

Ireland

Red List No. 7



THE IUCN RED LIST  
OF THREATENED SPECIES™

# Mayflies

(Ephemeroptera)







Ireland Red List No. 7:

Mayflies (Ephemeroptera)

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## EXECUTIVE SUMMARY

Based on almost 14,000 records for Ireland, the 33 species of Irish mayflies (Ephemeroptera) are evaluated for their conservation status using International Union for the Conservation of Nature (IUCN) criteria and guidelines (IUCN, 2001; 2003; 2010). Six (18%) of the Irish species are assessed as Threatened, two species as Near Threatened and two species as data deficient.

The six Threatened species are:

- *Siphonurus armatus* (Northern Summer Mayfly) – Critically Endangered
- *Baetis atrebatinus* (Dark Olive) - Endangered
- *Ephemerella notata* (Yellow Hawk) - Endangered
- *Rhithrogena germanica* (March Brown) - Vulnerable
- *Proclleon bifidum* (Pale Evening Dun) - Vulnerable
- *Leptophlebia marginata* (Sepia Dun) – Vulnerable

The two Near Threatened species are:

- *Kageronia fuscogrisea* (Brown May Dun)
- *Ameletus inopinatus* (Upland Summer Mayfly)

The two data deficient species are:

- *Baetis fuscatus* (Pale Watery)
- *Ecdyonurus torrentis* (Large Brook Dun)

The records used in this assessment have been largely based on collections of nymphs. This poses a problem for species which are only reliably confirmed from adult material and has been considered in the assessment. Interestingly, most of the Threatened species inhabit rivers, although some also occur in lakes, and their status possibly reflects a longer and more widespread history of pollution pressure on rivers. The Threatened species are also those that have restricted distributions and so are particularly vulnerable to impact. A number of other species (*Caenis macrura*, *Ecdyonurus torrentis* and *Siphonurus alternatus*) have restricted distributions but have not been listed because no significant change has occurred between the two time periods (pre-1990 and 1990-2011). Water pollution is the key threat to the species listed. The implementation of the objectives of the Water Framework Directive should bring about improvement in water quality which should help stem losses in aquatic biodiversity. In the interim the aforementioned species should be prioritised for monitoring together with the two Threatened and two data deficient species with sampling focussed particularly on the adults. It is also essential that knowledge gaps on the autecological requirements and pollution sensitivity of these species be addressed so as to inform conservation measures. Finally, it is crucial that we identify and protect species-rich refugia in catchments throughout the country that will become important source areas for ephemeropteran and other pollution-sensitive species as impacted systems recover in the future.

## **ACKNOWLEDGEMENTS**

The authors would like to thank the many scientists and naturalists who have contributed ephemeropteran records to the National Biodiversity Data Centre, in particular the Environmental Protection Agency, post-graduate students in the School of Biology and Environmental Science, University College Dublin, and Imelda O'Neill at the Northern Ireland Environment Agency who have made large databases available for this analysis. We are very grateful to the staff and students at these organisations who helped with the data collection including Hugh Feeley, Pamela Maher, Gary Free, Ruth Little, Deirdre Tierney, and Imelda O'Neill. Thanks are also due to Dr Naomi Kingston and Dr Brian Nelson, NPWS, for their assistance with the red listing and to John Lucey and Craig McAdam who were the external reviewers of this publication.

## INTRODUCTION

The Ephemeroptera, commonly known as mayflies, is an ancient order of insects dating from the Carboniferous and Permian periods, and the oldest of the extant winged insects. There are over 3,000 species from 42 different families (Barber-James *et al.* 2008). They are totally reliant on aquatic habitats where they live most of their life as juveniles, emerging solely to reproduce. They have colonised a range of aquatic habitats including streams, rivers, ponds and lakes. The greatest number of species are associated with running water where some have adapted to particular flow and substrate conditions, while other are not so restricted, e.g. *Baetis rhodani*. Most species are considered herbivorous and are categorised as grazers but some species are also gatherers feeding on fine particulate organic matter in addition to plant material. Few species are considered to be predators. In fact, many species have a fairly plastic diet capitalizing on seasonally abundant food sources. Mayflies do not feed during their short-lived adult stage. They are unique in that they have two adult phases, the sub-imago or dun which usually moults within 24 hours, and the imago or spinner which is the final reproductive stage. Life history strategies vary in that some complete their life cycle within two years while others can produce several generations each year.

In Ireland, the Ephemeroptera are species-poor compared to Britain and mainland Europe (represented by only 33 species) and this is due in large part to our glacial history and isolation from mainland Europe. Despite this they represent a key component of our freshwater biodiversity. In running water they can constitute a high proportion, both numerically and in terms of biomass, of the total macroinvertebrate fauna, except where conditions are highly acidic, and they also make a significant contribution to the diet of salmonid fishes. Their emergence is important in terms of the energy returned to terrestrial ecosystems. The adults are consumed by a variety of animals from birds to spiders.

The Ephemeroptera are particularly important as indicators of water quality and form the core of many biotic indices including the Irish EPA Q-value system. In the Irish index only *Baetis rhodani* and the Caenidae are considered relatively tolerant to pollution. This makes the group as a whole particularly vulnerable to species loss. Kelly-Quinn and Bracken (2000) expressed concern about the apparent loss of species richness in many river systems throughout Ireland.

The records of Ephemeroptera in Ireland date as far back as the late 1800s and all of our 33 species were first recorded in Ireland within 100 years of this first record (Figure 1). The work of Kelly-Quinn and Bracken (2000) brought together the extensive records that existed for the group. This database was updated by Mary Kelly-Quinn and the National Biodiversity Data Centre in 2012 with data from university research projects and from river biologists at the Environmental Protection Agency and the Northern Ireland Environment Agency. The primary data repository is the National Biodiversity Data Centre with all records verified by Mary Kelly-Quinn. This database was used for the red list analysis. It is now also available online through Biodiversity Maps (<https://maps.biodiversityireland.ie/>).

## Legal Protection

At the time of writing (May 2012) no ephemeropteran species are legally protected in Ireland.



## DEVELOPMENT OF THE RED LIST

### Methodology used

The mayfly list is the seventh in a series of regional red lists for the island of Ireland being developed by the National Parks and Wildlife Service and the Northern Ireland Environment Agency in conjunction with the National Biodiversity Data Centre and the Northern Ireland biological records centre, CEDaR. The International Union for the Conservation of Nature (IUCN) provides guidelines for using the red list categories at a regional level (IUCN, 2003). This guidance was used alongside the current IUCN categories and criteria (IUCN, 2001), and guidelines for their use (IUCN, 2010; see Appendix 1) in the production of this red list.

### Nomenclature & Checklist

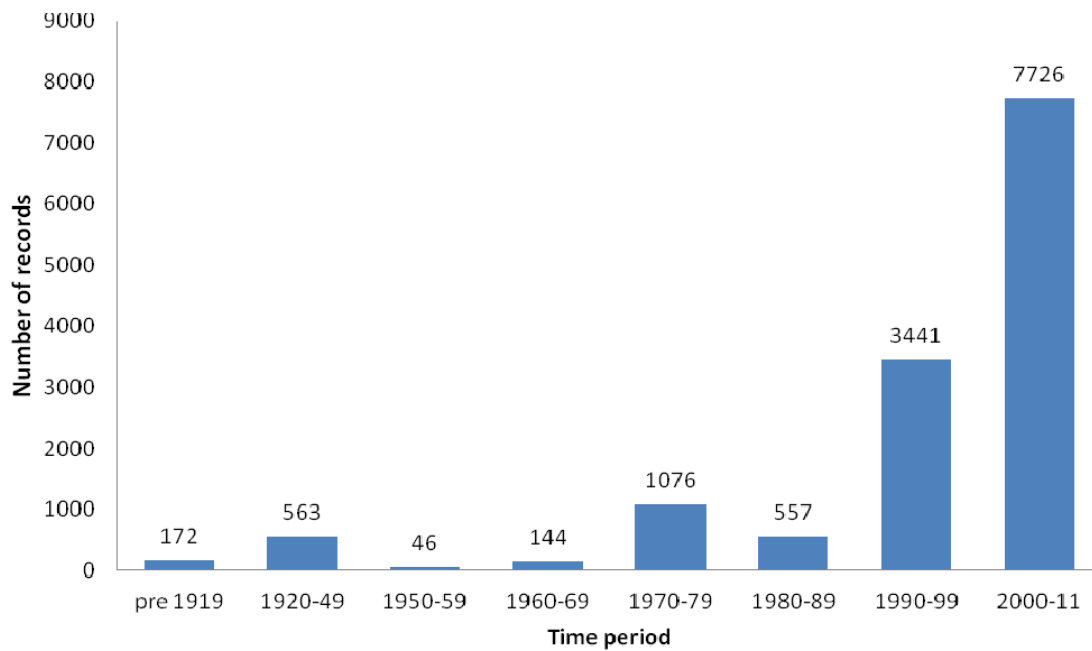
Nomenclature and checklist follows O'Connor and Nelson (2012). Nomenclature for common names follows MacAdam and Bennett (2010).

### Data sources

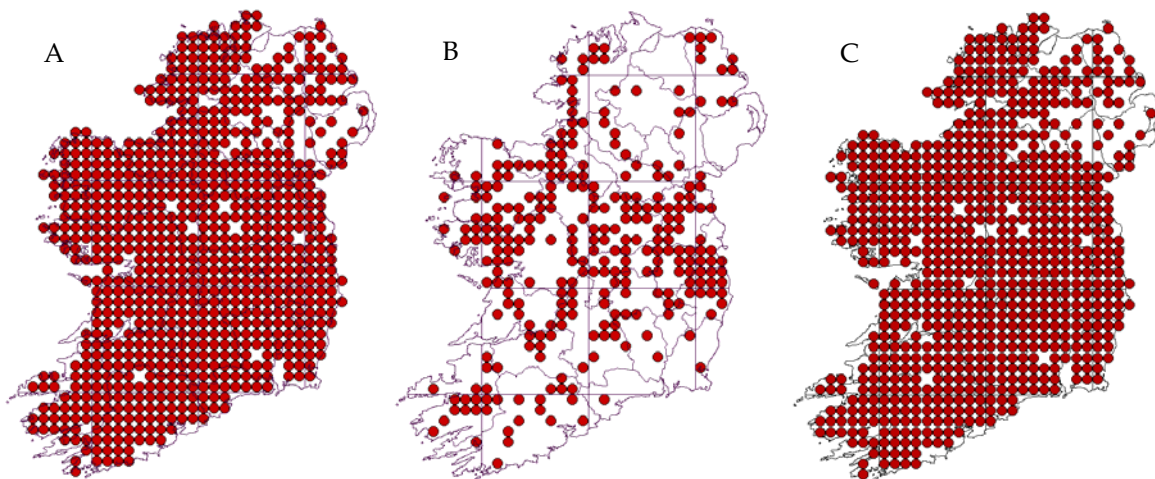
Of the five IUCN criteria only A, B and D2 were used in the absence of any population level data for the species under consideration (Table 2) (see Appendix 1).

### Regionally determined settings

The time frame for assessing change was set at 1990-2011 and pre-1990. The number and distribution of records in the Ephemeroptera of Ireland database from 1850 to 2011 are shown in Figures 1 and 2. There are more records for the period 1990-2011 which implies that any decline in distribution shown in the maps is conservative and the real decline may actually be greater than the maps show. However, it also needs to be taken into account that a large proportion of the 1990-2011 records come from the EPA River Biologists's data which holds records of only six ephemeropteran species. A species was considered extinct if it had not been recorded in over 100 years. Two species were considered data deficient, i.e. little or no information on the abundance and distribution of the species. The IUCN advise that red lists are re-evaluated every five years where possible, or at least every ten years. The next red list assessment for Irish Ephemeroptera should therefore take place no later than 2022. The assessment was carried out on an all-Ireland basis. The IUCN regional guidelines recommend that regional assessments should be carried out in a two-step process (IUCN 2003). Step one is the initial assessment of the regional population. Step two can be applied if there are any conspecific populations outside the region that may affect the risk of extinction within the region. This was determined not to apply to the Irish mayfly populations and the Red List Categories defined by the criteria were adopted unaltered.



**Figure 1:** The number of records in the Ephemeroptera of Ireland database from 1850 to 2011 (4,611 records are from the EPA River Biologist’s data from 2005 to 2009).



**Figure 2:** Coverage maps of records of Irish Ephemeroptera showing (A) all the hectads with at least one validated record (795), (B) hectads with records before the end of 1989 (282), and (C) hectads with records since the start of 1990 (776). The island of Ireland has just over 1000 hectads containing some land.

### Species coverage

A total of 33 species were assessed (Table 1), which includes all of the ephemeropteran species considered to occur in Ireland. The assessment included *Baetis fuscatus* which is indicated as unconfirmed on the current Irish checklist. Its presence in Ireland requires confirmation with adult male voucher material as previous records are based on females and nymphs (O’Connor and Nelson 2012). All taxa were assessed at the species level in accordance with the IUCN guidelines (IUCN 2001; 2003).

### Assessment group

The assessment was undertaken on the 14<sup>th</sup> of May 2012 by a panel comprising Mary Kelly-Quinn, Brian Nelson, Naomi Kingston and Eugenie Regan. The document was sent to two external assessors: Craig Macadam (Ephemeroptera Recording Scheme, Great Britain) and John Lucey (Environmental Protection Agency, Ireland).

### Species accounts

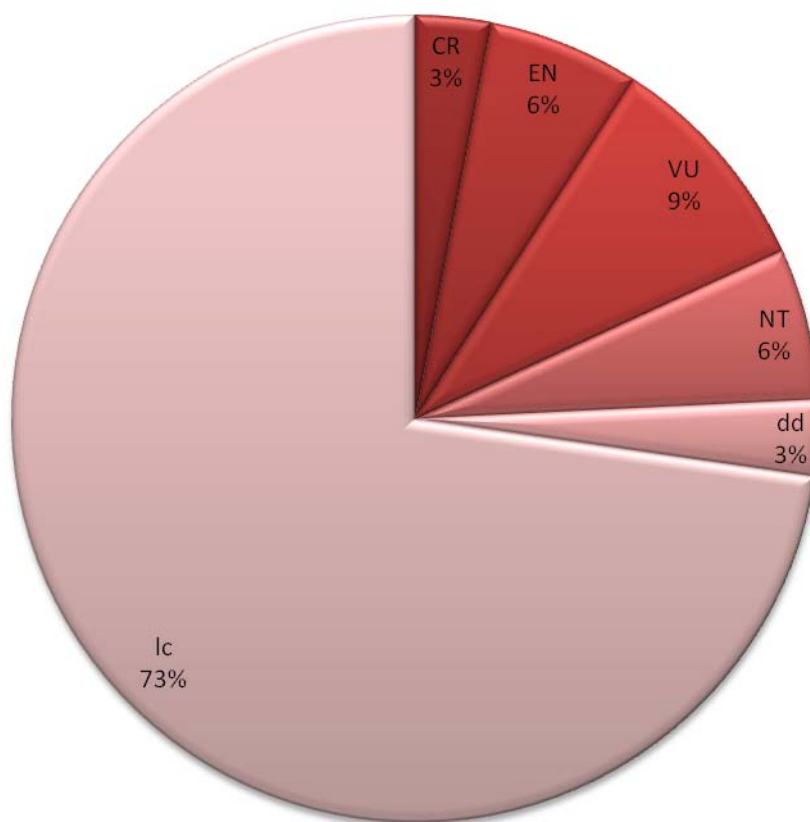
Brief species accounts are given with the information derived from Kelly-Quinn and Bracken (2000). Additional ecological information is taken from Buffagni *et al.* (2009). Information on pollution sensitivity is largely derived from the EPA Q-value sensitivity classification (McGarrigle *et al.* 2002). Sensitivity to deposited sediment (hereafter referred to as siltation) is taken from Extence *et al.* (2011). Maps are provided for the Threatened and Near Threatened species.

**Table 1:** Red list of Irish Ephemeroptera (Mayflies). CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, lc = least concern.

Species	Authority	Assessment	Criteria
<i>Siphonurus armatus</i>	Eaton, 1870	CR	B2(a)(b)(iii)
<i>Baetis atrebatinus</i>	Eaton, 1870	EN	A2(a)(c)
<i>Ephemerella notata</i>	Eaton, 1887	EN	A2(a)(c), B2(a)(b)(ii)(iv)
<i>Rhithrogena germanica</i>	Eaton, 1885	VU	D(2)
<i>Proclleon bifidum</i>	(Bengtsson, 1912)	VU	A2(a)(c)
<i>Leptophlebia marginata</i>	(Linnaeus, 1767)	VU	D(2)
<i>Kageronia fuscogrisea</i>	(Retzius, 1783)	NT	A2(a)(c)
<i>Ameletus inopinatus</i>	Eaton, 1887	NT	B2(a)(b)(iii)
<i>Baetis fuscatus</i>	(Linnaeus, 1761)	dd	
<i>Alainites (Baetis) muticus</i>	(Linnaeus, 1758)	lc	
<i>Baetis rhodani</i>	(Pictet, 1843)	lc	
<i>Baetis scambus</i>	Eaton, 1870	lc	
<i>Baetis vernus</i>	Curtis, 1834	lc	
<i>Caenis horaria</i>	(Linnaeus, 1758)	lc	
<i>Caenis luctuosa</i>	(Burmeister, 1839)	lc	
<i>Caenis macrura</i>	Stephens, 1835	lc	
<i>Caenis rivulorum</i>	Eaton, 1884	lc	
<i>Centroptilum luteolum</i>	(Müller, 1776)	lc	
<i>Cloeon dipterum</i>	(Linnaeus, 1761)	lc	
<i>Cloeon simile</i>	Eaton, 1870	lc	
<i>Ecdyonurus dispar</i>	(Curtis, 1834)	lc	
<i>Ecdyonurus insignis</i>	(Eaton, 1870)	lc	
<i>Ecdyonurus torrentis</i>	Kimmins, 1942	lc	
<i>Ecdyonurus venosus</i>	(Fabricius, 1775)	lc	
<i>Electrogena lateralis</i>	(Curtis, 1834)	lc	
<i>Ephemera danica</i>	Müller, 1764	lc	
<i>Heptagenia sulphurea</i>	(Müller, 1776)	lc	
<i>Leptophlebia vespertina</i>	(Linnaeus, 1758)	lc	
<i>Paraleptophlebia cincta</i>	(Retzius, 1783)	lc	
<i>Rhithrogena semicolorata</i>	(Curtis, 1834)	lc	
<i>Serratella ignita</i>	(Poda, 1761)	lc	
<i>Siphonurus alternatus</i>	(Say, 1824)	lc	
<i>Siphonurus lacustris</i>	Eaton, 1870	lc	

**Table 2:** Summary of evaluations and breakdown of main IUCN criteria.

	No. spp.	IUCN criteria		
		A2	B2	D2
Critically Endangered	1		1	
Endangered	2	2	1	
Vulnerable	3	1		2
Near Threatened	2	1	1	



**Figure 3:** Percentage of the Irish ephemeropteran (mayfly) fauna within each of the IUCN regional red list categories.

## SPECIES NOTES

This section gives brief notes on all the assessed species. More detailed information is given in Kelly-Quinn and Bracken (2000).

### *Alainites (Baetis) muticus*

**IUCN least concern**

#### Iron Blue

Formerly known as *Baetis muticus* and earlier as *B. pumilus*, this is predominantly a riverine species, inhabiting riffle areas among cobble substrates, but has been picked up in a small number of lentic habitats. *A. muticus* generally does not occur in large numbers but has a fairly wide distribution, similar to that of *Baetis rhodani*. Occasionally the species is found in high densities among aquatic macrophytes in limestone rivers. It also appears to be less tolerant of acidic conditions than *B. rhodani*. It is moderately tolerant of eutrophication/organic pollution but rated as highly sensitive to deposited sediment.

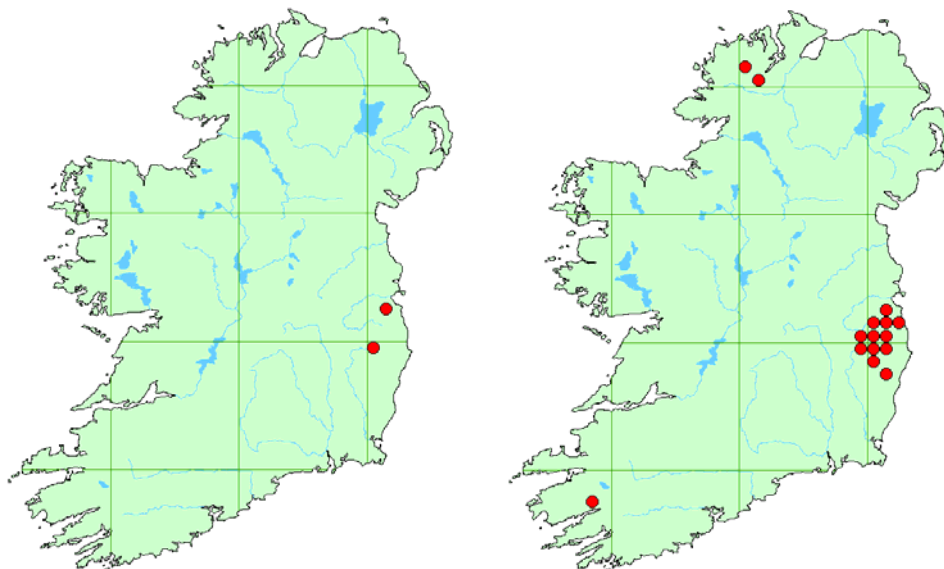
### *Ameletus inopinatus*

**IUCN Near Threatened**

#### Upland Summer Mayfly

**B2ab(iii)**

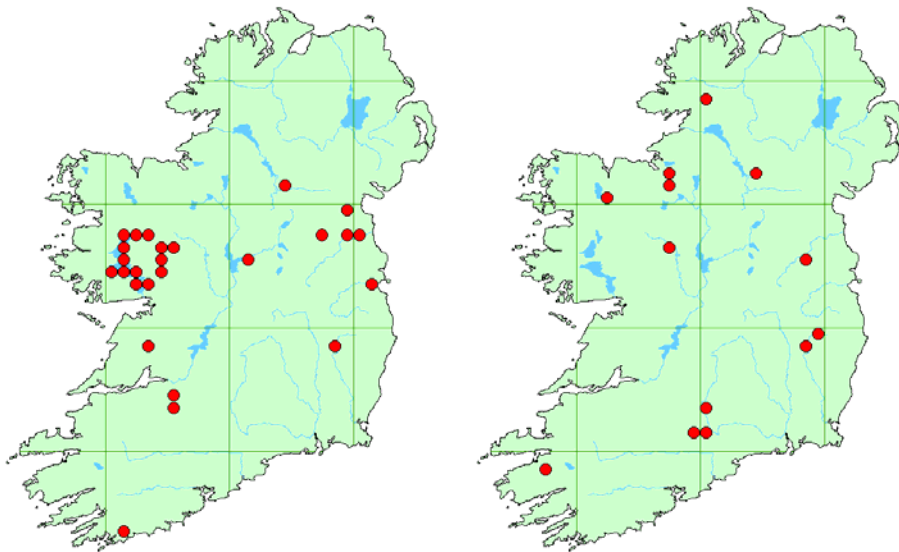
*Ameletus inopinatus* is considered an arctic-alpine relict species that is confined to the cool waters of upland streams and rivers where it can be locally abundant. So far it has been recorded in Wicklow, Donegal and Kerry. In Wicklow it is generally found in streams above 300m but in Donegal it can occur at lower altitudes. This is a potential climate change indicator species that is sensitive to increases in water temperature. It is also sensitive to organic pollution and nutrient enrichment which could originate from forestry operations within the current range of the species. Sediment input from felling could be a potential threat to this species. *A. inopinatus* is assessed as Near Threatened under the criteria B2ab(iii) because the area of occupancy is less than 2,000km<sup>2</sup>, the distribution is fragmented, and the quality of habitat could decline as a result of the aforementioned pressures.



**Figure 4:** Distribution of *Ameletus inopinatus* in Ireland pre-1990 (left) and post-1990 (right).

*Baetis atrebatinus***IUCN Endangered****Dark Olive****A2(a)(c)**

*Baetis atrebatinus* is one of the two narrow-bodied members of the Baetidae to be found in Ireland and is confined to streams and rivers, particularly in calcareous areas. Little is known about the ecology of *B. atrebatinus* but it is likely to be sensitive to organic pollution/eutrophication, and has been rated as highly sensitive to siltation. This species is assessed as Endangered because a population reduction of 50% has been directly observed (the area of occupancy has reduced from 26 to 13 hectads).



**Figure 5:** Distribution of *Baetis atrebatinus* in Ireland pre-1990 (left) and post-1990 (right).

*Baetis fuscatus***IUCN data deficient****Pale Watery**

*Baetis fuscatus*, formerly known as *Baetis binoculatus* Linnaeus, 1758, is a difficult species to identify from the nymphal stage. King and Halbert (1910) published records from Clare Island, Killarney, Wicklow and Armagh while more recently Wise and O'Connor (1997) published records from 1971-1972 from the Killarney area. Given the species' apparent preference for alkaline rivers (Buffagni *et al.* 2007; 2009) and the lack of adult male specimens, these records need to be verified. There are no modern records for this species although the species has been surveyed for. This species is indicated as unconfirmed on the current Irish checklist. Its presence in Ireland requires confirmation with adult male voucher material as previous records are based on females and nymphs (O'Connor and Nelson 2012).

*Baetis rhodani*

**IUCN least concern**

**Large Dark Olive**

*Baetis rhodani* is one of the most widespread and abundant mayflies that forms the core of the ephemeropteran community in Irish rivers where it is especially suited to fast currents. The plasticity of its life cycle and generalist feeding habits allows *Baetis rhodani* to inhabit a wide range of river types. The species is generally present in most rivers throughout the country including oligotrophic streams at altitudes up to 350m, where it is mildly tolerant of episodic acidity. Occasionally it appears at the inflow or outflow points of rivers entering or leaving lakes. It is relatively tolerant of eutrophication and therefore its absence from any lotic habitat is probably indicative of toxic conditions.

*Baetis scambus*

**IUCN least concern**

**Small Dark Olive**

*Baetis scambus*, a fairly small nymph, occurs in most rivers and in all parts of the country. It has also been found in episodically acidic waters near the headwaters of the River Liffey in the Wicklow Mountains. It is, however, more common in alkaline rivers with fast-flowing currents. It is probably moderately sensitive to organic pollution/eutrophication but is rated as highly sensitive to siltation.

*Baetis vernus*

**IUCN least concern**

**Medium Olive**

This is a riverine species with a higher occurrence in oligotrophic systems such as those of the Wicklow, Comeragh, Slieve Bloom and the Kerry Mountains. It has also been found in alkaline rivers. *Baetis vernus* often becomes numerically abundant in the absence of other Baetidae. Eutrophication in alkaline waters poses a threat to this species. In acid-sensitive rivers it probably escapes the worst of episodic acidity because it over-winters in the egg stage.

*Caenis horaria*

**IUCN least concern**

**Angler's Curse**

*Caenis horaria* is the largest of the Caenidae occurring in Ireland. In King and Halbert (1910) it appears under the name *Caenis dimidiata* Stephens. It is generally associated with silty, depositing habitats and is widely distributed in Ireland especially in lakes, ponds and slow-flowing sections of large river and is relatively tolerant of the effects of organic pollution/eutrophication and siltation of its habitat.



*Caenis luctuosa*

**IUCN least concern**

**Angler's Curse**

Originally known as *Caenis moesta* Bengtsson this species is common throughout Ireland typically occurring in slow-flowing sections of rivers or ponds/lakes with silty substrata. This is the most abundant of the lake-dwelling caenids and like the previous species is probably relatively tolerant of the effects of organic pollution/eutrophication and siltation.

*Caenis macrura*

**IUCN least concern**

**Angler's Curse**

This is a poorly recorded species occurring principally in slow-flowing section of rivers but has also been recorded in some lakes. It is considered a habitat generalist. Organic pollution/eutrophication and siltation pressures are unlikely to threaten this species.

*Caenis rivulorum*

**IUCN least concern**

**Angler's Curse**

*Caenis rivulorum* is the most commonly recorded and widely distributed caenid species preferring faster currents than the previous species. It occurs in oligotrophic streams and rivers but is most abundant in the more productive, alkaline rivers with clean, stony substrates. *C. rivulorum* lives among aquatic vegetation and debris rather than silt. Consequently, it would be one of the most sensitive of the caenid species to organic pollution/eutrophication and associated siltation.

*Centroptilum luteolum*

**IUCN least concern**

**Small Spurwing**

*Centroptilum luteolum* is ubiquitous in Ireland occurring in relatively low numbers most often in slow flowing, weedy areas of rivers but also on stony shores in some lakes. The species is considered sensitive to organic pollution/eutrophication but is rated as moderately tolerant of siltation.

*Cloeon dipterum*

**IUCN least concern**

**Pond Olive**

*Cloeon dipterum* is a commonly occurring species especially in ponds and small lakes but has also been recorded from slow-flowing sections of large rivers as well as turloughs and brackish-water lagoon systems. It is tolerant of temperature and oxygen changes and so is unlikely to be impacted by organic/pollution eutrophication or siltation.



*Cloeon simile*

**IUCN least concern**

**Lake Olive**

This is another common species occurring in a wide range of lentic habitats from ponds to lakes, including oligotrophic systems, unless they are highly acidic. Its pollution tolerances are likely to be fairly similar to the previous species although it is rated as slightly more sensitive to siltation.

*Ecdyonurus dispar*

**IUCN least concern**

**Autumn Dun**

*Ecdyonurus dispar*, formerly known as *Ecdyonurus longicauda* (Eaton, 1871), is a widely distributed species in Ireland occurring mainly in moderate to fast-flowing, cobble dominated, streams and rivers, including all but acidic or episodically acid systems. It has also been recorded on wave-washed lake shores. It is considered to be highly sensitive to acidification, organic pollution/eutrophication and siltation.

*Ecdyonurus insignis*

**IUCN least concern**

**Large Green Dun**

*Ecdyonurus insignis* is common in moderate to fast-flowing alkaline rivers especially in the midlands. Here again it would be associated with cobble substrates. Its sensitivity to pollution would be similar to the previous species.

*Ecdyonurus torrentis*

**IUCN data deficient**

**Large Brook Dun**

This is among the rarest of our mayfly species in terms of the current records and consequently its habitat requirements and pollution sensitivity are unknown, although it would be expected to be similar to other members of the Heptageniidae. While there are few current records for this species, it was not considered to meet the criteria to qualify as threatened and has been assessed as data deficient requiring targeted surveying.

*Ecdyonurus venosus*

**IUCN least concern**

**Late March Brown**

*Ecdyonurus venosus* is widely distributed in rivers and streams throughout Ireland especially where there is relatively fast flow and stony substrates. It tolerates waters of varying ionic composition but probably predominates in oligotrophic systems where it is often found in association with *Rhithrogena semicolorata*. It is highly sensitive to acidification, organic pollution/eutrophication and siltation.

*Electrogena lateralis*

**IUCN least concern**

**Dusky Yellowstreak**

This species was formerly known as *Heptagenia lateralis* Curtis. It is widely distributed and commonly encountered in fast-flowing streams or stony, wave-washed lake shores. While it is most likely encountered in low conductivity waters it has also been reported from alkaline systems. Pollution sensitivity would be similar to *Ecdyonurus venosus*.

*Ephemera danica*

**IUCN least concern**

**Green Drake Mayfly**

This is a widely distributed species occurring in lakes and the slow-flowing sections of rivers where bottom substrates support its burrowing habit. The nymphs are particularly common in alkaline waters perhaps because of the occurrence of marl in the substratum. The species is sensitive to organic pollution/eutrophication but is moderately tolerant of sedimentation.

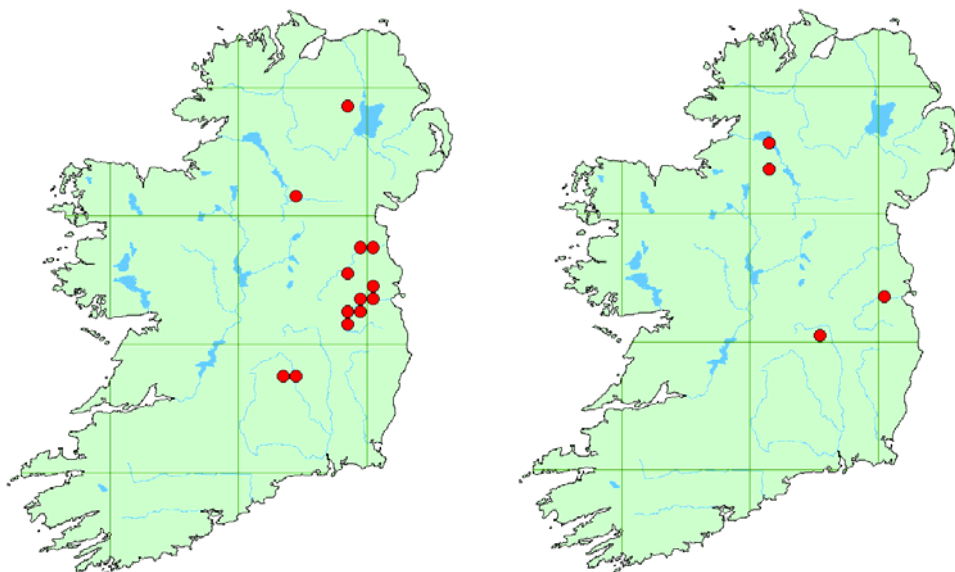
*Ephemerella notata*

**IUCN Endangered**

**Yellow Hawk**

**A2(a)(c), B2(a)(b)(ii)(iv)**

The few records of *Ephemerella notata* are mainly from alkaline rivers but it has also been recorded in low conductivity waters of the Owendoher Stream, a tributary of the Dodder. Reasons for the decline in this species are unclear but it is likely to be sensitive to organic pollution/eutrophication pressure. Consequently, this species is assessed as Endangered as a population reduction of greater than 50% has been directly observed and the current area of occupancy is less than 500km<sup>2</sup>, less than five locations, and there is a continuing decline in area of occupancy and number of locations.



**Figure 6:** Distribution of *Ephemerella notata* in Ireland pre-1990 (left) and post-1990 (right).

*Heptagenia sulphurea*

**IUCN least concern**

**Yellow May Dun**

*Heptagenia sulphurea* is commonly encountered in moderately-flowing sections of rivers, in particular the main channel of large alkaline rivers. It also occurs on the shores of lakes in limestone regions. It is generally absent from more acidic upland streams. The species would be considered sensitive to organic pollution/eutrophication and siltation.

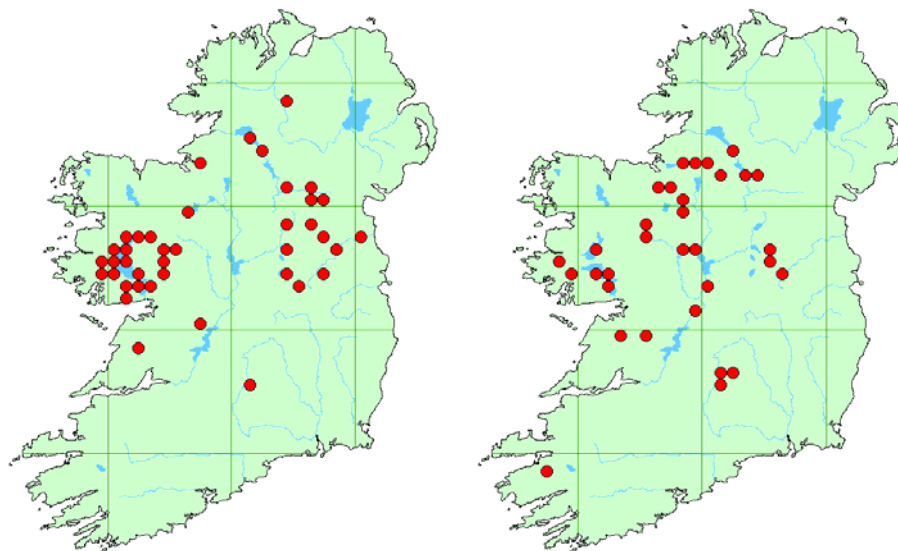
*Kageronia fuscogrisea*

**IUCN Near Threatened**

**Brown May Dun**

**A2(a)(c)**

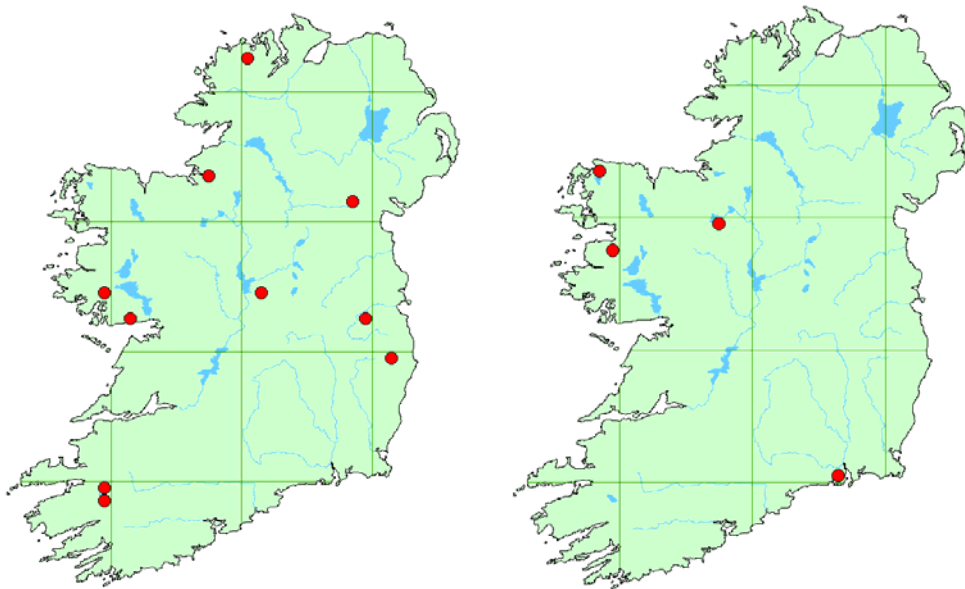
Formerly known as *Heptagenia fuscogrisea*, this species is generally found in alkaline rivers and lakes of the midlands but there are a few records from acidic sites. It is typical of well-vegetated areas but can also be found among stony substrata. This species is sensitive to deterioration in water quality and eutrophication, although the associated siltation is perhaps the most significant threat. It is a 'Nationally notable' species in Great Britain (Bratton, 1990). In Ireland it is assessed as Near Threatened because a population reduction of 23% has been directly observed in the area of occupancy has been reduced from 4,200km<sup>2</sup> to 3,200km<sup>2</sup>.



**Figure 7:** Distribution of *Kageronia fuscogrisea* in Ireland pre-1990 (left) and post-1990 (right).

*Leptophlebia marginata***IUCN Vulnerable****Sepia Dun****D2**

The majority of the records for *Leptophlebia marginata* are from lakes but it can also be found in slow-flowing areas of rivers. Further details on its habitat requirements in Ireland are difficult to extrapolate from the limited dataset. It is likely to have similar sensitivity to water pollution as other Leptophlebiidae (e.g. *Leptophlebia vespertina* and *Paraleptophlebia cincta*) and be vulnerable to the effects of eutrophication. However, it is considered tolerant of siltation. This species is assessed as Vulnerable to extinction as the population is restricted to four 10km<sup>2</sup> locations, has shown some decline and is a species that is sensitive to eutrophication and therefore is at risk from future pollution threats.



**Figure 8:** Distribution of *Leptophlebia marginata* in Ireland pre-1990 (left) and post-1990 (right).

*Leptophlebia vespertina***IUCN least concern****Claret Dun**

*Leptophlebia vespertina* occurs widely in both lentic (ponds and lakes) and slow-flowing lotic habitats. While particularly abundant in low conductivity, acidic waters it can also be found in alkaline systems. The species is likely to be sensitive to organic pollution/eutrophication but not to siltation.

*Paraleptophlebia cincta*

**IUCN least concern**

**Purple Dun**

*Paraleptophlebia cincta* is a riverine species with a fairly widespread distribution but numbers encountered tend to be small. It seems to favour moderate to slow-flow conditions and the presence of aquatic vegetation. It can occur in acid streams but tends to be more commonly encountered in alkaline waters. The species is likely to be sensitive to organic pollution/eutrophication and has been rated as highly sensitive to siltation.

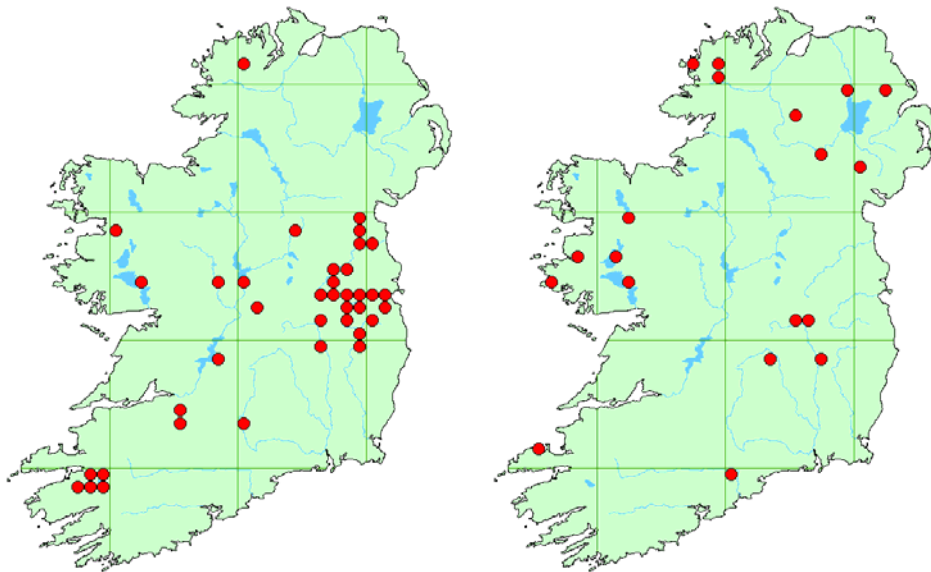
*Procloeon bifidum*

**IUCN Vulnerable**

**Pale Evening Dun**

**A2(a)(c)**

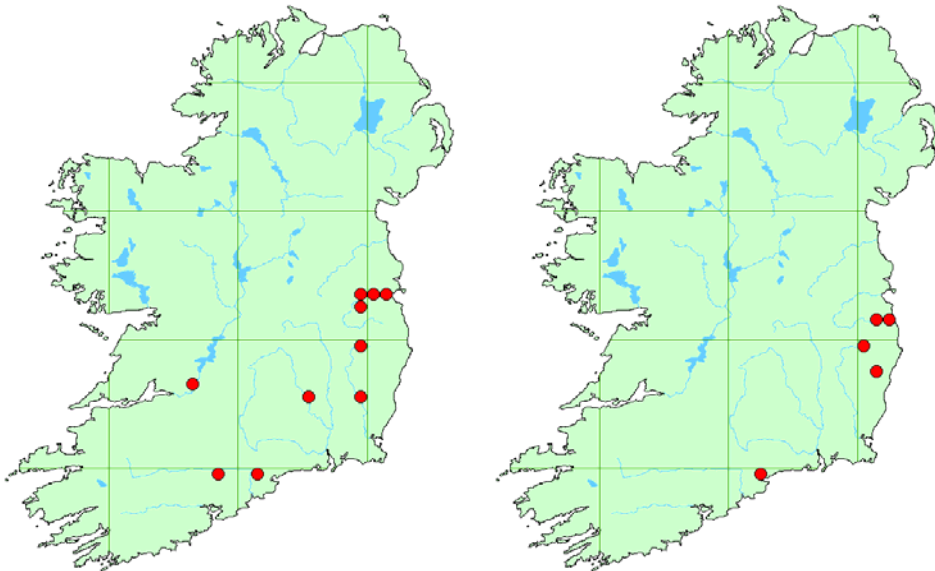
Formerly known as *Procloeon rufulum* Eaton and *Procloeon pseudorufulum* Kimmins, this species is generally encountered in sluggish-flowing sections of rivers but it has also been located in a small number of lakes. It tends to inhabit aquatic vegetation but is moderately tolerant of siltation. It is likely to be sensitive to organic pollution/eutrophication. This species is assessed as Vulnerable as a population decline of greater than 30% has been directly observed.



**Figure 9:** Distribution of *Procloeon bifidum* in Ireland pre-1990 (left) and post-1990 (right).

*Rhithrogena germanica***IUCN Vulnerable****March Brown****D2**

*Rhithrogena germanica* was formerly known as *Rhithrogena haarupi* Esben-Petersen. It has always been regarded as a rare species in Ireland and is considered to be more typical of the lower reaches of rivers where it is associated with cobble substrates. The limited records provide little information on its habitat requirements in Ireland. However, in Switzerland *R. germanica* can endure low to moderate organic pollution but requires high levels of oxygen in the water and favours riffles where the water is saturated with oxygen (Lubini and Sartori 1994). *R. germanica* is listed as Near Threatened in Sweden and Critically Endangered in the Czech Republic and Poland (Appendix 2). It is considered threatened and only occurs in small numbers across its geographical range (Lubini and Sartori 1994). *R. germanica* is assessed as Vulnerable in Ireland because of its very small and restricted population (Figure 10) and its sensitivity to habitat change.



**Figure 10:** Distribution of *Rhithrogena germanica* in Ireland pre-1990 (left) and post-1990 (right).

*Rhithrogena semicolorata***IUCN least concern****Olive Upright**

*Rhithrogena semicolorata* is widely distributed, occurring in riffle areas of rivers with moderate to fast flow, especially where the substrates are stony. It is ideally adapted to high-gradient mountain streams and is relatively tolerant of episodic acidity but can be eliminated by anthropogenic acidification. It is also sensitive to organic pollution/eutrophication and siltation.

*Serratella ignita*

**IUCN least concern**

**Blue-winged Olive**

This species, formerly known as *Ephemerella ignita* (Poda, 1761), shares the same ubiquitous distribution as *Baetis rhodani*. It is, however, a summer-species and the nymphs first appear in late spring and usually persist until October. It mainly occurs in rivers, avoiding only acid conditions, but can occur in some lake outlets. It is particularly abundant among aquatic macrophytes and filamentous algae. In Ireland it is tolerant of eutrophication but would be eliminated by severe organic pollution. The work of Extence *et al.* (2011) rates this species as highly sensitive to siltation.

*Siphonurus alternatus*

**IUCN least concern**

**Northern Summer Mayfly**

This species, formerly known as *Siphonurus linnaeanus* (Eaton 1871), has a patchy distribution with relatively few records in the two periods examined. It has been found in both lotic and lentic habitats, including turloughs, and tends to be more common in calcareous waters but has also been reported from low conductivity, episodically acidic streams. It is not considered sensitive to siltation but is likely to be impacted by eutrophication.

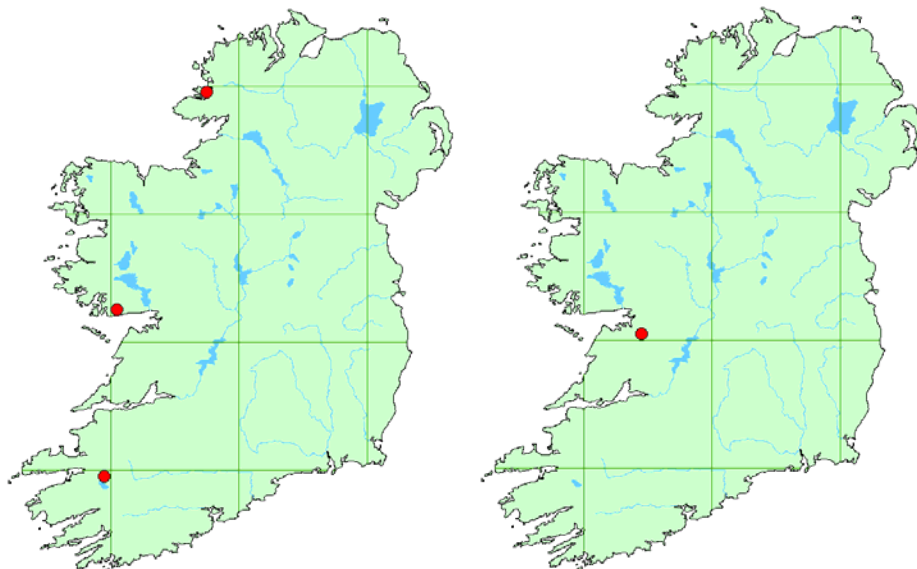
*Siphonurus armatus*

**IUCN Critically Endangered**

**Scarce Summer**

**B2(a)(b)(iii)**

*Siphonurus armatus* is our rarest mayfly. It can occur in ponds, lakes and slow-flowing rivers but overall little is known about its habitat requirements or pollution sensitivity. It seems to favour soft sediments and is not considered sensitive to siltation. Pre-1990 records are from 1850-1910 from Kerry, 1923 from Donegal and 1926 from Galway. The only modern record for this species is from 1996 from the Coole-Garryland Turlough complex. This species is assessed as Critically Endangered because the area of occupancy is less than 10km<sup>2</sup>, it occurs in only one location, and there is continuing decline in the quality of turlough habitat in which it occurs.



**Figure 11:** Distribution of *Siphonurus armatus* in Ireland pre-1990 (left) and post-1990 (right).

*Siphonurus lacustris*

**IUCN least concern**

**Summer Mayfly**

*Siphonurus lacustris* can become relatively abundant in certain localised habitats, such as soft-water mountain streams and lakes, but it also occurs in some alkaline rivers. It is a large summer species and in rivers favours backwaters where pool-like conditions exist. It is commonly encountered in mountain streams where it is tolerant of moderate episodic acidity. It would be considered sensitive to eutrophication and organic pollution but moderately tolerant of siltation.



## CONCLUSIONS

The Ephemeroptera, like most of our aquatic fauna, are species-poor compared to Britain and mainland Europe, due in large part to our glacial history and isolation from mainland Europe. Despite this, ephemeropteran nymphs constitutes a high proportion of the macroinvertebrate fauna in most rivers (except where conditions are highly acidic) and are a key component of the diet of salmonid fishes. As noted by Kelly-Quinn and Bracken (2000) many of the Irish species have broader distributions than their counterparts in Britain but the same authors expressed concern about reduced species diversity in Irish rivers. The records used in this assessment have been largely based on collections of nymphs but this has been taken into account particularly for species, e.g. *Rhithrogena germanica*, that are only reliably confirmed from adult material. This may in part account for the deficiency in data for some species.

Interestingly, most of those considered Threatened are riverine species possibly reflecting a longer and more widespread history of pollution pressure on rivers. It appears that the Threatened species are those that have restricted distributions and so are particularly vulnerable to impact. Furthermore, these are the species that we know least about their ecology, in particular habitat requirements and pollution sensitivity. *Ameletus inopinatus* is assessed as Near Threatened because its area of occupancy is less than 2,000km<sup>2</sup>, the distribution is fragmented and the quality of habitat could decline as a result of several pressures but particularly climate change. *Kageronia fuscogrisea*, one of the two Near Threatened species, is a Notable species in Great Britain (see Appendix 2). A number of other Irish species (*Caenis macrura*, *Ecdyonurus torrentis* and *Siphonurus alternatus*) have restricted distributions but have not been listed because no significant change has occurred between the two time periods (pre-1990 and 1990-2011). *Caenis macrura* has been listed as Vulnerable in Sweden and as Rare in Estonia (see Appendix 2). Water pollution is the key threat to the species listed. The implementation of the objectives of the Water Framework Directive should bring about improvement in water quality which should help stem the loss of aquatic biodiversity including the Ephemeroptera. In the interim the aforementioned species should be prioritised for monitoring with sampling focussed particularly on the adults. It is also essential that knowledge gaps on the autecological requirements and pollution sensitivity of these species be addressed so as to inform conservation measures. Finally, it is crucial that we identify and protect species-rich refugia in catchments throughout the country that will become important source areas for ephemeropteran and other pollution-sensitive species as impacted systems recover in the future.

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**APPENDIX 1: SUMMARY OF THE FIVE CRITERIA (A-E) USED TO EVALUATE IF A TAXON BELONGS IN A THREATENED CATEGORY; CRITICALLY ENDANGERED, ENDANGERED OR VULNERABLE (IUCN, 2010).**

Use any of the criteria A–E	Critically Endangered	Endangered	Vulnerable
<b>A. Population reduction</b>			
Declines measured over the longer of 10 years or 3 generations			
<b>A1</b>	≥ 90%	≥ 70%	≥ 50%
<b>A2, A3 &amp; A4</b>	≥ 80%	≥ 50%	≥ 30%
<p><b>A1.</b> Population reduction observed, estimated, inferred, or suspected in the past where the causes of the reduction are clearly reversible <b>AND</b> understood <b>AND</b> have ceased, based on and specifying any of the following:</p> <ul style="list-style-type: none"> <li>(a) direct observation</li> <li>(b) an index of abundance appropriate to the taxon</li> <li>(c) a decline in area of occupancy (AOO), extent of occurrence (EOO) and/or habitat quality</li> <li>(d) actual or potential levels of exploitation</li> <li>(e) effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.</li> </ul> <p><b>A2.</b> Population reduction observed, estimated, inferred, or suspected in the past where the causes of reduction may not have ceased OR may not be understood OR may not be reversible, based on (a) to (e) under A1.</p> <p><b>A3.</b> Population reduction projected or suspected to be met in the future (up to a maximum of 100 years) based on (b) to (e) under A1.</p> <p><b>A4.</b> An observed, estimated, inferred, projected or suspected population reduction (up to a maximum of 100 years) where the time period must include both the past and the future, and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible, based on (a) to (e) under A1.</p>			
<b>B. Geographic range in the form of either B1 (extent of occurrence) AND/OR B2 (area of occupancy)</b>			
<b>B1.</b> Extent of occurrence (EOO)	< 100 km <sup>2</sup>	< 5,000 km <sup>2</sup>	< 20,000 km <sup>2</sup>
<b>B2.</b> Area of occupancy (AOO)	< 10 km <sup>2</sup>	< 500 km <sup>2</sup>	< 2,000 km <sup>2</sup>
<b>AND at least 2 of the following:</b>			
(a) Severely fragmented, OR Number of locations	= 1	≤ 5	≤ 10
(b) Continuing decline in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals.			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals.			
<b>C. Small population size and decline</b>			
Number of mature individuals	< 250	< 2,500	< 10,000
<b>AND either C1 or C2:</b>			
<b>C1.</b> An estimated continuing decline of at least:	25% in 3 years or 1 generation	20% in 5 years or 2 generations	10% in 10 years or 3 generations
(up to a max. of 100 years in future)			
<b>C2.</b> A continuing decline			
<b>AND (a) and/or (b):</b>			
(a i) Number of mature individuals in each subpopulation:	< 50	< 250	< 1,000
<b>or</b>			
(a ii) % individuals in one subpopulation =	90–100%	95–100%	100%
(b) Extreme fluctuations in the number of mature individuals.			
<b>D. Very small or restricted population</b>			
<b>Either:</b>			
Number of mature individuals	< 50	< 250	<b>D1.</b> < 1,000 <b>AND/OR</b>
<b>VU D2.</b> Restricted area of occupancy or number of locations with a plausible future threat that could drive the taxon to CR or EX in a very short time.			<b>D2.</b> typically: AOO<20 km <sup>2</sup> or number of locations ≤ 5
<b>E. Quantitative Analysis</b>			
Indicating the probability of extinction in the wild to be:	≥ 50% in 10 years or 3 generations (100 years max.)	≥ 20% in 20 years or 5 generations (100 years max.)	≥ 10% in 100 years

**APPENDIX 2 – CHECKLIST OF MAYFLIES**

**IRL 2012 Status** – Red list status for Ireland based on this assessment; RE - Regionally Extinct, CR – Critically Endangered, EN – Endangered, VU – Vulnerable, NT - Near Threatened, dd - data deficient, lc – least concern. Great Britain status is taken from Bratton 1990, Swedish status from Gärdenfors 2005, Czech status from Farkač *et al.* 2005, Estonian status from Lilleleht 1998, Norwegian status from Kålås *et al.* 2006, Finnish status from Rassi 2001, and Polish status from Głowaciński 2002.

Scientific name	Irish 2012 Status	Great Britain 1990 Status	Swedish 2005 Status	Czech 2005 Status	Estonia 1998 Status	Norway 2006 Status	Finland 2001 Status	Poland 2002 Status
<i>Alainites muticus</i>	lc							
<i>Ameletus inopinatus</i>	NT				Rare			
<i>Baetis atrebatinus</i>	EN							
<i>Baetis fuscatus</i>	dd							
<i>Baetis rhodani</i>	lc							
<i>Baetis scambus</i>	lc							
<i>Baetis vernus</i>	lc							
<i>Caenis horaria</i>	lc							
<i>Caenis luctuosa</i>	lc							
<i>Caenis macrura</i>	lc		VU		Rare			
<i>Caenis rivulorum</i>	lc			NT		NT		
<i>Centroptilum luteolum</i>	lc							
<i>Cloeon dipterum</i>	lc							
<i>Cloeon simile</i>	lc							
<i>Ecdyonurus dispar</i>	lc							
<i>Ecdyonurus insignis</i>	lc			CR				
<i>Ecdyonurus torrentis</i>	dd							
<i>Ecdyonurus venosus</i>	lc							
<i>Electrogena lateralis</i>	lc							
<i>Ephemera danica</i>	lc							
<i>Ephemerella notata</i>	EN							
<i>Heptagenia sulphurea</i>	lc							
<i>Kageronia fuscogrisea</i>	NT	Notable						

Scientific name	Irish 2012 Status	Great Britain 1990 Status	Swedish 2005 Status	Czech 2005 Status	Estonia 1998 Status	Norway 2006 Status	Finland 2001 Status	Poland 2002 Status
<i>Leptophlebia marginata</i>	VU							
<i>Leptophlebia vespertina</i>	lc							
<i>Paraleptophlebia cincta</i>	lc							
<i>Procloeon bifidum</i>	VU							
<i>Rhithrogena germanica</i>	VU		NT	CR				CR
<i>Rhithrogena semicolorata</i>	lc							
<i>Serratella ignita</i>	lc							
<i>Siphonurus alternatus</i>	lc							
<i>Siphonurus armatus</i>	CR		NT					
<i>Siphonurus lacustris</i>	lc							