Paleontological Resources of the Lakes District Land Resource Management Plan (LRMP) Area British Columbia

Prepared by the
British Columbia Paleontological Alliance

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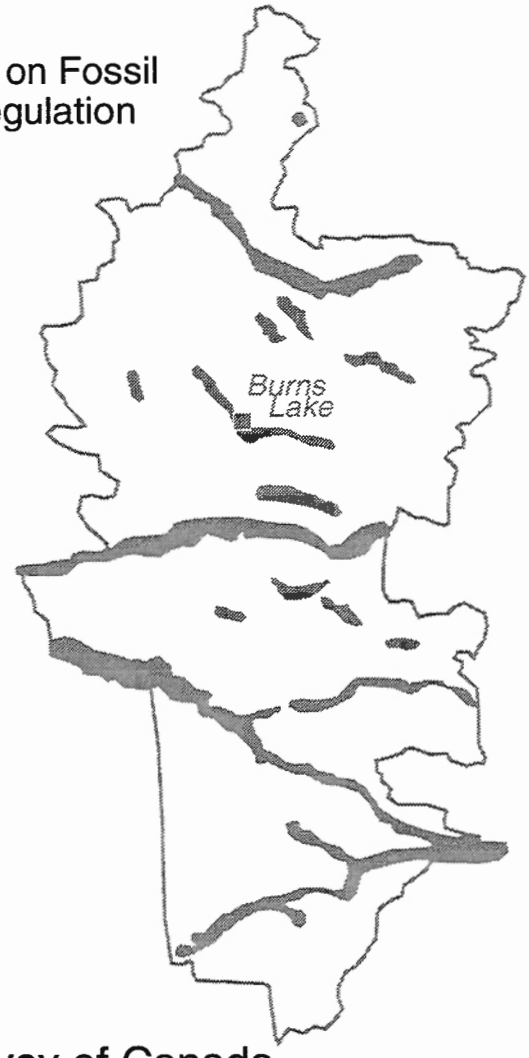

Geological Survey of Canada
Open File 3469
1997

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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 the 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 Lakes District Land Resource Management Plan team, to enable them to make informed decisions about land designation issues relating to paleontological resources.

The Lakes District LRMP area comprises several different geologic units. Fossils are distributed widely, although somewhat sparsely, in most of the principal recognized geologic units. Fossil taxa and assemblages at most localities are duplicated elsewhere in the LRMP or the province and are not considered especially unique or significant. It is the view of the BCPA that none of the known localities merits protected land designation status at this time.

The BCPA recommends that all parts of the Lakes District LRMP area remain open to fossil collecting by the professional and amateur community, but recommends against actively promoting fossil collecting in the area. Should new information come to light about fossil resources in the Lakes District 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 second in a series providing this information. The first report dealt with paleontological resources in the Kamloops LRMP area and was produced in Fall, 1996. This report has been prepared in response to a request from the Lakes District LRMP planners for needed information and advice on paleontological resources in the Lakes District 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 most commonly in limestone and shale rocks and when found in such rocks they 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 found in fewer numbers in rocks 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 greatly by paleontologists and geologists to date the age of the rocks containing them, and to help construct geological maps of the Earth's surface regions. They can be used to help interpret the environments of the rocks containing them. And of course, they are critical to unravelling 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 seemingly rapid intervals of geologic time. Our understanding of the processes by which this evolutionary development has taken place is based strongly on analysis of the fossil record, as well as observation of biological processes 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 fossils are found in, 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 milllion years old) fossil organismss 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. This status will likely be superseded by identification of the site as a Protected Area. Scientific fossil collecting has been undertaken at the site under this status. Management strategies have not yet been determined but it has been suggested, and we concur, that they should be carried out under the British Columbia Parks Act. Research permits have been issued for the area as well as a number of permits for commercial extraction (at least some of the commercial ventures have been overseen by the Tyrrell Museum).

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 LAKES DISTRICT 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 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 (Figure 1).

The Lakes District LRMP area sits squarely within the Intermontane Belt (Figure 1). The Intermontane Belt is a topographically-low and physiographically-subdued region, in comparison to the Omineca and Coast belts which lie to its east and west, respectively. The Intermontane Belt is primarily an amalgam of terranes, including Stikinia, Quesnellia, Slide Mountain and Cache Creek. In the Lakes District area, the underlying terranes are the Cache Creek and Stikine terranes (Wheeler et al., 1991).

Limited exposures of Cache Creek terrane rocks are found in the extreme northernmost part of the Lakes District LRMP (Figure 1). Rocks of the terrane consist of Mississippian to Jurassic oceanic volcanic rocks and sediments (Cache Creek Group), including accretionary melange. Fossils are typically rare in Cache Creek sedimentary rocks and consist, for the most part, of microfossils, including radiolarians and conodonts. No known macrofossil localities were identified in Cache Creek rocks of the Lakes District LRMP area.

Rocks exposed in the southern and western parts of the Lakes District LRMP area comprise the Stikine terrane, which consists of volcanic arc deposits of Devonian to Permian age (not present in the LRMP area), overlain by younger arc volcanic deposits of Triassic and Jurassic age (Stuhini and Hazelton groups). Although fossils, including macrofossils, are more common in rocks of Stikine terrane, such rocks in the Lakes District LRMP area are poorly fossiliferous. A few localities along Chelaslie, Tetachuk and Ootsa lakes have produced fossils, mostly mollusks and plant materials. Fossils found at these localities are typically preserved poorly and are known from occurrences of better-preserved material elsewhere in the province; none of these localities is thus considered unique or important.

TERTIARY ROCKS

NTC	*Chilcotin Group* (Neogene): basalts
PTK, PTS	*Endako Group, Ootsa Lake Group* (Eocene-Oligocene): diverse volcanics and associated epiclastic strata

CRETACEOUS ROCKS

KS	*Skeena Group*: volcanic wacke, conglomerate, sandstone, siltstone, mudstone; marine to mostly non-marine

STIKINE TERRANE ROCKS

JH	*Hazelton Group* (Lower-Middle Jurassic): mostly volcanics with associate epiclastic deposits; mostly non-marine
TrS	*Stuhini Group* (Upper Triassic): mostly volcanics with associate epiclastic deposits; mostly non-marine

CACHE CREEK TERRANE ROCKS

MtrC	*Cache Creek Group* (Mississippian-Jurassic): oceanic volcanics and sediments, including oceanic ultramafics (Mtruo)

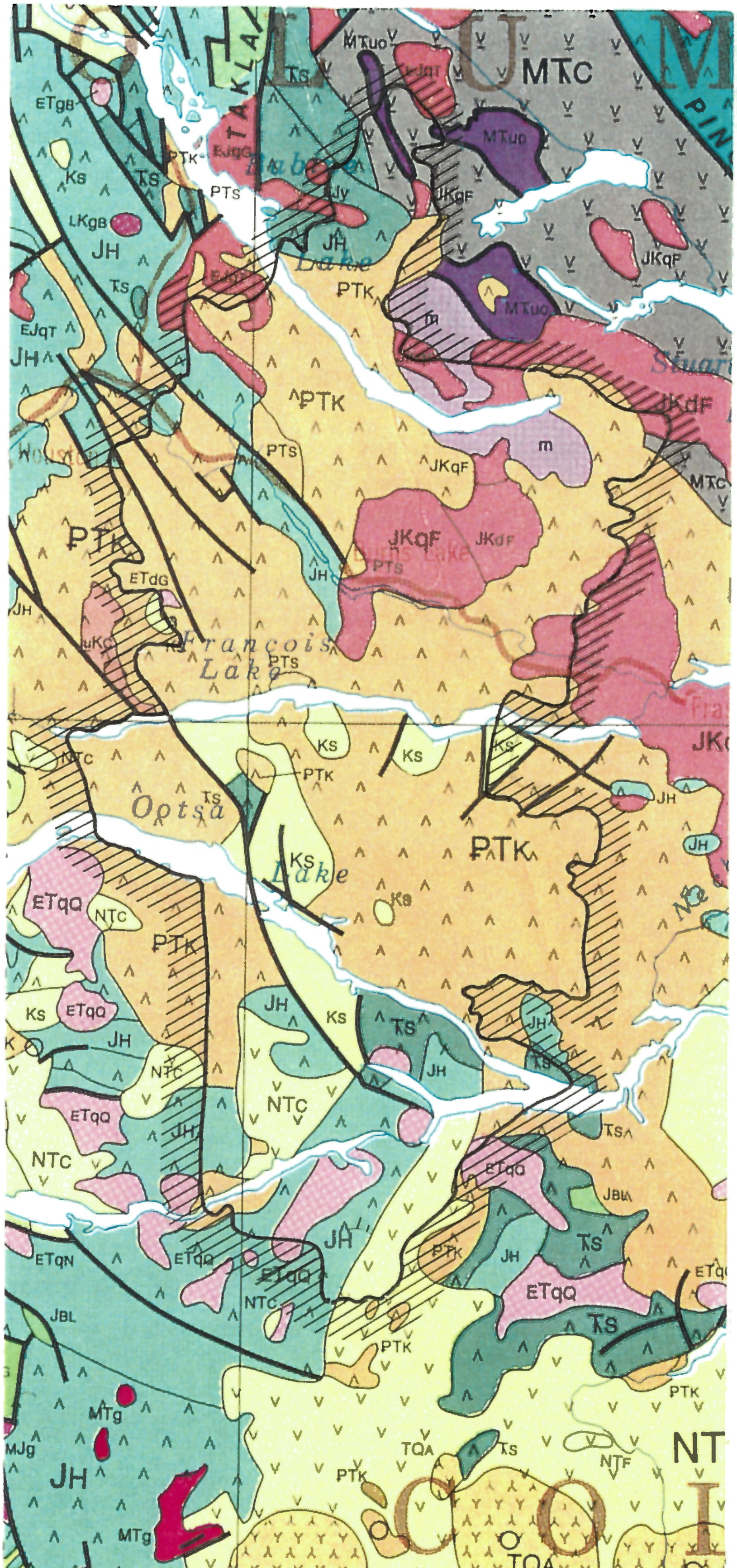
INTRUSIVE AND METAMORPHIC ROCKS (Non-Fossiliferous)

ETqQ, ETdG	Early Tertiary intrusives
JKqF, JKdF	Late Jurassic-Early Cretaceous intrusives
EJqT, EJqF, EJqT, EJY	Early Jurassic intrusives

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

Cretaceous sedimentary and volcanic rocks (Skeena Groupa) and flat-lying Tertiary volcanic and sedimentary rocks (Ootsa Lake and Endako groups) overlie the older, terrane rocks (Figure 1), producing a widespread, uniformly low relief within most of the Lakes District LRMP area. These rocks are locally fossiliferous also, especially the sedimentary rocks which are found locally interstratified within the Tertiary volcanic sequences. Again, however, all fossils found in these rocks are known from occurrences of better-preserved material elsewhere in the province, and the sites are thus not considered unique.

Thick deposits of Quaternary stratified sediments lie mainly in the valleys and coastal lowlands and were deposited in proglacial and ice-contact environments during periods of growth and decay of the Cordilleran Ice Sheet (Clague, 1991). The Lakes District LRMP area is no exception. Glacial deposits vary throughout the region and are confined primarily to valleys, where both glacial (ice-



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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. No Quaternary fossil localities were identified in our search of the geological literature covering the Lakes District LRMP area.

References

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1991 Quaternary glaciation and sedimentation, Chapter 12 of *Geology of the Cordilleran Orogen in Canada*, H. Gabrielse and C.J. Yorath (ed.); Geological Survey of Canada, Geology of Canada, No. 4, p. 419-434.

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1991 Part A. Morphogeological belts, tectonic assemblages, and terranes, *in* Chapter 2 of *Geology of the Cordilleran Orogen in Canada*, H. Gabrielse and C.J. Yorath (ed.); Geological Survey of Canada, Geology of Canada, No. 4, p. 15-28.

Wheeler, J.O. and McFeely, P. (comp.)

1991 Tectonic Assemblage Map of the Canadian Cordillera and adjacent parts of the United States of America; Geological Survey of Canada, Map 1712A, scale 1:2 000 000.

Wheeler, J.O. et al. (comp.)

1991 Terrane Map of the Canadian Cordillera; Geological Survey of Canada, Map 1713A, scale 1:2 000 000.

PALEONTOLOGICAL SITE ASSESSMENT PROCESS

The BCPA's Committee on Fossil Collecting and Regulation Policy was asked by members of the Lakes District LRMP team to assess the paleontological importance of all known sites within the Plan study area. In discussions with the Lakes District LRMP team leaders, 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 Province, an independent agency should undertake this effort.

Geological Compilation

The first step in the assessment process consisted of 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 compilation. Compilation information included locality, stratigraphic horizon, fossils collected and identified, age of strata, and the source of the reference. The compilation listing is retained at the Geological Survey of Canada office in Vancouver to protect the sites from unnecessary collecting by non-scientific parties. In addition, Dr. H.W. Tipper, Research Scientist Emeritus of the Geological Survey of Canada, who has undertaken extensive geological mapping in the area of the LRMP, was interviewed for information on any possible unpublished fossil localities.

The compilation process located only 10 fossil localities in the Lakes District LRMP area. Four of these localities are in the younger, Tertiary rocks of the area, in sedimentary strata interstratified within volcanic deposits. At these sites the following species of Eocene-Oligocene plant fossils have been reported:

Sequoia langsdorfii (Brongniart)
Taxodium occidentalis Newberry
Ulmus (?) sp., single leaf
Fruits (samara cf. *Ulmus*)
Cephalotaxus californica Potbury
Glyptostrobus oregonensis Brown

Metasequoia occidentalis (Newberry) Chaney
Alnus corallina Lesquereux
Alnus sp.
Ostrya oregoniana Chaney
Quercus consimilis Newberry
Quercus cowlesi Chaney
Macclintockia kanii (Heer) Seward & Conway
Cercidiphyllum crenatum (Unger)
Sassafras bendirei (Knowlton) Brown
Porana speirii Lesquereux
Rhamnites marginatus? (Lesquereux)
Spirodela? *scutata*? Dawson

Tertiary strata have also produced the following Eocene freshwater mollusks:

Sphaerium sp. (cf. *S. heskethense* Warren)
Lioplacodes sp. (cf. *L. sanctameriensis* (Russell))
Unionid gen. indet.

In addition, six localities are known from older rocks (Jurassic-Cretaceous Hazelton and Skeena groups), which underlie the Tertiary volcanic sequence and which crop out in various areas, especially around the margin of the LRMP area. The quality of fossil material found at these sites is generally poor, and all fossils found at the sites are known from elsewhere in the province. Included in these localities are the following fossil types:

Plants: Filicales, Gleicheniaceae (*Gleichenites* cf. *G. nordenskiöldi*)
Brachiopods:
'Terebratula' sp. indet.
'Rhynchonella' sp. indet.
Bivalves:
Pecten (Entolium) sp. indet.
Macrodon sp. indet.
Cucullaea? sp. indet.
Leda? sp. indet.
Corbula? sp. indet.
Other indeterminable bivalves

Belemnoids: Gen. and sp. indet.
Ammonites: Gen. and sp. indeterminate

Geological Consultations

After the literature compilation, discussion was undertaken with several university researchers who have undertaken studies of British Columbia fossils, to solicit their opinions on the quality and significance of paleontological sites in the Lakes District LRMP area. These researchers include Dr. Jim Basinger (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), Dr. Mark V.H. Wilson (University of Alberta, Edmonton), and Wesley C. Wehr (University of Washington, Seattle).

References

The following literature was consulted in compiling the listing of fossil localities in the Lakes District LRMP area.

Armstrong, J.E.

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RECOMMENDATIONS

Although all the researchers consulted were in agreement that all fossil sites in the LRMP provide useful information about the distribution of fossil species in the province, they did not suggest that any particular sites in the LRMP area are especially unique or significant.

> *Based on all the available information, The BCPA concludes that there are no known paleontological sites in the area of the Lakes District LRMP for which special land-use designation should be provided at present. We reiterate our belief that general fossil collecting, following the principles outlined in the BCPA Code of Ethics, should continue unfettered in this region.*

It is our further recommendation that no fossil sites presently known in the Lakes District 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 Lakes District LRMP area, we would 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).

Finally, the BCPA volunteers its services in assessing the scientific importance of any new fossil discoveries which might be made in the Lakes District in future. The BCPA will undertake 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 Lakes District LRMP planning team, in particular Chris Bechard, for supporting this initiative and providing advice on land status designations. We also extend our thanks to all those individuals who provided information about fossil resources in the Lakes District region. Mike Orchard is thanked for reviewing the manuscript and providing valuable input.

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