Paleontological Resources of the Dawson Creek Land Resource Management Plan (LRMP) Area, British Columbia

Prepared by the

British Columbia Paleontological Alliance

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SUMMARY

The British Columbia Paleontological Alliance (BCPA) is an organization of professional and amateur paleontologists of British Columbia, dedicated to advancing the science of paleontology in the province through education. The BCPA is a leading authority on paleontological resources in British Columbia, and has been endorsed by representatives of the Royal British Columbia Museum. This report has been prepared by the BCPA for the Dawson Creek Land Resource Management Plan team, to enable them to make informed decisions about land designation issues relating to paleontological resources.

The Dawson Creek LRMP area comprises many different geologic units and fossils are distributed widely in most of these units. Most fossil localities in the Dawson Creek LRMP area include fossil types and assemblages known from elsewhere in the Dawson Creek LRMP area, in British Columbia, or in Canada, and are therefore considered as not especially unique or significant. The exception to these are the localities along the shore of Williston Lake and in the area of Wapiti Lake.

Fossil localities along Williston Lake consist, in general, of one or a few specimens at each locality. Most of the known occurrences have already been excavated and removed for scientific study; therefore, there is no necessity to preserve these sites. If future finds indicate that one or more sites along the shores of Williston Lake are especially prolific in vertebrate or other fossils, the BCPA suggests that such sites be designated with Map Reserve status to protect them from exploitation.

The fossil localities in the vicinity of Wapiti Lake are known around the world for their unique, well-preserved, and extremely valuable specimens of Triassic fossil fish. The BCPA recommends that the present Map Reserve status of this site be changed, and the site enlarged, to a Paleontological Reserve, through Designated Use status under Section 13 of the British Columbia Land Act. Only controlled scientific collecting should be allowed in the expanded Paleontological Reserve, and applications for research collecting in the Reserve should be approved by an appropriate, scientific-based body. The BCPA further recommends that the Province of British Columbia negotiate with UNESCO to further classify the site as a World Heritage Site, maintaining administration of the site at the local level.

It is the further recommendation of the BCPA that all other parts of the Dawson Creek LRMP area remain open to fossil collecting by the professional and amateur community, under the standards of the BCPA Code of Ethics. The BCPA recommends against actively promoting fossil collecting as a recreational activity in the area, however. Should new information come to light about fossil resources in the Dawson Creek LRMP area, local land-use planners are encouraged to consult with the BCPA to assess the scientific value of such sites and decide on appropriate action for special designation status.

PREFACE

The British Columbia Paleontological Alliance (BCPA) is a union of professional and amateur paleontologists from across the province, dedicated to advancing the science of paleontology, chiefly through education. Amateurs and professionals have organized together in regional societies which hold regular meetings and field trips. The Board of Directors of the BCPA (see Appendix A) consists of 2 directors from each of the 5 regional societies presently active in the province, plus representatives from university, government, and museum organizations actively engaged in professional paleontological research or education in the province. As the largest organization of professional and amateur paleontologists in the province, the membership of the BCPA represents a wide spectrum of paleontological expertise. The BCPA has been endorsed by staff of the Royal British Columbia Museum, Victoria, as the body most capable of making informed judgements of paleontological issues affecting British Columbia.

The BCPA is working actively to provide needed information to land-use planners and other government officials to help them make decisions regarding paleontological resources in British Columbia. This report is the third in a series providing this information. The first report dealt with paleontological resources in the Kamloops LRMP area and was produced in Fall, 1996. The second covered paleontological resources of the Lakes District LRMP and was produced in Winter, 1996/97. This report has been prepared in response to a request from planners for needed information and advice on paleontological resources in the Dawson Creek LRMP area.

THE NATURE OF PALEONTOLOGICAL RESOURCES

Fossils constitute the remains of plants and animals that lived in the distant past and which have been subsequently petrified and preserved in the rock record. ***Paleontology*** is the scientific study of these fossils. In this report, we refer to ***paleontological resources***, also known as ***fossil resources***, as all those fossil materials which are present in the area of the report.

THE NATURE OF FOSSILS

One line of evidence that fossils represent ancient organisms is that they are usually found in hard rock, or lithified sediment, in contrast to human remains and artifacts, which are found in soft or unlithified sediments. However, not all rock types are fossiliferous. Fossils are most often found in a variety of sedimentary rocks, including sandstone, shale, conglomerate, and limestone. Fossils may also be preserved in metamorphic rocks, that is, those altered by the long-term effects of heat or pressure, but they are typically deformed and often unrecognizable. Fossils are not found in igneous rocks such as granite and volcanic rocks.

The fossil record shows that life on Earth has had a long and varied history. Life on our planet is considered to have evolved initially in the ocean environment, with the transition to land taking place much later in the Earth's history. The oldest direct evidence of biological organisms presently known consists of fossil bacteria, approximately 3 billion years in age. The first soft-bodied organisms, animals such as jellyfish and worms, probably evolved around 1 billion years ago. It was not until about 600 million years ago that the first shelled animals living in the oceans evolved, during the so-called "Cambrian Explosion." The first ancestors of ocean fishes subsequently evolved about 450 million years ago, and plants began to experiment with environments on the land at approximately the same time. All of this evolutionary history of life on the planet has been interpreted from analysis of the fossil record.

Distinction Between Paleontological and Archeological Resources

> *It is critical that resource planners understand that paleontological resources are distinct from archeological resources, and that different and unique criteria are used for determining where paleontological resources may occur in a region,*

as well as their scientific importance.

Confusion often exists among the lay public as to the precise nature of paleontological, anthropological, and archeological resources. Physical anthropology studies the evolutionary history of humans through analysis of their fossil remains and is thus a subdiscipline of paleontology. Such fossil resources generally range in age from approximately 250,000 to 1.75 million years old, the approximate length of time that direct human ancestors have been present on Earth. Such human remains predate the arrival of human cultures in North and South America and thus, research in physical anthropology is focused in Africa, the Middle East, and Asia.

In contrast, scientists consider paleontology to be distinct from archeology, or the branch of science that studies human cultures through excavation and recovery of relics left by them. Archeological resources, for example, are the criteria by which the presence and activities of native cultures in British Columbia over the past 10,000 years or so have been established.

Types of Fossils

For the purposes of this report, we ascribe fossils to two basic types: microfossils and macrofossils. Microfossils are those fossil materials which are too small to be seen readily with the naked eye and which therefore require a microscope for detailed study. To study microfossils, the paleontologist collects bulk samples in the field and then uses physical or chemical methods to break down the rock enclosing the microfossils. The isolated microfossils are then mounted on a specimen slide for study under the microscope. Common types of microfossils include radiolarians, conodonts, foraminifers, ostracodes, ichthyoliths (fish teeth and bones), and pollen grains. Generally, microfossils are found in limestone and shale rocks and are usually abundant. They are, of course, not generally recognizable until extracted from the host rock.

Macrofossils, in contrast, are those fossil materials which can be seen readily and studied without a microscope. Examples of this group include bone and bone fragments, plant and leaf material, corals, and shells. Macrofossils can be found in all the sedimentary rock types listed above. They are located by the paleontologist principally by applying mechanical action, usually hammers, to break apart the rock at the outcrop, splitting it into smaller pieces until a specimen

is found. In some instances, the paleontologist may bring bulk samples to the laboratory to break them down.

Occurrence and Preservation of Fossils

Macrofossils are generally less abundant than are microfossils. This is because of several factors, among them that microfossils are so much smaller than macrofossils, and many more of them can be preserved in the same area as a single macrofossil. In addition, the destructive forces which act to break down a formerly living animal or plant, such as biological decay, environmental weathering and chemical dissolution, work much more effectively on larger objects.

Generally, macrofossils are found in rock outcrops where these destructive forces have been minimal since the death of the once-living organism. However, if a particular rock unit contains fossils at one locality, it is reasonable to conclude that the same unit will also contain fossils at other localities where such destructive factors have also been minimal. Any locality where the rock unit is exposed at the surface may potentially contain similar, or different, fossils. It is important, however, that the rock itself be exposed at the surface and not covered with soil or vegetation. For this reason, road-cuts from new road-building activity are a favorite study area for the paleontologist: they expose fresh rock which may contain fossils. In this way, new fossil localities are continually coming into existence in areas of development. Similarly, storms and heavy rain may erode rock in drainages and on cliffs, providing new exposures to survey for fossil materials. Most fossils therefore constitute a resource that is continually being recharged as erosion or development exposes new and different areas of fossiliferous rocks.

> *In this manner, paleontological resources are not generally considered to be unique. This places them in direct contrast with archeological resources, which are considered unique for a specific time and place. Land managers and planners must keep this critical distinction in mind when assessing paleontological resources in their areas.*

USES AND VALUES OF FOSSILS

Fossils are extremely valuable in a variety of ways. They are utilized by paleontologists and geologists to date the age of the rocks containing them, and to help construct geological maps of the Earth's surface. They can be used to help interpret the environments of the rocks containing them. And of course, they are critical to unraveling the history of life on our planet and the processes that have shaped the evolutionary history of organisms.

Age Dating of Rocks

It has been known for nearly two centuries that fossils are very useful for defining the age of geological rock units, and a basic background in geology is thus necessary to properly interpret fossils and their geologic context. Because the evolutionary history of life is irreversible, the succession of fossils in the rock record has been used by geologists as the basis of the geological time scale (Appendix C). Rocks that contain a particular fossil or fossil assemblage are thus considered to be *correlative*, or the same age as all other rocks around the globe that contain the same fossils. The value of most fossils as geological correlation tools is based on their relatively widespread distribution and their abundance. Correlation of rocks underpins the production of geologic maps and the elucidation of Earth history.

Paleogeography and Paleoenvironmental Reconstruction

Interpreting the environment of deposition of ancient sedimentary rocks is a key role of fossils, and one for which they are highly valued. By studying assemblages of fossils preserved in a sedimentary rock, the paleontologist can ascertain whether the rock formed in the ocean, in a lake, or even in a desert environment. Knowing the depth in the ocean at which marine rocks accumulated is often crucial in the search for oil and natural gas, and such fossil information is highly prized by the petroleum exploration industry. Fossil assemblages can tell us whether the ocean or land temperatures were cold or hot in past times, whether land masses were covered by luxuriant forests or barren deserts, and which land areas were once connected but have been torn apart through the migration of the Earth's tectonic plates.

History of Life on Earth

Of course, fossils are also of great value in deciphering the history of life on Earth. The development of life on our planet has often been characterized by great leaps in evolutionary advancement, when many new life forms evolved over relatively rapid intervals of geologic time. Our understanding of the processes by which this evolutionary development has taken place is based primarily on analysis of the fossil record, as well as observation of biological processes active in the world today.

The history of life on Earth is also one of times of great crisis, when large-scale extinction events have decimated our biological world. The precise causes of many such extinctions in the geological past will perhaps never be fully known, but there is certainly no question that our planet has experienced many periods when great numbers of the plants and animals living have become extinct over very short periods of time, never to be seen again. Fossils play a critical role in helping paleontologists assess the extent and rapidity of these past extinction events. Through understanding the nature and pace of past extinction events, it is clear that our planet is currently experiencing a period of extinction equal to, and probably significantly greater than, any recorded in the fossil record.

THE ROLE OF AMATEUR COLLECTING

Traditionally, scientific collecting of fossils has been undertaken primarily by professional paleontologists, those trained researchers pursuing the science as a full-time career. Professional paleontologists have great interest in adequately assessing each paleontological site and in collecting from the site in a rigorous scientific manner. Increasingly, however, the abilities of professionals to undertake field expeditions to collect fossils are being restricted as their employment and funding organizations cut back on the amount of monies allocated for paleontological research. This problem is particularly acute in Canada at the present time.

For this reason, many professional paleontologists rely increasingly on contributions from the amateur collecting community to supplement their field activities. In British Columbia, for example, amateur collectors have been responsible for locating the first Eocene bird fossil in the province, and probably from Canada, the first Eocene crayfish, many new Eocene insect finds, a Cretaceous elasmosaur, dinosaur and other vertebrate remains on Vancouver Island, and many

new Jurassic and Cretaceous mollusk occurrences across the province. In addition, amateurs have located new localities for many known fossil types, greatly increasing the paleontologists' understanding of the geographic distribution of those fossils.

Most professional paleontologists in the province, including all professional members of the BCPA, encourage amateur collectors to make their finds known to the professional community. By doing so, professional paleontologists recognize that the maximum amount of information is made available for scientific study. Through the educational efforts of the BCPA, professionals work with the amateur community to ensure that amateur collecting is done in a rigorous and scientific manner. Professionals participate in field trips and demonstrations to show the amateur community how to collect fossils adequately, how to measure and describe the rocks containing the fossils, and how to curate their collections for long-term storage. In addition, the amateur collecting community follows a strict Code of Ethics (outlined in the BCPA Collecting Policy, Appendix B). The willingness of most collectors to provide their fossils for scientific study is to be commended.

Of course, not all amateur collectors will subscribe to the strict guidelines of the BCPA Collecting Policy. But this will be true whether such a policy exists or not. In fact, a very large number of amateurs *do* follow the guidelines and they *do* make their collections available for study. Most professionals are strongly concerned that, by restricting the access of amateurs to collect fossils, the free exchange of information that presently exists between the amateur and professional communities will evaporate. This is precisely the situation that has evolved in Alberta, where very restrictive legislation and a permit system have driven collecting underground. In spite of the existing legislation in Alberta, unmonitored fossil collecting continues in that province, but collaborative interactions with the scientific community have virtually ceased. For this reason, the BCPA strongly recommends that no limitations be placed on the rights of amateurs to collect fossils in all those areas not specifically designated in this report.

DESIGNATED FOSSIL SITES IN BRITISH COLUMBIA

In spite of the fact that most fossiliferous rocks in British Columbia contain fossils at numerous localities over their outcrop area, some rock units are known to contain only one or, at best, several fossil localities. Given that such fossil localities can be "one-of-a-kind" in a national or global sense, specific protection of such localities is often desirable. Several such fossil localities are already known to exist in British Columbia and they have been recognized previously for their unique paleontological materials. Chief among these are the Burgess Shale, Wapiti Lake, Puntledge River and Driftwood Canyon localities.

BURGESS SHALE

The Burgess Shale locality is found in Yoho National Park and is therefore administered federally through Parks Canada. This relatively small exposure of marine rocks is one of the few places in the world where soft-bodied Cambrian (530 million years old) fossil organisms have been preserved. It has been declared a World Heritage Site by UNESCO as a result of this uniqueness. The Burgess Shale locality is administered under National Park General Regulations with specific restrictions to access by a Superintendent's Order under Section 7. The order specifies two zones: Zone 1 allows access to researchers by permit only, with limited collecting allowed; Zone 2 allows licensed guided tours with no collecting allowed. A Mandate of Understanding places responsibility for research and management of the fossil beds with the Royal Ontario Museum, Toronto. Enforcement of regulations relies largely on National Park rangers and research staff (while on-site).

Contacts: Brian MacDonald, Department of Canadian Heritage, Vancouver
Paul Kutzer, Yoho National Park Administration, Field, B.C.

WAPITI LAKE (FOSSIL FISH LAKE)

This site is located in the Peace/Liard District and contains 240 million year-old marine vertebrates, including armored fish and coelacanths, which are remarkably complete and well preserved. Fossil specimens from Wapiti Lake are found today in museums around the globe. The 127.5 hectare site was designated as Management Class 0 by the British Columbia Ministry

of Forests in 1990, which excludes timber supply activities and notes high sensitivity features. Specifically, the area was covered at that time under Land Act Map Reserve No. 908049, established by the Ministry of Crown Lands on behalf of the Ministry of Municipal Affairs, Recreation and Culture for a period of five years, renewable for subsequent 5-year periods. A renewal of map reserve status was approved in 1995. Scientific fossil collecting and commercial extracting activity have been undertaken at the site under this status and permits have been issued for these activities. Research permits have been issued through the BC Lands Office in Fort St. John, while at least some of the commercial ventures have been overseen by the Royal Tyrrell Museum. The Wapiti Lake site is in the Dawson Creek LRMP area and specific proposals for protection and management of the site are presented below.

Contact: Jeff Beale, Ministry of Forests (Dawson Creek), Chair, Interagency Planning Team

PEACE RIVER ICHTHYOSAUR FOSSILS

This site is located in the Peace River District along the west bank of Peace River at the mouth of Nabesche River, presently flooded by Williston Lake. The ichthyosaur fossils were found in the early part of the century in Triassic strata. In order to preserve these and other vertebrate fossils found at the site, the area was designated an "Historic Object" under the Historic Objects Preservation Act by Order-in-Council (#1475), December 8, 1930. Subsequent flooding by Williston Lake precludes any further paleontological collecting at the site, although other collecting opportunities probably exist in the adjacent area.

PEACE RIVER DINOSAUR TRACKS

The Dinosaur Tracks site is also located in the Peace River District, along the north bank of Peace River in Rocky Mountain Canyon, opposite the mouths of Johnson and Moose Bar creeks. This site has also been subsequently flooded. Extensive dinosaur tracks and some bones were found here in the 1920s, in Lower Cretaceous strata, and the area was designated an "Historic Object" under the Historic Objects Preservation Act by Order-in-Council (#637), May 16, 1930. An extensive salvage survey in the late 1970s, in advance of the rising waters behind Peace Canyon Dam, located many hundreds of specimens, most of which are reposited at the Tyrrell Museum, Drumheller, Alberta. Subsequent flooding by Dinosaur Lake precludes any further

paleontological collecting in the area.

PUNTLEDGE RIVER PALEONTOLOGICAL SITE

The Puntledge River shales, exposed on southeastern Vancouver Island, contain abundant, well preserved marine fossils, including some vertebrates, approximately 70 million years old. These shales crop out extensively on the east side of Vancouver Island and the adjacent Gulf Islands. In April, 1989, a small section of the river (10 x 30 meters) was designated, under the Heritage Conservation Act, as a BC Provincial Heritage Site by Order-in-Council (#547), in order to facilitate the excavation of the fossilized skeleton of an elasmosaur, an extinct marine reptile. More recently, additional significant elasmosaur and vertebrate remains have been found on other nearby rivers. In February, 1996, the Puntledge River site was proposed for Protected Area status, the extent of which will be dependent on negotiations with private landowners who hold a considerable portion of the property in question, and subject to the ability of funds to purchase lands at fair market value. Subsequent management strategies have not yet been determined.

Contact: Lyn Barnett, Land Use Coordination Office, Ministry of Environment, Lands and Parks, Victoria

DRIFTWOOD CANYON

This site in the Skeena District consists of a small canyon containing well preserved, lacustrine plant, insect and fish fossils, approximately 40 million years old. Outcrops of similar Eocene strata are found extensively throughout the Smithers region, and also near Horsefly and throughout a large part of south-central British Columbia, in the Princeton/Kamloops region. Originally established as a Class A Provincial Park in 1967, Driftwood Canyon was recommended for reclassification as a Recreational Area in 1978 in order to allow public fossil collecting. The Driftwood Canyon locality was thus the first, and to date the only, site in the province with its special status conferred not due to the uniqueness of its fossils or their preservation, but rather to allow general collecting of fossils. Active promotion of the fossil beds as a local recreational attraction by the Smithers Chamber of Commerce has subsequently generated extensive excavation of the site, resulting in serious undercutting of the cliff face forming the major outcrop. This safety hazard, coupled with a request for protection from the Royal British Columbia Museum, resulted in a recent initiative to phase out public collecting

through a campaign of education and information.

Contact: Ken Zimmer, Acting District Manager, BC Parks, Smithers, B.C.

GEOLOGY OF THE DAWSON CREEK LRMP AREA

Gabrielse *et al.* (1991) noted that the geological architecture of the Canadian Cordillera, or Canada's western mountain region, can be described in terms of tectonic assemblages, terranes, and morphogeological belts. Each tectonic assemblage is unique, reflecting it's own depositional history, place of origin and subsequent changes as it accreted to the continent of North America during the Mesozoic and Cenozoic time periods (see Appendix C). This accretion and subsequent disruption through plate tectonic processes has led to the development of the five morphogeological belts of the province. These belts are (from east to west): the Foreland Belt; the Omineca Belt; the Intermontane Belt; the Coast Belt; and the Insular Belt (Wheeler *et al.*, 1991). The Foreland Belt is a zone of intensely-deformed strata which represents the eastern limit of deformation of rocks related to amalgamation of the more westerly tectonic terranes with the continental part of Canada. The structurally-disrupted strata of the Foreland Belt grade eastward into less-deformed exposures of the North American craton which, in British Columbia, underlie the region termed the Alberta Plains (Figure 1).

The Dawson Creek LRMP straddles the Foreland Belt and also includes portions of the Alberta Plains to the east and the Omineca Belt to the west (Figure 1). As such, the LRMP area includes features of each of these distinctively different geological regions. Strata of the Omineca Belt in the LRMP area consist of old rocks, Late Precambrian in age (Appendix C), and termed the Windermere Group. Windermere Group rocks are highly crystalline and metamorphosed, intensely deformed, and almost entirely devoid of fossils; consequently, they are not discussed in further detail here. Foreland Belt rocks are also structurally-deformed but they represent much younger rocks of Paleozoic to Mesozoic ages and fossils can often be found in these rocks. In fact, fossils are often critical for recognizing the complex thrust-fault geology prevalent in the Foreland Belt region. Strata of the Alberta Plains are also generally fossiliferous but much less deformed, often near flat-lying, and include rocks of Cretaceous to early Tertiary age at the surface.

In general, Foreland Belt rocks consist of a thick succession of clastic and carbonate rocks which accumulated along the old continental margin during Paleozoic time. Paleozoic rocks of the Foreland Belt in the Dawson Creek LRMP area are not particularly fossiliferous, such deposits being restricted mostly to outcrops of the Banff Formation. Only one fossil locality of the Banff Formation was identified in the Dawson Creek LRMP area, containing an assemblage of bivalve

CRETACEOUS - TERTIARY

KTB Brazeau Assemblage (foredeep clastics; Paskapoo, Wapiti, Bearpaw formations)

CRETACEOUS (foredeep clastics)

uKS Upper Cretaceous Smoky River Assemblage (Puskwaskau Formation)

uKTD Upper Cretaceous Dunvegan Assemblage (Muskiki, Goodrich formations)

mKB Mid-Cretaceous Blairmore Assemblage (Bullhead and Fort St. John groups, Gething, Cadomin, Hasler, Moosebar, Gates, Hulcross and Boulder Creek formations)

UPPER JURASSIC to LOWER CRETACEOUS

JKK Kootenay Assemblage (foredeep clastics; Minnes Group, Beattie Peaks, Monteith, Fernie transition, Monach formations)

TRIASSIC to LOWER JURASSIC

TrJS Continental margin sediments (Sulphur Mountain, Pardonet, Charlie Lake, Baldonel, Liard formations)

DEVONIAN to MISSISSIPPIAN

DCR, DMB, CM Continental shelf and margin sediments (Rundle Group, Banff Formation)

CAMBRIAN to DEVONIAN

CDR Passive continental margin sediments (Road River Group)

UPPER PROTEROZOIC to CAMBRIAN

PCG Passive and rifted margin sediments (Gog Group)

UPPER PROTEROZOIC

uPW Passive margin sediments (Windermere Group)

Figure 1 (above and right). Generalized bedrock geologic map of the Dawson Creek LRMP area, from Wheeler and McFeely (1991).

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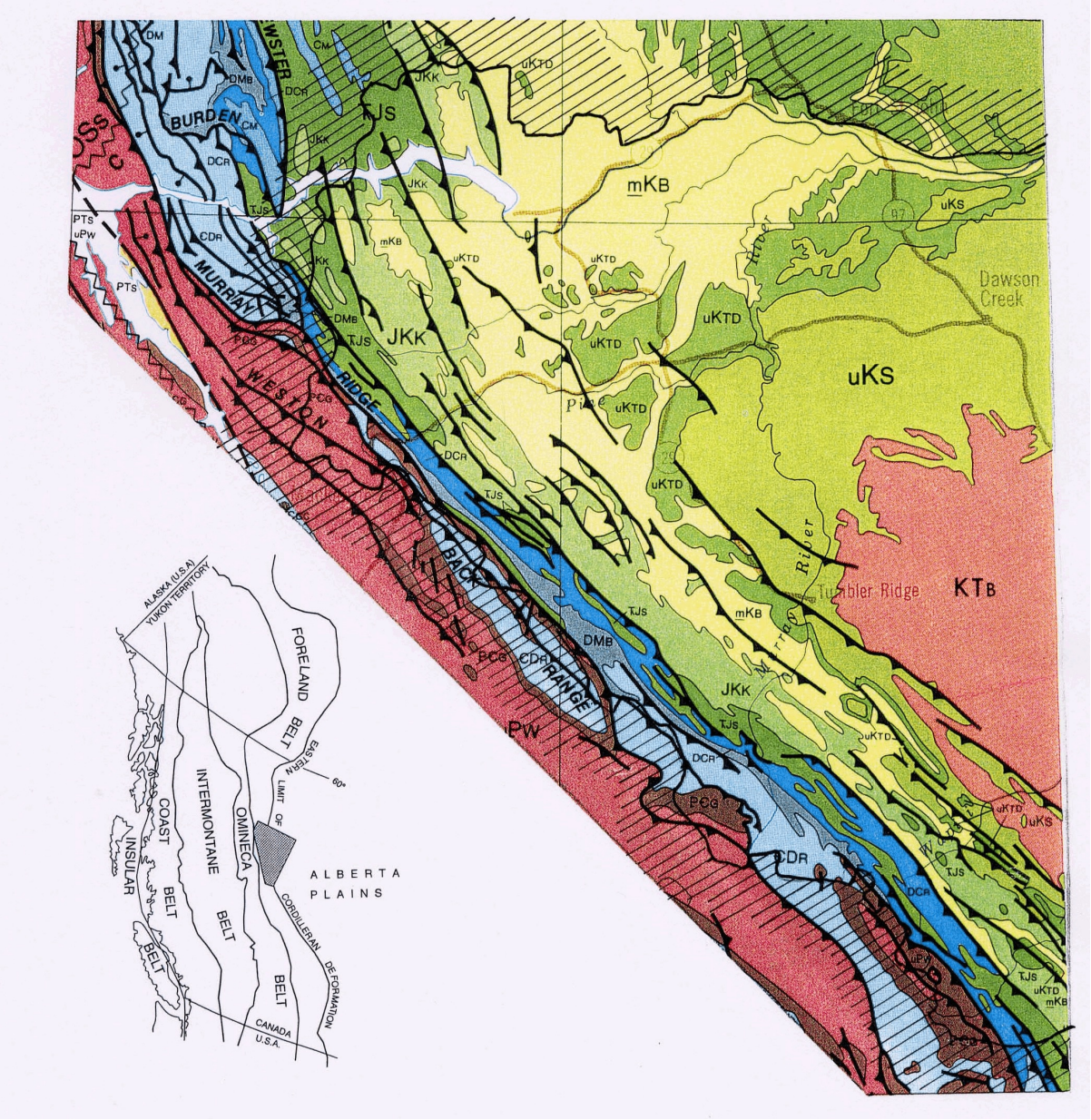
and brachiopod fossils. Unconformably overlying the Banff Formation are Permian rocks assigned to the Belcourt Formation (not shown on Figure 1), which are locally fossiliferous with bryozoans, fusilinid foraminifers, and echinoderm debris. Fossil resources of both the Banff and Belcourt formations reflect types that are widely distributed elsewhere in British Columbia and Canada and consequently are not considered of special value.

Triassic and Lower Jurassic rocks of the Foreland Belt also reflect sedimentation along the ancient continental margin during early Mesozoic time. Through this time interval, coarse clastic deposition gradually supplanted carbonate deposition as the principal rock-forming type. Included in this succession are the deposits of the Sulphur Mountain, Pardonet, Charlie Lake and Liard formations. All of these formations have produced fossils locally but only the Sulphur Mountain contains materials that are unique to British Columbia. These materials include the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uKS
PTS
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CDR
MURRAY
TJS
PCG
WESTON
RIDGE
BACK
RANGE
PW
Dawson Creek
Tumbler Ridge
KTB
Pine River
Murray River
ALASKA (U.S.A.)
YUKON TERRITORY
FORELAND BELT
EASTERN LIMIT OF
60°
INTERMONTANE BELT
OMINECA BELT
COAST BELT
INSULAR BELT
ALBERTA PLAINS
CORDILLERAN DEFORMATION
CANADA
U.S.A.

world-renowned Triassic fish that have been collected from the Wapiti Lake sites and which are discussed in more detail below.

Upper Jurassic and Cretaceous rocks of the Dawson Creek LRMP area reflect sedimentation in a long-lived foredeep basin adjacent to and east of an uplifting ancestral Rocky Mountains highland region. Active tectonic processes in the northeastern Pacific Ocean region during Jurassic-Cretaceous time resulted in uplift and subsequent erosion of the older, continental margin sedimentary strata to the west and this eroded material was deposited in the foredeep basins to the east, producing the Upper Jurassic-Cretaceous sequences found there today. These sequences are thick, and composed almost exclusively of coarse clastic detritus (sandstone, conglomerate, mudstone). Strata of this interval include the Kootenay, Blairmore, Dunvegan, Smoky River, and Brazeau assemblages (Figure 1). Fossils are widespread in these rocks, primarily invertebrates.

Deposits of Quaternary stratified sediments are found in many parts of the Dawson Creek LRMP area and were deposited in proglacial and ice-contact environments during periods of growth and decay of the Cordilleran Ice Sheet (Clague, 1991). Glacial deposits vary throughout the region and are confined primarily to valleys, where both glacial (ice-derived) and fluvial-glacial (water-derived) sediments are common. Deposits vary from sorted, very coarse gravels, sand and silts to unsorted tills. Due to the extent of coverage of Quaternary deposits, they are not included on the map of Figure 1. A few Quaternary fossil localities were identified in our search of the geological literature covering the Dawson Creek District LRMP area.

PALEONTOLOGICAL SITE ASSESSMENT PROCESS

The BCPA's Committee on Fossil Collecting and Regulation Policy was asked by members of the Dawson Creek LRMP team to assess the paleontological importance of all known sites within the Plan study area. In discussions with the Dawson Creek LRMP team personnel, the Committee stipulated that the BCPA would only deal with assessing which fossil sites in the study area are scientifically unique or of unusual value, such that special protection is merited in our view. The BCPA also agreed to suggest options for managing any sites it so proposed. Other multiple criteria upon which site management selection might be based, such as recreational potential, scenic attraction, commercial activity, etc., were specifically excluded from the BCPA assessment mandate. The BCPA is not prepared to assess such additional factors in total and, if such analysis is desired by the LRMP team, an independent agency should undertake this effort.

University and museum researchers who have undertaken studies of British Columbia fossils, particularly those of the Dawson Creek LRMP area, were solicited for their opinions on the quality and significance of paleontological sites in the LRMP area. These researchers include Drs. Jim Basinger and Elizabeth McIver (University of Saskatchewan, Saskatoon), Dr. Ruth Stockey (University of Alberta, Edmonton), Dr. L.V. Hills (University of Calgary), Dr. Steven R. Manchester (University of Florida, Gainesville), Dr. Terry Poulton (Chief Paleontologist, Geological Survey of Canada, Calgary), Drs. Michael J. Orchard and Tim T. Tozer (Geological Survey of Canada, Vancouver), Wesley C. Wehr (University of Washington, Seattle), Drs. Elizabeth Nicholls and Andrew Neuman (Royal Tyrrell Museum of Palaeontology, Drumheller) and Dr. Mark V.H. Wilson (University of Alberta, Edmonton).

RECOMMENDATIONS

Many fossil localities are known within the Dawson Creek LRMP area and these include mostly invertebrate fossil remains. They are generally concentrated in the younger, Mesozoic sedimentary rocks of the LRMP area. The quality of material preserved at these sites is generally good, and all fossils found at the localities are known from elsewhere in British Columbia or North America. The exceptions to this are the Triassic fossil fish localities of the Sulphur Mountain Formation south of Wapiti Lake, which have provided globally-unique fossil materials.

WAPITI LAKE

Based on the world-recognized importance of the Wapiti Lake fossil localities for their Early Triassic fish fossils, the BCPA proposes that the Province of British Columbia designate the area south of Wapiti Lake known as "Ganoid Ridge" as a Provincial Park. Management strategies for the Park should be carried out under the British Columbia Parks Act and a highlight of such management should be the continuation of appropriate scientific collecting for research purposes, as well as a minimum of tourist-related development. As a preliminary action leading to the creation of the park, the BCPA suggests that the area be designated as a Paleontological Reserve, invoking the status of Designated Use for the area under Section 17 (formerly Section 13) of the British Columbia Land Act. The proposed definition of a Paleontological Reserve is found in the BCPA's Policy on Collecting and Fossil Regulation (Appendix B). Figure 2 shows a map of the Wapiti Lake region with the area of the present Map Reserve indicated, as well as the area proposed by the BCPA for inclusion in the new Provincial Park/Paleontological Reserve. The proposed Provincial Park boundaries encompass all the known Triassic fish localities on Ganoid Ridge.

Under Paleontological Reserve status, legitimate scientific collecting can be undertaken at the site but no commercial collecting is allowed. The BCPA proposes that scientific collecting continues in the new park/reserve, under a permit basis, with applications for a research permit reviewed by a scientific-based body. Until such time as the Province of British Columbia establishes an adequate mechanism to undertake such scientific-based assessments of research applications, the BCPA suggests that the Royal Tyrrell Museum of Palaeontology in Drumheller,

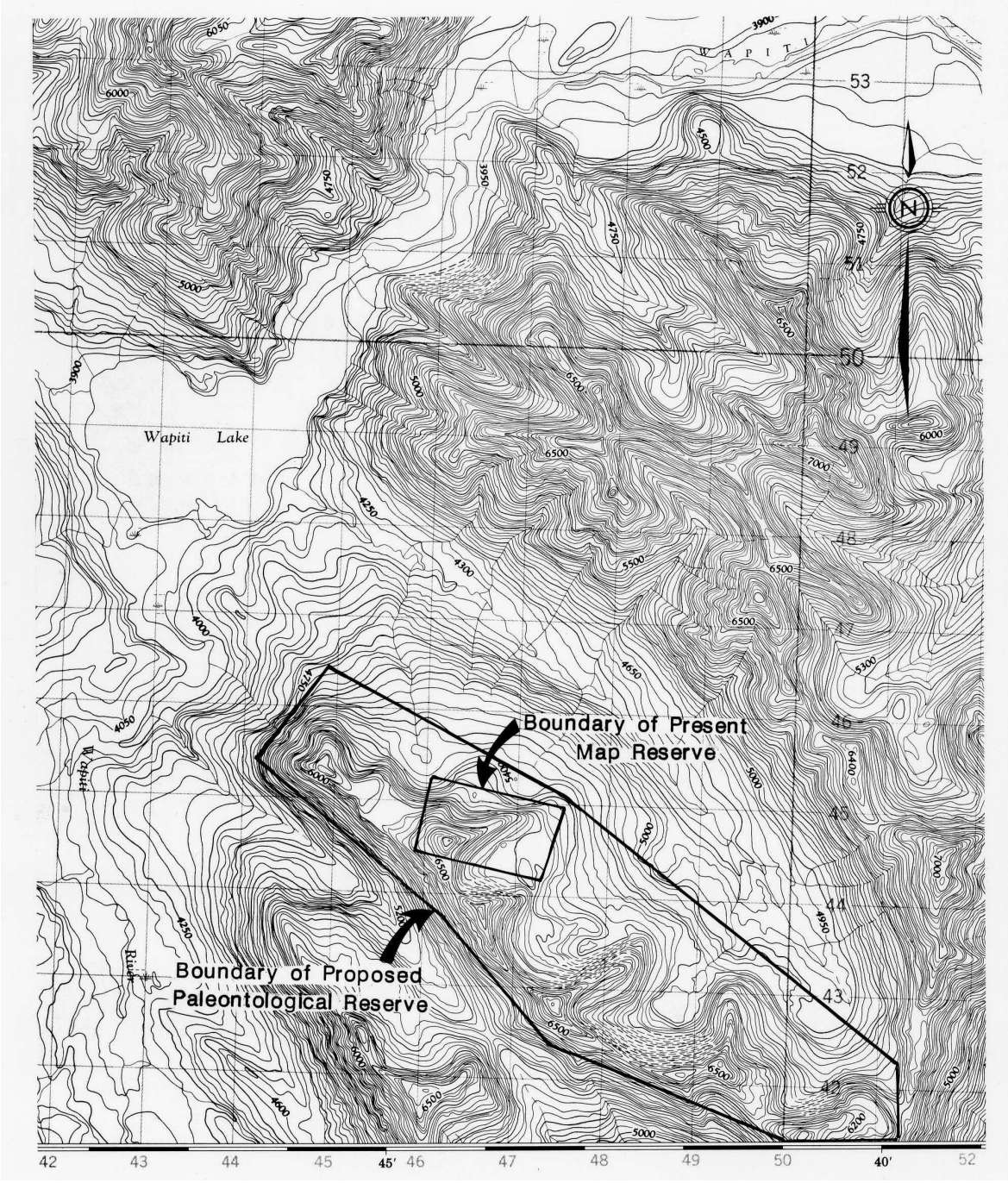

Figure 2. Location of proposed Wapiti Lake Paleontological Reserve (NTS 93I/10). Grid lines represent 1-km square grids.

Alberta, continue in this role. Alternatively, the BCPA is willing to take on this role, in

consultation with the Royal Tyrrell Museum. The BCPA further suggests that the Province of British Columbia pursue negotiations with UNESCO to attempt to obtain World Heritage Site designation for the Wapiti Lake site (such designation to be contingent upon the continuation of local management of the Provincial Park/Paleontological Reserve).

Recent work over the past two summers has shown that further Triassic fish localities exist in the Sulphur Mountain Formation in the vicinity of Meosin Mountain, south of Belcourt Lake. Pending future work, these localities may also be found to have great scientific value and may perhaps be annexed to the Wapiti Lake Provincial Park/Paleontological Reserve.

WILLISTON LAKE

Significant ichthyosaur vertebrate remains have been found previously along the shores of Williston Lake and these have already been removed for scientific study and reported in the scientific literature. It is likely that more sites will be found in future. Given that the fossils found at these sites generally occur as single specimens, it is the opinion of the BCPA that the value of long-term preservation for such sites is negligible. With continued collecting, one or more sites may be identified at Williston Lake where vertebrates are found in abundance. In such a case, the Province of British Columbia might consider invoking Map Reserve status for such sites, should they be deemed of special significance by the scientific community. Such designation would continue to allow for legitimate scientific collecting but would outlaw commercial collecting at the sites.

OTHER LOCALITIES

Most of the Paleozoic and Mesozoic fossil localities in the Dawson Creek LRMP area contain abundant to uncommon invertebrate fossil remains, including ammonoid, belemnoid, and nautiloid cephalopods, bivalves, brachiopods, corals, plants, echinoderms, and arthropods. It is these fossils that are often found by local collectors and which provide the nucleus for recreational collecting at sites such as "Rolla" and "Silver Sands." Professional paleontologists consulted in the preparation of this report are in agreement that, although all fossil sites in the LRMP area provide useful information about the distribution of fossil species in the province, none of the invertebrate fossil localities in the Dawson Creek LRMP area should be considered especially unique or significant. For this reason, the BCPA concludes that there are no known

invertebrate paleontological sites in the area of the Dawson Creek LRMP area for which special land-use designation should be provided at present. We reiterate our belief that scientific fossil collecting under the conditions of the BCPA Code of Ethics should continue at such localities in the Dawson Creek LRMP area.

It is our further recommendation that no fossil sites presently known in the Dawson Creek LRMP area be advertised to promote general collecting by the public as a recreational activity. Rather, it is our view that collecting be undertaken by persons interested enough to seek out information on localities from established organizations. This approach should facilitate public education about fossil resources and encourage responsible collecting within the framework of the Collecting Policy established by the BCPA.

It is possible that such collecting may generate new fossil discoveries that do merit special designation. Should the BCPA should become aware of any specific information about fossils of significant scientific importance in the Dawson Creek LRMP area, it will immediately convey this information to local planners for special-status consideration. Such status might include various restrictions on collecting at the site(s), as outlined in the BCPA Policy on Fossil Collecting and Regulation (Appendix B).

In addition, the BCPA volunteers its services in assessing the scientific importance of any new fossil discoveries which might be made in the Dawson Creek LRMP area in the future. The BCPA will endeavour to bring any such unstudied sites to the attention of appropriate scientific researchers and encourage them to initiate detailed research at these sites. In addition, the BCPA will be pleased to provide additional, detailed input on specific site-management strategies once formal designation of a site is established by the province.

ACKNOWLEDGMENTS

We sincerely thank the Dawson Creek LRMP planning team, in particular Chris Bechard, Jeff Beale and Jean McRann, for supporting this initiative and providing advice on land status designations. We also extend our thanks to all those individuals who provided information and advice about fossil resources in the Dawson Creek region, in particular Chris McGowan, Betsy Nicholls, Andy Neuman and Jim Basinger. Tom Cockburn, Mike Orchard and Steve Irwin are also thanked for reviewing the manuscript and providing valuable input.

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APPENDIX A

BRITISH COLUMBIA PALEONTOLOGICAL ALLIANCE
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APPENDIX B

BRITISH COLUMBIA PALEONTOLOGICAL ALLIANCE

POLICY ON FOSSIL COLLECTING AND REGULATION

Adopted February 24, 1996

The British Columbia Paleontological Alliance (BCPA) is a union of professional and amateur paleontologists working to advance the science of paleontology in the province through fostering public awareness, scientific collecting and education, and by promoting communication between all those interested in fossils. It is the position of the BCPA and its component regional societies that fossils comprise a critical record of past life forms and, therefore, fossils have important scientific, heritage and educational values. Any collecting of fossils must be made with due consideration of these factors.

General Scientific Collecting

Fossil collecting activities, by both professionals and amateurs, should be undertaken in a responsible manner, that is, suitable for subsequent scientific study and where collected materials receive proper curation, as described in the following BCPA Standards and Ethics for Scientific Collecting. Fossil collecting undertaken according to these standards provides a valuable record of British Columbia's paleontological resources and should be encouraged.

Standards and Ethics for Scientific Collecting

Determine the status of the land prior to collecting. Ensure that appropriate permission and permits have been obtained from landowners or governmental authorities before venturing to a fossil site. Leave each site as found with respect to gates, fences or constructions on the property.

Practice sound environmental etiquette. Ensure that the size of field groups, as well as collecting methods employed, minimize the impact of collection on the outcrop.

Take appropriate safety precautions while collecting and carry a first aid kit in each field group.

Collectors must record and maintain documentation of all relevant geographic and stratigraphic information for each fossil in their collections. Every effort should be made to ensure that this information is accessible to interested professional researchers.

Fossil collections must be properly curated. Each specimen should normally have a unique identifying number related to a documented fossil locality. Specimens should be stored in a

manner consistent with their long-term preservation. Important specimens should be housed in a recognized paleontological repository.

Sale of fossils for personal or corporate profit by any member of the Alliance is unacceptable.

Members who fail to adhere to these standards may have their membership in the Alliance revoked.

Paleontological Reserves

A few fossil localities in British Columbia are of outstanding scientific importance (e.g. Burgess Shale and Wapiti Lake, both presently protected) and merit specific protection and regulation as Paleontological Reserves. Measures of the importance of a Paleontological Reserve include, but are not limited to: uniqueness of the fossils found there (either individual specimens or associations of fossil types); unusual preservation of fossils; large, moderately-complete vertebrate remains; etc. It is the opinion of the BCPA that recommendations proposing such a locality, and the nature and extent of management of such sites, should be made to legislators by the BCPA in consultation with other professionals having specific knowledge relevant to the proposed locality.

General scientific collecting is not permitted in Paleontological Reserves. Locality protection should be flexible, to allow for periodic revision of the status, and should be designed so as not to hinder valid scientific research at the locality.

The BCPA will seek to work directly with provincial ministries and legislators to help develop a process whereby Paleontological Reserves can be designated promptly and with the input of the BCPA.

Paleontological Research Sites

The BCPA recognizes that valid scientific research may require that some fossil sites remain undisturbed for the duration of the study. Such sites are to be designated Paleontological Research Sites (PRS). Researchers may apply to the BCPA for PRS status. Research sites would be established typically for periods of six months to two or more years, depending on the nature of the research. Collecting by BCPA members will be prohibited for the duration of the Paleontological Research Site designation. At the conclusion of the assigned study period, the

site will revert to normal status unless the researcher demonstrates to the satisfaction of the BCPA that it should be further protected.

The BCPA will seek to work directly with provincial ministries and legislators to help develop a process whereby Paleontological Research Sites can be designated promptly and with the input of the BCPA.

Out-of-Province Paleontologists

Out-of-province paleontologists should not be restricted or hindered from fossil collecting, provided they follow adequate collecting and curatorial procedures, as outlined in the above Standards and Ethics for Scientific Collecting. Out-of-province paleontologists should inform the BCPA of their research program prior to initiation of their collecting program. Type specimens and general collections of fossils must be housed in appropriate institutions designated for such storage. In particular instances, the BCPA may request out-of-province paleontologists to deposit a representative suite of specimens in a British Columbia museum, or recognized institutional collection.

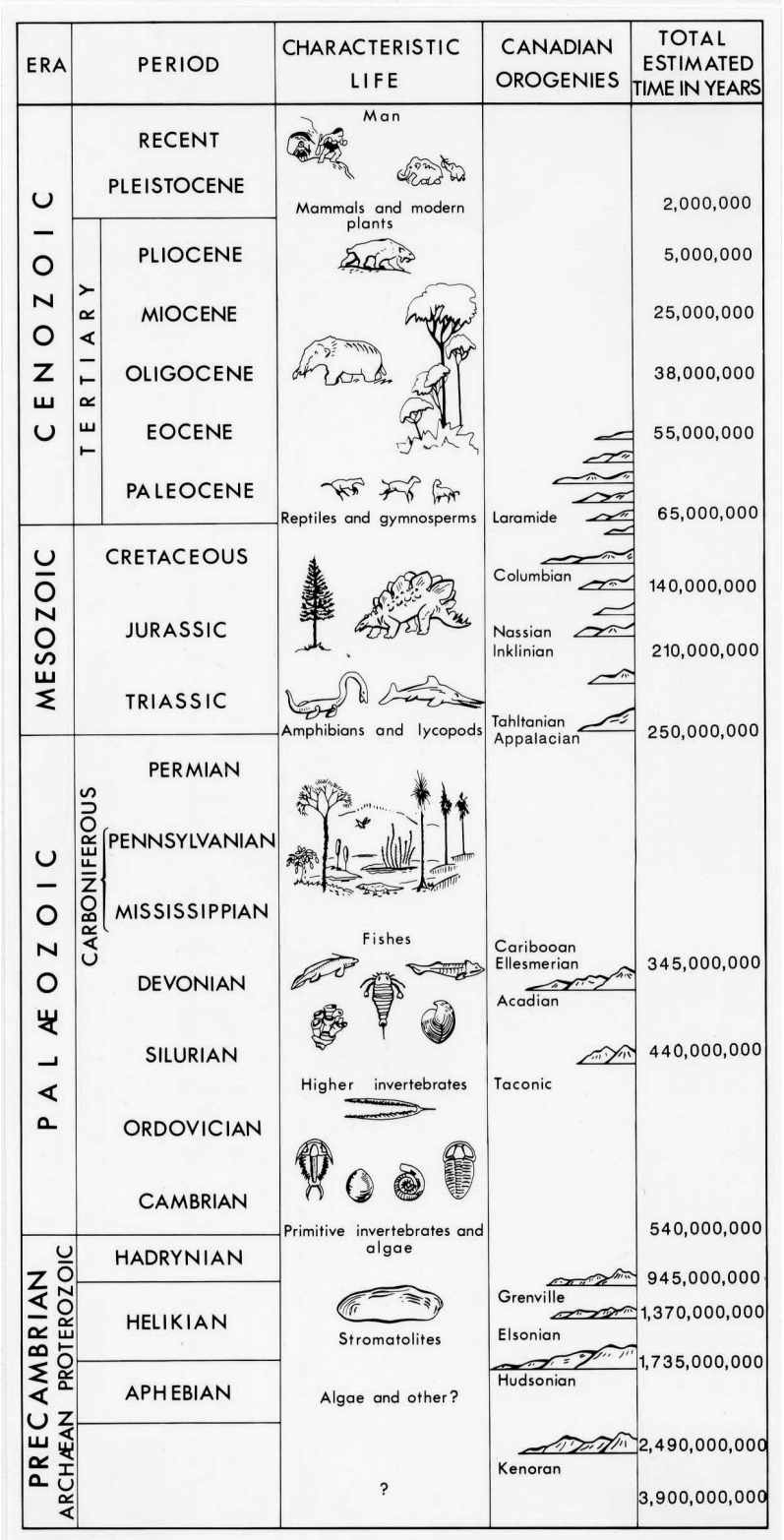
Commercial Collecting

The BCPA is opposed to commercial extraction of fossils by its member organizations or individuals. Any commercial fossil extraction activity should be regulated by the province and should require permits and/or licenses, with some sort of associated fee. The BCPA anticipates that its advice will be sought and followed by regulators in assessing each permit application for suitability.

The BCPA will seek to work directly with provincial ministries and legislators to help develop a method whereby guidelines for Commercial Fossil Collecting Standards and a Commercial Permit Application Process are established.

APPENDIX C

THE GEOLOGICAL TIME SCALE



APPENDIX D

PALEONTOLOGICAL RESOURCES OF THE DAWSON CREEK LRMP AREA

The first step in the assessment process entailed compiling a listing of all fossil localities in the LRMP area discussed in the geological literature. Library resources at the Vancouver office of the Geological Survey of Canada were utilized for this purpose. Compilation information included locality, stratigraphic horizon, fossils collected and identified, age of strata, and the source of the reference. Information on 75 macrofossil and 34 microfossil localities was obtained in this way. In addition, the database files of the Geological Survey of Canada office in Vancouver were searched and produced information on additional 51 macrofossil and 502 microfossil localities. The studied microfossil locality data include a variety of fossil types, principally conodonts, fusulinids and other foraminifers, radiolarians, and ichthyoliths. Given the abundance and widespread distribution of microfossils, these localities are not considered of especial significance and microfossil data are not presented in the following summary.

The following is a summary listing of the more common macrofossils found in the fossiliferous geological units of the Dawson Creek LRMP area, starting with the older rocks. The precise locations of fossil sites have been withheld from this report to protect the sites from overcollecting. This information is available to planning agents through the office of the Geological Survey of Canada in Vancouver.

CARBONIFEROUS

Banff Formation

Bivalves:

Avonia? *beckerensis* n. sp.

Brachiopods:

Brachythyris cf. *chouteauensis* (Weller)

Piloricilla desmentensis n. gen. n. sp.

Shumardella pygmaea n. sp.

Spinocarinifera (Spinocarinifera) copiosa n. sp.

overtoniid gen. et sp. indet.

Age: Early Carboniferous.

Unnamed Formation

Hydrozoan: *Palaeoaplysina* sp. (tentatively referred to Hydrozoa - one of the oldest known occurrences of this group)

Molluscan detritus

Minor echinoderm detritus

Age: Late Carboniferous.

PERMIAN

Belcourt Formation

Fusulinids

Bryozoans

Echinoderm columnals

Age: Permian, Early to mid-Asselian (Wolfcampian).

TRIASSIC

Sulphur Mountain Formation

Brachiopods:

Terebratulids

Orbiculoididae *incertae sedis*

Lingulidae *incertae sedis*

Ammonoids:

Arctoceras sp.

Xenoceltites subevolutus Spath

Xenoceltites sp.

Xenoceltites cf. *hannai* (Mathews)

Juvenites sp.

cf. *Euflemingites* sp.

Parapopanoceras cf. *verneuili* Mojsisovics

Gymnotoceras sp.

Ptychites cf. *trochleaeformis* (Lindstroem)

Ptychites sp.

Progonoceratites poseidon Tozer

Lobites pacianus McLearn

Lobites sp.

Frechites? sp. indet.

Bivalves:

Posidonia mimer

Gervillia sp.

"Pseudomonotis" occidentalis

Claraia stachei

Tridonodus sp.

Daonella cf. *dubia*

Daonella cf. *degeeri*

Daonella sp.

Arthropods:

phyllocarids

Arthropoda *incertae sedis*

Fish: More than 1000 specimens, many articulated, representing 16 genera and 3 distinct faunas including:

Hybodontidae *incertae sedis*

cf. *Palaeobates* sp.

Edestodus sp.

cf. *Listracanthus* sp.

Pteronisculus sp.

Birgeria sp.

Boreosomus sp.

Paleoniscoidea *incertae sedis*

Bobasatrania canadensis

cf. *Bobasatrania* sp.

Bobasatrania n. sp.

Perleidus n. sp.

cf. *Perleidus* n. sp.

Australosomus sp.

Saurichthys spp.

Watsonulus cf. *eugnathoides*

Parasemionotidae n. gen. et sp.

Albertonia cupidinia

Albertonia n. sp.

Actinopterygii *incertae sedis*

Whiteia sp. (coelacanth)

Coelacanthidae *incertae sedis*

Chondrichthyian spines believed to represent some part of the skin of ancient sharks

Ichthyosaurs:

Mixosaurus cf. *nordenskioldii* Nicholls, Brinkman & Calloway

Grippia cf. *longirostris*

Utatsusaurus sp.

Pessosaurus sp.

Parvinatator wapitiensis Nicholls & Brinkman

Phalarodon cf. *fraasi*

Plesosauria? *incertae sedis*

Thalattosauria:

Thalattosaurus borealis Nicholls & Brinkman

Paralonectes merriami Nicholls & Brinkman

Paralonectes sp.

Agkistognathus campbelli Nicholls & Brinkman

Thalattosauridae gen. et sp. indet.

Diapsida:

Diapsida *incertae sedis*

Wapitisaurus problematicus Brinkman

Age: Early Triassic (this locality includes some ichthyosaur material equal in age to the oldest yet known, and certainly the most ancient from North America).

Liard, Charlie Lake, Pardonet and Baldonel Formations

Numerous occurrences of ichthyosaur fossils along the shore of Williston Lake, including partial to near-complete specimens of the following taxa:

Ichthyosaurus janiceps McGowan

Hudsonelpidia brevirostris McGowan

Shastasaurus neoscapularis McGowan

Age: Middle to Late Triassic.

Indeterminate Stratigraphic Unit

Ammonites:

Atractites sp. indet.

Metasibirites sp

Paraguembelites ludingtoni Tozer

Rhabdoceras suessi Hauer

Bivalves:

Cardinia? aff. *regularis* Terquem

Chlamys n. sp. aff. *textorius* (Münster)

Entolium cf. *calvum* (Goldfuss)

Furcirhychia striata (Quenstedt)

Gryphaea sp.

Monotis ochotica (Keyserling)

Monotis subcircularis Gabb

Oxytoma cf. *inaequivalvis* (Sowerby)

Nautiloids:

cf. *Proclydonautilis natosini* (McLearn)

"Reptilian remains are known, and black fossilized pieces of bone are often found..."

Age: Latest Triassic to earliest Jurassic.

JURASSIC-CRETACEOUS

Beattie Peaks Formation

Ammonites:

Amundiptychites n. sp. aff. *sverdrupi* Kemper & Jeletzky

Amundiptychites cf. *thorsteinssoni* Jeletzky & Kemper (ms name)

Dorsoplanites n. sp. ex. aff. *crassus* Spath

Pectinaites sp. aff. *eastlecottensis* (Salfeld)

Polyptychites (Polyptychites) cf. *keyserlingi* (Neumayr & Uhlig)

Ringnesiceras (Ringnesiceras?) sp. indet.

Belemnoids:

Cylindroteuthis (Arctoteuthis) sp. cf. *baculus* (Crickmay)

belemnite gen. indet.

Bivalves:

Arctica (s. lato)? sp. indet.

Buchia bulloides (Lahusen)

Buchia concentrica (Sowerby) s. lato

Buchia sp. aff. *crassicollis* (Keyserling) var. *solida* (Lahusen)

Buchia ex aff. *fischeriana* (d'Orbigny)

Buchia inflata (Toula) s. str.

Buchia n. sp. aff. *inflata* (Toula)

Buchia keyserlingi (Lahusen) s. lato

Buchia okensis (Pavlov)

Buchia sp. cf. *piochii* (Gabb) s. lato

Buchia sp. cf. *sublaevis* (Keyserling)

Buchia tolmatschowi (Sokolov) var. *americana* (Sokolov)

Buchia cf. *uncitoides* (Pavlov)

Buchia n. sp. aff. *volgensis* Jeletzky *non* Lahusen

Buchia sp. indet.

Camptonectes (McLearnia?) sp. indet.

Corbicula-like bivalve

Oxytoma sp. indet.

Pecten (Entolium) sp. indet.

Pecten (Pseudamusium?) sp. indet.

Tellina? sp. indet.

Age: Latest Jurassic to earliest Cretaceous.

CRETACEOUS

Monteith Formation

Ammonites:

Dichotomites cf. *giganteus* (Imlay)

Lytoceras sp. cf. *colusaense* (Anderson)

Praetollia (Ronkinites) n. sp. ex aff. *rossica* Shulgina

Praetollia (Ronkinites) bodylevskii (Voronets)

"Tollia (Subcraspedites)" sp. cf. *stenomphala* Jeletzky *non* (Pavlov)

Bivalves:

Buchia sp. cf. *fischeriana* (d'Orbigny)

Buchia okensis (Pavlov) f. typ.

Buchia terebratuloides (Lahusen) s. lato

Buchia uncitoides (Pavlov) s. lato

Buchia n. sp. aff. *volgensis* Jeletzky *non* Lahusen

Modiolus (s. lato) sp. indet.

Ostrea (s. lato) sp. indet.

Age: Berriasian to Valanginian.

Minnes Group, undifferentiated

Plants:

Baierad cf. *gracilis* (Bean)

Coniopteris brevifolia (Fontaine)

Ctenopsis insignis (Fontaine)

Czekanowskia cf. *rigida* (Heer)

Phoenocopsis angustifolia (Heer) f. *media* (Krasser)

Pityophyllum cf. *nordenskioldi* (Heer)

Pseudocycas sp.

Sphenopteris acrodentata (Fontaine)

Sphenopteris gopperti

Thallites zeilleri (Seward)

Age: Early Cretaceous or earlier?

Bullhead Group, undifferentiated

Dinosaur tracks(?)

Bivalves:

Arctica? sp. indet.

Aucellina? sp. indet.

Pecten (Entolium) sp. indet.

Plants:

Arliaephyllum? sp.

Athrotaxites berryi (Bell)

Cladophlebis parva (Fontaine)

Cladophlebis strictinervis (Fontaine)

Cladophlebis virginiensis (Fontaine)

Cladophlebis virginiensis ?cf. *acut-dentata* (Fontaine)

cf. *Coniopteris brevifolia* (Fontaine)

Ctenis borealis (Dawson)

cf. *Cyparissidium gracile* (Heer)

cf *Dicksonia conferta* (Heer)

Elatocladus brevifolia (Fontaine)

Elatides curvifolia (Dunker)

Elatides splendida (Bell)

Gingko pluripartita (Schrimper)

Hausmannia? sp.

Nilssonia brongniarti (Mantell)

Nilssonia canadensis (Bell)

Nilssonia curvifolia (Dunker)

Nilssonia yukonensis (Hollick)

Phoenicopsis angustifolia (Heer) cf. *media* (Krasser)

Pityophyllum cf. *nordenskioldi* (Heer)

Pluripartita sp. (Schrimper)

Podozamites lanceolatus (Lindley & Hutton)

Pterophyllum plicatum (Bell)

Pterophyllum rectangulare (Bell)

Ptilophyllum arcticum (Goppert)

Ptilophyllum (Anomozamites) montanense (Fontaine)

cf. *Ptilophyllum robustum* (Bell)

Ptilophyllum sp.

Podozamites lanceolatus (Lindley & Hutton)

Pseudocycas dunkeriana (Goppert)

Pseudocycas sp. A Bell; ?cf. *unjiga* (Dawson)
Pseudocycas sp.
Pterophyllum plicatum (Bell)
Pterophyllum rectangulare (Bell)
Sagenopteris williamsii (Newberry)
Sagenopteris sp.
cf. *Sapindopsis belviderensis*
Sequoia condita (Lesquereux), cone
Sphenopteris cf. *S. (Ruffordia) gopperti* (Dunker)
Sphenopteris latiloba (Fontaine)
Sphenopteris sp.
Thallites blairmorensis (Berry)

Age: ?Early Cretaceous, ?Aptian to Albian.

Gething Formation

Foraminifera
Ostracods
Spores and pollen
Bivalve shell fragments
Plants:

Cladophlebis virginiensis (Fontaine emend Berry)
Sagenopteris williamsii (Newberry) Bell
Ginkgo pluripartita (Schrimper) Heer
Pterophyllum rectangulare (Bell)
Elatides curvifolia (Dunker) Nathorst
Nilssonia yukonensis (Hollick)
Pityophyllum cf. *nordenskioldi* (Heer) Krystofovich

Age: Aptian to early Albian.

Gates Formation

Ammonites:

Beudanticeras? sp. indet.

Bivalves:

Pleuromya? sp. indet.

Age: Albian.

Goodrich Formation

Ammonites:

Gastroplites cf. *kingi* (McLearn)

Bivalves:

Anomia sp. indet.

Modiolus (Brachydontes) ex aff. *fulpensis* (Stephenson)

Ostrea sp. indet

Pholadomya? sp. indet.

Posidonia nahwisi (McLearn) var. *goodrichensis* McLearn

Pteria (Oxytoma) cf. *pinania* McLearn

Tellina? sp. indet.

Bivalve, gen. et sp. indet.

Bryozoan, gen. et sp. indet.

Plants:

Dryophyllum sp.

Angiosperm fragments

Age: Albian.

Hasler Formation

Ammonites:

Gastroplites cf. *allani* (McLearn)

Gastroplites n. sp. aff. *liardense* (Whiteaves)

gastroplitid ammonite, gen. et sp. indet.

Bivalves:

Arctica? sp. indet.

Inoceramus ex gr. *anglicus* (Woods)

Echinoderms:

Lophidiaster cf. *silentiensis* (McLearn)

Age: Albian.

Hulcross Formation

Ammonites:

Gastroplites cf. *kingi* (McLearn)

Bivalves:

Inoceramus cadottensis McLearn var. *altiflumis* McLearn

Age: Albian.

Moosebar Formation

Ammonites:

Arcthoplites (= *"Lemuroceras"*) sp.

Lemuroceras-Beaudanticeras affine (Whiteaves)

Bivalves:

Corbula sp.

Goniomya sp.

Lima sp.

Modiolus? sp.

Pecten (Camptonectes?) sp. indet.

Pecten (Entolium) sp.

Pleuromya sp.

Pleuromya? sp.

Protocardium? sp.

Psilomya sp.

Yoldia cf. *kissoumi*

Echinoderms:

Starfish, gen. et sp. indet.

Age: Middle Albian.

Boulder Creek Formation

Ammonites:

Neogastroplites cornutus (Whiteaves)?

Stotticeras? sp.

Age: Late Albian.

Muskiki Formation

Ammonites:

Scaphites mariasensis (Cobban)

Scaphites mariasensis var. *gracillirostris* (Cobban)

Scaphites preventricosus (Cobban)

Scaphites preventricosis var. *sweetgrassensis* (Cobban)

Scaphites ventricosus (Meek & Hayden)

Bivalves:

cf. *Anatina lineata* (Stanton)

Cyrena securis (Meek)

Inoceramus albertensis (McLearn)

Inoceramus deformis (Meek)

Inoceramus involutus (Sowerby)

Inoceramus lamarcki (Parkinson) s. lato

Inoceramus subcardissoides (Schlüter)

Inoceramus sp. indet.

Mactra? sp. indet.

Pteria (Oxytoma) aff. *nebrascana* (Evans & Shumard)

Pteria (Pseudopteria)? sp. indet.

Bryozoan, indet.

Age: Late Turonian or Early Coniacian(?)

Puskwaskau Formation

Ammonites:

Baculites ovatus var. *haresi* (Reeside)

Baculites sp. indet.

cf. *Scaphites depressus* (Reeside) or *montanensis* (Cobban)

Scaphites ventricosus (Meek & Hayden)

Scaphites ex gr. *ventricosus* (Meek & Hayden) s. lato

Scaphites (Clioscaphites) montanensis (Cobban)

Scaphites (Clioscaphites) sp. indet.

Scaphites aff. *S. novimexicanus* (Reeside)

Scaphites sp. indet.

Bivalves:

Anomia subquadrata (Stanton)

Corbula sp. indet.

Cyrena sp. indet

Inoceramus cardissoides (Goldfuss) s. lato

Inoceramus cordiformis (Sowerby)

cf. *Inoceramus cordiformis* var. *haenleini* (Muller)

Inoceramus cordiformis var. *lesginensis* (Dobrov)

Inoceramus ex gr. *lobatus* (Goldfuss)

Inoceramus steenstrupi (de Loriol)

Inoceramus sp. indet.

Ostrea sp. indet.

Pteria (Oxytoma) nebrascana (Evans & Shumard)

Tancredia? sp. indet.

Gastropod, gen. et sp. indet.

Age: Santonian to Early Campanian.

Unknown Stratigraphic Unit

Dinosaur footprints, both carniverous and herbiverous and including possible horned dinosaurs, are represented, referred to 6 genera and 8 species

Age: Cretaceous.

PLEISTOCENE

Vertebrates:

Alces alces

Bison sp. ?cf. *crassicornis*

Mammuthus primigenius

Age: Probably late Pleistocene to Recent.