The Dragonflies (Insecta: Odonata) of Northern British Columbia: Field Surveys, Collections Development and Public Education

2000-2005

Somatochlora brevicincta ♂

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INTRODUCTION

As part of the *Living Landscapes* Project in northern British Columbia (BC), the Royal British Columbia Museum (RBCM) and the Ministry of Environment's British Columbia Conservation Data Centre (CDC) joined forces, beginning in 2000, to study the dragonflies (Insecta: Odonata) of the region. The study area includes the province north of about 52º N, approximately the latitude of Williams Lake. Within this area, many wetlands such as streams, springs, marshes, peatlands, ponds and lakes are being sampled. Once ecosystem classification is complete, some of these ecosystems might be considered threatened or endangered by the CDC. Sites east of the Rockies and along the Alaska Highway corridor east of Lower Post were sampled in 1997.

Northern BC was sampled in several stages. Figure 1 shows the annual survey areas. The first survey, which began in 2000, focused on the Upper Fraser Basin, centred on Prince George: field work covered the regions around the city and those far to the east and south, that is, the western slopes of the Rockies from Tête Jaune Cache north to Pine Pass, the northeastern Chilcotin Plateau (Nazko area) and the northern Cariboo Mountains (Likely, Quesnel Lake). Sporadic collecting also occurred along Highway 20 to the eastern boundary of Tweedsmuir Park. In 2001 the Vanderhoof-Omineca-Williston regions were examined; in 2002 it was the North Tweedsmuir-Babine-Bulkley-Skeena regions and, in 2003, the far Northwest, including the Hwy 37 corridor, Atlin area, Skagway and Haines roads were studied. No fieldwork was undertaken in 2004 in order to consolidate specimens, databases and other information. In 2005 some of the north coast around Prince Rupert, including the Skeena, Kitimat and Nass river valleys, were examined.

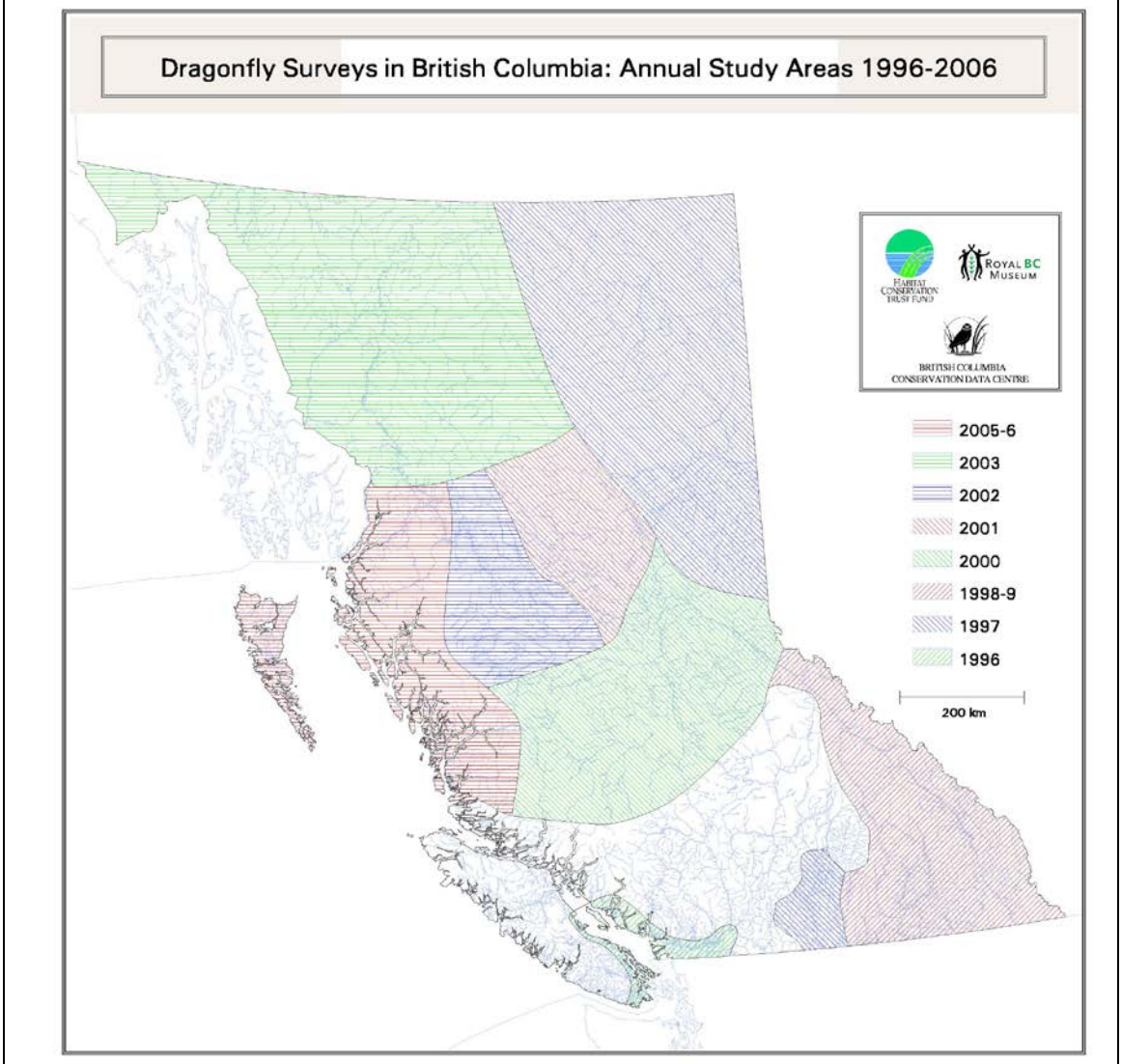

Figure 1. Dragonfly survey areas in British Columbia 1996-2006.

The project is a multi-year effort to determine the present status, precise location of occurrences and habitat requirements of the dragonflies of selected areas of northern BC. Although the RBCM had dragonfly specimens and a species list for the region that represented our knowledge up to 1999, with the exception of the Peace River drainage area, no comprehensive survey for dragonflies had ever been made; some of the recorded populations were known only from collections made in the mid-1900s.

The first dragonfly records from the northern parts of BC were published by Walker (1912, 1925, 1927), Buckell (1938) and Whitehouse (1941). Walker (1953, 1958), Walker and Corbet (1975), Scudder *et al*. (1976) and Cannings and Stuart (1977) updated and summarized the information known for BC. This latter book is out of print, but is available on the internet at http://wlapwww.gov.bc.ca/wld/documents/dragon/. Since then, general collecting, mostly by RBCM, UBC and CDC staff, has improved our understanding of species distributions in BC and Yukon (Cannings 1980, 1996; Cannings *et al*. 1980, 1991; Cannings and Cannings 1987, 1994, 1997). The main sources of distributional information on the species of the region are the databases of the Spencer Entomological Museum at the University of BC in Vancouver and the Royal BC Museum in Victoria. These data have been used to produce distribution maps for BC species, current to the end of 2004, for all BC species.

Despite the fact that aquatic invertebrates make up a key part of freshwater ecosystems, little is known of the distribution and ecology of most aquatic invertebrate groups, especially in the northern part of BC. This is true of even normally well-studied groups such as dragonflies (Cannings and Stuart 1977). Dragonflies are a priority group for inventory (Scudder 1996) because, unlike most invertebrates, they can be identified in the field and because field personnel experienced in dragonfly collecting are available.

Although development in northern BC has been concentrated for the most part in a few population centres, and the condition of most freshwater habitats (with some notable exceptions, such as those flooded by the WAC Bennett and Kenney dams) remains close to a pristine state, there is a need to establish baseline information regarding the distribution and habitat choice of aquatic invertebrates. The pace of development in the north is increasing and will undoubtedly continue to increase dramatically in the next century.

The dragonflies (including damselflies) comprise a relatively well-known order of insects that breeds in a wide variety of aquatic habitats. Some species are specialists using discrete habitats; others are generalists, able to survive in a wide variety of environments. In BC wetland habitats have been, and continue to be, altered, lost or destroyed because of urban development, agriculture and resource extraction (Stevens *et al*. 1995). Estimates indicate that 65 to 80% of wetlands have been altered or destroyed, depending on the region. Odonata are considered a priority for inventory for several reasons (Scudder 1996). Unlike most invertebrates, they can be relatively easily identified, even in the field in many cases

Dragonflies are upper-level predators in the invertebrate food-web, they can be linked to habitat quality and have often been identified as excellent indicators of ecosystem health (e.g., Carle 1979, Trevino 1997, Corbet 1999, Clarke and Samways 1996, Walker and Corbet 1975, Takamura *et al*.1991). Knowledge of the ecology of even common dragonflies is important; many aquatic ecosystems such as peatlands, marshes, and small lakes are not home to fish, and invertebrates are the dominant animals in them, yet at present we have no way to describe these communities or characterize their health. In these habitats, invertebrates such as dragonflies are the only animals convenient as indicators of ecosystem health. Many species are habitat-specific and their presence can be used to characterize healthy wetlands of all sorts. Within the constraints of weather, surveys are well-suited for long-term monitoring programs. Finally, because they are large, colourful, diurnal creatures with interesting behaviours, Odonata are excellent subjects for nature interpretation programs and public education about aquatic ecosystems in general.

The inventories in the North complement similar projects undertaken throughout much of southern British Columbia over the past four years. Surveys in the Georgia Depression (1996), the Okanagan drainage (1997), the Peace River/Fort Nelson region (1997) and the Columbia/Kootenays (1998-99) (Fig.1) have resulted in many new discoveries, including the addition of five species to the provincial list (Cannings *et al.* 2005a, Kenner, 2000) and have consequently allowed us to make much more realistic conservation priorities for this group of insects (Cannings *et al*. 2000, Ramsay and Cannings 2000, 2005). The surveys can also be used as a baseline study in future aquatic ecosystem assessments. There are essentially no risks to populations, even of rare species, from this sort of limited collecting. Specimens in research collections have many values. For example, they serve as standards for species identification and unequivocally document historical status, distribution, and present geographical variation, including 'hidden', as yet undescribed species. In addition, they contain life-history and ecological information such as the habitat choice of species and the time of adult emergence and breeding.

Despite the ecological importance of dragonflies, general public awareness and appreciation of them (and of other aquatic invertebrates, for that matter) is minimal. During the project, however, we have had much positive public feedback concerning dragonflies, largely because of the public talks given during the project and the publication of the *Introduction to the Dragonflies* (Cannings 2002a). In addition, dragonfly information posted on the RBCM's Living Landscapes Web page will be a popular addition to the material on these insects available on-line.

Although a provincial handbook on dragonflies existed (Cannings and Stuart 1977) before the start of the project, its species range maps revealed vast blank areas of ignorance north of Quesnel. A new book designed for the use of the general public and project volunteers was produced as part of the project (Cannings 2002a). It contains colour photos and simple identification information. Because the region is vast and so poorly known, it is impossible to complete an *intensive* inventory, even in six or seven seasons—local volunteers were recruited and trained to build upon the foundation of the Living Landscapes survey.

The objectives of the study are:

- To determine the status, precise locations of occurrences, and habitat associations of the approximately 68 species of Odonata known or expected from northern BC, with a search emphasis on the 14 species considered to be potentially at risk (red- or blue-listed, as ranked by the Conservation Data Centre) at the outset of the survey in 2000.
- To present a revised list of Odonata of BC, with conservation ranks assigned to species.
- To develop management guidelines for each of the species considered at risk.
- To provide baseline data that can be used for habitat monitoring and for the potential development of indicators of ecosystem health.
- To improve the scope and utility of RBCM research collections.
- To leave a legacy of awareness and knowledge of dragonflies in the region.
- To foster an ongoing, local interest in dragonfly monitoring and research.

INTRODUCTION TO THE DRAGONFLIES

The insect order Odonata (Greek for “toothed jaws”) contains the groups of insects known in English as dragonflies and damselflies, but “dragonflies” is often used to refer to the whole order. “Odonates” is another name that is gaining popularity. The Odonata contains about 5,500 named species in 33 families worldwide. For comparison, there are roughly the same number of mammal species in the world and almost twice as many birds. Most dragonflies live in the tropics, but a few have adapted to the cooler temperatures of higher latitudes; even in our region there are many more species living in the south than the north.

Dragonflies are large and abundant insects and, because of this, the order forms one of the predominant groups in standing freshwater communities in the northern regions of British Columbia. We have recorded 87 species in the province. In the western mountains, species are less abundant in running water than they are in standing water habitats. Dragonflies live around most types of fresh water. Certain kinds prefer lakeshores, others are found only along streams, or around springs and in peatlands. Ponds and marshes rich in aquatic vegetation support the most species.

Dragonflies are among the most ancient insects – their ancestral line goes back to the Carboniferous Period, about 300 to 350 million years ago. They have retained many primitive characteristics and developed some specialized features for a successful aerial and predatory lifestyle. Dragonflies share with mayflies the ancient inability to fold their wings flat over the body. They differ from all other insects in their combination of biting mouthparts; their two equal (or almost equal) pairs of long, membranous, net-veined wings; their large, bulging eyes and short, thread-like antennae; and their long, slender abdomen that, in the male, bears secondary genitalia at the base.

A dragonfly leads a dual life – in its immature stage, the larva lives in water, obscure and camouflaged. When it is time to mature, the changing larva emerges from the water and transforms into a colourful, flying adult.

Some early dragonfly-like insects were enormous – fossils from the Carboniferous Period show that one had a wingspan of 70 cm – but the largest North American species found today measures about 14 cm across the wings. The greatest wingspans in modern times – about 17 cm – belong to the giant damselflies of the American tropics.

Many dragonflies around the world are as colourful and flashy as the most spectacular birds and butterflies. Most of our local dragonflies are more subdued, but they are still lovely and striking insects. They come in a myriad of colours, from iridescent metallic green to breathtaking crimson. Their bodies can be boldly spotted or striped, and their wings are often strongly patterned with spots and bands of colour.

The order Odonata is usually divided into three suborders: the Zygoptera (damselflies), the Anisoptera (true dragonflies) and the Anisozygoptera (a tiny group of two rare species from the mountains of eastern Asia). Damselflies are slimmer, often smaller and

usually fly more slowly than true dragonflies. At rest they usually hold their equal-sized wings together above the body – Zygoptera means “joined wings”. Anisoptera means “unequal wings”, because the hindwings of the true dragonflies are broader than the forewings. When perched they hold their wings out away from the body.

The flying ability of dragonflies amazes most people (Fig. 2). Although the wing structure and arrangement of the flight muscles are primitive, the flight performance and efficiency are remarkable. Unlike most insects, dragonflies usually beat their forewings and hindwings separately – when the forewings are up, the hindwings are down. Each wing also has much independent control, accounting for the surprising manoeuvrability of many species, which can fly upwards, sideways, backwards and forwards. A large darner can fly up to 60 km per hour. Aeshnidae (darners), Corduliidae (emeralds), Cordulegastridae (spiketails), Macromiidae (river cruisers) and some Libellulidae (skimmers) are called *flyers* because they spend most of their active life flying – they even generate additional body heat from their wing muscles. Damselflies, Gomphidae (clubtails) and most Libellulidae are often called *perchers*, because they spend more time perching than flying. Perchers gain much of their body heat from basking in the sun and make only short flights to catch food or mate.

Figure 2. Dragonflies are amazing fliers. *Aeshna palmata* male. Photo: George Doerksen, RBCM.

For millennia, dragonflies have instilled superstitious fear in humans, even though they do not sting or bite people. Maybe their boldness takes us aback, or their speed startles

us. To the uninitiated, their strange appearance up close can make them seem fearsome. The English name “dragonfly” echoes the feelings these insects sometimes arouse – they are the fanciful “devil’s darning needles” that sting venomously or sew up the lips; they are “snake doctors” with the power to bring dead snakes back to life. These legends and folktales are groundless – dragonflies are harmless to humans.

Dragonflies spend their youth as aquatic larvae preying on other underwater animals. Dragonfly larvae – sometimes called nymphs – have an enormous (for their size) hinged labium (a sort of lower lip armed with pincers) that they use as an extendible grasping organ for capturing prey. They are voracious predators, eating small aquatic insects, crustaceans and even fish and tadpoles.

Figure 3. *Aeshna interrupta* larva. Photo: Robert A. Cannings, RBCM

Biologists place dragonfly larvae into three categories, according to their feeding behaviour: *Claspers* (Zygoptera and Aeshnidae stalk their prey while using their clasping legs to hold onto vegetation (Fig. 3); their colour patterns of green and brown help camouflage them among the water plants. *Sprawlers* (Macromiidae, Corduliidae and most Libellulidae) lie spread-eagled on the bottom mud and debris or on vegetation, waiting to ambush prey; they often keep hidden under a coating of mud and algae. *Burrowers* (Gomphidae) and Cordulegastridae) dig into the sand and silt, where they await their prey.

Damselfly larvae, like the adults, are slender animals. The tip of the abdomen bears three leaf-like gills, richly laced with the fine tubes that carry oxygen and carbon dioxide throughout the body. The stouter larvae of the true dragonflies do not have external gills; instead, they pump water in and out of the gut and breathe through gills lining the rectum. Damselflies use their gills to help them get around, sweeping them back and forth like swimming fins. Larvae of true dragonflies also use their breathing mechanism to help them move: they can blast pressurized water out the anus, jet-propelling them through the water – an effective tactic for escaping predators or attacking prey.

Dragonflies, like grasshoppers and many other insects, develop without a pupal stage. After the larva pops out of the egg, it eats, grows and moults 8 to 17 times (usually 10 to 14), depending on the species and the conditions. The developing wingbuds get larger with each moult. For many species in British Columbia, the life cycle takes about a year. Some *Lestes* (spreadwings) and *Sympetrum* (Meadowhawks) that live in temporary ponds overwinter as eggs, hatch in the spring, grow rapidly and emerge as adults in the summer. Many species overwinter as larvae and emerge the following spring or summer; others spend two years in the larval stage. For some dragonflies (especially certain Aeshnidae and Corduliidae), the larval life may last six years or longer. Development time depends on the species and also on altitude, latitude and amount of daylight. Growth slows with the shorter summers and colder temperatures of northern habitats and high altitudes.

In British Columbia, dragonflies live only a short time as adults – about one to two months. A dragonfly begins its adulthood when the fully grown larva metamorphoses into an adult inside its last larval skin, then crawls out of the water, up a plant stalk or some other support. Gomphidae and Coenagrionidae (pond damsels)can emerge horizontally on rocks, floating logs and plants, or the shore.

Now exposed to air, the dragonfly begins its final moult: the top of the thorax splits open and the adult dragonfly squeezes out of the larval skin (Fig. 4). It pumps blood into its wings and abdomen, which expand slowly, and gradually, the body hardens. After an hour or two the dragonfly can fly, weakly at first, on fragile, glistening wings. It leaves the empty larval skin, the exuvia, clinging to the support. Once its body has hardened, the adult dragonfly will not grow larger even though it eats a lot.

Figure 4. The mature larva crawls out of the water and
larval skin. *Aeshna interrupta* male. Photo: Robert A.

Emergence can occur by day or night. Most Zygoptera , Gomphidae and some Libellulidae emerge during the day. Many darners emerge at night, but in cool weather or in the far north, may transform during the day. The newly emerged adult, called a teneral, is vulnerable to predators and bad weather.

Dragonflies have characteristic flight periods. This is the period during which adults may be seen and does not necessarily represent the adult lifespan of a particular individual. Many species may live in the same locality: some emerge early in the spring and are rare by summer; others appear in mid summer and fly into the fall; still others fly from spring to fall.

After emergence, most adults leave the shoreline to hunt and eat for a few days or even weeks as they mature. They are powerful predators that hunt by sight. They usually capture prey while flying, grabbing it with long, spiny legs and then chewing it with powerful jaws. Adult dragonflies eat mainly flying insects, but some species will pluck insects, spiders and even small frogs off vegetation or the ground.

Immature adults are pale in colour, but gradually become darker and often brighter as they mature. Some species produce a waxy, white or pale blue powder, called pruinescence, over parts of the body and wings; this is especially obvious in some male Libellulidae and *Lestes* and some female *Ischnura* (Forktails).

When they are sexually mature, dragonflies return to the water to breed. Most of the dragonflies you see near water are males aggressively searching for mates. In many species (Zygoptera, Petaluridae (Petaltails), Gomphidae, Corduliidae) and many Libellulidae), mature males defend a territory against other males of the species, patrolling the habitat or sallying out from perches. This territorial behaviour limits aggression by spacing males along the shore and helps prevent undue disturbance of egg-laying females.

Females coming to the water to breed quickly attract mates. With the appendages at the tip of the abdomen, a male grasps a female by the front of the thorax (Zygoptera) or by the top of the head (Anisoptera). This head to tail arrangement is called the tandem position. Before joining with a female or even while in the tandem position, the male transfers sperm from the tip of his abdomen to his penis, which is under the second abdominal segment. The female then loops the end of her abdomen up to the penis so that the male can transfer the sperm to her. The Odonata are the only insects that mate in this circular formation, called the wheel position, which they maintain for a few seconds or several hours, depending on the species (Fig. 5). Female dragonflies usually mate more than once, and in an attempt to ensure that their sperm fertilizes her eggs, males may spend much of the copulation period removing the sperm of other males – the penis is modified to pull another's sperm out of the female or push it aside so that it is inactivated.

Figure 5. Mating *Enallagma boreale*. Photo: George Doerksen, RBCM

The female lays her fertilized eggs by the hundreds. All Zygoptera, Aeshnidae and Petaluridae have a knifelike egg-laying structure with pointed blades, called an ovipositor, at the tip of the abdomen; they lay their eggs in plant tissue (Fig. 6), although some darners and petaltails insert eggs into soil. Cordulegastridae shovel the eggs into a streambed. Other species – without ovipositors, or with simply a scoop-shaped plate called a vulvar lamina – drop eggs into the water, tap the eggs into mud and moss, or simply dip the tip of the abdomen into the water and wash the eggs off.

Figure 6. *Lestes disjunctus* ovipositing. Photo: George Doerksen, RBCM

Competition for mates is usually fierce, and male aggression can prevent females from laying their eggs. Females that lay their eggs alone, especially mosaic darners (Fig. 7), often do so stealthily, flying low among the plants along the shore, wings rustling in the stems as they settle to deposit the eggs. Some Zygoptera actually crawl below the water's surface to escape the attention of males, often remaining submerged for more than an hour – they take a film of air down with them, trapped in the hairs on their body, so they can breathe while they lay their eggs. In many Zygoptera, *Sympetrum* and *Anax junius* (Common Green Darner), the male stays in tandem, retaining his hold on the female while she lays her eggs (Fig. 6). In some other species, the male hovers protectively nearby, guarding the egg-laying female from any other males who may attempt to mate with her, and allowing her to lay her eggs undisturbed.

Figure 7. *Aeshna palmata* female ovipositing in wet log. Photo: George Doerksen, RBCM

PARTNERS

- Northern dragonfly inventory is the priority of the entomological research and inventory efforts of the Royal British Columbia Museum in its *Living Landscapes* project for 2000-07, a major effort to link regional participation with museum inventory, research and public activities.
- BC Ministry of Environment, through the BC Conservation Data Centre, is the main partner in the inventory. Other headquarters personnel of this ministry, as well as regional staff, are also participating. BC Parks is a partner in the project, providing Park Use Permits and mapping and vegetation studies, and giving advice on study areas. Parks will use the information gathered for park interpretation and school programs.
- Habitat Conservation Trust Fund. Significant support from the fund finances the hiring of field contractors and coop students and supports field work in general (2000-2004). The production of detailed species distribution maps were also funded by the HCTF (2004).
- BC Ministry of Forests. The Research Branch is supporting the work designed to link inventory results to their wetland classification scheme.
- The University of Northern British Columbia (UNBC) is a partner; entomologist Dr. S. Lindgren has helped with logistics. A synoptic collection of dragonflies from the project will be deposited at UNBC to aid in future teaching and research.
- The Peace/Williston Fish and Wildlife Compensation Program (BC Hydro) supplied some helicopter time in the 2000 field season and will do so again, subject to the availablilty of field funds. This shared helicopter use allowed the project into areas that were otherwise not accessible

METHODS

Field surveys were undertaken through the primary adult activity season from mid-June through at least August in order to cover all species' flight periods. We visited the widest possible array of habitats to identify and note adult dragonflies, emphasizing those habitats that were likely to support rare species. Sites were chosen on the basis of historical records and remaining aquatic ecosystems. The timing of visits to particular sites was determined by the known flight times of the species being searched for there. As specified in the Resource Inventory Committee's standardized arthropod sampling methodology, each site was visited for at least five hours (or for a shorter time if population estimates could be done more quickly) during fine weather during the period of the study to attempt to ensure that no species is missed.

Often, specimens were netted for close examination and voucher specimens were collected (Fig. 8) if we believed that their collection would not harm the viability of the population. These were deposited in the RBCM. Larval specimens or the cast skins of larvae were also used as indicators of a species' use of a particular site and were collected as needed. Both adult and larval specimens were prepared, labelled, identified and accessioned into the RBCM collections.

Details of numbers of dragonflies, their behaviour and ecology, as well as precise UTM grid coordinates were recorded on CDC field forms and cross-referenced to dragonfly specimens. The data were entered into an RBCM database. The physical and floristic characteristics of the wetland habitats were also described using CDC forms. Dominant plant species were recorded, and any rare plants (those taxa tracked by the CDC) found were documented by CDC field observation forms and voucher specimens deposited at the RBCM.

Distribution maps of each species have been produced using ArcView GIS. The distribution of larvae and breeding adults will be analysed to determine critical habitats. The English names of dragonflies used in this report are those adopted by the Dragonfly Society of the Americas (Paulson and Dunkle 1996, Catling *et al.* 2005). These names are not used in the body of the report but are listed in Appendix 1.

Figure 8. Andrew Harcombe drying dragonfly specimens in the sun north of Fort St. James. Specimens are placed in envelopes and submersed in acetone for 24 hours to preserve colours. The envelopes and specimens are later dried. Photo: Robert A. Cannings.

EXTENSION/PUBLIC INFORMATION

The response from the naturalist community was extremely encouraging. Over the project, many local biologists and naturalists from Williams Lake, McBride, Prince George, Mackenzie, Burns Lake, Smithers, Hazelton, Terrace, Whitehorse and other places attended talks on dragonfly biology and inventory and participated in collecting field trips. These people learned a great deal about dragonfly inventories and we hope that their enthusiasm for monitoring populations will stretch into the future (Fig. 9). Firm foundations have been laid for ongoing dragonfly study in the region, a benefit that will extend far beyond the scheduled time of this project.

The results of the project have not yet been fully compiled. Preliminary, informal communications of important findings were sent to the volunteers involved via electronic mail, and to the dragonfly biology community via the newsletters of the Dragonfly Society of North America and the Entomological Society of British Columbia. Other community activities and published results are indicated below under *Results*.

Odonata species are listed and their conservation ranks and distribution maps are given on the CDC website at http://srmapps.gov.bc.ca/apps/eswp/search.do. Much of this information and the maps are the result of these inventories. This information has also been used in national general ranking of Odonata species.

All new discoveries will be summarized in print in the future; a summary article is planned for the Journal of the Entomological Society of BC. When the inventories are complete, this RBCM's *Living Landscapes* web page will include the final project report, species accounts, distribution maps, colour photos, and field identification keys.

Figure 9. Volunteers played a major role in the surveys: they recommended collecting sites, helped with logistics and participated in collecting specimens and habitat data. They form a useful local resource for future monitoring of wetlands. Joanne Vinnedge and her daughter Laura at a peatland pond near Fort St. James. Photo: Robert A. Cannings

RESULTS

1. Summary of Results 2000-2005

- Approximately 780 separate sites were visited at least once.

- Approximately 10,340 adult and 1400 larval dragonflies (total of 11,740) were collected and deposited in the Royal BC Museum. The amount of new habitat-association information that can be gleaned from associating these dragonfly records with the ecological data of sites is considerable. The ensuing baseline information for long-term ecosystem health monitoring is also considerable. The risks to dragonfly populations and other organisms from these collecting efforts is minimal. There are essentially no risks to populations, even of rare species, from this sort of collecting. Specimens in research collections have many values. For example, they serve as standards for species identification and unequivocally document historical status, distribution, and present geographical variation, including 'hidden', as yet undescribed species. In addition, they contain life-history and ecological information such as the habitat choice of species and the time of adult emergence and breeding.

- 56 species were known in the region at the beginning of the survey; 9 more species were discovered: *Lestes forcipatus, Amphiagrion abbreviatum, Aeshna tuberculifera, Rhionaeschna californica, Epitheca spinigera, Somatochlora brevicincta, S. forcipata, Sympetrum corruptum* and *S. madidum.* Two of these, *Amphiagrion* and *Epitheca,* were not on the list of probable species at the start. Three species from the original probable list still remain to be found in the study area. A total of 65 species is now known for the study area (north of latitude 52º) and at least three additional species probably occur in the region. The total of 68 species represents 78% of the provincial fauna.

- One species, *Somatochlora brevicincta* was the only species recorded new to BC. This was a surprising discovery; previously it was known from only a few locations in Quebec, Maine and the Atlantic provinces. After its initial discovery on Bell Mountain near McBride in 2000, we collected it at another nine locations, all along the eastern margin of the Rocky Mountains.

- Between 2000 and 2003 the conservation status ranks of 15 species found in northern BC were changed. This is 17% of BC species; 14 species are now less at risk and one is considered more at risk. Of the 14 species considered of management concern at the beginning of the surveys in 2000, only nine are so designated as of December 2005. The changes to the provincial Red and Blue lists as a result of this inventory mean that conservation studies are more able to focus on species truly in need of individual attention. Our knowledge of the distribution and status of northern dragonfly taxa has been enhanced. As the region they inhabit is being altered by human development, such improved understanding of the fauna will help in their conservation. Locating viable populations will give agencies and

organizations concerned with conservation critical knowledge to enable them to secure habitat through land designation, habitat enhancement, or stewardship agreements with landowners. Once the true status and detailed distribution of the rarer dragonflies is known, management guidelines can be drawn up. Preliminary management information is a product of the project.

- Four types of colour distribution maps (including histograms showing flight period) for each dragonfly species in BC were produced. These 348 maps (plus 3 summary maps) are a major product of this project.

- Public knowledge and appreciation will increase significantly as a result of the information gathered by the inventory and distributed via publications, presentations, and the RBCM's Living Landscapes Web page.

2. Annual Summaries

Year 1: 2000

In the 2000 field season, inventory was concentrated around around Prince George and the regions east and south of the city, that is, the western slopes of the Rockies from Tête Jaune Cache north to Pine Pass, south to the northeastern Chilcotin Plateau (Nazko area) and the northern Cariboo Mountains (Likely, Quesnel Lake). Sporadic collecting also occurred along Highway 20 to the eastern boundary of Tweedsmuir Park. Rob Cannings and Leah Ramsay each visited the study area twice, and Syd Cannings made one trip, for a total of 39 days in the field by the principal biologists. Sid Dunkle (Plano, Texas), one of the leading dragonfly biologists in North America, joined Syd Cannings for part of his trip. Five additional provincial government biologists were temporarily assigned to this project, and contributed about 29 days total. Three biologists were contracted to search for and collect dragonflies: Gina Roberts surveyed the Horsefly Forest District, Crispin Guppy surveyed the Quesnel Forest District, and Gordon Hutchings surveyed the southern portion of the Prince George Forest District. Pamela Hengeveld was hired to visit major sample sites and describe the habitat in detail, and Will MacKenzie, the provincial wetlands ecosystem specialist, spent three days with us, training us in the provincial wetlands classification scheme

Two hundred fifty-six sites were visited at least once. Approximately 4000 adult and 300 larval specimens of at least 51 species were collected. Fifty-eight species were known from the region before the start of the project; four species new to the region were discovered.in 2000. These additions were *Amphiagrion abbreviatum, Aeshna tuberculifera, Epitheca spinigera,* and *Somatochlora brevicincta*. The latter is new to the provincial list as well; this was the "*range extension of the year*" according to the newsletter of the Dragonfly Society of the Americas. *S. brevicincta* is a very rare species previously known only from a handful of localities in the world, all from central Quebec, the Atlantic

Provinces and Maine; it was found at *four* sites: three on the wet windward slopes of the Rockies and one in the Cariboo Mountains near McBride.

Rob Cannings visited the Prince George in June and gave an evening presentation on dragonfly biology and identification, followed by a day-long field workshop to those who had expressed enthusiasm in developing their inventory skills. A total of 12 professional biologists, dragonfly specialists and local naturalists from Williams Lake, McBride, Prince George, Mackenzie, and Burns Lake volunteered their services. We were especially fortunate to secure the participation of Sid Dunkle (Texas) (11 days) and Dennis Paulson (Washington State) (1 day), two of the leading dragonfly experts in North America.

Publications. A popular article on the discovery of the Quebec Emerald is posted on the Conservation Data Centre website and was published in the Entomological Society of BC's newsletter Boreus (Cannings 2000). Rex Kenner reported the first record of *Somatochlora kennedyi* in BC (Kenner 2000) and the original description of the larva of *Leucorrhinia patricia*, based on collections from northern BC and the Yukon, was published (Kenner *et al.* 2000). The final web report of the Columbia Basin dragonfly survey (Cannings *et al.* 2000), which describes many of the same aspects of dragonfly inventory found in the northern inventories, was produced; it is on the internet at http://www.livinglandscapes.bc.ca/cbasin/www_dragon/toc.html.

Year 2: 2001

In the 2001 field season we surveyed dragonflies in selected areas throughout the Vanderhoof-Omineca-Williston region, concentrating on the areas around the south end of Williston Lake, the Omineca mountains west of the lake, the Fort St. James – Takla Lake region and the Highway 16 area near Vanderhoof. Rob Cannings, Leah Ramsay, and Syd Cannings each visited the study area once, for a total of 35 days in the field by the principal biologists. Six additional provincial government biologists were temporarily assigned to this project, and contributed about 33 days total. Two government vehicles were made available to us at cost, reducing our expected costs. Two biologists were contracted to search for and collect dragonflies: Cris Guppy surveyed the Fort St. James Forest District, and Gord Hutchings surveyed the southern portion of the Mackenzie Forest District. Pamela Hengeveld was again hired to visit major sample sites and describe the habitat in detail. A total of six professional biologists, dragonfly specialists and local naturalists volunteered their services. We were especially fortunate to secure the volunteer participation of Tim Vogt, Illinois State Museum, one of North America's leading experts on boreal dragonflies.

A total of 250 sites was visited at least once. Again, poor weather plagued the survey, especially in the early weeks. Until August 8, the summer was almost uniformly cloudy and wet, so fewer adult dragonflies were encountered and sampled than would be expected with the effort made. Approximately 2500 adult and 200 larval specimens of at least 50 species were collected. *Somatochlora forcipata* was added to the regional list, bringing the total to 63 species. This species of mountainside fen springs was only added to the provincial list during our Rocky Mountain survey in 1998; this year's collection represents a range

extension of over 600 kilometres to the northwest. Three species formerly on the Blue List were found with such frequency that they were delisted: *Aeshna septentrionalis*, *Ophiogomphus colubrinus*, and *Somatochlora cingulata.* Thus, after the 2001 field season, the number of species of management concern dropped from 14 to 11. The major discovery of 2000, *Somatochlora brevicincta*, was found at several more sites, and its rank was changed from S1 to S2 to reflect its greater range, although records are still very sparse. A new ranked provincial dragonfly list was produced in October 2001 and was posted on the CDC's website.

The response from the naturalist community for the project was again encouraging; we had a positive response from six local biologists and naturalists from Mackenzie and Fort St. James. Syd Cannings and Cris Guppy visited the area in July and gave evening presentations in Mackenzie and Fort St. James on dragonfly biology, collection and identification, followed by a day-long field workshop to those who had expressed enthusiasm in developing their inventory skills. A successful partnership was forged with Slocan Forest Products and Forest Renewal B.C. where helicopter time was shared, allowing the project into areas that were otherwise not accessible.

Publications. Preliminary communications of important findings were sent to the volunteers involved via electronic mail

Year 3: 2002

In the 2002 field season we surveyed northern Tweedsmuir Park, the Babine and Bulkley regions, the upper Skeena region, including the Kispiox Valley and the southern parts of the Highway 37 corridor. A side trip to Williams Creek Ecological Reserve near Terrace was undertaken because of strong BC Parks interest in the project. Two contractors who were hired to search for and collect dragonflies: Syd Cannings worked in the Smithers-Skeena regions early in the season, scouted for good mid and late season sites and undertook mid season sampling. Gord Hutchings surveyed the western portion of the study area. Rob Cannings, Leah Ramsay, and Leah Westereng each visited the study area once, for a total of 37 days in the field by the principal biologists. Four additional provincial government biologists were temporarily assigned to this project, and contributed about 41 days total.

A total of 175 sites was recorded. Approximately 2200 adult and 250 larval specimens of at least 50 species were collected. *Rhionaeschna californica* was the only species added to the regional list in 2002. This southern species of rich, lowland marshes was known from just south of the study area in the southern Cariboo-Chilcotin, but in 2002 was found in the Smithers area, far to the north. We downlisted the conservation ranks of several species. *Epitheca canis* was downlisted from S2S3 to S3 and *Somatochlora forcipata* from S1S2 to S2; a significant population of the latter rare species was found at Cinema, near Quesnel, on Highway 97. *Somatochlora septentrionalis* was collected at two more sites and went from S2 to S3. *Somatochlora brevicincta*, although not collected in 2002, was listed at S2S3, down from S2; this rank reflects the wide distribution range of this rare and local species. Another significant record represents the second site of *Ischnura damula* in the province. Previously known only from the warm waters of Liard River Hot Springs, this red-listed

damselfly was found in the Kispiox Valley. This is a major range extension, about 450 km southwest of Liard and the first record of this species west of the Rocky Mountains in Canada. There was no evidence of springs at this site.

The naturalist community in Smithers, Terrace, Houston and New Hazelton responded positively to our request for volunteers. Fourteen naturalists and biologists living in the study area volunteered their time during the project. Syd Cannings visited the area in June and gave an evening presentation in Smithers on dragonfly biology and identification, followed by a day-long field workshop to those enthusiastic attendees who were interested in developing their inventory skills. A successful partnership was forged with BC Ministry of Forests; helicopter time was shared, allowing the project into an area that was otherwise inaccessible.

From 2 to 5 May, 2002, The RBCM held a series of public programs in Williams Lake as part of its Living Landscapes project. The Northern Dragonfly Survey is a significant part of this project, and an exhibit and specimens were on display. During this event, Rob Cannings presented several school programs and public talks on dragonflies in the north. The exhibit on the dragonfly project was displayed at a similar public event in Quesnel the next week, but no school programs or lectures were presented

Rob Cannings was an invited speaker at the symposium entitled "North American Dragonflies" held at the joint annual meeting of the Entomological Society of Canada and the Entomological Society of Manitoba, 9 October 2002, in Winnipeg. Representatives from most regions of Canada presented overviews of dragonfly inventories undertaken in their jurisdictions. Cannings outlined the purpose and results of the Northern Dragonfly Survey project in BC. A workshop entitled "Dragonflies: a status assessment" was also held. This was the first time researchers from across Canada had gathered to discuss the national conservation status of all the species on the Canadian list. Results from the BC inventories played an important role in these discussions. Rob Cannings also gave a lecture on the BC dragonfly survey at the annual Invertebrate Symposium held at the University of Victoria on 21 March 2003.

The RBCM held a series of public programs in Prince George from 17 to 20 October 2002 to wrap up the Upper Fraser Basin portion of the Living Landscapes project. As in Williams Lake earlier in the year, the exhibit on the Northern Dragonfly Survey was on hand, and Rob Cannings gave a lecture about the dragonfly survey during the symposium that highlighted all the projects undertaken in the Living Landscapes program. Copies of the recently published field guide to the dragonflies of British Columbia and the Yukon (Cannings 2002a), written by Rob Cannings as part of the Northern Dragonfly Survey project, were sold.

Publications. A Species at Risk brochure on rare dragonflies of BC came out in May 2002, published jointly by the Ministry of Sustainable Resource Management and Ministry of Water, Land and Air Protection (Cannings 2002b). The brochure is distributed throughout BC in paper format and is on the web:

(http://wlapwww.gov.bc.ca/wld/documents/dragonflies.pdf). Information from the Northern Dragonfly Survey surveys was used in the publication.

Rob Cannings wrote a new book, *Introducing the Dragonflies of British Columbia and the Yukon*, as part of the project (Cannings 2002a). This is a 96-page field guide with colour photos, species descriptions, and information on distribution, habitat and behaviour for every species in British Columbia and the Yukon. An introduction to dragonfly biology and dragonfly study is also included. Copies were distributed to survey volunteers. The first printing of 2000 copies was exhausted by the end of 2004; a second printing was completed in 2005.

Year 4: 2003

In the 2003 field season, collections work focused on the Hwy 37 (Stewart-Cassiar) corridor, the Telegraph Creek Road, The Atlin and White Pass areas and the portion of the Alaska Highway (#97) in BC along the Swift River. Because access to the extreme Northwest is through Whitehorse, we were joined by staff from the Yukon Department of the Environment. Two contractors were hired to search for and collect dragonflies: Syd Cannings worked along with Dave Fraser and two Yukon government workers in the Atlin-White Pass regions in July. Gord Hutchings surveyed Hwy 37 in early July and the Atlin area later in the month. Several other teams collected Hwy 37 and Alaska Hwy: Rob Cannings/ Leah Ramsay (also covered the Telegraph Creek road) and Mike Badry/ Anne Hetherington in July; Rob Cannings/ Andrew Harcombe and Leah Ramsay/ Ian Hatter in August. In addition, Rob Cannings/ Andrew Harcombe visited the Atlin area in August and during the same month, Leah Ramsay/ Ian Hatter drove the Haines Road. During five days from June to August, Rosamund Pojar of Smithers collected along Hwy 37, at Bella Coola and in Tatlatui Provincial Park. Five principal investigators members were in the field for a total of 53 person-days. Eight additional provincial and territorial government biologists were temporarily assigned to this project, and contributed about 41 days.

This year represented the last of the four years partially funded by the Habitat Conservation Trust Fund. Funding from HCTF averaged about $30,000 each year between 2000 and 2003, amounting to about half the total cost of the project over these years, including government salaries and in-kind contributions.

A total of about 85 sites was recorded and each site was visited at least once. Approximately 990 adult and 200 larval specimens of at least 34 species were collected. No new species were added to the regional list in 2003. The conservation ranks of several species were downlisted as a result of the collections in 2003. *Somatochlora septentrionalis* was found at many more sites (In BC it appears most common in the extreme northwest) and dropped from S3 to S4. The big story in 2003 was the change in our understanding of the distribution and rarity of *Somatochlora kennedyi*, which we collected in four places, doubling the provincial locality list. We downlisted the species from S1S2 to S3S4.

Syd Cannings gave a talk to about 200 interested people in Whitehorse on the project and dragonfly biology, setting the stage for inventory in the Northwest. Rob Cannings was invited to participate in the COSEWIC general ranking meetings in Ottawa in November 2003. The Odonata are being considered for inclusion in a new COSEWIC subcommittee on endangered invertebrates. The general ranking meeting establishes baseline rankings for all species so that rare and endangered ones can be defined.

Publications. No publications of direct relevance to the northern surveys were produced in 2003.

Year 5: 2004

No field work was undertaken. Northern specimens in the RBCM were completely curated, databases were brought up to date and new distribution maps were printed. Field surveys were initiated in the Yukon by Syd Cannings and Cameron Eckert of NatureServe Yukon. Most of the specimens were deposited in the RBCM and databased and curated by Moretta Frederick. They represent an important complement to the RBCM's holdings of northern BC material.

A paper entitled "Determining the status of British Columbia's dragonflies" was prepared by Leah Ramsay and Rob Cannings for the Species at Risk Conference held in Victoria in early March 2004. The paper was delivered by Ramsay.

Publications: Rob Cannings published an article, "Resources for the study of the Odonata in Canada" in the Newsletter of the Biological Survey of Canada (Cannings 2004). The article outlines the major publications, web sites, museum collections and databases that are useful in studying dragonflies. The closely related damselflies *Lestes disjunctus* and *L. forcipatus* are frequently collected in the northern surveys; new characters for separating these similar species were reported in Simaika and Cannings (2004).

Year 6: 2005

The 2005 field season found us surveying selected areas throughout the northwest coastal region: Prince Rupert and environs; the north side of the Skeena Valley east to Terrace; Terrace to the Nass River and the Nass valley east to Highway 37, including the Kitsault Road; and the Highway 37 corridor from Terrace to Kitimat (Figs. 10-15). Claudia Copley took part in a multi-disciplinary collecting expedition by boat through the islands south of Prince Rupert (Porcher, Banks, Pitt, Princess Royal islands) from 19 to 28 June. During their own studies, RBCM staff, Ken Marr and Mike McNall, helped Claudia collect. Rob Cannings and Jennifer Heron (Invertebrate Species at Risk Specialist, Ministry of Environment) surveyed the Terrace, Prince Rupert and Nass Valley regions from 5 to 13 July. The same areas were collected by Rob Cannings, Claudia Copley and Darren Copley

from 14 to 19 July and by Claudia and Darren Copley from 20 to 26 July. This is a total of 32 collecting days.

Several volunteers from the region gave advice, permission to collect or joined us in the field periodically. Ben Sabal (BC Parks, Terrace) aided with logistics and planning. Lars Reese-Jensen, also of the BC Ministry of Environment, advised us on collecting sites and guided us in the field. Robin Weber, Director, Prince Rupert Museum, helped with logistics and participated in collecting specimens. Dennis Horwood (Kitimat), Will Mackenzie (Ministry of Forests, Smithers) Jim Pojar (Whitehorse), Kathy Stuart and Don Youds (Terrace) suggested collecting sites. Carl Lofroth loaned us his house in Terrace as a base for field work. Collier Azak and Harry Nyce of the Nisga'a Lisims Government gave us permission to collect on Nisga'a lands in the Nass Valley.

Figure 10. Darren Copley and Rob Cannings – tired and wet dragonfly larvae collectors, Prince Rupert. Photo: Claudia Copley, RBCM.

A total of 82 separate collections was made; 507 adults and 190 larval lots were collected. Poor weather was a significant problem. In fact, the summer was a very wet one, and fewer adult dragonflies were encountered and sampled than would be expected, given the effort made. However, our extensive larval collections made up for much of the lack of adult material, although it was wet work. At the RBCM, Rob Cannings, and

Claudia Copley checked the identifications of the specimens and Claudia entered the collection information into the database and curated the collection. No new species to BC were encountered.

Figure 11. The coastline near Prince Rupert from Mount Hayes. Metlakatla village is in the distance. Photo: Claudia Copley, RBCM. The summit of Mount Hayes contains many small coastal bog pools.

Figure 12. Fen in Diana Lake Provincial Park near Prince Rupert. Coastal. Photo: Claudia Copley, RBCM.

The broad Skeena River basin extends well inland from the Pacific Ocean, allowing some species mainly found in the Interior of the province to range into coastal habitats. The area contains a fascinating mixture of interior and coastal environments. The focus of the survey this year was to document any dragonfly species, normally restricted to habitats east of the Coast Range, ranging into coastal (or coast-influenced) areas. In 2002 we collected *Somatochlora whitehousei* at Williams Creek Ecological Reserve south of Terrace. This is a good example of a boreal species, once known only from the east side of the Coast Mountains, living in a mainly coastal habitat in this transitional area. Like some other coastal populations of dragonflies, the Williams Creek population appears to have significantly larger individuals than those from east of the mountains. In 2005 we found the first *S. franklini* in what could be considered coastal habitat (Nalbeelah wetlands north of Kitimat). In the same place, the only coastal records of *Lestes forcipatus* north of southern Vancouver Island (600 km to the south) were tallied. Likewise, *Aeshna tuberculifera* was collected in the Kitsumkalum Valley (the nearest coastal records are on Vancouver Island) and *A. subarctica* at Prince Rupert (the nearest coastal records are at Bella Bella). Claudia collected several species far to the north of their previous coastal localities – *Ladona julia, Sympetrum pallipes* and, especially, *Coenagrion resolutum*.

Figure 13. Pond at summit of Kitsault Road, between the Nass River and Alice Arm. This area contains many hectares of fine subalpine fens, ponds and lakes. Photo: Claudia Copley, RBCM.

Figure 14. Rob Cannings collecting dragonfly larvae at Herman Lake, Terrace. Photo: Jennifer Heron.

Figure 15. Nalbeelah wetlands near Kitimat, the site of several dragonfly range extensions in 2005. Photo: Jennifer Heron.

The Odonata surveys in the Yukon continued in 2005 and, as in 2004, much of the material was deposited in the RBCM collection, helping to put the RBCM's northern BC specimens in a broader biogeographical context.

At an Invertebrate Species at Risk Symposium in Victoria in October, 2005, Rob Cannings presented an overview of the survey and the changes in species conservation ranks that have resulted from the work (Cannings and Ramsay 2005).

Publications. A paper on four of the species discovered in the province during recent inventories was published in Notulae odonatologicae (Cannings *et al*. 2005a); the fifth species had been published earlier (Kenner 2000). New information on the relationships between *Lestes disjunctus* and *L. forcipatus* and our new understanding of these species distribution and status are related in Cannings and Simaika (2005). A comprehensive report to the Habitat Conservation Trust Fund, which funded much of the northern survey, was submitted in 2005 (Cannings *et al.* 2005b). Rob Cannings co-authored a new annotated list of the Odonata of Canada (Catling *et al*. 2005); much of the BC information in this list is influenced by the dragonfly surveys.

3. Changes in Conservation Status

The inventories provided critical information for assigning and modifying existing conservation status ranks for dragonfly species. Preliminary conservation status ranks were updated in 2000 after the first year of the northern surveys. Subsequently, we focused inventory efforts on the species considered at risk in order to more accurately determine their status. During these surveys, known ranges of many species were extended, knowledge of habitat requirements increased, and one new species was confirmed for the province. Many of the targeted species were more abundant than previously thought, and their conservation ranks were changed accordingly. Others were found only rarely or not at all

Criteria for conservation rank assessments for 1995 were number of element occurrences, population, trend, threats and protection. The latest assessments, made in 2004 separated threats into severity, scope and immediacy; the trends were divided into long and short term and environmental specificity and intrinsic vulnerability were added. The criteria are only used when the relevant information is known. A summary of changes for all BC species as of 2004 is given in Table 1.

The original list of Odonata from northern BC contained ten species that were probable inhabitants but which had not yet been recorded in the region. We were successful in recording all but three of these probable species and added nine. Ranking poorly known species is challenging, particularly if samples are small or habitats are difficult to access. By increasing our knowledge of these species and their requirements, we can assign them more accurate ranks, thus ensuring that conservation efforts will target the species and habitats that truly require them.

Between 2000 and 2003 we changed the rank of 15 species (17% of BC species) -- 14 are now less at risk and one is considered more at risk (Table 1). Appendix 3 contains the definitions of symbols and the complete list of conservation ranks for these and all other BC species. For more about conservation ranking and species and habitats at risk, see the CDC website at http://srmwww.gov.bc.ca/cdc/.

Table 1: Changes in the conservation status of British Columbia Odonata: 1995 to 2004. Species with scientific names in bold are found in northern British Columbia.

Scientific Name	**English Name**	**1995**	**2000**	**2004**	**Rank Change**
Lestes forcipatus	Sweetflag Spreadwing	unknown	S3	S4	+2.0
Coenagrion angulatum	Prairie Bluet	S1S2	S4	S3S4	+2.0
Coenagrion interrogatum	Subarctic Bluet	S4	S4	S4S5	+0.5
Ischnura erratica	Swift Forktail	S3?	S4	S4	+0.5
Nehalennia irene	Sedge Sprite	S4	S5	S5	+1.0
Aeshna constricta	Lance-tipped Darner	S2S3	S2S3	S2	-0.5
Aeshna septentrionalis	Azure Darner	S4S5	S3S4	S4	+0.5
Aeshna tuberculifera	Black-tipped Darner	S2S3	S3	S4	+1.5
Gomphus graslinellus	Pronghorn Clubtail	S2	S2	S2S3	+0.5
Ophiogomphus colubrinus	Boreal Snaketail	S3?	S3?	S4	+0.5
Stylurus olivaceus	Olive Clubtail	S2	S2	S1S2	-0.5
Epitheca canis	Beaverpond Baskettail	S2S3	S2S3	S3	+0.5
Somatochlora brevicincta	Quebec Emerald	unknown	S1	S3	+2.0
Somatochlora cingulata	Lake Emerald	S2S3	S3	S4	+1.5
Somatochlora forcipata	Forcipate Emerald	unknown	S1S2	S2S3	+1.0
Somatochlora franklini	Delicate Emerald	S4S5	S4S5	S5	+0.5
Somatochlora hudsonica	Hudsonian Emerald	S5	S4S5	S4S5	-0.5
Somatochlora kennedyi	Kennedy's Emerald	unknown	S1S2	S3S4	+2.0
Somatochlora septentrionalis	Muskeg Emerald	S3S4	S3?	S4	+0.5
Somatochlora whitehousei	Whitehouse's Emerald	S4	S4	S5	+1.0

Erythemis collocata	Western Pondhawk	S2S3	S2	S3	+0.5
Leucorrhinia patricia	Canada Whiteface	S3S4	S3?	S4	+0.5
Pachydiplax longipennis	Blue Dasher	S2S3	S2S3	S3S4	+1.0

Figure 16. *Aeshna tuberculifera* ♀, a species whose conservation rank was lowered after collecting in northern BC showed it to be uncommon rather than rare. Photo: Robert A. Cannings, RBCM.

Figure 17. *Amphiagrion abbreviatum* ♀, a species reported from the North for the first time during the surveys. Photo: Robert A. Cannings and M. Brent Cooke, RBCM.

4. Other Knowledge

In addition to increasing our knowledge of the habitats and distributions of the species of dragonflies considered at risk we learned much more about the habitat needs, status and behaviour of the more common species. A few examples of the latter species are given here. *Somatachlora walshii* (Scudder) was originally known only from half a dozen locations scattered throughout the southern half of the province. It is now clear that this species is widespread across the southern two-thirds of the province and that it inhabits many spring-fed wetlands containing slow moving water. We had always assumed that *Aeshna subarctica* was more common than the scanty records indicated; our surveys confirmed this. Even though it was known from the southern Yukon (Cannings *et al*. 1991), *Somatochlora minor* had been only found in British Columbia south of 52°N. We now have several records from as far north as Fort Nelson. A large amount of other species-specific information is recorded in the individual species accounts in Appendix 4.

These results highlight the value of intensive, targeted surveys and illustrate the dynamic nature of the ranked lists. A common question posed by wildlife or land managers and policy makers is, "How can we reduce the number of species on tracked or "at risk" lists?" Undertaking inventories focused on particular species is the most straightforward way to answer the question. Intensive collecting often reveals that many species appear rare only because they are poorly sampled. In the course of establishing distributions and numbers during inventories, other criteria that are used to establish conservation status ranks can be determined; including habitat or threats. The resulting lists can then be used to focus efforts and resources on those species or habitats that are truly at risk, either by addressing the threats or considering recovery planning. This is, of course, true for not only the Odonata but for all taxa. Inventories not only fill key gaps in our knowledge, but also focus future studies on species and regions for which there is still a lack of information.

5. Distribution Maps

Four types of colour distribution maps for each species in BC were produced in both jpg and pdf format.); they show BC distribution based on the collections of the Royal BC Museum and Spencer Entomological Museum, University of BC. Map 1 is the basic distribution map. Map 2 separates records made before 1996 and those made from 1996 to 2004. This highlights the effectiveness of intensive surveys in improving our understanding of dragonfly distribution in BC. Map 3 shows species distribution and the relative abundance of collection records in each 1/50,000 NTS map sheet in BC. Map 4 shows the same, except the number of localities in each map sheet, rather than total specimen records, is shown. Each map also presents a histogram of collection records of adult dragonflies graphed in 10-day periods throughout the year. These represent the known flight period of the species. Two summary maps representing the combined data from all species used in Maps 3 and 4 were also produced and are included herein (Figs. 18 and 19). A map showing annual survey regions was also made (Fig.1). Examples of all types of distribution maps are shown in the species accounts in Appendix 4. The content

of these maps, although dealing with all BC, would have been much less useful without the results of detailed inventories in the North.

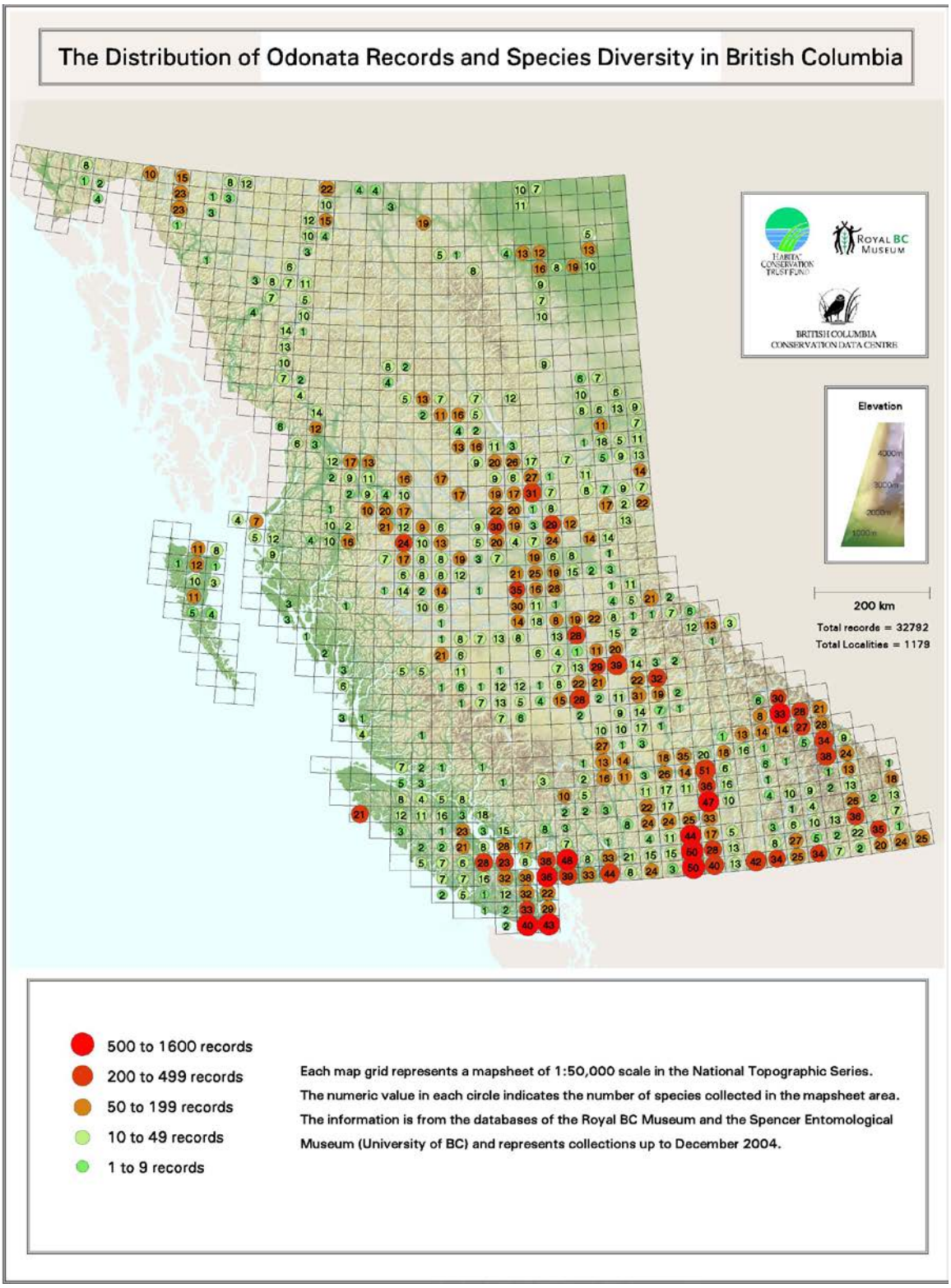

Figure 18. Species distribution and the relative abundance of collection records in each 1/50,000 NTS map sheet in BC.

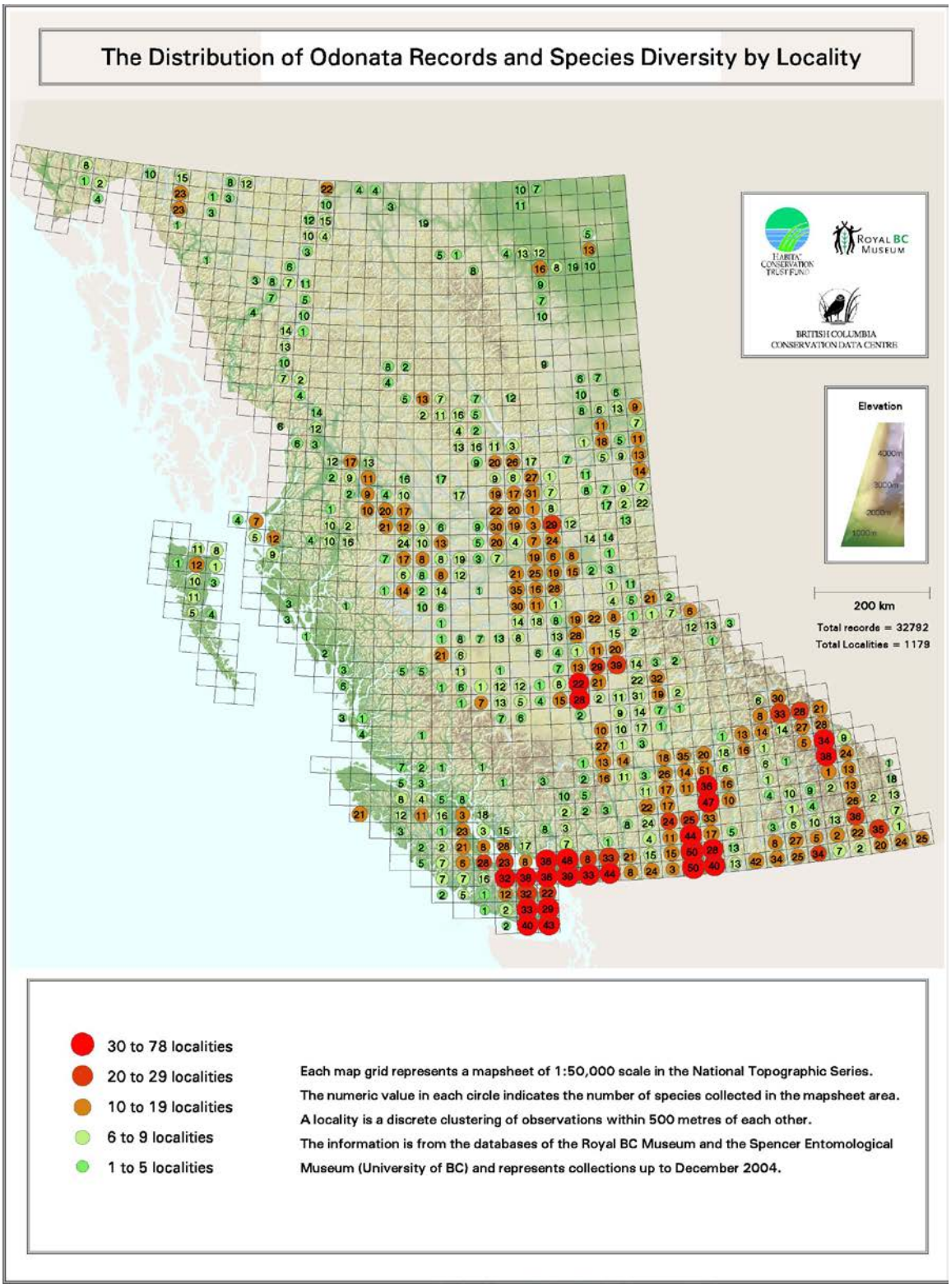

Figure 19. Species distribution and the relative abundance of collection localities in each 1/50,000 NTS map sheet in BC.

Acknowledgements

All of these surveys were cooperative efforts funded from a variety of sources, and involving several agencies and many volunteers. Management help, financial support and aid in kind came from: Habitat Conservation Trust Fund; The Royal BC Museum; Ministry of Sustainable Resource Management; Ministry of Water, Land and Air Protection (the latter two ministries now joined as the Ministry of Environment); and Forest Renewal British Columbia. The principal investigators have been Leah Ramsay, Robert Cannings, Sydney Cannings, Gord Hutchings and Claudia Copley. Additional collectors are too numerous to list in total, but several people did participate over several years including Mike Badry, David Fraser, Cris Guppy, Andrew Harcombe, Ian Hatter, Pamela Hengeveld, Rosamund Pojar and Leah Westereng. BC Parks and Parks Canada provided collecting permits. Staffan Lindgren, Will MacKenzie, Dennis Paulson, Jim Pojar and Doug Wilson helped with advice and David Blades, Moretta Frederick, and Chris Borkent (RBCM) helped with database management and report preparation. Many others enthusiastically swung nets, pointed out wonderful wetlands and provided access to collecting areas.

Appendix 1. Dragonfly Habitats in Northern British Columbia

There is a wide variety of aquatic habitats available to dragonflies in northern British Columbia. A general overview is presented below, with a few of the distinctive dragonfly species associated with each. The wetland site association classification used is that of MacKenzie and Moran (2004); pertinent parts are summarized in Table 2 below. Dragonfly associations are much broader than plant site associations, largely because dragonflies (in both adult and larval stages) appear to react to the structure of plants and plant communities rather than plant species.

Some species, such as *Libellula quadrimaculata,* have such wide tolerances that almost any standing freshwater body half a square metre or larger in any habitat is adequate for breeding. On the other hand, *Aeshna subarctica* requires submerged moss for larval habitat. And although it requires peatlands of a certain structure (peatlands characterized by shallow pools supporting short sedges, such as *Carex limosa* and *C. livida*), *Aeshna sitchensis* apparently does not discriminate if the pond is in an acid coastal bog dominated by *Sphagnum* mosses and ericaceous shrubs with *Carex livida* in the pools (Wb52) or if the habitat is a neutral interior fen with a *Drepanocladus* moss mat, shrubby willows and *Carex limosa* in the pools (Wf08). In this case the plant lists from the two places will be radically different, but the dragonfly community will show much less variability. For this reason, at least, the occurrence of any dragonfly species overlaps many of the wetland site associations described in MacKenzie and Moran (2004) and the following discussion is kept relatively general and only the more common and obvious site associations are mentioned.

1. Large lakes (wave-washed shores with little vegetation)

Many northern lakes, such as Fraser, Purden and Moberly lakes, to name only a few, have wave-washed shores with little aquatic vegetation. In some sheltered situations, sparse stands of bulrushes (*Schoenoplectus acutus,* Wm06) or horsetails (*Equisetum fluviatile,* Wm02) may occur. The dragonflies associated with this habitat are: *Enallagma carunculatum* (in bulrush beds), *E. ebrium, Aeshna umbrosa, Ophiogomphus severus* and *Somatochlora cingulata*. In larger, deeper lakes (Fig. 20), such as Atlin, Babine and Stuart lakes, the waters are colder and less productive, and dragonflies are restricted to shallow waters in sheltered bays, where the fauna resembles that found in small lakes and ponds.

Figure 20. Tatlayoko Lake, Chilcotin. A large lake with little aquatic vegetation. Photo: Robert A. Cannings.

2. Small lakes and ponds with floating, but little emergent, vegetation)

A wide variety of small lakes and ponds are present in the North. Those lacking emergent vegetation of any significance often support *Nuphar lutea* -- *Utricularia macrorhiza* communities (Fig. 21). Yellow pond-lily ecosystems occur on a variety of sites from deep (5 m) lakes with gravel bottoms to shallow, acidic, peat-degradation pools in coastal bogs (MacKenzie and Moran 2004). In lake habitats, a diverse array of Odonata occurs: *Enallagma ebrium, Aeshna canadensis, A. eremita, A. palmata, A. tuberculifera, A. umbrosa, Cordulia shurtleffi, Somatochlora albicincta, S. cingulata, Leucorrhinia glacialis, L. hudsonica, L. proxima, Ladona julia* and *Sympetrum obtrusum.*

Figure 21. Mitten Lake, Kispiox. A small lake with *Nuphar lutea* association. Photo: Gord Hutchings

3. Saline lakes

These salty lakes occur primarily in grasslands and open forests on the plateaus of the Chilcotin and Cariboo (Fig. 22). Site associations in the saline meadows adjacent to the lakes and ponds include *Juncus balticus* (Wm07) marshes, *Distichlis spicata* var. *stricta* (Gs01), *Puccinellia nuttalliana – Hordeum jubatum* (Gs02) and *Carex praegracilis* (Gs03) associations. Some dragonfly species are able to live in this unusual habitat despite the often high salinity, and their life histories enable them to take advantage of the ephemeral nature of the shallower lakes and ponds: *Enallama boreale, E. clausum, Lestes congener, L. unguiculatus, Sympetrum internum, S. corruptum* and *S. costiferum.* These species are not restricted to this habitat.

Figure 22. Rock Lake, Riske Creek, Chilcotin -- a saline lake. Photo: Robert A. Cannings

4. Ephemeral ponds (temporary ponds)

In addition to some saline ponds that may disappear during hot weather, fresher ephemeral waters in the southern parts of the study area (Fig. 23) support the following species: *Lestes dryas, L. unguiculatus, Sympetrum internum, S. madidum* and *S. pallipes.* Some of these species overwinter as eggs in the dry pond basin. These habitats may represent a wide range of site associations, e.g., *Schoenplectus acutus* (Wm06), *Eleocharis palustris* (Wm04), and *Juncus balticus* (Wm07) marshes.

Figure 23. Grassland pond near Rock Lake, Riske Creek, Chilcotin. Such ponds often dry completely in summer. Photo: Robert A. Cannings

5. Cattail/bulrush marshes (including margins of lakes, streams and ponds)

Marshes are permanently to seasonally flooded non-tidal mineral wetlands dominated by emergent grass-like vegetation. Low species diversity is typical with strong dominance by one or two aggressive species that spread vegetatively (MacKenzie and Moran 2004). Tall stands of cattails *(Typha)* and bulrushes *(Shoenoplectus)* are most common in nutrient-rich, warm waters at lower elevations having warm, dry summers. They are most common in the southern parts of the region. *Typha latifolia* marshes are designated Wm05 (Fig. 24); *Schoenplectus acutus* ones are Wm06 (Fig. 25). Species associated with these habitats are: *Lestes congener, L. disjunctus, L. dryas, L. forcipatus, L. unguiculatus, Coenagrion angulatum, Enallagma annexum, E. carunculatum, , Ischnura cervula, I. perparva, Aeshna canadensis, A. interrupta, A. palmata, Anax junius, Rhionaeschna californica, R. multicolor, Leucorrhinia intacta, Libellula*

Figure 24. Blackburn Lake, Fort St. James. *Typha* marsh. Photo: Robert A. Cannings, RBCM

quadrimaculata, Sympetrum costiferum, S. danae, S. internum, S. obtrusum and *S. pallipes.*

Figure 25. Pond near Como Lake, Atlin. *Schoenoplectus* marsh. Photo: Gord Hutchings.

6. Sedge marshes

Carex utriculata – Carex aquatilis marshes (Wm01) (Fig. 26) represent the most common and widespread marsh association in BC. This community is frequent on sites inundated by shallow low-energy floodwaters that have some drawdown in the late season. They include flooded beaver ponds, lake margins and floodplains. This association is found on mineral soils rather than on peat (the fen equivalent, Wf01); in general, Wm01 is more deeply flooded, has a more dynamic hydrology and has a higher cover of *C. utriculata* (MacKenzie and Moran 2004). The *Equisteum fluviatile – Carex utriculata* association (Wm02) is similar and occurs more on lake margins and floodplains where there is more water movement. Some swamp associations such as Ws02, Ws04, Ws05 and Ws06 also may be related. Typical species in these habitats are: *Lestes congener, L. disjunctus, L. dryas, L. forcipatus, Coenagrion resolutum, Enallagma annexum, E. boreale, Nehalennia irene, Aeshna canadensis, A. interrupta, A. juncea, A. palmata, Epitheca canus , E. spinigera, Somatochlora semicircularis, S. hudsonica, Libellula quadrimaculata, Leucorrhinia borealis, L. hudsonica, Sympetrum internum* and *S. obtrusum.* Other types of sedge marshes have similar dragonfly faunas.

Figure 26. Lake at head of Yahwa Creek, Mackenzie. *Carex utriculata – Carex aquatilis* marsh. Andrew Harcombe and Tim Vogt collecting *Aeshna juncea.* Photo: Robert A. Cannings.

7. Small peatland ponds with aquatic moss

Peatlands are poorly drained wetlands where decaying moss and other vegetation accumulates as peat. Bogs are nutrient-poor peatlands where ericaceous shrubs and hummock-forming *Sphagnum mosses* form distinctive communities adapted to highly acid and oxygen-poor soils. The rooting zone is isolated from mineral-enriched groundwater (MacKenzie and Moran). Fens are nutrient-medium peatlands dominated by non-ericacious shrubs, sedges and brown mosses, where mineral-bearing groundwater is within the rooting zone. A few examples of site associations are *Carex limosa – Menyanthes trifoliata – Sphagnum* bogs (Wb13), *Ledum groenlandicum – Kalmia microphylla – Sphagnum* bogs (Wb50), *Juniperus communis – Trichophorum cespitosum – Rhacomitrium lanuginosum* bogs (Wb52), *Betula nana – Menyanthes trifoliata – Carex limosa* fens

Figure 27. Heckman Pass, western Chilcotin. Peatland ponds with submerged and floating aquatic moss. Photo: Robert A. Cannings.

(Wf07) and *Carex limosa – Menyanthes trifoliata – Drepanocladus* fens (Wf08). Standing, open water occurs in many of these habitats; in these ponds and pools, especially if there is floating and submerged moss, a special group of dragonflies may occur along with species having wider ecological tolerances: *Coenagrion interrogatum, A. septentrionalis, A. subarctica, Somatochlora kennedyi, S. septentrionalis, Leucorrhinia patricia*. A few of the more important specific peatland types are summarized below.

8. Water Sedge-Beaked Sedge fens

Sedges (*Carex*) form dense stands in water-saturated areas or around many lakes and ponds. The most common site association type is Wf01 (*Carex aquatilis -- Carex utriculata* fens) (Fig. 28). It occurs from low to subalpine elevations on sites that are annually inundated by shallow, low-energy flood waters. They occupy wetter zones in larger peatlands but also form extensive pure meadow-like basins (MacKenzie and Moran 2004). Some swamp associations such as Ws02, Ws04, Ws05 and Ws06 also may be related. Some dragonfly species associated with this habitat are *Lestes congener, L. disjunctus, L. dryas, L. forcipatus, Coenagrion resolutum, Enallagma annexum, E. boreale, Nehalennia irene, Aeshna interrupta, A. juncea, A. palmata, Somatochlora semicircularis, S. hudsonica, Libellula quadrimaculata, Leucorrhinia borealis, L. hudsonica, Sympetrum internum* and *S. obtrusum.*

Figure 28. *Carex aquatilis -- Carex utriculata* fen Fen near Takla Landing. Andrew Harcombe collecting. Photo: Robert A. Cannings.

9. Slender Sedge fens

Common on peat flats surrounding small lakes and ponds or in infilled basins. Prolonged shallow surface flooding is typical. Common associations are Wf05 (*Carex lasiocarpa – Drepanocladus aduncus* fens) and Wf06 (*Carex lasiocarpa – Menyanthes trifoliata* fens) (Fig. 29). Shrubs such as *Salix pedicellaris, S. candida* and *Betula nana* can occur.

Wf06 has less flooding and greater peat saturation than Wf05; the former almost always occurs as a floating mat adjacent to a lake or pond. This habitat supports a diverse species list, including *Lestes disjunctus, Coenagrion interrogatum, C. resolutum, Nehalennia irene, Aeshna juncea, Aeshna subarctica, Leucorrhinia hudsonica, L. proxima* and *Sympetrum obtrusum.* Along the open edge of the water body, or in associated pools, *A. septentrionalis, A. subarctica, A. tuberculifera, Somatochlora kennedyi, S. septentrionalis, Leucorrhinia patricia,* among others, may occur.

Figure 29. *Carex lasiocarpa* fen at Bear Lake, north of Prince George. Photo: Robert A. Cannings.

10. Shallow sedge/moss fens: *Betula nana – Menyanthes trifoliata – Carex limosa* (Wf07) and *Carex limosa – Menyanthes trifoliata – Drepanocladus* (Wf08) associations

Peatlands affected by flowing water, evenly vegetated with low sedges and shallowly flooded or dotted with shallow pools only a few centimetres deep (Fig. 27, 30, 31).

Carex limosa rooted in shallow water is the constant characteristic of Wf08 (Fig. 30), which is typical of patterned fens host a particular assemblage of species: *Lestes disjunctus, L. congener, L. forcipatus, Enallagma boreale, Coenagrion resolutum, Nehalennia irene, Aeshna septentrionalis, A. sitchensis, A. tuberculifera, Somatochlora brevicincta, S. franklini, S. kennedyi, S. semicircularis* and *S. whitehousei, Leucorrhinia hudsonica and Sympetrum danae*. Widspread species and those noted in #9 above may also occur.

Figure 30. Patterned fen at Williams Creek Ecological Reserve, Terrace. Photo: Robert A. Cannings.

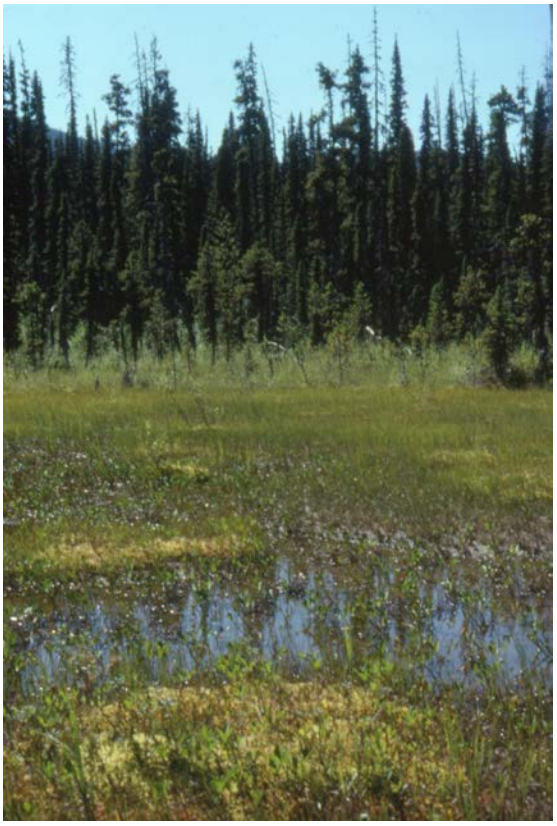

Figure 31. Fen near Takla Landing. Photo: Robert A. Cannings.

11. Outer Coastal bogs

Bogs on the outer coastal lowlands form a blanket mire complex on level or sloping terrain (Fig. 32). Hypermaritime climate, high precipitation and humidity and mineral-poor bedrock produce these bogs. The *Pinus contorta – Empetrum nigrum – Sphagnum austinii* site association (Wb51) and *Juniperus communis – Trichoporum cespitosum – Rhacomitrium lanuginosum* (Wb52) association are typical and are perhaps the most important for Odonata. Stunted *Pinus contorta, Chamaecyparis nootkatensis* and Thuja plicata are common; shrubs such as *Empetrum nigrum, Myrica gale, Ledum groenlandicum* and *Juniperus communis* are common. Ponds and

pools usually have firm, peaty margins. *Lestes disjunctus*, *Enallagma boreale, Aeshna interrupta, Aeshna sitchensis, Cordulia shurtleffii, Somatochlora albicincta, Leucorrhinia hudsonica, Libellula quadrimaculata* and *Sympetrum danae* are typical species.

Figure 32. Tow Hill Bog, Graham Island, Queen Charlotte Islands. A coastal *Sphagnum* bog. Photo: Robert A. Cannings.

12. Streams

Odonata are not normally found in the cold streams of mountainous areas. The following species, when living in flowing waters, are generally restricted to rather warm, slow streams or montane streams that drain lake basins (Fig. 33), beaver ponds or peatlands: *Ophiogomphus colubrinus*, *Ophiogomphus severus* and *Aeshna umbrosa*. The latter two species also live in lakes. *Somatochlora minor* inhabits small montane streams and *S. walshii* lives in streams or slowly flowing water in

Figure 33. Tezzeron Creek, Fort St. James. Andrew Harcombe hunting *Ophiogomphus colubrinus*. Photo: Robert A. Cannings.

peatlands. Yet to be found in the region, but to be looked for, *Cordulegaster dorsalis* is found in many warm streams draining lakes on the west side of the Coast Mountains south of 52º. It is known from coastal Alaska and from spring-fed streams in the southern Interior.

13. Springs and shallow seeps

Some of the more uncommon species of Odonata are associated with small springs and shallow seeps. *Amphiagrion abbreviatum* is known from only one locality in the region in such habitats. In the northern fringes of its range, *Ischnura damula* is normally restricted to warm springs, such as Liard River Hot Springs (Fig. 34). *Somatochlora forcipata* is apparently restricted to spring-fed streamlets through sloping fens. Potential habitat occurs in subalpine fens such as *Salix barclayi – Carex aquatilis – Aulacomnium palustre* (Wf04) and *Eriophorum angustifolium – Caltha leptosepala* (Wf12*). Tanypteryx hageni* larvae burrow in seepage areas in coastal fen associations such as *Eriophorum angustifolium – Sphagnum* (Wf50).

Figure 34. Liard River Hot Springs. Photo: Robert A. Cannings.

Table 2. Site Association Information (after MacKenzie and Moran, 2004)

Ecosystem Type	Association Code	Site Association Name
Saline associations at grassland ponds	Gs01	*Distichlis spicata* var. *stricta* (Alkali saltgrass)
	Gs02	*Puccinellia nuttalliana – Hordeum jubatum* (Nuttall's alkaligrass - Foxtail barley)
	Gs03	*Carex praegracilis* (Field sedge)
Bogs	Wb12	*Scheuchzeria palustris – Sphagnum* (Scheuchzeria – Peat-moss)
	Wb13	*Carex limosa – Menyanthes trifoliata – Sphagnum* spp. (Shore sedge - Buckbean - Peat-moss)
	Wb50	*Ledum groenlandicum – Kalmia microphylla – Sphagnum* spp. (Labrador Tea – Bog-laurel - Peat-moss)
	Wb51	*Pinus contorta – Empetrum nigrum – Sphagnum austinii* (Shore pine – Black crowberry – Tough peat-moss)
	Wb52	*Juniperus communis – Trichoporum cespitosum – Rhacomitrium lanuginosum* (Common juniper – Tufted clubrush – Hoary rock-moss)
Fens	Wf01	*Carex aquatilis* -- *Carex utriculata* (Water sedge – Beaked Sedge)
	Wf02	*Betula nana – Carex aquatilis* (Scrub birch – Water sedge)
	Wf03	*Carex aquatilis – Sphagnum* (Water Sedge – Peat-moss)
	Wf04	*Salix barclayi – Carex aquatilis – Aulacomnium palustre* (Barclay's willow – Water sedge – Glow moss)
	Wf05	*Carex lasiocarpa – Drepanocladus aduncus* (Slender sedge – Common hook-moss)
	Wf07	*Betula nana – Menyanthes trifoliata – Carex limosa* fens (Scrub birch – Buckbean – Shore sedge)
	Wf08	*Carex limosa – Menyanthes trifoliata – Drepanocladus* spp. (Shore sedge – Buckbean – Hook moss)
	Wf09	*Eleocharis quinqueflora – Drepanocladus* (Few-flowered spike-rush – Hook moss)
	Wf10	*Trichophorum alpinum – Scorpidium revolvens* (Hudson Bay clubrush – Red hook-moss)
	Wf12	*Eriophorum angustifolium – Caltha leptosepala* (Narrow-leaved cotton-grass – Marsh-marigold)

	Wf50	*Eriophorum angustifolium – Sphagnum* spp. (Narrow-leaved cotton-grass – Peat-moss)
Ecosystem Type	**Association Code**	**Site Association Name**
Marshes	Wm01	*Carex utriculata – Carex aquatilis* (Beaked sedge – Water sedge)
	Wm02	*Equisetum fluviatile - Carex utriculata* (Swamp horsetail – Beaked sedge)
	Wm05	*Typha latifolia* (Cattail)
	Wm04	*Eleocharis palustris* (Common spike-rush)
	Wm06	*Schoenoplectus acutus* (Great bulrush)
	Wm07	*Juncus balticus* (Baltic rush)
Swamps	Ws02	*Alnus incana – Spiraea douglasii – Carex sitchensis* (Mountain alder – Pink spirea – Sitka sedge)
	Ws04	*Salix drummondiana – Carex utriculata* (Drummond's willow – Beaked sedge)
	Ws05	*Salix maccalliana – Carex utriculata* (MacCalla's willow – Beaked sedge)
	Ws06	*Salix sitchensis – Carex sitchensis* (Sitka willow – Sitka sedge)

Appendix 2. Checklist of the Dragonflies of Northern British Columbia and their Faunal Elements.

Sixty-four species are known from the region defined here as Northern British Columbia (north of latitude 52º) At least four additional species probably occur in the region; these are marked (*). The total of 68 species represents 78% of the provincial fauna. As of December 2005, nine of this total of 68 dragonfly species are considered rare and potentially threatened and are marked (**); see also Table 1. These species are tracked by the BC Conservation Data Centre. The first column lists the scientific name of the families and species, the second gives the English names, and the third indicates the faunal element of the species. The faunal elements, which categorize the species' range types, are defined below.

Order Odonata **Suborder Zygoptera**	**Dragonflies** **Damselflies**	**Faunal Element**
Family Lestidae (5 species recorded)	**Spreadwings**	
Lestes congener Hagen	Spotted Spreadwing	Widespread
Lestes disjunctus Selys	Northern Spreadwing	Widespread
Lestes dryas Kirby	Emerald Spreadwing	(H) Widespread
Lestes forcipatus Rambur	Sweetflag Spreadwing	Austral
Lestes unguiculatus Hagen	Lyre-tipped Spreadwing	Widespread
Family Coenagrionidae (14 species recorded, 1 additional expected)	**Pond Damsels**	
Amphiagrion abbreviatum (Selys)	Western Red Damsel	Western
Coenagrion angulatum Walker(**)	Prairie Bluet	Western
Coenagrion interrogatum (Hagen)	Subarctic Bluet	Northern Boreal
Coenagrion resolutum (Hagen)	Taiga Bluet	Widespread Boreal
Enallagma annexum (Hagen)	Northern Bluet	(H) Widespread Boreal
Enallagma boreale Selys	Boreal Bluet	Widespread Boreal
Enallagma carunculatum Morse	Tule Bluet	Austral
Enallagma civile (Hagen) (*/**)	Familiar Bluet	Austral
Enallagma clausum Morse	Alkali Bluet	Western
Enallagma ebrium (Hagen)	Marsh Bluet	Transition
Enallagma hageni (Walsh) (**)	Hagen's Bluet	Transition
Ischnura cervula Selys	Pacific Forktail	Cordilleran
Ischnura damula Calvert (**)	Plains Forktail	Western
Ischnura perparva Selys	Western Forktail	Western
Nehalennia irene (Hagen)	Sedge Sprite	Southern Boreal

Suborder Anisoptera **Family Aeshnidae** (13 species recorded)	**Dragonflies** **Darners**	
Aeshna canadensis Walker	Canada Darner	Transition
Aeshna eremita Scudder	Lake Darner	Widespread Boreal
Aeshna interrupta Walker	Variable Darner	Southern Boreal
Aeshna juncea (Linnaeus)	Sedge Darner	(H) Widespread Boreal
Aeshna palmata Hagen	Paddle-tailed Darner	Cordilleran
Aeshna septentrionalis Burmeister	Azure Darner	Northern Boreal
Aeshna sitchensis Hagen	Zigzag Darner	Widespread Boreal
Aeshna subarctica Walker	Subarctic Darner	(H) Widespread Boreal
Aeshna tuberculifera Walker	Black-tipped Darner	Transition
Aeshna umbrosa Walker	Shadow Darner	Transition
Anax junius (Drury)	Common Green Darner	Austral (also in parts of Asia and the Pacific Islands)
Rhionaeschna californica Calvert	California Darner	Cordilleran
Rhionaeschna multicolor Hagen	Blue-eyed Darner	Western
Family Petaluridae (1 species recorded)	**Petaltails**	
Tanypteryx hageni (Selys) (**)	Black Petaltail	Cordilleran
Family Gomphidae (2 species recorded)	**Clubtails**	
Ophiogomphus colubrinus Selys	Boreal Snaketail	Southern Boreal
Ophiogomphus severus Hagen	Pale Snaketail	Western
Family Cordulegastridae (1 species expected)	**Spiketails**	
Cordulegaster dorsalis Hagen (*)	Pacific Spiketail	Cordilleran
Family Corduliidae (15 species recorded)	**Emeralds**	
Cordulia shurtleffi Scudder	American Emerald	Widespread Boreal
Epitheca canis MacLachlan (**)	Beaverpond Baskettail	Transition
Epitheca spinigera (Selys)	Spiny Baskettail	Transition
Somatochlora albicincta (Burmeister)	Ringed Emerald	Widespread Boreal
Somatochlora brevicincta Robert (**)	Quebec Emerald	Southern Boreal
Somatochlora cingulata (Selys)	Lake Emerald	Southern Boreal
Somatochlora forcipata (Scudder) (**)	Forcipate Emerald	Transition
Somatochlora franklini Selys	Delicate Emerald	Widespread Boreal
Somatochlora hudsonica (Selys)	Hudsonian Emerald	Western Boreal

Somatochlora kennedyi Walker (**)	Kennedy's Emerald	Southern Boreal
Somatochlora minor Calvert	Ocellated Emerald	Southern Boreal
Somatochlora semicircularis (Selys)	Mountain Emerald	Cordilleran
Somatochlora septentrionalis (Hagen)	Muskeg Emerald	Northern Boreal
Somatochlora walshii (Scudder)	Brush-tipped Emerald	Southern Boreal
Somatochlora whitehousei Walker	Whitehouse's Emerald	Widespread Boreal
Family Libellulidae (14 species recorded, 2 additional expected)	**Skimmers**	
Ladona julia Uhler	Chalk-fronted Corporal	Transition
Leucorrhinia borealis Hagen	Boreal Whiteface	Western Boreal
Leucorrhinia glacialis Hagen	Crimson-ringed Whiteface	Transition
Leucorrhinia hudsonica (Selys)	Hudsonian Whiteface	Widespread Boreal
Leucorrhinia intacta (Hagen)	Dot-tailed Whiteface	Transition
Leucorrhinia patricia Walker	Canada Whiteface	Northern Boreal
Leucorrhinia proxima Calvert	Belted Whiteface	Southern Boreal
Libellula quadrimaculata Linnaeus	Four-spotted Skimmer	(H) Widespread
Sympetrum corruptum (Hagen) (*)	Variegated Meadowhawk	Widespread (also in far eastern Russia)
Sympetrum costiferum (Hagen)	Saffron-winged Meadowhawk	Transition
Sympetrum danae (Sulzer)	Black Meadowhawk	(H) Widespread Boreal
Sympetrum internum Montogomery	Cherry-faced Meadowhawk	Transition
Sympetrum madidum (Hagen)	Red-veined Meadowhawk	Western
Sympetrum obtrusum (Hagen)	White-faced Meadowhawk	Transition
Sympetrum occidentale Bartenev (*)	Western Meadowhawk	Western
Sympetrum pallipes (Hagen)	Striped Meadowhawk	Western

Faunal Elements

Dragonfly species may be grouped with others that share similar distributions to form what can be termed faunal elements. The majority of the 68 species known or expected from northern British Columbia are restricted to North America (Nearctic Region), although six are Holarctic (H), and are defined here as species with transcontinental ranges in both North America and Eurasia. Two species (*Anax junius* and *Sympetrum corruptum*) are known from eastern Asia but do not have holarctic distributions. This section describes the Nearctic faunal elements found in the North (species with holarctic distributions are also assigned to a North American faunal element. The faunal elements are:

1. Boreal (28 species, 41%). Species occurring in the northern spruce (*Picea*) forests, across the boreal zone from treeline to the southern margin. In general, these species range from the Atlantic Provinces across the northern New England states, Quebec, northern Ontario, parts of the northern tier of mid-western states, the Prairie Provinces north of the Great Plains, and northern British Columbia, often ranging considerably southward in the higher mountains and plateaux of the western Cordillera. These species can be further subdivided into:

> **i. Widespread Boreal** (13 species, 19%). With ranges as described above. *Coenagrion resolutum, Enallagma annexum, E.boreale, Aeshna eremita, A. juncea* (also Holarctic), *A. sitchensis, A. subarctica* (also Holarctic), *Cordulia shurtleffi, Somatochlora albicincta, S. franklini, S. whitehousei, Leucorrhinia hudsonica, Sympetrum danae* (also Holarctic).
>
> **ii. Northern Boreal** (4 species, 6%). Species that are common near the northern treeline, but that are virtually absent from the northern contiguous United States and from the southeastern Atlantic Provinces, and do not extend far south into the Cordillera. These species are *Coenagrion interrogatum, Aeshna septentrionalis, Somatochlora septentrionalis* and *Leucorrhinia patricia*.
>
> **iii. Southern Boreal** (9 species, 13%). Species that are uncommon north of 60º N in the West and absent near the Arctic treeline in the East, but range far down the Cordillera and/or into the southeastern Atlantic Provinces and New England states. Some (e.g. *Aeshna interrupta*) are common on the Great Plains. *Nehalennia irene, Aeshna interrupta, Ophiogomphus colubrinus, Somatochlora brevicincta, S. cingulata, S. kennedyi, S. minor, S. walshii* and *Leucorrhinia proxima*.
>
> **iv. Western Boreal** (2 species, 3%). Species not found east of Hudson Bay: *Somatochlora hudsonica* and *Leucorrhinia borealis*.

2. Transition (14 species, 20%). Species generally most common in the southern boreal forests and adjacent montane forests in the West, and mixed and deciduous forests in the East. *Enallagma ebrium, E. hageni, Aeshna canadensis, A. tuberculifera, A. umbrosa, Epitheca canis, E. spinigera, Somatochlora forcipata, Leucorrhinia glacialis, L. intacta, Ladona julia, Sympetrum costiferum, S. internum, S. obtrusum*.

3. Cordilleran (6 species, 9%). Species confined to the western mountains and their intervening valleys and plateaux. *Ischnura cervula, Rhionaeschna californica, Aeshna palmata, Tanypteryx hageni, Cordulegaster dorsalis, Somatochlora semicircularis*.

4. Western (10 species, 15%). Species confined to west of the 100th meridian but otherwise ranging widely in North America. *Amphiagrion abbreviatum, Coenagrion angulatum, Enallagma clausum, Ischnura damula, I. perparva, Rhionaeschna multicolor, Ophiogomphus severus, S. madidum, S. occidentale, S. pallipes*.

5. Austral (4 species, 6%). Species ranging across the continent south of the boreal forests, often extending into Transition areas, but with most of the range in the United States. *Lestes forcipatus*, *Enallagma carunculatum*, *E. civile*, *Anax junius* (also in parts of Asia and the Pacific Islands).

6. Widespread (6 species, 9%). Species with broad distributions in North America, from north to south and east to west, overlapping several of the other elements listed. These species range into boreal regions to varying degrees. *Lestes congener*, *L. disjunctus*, *L. unguiculatus*, *L. dryas* (also Holarctic), *Libellula quadrimaculata* (also Holarctic) and *Sympetrum corruptum* (also in parts of Asia).

Appendix 3. List of the Dragonflies (Odonata) of British Columbia and their Conservation Status (December 2005).

The provincial red or blue list designations are based on a ranking process that has been developed over the past 30 years by The Nature Conservancy. Ranking is based on factors such as the population size, quality of remaining habitat, condition and viability of the populations; trends, range and threats that face the species within a jurisdiction. Based on this process, there is a rank assigned by the BC Conservation Data Centre -- an "S" rank. This is indicated on a scale of one to five -- one means that the species is extremely rare; five denotes a common species. For more about conservation ranking and species and habitats at risk, see the CDC website at http://srmwww.gov.bc.ca/cdc/.

Definitions of Provincial (sub-national) Conservation Ranks

Global ranks use the same numbers, reflecting an assessment of the condition of the species across its entire range, rather than only provincially.

S1: Critically Imperiled -- Critically imperiled in the province because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state/province.

S2: Imperiled -- Imperiled in the province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the province.

S3: Of Special Concern -- Vulnerable in the province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.

S4: Apparently Secure -- Uncommon but not rare; some cause for long-term concern due to declines or other factors.

S5: Secure -- Common, widespread, and abundant in the province.

S#S#: Range Rank -- A numeric range rank (e.g., S2S3) is used to indicate any range of uncertainty about the status of the species.

Q: Questionable taxonomy -- Taxonomic distinctiveness of this entity at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or the inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority conservation priority.

Definitions of Colour Lists

Red List: Species are extirpated, endangered or threatened in BC. Red listed species are candidates for official Extirpated, Endangered or Threatened Status in BC. Not all Red-listed taxa will necessarily become formally designated. Placing taxa on these lists flags them as being at risk and requiring investigation. *Extirpated* species are those that no longer exist in the wild in BC but do occur elsewhere. *Endangered* species are those facing imminent extirpation or extinction. *Threatened* species are those likely to become endangered if limiting factors are not reversed). Includes provincial ranks S1, S1S2, S1S3 and S2.

Blue List: Indigenous species *of special concern* (particularly sensitive to human activities or natural events but not endangered or threatened) in BC. (formerly called *vulnerable.* Includes provincial ranks S2S3, S3 and S3S4.

Yellow List: List of indigenous species that are *not at risk* in British Columbia. Includes all provincial ranks not listed in red and blue above.

Scientific Name	**English Name**	**Global Rank**	**Prov. Rank**	**List**
Family Calopterigidae	**Jewelwings**			
Calopteryx aequabilis	River Jewelwing	G5	S1	Red
Family Lestidae	**Spreadwings**			
Lestes congener	Spotted Spreadwing	G5	S5	Yellow
Lestes disjunctus	Northern Spreadwing	G5	S5	Yellow
Lestes dryas	Emerald Spreadwing	G5	S5	Yellow
Lestes forcipatus	Sweetflag Spreadwing	G5	S4	Yellow
Lestes unguiculatus	Lyre-tipped Spreadwing	G5	S5	Yellow
Family Coenagrionidae	**Pond Damsels**			
Amphiagrion abbreviatum	Western Red Damsel	G5	S4	Yellow
Argia emma	Emma’s Dancer	G5	S3S4	Blue
Argia vivida	Vivid Dancer	G5	S2	Red
Coenagrion angulatum	Prairie Bluet	G5	S3S4	Blue
Coenagrion interrogatum	Subarctic Bluet	G5	S4S5	Yellow
Coenagrion resolutum	Taiga Bluet	G5	S5	Yellow
Enallagma annexum	Northern Bluet	G5	S5	Yellow
Enallagma boreale	Boreal Bluet	G5	S5	Yellow
Enallagma carunculatum	Tule Bluet	G5	S5	Yellow
Enallagma civile	Familiar Bluet	G5	S1	Red
Enallagma clausum	Alkali Bluet	G5	S4	Yellow
Enallagma ebrium	Marsh Bluet	G5	S5	Yellow
Enallagma hageni	Hagen's Bluet	G5	S3S4	Blue
Ischnura cervula	Pacific Forktail	G5	S5	Yellow
Ischnura damula	Plains Forktail	G5	S1	Red
Ischnura erratica	Swift Forktail	G4	S4	Yellow
Ischnura perparva	Western Forktail	G5	S5	Yellow
Nehalennia irene	Sedge Sprite	G5	S5	Yellow
Family Petaluridae	**Petaltails**			
Tanypteryx hageni	Black Petaltail	G3	S2S3	Blue

Family Aeshnidae	**Darners**			
Aeshna canadensis	Canada Darner	G5	S5	Yellow
Aeshna constricta	Lance-tipped Darner	G5	S2	Red
Aeshna eremita	Lake Darner	G5	S5	Yellow
Aeshna interrupta	Variable Darner	G5	S5	Yellow
Aeshna juncea	Sedge Darner	G5	S5	Yellow
Aeshna palmata	Paddle-tailed Darner	G5	S5	Yellow
Aeshna septentrionalis	Azure Darner	G5	S4	Yellow
Aeshna sitchensis	Zigzag Darner	G5	S5	Yellow
Aeshna subarctica	Subarctic Darner	G5	S5	Yellow
Aeshna tuberculifera	Black-tipped Darner	G4	S4	Yellow
Aeshna umbrosa	Shadow Darner	G5	S5	Yellow
Anax junius	Common Green Darner	G5	S5	Yellow
Rhionaeschna californica	California Darner	G5	S5	Yellow
Rhionaeschna multicolor	Blue-eyed Darner	G5	S5	Yellow
Family Gomphidae	**Clubtails**			
Gomphus graslinellus	Pronghorn Clubtail	G5	S2S3	Blue
Octogomphus specularis	Grappletail	G4	S2	Red
Ophiogomphus colubrinus	Boreal Snaketail	G5	S4	Yellow
Ophiogomphus occidentis	Sinuous Snaketail	G4	S4	Yellow
Ophiogomphus severus	Pale Snaketail	G5	S5	Yellow
Stylurus olivaceus	Olive Clubtail	G4	S1S2	Red
Family Cordulegastridae	**Spiketails**			
Cordulegaster dorsalis	Pacific Spiketail	G5	S5	Yellow
Family Macromiidae	**Cruisers**			
Macromia magnifica	Western River Cruiser	G4	S3	Blue
Family Corduliidae	**Emeralds**			
Cordulia shurtleffii	American Emerald	G5	S5	Yellow
Epitheca canis	Beaverpond Baskettail	G5	S3	Blue
Epitheca spinigera	Spiny Baskettail	G5	S5	Yellow
Somatochlora albicincta	Ringed Emerald	G5	S5	Yellow
Somatochlora brevicincta	Quebec Emerald	G3	S3	Blue
Somatochlora cingulata	Lake Emerald	G5	S4	Yellow
Somatochlora forcipata	Forcipate Emerald	G5	S2S3	Blue
Somatochlora franklini	Delicate Emerald	G5	S5	Yellow
Somatochlora hudsonica	Hudsonian Emerald	G5	S4S5	Yellow
Somatochlora kennedyi	Kennedy’s Emerald	G5	S3S4	Blue
Somatochlora minor	Ocellated Emerald	G5	S5	Yellow

Somatochlora semicircularis	Mountain Emerald	G5	S5	Yellow
Somatochlora septentrionalis	Muskeg Emerald	G5	S4	Yellow
Somatochlora walshii	Brush-tipped Emerald	G5	S4	Yellow
Somatochlora whitehousei	Whitehouse's Emerald	G5	S5	Yellow
Family Libellulidae	**Skimmers**			
Erythemis collocata	Western Pondhawk	G5	S3	Blue
Ladona julia	Chalk-fronted Skimmer	G5	S5	Yellow
Leucorrhinia borealis	Boreal Whiteface	G5	S5	Yellow
Leucorrhinia glacialis	Crimson-ringed Whiteface	G5	S5	Yellow
Leucorrhinia hudsonica	Hudsonian Whiteface	G5	S5	Yellow
Leucorrhinia intacta	Dot-tailed Whiteface	G5	S5	Yellow
Leucorrhinia patricia	Canada Whiteface	G4	S4	Yellow
Leucorrhinia proxima	Belted Whiteface	G5	S5	Yellow
Libellula forensis	Eight-spotted Skimmer	G5	S5	Yellow
Libellula pulchella	Twelve-spotted Skimmer	G5	S3	Blue
Libellula quadrimaculata	Four-spotted Skimmer	G5	S5	Yellow
Pachydiplax longipennis	Blue Dasher	G5	S3S4	Blue
Pantala hymenaea	Spot-winged Glider	G5	SA	Accidental
Plathemis lydia	Common Whitetail	G5	S4	Yellow
Sympetrum corruptum	Variegated Meadowhawk	G5	S5	Yellow
Sympetrum costiferum	Saffron-winged Meadowhawk	G5	S5	Yellow
Sympetrum danae	Black Meadowhawk	G5	S5	Yellow
Sympetrum illotum	Cardinal Meadowhawk	G5	S4	Yellow
Sympetrum internum	Cherry-faced Meadowhawk	G5	S5	Yellow
Sympetrum madidum	Red-veined Meadowhawk	G4	S4	Yellow
Sympetrum obtrusum	White-faced Meadowhawk	G5	S5	Yellow
Sympetrum occidentale	Western Meadowhawk	G?Q	S5	Yellow
Sympetrum pallipes	Striped Meadowhawk	G5	S5	Yellow
Sympetrum vicinum	Autumn Meadowhawk	G5	S3S4	Blue
Tramea lacerata	Black Saddlebags	G5	S1	Red

Appendix 4. Species Accounts

Add Appendix 4 file here.

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