from country to country. For these reasons it is not possible to estimate the costs of establishing new protected areas.

The work proposed for individuals would entail local travel, telephone etc. calls and postage. Cost: minimum US$500 - 2,000 according to country. Estimated costs will vary between countries and with currency fluctuations following date of publication.

7.2 Studies on the status of endemic species in centres of endemism

7.2.1 Objective

To build a source of information that will contribute towards conservation of the communities of rare endemic dragonfly species in notable, threatened centres of endemism.

7.2.2 Background

Notable centres of endemism in dragonflies occur in Africa, Meso and South America, Southeast Asia and Australasia (see p. 13). They are of great interest in their own right and their conservation is essential for maintaining global biodiversity of dragonflies. Despite their interest and importance, some have been little studied and some of the least well known are under serious threat. Priority should be given to those centres where least information exists and/or where the threat is greatest, hence to forests, and especially montane forests in

Cambodia
Colombia
Southern China
Indonesia
Laos
Madagascar
New Caledonia
Papua New Guinea
The Philippines
Vietnam
West and Central Africa (all countries between and including Guinea and Uganda)

7.2.3 Actions Proposed

1. Collate existing information on the centre of endemism or the part of it which is being studied.
2. Contact conservation organisations, both local and expatriate, which are working in the area, and seek their collaboration.
3. If the organiser is expatriate he/she must obtain the collaboration of an assistant from the nation in which the centre of endemism lies. If necessary, the organiser should train the assistant in the identification of the odonate species of the area, while undertaking surveys.
4. Determine range and habitat of endemic species of the area.
5. Determine the extent to which the endemic species occur in existing protected areas.
6. Determine whether current management of protected areas conserves endemic species adequately and, if it does not, suggest remedial measures.
7. If existing protected areas are insufficient to conserve their endemic species, suggest measures to ensure their survival elsewhere in the area, eg. by establishing new protected areas, by suggesting changes in commercial forestry management etc.
8. Submit report to the national conservation agency of the area and to relevant supporting international agencies, including IUCN. This should include proposals for monitoring the status of endemic species and/or their habitats following the completion of the project. Copy report to the chairman of the Odonata Specialist Group (see Appendix 2).

7.2.4 Procedure and costing

The procedure adopted will depend on whether the organiser of the project is local or expatriate. If expatriate it is essential that he/she undertakes the action proposed under 3 above.

Costs: a minimal study for New Caledonia involving two workers for one year would cost US$30,000, one for the Philippines, Vietnam, Cambodia, Laos or Madagascar would cost US$50,000 and one for Colombia, Indonesia, West Africa, Democratic Republic of the Congo or South China for two workers for three years US$90,000.

When submitting applications for grants the objectives of the project should always be clearly defined and costings itemised.

7.3 Improvement of the listing of dragonflies in the IUCN Red List of Threatened Animals

7.3.1 Objective

To confirm or amend the threat categories assigned to species in the 1996 Red List of Threatened Animals (IUCN 1996), to identify and categorise other threatened species which should be added to the Red List.

Table 7.1. Dragonflies in the 1996 Red List of Threatened Animals listed under the countries in which they occur

Country	Species
Angola	*Aciagrion rarum* (Coen) DD
	Monardithemis flava (Lib) VU(B1, 2c)
Armenia	*Calopteryx syriaca* (Cal) EN(A2c)
	Onychogomphus assimilis (Gom) VU(B1,2c)
	Cordulegaster mzymtae (Clg) VU(B1,2c)
Australia	*Hemiphlebia mirabilis* (Hem) VU(B1,2c)*
	Acanthaeshna victoria (Ae) VU(B1,2c)*
	Petalura pulcherrima (Pet) EN(B1,2c)*
	Austrocordulia leonardi (Cord) CR(B1,2c)
Azerbaijan	*Onychogomphus assimilis* (Gom) VU(B1,2c)
	Cordulegaster mzymtae (Clg) VU(B1,2c)
Bangladesh	*Lyriothemis tricolor* (Lib) EN(B1,2c)
Belize	*Amphipteryx agrioides* (Amph) EN(A1 c)*
Brazil	*Mecistogaster asticta* (Pst) VU(A1c)
	Mecistogaster pronoti (Pst) CR(A1c)
Cameroon	*Argiocnemis umbargae* (Coen) EN(B1,2c)
	Enallagma camerunense (Coen) EN(B1,2c)
Canada	*Somatochlora brevicincta* (Cord) VU(D2)
China	*Macromia urania* (Cord) EN(B1,2c)
	Libellula angelina (Lib) CR(A1,2c)
Colombia	*Amphipteryx agrioides* (Amph) EN(A1c)*
Congo	*Aethiothemis watuliki* (Lib) DD
Costa Rica	*Thaumatoneura inopinata* (Meg) EN(A1,2c)*
	Palaemnema chiriquita (Plst) EN(A1,2c)
	Palaemnema gigantula (Plst) EN(A1,2c)
	Palaemnema melanota (Plst) EN(A1,2c)
	Palaemnema reventazoni (Plst) EN(A1,2c)
	Epigomphus camelus (Gom) EN(A1,2c)
	Epigomphus subsimilis (Gom) EN(A1,2c)
	Epigomphus verticornis (Gom) EN(A1,2c)
	Diaphlebia pallidistylus (Gom) EN(A1,2c)
Cuba	*Hypolestes trinitatis* (Meg) EN(A1,2c)*
Democratic Republic of the Congo	*Pseudagrion quadrioculatum* (Coen) DD
	Anectothemis apicalis (Lib) DD
	Congothemis longistyla (Lib) DD
Dominican Republic	*Hypolestes clara* (Meg) EN(A1c)*
Egypt	*Paragomphus sinaiticus* (Gom) VU(A2c)
	Calopteryx syriaca (Cal)
El Salvador	*Amphipteryx agrioides* (Amph) EN(A1 c)*
Equatorial Guinea	*Cornigomphus guineensis* (Gom) EN(A1 c)*
	Trithemis hartwigi (Lib) EN(A1c)
Ethiopia	*Urothemis thomasi* (Lib) DD
France	*Gomphus graslini* (Gom) VU(B1,2c)
	Macromia splendens (Cord) VU(B1,2c)
Gabon	*Palpopleura albifrons* (Lib) CR(A1c)
Georgia	*Onychogomphus assimilis* (Gom) VU(B1,2c)
	Cordulegaster mzymtae (Clg) VU(B1,2c)
Guatemala	*Amphipteryx agrioides* (Amph) EN(A1 c)*
	Hetaerina rudis (Cal) EN(B1,2c)
	Heteragrion eboratum (Meg) EN(A1c)
	Heteragrion tricellulare (Meg) EN(A1 c)
	Epiogomphus clavatus (Gom) EN(A1 c)
	Progomphus risi (Gom) EN(A1 c)
Guinea-Bissau	*Brachythemis liberiensis* (Lib) CR(A1 c)
Haiti	*Phylolestesethelae* (Syn) VU(A1c)
	Hypolestes trinitatis (Meg) EN(A1c)*
	Hypolestes clara (Meg) EN(A1 c)*
Hawaii (USA)	*Megalagrion adytum* (Coen) VU(B1,2c)
	Megalagrion leptodemas (Coen) EN(B1,2c)
	Megalagrion nigrohamatum (Coen) LR
	Megalagrion nigrolineatum (Coen) VU(B1,2c)
	Megalagrion oahuense (Coen) VU(B1,2c)
	Megalagrion oceanicum (Coen) VU(B1,2c)
	Megalagrion pacificum (Coen) VU(B1,2c)
	Megalagrion xanthomelas (Coen) VU(B1,2c)
Honduras	*Amphipteryx agriodes* (Amph) EN(A1 c)*
	Heteragrion eboratum (Meg) EN(A1c)
India	*Epiophlebia laidlawi* (Ep) VU(B1,2c)*
	Cephalaeschna acutifrons (Ae) VU(B1,2c)
	Burmagomphus sivalikensis (Gom) CR(A1c)
	Lyriothemis tricolor (Lib) EN(B1,2c)
Iran	*Brachythemis fuscopalliata* (Lib) VU(B1,2c)
	Onychogomphus macrodon (Gom) EN(B1,2c)
Iraq	*Brachythemis fuscopalliata* (Lib) VU(B1,2c)
Israel	*Onychogomphus macrodon* (Gom) EN(B1,2c)
	Brachythemis fuscopalliata (Lib) VU(B1,2c)
Jamaica	*Hypolestes clara* (Meg) EN(A1c)*
Japan	*Rhinocypha ogasawarensis* (Chl) CR(B1,2c)
	Rhinocypha uenoi (Chl) EN(B1,2c)
	Indolestes boninensis (Lest) CR(B1,2c)
	Rhipidolestes okinawanus (Meg) EN(B1,2c)*
	Boninagrion ezoin (Coen) CR(B1,2c)*
	Mortonagrion hirosei (Coen) EN(B1,2c)
	Oligoaeschna kunigamiensis (Ae) ENM(B1,2c)
	Asiagomphus yayeyamensis (Gom) EN(B1,2c)
	Leptogomphus yayeyamensis (Gom) EN(B1,2c)
	Chlorogomphus iriomotensis (Clg) EN(B1,2c)
	Hemicordulia ogasawarensis (Cord) EN(B1,2c)
	Hemicordulia okinawensis (Cord) EN(B1,2c)
	Macromidia ishidai (Cord) EN(B1,2c)
	Macromia kubokaiya (Cord) EN(B1,2c)
	Macromia urania (Cord) EN(B1,2c)
	Boninthemis insularis (Lib) CR(B1,2c)*
	Libellula angelina (Lib) CR(A1,2c)
	Lyriothemis tricolor (Lib) EN(B1,2c)
Jordan	*Calopteryx syriaca* (Cal) EN(A2c)
	Onychogomphus macrodon (Gom) EN(B1,2c)
Lebanon	*Onychogomphus macrodon* (Gom) EN(B1,2c)
Liberia	*Brachythemis liberiensis* (Lib) CR(A1c)
Korea	*Libellula angelina* (Lib) CR(A1,2c)
Madagascar	*Isomma hieroglyphicum* (Gom) VU(A1c)*
	Libellulosoma minuta (Cord) VU(B1,2c)*
Mauritius	*Platycnemis mauriciana* (Plcn) CR(B1,2c)
Mexico	*Amphiperyx agrioides* (Amph) EN(A1 c)*
	Hetaerina rudis (Cal) EN(B1,2c)
	Heteragrion tricellulare (Meg) EN(A1 c)

7.3.2 Background

While top priority should be given to completing the national network of protected areas in each country (see p. 18) and to study threatened centres of endemism (see p. 19) it is highly desirable to undertake supporting work on individual species in each country. Table 7.1 drawn from the 1996 Red List should provide a starting point for selecting species to study. However, it is a very uneven and incomplete document. Only in countries like Japan, where dragonflies have been extensively studied, is it possible to attribute a category of threat to a species with much confidence. Very few evaluations have been made of tropical dragonflies. For example, no species from Indonesia, Thailand or Peru is on the list. Consequently it can be inferred that most species which are actually threatened are not yet on the Red List. Further, experience shows that as more information is obtained, the categorisation of species already on the list has to be changed. For example, *Ophiogomphus*

Table 7.1. continued

Country	Species
	Paraphlebia zoe (Meg) EN(A1c)
	Palaemnema paulicoba (Plst) EN(A1c)
	Aeshna williamsoniana{Ae) EN(A1c)
	Epigomphus crepidus (Gom) EN(A1 c)
	Epigomphus paulsoni (Gom) EN(A1c)
	Progomphus risi (Gom) EN(A1 c)
Mozambique	*Ceriagrion mourae* (Coen) DD
Myanmar	*Cephalaeschna acutifrons* (Ae) VU(B1,2c)
	Lyriothemis tricolor (Lib) EN(B1,2c)
Nepal	*Epiophlebia laidlawi* (Ep) VU(B1,2c)*
	Cephalaeschna acutifrons (Ae) VU(B1,2c)
New Zealand	*Antipodochlora braueri* (Cord) LR
Niger	*Paragomphus sinaiticus* (Gom) VU(A1 c)
Oman	*Paragomphus sinaiticus* (Gom) VU(A2c)
	Urothemis thomasi (Lib) DD
Pakistan	*Burmagomphus sivalikensis* (Gom) CR(A1 c)
Panama	*Thaumatoneura inopinata* (Meg) EN(A1,2c)*
	Aeshna williamsoniana{Ae) EN(A1c)
Philippines	*Rhinocypha hageni* (Chl) EN(B1,2c)
	Rhinocypha latimaculata (Chl) EN(B1,2c)
Portugal	*Gomphus graslini* (Gom) VU(B1,2c)
	Macromia splendens (Cord) VU(B1,2c)
Principe (Sao Tome)	*Trithemis nigra* (Lib) CR(B1,2c)
Rodrigues (Mauritius)	*Argiocnemis solitaria* (Coen) CR(B1,2c)
Saudi Arabia	*Paragomphus sinaiticus* (Gom) VU(A2c)
	Urothemis thomasi (Lib) DD
Sierra Leone	*Argiagrion leoninum* (Coen) EN(B1,2c)
	Allorhizucha campioni (Lib) EN(A1c)
Somalia	*Urothemis thomasi* (Lib) DD
South Africa	*Chlorolestes apricans* (Syn) CR(A1a)
	Chlorolestes draconicus (Syn) LR
	Ecchlorolestes nylephtha (Syn) LR
	Ecchlorolestes peringueyi (Syn) VU(B1,2c)
	Enallagma polychromaticum (Coen) DD
	Metacnemis angusta (Plcn) DD
	Orthetrum rubens (Lib) DD
	Urothemis luciana (Lib) DD
Spain	*Gomphus graslini* (Gom) VU(B1,2c)
	Macromia splendens (Cord) VU(B1,2c)
Sudan	*Paragomphus sinaiticus* (Gom) VU(A2c)
Syria	*Calopteryx syriaca* (Cal) EN(A2c)
	Brachythemis fuscopalliata (Lib) VU(B1,2c)
	Onychogomphus macrodon (Gom) EN(B1,2c)
Tanzania	*Amanipodagrion gilliesi* (Meg) EN(B1,2c)
	Aeshna meruensis (Ae) EN(B1,2c)
Taiwan	*Macromia urania* (Cord) EN(B1,2c)
	Lyriothemis tricolor (Lib) EN(B1,2c)
Turkey	*Calopteryx syriaca* (Cal EN(A2c)
	Onychogomphus assimilis (Gom) VU(B1,2c)
	Onychogomphus macrodon (Gom) EN(B1,2c)
	Cordulegaster mzymtae (Clg) VU(B1,2c)
	Brachythemis fuscopalliata (Lib) VU(B1,2c)
USA	*Calopteryx angustipennis* (Cal) LR
	Nehalennia pallidula (Coen) VU(B1,2c)
	Enallagma recurvatum (Coen) VU(A2c)
	Ischnura gemina (Coen) N(A2e)
	Aeshna persephone (Ae) VU(B1,2c)
	Erpetogomphus lampropeltis (Gom) EN(B1,2c)
	Gomphurus consanguis (Gom) VU(B1,2c)
	Gomphurus lynnae (Gom) EN(B1,2c)
	Gomphurus modestus (Gom) LR
	Gomphus diminutus (Gom) LR
	Gomphus hodgesi (Gom) LR
	Gomphus sandrius (Gom) EN(A1 c)
	Gomphus septima (Gom) (Gom) VU(B1,2c)
	Hylogomphus geminatus (Gom) LR
	Hylogomphus parvidens (Gom) LR
	Ophiogomphus acuminatus (Gom) VU(A2c)
	Ophiogomphus anomalus (Gom) LR
	Ophiogomphus edmundo (Gom) CR(D2)
	Ophiogomphus howei (Gom) VU(A2c)
	Ophiogomphus incurvatus (Gom) LR
	Progomphus bellei (Gom) VU(A2c)
	Stylurus potulentus (Gom) VU(A2c)
	Stylurus townesi (Gom) VU(A2c)
	Zoraena sayi (Clg) VU(B1,2c)
	Macromia margarita (Cord) LR
	Somatochlora calverti (Cord) LR
	Somatochlora hineana (Cord) EN(B1,2c)
	Somatochlora margarita (Cord) VU(D2)
	Somatochlora incurvata (Cord) LR
	Somatochlora ozarkensis (Cord) LR
	Williamsonia lintneri (Cord) VU(A2c)
	Libellulajesseana (Lib) VU(A2c)
Vietnam	*Macromia urania* (Cord) EN(B1,2c)
Zambia	*Monardithemis flava* (Lib) VU(B1,2c)

Note:
Each species name is followed by the abbreviation of its family (see Table 2.1), its threat category (DD = data deficient, EN = endangered, LR = lower risk - near threatened, VU = vulnerable) and the criteria used in selecting its threat category (see IUCN 1994 and 1996).
Note that several species occur in more than one country.
* = Priority Species including those of monotypic genera confined to one country.

Some country entries have been added since the publication of the 1996 Red List. Three European species *Coenagrion mercuriale* (Coen) VU (A2c); *Oxygastra curtisii* (Cord) VU(A1 c); and *Aeshna viridis* (Ae) LR occur in many countries and have been omitted to save space. Their distribution and the threats to them are sufficiently well known for confidence to be placed in their present categorisation.

edmundo, which was previously listed as Extinct, was rediscovered in the USA in 1995 (Dunkle - personal communication), and *Hemiphlebia mirabilis*, which had been categorised as Endangered since it was only known from one site in Australia, has been found to occur in seven widely separated localities there (Watson 1995) and so is now classified as Vulnerable. Future work will almost certainly show that some species on the current Red List are much more abundant than was thought previously and so should be removed from it. Clearly the Red List needs to be checked and added to. The process of improving the Red List will bring to light much information that can be used to help conserve the species selected for study.

7.3.3 Actions proposed

1. Select species to study: use Table 7.1 to determine whether your country contains listed threatened dragonflies. If it does, check the threat category assigned to the species, referring to the categories and criteria in IUCN 1994 (Appendix 1). If the threat category appears to be incorrect for any species, that species should be studied. If local knowledge suggests that other species should be added to the list, particularly if they are Priority Species (Tables 6.1, 6.2 and 6.3) they also should be studied. If your country contains no species in the current Red List, study species which you think should be added to it, giving priority to species according to the criteria outlined in section 6.3.2.
2. Assemble available data on the species to be studied (see also 7.4).
3. Determine range and habitat of species.
4. Assess threats to species studied and where warranted ensure their listing in the next IUCN Red List.
5. Submit report listing species, categories and criteria to the Chairman of the Odonata Specialist Group (see Appendix 2) who will make amendments to the Red List.

7.3.4 Procedure and costing

Whenever possible the project should be carried out by one or more local specialists who are knowledgeable about the species to be studied. When this is not possible an expatriate specialist should organise the project and then endeavour to enlist the support of a local worker and train the latter so that he/she can monitor the species in future years.

Cost: the number of species which can be studied in any one country will vary considerably. Some studies in some countries could be done very cheaply, but where one person is employed full time for a year the cost will be of the order of US$20,000.

7.4 Advice to national conservation organisations concerning species studied in the course of revising the list of dragonflies in the IUCN Red List of Threatened Animals (see 7.3)

7.4.1 Objective

To record and expand information gathered when revising the Red List so that it can be used by national conservation organisations immediately.

7.4.2 Background

The revised listing of threatened species (see 7.3) will be of value to national conservation organisations, but it will be much more useful if it is linked with additional information about the threats to species in protected areas. The total information will enable up to date, practical proposals to mitigate these threats to be made to national conservation organisations.

7.4.3 Actions proposed

1. Determine the extent to which the threatened species studied under 7.3 occur in protected areas.
2. Determine whether current management of protected areas conserves each species adequately and, if it does not, determine remedial measures.
3. Assess the status of each threatened species in your country and determine what measures additional to changes in management of protected areas are required. Measures might include the establishment of new protected areas or changes in commercial forestry management.
4. Submit reports on requirements in protected areas and proposals for new conservation measures to relevant government and non-governmental organisations in the country concerned. Copies of the report should be sent both to the Chairman and to the Data Coordinator of the Odonata Specialist Group (see Appendix 2).

7.4.4 Procedure and costing

This action should normally be undertaken by those undertaking action 7.3.

Costs: costs will vary greatly between countries. Estimates should be based on the rate of US$10 per hour. Travel expenses will be involved.

7.5 Collection of data on priority species from collections

7.5.1 Objective

To enable full use to be made of existing information on collections, by incorporating it into the Odonata Conservation Database.

7.5.2 Background

Much information on the distribution and habitats of Priority Species exists in collections and in the field notebooks of collectors, but much of it is unpublished and unavailable for conservation purposes. There is an urgent need to make better use of this information, but few workers have enough time to collate it without some financial support.

7.5.3 Actions proposed

1. Identify principal collections in the country concerned.
2. Obtain permission to search for data in them.
3. Examine labels of all specimens of Priority Species (see Tables 6.1, 6.2 and 6.3). On Record Cards provided by the Data Coordinator of the Odonata Specialist Group (Dr J. van Tol, PO Box 24, 2250 AA Voorschoten, The Netherlands) enter information on locality, date, collector, and where possible, coordinates and altitude. Where supporting information on habitats is available on the labels or in field note books this information should be added on the back of the Record Card.
4. Having entered information on Record Cards send them to the Data Coordinator of the Odonata Specialist Group (see Appendix 2).

7.5.4 Procedure and costing

Note that if the collection is an important one and appears to be in need of conservation, support for its future maintenance should be sought under Action Proposal 7.6.

Cost: if on average one specimen can be processed in a minute, at a rate of US$10 per hour, the processing of 1,000 specimens would cost US$170. The cost of calculating coordinates and altitudes and the cost of travelling expenses would be additional.

7.6 Collection of data on priority species from published literature

7.6.1 Objective

To improve the Odonata Conservation Database by incorporating published information on the distribution and habitats of Priority Species.

7.6.2 Background

Published information on Priority Species is scattered in a wide range of publications throughout the world. It needs to be assessed, collated and made available as soon as possible. To make full use of local knowledge of dragonflies, publications and language this is best done on a national basis.

7.6.3 Actions proposed

1. Identify journals and books published in your country which contain data on Priority Species (see Tables 6.1, 6.2 and 6.3).
2. Search for data on Priority Species in these publications and enter them on Record Cards obtained from the Data Coordinator of the Odonata Specialist Group (see Appendix 2). Include information on location, date and author, and where possible, coordinates and altitude, citing the publication in full.
3. Send the completed cards to the Data Coordinator of the Odonata Specialist Group

7.6.4 Procedure and costing

The amount of work required will vary greatly between countries. Estimates should be based on the rate of US$10 per hour.

7.7 Conservation of important collections of dragonflies

7.7.1 Objective

To ensure the preservation of important collections of dragonflies for future research.

7.7.2 Background

Collections of dragonflies provide important evidence, sometimes the only evidence, of localities of dragonflies. On the death of a collector his/her collection may deteriorate

or even be lost or destroyed. Collections, even in well-known museums, may deteriorate through lack of funding. Therefore there is a great need to identify those collections which are threatened and then to ensure that they are adequately cared for in the future.

7.7.3 Actions proposed

1. Identify a collection which is at risk and visit owner.
2. Obtain or make a list of the species in the collection. If the collection contains specimens of Priority Species additional support for obtaining data on them can be sought under Action Proposal 4.
3. After consultation with the owner, propose practical means for ensuring the conservation of the collection in the future.
4. Submit proposals for the future care of the collection to the Chairman of the Odonata Specialist Group (see Appendix 2) outlining what assistance is required and enclosing a copy of the list of species in the collection.

7.7.4 Procedure and costing

The full support of the collection owner, whether individual or organisation, is crucial. The organiser of the project should be an entomologist, preferably an odonatologist with experience in working on collections in museums.

Costs will consist mainly of travel expenses and usually will be small unless the work has to be done by an expatriate. Estimates should be based on the rate of US$10 per hour.

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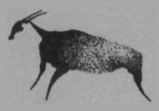

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