

# Status Report on the Scientific Case for Designation of Joggins as a UNESCO World Heritage Site

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## Introduction

The long-celebrated cliff section at Joggins (NTS 21H/09), Nova Scotia, has the potential to become Maritime Canada's first natural World Heritage Site and only the eighth fossil site world wide, but the scientific case presented must be skilfully argued. Late in 2001, a Scientific Subcommittee was formed to oversee and further develop a strategy in building the case for Joggins. The Scientific Subcommittee reports through the Chair to a broad-based Steering Committee concerned with issues of site management, infrastructure development and community. The importance of these issues notwithstanding, UNESCO (1996) describes scientific justification as "the most crucial aspect of the whole nomination dossier" that must be submitted. The subcommittee must present irrefutable evidence that Joggins represents a natural site of "outstanding universal value" representing a major stage in the history of life, specifically, the Upper Carboniferous 'Coal Age' wetlands of Euramerica.

The Scientific Subcommittee presently comprises: John Calder (Chair: NSDNR), Kenneth Adams (Fundy Geological Museum), Howard Falcon-Lang and Martin Gibling (Dalhousie University), Deborah Skilliter (Nova Scotia Museum) and Graham Williams (GSC Atlantic). The participation of key vertebrate paleontologists is being sought. During the summer of 2001, Dalhousie University graduate student Heidi MacDonald carried out background research, described below.

## The Proposed Case

The case being developed by the Scientific Subcommittee is built upon the following pillars.

*The site itself.* Although largely taken for granted by those familiar with Joggins, the coastal cliff section is a dramatic yet accessible site, hewn and replenished by the world's highest tides. Coastal erosion in this dynamic setting virtually guarantees the prospects for ongoing discovery, which is one of the criteria for judgement established by UNESCO (United Nations Educational, Scientific and Cultural Organization) and the IUCN (the World Conservation Union).

*The fossil record.* The fossil record of Joggins, collated by the author over past years, confirms that Joggins indeed records an entire ecosystem, with equal vertebrate, invertebrate and floral records, satisfying requirements of biodiversity, evolutionary innovation, community and uniqueness (Tables 1 and 2). Nowhere is there found a more complete record of the terrestrial Coal Age environment. Crowning this record, Joggins can continue to claim the appearance in the fossil record of the earliest reptile, *Hylonomus lyelli* (Fig. 1), now that the older tetrapod *Westlothiana lizae* from the Viséan of Scotland is considered to be a more primitive stem amniote (Ahlberg and Milner, 1994; Carroll, 1992; A. R. Milner, personal communication, 1999). The famous, unusual tree stump fauna of Joggins (Benton, 2000) contributes to the rich record of terrestrial Coal Age life seldom preserved in the fossil record elsewhere (Carroll *et al.*, 1972; Carroll, 1994; Milner, 1987).

*The sedimentary record.* "But the finest example in the world of a natural exposure in a continuous section ten miles long, occurs in the sea cliffs bordering a branch of the Bay of Fundy in Nova Scotia." So wrote Sir Charles Lyell in his discussion of the Carboniferous coal measures in *Elements of Geology* (1871). We contend that Joggins is indeed the world's best exposed

**Table 1.** Criteria for the evaluation of palaeontological sites nominated for inscription on the World Heritage list (Thorsell, 1994).

Question 1:	Does the site provide fossils which cover an extended period of geological time? i.e. how wide is the geological window?
Question 2:	Does the site provide specimens of a limited number of species or whole biotic assemblages? i.e. how rich is the site in species diversity?
Question 3:	How unique is the site in yielding fossil specimens for that particular period of geological time? i.e. would this be the type locality for study or are there similar areas that are alternatives?
Question 4:	Are there comparable sites elsewhere that contribute to the understanding of the total “story” of that point in time/space? i.e. is a single site nomination sufficient or should a serial nomination be considered?
Question 5:	Is this site the only or main location where major scientific advances were (or are being) made that have made a substantial contribution to the understanding of life on earth?
Question 6:	What are the prospects for on-going discoveries at the site?
Question 7:	How international is the level of interest in the site?
Question 8:	Are there features of natural value (e.g. scenery, landform, vegetation) associated with the site? i.e. does there exist in the adjacent area modern geological or biological processes that relate to the fossil resource?
Question 9:	What is the state of preservation of specimens yielded from the site?
Question 10:	Do the fossils yielded provide an understanding of the conservation status of contemporary taxa and/or communities? i.e. how relevant is the site in documenting the consequences to modern biota of gradual change through time?

continuous succession of Carboniferous coal measures (Fig. 2). The dramatic rock record, significant in its own right, is especially important in providing environmental context to the fossil record, including fossil forests (Fig. 3). This contextual framework is lost in most fossil Lagerstätten (exceptionally well-preserved biotas of whole fossils), wherein the terrestrial record comprises transported accumulations rather than an *in situ* record, as at Joggins. An important aspect of the paleontological record at Joggins emerging from current research is the history of climate change, with periodic dryland conditions that contrast with the better known wetland landscape of the paleoequatorial ‘Coal Age’.

*The history of science.* Lyell’s enthusiasm for Joggins is a matter of historic record (Lyell, 1845, and later letters), not only because it yielded important new discoveries of the history of life on earth, but Joggins was a proving ground for his *Principles of Geology*. Sir Charles Darwin himself

drew upon the discourse of the Joggins section by Lyell (1843 and others) and Dawson (1845, 1855) in developing the case for his theory of evolution in *Origin of Species*. For both Lyell and Darwin, Joggins served as their ‘Coal Age Galapagos’. To these impressive credentials can be added the pioneering role played by fossil discoveries at Joggins in our understanding of the history of life.

## Complementary Arguments

The depth of the case for the inscription of Joggins on the World Heritage list is compelling. Complementing the four major ‘pillars’ described above are the following, which contribute to the justification of Joggins.

*Cultural history:* Joggins has been the site of coal mining since the early Seventeenth Century, when its coal was used to fuel the fires of the first French settlement at Port Royal, a history spanning four centuries. Vestiges of a thriving export

**Table 2.** Recommendations of Wells (1996) for evaluation of fossil sites nominated as prospective World Heritage Sites.

Recommendation 1:	Choose sites that contain well-preserved fossil accumulations of high species diversity which in combination best document the story and environmental change through time;
Recommendation 2:	The ‘events’ to be represented in the history of life should, where possible, encompass the iconography of a tree of life not a ladder of progress;
Recommendation 3:	Choose fossil Lagerstätten and make provision for expanding the list or substituting sites/fossils to better tell any chapter of the story;
Recommendation 4:	Separate Precambrian history from Phanerozoic history (the roots from the upper branches of the evolutionary tree respectively), Present Precambrian history as major events, such as the origin of life, multi cellularity, etc., and Present Phanerozoic history in terms of communities and/or stages in the evolution of major groups;
Recommendation 5:	All published Precambrian fossil sites should be reviewed by an expert panel to select those worthy of evaluation for Heritage listing;
Recommendation 6:	Phanerozoic sites should be chosen so as to be representative in time and space of both community structure and selected phylogenetic lineages;
Recommendation 7:	Any fossil Lagerstätten chosen from the Phanerozoic should wherever possible be of high diversity and include significant invertebrate as well as vertebrate assemblages;
Recommendation 8:	A condition for granting World Heritage status should make provision for curation, study and display of any site/fossils;
Recommendation 9:	Specialists in the major Phanerozoic groups and time periods should be consulted to refine and update the indicative list.

industry to the eastern United States during the Eighteenth and Nineteenth Centuries can still be found at Lower Cove, where millstone and grindstone quarries once operated, and where huge millstones lie exposed at low tide between the resistant sandstone ridges (“reefs”) of the intertidal zone.

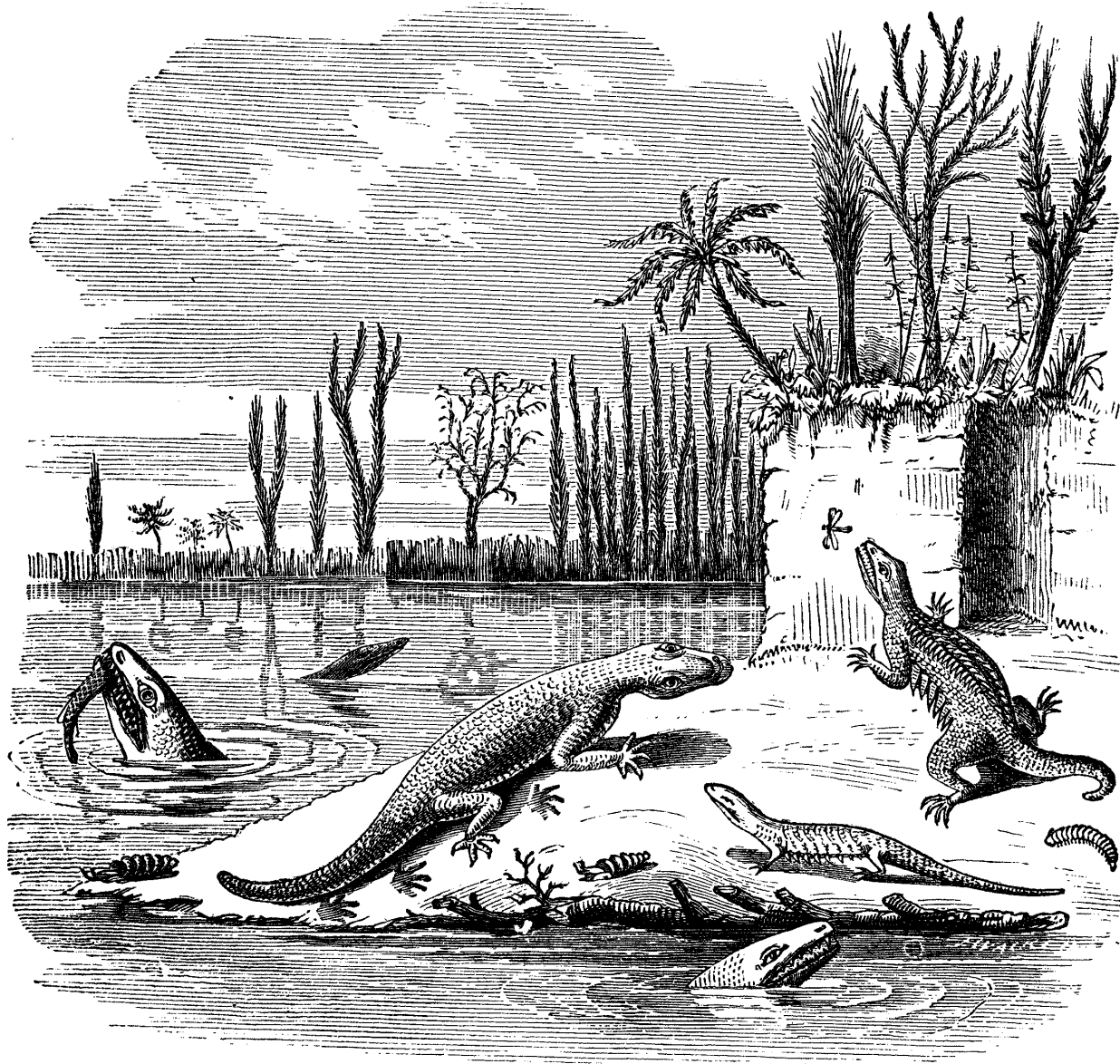
*Significance to ongoing research and education:* Joggins remains the site of innovative geological research and discovery, documented in benchmark journal manuscripts in preparation by international scientific teams. The section is a required stop on field trips by scientific groups, and is regularly visited by local and international universities and schools.

*Historical recognition:* This celebrated section has been an international field trip destination (Fig. 4) since the visits of Sir Charles Lyell in 1842. That same year, Joggins became the subject of the first field project of the Geological Survey of Canada, led by Sir William Logan.

*International interest:* Records of the Joggins Fossil Centre indicate that the cliffs have been sought out in recent years by visitors from at least 44 countries, this even before inscription and significant infrastructure development. The section has been the subject of international research, as witnessed by the scientific bibliography, and its fossil record is featured in the majority of textbooks on vertebrate paleontology and the history of life. Joggins fossils, including type specimens, reside in world museum collections including those of the British Museum of Natural History, Harvard, McGill and Yale.

Although not part of the Carboniferous story, Joggins also exposes a classic multiple till section recording Quaternary glaciations. The till section recently was brought into prominence on the cover of Special Publication No. 185 of the Geological Society of London, *Drift Exploration in Areas of Glaciated Terrain*, photographed by R. R. Stea of NSDNR.

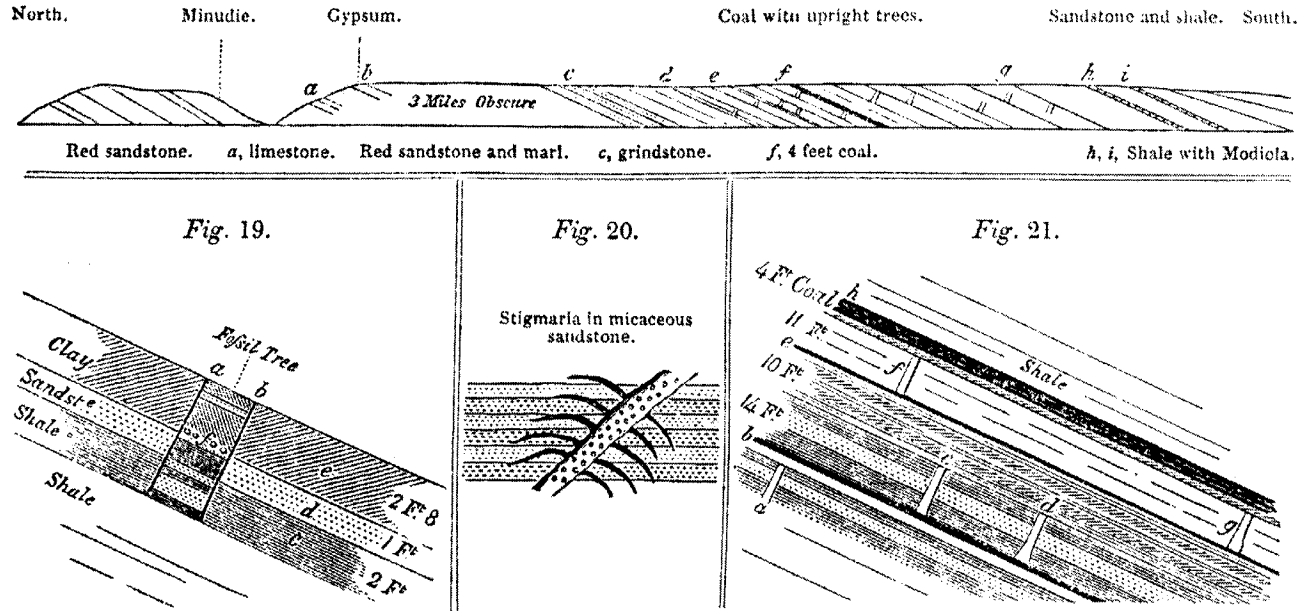
REPTILES OF THE COAL PERIOD.



RESTORATIONS OF BAPHETES, DENDRERPETON, HYLONOMUS, AND HYLERPETON.

**Figure 1.** Dawson's (1863) early reconstruction of life at Joggins, which included the earliest known reptile, *Hylonomus lyelli*.

## Section of the cliffs of the South Joggins, near Minudie, Nova Scotia.



**Figure 2.** The classic stratigraphic succession exposed at Joggins, with details of the standing fossil trees, as figured by Sir Charles Lyell (1845).

## Projects and Their Status

Individual projects fulfill specified requirements of UNESCO. Projects required in the nomination format guidelines include:

- compilation of the floral and faunal record of biodiversity;
- type specimens and collections from Joggins housed in world museums;
- atlas of specimens and features; and
- scientific bibliography.

Chief among required and recommended projects is a comparative study to confirm Joggins's standing amongst contemporary world sites. During the upcoming year (2002), the Scientific Subcommittee will enlist international scientific authorities from outside Canada to co-author the study. Background research of possible competing sites was undertaken during the past year by Heidi MacDonald and the author.

Specific projects are being planned and carried out to strengthen strategic aspects of the case. Many of these take the form of journal manuscripts in preparation by members of the Scientific Subcommittee and others. Section logs for the

entire Joggins Formation, spanning 2 km of section from Lower Cove to MacCarrens Creek, have been compiled by Sarah Davies (Leicester University), Martin Gibling (Dalhousie University) and the author. These logs have been recorded graphically in the field at a scale of 1:100 and digitally transcribed by Andrew Henry in the past year under contact to the Cumberland Regional Economic Development Association (CREDA). The section logs represent the first bed-by-bed description since Logan (1845), and will provide an important contextual framework for future research and collection at the site.

## Conclusions

As of December 2001, only seven fossil sites worldwide have been recognized as natural World Heritage Sites. Recently successful cases for the Devonian site at Miguasha, Gaspé, inscribed on the World Heritage list in December 2000, and the Mesozoic section of the Dorset Coast, UK, in December 2001, provide useful points of comparison in developing the case for Joggins. In June 2002, a working visit to Parc de Miguasha is planned by the Steering Committee.



**Figure 3.** An erect fossil lycopsid tree of the Joggins Formation, entombed in growth position.

Ultimately, the case for scientific justification will be presented by Canada to the World Conservation Union (IUCN), the body designated by UNESCO to evaluate natural sites. A timeline for projects is currently being evaluated by the Scientific Subcommittee, but it is hoped that the bulk of the justification dossier will be in hand within two years. Although not explicit in the UNESCO and IUCN guidelines, it is clearly implied that sites that represent certain periods of Earth history are favoured, and time is of the essence if Joggins is to be the first, and possibly only, site considered for the Carboniferous 'Coal Age'.

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**Figure 4.** Delegates to the International Geological Congress of 1913 at lunch on their field trip to the coastal section at Jogjins. The locality of the photograph is in the vicinity of the Fundy Seam (GSC photograph 24289).

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